Hupacasath First Nation Community Energy Plan

Prepared for the Hupacasath First Nation

Report and Analysis by

Aaron Hamilton
Nicholas Heap

In collaboration with:
Tim Weis
Matthew Salkeld

Acknowledgements

The Hupacasath First Nation would like to acknowledge the support of

- Nicholas Heap, Pembina Institute
- Andrew Pape-Salmon, Pembina Institute
- Matthew Salkeld, EnergyWise Technologies
- Tim Weis, Pembina Institute
- Stephen Watson, BC Hydro PowerSmart
- Michael Cooke, SunWind Solar
- Doug McNell & Rick Williamson, *Pride Home Improvements*
- Biren Juttun, INAC
- Grant McCallum, Terasen Gas
- Scott Smith, City of Port Alberni
- Mike Irg, Regional District of Alberni-Clayoquot
- Odette Brassard and Laura Porcher, Community Energy Association
- Frank Stini, Alberni Environmental Coalition
- Koren Bear, Nawt'sa mawt Resources Group

We would also like to acknowledge the financial support of the Aboriginal and Northern Climate Change Program of Indian and Northern Affairs Canada.

1.1.1

Contents

Tables and Figures

1 Introduction

1.1 Background on the Hupacasath First Nation

The Hupacasath First Nation is a member of the Nuu Chah Nulth Tribal Council, whose collective territory extends over most of the western half of Vancouver Island in British Columbia, Canada.

The Hupacasath First Nation, currently numbering approximately 250 members, has occupied the lands surrounding Vancouver Island's Alberni Inlet, Sproat Lake and Great Central Lake since time immemorial.[1] As such, Hupacasath traditional lands encompass the entirety of the City of Port Alberni as well as extensive areas of the Alberni-Clayoquot Regional District. About half of the Hupacasath First Nation's membership lives on two reserves in the immediate vicinity of the city of Port Alberni, while three additional reserves along the Alberni Inlet are not currently occupied on a year-round basis. Ahahswinis Reserve, home to approximately 115 Hupacasath members (and 95% of all on-reserve Hupacasath members), is situated within the city limits of Port Alberni, on the north bank of the Somass River. Klehkoot Reserve, presently home to six Hupacasath members, is located 4 km northwest of town along the Sproat River, just off of Hwy #4.

Both Ahahswinis and Klehkoot are connected to the BC main electrical grid and receive electricity at the provincial rate of 5.77 ¢/kWh (plus GST).

It should be noted that this report is focused solely on on-reserve residents, and does not consider the energy use of off-reserve residents. For the purposes of this report "on-reserve residents" are defined as the population currently living on the Ahahswinis or Klehkoot reserves, as well as the growing population which the HFN Development Plan projects will be resident on these (or other) reserves in the future. This is significant because significant numbers of off-reserve HFN members are expected to move onto HFN reserve lands within the next 20 years. As a result, the projection of total HFN energy consumption, shown in chapter five trends sharply upward.

1.2 Community Energy Planning Project Background

The HFN CEP is the result of Chief Judith Sayers playing an important role in defeating a natural gas fuelled power generation project that was slated for the Port Alberni area.

[1] More specifically, the Hupacasath First Nation's traditional territory encompasses the headwaters of the Ash and Elsie River systems in the northwest, east to the height of land on the Beaufort Range and then southeast to Mount Arrowsmith to Labour Day Lake and the Cameron River system. The southeast boundary includes the China Creek, Franklin River, Corrigan Creek Areas and the north part of the Coleman Creek Area. Within this traditional territory are the inhabited reserves of Ahahswinis (I.R. No.1) and Klehkoot (I.R. No.2), which are located along the Somass River and Sproat River respectively. There are three other reserves: Cous (I.R. No.3), Chuchakacook (I.R. No.4) along the Alberni Inlet, and Nettle Island (I.R. No. 5) near Barclay Sound.

Chief Judith Sayers wanted to do more than oppose the energy strategy and decided to develop and implement positive alternatives to conventional energy production and consumption.

In 2002 the Pembina Institute was approached by the Hupacasath First Nation to undertake an analysis of sustainable energy options within the Hupacasath traditional territory.

This project looked at the potential of wind and small hydro, and the findings of this report led to the development of the 5.2 MW China Creek hydroelectricity project. A long-term contract for sale of this power to BC Hydro has been negotiated and financing negotiations are well advanced at the time of writing. More information on the China Creek project is presented in Chapter 4 below.

With the completion of the first report investigating renewable energy options, the Hupacasath First Nation broadened its objectives. Rather than simply promote a better approach to generating electricity, the Hupacasath now sought to provide leadership in the use of energy as a whole.

The Hupacasath First Nation decided to proceed with a Community Energy Plan (CEP), with the following specific objectives:

Table 1: Objectives of the Hupacasath Community Energy Plan Process

1. *Consult with community members on their specific objectives related to energy supply and potential energy supply options;*
2. *Build community awareness with regards to energy issues and environmental impacts of energy supplies through various educational activities, including school programs, community newsletters, community forums;*
3. *Build expertise within the community, which can be exported to other communities with similar projects*
4. *Estimate the current community energy demand and forecast future energy demands;*
5. *Assess the environmental, social, and economic feasibility of electricity supply options for meeting the community's energy needs;*
6. *Develop a Community Energy Plan that would serve as a blueprint for developing a long-term energy supply strategy for the Hupacasath First Nation as well as a model to other communities*

The Hupacasath First Nation hired HFN member Aaron Hamilton as Community Energy Planning Manager and approached the Pembina Institute to provide expert advice and support in his work on the CEP.

The project support team included:

Nicholas Heap – Director, Community Eco-Solutions Group, Pembina Institute
Tim Weis – Research Analyst, Pembina Institute
Matthew Salkeld – EnergyWise Technologies

Funding for this project came from Indian and Northern Affairs Canada and Natural Resources Canada through the Aboriginal and Northern Climate Change Program.

This document reports out what has been achieved with respect to all of these objectives, and focuses on the last objective – setting out a Community Energy Plan - in particular.

1.3 Outline of the Paper

This report provides an overview of energy options to meet the anticipated energy needs of the community in a manner that accommodates the economic, environmental, and social objectives of the community as they relate to energy. This chapter has provided a general introduction to the Hupacasath First nation, the background and the structure of this report.

Chapter 2 sets out the community objectives for the Hupacasath Community Energy Plan, and on education work and skills transfer undertaken as part of the CEP process.

Chapter 3 presents data on HFN on-reserve energy consumption, energy costs, greenhouse gas, and air contaminant emissions.

Chapter 4 reports out on work done to date by the HFN to develop renewable energy as the increased supply component of the community energy plan

Chapter 5 presents a set of energy demand reduction measures as the reduced demand component of the community energy plan

2 Scope and Overview of the Hupacasath First Nation Community Energy Plan

2.1 Introduction

Community energy planning (CEP) considers both energy supply and demand, and looks at measures to improve energy use from the scale of a single building to the community as a whole, with the goal of creating a more environmentally, socially, and economically sustainable community. A well-designed CEP process will involve the community, encourage members to maximize energy and transportation efficiency, shift transportation modes to less energy-intensive ones, and utilize low-impact renewable energy resources, especially local resources where these are available.

During the early stages of developing the CEP initiative, Hupacasath Chief and Council set out the following series of objectives for the project, which were reviewed and confirmed by the Advisory Committee at their initial meeting in May 2003. They were:

- To create greater awareness of energy efficiency and green energy solutions to climate change
- To meet majority or all of the reserves energy needs
- To be a model for the Hupacasath community, as well as the city of Port Alberni, and other communities
- To leverage financing for the China Creek small hydro project
- To achieve a moderate GHG emissions target of "1-tonne challenge"
- To build expertise within the community, which can be exported to other communities

2.2 Overview of Planning Process

A community energy plan (CEP) typically starts with a baseline assessment of the community's energy situation, which shows how energy is supplied to a community, how it is consumed, and how much these activities cost in a financial and environmental aspect. The baseline information is used as a starting point to look at what other energy options might be available to the community, how much they would cost to implement, how much they could save residents in the long run, how much they could reduce environmental impacts, and how they might influence the community and/or the surrounding environment. The results of this study are presented in greater detail in Chapter 3.

Conventional community energy plans identify and evaluate local renewable energy opportunities. In the case of the HFN CEP, an in-depth assessment of renewable energy options has already been performed prior to the start of this CEP initiative. An overview of work done, and the current status of the China Cheek green hydro project, which constitutes the renewable energy portion of the HFN CEP, is presented in Chapter 4.

Figure 2.1: Timeline of project components

April:	-	Project start
May:	-	Education/Communication: Project kick off meeting Newsletter #1
	-	Design of survey and selection of EnerGuide audit homes
June – July:		
	-	EnerGuide Audits
	-	Home surveys
	-	Newsletter #2
September – October:		
	-	Review of EE options
	-	Completion of HFN baseline report
November:		
	-	Forum: presentation of EE options
	-	Education - Newsletter #3
December:		
	-	Writing of final report

A typical CEP also includes the assessment of Energy Efficiency options. Given the work previously done on renewable energy options, the project team decided to focus its energies on the identification and assessment of simple and practical energy efficiency measures, and the identification of promising longer-term measures for increased energy efficiency through community design and development. The results of this work are presented in the chapter on Energy Efficiency measures in Chapter 4.

The team then assembled several packages of potential options for a community energy plan, which was presented to the community at a half-day energy forum event at the House of Gathering. Community feedback from this event informed the overall shape of the final draft of the plan, and the specific measures are presented in Chapter 5.

As noted in the objectives of the HFN Chief and Council, consultation, education and skills development were addressed throughout the CEP process. Work done and results achieved in these areas is detailed in the following sections of this chapter.

2.3 Consultation

HFN CEP Objective 1: Consult with community members on their specific objectives related to energy supply and on potential energy supply options

A fundamental component of a community energy planning process is consultation. Through consultation, a diversity of perspectives on energy planning options may be considered and incorporated into the design and development of a community energy system. The consultation process involves a collaborative approach to developing community energy solutions. It also ensures that all information is shared, areas of concern are addressed, the community's needs and priorities are met, and energy supply options have the full support of community members.

In addition to the major elements highlighted below, the community consultation process also included the following activities in which the Community Energy Planning Manager, Aaron Hamilton, undertook from May 2003 to November 2003.

- Presentation at a band meeting to relay information that contained: what was going to be happening, when it was going to happen, who was involved, and how long it would take to be completed.
- Informal discussions during house visits in May 2003, in which these visits occurred during the EnerGuide audits
- Informal discussions with other households in June/July 2003 to obtain completed surveys and any other information pertaining to energy planning as well as any traditional ecological knowledge that community members may have possessed.
- Circulation of four newsletters illustrating what has taken place within the Hupacasath First Nation with the focus on Community Energy Planning.
- Informal meeting with Chief and Council August 2003 to encourage Energy Efficient windows and doors for a new community development.

2.3.1 Advisory Committee:

An Advisory Committee was established which included representatives from the HFN, technical advisors and non-native representatives from the surrounding community:

- Hupacasath First Nation Chief and Council (Chief Councilor Judith Sayers)
- HFN Executive Director (Trevor Jones)
- Indian and Northern Affairs Canada (Biren Juttun)
- Community Energy Association (Odette Brassard & Laura Porcher)
- City of Port Alberni (Scott Smith)
- Regional District of Alberni-Clayoquot (Mike Irg)
- Terasen Gas (Grant McCallum)
- Alberni Environmental Coalition (Frank Stini)

This committee met three times during the course of the CEP process in which they were briefed on what the whole process was all about at the inaugural meeting and then were consulted with, in order to gather their relative knowledge and suggestions as it pertained to the HFN CEP. The Advisory Committee will continue to be consulted with in regard to any implementation of any of the energy options listed later in this report.

2.3.2 Community Objectives Survey

One important product of the consultation process was obtained through the household surveys (See Appendix A). Among other questions, the survey asked community members to rank in order of importance five objectives listed below, which are presented in their order of preference by the community. These objectives elaborated on the goals that were stated by Chief and Council.

1. *Minimizing Environmental Impacts*

The energy option should minimize environmental impacts such as: emissions of greenhouse gases, which have an impact on global climate, emissions that impact on local air quality, and impacts on land-use and watersheds. Efforts that would enhance the efficiency of energy use should be given priority to minimize environmental impacts.

2. *Maximizing Renewable Energy Options and Achieving Self-reliance*
   An effort should be made to maximize the use of local renewable energy resources that are not depleted upon use. This will help to ensure and maximize the community's energy self-reliance to its fullest potential.

3. *Minimize the Cost of Energy*
   The full cost of electricity production for each energy system option should be expressed in dollars per kilowatt-hour and compared, with priority given to lower-cost options. "Present Value" and "Payback Period" will be used to indicate the financial benefits each option would attain.

4. *Maximizing Local Ownership and Management of Energy Options*
   Efforts will be made to maximize local ownership and management opportunities when the supported energy option is selected and the financial aspects for the construction and operation of the option are being pursued.

5. *Maximizing Local Employment Creation*
   Efforts should be made to maximize local employment and capacity building opportunities.

6. *Maximize Usage of Local Resources*
   An effort will be made to ensure that any materials, equipment, infrastructure, human resources, and any other resources that may be needed will be provided if possible by the Hupacasath First Nation or within the Alberni Valley.

The results above are remarkably “green”. In many communities, the most popular objectives for members of the local community are reducing energy costs and increasing local jobs. The fact that environment and community development objectives top the list appears to reflect the Hupacasath First Nation’s opposition on environmental grounds to an earlier proposed power generation facility in Port Alberni. The proposed power generation facility for Port Alberni would have burned polluting, non-renewable and non-local natural gas. Active opposition by the First Nation, led by Chief Judith Sayers was instrumental in defeating this proposal. In sum, community members appear to believe that it is both desirable and achievable to adopt an environmentally friendly approach to generating and using energy, using local resources and enabling the local community.

These results helped guide the Project Team in developing the project and evaluating possible measures for the Hupacasath First Nation Community Energy Plan.

2.3.3 HFN Energy Forum, November 8, 2003

This community forum took place November 8, 2003, involving about a third of the on-reserve population to discuss which options to pursue within our CEP, and to also present all of the work that had been done up to then.

At this forum the HFN Baseline Report as well as the HFN Energy Efficiency Options were presented to the general population for review and discussion. The end result of this forum was the community's clear support for the "let's do it all" approach of Package C. This is very important as it is a justification for including the entirety of all Package A, B and C measures listed later on in this report.

2.3.4 Conclusion

Overall a clear community consensus was generally reached on most issues that were raised, and an effort was made to identify community energy planning objectives that address the majority of the views of community members.

2.4 Education Initiatives

HFN CEP Objective 2: Build community awareness with regards to energy issues and environmental impacts of energy supplies through various educational activities, including school programs, community newsletters, community forums;

Throughout this project, the Pembina Institute has played an instrumental role in delivering educational materials to the Hupacasath First Nation. The main purpose of such materials was to raise awareness on energy efficiency and renewable energy issues that affect community members, the local economy, and the environment. Also in addition to raising awareness of renewable energy and energy efficiency, the Pembina Institute highlighted opportunities to implement these approaches by the Hupacasath First Nation.

2.4.1 Community Education Initiatives

Community education programs served as a crucial component of the community consultation process. Its key purpose was to provide knowledge about various energy technologies and issues to the community in order for the community to be able to make informed decisions and have the capacity to choose what alternative would best suit them. The way in which these education activities were relayed to the Hupacasath First Nation will be presented in the following chapter of this report.

The education activities used during the course of the project included:

- Kick-off event
- Home visits
- Bi-monthly newsletters sent to all on-reserve band members, which informed members of the progress that has been made up to date.

- An education workshop conducted by Mike Cooke of SunWind Solar, which conveyed relevant information regarding energy efficiency and renewable energy to HFN youth. This also resulted in the youth participating in a hands-on model of learning, by using solar panels to build cars and make them move using the energy generated by the solar panels.
- On-going mentoring of the HFN Community Energy Planning Manager, which then relayed the majority of the obtained knowledge to the broader community

2.4.1.1 Kick-off event

At this kick-off event the community was informed of the Community Energy Planning process at a community band meeting that was held on May 8th, 2003. The community was brought up to date on the current situation of the process, which included:

- Describing what a community energy plan (CEP) is
- Explaining why the Hupacasath First Nation is doing this project
- What the CEP project will include
- When this work would take place

Also discussed and reviewed were the community's goals of the CEP process and a brief description of the process that was to come.

2.4.1.2 Home visits

The purpose of these house visits was to educate the homeowner (and occupants) on the purpose of the CEP program as well as create a baseline account of energy consumption, GHG emissions, and pollutant emissions. Also, the visits served as a way to gather members' attitudes towards energy and the usage of energy and any observations of climate change that they may have witnessed. Samples of such observations include: "Weather seems to be warmer, this may be due to less snow-shed and warmer water, due to the loss of first growth trees that held great amounts of snow under their canopy, all summer long" and "We should make sure our methods of using resources for heating our home and buildings and use of our vehicles are the ones that do not contribute to global warming, by choosing the best alternatives available."

2.4.1.3 Newsletters

The main goal of the newsletters was to convey all of the information that we have gathered within a certain period of time and present it in a brief and compact form to all members. The newsletter provided information regarding the CEP process and served as tool to highlight key events that had occurred and/or were planned for the future. These newsletters also included descriptions of various renewable energy options in order to better prepare ourselves for when it comes time to choose what options we want to pursue in our territory as well as ways (both free and with $$) in which we can make our homes more energy efficient, which in the long and short run will save your household money, and help better our environment. In total 4 newsletters were constructed and sent to every on-reserve household.

2.4.1.4 Educational Component from Community Forum

At the Community Energy Forum, a renewable energy educator by the name of Michael Cooke of SunWind Solar (www.sunwind.ca); was sponsored by the Pembina Institute to lead the children in attendance in their own electrical power generation. Michael led about a dozen children aged 9 - 17 in building their own power generators. It was presented to the children that this is a solar-driven planet, sunlight playing with gravity, and that water evaporation (taking energy) raises water into the air, which leads to clouds, blown by winds (caused again by the Sun, unevenly heating the atmosphere) to other places, sometimes over land. When rain falls against the hills, and is on its way back to the Ocean in streams, we can capture some of that "solar energy" by having the force of the gravity-pulled water turn a dynamo. With coroplast, wood blocks, screw eyes, wood dowels, pulleys, motor clips and motors, several simple generators were made, with shafts that could be turned by either hand-crank or hub. The hubs held either small water blades for micro-hydro, or larger wind vanes for wind charging. Applied energy transferred through a series of pulleys and another shaft and drive-belt assembly to the shaft of a permanent magnet DC motor caused the motor to spin as a generator, producing electricity. The children now had several ways to produce their own electricity, all of them using renewable energies.

The children's power generators were employed to light LED lamps, sound buzzers, and to turn motors at a distance - in this, case, on small carts that ran along the floor. The point was made that electricity is a medium for the transfer of applied forces, and that we can choose which source of energy we use to turn the dynamo's shaft. We can choose to use steam turbines, driven by fossil fuels or nuclear fission or wood waste or hydrogen, to spin the shaft, or we can choose to use renewable energies directly to spin the shaft. The children were also introduced to another form of electrical power generation, solar cells, through displays and demonstrations. Each was given a small solar car model kit to build and take home.

2.5 Skills Transfer

HFN CEP Objective 3: *Build expertise within the community, which can be exported to other communities with similar projects*

With the continued assistance from the Pembina Institute as well as the whole project team mentioned previously, the Community Energy Planning Manager was able to acquire knowledge and training and practical skills with regards to energy planning, climate change, energy efficiency, and report structure. Through being involved with every aspect of the HFN CEP, the Community Energy Planning Manager was able to achieve the following:

- An overall understanding of climate change and its effects, both locally and globally. This was achieved through educational resources in which the Pembina Institute either provided or recommended. The Community Energy Planning Manager gained additional knowledge on the challenges posed by climate change by attending 4 out of 5 Environmental and Energy Planning Workshops put on by INAC during the latter half of 2003.

- An understanding of what energy efficiency means, how to achieve energy efficiency, what types of energy efficiency options are available, and the advantages of incorporating energy efficiency. The Community Energy Planning Manager accompanied project team member Matthew Salkeld and workers from Pride Home Improvements as they conducted the 13 EnerGuide Audits on selected on-reserve homes, which included a door blower test, and the use of a smoke wand to detect airflow leakages. This provided hands-on awareness of energy-efficiency options (through addressing the homes that already had had some energy efficient measures installed already) and highlighted areas in which homes could improve. The whole project team was also instrumental in the educating of the Community Energy Planning Manager through numerous conversations (telephone, e-mail, face to face) as well as the relaying of pertinent information and numerous contacts and resources to the managers needed.
- Experience in survey design and construction, as well as conducting a survey during house visits. Also analyzing and reporting of the results into a database constructed by Tim Weis for the Pembina Institute, in which the results from these surveys were calibrated, creating a great deal of information used in the Baseline Report. This was achieved through the assistance from the whole project team, especially Matthew Salkeld and Tim Weis of the Pembina Institute.
- Experience in public speaking and information sharing with a wide variety of audiences. The Community Energy Planning Manager attended and presented at a series of Environmental and Energy Planning Workshops referred to above. These workshops were attended by First Nations, local government, and NGO representatives attended from all across British Columbia. The Community Energy Planning Manager presented materials developed by Pembina Institute staff, but with the on-going encouragement of the project team the Manager was the public face of the Hupacasath CEP process from start to finish. This resulted in the Community Energy Planning Manager speaking about the CEP process not only at the fore-mentioned workshops, but also at community band meetings, band council meetings, advisory group meetings and the community energy forum.
- Experience in the review, ranking and packaging of the planning options presented in this report. This resulted in continuous discussions on which actions would be pertinent to the various options, and was attained with the assistance from the Pembina Institute staff and Matthew Salkeld of EnergyWise Technologies.
- An introduction to effective project management methods in which the Community Energy Planning Manager was coached and assisted by members of the project team. Skills involved included meeting deadlines, performing tasks in the most efficient manner, making sure all objectives were satisfied, providing appropriate consultation at all levels, and keeping effective cooperation between all parties involved in the project.

- An introduction to the structuring and writing up of project reports. With advice and guidance from Pembina Institute staff, the Community Energy Planning Manager designed and drafted a complete and comprehensive report on the CEP process in which all of the previous skills mentioned were utilized in order to complete this document.

3 Community Energy Demand

3.1 Introduction

An Energy Demand Assessment (EDA) is necessary to determine the community's current levels energy consumption and to forecast for future energy needs. The first step in the analysis of the current, or "baseline" energy demand is to determine the present community annual consumption as well as the distribution of energy in terms of residential and non-residential loads. It is also important to determine current cooking, space and water heating methods. By understanding the distribution of current energy consumption it is then possible to predict for the community's possible future energy requirements.

This chapter contains the steps taken to complete the Energy Demand Assessment and the results of that assessment.

A comprehensive assessment of the current community demand for energy was performed in order to understand the distribution of and the costs associated with energy consumption in the community. The energy demand assessment includes the use of electricity, as well as the energy consumed for cooking, water and space heating as well as fuel consumed for transportation in the community. The Hupacasath community currently uses natural gas, propane, wood, and fuel oil as sources of energy for electricity, cooking and heating, and gasoline for motorized transportation. The energy demand assessment includes estimates of current energy demand as well as the anticipated future demands for the next 20 years.

The energy demand assessment includes all of the residential dwellings on reserve (45 houses in 2003), as well as 3 non-residential buildings, which are the administration office, old community hall, and the old administrative trailer. Also included in this report is the street lighting for both housed reserves, as well as a water pump house.

In-migration as well as natural population growth within the community will lead to an estimated total on-reserve population of 277 people in the year 2023. The energy demand assessment takes this into account and encompasses a future demand of 12 new houses in each of the five-year intervals (i.e. 63, 74, 84, and 92 houses in 2008, 2013, 2018, and 2023 respectively). This housing development assumption was derived from the population growth expectations that were provided by the "Hupacasath First Nation Comprehensive Development Plan" which was completed in February of 2003 by David Nairne & Associates Ltd. There are also plans within the next 1-2 years to build a safe house, as well as some rent-to own, elders, and social housing units. These were accounted for by forecasting an additional 5 houses by 2008. Finally, the Hupacasath First Nation expects to be a 10% owner in the proposed Eagle Rock Quarry. Ten percent (5,500 MWh of the 5,500 annual GWh) of the overall electrical consumption of the quarry is thus added to the community's electrical consumption in the next five years.

The current energy resources used to meet the energy demands of the Hupacasath First Nation include the following:

- motorized transportation: gasoline
- space heating: electricity, propane, natural gas, fuel oil, wood
- water heating: electricity, natural gas, wood, propane
- cooking: electricity
- clothes washing and drying: electricity
- refrigeration: electricity
- freezing: electricity
- lighting: electricity
- other, such as televisions, computers, and small appliances: electricity

For the purposes of the study, energy use is categorized into:

1. electricity consumption for electrical appliances and lighting
2. space heating for buildings
3. water heating for buildings
4. food cooking within buildings

Three scenarios of potential energy demand outcomes were considered for the community's demand assessment over the next 20 years:

More details about the different scenarios can be found in Section 2.5.

3.2 Methodology

The Pembina Institute developed an estimate of household electrical demand by comparing the results of two independent data collection techniques: household surveys (Method A) and end-use records/bills from BC Hydro and Terasen (Method B). EnerGuide Audits were also performed on 20 homes in the community to get an estimate of the overall state of energy efficiency in the community. Method B provides a good estimate of the community loads as a whole, while Method A allows for a more detailed analysis of the sources of energy consumption. Method A helps to highlight areas where energy efficiency can be focused. The survey method and analysis tool has been developed by the Pembina Institute and can be implemented by both on and off-grid communities. The survey that was used for the Hupacasath study was carried out in the community by Aaron Hamilton, the Community Energy Planning Manager for the Hupacasath First Nation, and can be found in Appendix I.

3.2.1 Data Collection Method A - Survey Method

Community members were asked to fill out a survey that recorded the number of and types of appliances present in the home, as well as how often they are in use. Of the 45 surveys that were sent out, 21 (47%) households completed and returned the survey. The remainder of the community energy demands were extrapolated from the data that was collected from the completed surveys. Average values were used for appliance loads, and annual demand was based on the number of hours listed for each appliance for each home. Table 1 lists the different energy sources used in the community's homes.

Table 3.4: Distribution of homes using energy sources - Extrapolated from surveys

	Space Heating	Cooking	Water
Natural Gas	5.0	2.0	5.0
Electricity	27.0	43.0	38.0
Fuel Oil	9.0	0.0	0.0
Wood	4.0	0.0	2.0
Propane	0.0	0.0	0.0
Elec. Heated Water Radiators	0.0	0.0	0.0
Total	45.0	45.0	45.0

Surveys were not applied to the non-residential sector of the Hupacasath community. Data for the energy consumption of non-residential buildings was generated solely through the utility and fuel purchase records. Therefore, no estimates were made for energy breakdown for cooking, space, or water heating in the non-residential buildings.

3.2.2 Data Collection Method B - Fuel Purchases and Production Records

Purchase records were collected from BC Hydro and Terasen Gas, the community's electricity and Natural Gas suppliers. These records were comprised of the last two years of consumption data for each specific household. These records were used to determine the annual amount of energy used by the community.

3.3 Energy Demand Assumptions

In order to convert the data collected in the community surveys to annual energy demands and energy costs, certain assumptions were necessary. Energy demand for hot water, cooking, and space heating was calculated using standardized factors from Energy Mines and Resources Canada[2]. This allowed for an assessment of total demand for electricity, fuel oil, natural gas, propane, and wood.

3.3.1 Electricity

End-use electricity demands were estimated through standardized consumption levels for different appliances, light bulbs, etc. provided by Energy Mines and Resources Canada and BC Hydro[3]. The cost of on-grid electricity is approximately 6.2 ¢/kWh (5.77 ¢/kWh + GST), which was used for the baseline study.

3.3.2 Space Heating

Annual heating demand were predicted using the average "degree-days" of heating demand for Alberni as listed by Energy Mines and Resources Canada, and multiplied by

[2] Canadian Centre for Mineral and Energy Technology (CANMET). 1989. *Canadian Small Hydropower Handbook: British Columbia Region*. Prepared by Sigma Engineering Ltd.
[3] BC Hydro Power Smart - Appliance calculator: ewa.bchydro.bc.ca/hep/appcalc/calc0619/pg1.asp?ID=1

the floor area of each building. This reflects the amount of energy required to heat each building. For electric heating, this number can be used directly, while for fossil fuel heating (natural gas, fuel oil, propane and wood) a higher overall energy input is required given that energy is lost in exhaust. That is the input chemical energy in furnaces and wood stoves must be more than the input electrical energy required by electric baseboard eaters. Conversion efficiencies of 85%, 60%, 50%, and 50% were assumed for natural gas, propane, fuel oil, and wood heating respectively.

It was assumed that the average home size is about 128 square meters (1385 square feet), and is built to "1975" building standards. This standard assumes R20 insulation in the roof, R12 in above grade walls and single-glazed windows. According to Energy Mines and Resources Canada, on the basis of floor space, a building built to this standard requires a residential heating demand of 76.8 kWh/m^2 and a residential heating peak load of 0.082kW/m^2.

3.3.3 Water Heating

Hot water electricity consumption was assumed to reflect the number of occupants in each building and the average British Columbia consumption of 4,200 kWh per year for a three-person household. Natural Gas energy demands were assumed to be 1.2 times the electrical demand and wood heating was assumed to be 2 times the electrical demand, again due to chemical energy lost in the exhaust.

3.3.4 Cooking Energy

Cooking electricity consumption was based on the daily usage of a 12 kW electrical range.

3.4 Baseline Energy Demand Assessment

3.4.1 Annual Energy Consumption

The results from the two different methods of data collection are compared in the table below.

Table 3.5: Data Collection Method Comparison

	Electricity Demand	Heating Demand				Transportation Demand	
	Total Electricity Generated (kWh)	Total Fuel Oil Consumed (L)	Total Natural Gas Consumed (m3)	Total Wood Consumed (cords)	Total Propane Consumed (L)	Total Gasoline Consumed (L)	Total Two-Stroke Gas/Oil Consumed (L)
Method A	1,023,847	16,086	11,400	20	2,032	87,019	3,161
Method B	948,724	0	10,656	0	2,664	0	0
Average	986,286	16,086	11,028	20	2,348	87,019	3,161

The estimated electricity demand is expressed in terms of kilowatt-hours (kWh). Table 2 shows very close predictions for annual electricity consumption using the two methods of data collection that were available; they are both within 8% of each other. Method B can be assumed to be a more accurate reading as it consists of all of the electric records for the community directly from BC Hydro, although some extrapolation was necessary for these as well. Given that these two methods yield similar total results, it is likely that the electricity usage breakdown that is based on the surveys in Method A are a good representation of the community's electrical consumption patterns. The same can be said for both the natural gas and propane consumption as both methods are in good agreement.

No purchase records were available for fuel oil, wood or gasoline consumption in the community. Given that both methods show reasonable similar results for categories where both data sets were available, Method A was chosen for comparative analysis to be consistent for all energy sources, despite Method B being slightly more accurate.

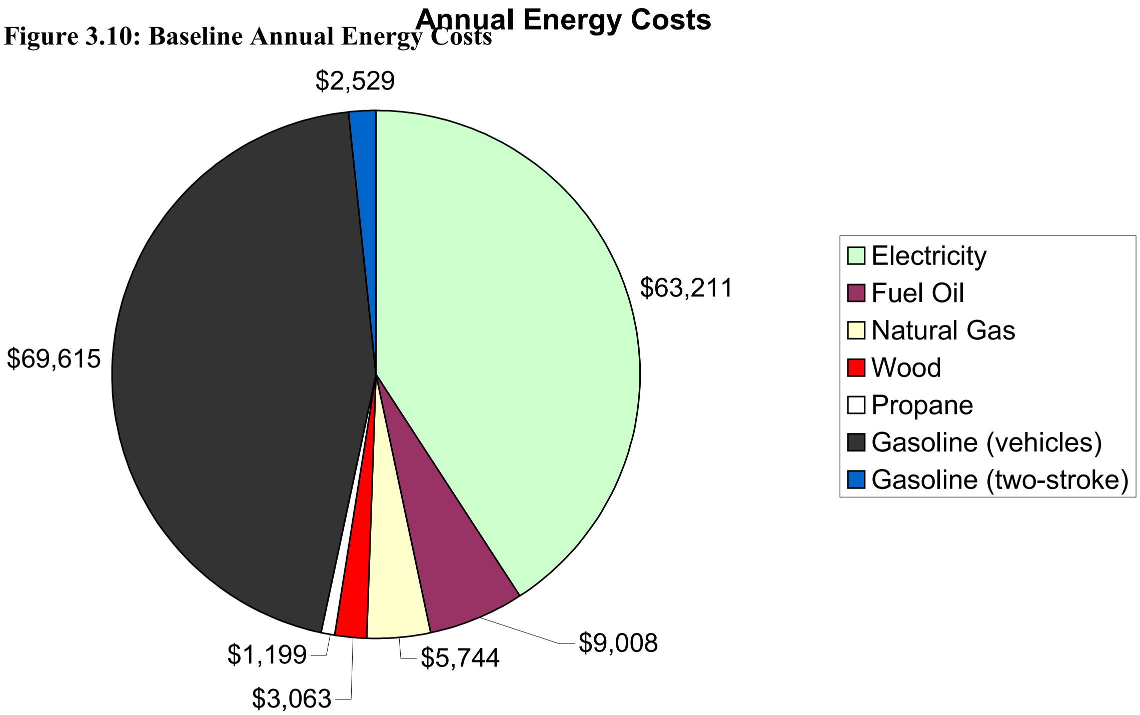
Table 3 shows the values used as a baseline by the Pembina Institute for future energy planning, and which methods were selected for each estimate. Based on these results, Figure 1 compares the annual costs accrued for each of the different energy sources.

Table 3.6: Baseline Energy Consumption

	Electricity Demand	Heating Demand			
	Total Electricity (kWh)	Total Fuel Oil Consumed (L)	Total Natural Gas Consumed (m3)	Total Wood Consumed (cords)	Total Propane Consumed (L)
Baseline Consumption	1,023,847	16,086	11,400	20	2,032
Energy Consumed (kWh)	1,023,847	176,947	122,213	92,643	12,800
Annual Cost ($)	$63,211	$9,008	$5,744	$3,063	$1,199

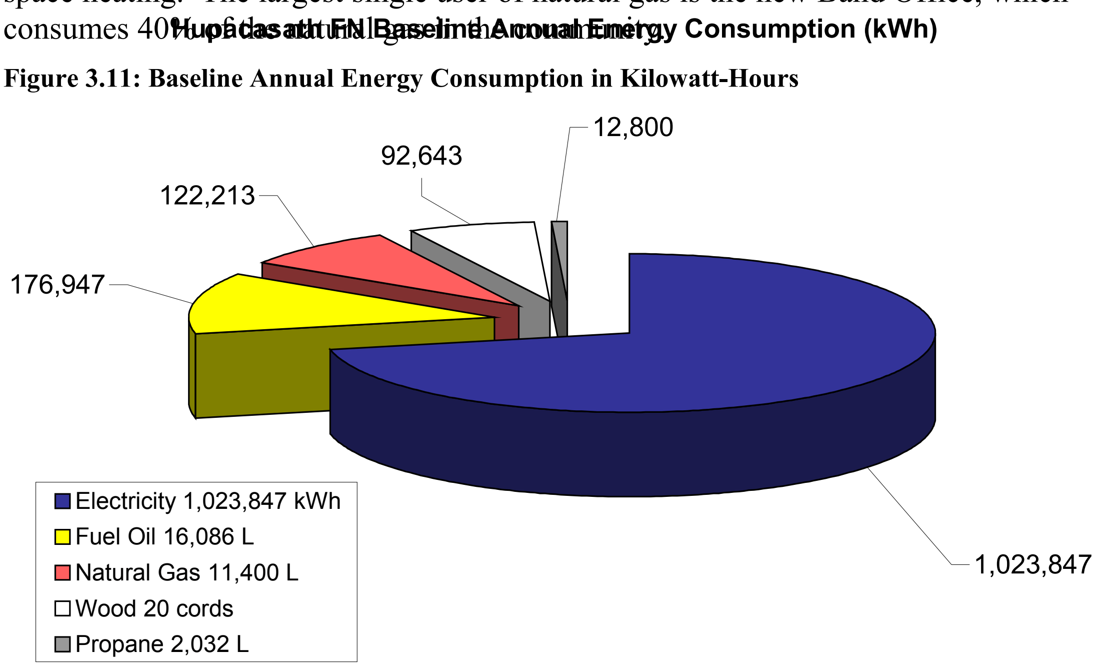
	Transportation Demand	
	Total Gasoline Consumed (L)	Total Two-Stroke Gas/Oil Consumed (L)
Baseline	87,019	3,161
km OR hphr	1,110,510	7,902
Annual Cost	$69,615	$2,529

Figure 3.10: Baseline Annual Energy Costs



In terms of building energy usage, Figure 2 shows that electricity is the dominant energy source within the community. Much of this has to do with the fact that most community members use electric cooking and water heating and a smaller majority also electric space heating. The largest single user of natural gas is the new Band Office, which consumes 40% of the natural gas in the community.

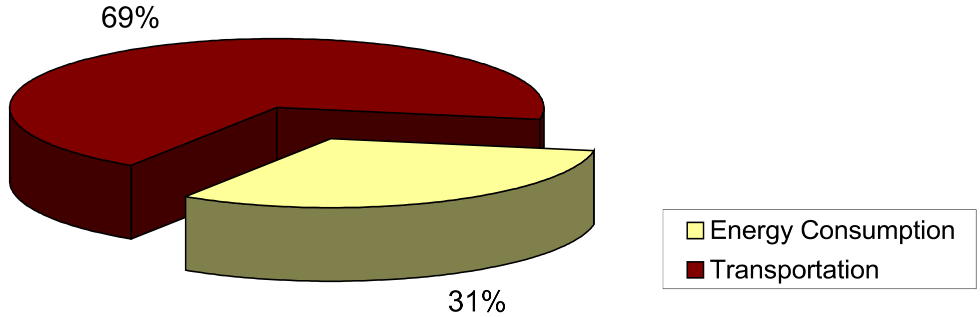
Figure 3.11: Baseline Annual Energy Consumption in Kilowatt-Hours



Using emission conversion factors, the total annual community emissions can be calculated based on the annual consumption values. It can be seen in figure 3 that the majority of the greenhouse gas emissions from the community result from motorized vehicles driven by community members.

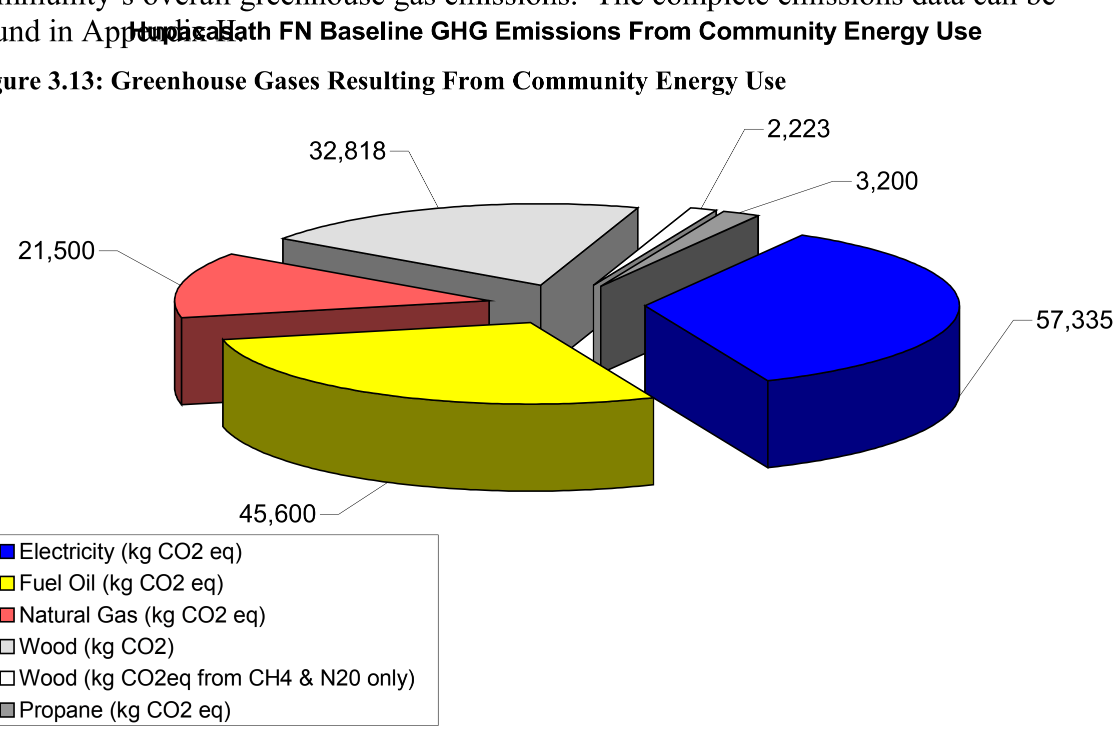
Sources of Greenhouse Gases

Figure 3.12: Community Sources of Greenhouse Gases



Over 90 percent of the electricity on the BC grid generated by BC Hydro is hydroelectricity, with the remaining 10 percent coming from natural gas and biomass. Although it is relatively small when compared to other provinces, there are still greenhouse gases associated with consuming electricity in British Columbia. Given that electricity is the dominant non-transportation energy source in the community, it is not surprising that it also contributes the most to community greenhouse gas emissions, as shown in figure 4. Because the greenhouse gas intensity of electricity is lower than the other sources of energy in the community, and so while electricity use makes up over 75% of the community's energy usage, it contributes approximately 50% of the community's overall greenhouse gas emissions. The complete emissions data can be found in Appendix H.

Figure 3.13: Greenhouse Gases Resulting From Community Energy Use



The carbon dioxide released from wood use is re-absorbed when new trees are grown in place of those that are cut. Therefore the carbon dioxide released from wood burnt in the community can in fact be removed from the net greenhouse gas emissions emitted by the community as shown in figure 5.

Figure 3.14: Net Greenhouse Gas Emissions Assuming Wood is Sustainably Harvested

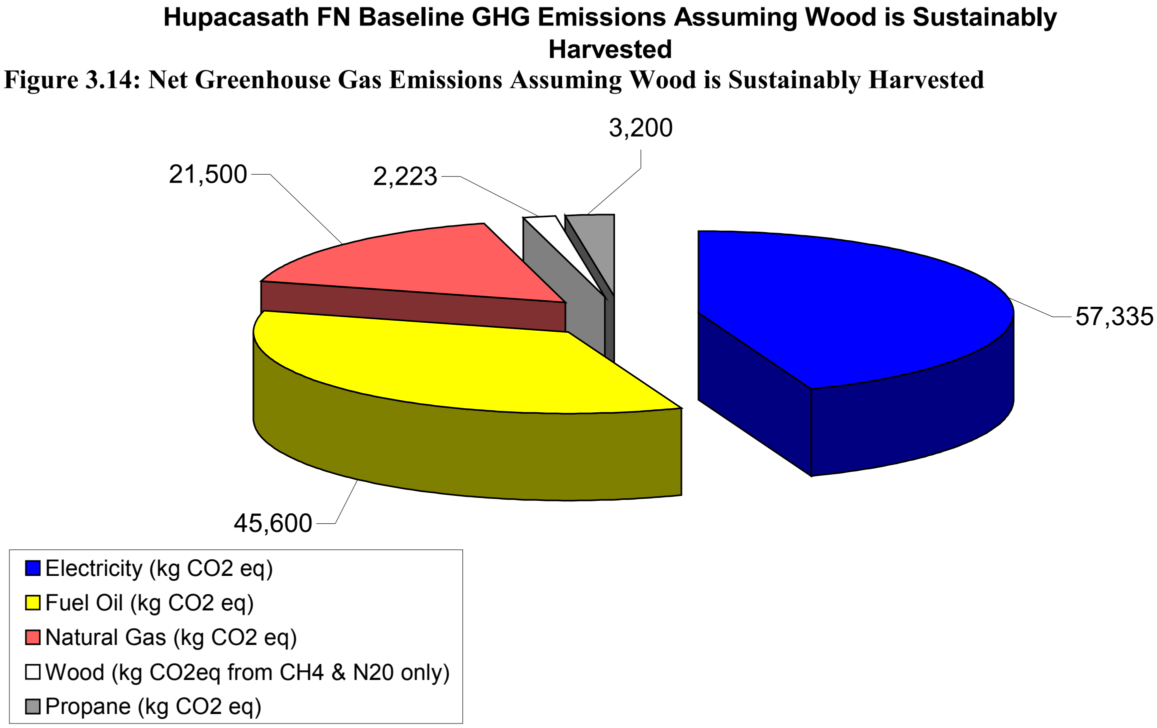
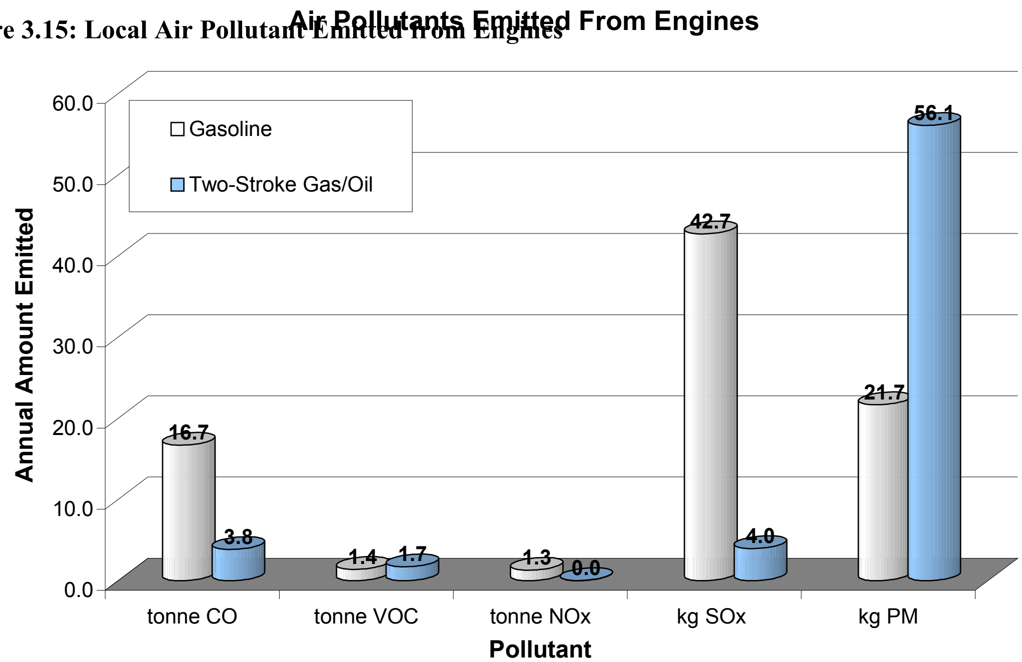


Figure 3.15: Local Air Pollutant Emitted from Engines



Although wood contributes a relatively small amount of greenhouse gases, it is the largest source annual local air emissions from energy in the community, with annual Carbon Monoxide (CO) and Volatile Organic Compounds (VOC) emissions of 1.0 and 0.27 tons per year. As shown, in figure 6 the local air contaminants associated with lawnmowers and vehicles dwarf the contaminants associated with wood use. It is worth noting that two-stroke engines used for lawnmowers contribute to twice the amount of particulate matter (PM) – a known cancer-causing agent – than all of the cars and trucks in the community combined.

3.4.2 Community Energy Consumption Breakdown

Electricity demand estimates for the residential sector were derived from the data that was collected from the community surveys. The estimates of energy used per household are as follows:

1. General electricity use: 8,559 kWh.
2. Cooking: 800 kWh.
3. Heating: 9,830 kWh.
4. Hot water heating: 4,000 kWh.
5. Total electricity demand per house with all electric amenities: 19,997 kWh, or $1,239 / year.

The average space heating demand for mainland British Columbians is equivalent to 17,500 kWh[4] of space heat compared to the 9,830 kWh within the Hupacasath community. However, average British Columbian homes are significantly larger[5] than those within the Hupacasath community (190 m^2 compared with 122 m^2).

Figure 3.16: Major Residential Energy Consuming Appliances

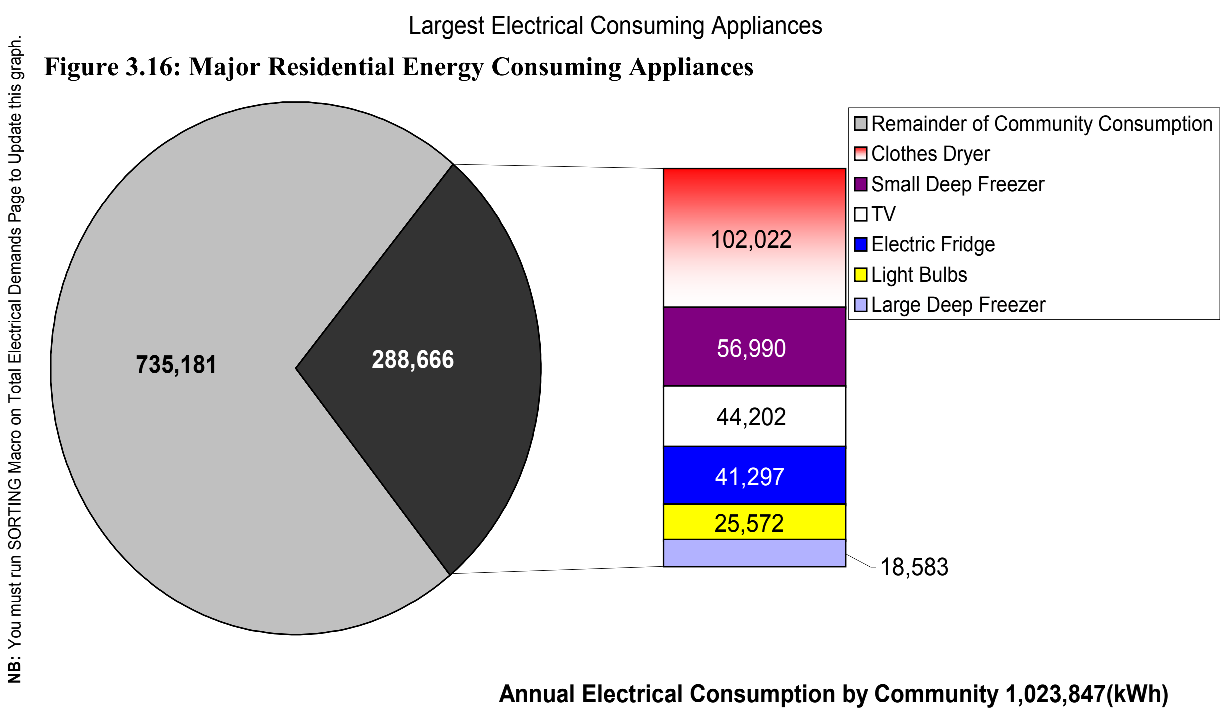


Figure 7 shows the residential appliances that consume the most amount of energy annually in the Hupacasath community. It can be seen that clothes dryers and small deep freezers account for over 15% of the community's total electrical consumption. Other major electrical energy consuming appliances include televisions and electric fridges.

[4] BC Hydro, Fuel Cost Comparisons, http://www.bchydro.com/policies/rates/rates767.html
[5] Canadian Home Builders Association, http://www.home-n-house-plans.com/8863-home-builders.html

The Hupacasath community could immediately reduce the community's electrical consumption by 10% by using a clothesline in the summertime (or a indoor clothes hanger in the cooler months) and turning the television off when there is nobody watching it. Reducing the clothes dryer and the television usage by 50% would save the average community member $100 per year.

3.5 Future Scenarios

The Hupacasath community is expecting to grow significantly in the upcoming years. Three scenarios of potential energy demand outcomes were considered for the community in the next 20 years. In each case, it was assumed based on the community development plan that 17 new houses would be built in the community within the next five years, and 12 new homes every five years for the following 15 years. Also, it was assumed that 1 new non-residential building would be built every 5 years in the community. The three scenarios are listed below.

1. The first scenario assumes that all new buildings erected in the Hupacasath community in the future will have the same energy source distribution as they have currently. That is to say that 27 of the 45 homes on reserve, or 60%, currently use electric heating, therefore of the 17 new homes built in the next five years, 10 of them will use electric heating. Similarly, existing energy distributions for cooking, space and water heating are projected for new buildings in this “business-as-usual” scenario. No one in the community will retrofit their home to a new energy source, or energy efficiency upgrades.
2. The second scenario assumes that the First Nation will build their own source of electricity and will want to increasingly use their own resources so that 100% of new houses are built using electricity for cooking, space and water heating, it also assumes that new houses will be built to “DD” building standards[6] It is also assumed that local ownership of an electricity source will attract 5% of existing homes to convert to electricity for cooking, space heating, and water heating every 5 years (2.25 homes every 5 years). Finally, in this scenario, community members will also reduce their electrical consumption immediately by 10%.
3. The third scenario is the same as the second, except it assumes that all new houses are built it “EE” building standards[7]. Furthermore, it assumes that the community members implement energy efficiency methods immediately to reduce their electrical consumption by 10%.

Figure 8 shows the different electrical consumption forecast of these three scenarios for the years from 2003 to 2023. It is worth noting that by upgrading the building insulation levels of new buildings, and reducing current energy consumption by 10%, even if all of

[6] Insulation - R40 ceiling, R20 above grade walls, R12 below grade walls, double glazed windows. For Hupacasath, heating for buildings built to this standard would require 38.4 $kWh/m^2_{floor\ area}$.
[7] Insulation - same as DD. House also complies with energy conservation standard set by the Canadian Electrical Association. Heating for buildings built to this standard would require 25.6 $kWh/m^2_{floor\ area}$ in Hupacasath.

the new homes are built using electricity exclusively, less electricity will be consumed by the community than the ‘business as usual’ case.

The Hupacasath First Nation and the Pembina Institute pursued “EnerGuide Audits" for 13 residential buildings and 2 non-residential buildings within the community. The audits were performed on a cross-section of houses in the community, which took into account the buildings age, fuel type, and the number of occupants, as well as other factors. Pride Home Improvements based out of Ladysmith, B.C, performed these audits. The data that was collected through these audits determined the state at which the houses were in, with regards to the energy efficiency of the homes. The outcome of these audits determined energy performance, energy savings opportunities, and the homes' heat loss. The details and results of these audits will be discussed in the Community Energy Plan report, but it is important to note that they have pointed out many options and opportunities for energy savings in the community.

As a result of the EnerGuide option program identifying opportunities for energy savings within the community, scenario 3 is a realistic option for Hupacasath. The distribution of electrical loads for this scenario can be seen in figure 8, while the details of this scenario can be found in Appendix III.

Figure 3.17: Anticipated Electrical Demand

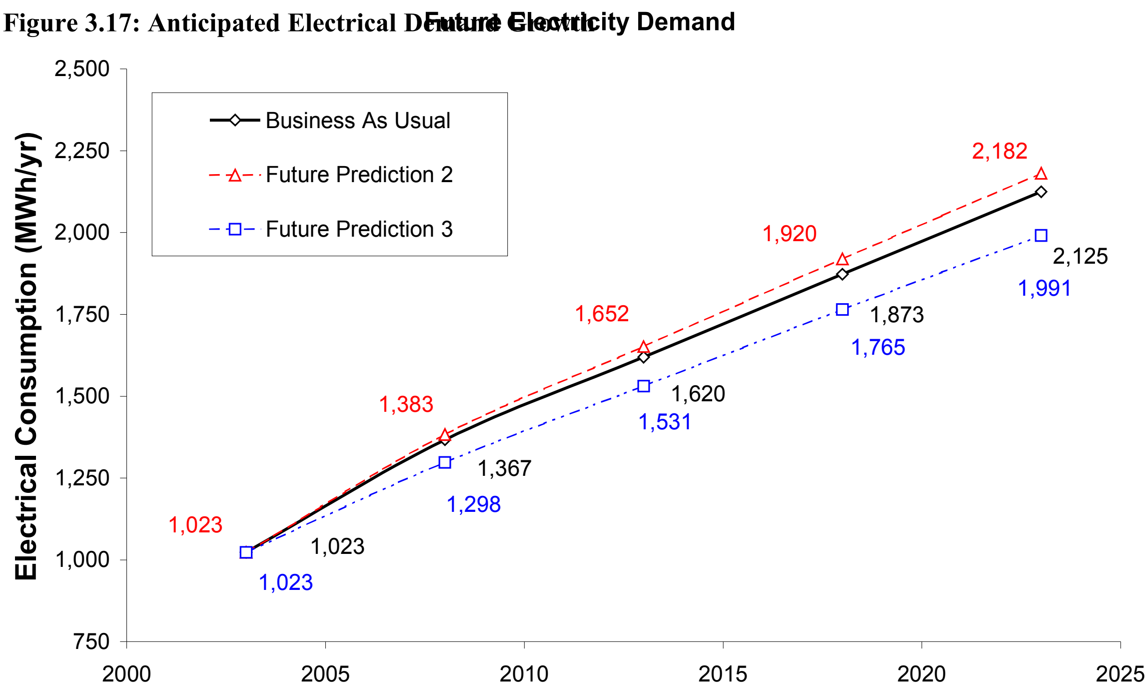
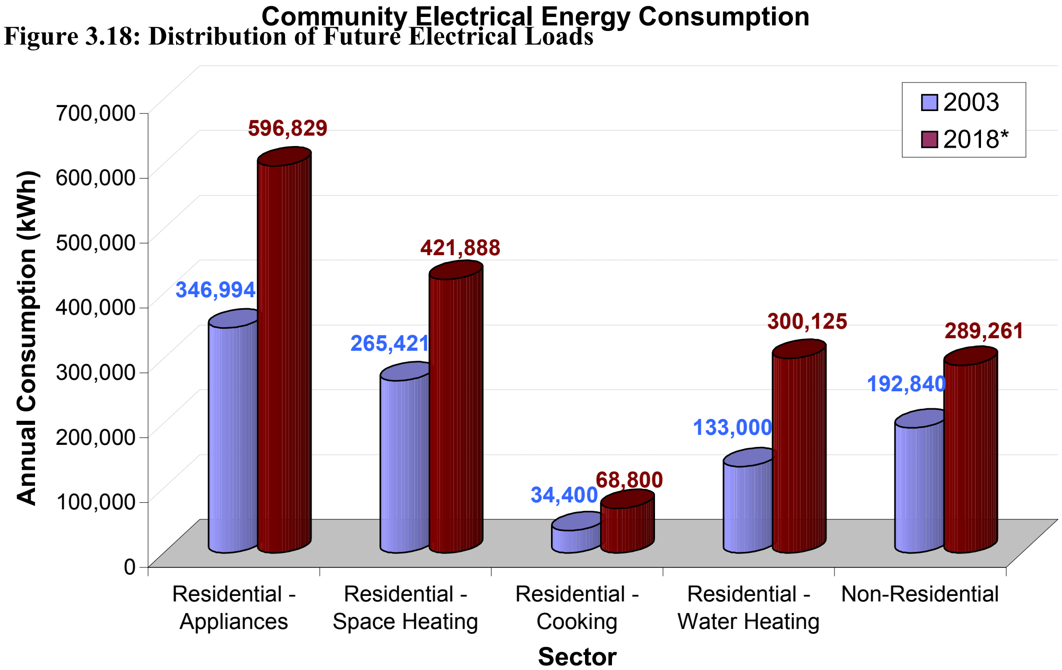


Figure 3.18: Distribution of Future Electrical Loads



*assumes that 100% of new houses are built with electric systems for cooking, space and water and heating, and 5% of existing homes switch over to all electric systems every 5 year.

3.6 Conclusions and Recommendations

3.6.1 Electricity in Hupacasath

Electricity is the largest source of energy used in the Hupacasath community. Electricity is also the largest cost of energy to community members, and the largest source of greenhouse gas emissions, although these emissions are disproportionately smaller other sources of energy in the community compared to the amount of energy used. Securing a stable source of energy will be important for the community of Hupacasath for the future.

4 Energy Supply

4.1 China Creek Micro Hydro Project

The China Creek Micro Hydro Project has came into effect through the Hupacasath First Nation taking major steps in embracing economic development as the stepping-stone in reaching self-reliance and economic self sufficiency. Through defeating a natural gas fuelled power generation project in Port Alberni, the HFN took it upon them to search for sustainable renewable energy within their traditional territory.

4.1.1 Pre-Screening of Watersheds

In the summer and fall of 2001, the HFN, with the assistance of the Pembina Institute, performed a territorial wide assessment of potential watersheds, which could be suitable for small hydro projects.

The fieldwork done for the Hupacasath Renewable Energy project identified several mini-hydroelectricity local options with economic potential. These sites could be economically linked to existing B.C. Hydro transmission infrastructure, could be accessed by an existing road or potential new route, do not pose significant risks on salmon spawning areas, do not impact on culturally significant areas, and had a sufficient vertical drop to generate significant amounts of electricity. It should be noted that one candidate site - Friesen Creek - was removed from consideration during this process because of its cultural importance to the Hupacasath First Nation.

Of the five short listed streams, China Creek, located immediately south of the City of Port Alberni on the east side of the Alberni Inlet, was determined to be the most suitable for a green hydro project. China Creek was distinguished from the other candidate streams by having a long-established dam structure, which is now used by the City of Port Alberni to obtain drinking water. Because activities at the dam included water level monitoring, China Creek was distinguished from other candidate streams by an extensive and accurate data record, allowing a high level of confidence in estimating power generation from a hydro facility on this stream.

4.1.2 Project Description

As originally proposed, China Creek hydroelectricity project was slated to be a 2.2 MW hydroelectric project. However, through a March 2003 preliminary feasibility study conducted by Sigma Engineering concluded that a larger project (approximately 5.6MW) could be built on the creek, by locating an intake further upstream. This now represents the size of the China Creek Small Hydroelectric Project. The intake for the project is located approximately 5 km from the southern limits of the City of Port Alberni and approximately 2 km upstream of the existing City water intake. It is estimated the project will generate 26,300 MWh annually, providing much needed electricity for the Vancouver Island region, which currently needs to import much of its electricity. Because this hydro project will have a very small flooding impact on surrounding lands (the impoundment or water reservoir for the intake will store less than 48 hours worth of stream flow), because fisheries impacts will be minimal, and because hydroelectric technology does not produce air pollutants and greenhouse gases when producing electricity, the China Creek project produces "green power" with minimal environmental impacts.

The following work/applications have been completed on the project to date:

- Feasibility Study - Sigma Engineering
- Water License Application and Application for Crown Land
- Application to BC Hydro for formal approval to develop the project
- Engineering Hydrology and power assessments
- Environmental assessments
- Fisheries Studies satisfying conditions set be Department of Fisheries and Oceans
- Archaeology studies that meet the needs of HFN
- Completion of design, site survey, and geo technical
- Electricity Purchase Agreement signed with BC Hydro

The HFN have also received significant community support for this project which demonstrates the positive impact that this project will have on both the Aboriginal and non-Aboriginal citizens of the area. The following have stated their support of the project:

- The City of Port Alberni
- VanCity Capital
- Weyerhaeuser
- EcoTrust Canada

The Provincial Government, through the new B.C. Energy Plan, has set a voluntary target to acquire 50% of its [additional electricity needs, or all of its electricity needs?] from clean electrical sources based in BC [that are contructed?] over the next ten years. This commitment supports the development of projects like the China Creek project.

4.1.3 Project Timeline of Events

The following is a list of key events that have happened through the timeline of the project:

- Summer-Fall 2001 — Micro-hydro survey and selection of China Creek as the lead candidate.
- December 2002 — Original project (2.2MW) submitted to BC Hydro's request for Qualification (RFQ) and qualified to participate in their 2002/03 Green Power Generation (GPG) Call for Tenders (CFT)
- February 2003 — China Creek Project short-listed from 200 applications to 30.
- June 2003 — 5.6 MW project was submitted to BC Hydro and qualified for the 2002/03 GPG CFT
- August 2003 — Submitted Bid Price and Development Security to BC

Hydro and surveyed proposed penstock route

- September 2003 — Selected by BC Hydro as one of 30 projects approved for their GPG projects
- October 2003 — Electricity Purchase Agreement signed with BC Hydro

5 Energy Demand Reduction Packages

5.1 Introduction

The previous chapter discussed the work that the Hupacasath First Nation has undertaken to increase production of low-impact renewable or "green" energy. A community energy plan also involves energy efficiency measures. Energy efficiency measures will allow the Hupacasath First Nation to get the same benefits of their current energy use while using less energy, and spending less money. As a result, these measures reduce the total demand for energy by the Hupacasath First Nation. By reducing our energy demand, the Hupacasath First Nation save money currently spent on energy, avoid the environmental damage caused by generating electricity from non-'green' technologies, and ensure that our community uses energy in a way that is more closely linked with our values and our goals.

Much of the information presented in this chapter was initially investigated and evaluated by Matthew Salkeld of EnergyWise Technologies. The project team reviewed these findings, and developed three energy options (packages). These options took into consideration the community's objectives that were illustrated through the community survey. The packages range from quick and easy (Package A), to bigger investments and returns (Package B), to finally building a new energy future (Package C). Each package incorporates the previous packages within it. As a result Package B incorporates all measures from Package A as well as all of the new measures in Package B. Similarly, Package C includes all of the measures in both Package A and Package B.

These three energy options were presented to the members of the Hupacasath First Nation at the Energy Forum event on November 8, 2003. As noted above, community members and Chief Judith Sayers supported the adoption of all three packages of options within the HFN Community Energy Plan.

The following materials were considered and referenced in the measures assessment phase:

- Document: Hupacasath First Nation – Community Development Plan
- Document: Hupacasath First Nation – Land Use Plan
- Financial issues, such as cost per unit of energy production, total capital cost, and sources of financing.
- Economic and management issues, such as community economic development and wealth creation, expandability of energy supplies, and level of local ownership.
- Social issues, such as local employment opportunities, degree of local control over the management of energy systems, capacity building, cultural significance of any areas impacted by energy supplies and distribution, changes in society caused by new energy supplies, changes in community members' relationships through the development of new business opportunities, impact of energy costs on low-income people, as well as several political dimensions of energy planning.

- Environmental issues, such as emissions which affect local air quality, greenhouse gases which affect the global climate, impacts on watersheds and aquatic organisms, land-use and visual impacts, biodiversity impacts, noise, and potential toxic waste build-up.

5.2 Special cost reduction opportunities

In addition to the energy options outlined below, research by the project team additionally highlighted several areas where the Hupacasath First Nation has been billed too much for its energy use in the past. When the Community Energy Planning Manager brought this unclaimed money to the attention of the Band Administration [?], it was decided to apply these funds to the implementation of energy efficiency measures.

5.2.1 HFN BC Hydro Electricity Accounts should be PST Exempt

Electricity sales to First Nations are exempt from GST & PST. This applies to all the six Band-owned accounts, which include:

- Pump house
- Trailer / Old Office
- Old Hall
- New House of Gathering
- Streetlights Ahahswinis
- Streetlights Klehkoot

Except for the Old Hall, all accounts are currently being charged PST.

It was noted that BC Hydro will rebate the PST it has charged retroactive six years. This led to the Community Energy Planning Manager phoning the Consumer Taxation Branch and applying for the rebate. Also the HFN contacted BC Hydro and informed them that the accounts were to now be PST exempt in the future. The amount of the rebate is approximately $1,200 for the last six years of billings and the HFN is currently awaiting a response from the Consumer Tax Branch.

5.2.2 Cost savings from switch From Flat Rate to Consumption Rate for Street-lighting

Currently the HFN is being charged a rate of 1701, which translates into a flat rate of $12.45/month per 150-watt street lamp. Three lamps are being charged for a total bill of $37.35/month, or $448/year. It was brought to our attention that it may be possible to reduce the billing amount by switching to a metered commercial rate 1220 which charges $0.0649/kWh. The cost of electricity under rate 1220 would be approximately $200 per year assuming lamps are turned on at sunset and off at sunrise.

The annual savings could be in the order of $200 to $280. The total cost of the retrofit to wire in a meter base and main switch would likely be in the order of $500 to $600. This includes BC Hydro's meter connection fee of $120. Further work is being considered in order to refine this analysis by confirming the number and wattages of streetlights on this account, the number of hours of use, and the cost for an electrician to install a meter.

5.3 Energy Options (Packages)

It is worth noting again what the Community Priorities were as determined through the house visits and surveys in order to convey the relevance of the Energy Options that are presented in this report. Each of these priorities was considered when choosing these packages (options).

•Reduce Environmental Impacts
•Increase Energy Sustainability
•Reduce Energy Cost
•Increase Local Ownership
•Increase Local Job Creation
•Increase Use of Local Resources

Table 5.1 Overview of HFN Energy Efficiency Packages

	Package "A"	Package "B"	Package "C"
Overall strategy	Quick and easy	Bigger investments – big returns	Building a new energy future
Renewable Energy	*Package "C"* →	*Package "C"* →	**China Creek**
Energy Efficiency	Low costs, quick savings	Higher costs, greater savings	*(see below)*
Transport-ation	Education	Voluntary measures	*(see below)*
Land Use & Development	Education	Commitment to EE for HFN projects	Comprehensive land use bylaw for

5.3.1 Package A

As described in Package A measures are "quick and easy," requiring little effort on the part of community members, and low levels of investment. The financial returns on these measures are significant when compared with the modest costs or the voluntary effort involved.

5.3.1.1 Renewable Energy (See Package C below.)

5.3.1.2 Energy Efficiency

In package A the residential community would install quick and easy energy savers such as CFL's (compact fluorescent light bulbs), hot water tank insulation, and low flow showerheads. These types of measures do cost money to purchase and install. However the return on investments for these far outweighs the investment. The HFN would be able to encourage implementation of this measure by providing partial funding for the materials, and by providing the services of the HFN maintenance worker to install these simple energy retrofits.

Package A would largely consist of voluntary measures with regards to the community buildings and businesses. These measures would include turning off light switches in bathrooms and unoccupied rooms, and turning down baseboard heaters after work. In addition, the Community Energy Planning Manager would retrofit the building's ventilation fan with a manual switch so it can be turned off when not needed.

When dealing with transportation and land use and development, package A would consist of education and awareness about each initiative. With transportation the focus would be on reducing costs of car ownership and benefits of having regular maintenance performed on your vehicle. On the land use and development aspect the community would be informed on the energy and cost benefits of a more compact community.

Energy Efficiency: Homes

In regards to homes the strategy was to use cheap and easy energy savers such as compact fluorescent light bulbs (CFL's), low flow showerheads, and hot water tank insulation.

Compact Fluorescent Light Bulbs

Discussion of measure:

CFL's cost more than conventional incandescent bulbs, but are far more efficient and last much longer, resulting in very large per-bulb energy savings, as compared with the total costs of using incandescent bulbs. The greatest energy and cost savings from using compact fluorescent bulbs is achieved by replacing bulbs in the most heavily used light fixtures.

A program by the Hupacasath First Nation, encouraging on-reserve residents to replace half the light bulbs in their households would have cost benefits on individual homeowners' electricity bills, and would reduce the communities' total power consumption.

Costs and Benefits of measure

Compact Fluorescent Light Bulbs

For each 20 watt CFL, used for X hours per day:

- Each bulb costs $7
- Saves $40 in electricity over 5 years
- Return on investment: **75%**

If used in 50% of all household light fixtures community wide, the community would save:

Electricity: 48,500 kWh/yr

Energy costs: $2,500

Standard incandescent light bulbs waste more than 90% of their energy as heat. Compact fluorescent light bulbs (CFL's) produce enough light to replace standard 60-100 watt incandescent bulbs and use less than 1/3 of the energy.

According to BC Hydro the average life of an incandescent bulb is 750 hours and 8,000 hours for a CFL. The cost of a 75-watt incandescent bulb is estimated at $0.70 and $6.98 for a 20 watt CFL.

A CFL is assumed to consume 26.7% the energy of an incandescent bulb based on Manufacturer's data. (Some bulbs are even more efficient.) As shown in the following table, CFL's are economical substitutes to incandescent bulbs in light fixtures, which are used as little as 1 hour per day.

Table 5.2 Residential Lighting – Single Light Bulb Analysis

Light Bulb	Hours on per day	Annual Electricity Cost	Bulb Replacement cost per year*	Total Annual Cost	Return on Investment	Net Present Value	Simple Payback (years)
75 watt incandescent	5	$7.94	$1.70	$9.64			
20 watt fluorescent	5	$2.12	$1.59	$3.71	98%	$21.65	1.2
75 watt incandescent	4	$6.35	$1.36	$7.71			
20 watt fluorescent	4	$1.69	$1.27	$2.97	75%	$15.55	1.5
75 watt incandescent	2	$3.18	$0.68	$3.86			
20 watt fluorescent	2	$0.85	$0.64	$1.48	33%	$9.78	3
75 watt incandescent	1	$1.59	$0.34	$1.93			
20 watt fluorescent	1	$0.42	$0.32	$0.74	11%	$4.43	6

The survey of 21 homes indicated that all lamps in the home were used an average of 3.9 hours per day. Each home used an average of 24 lights, consuming approximately *2,100* kWh per year, and costing $118 per year. Replacing half the home's light bulb with fluorescents would save each household approximately $44 per year.

The estimated number of light bulbs, wattages and time of usage were taken from the Energy Baseline Spreadsheet, which represents 21 surveyed homes. The calculated total annual energy consumption for 21 homes is 25,025 kWh/yr for the kitchen, living room, and general indoor locations, and 43,415 kWh/yr for entire homes.

Based on the surveys completed for 21 homes, 47 homes in the community use approximately *97,000* kWh of electricity per year for lighting. This electricity costs approximately $5,600. The following table shows potential savings for changing out bulbs in a) the highest use areas - kitchens, living rooms and "indoor general", and b) all areas of the house.

Table 5.3 Residential Lighting - Potential Community Savings

Rooms Replaced with CFL's	Average Hours Light is On Per Day*	Annual Electricity Consumption (kWh/yr)	Annual Communit y Electricity Cost	Potential Annual Community Energy Avoided (kWh/yr)	Potential Annual Community Cost Savings	Potential GHG Emissions Avoided* (kg/ yr)
Kitchen, Living Room, "Indoor General" only	5	56,010	$3,193	41,078	$2,341	3,040
Entire House	4	97,168	$5,539	71,263	$4,062	5,273

*based on the survey questionnaire from 21 homes

Home Depot sells an assortment of CFLs at very reasonable prices. Some CFLs come with a regular globe bulb cover, which is more attractive than the finger tube or "twister" style bulbs.

Low Flow Showerhead

Low-flow Showerheads

- Each showerhead costs $15
- Saves $35 to $55 per year in hot water
- Return on investment: 250%

If used in all community homes the community would save:

Electricity: 45,000 kWh/yr

Energy costs: $2,600

GHG emissions: 3.3 tons

Discussion of measure:

Showering is usually the largest single use of hot water in a home and can account for 10 to 15 percent of the homes total energy use. Old style showerheads produce 3 or even 4 gallons per minute (gpm). Newer models typically produce 2.5 or 2.2 gpm, and these may already be present in newer homes in the community. Super low-flow showerheads produce only 1.75 gpm. Low-flow showerheads are specially designed so that the effectiveness and "feel" of the spray is not sacrificed. Other benefits of low-flow showerheads include water conservation, and reduced burden on municipal water and wastewater treatment systems. Homeowners can similarly take advantage of low-flow faucet aerators, which typically flow at 1 gpm.

The analysis below shows that a $15 low-flow or super low-flow showerhead results in substantial savings. The calculations assume that the typical home's showerhead produces 3 gpm.

Table 5.4 Low Flow Showerheads – Single Home Savings

Type of Showerhead	Annual Energy Use* (kWh/yr)	Annual Energy Cost	Annual Savings Potential	Shower-head Cost	Return on Investment	Net Present Value	Simple Payback Period	Energy Avoided per Home (kWh/yr)	GHG Emission Avoided per Home (kg/yr)
Base Case - 3 gallons per minute	2,311	$133							
Low Flow - 2.2 gallons per minute	1,694	$97	$35	$15	248%	$313	4 months	616	46
Extra Low-Flow - 1.75 gallons per minute	1,348	$77	$55	$15	465%	$603	3 months	963	71

* based on 21 minutes of showering per day

Table 5.5 Low Flow Showerheads - Community Savings

Type of Showerhead	Estimated Current Annual Cost per Home	Potential Energy Savings	Average Annual Savings	No. Homes	Community Cost Savings/yr	Community Energy Avoided (kWh/yr)	Community GHG Emissions Avoided (kg/yr)
Low Flow - 2.2 gallons per minute	$133	27%	$36	47	$1,671	28,959	2,143
Extra Low-Flow - 1.75 gallons per minute	$133	42%	$56	47	$2,611	45,249	3,348

Hot Water Tank Insulation

Hot Water Tank Insulation

- Insulation costs $35
- Saves $30 per year in energy
- Return on investment: 90%

If used in all commu
community would s

Electricity: 24,000 kW

Energy costs: $1,400

GHG emissions: 1.8 tons

Discussion of Measure

Most hot water tanks are insulated with one to two inches of fiberglass for an effective insulation value of about R3 to R7. The hot water tank loses heat as it dissipates and radiates to the surrounding air space. Wrapping the tank in a special reflective bubble wrap called "reflectix" can reduce the heat loss significantly. The tank wrap is sold either in bulk sheet or in pre-cut pieces packaged together for $30 to $40 depending on the size of tank. The payback is excellent:

Table 5.6 Hot Water Tank Insulation – Single Home Analysis

Hot Water Tank	Typical Annual Energy Consumption (kWh/yr)	Potential Annual Energy Savings (kWh/yr)	Annual Electricity Cost	Annual Electricity Savings	Capital Cost of Tank Wrap	Return on Investment	Net Present Value	Simple Payback (years)
Existing	5770*		$334.66					
With Insulation Wrap	5250	520	$304.50	$30.16	$35.00	90%	$160	1.2

*based on estimated 225 liters per day of hot water per home

Table 5.7 Hot Water Tank Insulation – Community Savings

	Estimated Current Annual Cost per Home	Potential Energy Savings	Average Annual Savings	No. Homes	Community Cost Savings/yr	Community Energy Avoided (kWh/yr)	Community GHG Emissions Avoided (kg/yr)
Existing Hot Water Tank	$335	9%	$30	47	$1,410	24,440	1,800

Some new hot water tanks such as the green foam model use 2-inch thick rigid foam insulation, which can insulate up to R16. When purchasing a new tank, these type are preferable and do not benefit as much from the additional insulation.

It is also useful to insulate the first six feet of hot water pipe exiting the hot water tank. This reduces the heat being conducted out of the hot water tank.

Also note that homeowners using natural gas hot water tanks should consider switching to an electric hot water tank when they need a replacement. Gas hot water tanks use about 30% to 40% more energy (they are only 55% efficient), and are also more expensive to purchase.

Implementation of Package A for Homes

There are clear costs and energy savings from using compact fluorescent bulbs and these bulbs are now widely available for purchase by residents. However, CFL technology is still new and somewhat unfamiliar, and it is likely that relying on education alone will only result in partial implementation by community members. This recommends that the Hupacasath First Nation undertake a program combining CFL replacement with several other measures, including installation of low-flow showerheads and the insulation of domestic hot water tanks.

This report proposes that the Community Energy Planning Manager oversee the training of an HFN employee so that they are capable of making these simple retrofits. It is hoped that the PST rebate amount mentioned above in section 5.1.1.1 can be re-invested into the purchasing of materials (CFLs, low-flow showerheads and insulation), and/or off-setting the labor costs of installing these items in residents' homes. It is estimated that each house visit would take approximately 1.5 hours to install each of the measures mentioned, with a total labor time of 67.5 hours to complete all of the houses on-reserve.

Community members would be able to sign up to have the employee make a house visit and install these simple retrofits, making these energy savings fast and convenient for local homeowners. The Hupacasath First Nation would purchase the retrofit supplies in bulk, which could reduce the total cost of these materials. Depending on sources of funding the community members could either receive these installations free of charge or would pay a fee for this service that would pay for some of the costs of the materials involved. Community members who commit to making the necessary retrofits with their own labor, and who do not need the HFN employee to do the work of installing the light bulbs, showerhead and hot water tank insulation would be able to have the supplies delivered at a somewhat lower cost. It is worth emphasizing, however, that these retrofits are a very good investment even at full cost, and will save residents considerable energy and energy cost. The lowered cost is simply intended to increase the proportion of community members who participate in this measure.

Energy Efficiency: Community Buildings

New House of Gathering

When the focus shifted to the Hupacasath House of Gathering and other non-residential buildings, the strategy that was put forth was to use cheap and voluntary energy saving options.

Turn off lights in unoccupied rooms

While the project team was on site they noticed that the lighting and fan in the men's bathroom was on while it was not in use. Lighting was also observed to be left on in a seemingly unoccupied room, and a storage room. In bathrooms and other intermittently used rooms, staff could be encouraged to turn lamps off when not in use. The use of positive signage around switches and a simple information campaign to all employees can be useful to eliminate such a problem.

Alternately, motion detectors could be fitted over existing light switches in which the motion detector would switch on the lights and fan when someone was to enter the room, and keep them on for pre-set times such as 7 minutes. Motion detectors could also be effective in seldom-used rooms such as storage rooms where lights may tend to be left on. Simple motion detector switches cost approximately $30 to $40.

Turn down baseboard heaters after work

The electric baseboard heaters in the office rooms (and throughout the building) are controlled with a dial located directly on the baseboard unit. It was noticed that some of these baseboard heaters units are somewhat inaccessible, being located under desks. One staff member that was spoken to said that once she turned the heater on during the heating season, she left it turned up permanently, i.e. did not turn it down at the end of the work day.

Nighttime temperature setback is an important energy saving practice. Typically, wall-mounted thermostats are used to allow easy adjustment of room temperature. To retrofit office rooms in this building would require rewiring power to the baseboard heater via a wall thermostat. Some further analysis and design would be required to determine if this would be cost-effective. A simpler solution would be to ask staff to turn down their thermostats at night to 15˚ C. It may be preferable to have one dedicated staff member check all the rooms at day's end to make the temperature adjustment, and turn them back to 20˚ C first thing in the morning.

Retrofit building ventilation fan with a manual switch

The outdoor air ventilation fan uses a 5 horsepower (3750 watt) motor, which currently runs 24 hours a day 7 days a week. Most large public facilities such as schools shut down the ventilation fan during unoccupied hours. In this building, shutting down the ventilation at night and on weekends could reduce the fan power consumption by 65%, and save up to $1,300 per year. A wall switch or timer could be installed in a convenient location to allow direct control of the ventilation fan. This is likely to be a very cost-effective retrofit. Some further analysis and design would be required.

Old Office/Trailer

Turn down thermostat at night

Staff should ensure that the thermostat is turned down to 10˚ C every night. This measure alone is a significant energy saver for this building is not used a whole lot each night. Also, it may be worth looking into the installation of a programmable thermostat for these facilities.

Old Hall

Nighttime Temperature Setback

Staff should ensure that electric baseboard heaters are turned down to 10˚ C every night. As noted with the old office/trailer, this measure would result in a considerable energy saver.

Insulate Hot Water Tank

The hot water tank should be insulated with reflective wrap such as “Reflectix” or equivalent. Also the first 2 meters of cold and hot water pipes should be insulated with foam pipe insulation. The payback period would be less than 2 years.

Compact Fluorescent Light Bulbs

Seven 100-watt bulbs could be replaced with 28-watt compact fluorescent bulbs. The annual electricity and bulb replacement cost savings would be approximately $22, and the payback on this measure would be approximately 2 years. Also ensure lighting is turned off when not in use.

Replace Old Refrigerators

Refrigerators older than 15 years consume a lot of energy and are typically worth replacing with a brand new model.

Implementation of Package A for Community Buildings

Most of these measures are voluntary in nature in which the employees and general users of such buildings within the Hupacasath First Nation would need to implement them on their own. The role of the Community Energy Planning Manager would be to remind and encourage people to implement these voluntary measures, by communicating the benefits of taking the trouble to make these changes through personal conversations or office memos, posting reminder signs, and recognizing the efforts of who implement the measures.

Several of the non-residential measures are straightforward in nature and can be directly implemented by the Community Energy Planning Manager, working with the HFN maintenance person. These measures include the changing the ventilation fan switch at the house of gathering, and installing CFLs and hot water tank insulation at the Old Hall.

Transportation

Voluntary measures consist of Community Energy Planning Manager distributing info on:

Reduced Idling

Discussion of measure:

Many car drivers idle their vehicles when they are parked, or before they begin to drive on cold days. Not only does this habit consume energy, produce GHG emissions and increase vehicle fuel bills, but also it does nothing to help a modern car or truck with electronically controlled engines. In fact, excessive idling can actually increase the maintenance and operation costs of a vehicle. Even in the coldest parts of Canada, where block heaters are a necessity during wintertime, it takes only 30 seconds for the engine in a modern vehicle to warm up properly (if a car cannot pull away smoothly after a 30-second warm-up, it requires a tune up). In Port Alberni’s mild climate, even this amount of time is unnecessary except on the coldest of days. Moreover, because the car engine runs at a lower temperature when idling, idling contributes to the build-up of fuel residues within the engine, degrading it performance.

There is also a popular belief that turning a vehicle engine off and on requires more energy than simply letting it idle, but this is untrue. A vehicle that idles for more than 10 seconds uses more fuel than it requires when restarting the engine, and the value of the fuel saved greatly exceeds the cost of the increased wear and tear on the vehicle's starter. Therefore, anytime a vehicle is parked for more than ten seconds, it is more fuel efficient, and more beneficial for the car, to stop the engine. For important safety reasons, however, one should never turn off a vehicle's engine when stopped in traffic. (Source: "Welcome to the Idle-Free Zone", NRCan http://oee.nrcan.gc.ca/idling/home.cfm?PrintView=N&Text=N, **2003-11-26)**

Costs and benefits of measure:

The average Canadian car owner idles their vehicle(s) for about 10 minutes each day. This measure assumes that on-reserve members of the Hupacasath First Nation were also average in their vehicle idling behavior, but that as a result of education and awareness, on-reserve members decided to reduce vehicle idling by 50% to 5 minutes per day. Even including some added costs for the wear and tear of additional restarts, fuel savings would result in a net annual benefit of $25 for each car owner. This measure would also result in an average estimated greenhouse gas emission reduction of 120kg for each car owner, of 12% of one ton.

Table 5.8 Reduce vehicle idling by 50% - Potential Community Savings

	Estimated vehicles on reserve	Potential Annual Community Energy Avoided (kWh/yr)	Potential Annual Community Cost Savings	Potential GHG Emissions Avoided* (kg/yr)
Community Total	54	24,000	$1,350	6400

If all on-reserve residents reduced their vehicle idling by one-half, the community as a whole would reduce energy consumption by 24 MW, reduce total GHG emissions by 6 and a half tons, and save $1350 in energy costs.

Proper tire inflation

Discussion of measure:

One of the simplest ways of improving the both the safety and the fuel economy of your car and truck is to have all four tires inflated to the right air pressure. Under-inflated tires can lower gas mileage by 0.4 percent for every 1 pound per square inch (psi) drop in pressure of all four tires (http://www.fueleconomy.gov/feg/maintain.html). A recent study found that 70 per cent of Canadians drive with at least one tire under-inflated by at least 10 per cent, and that 40% have tires under-inflated by 20% or more (Canadians don't keep tires pumped up, study says **,** *Last Updated Thu, 09 Oct 2003* http://www.cbc.ca/stories/2003/10/08/Consumers/tire_pressure031008) This increases the rolling resistance of vehicles, and reduces the effectiveness of the steering and breaking systems.

It is simple to inflate tires as most gas stations provide free access to a pressurized air hose. In most cases, these hoses are equipped with air pressure gauges that provide instant information on the air pressure within the tire being inflated. Ideally, you should check the air pressure in your tires once a month when you fill up at the gas station.

There is a range of optimum tire air pressures, ranging from 20 to 50 pounds per square inch. While a maximum tire pressure is embossed on are the sidewall of every tire, this is not necessarily the optimum air pressure for that vehicle. The Owner's Manual for the vehicle will state the correct tire pressure. The correct air pressure for each vehicle is also printed on its "information placard," a label that is usually found either:

- on the edge of one of the doors,
- the inside post of one of vehicle's doors
- inside the glove compartment,
- inside the trunk; or
- inside the fuel door

70% of car owners who have tires that are at least 10% under-inflated can save at least $25 dollars a year, and reduce their greenhouse gas emissions by 80 kg or more, meeting 8% or more of a one-ton challenge with no cost investment. For the 40% of car owners who drive vehicles with tires 20% under-inflated, cost savings and greenhouse gas emission reductions are double, at $50, and 160 kg or reduced emissions.

Table 5.9 Proper vehicle tire inflation - Potential Community Savings

Tire inflation	Estimated vehicles on reserve	Potential Annual Community Energy Avoided (kWh/yr)	Potential Annual Community Cost Savings	Potential GHG Emissions Avoided* (kg/yr)
30% of vehicles properly inflated	16/54	0	$0	0
30% of vehicles more than 10% under-inflated	16/54	5,000	$396	1300
40% of vehicles more than 20% under-inflated	22/54	13,000	$1,077	3500
Community Total	54	18,000	$1,473	4800

If on-reserve residents properly inflated all their vehicles, the community as a whole could reduce energy consumption by 18 MW, reduce total GHG emissions by almost 5 tons, and save almost $1500 in energy costs.

Using "right-sized" vehicles

Discussion of measure:

Next to their homes, vehicles are often the most expensive things that most people own, and the ongoing expense of car ownership is a major household expense. The Canadian

Automobile Association calculates the average cost of owning and operating a 2003 model car to be just over $7000. (Source: Canadian Automobile Association, Driving Costs, 2003 Edition http://www.caa.ca/e/automotive/pdf/driving-costs-03.pdf). In Chapter 3, gasoline costs alone are shown to cost the on-reserve community more than $70,000 each year - almost half of total community energy expenditures on the Hupacasath reserves.

Automobiles are also a major source of air pollutants and greenhouse gas emissions. As shown in Chapter 3, transportation (i.e. automobiles, trucks, other vehicles and boats) accounts for an estimated 69% of all green house gas emissions from Hupacasath reserve lands.

Clearly, managing to do without a car or truck could potentially have a huge effect on lowering household costs and greenhouse gas emissions. But because of our modern patterns of life, with home, work, shopping, school and social destinations located far apart from each other, it is often not possible for individuals to do without a vehicle. What residents can do quite easily, however, is to examine their transportation needs, and only buy as large a vehicle as they need. The monetary and environmental benefits of doing so can be impressive.

There is also a tremendous range in the prices of vehicles, even when comparing new cars for the same model year. In addition to this, there is also a huge difference in the fuel costs required to run different vehicles – and the varying amounts of fuel these different cars consume also creates large differences in amount of greenhouse gases they produce.

Clearly, a small car or truck is not able to haul heavy loads like a large truck can. In most other respects - notably including driver and passenger safety - small cars and minivans out-compete larger trucks and SUVs, because of their superior design (New York Times recent article – Malcolm Gladwell).

As a result, one of the best ways for individuals to save large amounts of money, emissions and energy when purchasing a new vehicle is to buy only as large a vehicle as they actually need for the majority of their trips. Remember that a one-a-year requirement for a large truck can be best met by purchasing a car, and then using a small portion of the costs saved in renting a large truck for this single use.

Costs and benefits of measure:

The average cost for a new truck or SUV is now $36,000, as opposed to $30,000 for a minivan or large car, and only $17,000 for a small car. In a similar manner, individuals who purchase large cars emits almost 800 kg of GHG's more each year than they would driving a small car the same distance (17,000 km/yr). Those who decide to buy a new SUV or truck end up emitting almost 2600 kg more greenhouse gases than the average driver of a new small car.
While the choice of what car to drive is influenced by many factors – of which cost, efficiency and environmental impacts are rarely the most important – a decision to buy a

smaller vehicle can deliver more financial and emission reduction benefits to individuals than almost any other measure outlined in this report.

Table 5.10 Using Right-Sized vehicles - Potential Community Savings

	Estimated vehicles on reserve	Potential Annual Community Energy Avoided (kWh/yr)	Potential Annual Community Cost Savings	Potential GHG Emissions Avoided* (kg/yr)
80% of existing cars already 'right-sized'	20/25	0	$0	0
20% of existing cars are large cars "right-sized" to small cars	5/25	--	$65,000	4,000
60% of existing trucks already "right-sized"	17/29	0	0	0
20% of existing trucks "right-sized" to large cars or minivans	6/29	--	$36,000	10,800
20% of existing truck "right-sized" to small cars	6/29	--	$114,000	15,600
Community Total	54	--	$215,000	30,400

Implementation of Transportation measures

All of the transportation measures above would cost community members nothing to implement. These measures are voluntary, and depend on community members adopting the measures of their own accord. The Community Energy Planning would have a crucial role in presenting information on these measures to the membership, highlighting the personal and community benefits of action, and encouraging members to adopt them. The material presented here, and other supporting information could be presented to the membership through a combination of presentations, posters and/or newsletters, and personal communication.

Land Use

See measures in Package B and C below.

5.3.2 Package B

As compared with the Package A measures described above, Package B measures for both residential and non-residential buildings require more money up front, but provide bigger savings over time. As previously noted, this report suggests that all of the measures in all three packages be implemented – Package B is additional to, not an alternative to, Package A.

5.3.2.1 Renewable Energy

See Package C below.

5.3.2.2 Energy Efficiency

Energy Efficiency: Homes

The first stage of Package B is the essential stage of upgrading the home "envelope", which means sealing the whole house to prevent heat loss and air leakage.

It must be noted that the assumptions presented are found from the results of the surveys and the baseline study. These assumptions also assume that survey results are representative of the community as a whole (i.e. if 50% of the survey group would benefit from home upgrades, it is assumed that 50% of all homes on reserve could benefit)

The following tables show examples of capital costs to upgrade homes, and the resulting energy savings. These figures are averages, based on cost estimates provided by Pride Home Improvements to install upgrades for six homes.

Total for Upgrade Home Envelope measures:
200,000 kWh saved
20 tonnes of GHG avoided
$12,000 annually

Table 5.11 Home Building Envelope Energy Upgrades – Single Home Analysis

The following estimate of annual cost savings is based on implementing one or two top priority improvements (of the five listed above) recommended in the EnerGuide Audits performed on 13 homes. An average value was calculated and extrapolated to the 47 homes in the community. The economic returns are not shown here since each home would require a cost estimate for its particular upgrades; the examples in the table above however, give a good idea.

Measure	Capital Cost per Home	Annual Savings	Return on Investment	Net Present Value	Simple Payback (years)	Energy Avoided (kWh/yr)	GHG Emissions Avoided* (kg/yr)	Sample Size
Reduce air leakage by 50%	$833	$323	35%	$3,935	2.6	4,928	502	3
Insulate floor joists	$1,879	$493	24%	$4,800	3.8	6,061	617	1
Insulate crawl space walls	$1,820	$371	22%	$4,100	6.0	1,684	171	4
Add more attic insulation	$942	$122	12%	$708	7.7	6,816	694	1
Replace 6 windows	$3,160	$203	6%	$380	15.6	3,561	363	1

Table 5.12 Home Building Envelope Energy Upgrades – Community Wide Estimate

Estimated Average Annual Heating Cost per Home	Potential Energy Savings	Average Annual Savings	No. Homes	Total Community Energy Cost Savings/yr	Energy Avoided (kWhr/yr)	GHG Emissions Avoided (kg/yr)
$904	28%	$250	47	$11,772	199,747	20,340

*uses an averaged emissions factor of 0.102 kg CO_2/kWh

All the measures except replacing windows are economically attractive as investment opportunities for the homeowner. (Replacing windows, although not as economical, can improve the comfort, aesthetics and value of the home.)

There is an opportunity for homeowners to reduce the capital cost of these upgrades significantly by doing the labor themselves. Insulating attics, floor joists and/or crawl space walls can readily be done by a homeowner and the cost savings may be up to 40% over hiring a contractor. Reducing air leakage by draft proofing and weather stripping can be done by the homeowner, but a professional contractor achieves the best job by using a door fan to pinpoint air leaks, and testing the results of their sealing work.

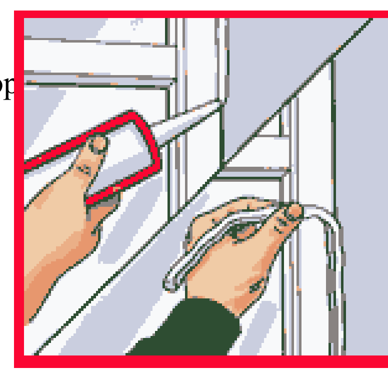
The figures above also do not factor in monetary incentives that are being offered by both Federal (program is effective October 15, 2003) and Provincial governments. These incentives may improve the economics by an estimated 25% to 50%.

[See the attached document which evaluates the cost savings for Do-It-Yourself installations and the Federal and Provincial homeowner rebates]

5.3.2.3 Home Building Envelope Energy Upgrades

5.3.2.3.1 Draft Proofing

A lot of warm air escapes through small cracks in the house when it is not prop proofed. The following is a breakdown of what this measure has to offer.



•Costs $400 to $800
•Saves $150 to $300 per year in energy costs
•Return on investment: 35%

5.3.2.3.2 Insulating the Crawlspace

The insulation of the crawlspace should occur between the floor joists or inside walls of crawl space. These two measures are relatively easy for the handy homeowner to do him or herself, and the economic returns will be much better than if hiring a contractor. The floor joists should be upgraded to a minimum of R28 (8" fiberglass bat). As shown in the tables below, the savings in these two cases were 30% and 54% when doing it

The price of materials and the value of the homeowner's own labor is zero. The economics are then based on material costs alone. The same idea holds for attic insulation as well.

Table 5.13 Insulation of Crawlspace and Floor Joists for random HFN Home

Measure	Are of Home (square feet)	Cost of R28 bat per sq. ft.*	Materials Cost	Cost savings versus using a contractor at $1,879	Percent savings over a contractor	Annual Heating Cost Estimate*	Annual Energy Cost Savings	Simple Payback (years)
Insulate between floor joists to R28	2200	$0.40	$880	$1000	***30%***	$1,334	$493	1.8

* includes BC Hydro Grant of $0.2/sq.ft.

Measure	Wall area of Crawl Space (square feet)	Cost of R12 foam per sq. ft.*	Materials Cost	Cost savings versus using a contractor at $1,800	Percent savings over a contractor	Annual Heating Cost Estimate*	Annual Energy Cost Savings	Simple Payback (years)
Insulate crawl space walls with rigid R12 joists	540	$1.30	$702.00	$1100	***54%***	$1,250	$250	2.8

* includes BC Hydro Grant of $0.2/sq.ft

Alternately, by insulating the joist spaces with R28 bat and not insulating the walls of the crawl space, the floor will tend to be somewhat cooler since heat moves from warm to cold which means feet will also feel the cold. However, the entire crawl space is eliminated as a "heated" part of the house, which should achieve significant energy savings.

•Costs $400 to $900
•Saves $200 to $500 per year in energy costs
•Return on Investment: 50%

5.3.2.3.3 Attic Insulation

This measure will reduce heat loss by adding more attic insulation in certain homes.

•Costs $200 to $500
•Saves $40 to $150 per year in energy costs
•Return on investment: 20%

5.3.2.3.4 Energy Efficient Windows

Upgrading to energy efficient windows is by far the most expensive of these measures, but saves energy and can provide extra comfort.

•Costs $1000 to $5000
•Saves $70 to $300 per year in energy
•Return on investment: 6%

5.3.2.3.5 EnerGuide for Houses Evaluations

This evaluation identifies the best ways in which the homeowner can save energy for heating, and qualifies the home for a federal grant to install the upgrades.
"EnerGuide for Houses" evaluations were already performed on 13 homes as derived from a cross section of the homes taking into consideration the homes:

- Age
- Number of Occupants.
- Fuel Type
- Square Footage

One way to obtain such an upgrade would be to have an EnerGuide audit performed on each house on the reserve. Such an evaluation identifies the best way in which you can save energy for heating. A federal grant is possible for homes that have EnerGuide Evaluations conducted on the home both before and after the energy upgrades are installed. The grant is based on the improvement in the EnerGuide rating calculated during the post-retrofit evaluation. Evaluations can be performed on all the homes and should be free of charge to the homeowner in 2004.The following are two examples of how the grant can save on retrofit costs.

Table 5.14 Savings through EnerGuide Evaluations

Example Home	measures	EnerGuide rating now	EnerGuide rating with improvements	Estimated EnerGuide Grant amount	Estimated BC Hydro Home Improvement Grant for Insulation	% savings on contractor's retrofit costs
Joe Smith	Crawl space wall insulation	63	76	$501.85	$108	25%
Jane Doe	Crawl space wall insulation and air leaks	57	71	$561.73	$85	40%

The application for the grant shall be made by an authorized EnerGuide for Houses delivery agent on behalf of the homeowner. The application requires that the following information be submitted to Natural Resources Canada:

- the pre-retrofit EnerGuide for Houses evaluation files in an approved software version;
- the post-retrofit EnerGuide for Houses evaluation files in an approved software version

5.3.2.3.6 BC Hydro's Home Improvements Grants

These grants can also be exploited for additional savings as shown in the table above and can be accessed by contacting BC Hydro. The homeowner then sends BC Hydro original receipts of material purchases, and BC Hydro performs an inspection process. Also worth noting is that homes must be electrically heated and must presently use a minimum of 15,000 kWh/hr, about $900, in electricity. This program also will contribute $50 toward the cost of an EnerGuide for Homes audit.

Here are the details:

Measure	Grant
Low-e windows	$1 /sq. ft
Low-e and Argon-filled windows	$1.25/sq.ft
Crawl Space Insulation (R28 bat or R12 rigid)	$0.20/sq.ft.
Attic Insulation to R40 (Attic must have R12 or less)	$0.15/sq.ft.

5.3.2.4 Upgrade to more efficient furnaces and wood stoves

Secondly with regards to Package B is the upgrading to more efficient furnaces and woodstoves. A high efficiency woodstove has a high initial cost, but would see the homeowner save considerably over the year, are much cleaner and healthier to use, and provide more heat with less wood.

5.3.2.4.1 Replace inefficient wood stoves with High Efficient Ones

Conventional wood stoves are typically 40% to 50% energy efficient and produce a relatively high amount of microscopic particulate matter (PM), and other toxic gases. These emissions have been proven to cause a number of health problems including respiratory function.

High efficiency or advanced combustion stoves operate up to 70% efficient and produce about one tenth of the particulate matter and toxic gases. High efficiency stoves are “EPA” or CSA tested for particulate emissions. EPA stoves were introduced in the early 1990s, so wood stoves older than 10 years are most likely mid-efficiency units with high PM emissions.

The following table estimates the financial benefit of replacing an existing conventional wood stove with a high efficiency model, using the examples of burning 2, 3 or 4 cords of firewood a year. By upgrading to the high efficiency model, there is an opportunity to save on the cost of firewood (since the same amount of heat can be produced using less wood), and reduce harmful particulate emissions.

Table 5.15 Comparison of Conventional and High Efficiency Wood Stoves

Wood Stove	Capital Cost	# Cords Burned/yr	Annual Fuel Cost Estimate[3]	Annual Cost Savings	Return on Investment	Net Present Value	Simple Payback (years)	Annual Particulate Emissions (kg)
Conventional 50% efficient		2.0	$300					28
EPA certified 70% efficient	$783	1.4	$214	$86	10.0%	$354	9.1	2
Conventional 50% efficient		3.0	$450					42
EPA certified 70% efficient	$783	2.1	$321	$129	18.0%	$950	6.1	3
Conventional 50% efficient		4.0	$600					56
EPA certified 70% efficient	$783	2.9	$429	$171	24.0%	$1490	4.6	3

The majority of new wood stoves for sale are EPA certified. Homeowners using a lot of firewood for heating (3 cords or more) may find it worthwhile to replace an older stove with an advanced combustion model. The impact of replacing conventional wood stoves would result in a dramatic decrease in the level of particulate emissions in the community. When purchasing new wood stoves, buyers should ask for low-emission EPA certified models.

A high efficiency stove costs $800 and saves up to $170 per year in firewood. The return on investment is equal to 24%

[A community wide assessment has not been done since it is unknown how many existing stoves are EPA certified. Stoves older than 10 years are not EPA certified] Budget limitations did not permit the project group to estimate total benefits of this measure for HFN

5.3.2.4.2 Replace Oil Furnaces with Natural Gas

Package B would also see the replacement of oil furnaces with natural gas furnaces. The installation of these furnaces can also receive total rebates of $900 through various sources and the energy savings alone in one year, amounts to approximately $700.

Switching an Oil Furnace to High Efficiency Natural Gas Furnace

Most oil furnaces found in homes are older models, which operate at only 69% efficient or less. Five homes in the community use oil heating and these could profit well by switching to natural gas heating. Terasen has natural gas available along River Road and will extend gas lines into homes free of charge. Terasen offers a $300 rebate on the cost of installing a natural gas furnace and the Province rebates $600. The cost of installing a new high efficiency-condensing furnace is approximately $3,500, so after the rebates it becomes $2,600. Taking part in such an option would result in a 30% Return on Investment.

Table 5.16 Switching an Oil Furnace to a High Efficiency Natural Gas Furnace

Furnace Type	Typical Annual Heating Energy Consumption (GJ/ yr)*	Effective Price of Fuel ($/ GJ)*	Annual Fuel Cost Estimate	Annual Savings	Capital Cost of Gas Furnace	Return on Investment	Net Present Value	Simple Paybac (years)
Old Oil Furnace - 69% efficient	76	$22.90	$1,739					
New Condensing Natural Gas Furnace - 94% efficient	76	$13.30	$1,010	$728	$2,600	30%	$5,348	3.6

*Source: NRCan

**assumed winter heating oil price of $0.60/litre, natural gas price of $12.50/GJ

There is an option to switch to natural gas hot water heating at the same time as installing the new furnace. This is not recommended since natural gas hot water tanks operate at 55% efficient versus 83% to 90% efficient for electric hot water tanks, and therefore cost significantly more to run.

5.3.2.5 Upgrade to efficient appliances

The HFN would also see upgrades to their current appliances to meet certain energy efficiency standards. These upgrades would include:

5.3.2.5.1 Install Front-Loading Washers

Front-loading washing machines use less soap, electricity, and hot water. They also do not leave excess water with them, therefore leading to less time in the dryer. This option is best suited for large families that require many loads of laundry. To purchase a front-loading washer it would cost approximately $900, but this upgrade can save upwards to $120 per year in energy illustrating a 65% return on investment.

Front loading washing machines have been used for decades in Europe and are rapidly being adopted in Canada. They use approximately half the amount of water and soap of a top-loading washer. Due to much higher spinning speeds, they also extract more moisture from clothing which results in reduced dryer time. An additional benefit is that front-loading (or horizontal axis) tumbling action is much gentler on clothing fabric. Although not quantified here, this results in reduced costs for replacing worn-out clothing.

New front-loading washers use 3 to 4 times less energy than new top-loading models. When purchasing a new machine, the extra premium paid for a front-loading machine is returned very quickly in savings on electricity and soap. Expect prices of front-loaders to drop even more as their sales increase

The following table considers three cases: 1) replacing a 1990 top-loading model, 2) replacing a 1996 top loading model, and 3) purchasing a new front-loading instead of top-loading machine. The economic returns are acceptable for all three cases, and especially good for case three.

Table 5.17 Front Loading Clothes Washers – Single Home Savings

Washer Type	Annual Energy Consumption (kWh/yr)	Annual Electricity Cost	Annual Electricit y Cost Savings	Annual Savings on Soap	Annual Savings on Drying	Total Annual Savings Potential	Capital Cost of Washer	Return on Invest ment	Net Present Value	S Pa (y
1990 – top loading	1150	$67								
2003 – front-loading	259	$15	$52	$68	$13	$133	$900	16%	$860	
1996 – top loading	900	$52								
2003 – front-loading	259	$15	$37	$68	$10	$116	$900	14%	$650	
2003 – top loading	960	$56					$699			
2003 – front-loading	259	$15	$41	$68	$11	$120	$900	65%	$1,400	

The next table showcases the result of the whole community using a front-loading washer.

Table 5.18 Front Loading Clothes Washers – Community Savings for Change Out

Type of Washer	Estimated Current Annual Cost per Home	Potential Energy Savings	Average Annual Savings	No. Homes	Communit y Cost Savings/yr	Communit y Energy Avoided (kWh/yr)	Communit y GHG Emissions Avoided (kg/yr)
1996 top-loading replaced with a 2003 front-loading	$188*	97%**	$116	47	$5,452	41,000	3,000

*Includes soap and electricity ** Includes reduced dryer energy estimate of 230 kWh/yr

If implemented throughout the reserve, savings are estimated at:

Electricity savings of 41,000 kWh/yr
GHG reduction of 6 tons
Energy savings of $5,400 a year.

5.3.2.5.2 Replace Old Fridges and Freezers

Fridges and freezers have become dramatically more energy efficient over the last ten years. A ten-year-old refrigerator or freezer can cost considerably more to operate than a new energy-efficient model of the same size. Improvements in the design of compressors and cooling coils, better insulation, tighter door seals, and other design improvements all contribute to the higher efficiencies of newer models.

As shown in the following table, energy savings can be significant when replacing an old fridge. Due to the high cost of the appliance, however, the energy savings make it only marginally economical to replace models that are older than 10 years. Replacing a fridge, which is 5 year old or newer, is unlikely to be economical, but does save energy.

Table 5.19 Fridge – Single Home Savings

Typical Fridge Model (18-20 cu. Ft.)	Typical Annual Energy Consumption (kWh/yr)	Potential Annual Energy Savings (kWh/yr)	Annual Electricity Cost	Annual Electricity Savings	Capital Cost of New Fridge	Return on Investment	Net Present Value	Simple Payback (years)
pre-1998	1500*		$87.00					
2003	479	1021	$27.78	$59.22	$799.00	6%	$88	13.5
1998	740*		$42.92					
2003	479	261	$27.78	$15.14	$799.00	-7%	-$576	52.8

* Source BC Hydro

Assuming the average age of fridges is 9 years and they each consume 1500 kWh/yr, replacing all 47 would save 48*,000 kWh/yr* for all 47 homes. The annual cost savings on electricity would be approximately $2,780.

BC Hydro offers a fridge buy-back program in which they pay $30 to take your old secondary fridge off of your hands. It is worth noting that 20-year-old fridges can consume 3-9 times as much power than new ones and fridges more than 10 years old can use 3 times as much power. On the contrast a new model can save **$**60 per year or more and if implemented throughout the reserve, savings are estimated at 48,000 kWh / yr in electricity savings, 3.5 tons of GHG reductions, and $2700 in energy savings

Deep Freezers

The same trends in energy efficiency improvements apply to freezers. However, freezers typically consume only 65% (300 to 500 kWh/yr) of the energy of fridges, mainly because they are opened much less often. Chest freezers are proportionally less expensive than fridges, so expect the economic returns to be similar to those presented above for fridges.

Large, old (more than 15 years old) chest freezers that are seldom used are best consolidated into smaller freezers, or upgraded with a newer efficient model.

A useful website calculator: (http://oee.nrcan.gc.ca/equipment/english/page10.cfm?PrintView=N&Text=N) allows you to enter your model of fridge to check the EnerGuide consumption rating. This can give an idea of how efficient your model is and the savings that are possible using a new model.

Non-residential Applications

Package B's objectives when dealing with non-residential buildings consists of such energy-saving measures as installing individual wall thermostats for baseboards in the Hupacasath House of Gathering as well as possibly a hot water re-circulation pump in which a time clock would be installed on the device in order to save energy costs. With respect to the other buildings, the trailer could switch from a propane furnace to a natural gas furnace, as well as having draft proofing performed.

House of Gathering

Installation of Ventilation Fan

Installing a ventilation fan switch within the House of Gathering would have savings estimated at 21,000 kWh / yr in electricity savings, 1.5 tons of GHG reductions, and $1,300 in energy savings if this option was implemented.

With regards to installing a domestic hot water recirculation device the estimated savings would be 3,000 kWh / yr in electricity savings, 0.2 tons of GHG reductions, and $200 in energy savings.

Old Office/Trailer

Reduce Air Leakage

When looking at the old office/trailer if air leakage is reduced through draft proofing and weather stripping alone the savings would be estimated at 3,300 kWh/year in electricity, 0.75 tons of GHG, and $320 in energy costs. Replacing windows would result in 4,200 kWh in electricity, 0.95 tons of GHG, and $400 in energy costs.

Table 5.20 Old office/trailer Upgrade costs using Package B

Measure	Capital Cost	% Savings on Heating	Annual Heating Cost Estimate*	Annual Savings	Payback (years)
reduce air leakage by 50%	$1,100	23%	$1,400	$320	3.4
replace 6 windows	$3,160	29%	$1,400	$405	7.8

Also worth looking into would be switching from propane to a natural gas furnace within the trailer. The winter price of propane is approximately $26.40/Gigajoule ($0.66/litre) whereas the price of natural gas is almost half of that, currently $13.74/Gigajoule. Most models of propane furnaces can be converted to natural gas by a qualified gas fitter for about $200. Terasen Gas would install a gas line from River Road to the building, likely without a charge. Based on these assumptions, the simple payback on such a conversion would be less than 6 months.

Old Hall

The old hall received an EnerGuide Evaluation during the evaluations that took place during the CEP process. The priority energy efficiency improvements identified were a) to increase insulation in walls, b) to reduce air leakage by 50%, and c) to replace old windows with high efficiency double glazed windows (R4.2).

The evaluation identified that there is poor insulation in the upper floor walls. This could be improved by retrofitting either the interior or exterior walls. However the cost to do this would be high and the cost-benefit would most likely be unattractive.

The following table shows estimated retrofit costs and the potential energy savings of possible retrofits.

Table 5.21 Old Hall Upgrade costs using Package B

Measure	Estimated Range of Capital Cost	% Savings on Heating	Annual Heating Cost Estimate*	Annual Savings	Payback (years)
Reduce air leakage by 50%	$600-$800	8%	$2,700	$216	4to 6
replace all windows	$1,500-$2,500	14%	$2,700	$378	6 to 11

*estimated from past years electricity billings

By reducing air leakage and replacing windows combined the savings for the old hall would be 5500 kWh/yr in electricity, 0,407 tons of GHG, and $360 in energy costs.

5.3.2.6 Transportation and Land Use

In Package B, transportation and land use and development strategies, the HFN goes one step further than education and actually starts implementing some of these strategies. In respect to transportation, possible programs that could be looked at include:

Bus Stop Shelters

Discussion of measure

Increased use of public transit, for those trips which are efficiently served by the existing bus routes, is an effective way of avoiding the energy costs, air pollutants and greenhouse gas emissions resulting from the use of private cars and trucks for transportation. In those communities with a lower frequency of service, one of the main factors limiting transit use is the discomfort people experience when they wait for the bus. In the case of Port Alberni, with its high rainfall, the most important comfort factor is judged by the project team to be shelter from the rain.

The Ahahswinis Reserve is currently served by two bus routes of the Port Alberni public transit system. Route 3 – River Road heads towards Port Alberni along River Road and travels out of town along Compton Road and Beaver Creek at one hour intervals between 8 a.m. and 5 p.m., from Monday to Saturday. In addition, the Route 4 – Evening bus travels the same route between 6:30 p.m. and 9:30 p.m. There would appear to be a need for two bus shelters, located on River Road, and on Compton Road, at opposite ends of Ahahswinis Reserve.

Costs and benefits of measure

The costs and benefits of this measure have not been assessed. Further investigation of this measure would benefit from a survey of reserve residents to determine current rider-ship, and their interest in increased transit use using a more comfortable bus stop. The cost of purchasing or constructing two bus shelters (see implementation section below) should also be investigated.

Implementation

This report recommends that the Community Energy Planning Manager oversee the installation of a bus shelter providing adequate shelter from the rain on reserve land along River Road. In addition, this report suggests that installation of a second bus shelter be investigated along Compton Road. Installation of a bus shelter on the north side of Compton Road, outside of reserve boundaries could be provided with the cooperation of the City. Conversely, a bus shelter could be located on the south side of the road on reserve property, across the road from the bus stop.

Once installed, these modest roadside structures would be one of the most visible structures to those driving past the reserve. As a result, a bus shelter could provide – on a much more modest scale – an opportunity like that at the House of Gathering, where an amenity for the community also displays Hupacasath culture, heritage and pride.

HFN car co-op

As noted above in the Package A measures, the cost of owning and operating a car is usually one of a household's main expenses, and while individual households could enjoy a large reduction in their total expenditures by getting rid of their car, it is usually impractical to do so. One way of significantly decreasing the expense of a car that has been put into practice in Vancouver and other cities is to form a car-share co-operative, in which a large pool of users collectively owns one or more vehicles. In a "car co-op," members share the insurance and maintenance costs for these vehicles, and set up a sign-out list for use of the vehicle. In practice, car co-ops work well for people who need a car only a few times a week, for trips they can plan ahead (and schedule on the car sign-out list).

Costs and benefits of measure

The costs and benefits of this measure for the Hupacasath First Nation have not been fully assessed. However, the cost savings for co-op members in Vancouver are very substantial. On average, the 1300 members of the 71-vehicle Vancouver Cooperative Automobile Network pay only $900 a year for all car-related expenses – little more than 10% of the estimated $8000 per year it costs the average Vancouverite to own and operate a car (Source: CAN, Frequently Asked Questions, http://www.cooperativeauto.net/Q&Aout.htm).

Implementation

This report recommends that the Community Energy Planning Manager further investigate the possibility of setting up a small automobile cooperative for Hupacasath members, by determining the level of community interest in such a program, and the cost of setting up such a program. Vancouver's CAN program offers consulting services for those wanting to establish their own car co-ops, and could be a valuable source of information for the Community Energy Planning Manager. Information on Vancouver's successful Co-operative Auto Network (CAN) can be found at: http://www.cooperativeauto.net

Engine tune-ups

Discussion of measure

Modern cars and trucks have long-lasting precision parts that are designed to last years before wearing out. In many cars, parts such as spark plugs are only recommended for replacement every 80,000 kilometers or two and a half years! However, because of the high precision and low tolerances in modern engines, these components are also very sensitive to the build up of contaminants. An out-of-tune engine will often decrease fuel efficiency by 10% or more. As a result, it is important to have your vehicle services at least as often as recommended by the vehicle's manufacturer. While regular vehicle maintenance visits do cost money, it is far more cost-effective to pay for them than to avoid them, as continued operation of a poorly adjusted vehicle can lead to much more expensive repairs.

Costs and benefits of measure

This study looks at the cost benefits of only one of the improvements that should be made in a semi-annual or annual vehicle tune-up – replacement of the vehicle's air filter. Replacement of a clogged air filter results in an fuel-efficiency improvement of 10%. Assuming a gasoline price of $0.70 per liter, this efficiency gain can add up to $120 per vehicle per year in fuel savings, and a greenhouse gas emission reduction of 400 kg, or 40% of one ton.

Table 5.22 Replacement of vehicle air filters - Potential Community Savings

	Estimated vehicles on reserve	Potential Annual Community Energy Avoided (kWh/yr)	Potential Annual Community Cost Savings	Potential GHG Emissions Avoided* (kg/yr)
50% of vehicles do not require change of air filters	27/54	0	$0	0
50% of vehicles require replacement of air filter	27/54	--	$3240	10,800
Community Total	54	--	$3240	10,800

Assuming that only half of the vehicles estimated to be on reserve would benefit from an air filter replacement – itself only one component of a full engine tune-up – in a given year, the community as a whole could reduce its total energy costs by over $3000 dollars, although the cost savings would depend on the overall costs charged for the engine tune-ups. Greenhouse gas emissions would also be reduced by almost 11 tons.

Implementation

Because several members of the Hupacasath First Nation are already knowledgeable car mechanics, it may be possible to create additional work for community members through implementation of this measure. This report recommends that the Community Energy Planning Manager investigate a program in which the Hupacasath First Nation could work with the local mechanics to set up and publicize high-quality engine tune-ups at a reasonable cost to local Hupacasath members. A successful program operated along these lines would not only result in reduced community energy costs and greenhouse gas emissions, but also provide additional work for community members, and increase the flow of local dollars back into the community.

Land Use

HFN Corporate Commitment to energy-wise development standards

Discussion of measure

As is demonstrated in this report, there are numerous opportunities available to improve the energy performance, and reduce energy costs and greenhouse gas emissions from existing buildings on Hupacasath First Nation reserve land. In almost all cases, however, these retrofits cost more money – and thus return less cost savings – than would be the case if the building was originally constructed with these features. More importantly, many significant energy efficiency measures are only cost-effective if they are implemented during the building design and construction phase.

As a result, a commitment to include energy-efficient and other cost-effective green building technologies in all new construction projects of the Hupacasath First Nation could provide overall cost and emission benefits much greater than those highlighted for retrofits elsewhere in this report.

In order to implement this measure, the Hupacasath First Nation could commit to achieving a specified target for all of its future building projects. There are a number of building standards promoting energy efficiency, or the wider concept of "green" buildings, including the federal government's R-2000 energy efficiency code, and the well-known LEED criteria for certifying green buildings. Use of a widely-used standard would increase the likelihood that project architects and project managers had previous experience in working within these parameters, which could reduce overhead costs and increase project quality.[8]

As part of this commitment, this report recommends that the Hupacasath First Nation pay particular attention to the idea of compact development. At present, the First Nation has a limited land base suitable for development. The most recent housing plan indicated that the existing land base would be insufficient to provide the projected amount of housing required for First Nation members over the next twenty years. Since the completion of this report, further investigation of potential development sites, and development of previously allocated Certificate of Possession (CP) lots has further reduced the amount of land available to the First Nation for the construction of housing. Given the present

[8] The City of Seattle has committed to meeting a LEED "Silver" target in all new buildings. Employee Lucia Athens comments that "one of LEED's greatest values is that it provides clear design criteria and a common language for design teams, allowing for a more efficient and effective process. By defining benchmarks and organizing critical issues into theme areas, the sustainable design process is expedited. In addition, because it is a national tool developed by many experts, it allows the city to compare its performance to other jurisdictions in other parts of the country. Source:
"Seattle LEEDs the nation in sustainable building, July 25, 2002http://www.djc.com/news/en/11135658.html

availability of developable land, there are presently compelling reasons to investigate more compact forms of development, comparable to those found in the neighboring City of Port Alberni.

Ongoing land claims negotiations with the province and the federal government could result in a settlement including title to additional blocks of land sufficient to house all First Nations members in low-density pattern of development. However, implementation of a compact development pattern would provide very significant cost and emissions benefits, and preserve significantly more reserve land for other uses.

Ideally, new development at a density of 20 units per hectare which would allow for cost effective transit for the area. This new development would take place on land situated as near the City of Port Alberni as possible, in order to utilize the amenities (schools, grocery stores, work, etc.) that are already provided in the city.

This report recognizes that for many people, ownership of a separate house on its own plot of land is strongly associated with values such as freedom, independence and connection to the land. Regardless of the benefits that are noted below, the price of giving up more space may be too high for the community. It is important to remember that any decision about moving to more compact development patterns is a decision that should be made by the community, and that the community should be guided by its own values and aspirations for the future.

Costs and benefits of measure

It is very difficult to accurately calculate the costs and benefits of increased energy efficiency standards and compact development patterns in future projects in the absence of specific proposals or site plans. However, it is clear that the cost savings and emissions reductions achievable through this approach are quite substantial.

One report recently produced for agencies in California estimated that the financial benefits of green design were ten times greater than the additional construction costs involved in construction, and estimated the benefits to be as great as US$70 per square foot in a LEED building. The benefits accounted for included cost savings from reduced energy, water, and waste; lower operations and maintenance costs; and enhanced occupant productivity and health.[9]

In similar fashion, a survey of reports calculating the cost benefits of compact development reported that per-unit infrastructure costs in compact developments were reduced by an average of 32% as compared with business-as-usual development patterns, that transportation miles traveled decreased by 17%.[10]

[9] Source: The Costs and Financial Benefits of Green Buildings, October 2003, http://www.usgbc.org/Docs/News/News477.pdf

[10] "Exploring the Benefits of Compact Development", 29 August 2003 http://www.ipa.udel.edu/students/mix/Benefits_of_Compact_Develop.pdf

This report recommends that the Community Energy Planning Manager further investigate established energy efficiency standards, and that a standard be recommended for all developments undertaken by the First Nation.

Implementation

There are already a number of innovative green buildings in British Columbia, and several of these are the result of First Nations initiatives. The Seabird Island First Nation near Chilliwack has recently completed a group of seven townhouses incorporating simple but effective energy efficiency and renewable energy technologies. The Morricetown Band of the Wet'suwet'en Nation near Hazelton recently constructed a green Community Hall heated with a ground-source heat pump system that dramatically lowers heating costs.

INAC presently has no provision to provide increased funding for green building projects. The Seabird Island project benefited from funding by the Canada Mortgage and Housing Corporation (CMHC), which funds several demonstration housing projects in Canada each year. In recent years, CMHC has funded a number of projects, which demonstrate energy efficiency and renewable energy technologies, green building technologies, and "healthy housing" approaches.

With regard to compact development, INAC financial contribution to new housing units can provide a powerful incentive for densification. As discussed above, a compact development pattern substantially lowers infrastructure provision costs within serviced areas. Because the INAC funding is provided on a per unit basis, and because a significant portion of total housing costs are spent on providing infrastructure, a compact development pattern for new housing means these contributions can cover more of the house itself. This could result either in a less expensive housing, with lower costs borne by the community, or more house for the same financial contribution from the community, as compared with a lower density development model.

None of the options highlighted above effectively deals with the most significant barrier to wider implementation of cost-effective energy efficiency and renewable energy technologies in new construction – the high initial capital cost of these technologies. As has been stated above, there is not currently a stable source of funding or financing for these technologies. However, the Hupacasath First Nation will be receiving a large amount of energy-related income in the form of payment from BC Hydro for the electricity generated by the China Creek Hydroelectric Project. This report recommends that the Community Energy Planning Manager investigate the feasibility of setting aside a modest portion of the income from the China Creek small hydro project as seed capital for a revolving fund to finance cost-effective energy efficiency and renewable energy components in all future Hupacasath First Nation developments. It is suggested that money from this fund could be used to pay the up-front capital costs of energy efficiency for renewable energy components in future Hupacasath buildings. The fund would also be used to pay the actual monthly energy bills of the constructed building. The Hupacasath First Nation would then repay the fund in monthly installments at a rate lower than that the projected business-as-usual energy cost for that building, but considerably higher than the actual resulting energy cost.[11]

5.3.3 Package C

The final package is also the most comprehensive package of the three. It states that energy efficiency will be built into every new building situated on any of the HFN's reserves.

5.3.3.1 Renewable Energy

As outlined in Chapter 4 above, the Hupacasath First Nation is already committed to the development of the China Creek green hydroelectric project, and has received the offer of a 20-year purchase contract from BC Hydro for power produced by the facility. Given the large size of the China Creek green hydroelectric project, which is far in excess of the energy demands of the Hupacasath First Nation, and the low power production costs projected for this project, no renewable energy technology are required in this plan.

5.3.3.2 Energy Efficiency

All cost-effective retrofits for existing buildings have been highlighted in Packages A and B. By contrast, energy efficiency measures for Package C focus on new development. These energy efficiency gains would be obtained through the development and implementation of energy efficiency standards for all new development on HFN reserve lands. In contrast to Package B, these energy efficiency standards would regulate all future development on all reserve lands and owners, including all Certificate of Possession lots. Development and adoption of this form of development standard should provide very significant energy-efficiency benefits for all future development, exceeding the benefits gained from the retrofit measures in Packages A and B, since in almost all instances, installing retrofits is more expensive than installing energy efficient materials during original construction.

Transportation and Land Use

Implementation of Community Energy Planning

Discussion of measure

The intent of this measure would be to regulate all future development on Hupacasath First Nation reserve lands, including all Certificate of Possession lots. If it could be implemented, this measure would be equivalent to the long-existing land use and zoning bylaws, which regulate all development within the City of Port Alberni and the Regional District of Alberni-Clayoquot. Because few Canadian municipalities have included energy management as a component of their bylaws and development standards, this level of commitment would truly place the Hupacasath First Nation at the forefront of all Canadian communities.[12]

[11] This approach has been adopted on a large scale in Toronto (the Better Building Partnership) with great success (source: http://www.city.toronto.on.ca/wes/techservices/bbp/index.htm).

In principle, through its constitutionally protected right to self-government, the Hupacasath First Nation has all the mandate it requires to develop and implement a Community Development Plan in line with community energy planning principles, referred to as a Community Energy Plan below.

Section 60 (1) of the *Indian Act* states that the Governor in Council may, upon the request of the band council, grant the band "the right to exercise such control and management over lands in the reserve occupied by the band as the Governor in Council considers desirable."

Further, Section 80(1) of the Indian Act states that a First Nation may enact by-laws provided that they are not inconsistent with any regulation created by the Governor in Council of the Minister pertaining to the following areas:

(g) the dividing of the reserve or a portion thereof into zones and the prohibition of the construction or maintenance of any class of buildings or the carrying on of any class of business, trade or calling in any such zone

(h) the regulation of the construction, repair and use of buildings, whether owned by the band or by individual members of the band

In addition to these regulations, INAC is officially committed to fostering goals of sustainable development and increased self government within First Nations communities. Unfortunately, it is not clear whether the federal government would be supportive of or obstructive to the Hupacasath First Nation in implementing a comprehensive community energy plan for future development. The INAC website pointedly states that "It is not likely that First Nations have the delegated authority to adopt … standards for fire safety, occupancy, building services, structural design, environmental separation, hazardous materials and energy conservation … even if they chose to do so."[13] There is a clear need to explore this issue in greater detail with INAC

There are at least two First Nations governments in British Columbia which currently have well-developed land use and development control more than sufficient to develop, implement and enforce a Community Energy Plan, although neither have thus far adopted land use bylaws or development standards which address energy issues. The Westbank First Nation has recently developed an extensive bylaw and land use framework, including development standards addressing roads, lighting, water and sewerage. However, this regulatory structure appears to be founded not on the Indian Act as much as on the impending Westbank First Nation Self-Government Act, a recently negotiated agreement specific to that First Nation. More promisingly, the Kamloops Indian Band also has a large Land Use and Development regulatory framework, which appears to be based on the provisions of the Indian Act alone. It should be noted that both of these First Nations have a population and reserve land base relative to the Hupacasath First

[12] The City of Vancouver is notable for setting more stringent energy-efficiency standards for new development than required by the province.
[13] Source: Backgrounder - Public Works Function in Self-Government, Jan 6, 2004 http://www.pwgsc.gc.ca/rps/inac/content/docs_governance_backgrounder_part4-e.html#backg4-3

Nation, and derive considerable income from leases to non-aboriginal businesses – income that helps fund the more extensive governance structures of these First Nations.

Given the uncertainty at this stage of investigation regarding the ability of the Hupacasath First Nation to implement and enforce a Community Energy Plan, further research and consultation with INAC is required before work on any plan or development standard itself could start. This stated, the Hupacasath First Nation may have a sufficient mandate to develop a comprehensive Community Energy Plan for future development, and INAC's recent commitments could provide critical administrative and possible financial support to this end. The result could be a Hupacasath First Nation Community Energy Plan setting out minimum standards for energy efficiency in all new on-reserve development, providing strategic guidance towards a cost-effective, reduced GHG-emission development future.

Costs and Benefits

As noted in the Land Use measure in Package B, the benefits of this measure promise to be very substantial, but at the present stage of investigation, it is very unclear what level of cost and effort would be involved in successfully developing and implementing a comprehensive community energy plan for future development.

Implementation

This report recommends that the Community Energy Planning Manager further investigate the possibility of developing and implementing a comprehensive community energy plan for future development.

Conclusion

The following table illustrates the annual estimated benefits of Package A and B compared with the current consumption levels.

Figure 5.1 Annual Estimated Benefits of Package A & B

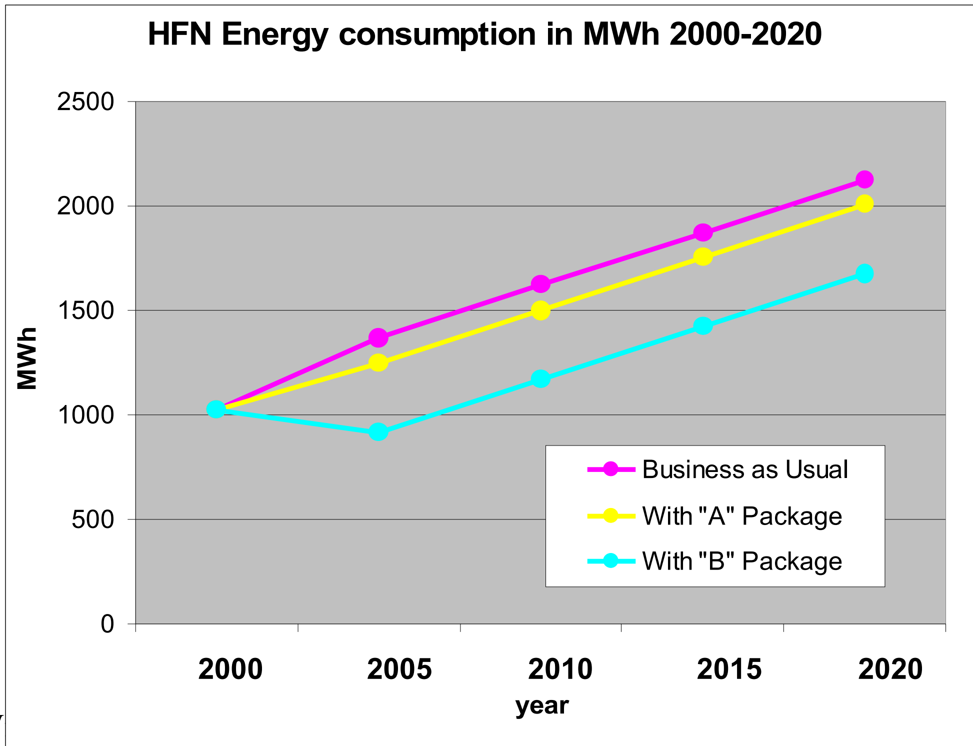
Annual Estimated Benefits of "A" and "B" packages

(compared with current consumption)

	"A" Package	"B" Package
Energy reduction (kWh)	**118000 kWh**	**485000 kWh**
Energy reduction (%)	**5%**	**21%**
GHG reduction (kg)	**9,000 kg**	**59,000 kg**
GHG reduction (%)	**2%**	**11%**
Cost reduction ($)	**$6,500**	**$33,000**
Cost reduction (%)	**4%**	**22%**

Benefits of "C" package should be much greater than "B" package

Figure 5.2 Projected HFN Energy Consumption 2000-2020



W an that of "B". The reason that the graph continues to move upwards after 2005 is simply due to increases in the population of the Hupacasath First Nation.

5.4 Conclusion

When community members attending the HFN Energy Forum were asked to make a selection of the options presented to them, they unanimously supported implementation of Package C in addition to Packages A and B. Through choosing Package C, the HFN membership laid the groundwork for the next tasks to come. Although Package C consists of a lot of work, the HFN came to the conclusion that the benefits far out weigh the costs. As one member stated "These packages make sense for everyone." As seen in the community surveys, and confirmed at the Energy Forum It is clear that the HFN membership understands that our attitudes regarding energy efficiency and renewable energy need to be adjusted, and that the benefits of a more energy wise community are worth the changes involved.

6 Conclusion

6.1 Net energy Balance

The HFN through the operation of the China Creek Small Hydro project will be generating considerably more power than they will consume. However, the HFN is still a net contributor of GHG emissions and local air contaminants through their everyday consumption along with their involvement with the Eagle Rock Quarry project. This is so, due to the HFN, as part of their deal with the China Creek project, will be selling any and all of the GHG credits that they would have received in order to generate income. Therefore, reducing GHG emissions is still a primary objective of the HFN, and through reducing energy consumption the HFN will be able to take energy savings and reintroduce them into such programs as laid out in the fore-mentioned energy options that were presented to the community. The project however, did not allow for the calculation of the total GHG emissions of the Eagle Rock Quarry, and therefore a net GHG and air pollutant emissions illustration was not possible.

6.2 Findings and Recommendations

Throughout this document there have been key findings and a lot of recommendations that can be made due to the community giving direction to move towards achieving the outcome of what Package C would offer. The following is an overview of those findings and the recommendations to go along with them.

This report recommends:]

Immediate implementation of Package A measures, including:

A. Installation of quick and easy energy efficient measures for all on-reserve homes. These measures consist of the installation of CFL's, the installation low-flow showerheads, and the insulation of hot water tank and adjoining pipes. . As part of implementing this measure, the Community Energy Planning Manager would ensure that each homeowner would also be educated on the description of each measure and how much energy they will save by having them installed.
B. Immediate implementation of the quick and easy energy efficiency measures for community buildings. The Community Energy Planning Manager should provide reminders to staff in all community buildings to remind them to turn off lights in unoccupied rooms as well as turning down thermostats after work. The Community Energy Planning Manager should also directly oversee implementation of the manual ventilation switch at the House of Gathering, and the installation of CFL lighting and hot water tank insulation at the Old Hall. The Community Energy Planning Manager may also choose to install sensor lights for community building bathrooms to ensure that the lights are off when these rooms are not in use.

Coordination and Implementation of Package B measures, including

C. EnerGuide audits for all houses on reserve that have not yet been assessed which would be arranged by the Community Energy Planning Manager. These audits are crucial to determine where the house is losing heat and leaking air. Thirteen home audits have already been performed for the Community Energy Planning process, so only 32 need to have such audits done. It is further recommended that the Community Energy Planning Manager arrange for houses to receive the secondary audit once upgrades have been completed on these houses.

D. Install draft proofing, replace inefficient windows, and insulate crawlspaces and attics of all houses as recommended on all houses that have received EnerGuide audits. Not only do these actions save energy costs, but they also provide the homeowner with a much more comfortable home to live in. The Community Energy Planning Manager…

E. Replace any out-dated wood stoves with newer more efficient ones as today's woodstoves are much more efficient (produce more heat with less wood) and healthier than past models. Such an initiative would also lead to cost savings (less wood) and better air quality.

F. Replace all Oil Furnaces with more cleaner and efficient Natural Gas Furnaces, which would lead to significant energy savings per year. With this option there are also rebates in which the individual could apply for.

G. Upgrade inefficient refrigerators and other appliances within the house to more energy-efficient models, and get rid of unneeded extra appliances. This would involve the free disposal of a person's secondary refrigerator through BC Hydro's Fridge buy-back program. This program offers the homeowner $30 for their old fridge and then takes the fridge and disposes of it. Benefits are greatest for fridges more than 10 years old.

H. Install individual wall thermostats for baseboard heaters in the Hupacasath House of Gathering as well as a hot water re-circulation pump.

I. Oversee the installation of a bus shelter providing adequate shelter from the rain on reserve land along River Road and investigate the installation of a second bus shelter along Compton Road.

J. Support HFN members with automotive skills by approaching them with possibly building some sort of garage for them to perform engine tune-ups for band members in need of such services. Community Energy Planning Manager would investigate a program in which the Hupacasath First Nation could work with the local mechanics to set up and publicize high-quality engine tune-ups at a reasonable cost to local Hupacasath members

K. Investigate the possibility of setting up a small automobile cooperative for Hupacasath members, by determining the level of community interest in such a program, and the cost of setting up such a program.

L. Further investigate established energy efficiency standards, and that a standard be recommended for all developments undertaken by the First Nation.

M. Investigate the feasibility of setting aside a one-time lump sum from this income source as capital for revolving fund to finance cost-effective energy efficiency and renewable energy components in all future Hupacasath First Nation developments.

Coordination and implementation of Package C measures, including:

N. Further investigate the possibility of developing and implementing a comprehensive community energy plan for future development.

O. Creating an ongoing Community Energy Planning Manager as a position to coordinate, implement and monitor effectiveness of Package A, B and C measures.

P. Applying for additional funding to fund the work of the Community Energy Planning Manager, implement package B measures, and to further develop the measures outlined in Package C.

6.3 Next Steps

The next steps for the HFN are to have Chief and Council formally adopt this report at the next council meeting. Also the Community Energy Planning Manager will now begin looking into the second phase of funding through ANCCP which is now ????, as well as other funding sources in order to start implementing the recommendations set forth in this report.

Also work will continue on the community consultation and educational aspect of the CEP, by continuing to inform community members of what they can be doing to change how they view energy and showcase the savings that can be had by simply changing one's lifestyle.

Completing regulatory and financial work pending on the proposed China Creek small hydroelectric dam, and building this "green" power-generation facility will also be a main focal point in the next few months as the project wants to be up and running by 2005.

The implementation of Package A energy efficiency measures are currently in the stages of finding funding to help offset the costs of installing these measures, and should be implemented within the next couple of months. Another major priority is to raise funds for implementation of Package B energy efficiency measures which would lead to having the groundwork in place to go ahead in the developing of a land use and development bylaw for HFN lands, which would be the starting point for the options that were presented in Package C.

<u>Appendix A:</u>

Hupacasath First Nation Community Energy Plan
Energy Efficiency Options Assessment
Assumptions and Calculations, Notes and Additional Information

1.0 Home Building Envelope Energy Upgrades

Assumptions and Calculations

The following contractor's quotations for energy retrofits to six homes were used to calculate the economics of the upgrades.

Home Pride Improvements Contractor Quotations for Retrofits

Home	Measure	Capital Cost	% Savings on Space Heating	Annual Heating Cost Estimate*	Annual Savings
Tom Tatoosh	insulate floor joists, **or**	$1,879	37%	$1,334	$493
	insulate crawl space walls with rigid R12	$1,248	37%	$1,334	$493
G Hamilton	reduce air leakage by 50%	$800	25%	$1,524	$381
	add attic insulation	$942	8%	$1,524	$122
J Sayers	reduce air leakage by 50%	$650	20%	$1,450	$290
	insulate crawl space walls with rigid R12	$1,860	13%	$1,450	$189
Hupacasath Old Office	reduce air leakage by 50%	$1,100	23%	$700	$161
	replace 6 windows	$3,160	29%	$700	$203
J McCarthy	reduce air leakage by 50%	$1,050	24%	$1,250	$300
	insulate basement walls with rigid R12	$1,800	20%	$1,250	$250
B Hamilton	insulate basement walls above and Below grade with rigid R12	$2,375	37%	$1,500	$555

Return on Investment, Net Present Value and Simple Payback were calculated using NRCan's *RETScreen* software tool. The following are financial parameters assumed for this analysis:

Energy cost escalation rate	3.5%
Inflation	2.0%
Discount rate	5.0%
Project life	20 yr

The project life refers to the estimated lifetime of the particular retrofit or appliance under consideration.

Calculation for a Weighted Average GHG Emission Factor

Fuel	Percentage of Homes	Emission Factor (kg/kWh CO_2)
Electric	80.9%	0.074
Gas	8.5%	0.176
Oil	10.6%	0.254
Weighted average:		**0.102**

2.0 Home Building Envelope Energy Upgrades – Community Wide Estimates

Assumptions and Calculations

The following lists potential space heating savings identified in the 13 EnerGuide for Houses Evaluations. We have made a subjective selection of the one or two retrofits, which we believe the homeowner might choose based on best economic returns, and then calculated an average potential savings per home. The average was then simply multiplied by 47 homes to calculate the community savings. (Note there are some additional improvements identified in the EnerGuide Evaluations, which the homeowner could also choose to implement.)

Priority Improvements Results from the 13 EnerGuide Audits

Owner	Estimated Annual Heating Cost	Potential Savings on Space Heating	1 or 2 Priority Improvements Identified
Buddy Hamilton	$1,500	37%	Insulate walls above and below grade
Danny Watts	$1,100	19%	Insulate walls above grade
Diana Evaniuk	$300	0%	No compelling priority improvements
George Hamilton	$1,524	33%	Air leakage, attic insulation
Heather Joseph	$700	30%	Replace windows
Jennifer McCarthy	$1,250	45%	Air leakage, insulate walls above and below grade
Judy Sayers	$1,450	38%	Air leakage, insulate walls above and below grade
Ken Tatoosh	$700	8%	Insulate walls above grade
Maggie Lauder	$500	32%	Replace windows
Mark Joseph	$300	37%	Replace windows
Shawn McAnerin	$400	11%	Insulate attic
Tom Tatoosh	$1,334	37%	Insulate floor joists
Tooie Casavant	$700	33%	air leakage
Average	**$904**	**28%**	

3.0 High Efficiency Wood Stoves

Notes

1. Wood stoves are generally tested for particulate matter emissions expressed as grams per hour. Typical emissions for conventional wood stoves are 60 g/hr, and for EPA stoves 2-7.5 g/hr. Other gaseous emissions related to incomplete combustion, CO, CH_4 and VOCs would likely be reduced in similar proportions. GVRD's emission factor of 15.3 kg/ton of wood is assumed to be for conventional wood stoves.
2. Canadian Lung Association web site
3. Assumed average cost per cord firewood on Vancouver Island is $150.

Assumptions and Calculations

We have used the GVRD's PM emission factor of 15.3 kg/ton of wood, and assumed this to correspond to a 60g/hr PM emission rate from a conventional wood stove.

One chord of firewood weighs 1.089 tons (Source: Pembina)

Price of firewood: $150 assumed for delivered split mixed hard and softwood on Vancouver Island.

EPA Wood Stove Price:
"Vista model, made by Pacific Energy, costs $783 at Pioneer Fireplaces in Parksville, (250) 954-0331.

Financial Parameters:

Energy cost escalation rate	3.5%
Inflation	2.0%
Discount rate	5.0%
Project life	15 yr

Additional Information

Particulate Matter Levels in Port Alberni
The following summary on particulate matter air quality has been excerpted from the BC Ministry of Environment web page. This publication can be found at the web site:
http://wlapwww.gov.bc.ca/air/particulates/aqrfbcfp/aqrfbcp.html#PtAlberni

5.3.4 Port Alberni Courthouse Monitoring Site

The Courthouse site is one of the oldest monitoring sites for fine particulates in the provincial network, with measurements dating back to February 1985. Reflecting the previous definition for "inhalable particulates," the early measurements are believed to be for PM_{15}, i.e. particles 15 µm and smaller in diameter. The current analysis is restricted to data from 1990 onwards, which are known to represent PM_{10}. Data are summarized on an annual and a monthly basis in Figure 7.2 and in Appendix II.

Data capture has been satisfactory since 1993. PM_{10} levels at this site have been very low relative to other areas of the province, particularly over the past two years. In 1994 and 1995, no exceedances of the air quality objective for PM_{10} were reported. Mean concentrations ranged from 11-13 µg/m^3. The number of annual PM_{10} increments was less than 10, which is a significant decrease from the over 200 increments estimated for 1993.

> On a monthly basis, mean PM_{10} concentrations were highest in December-February (24-25 μg/m^3) and lowest during April-August (12-15 μg/m^3). The maximum-recorded concentration was 81 μg/m^3 in June 1992. Exceedances of the air quality objective were observed during the months of January-February, June and October.

<u>The Cost of Heating with a High Efficiency Wood Stove is Economical</u>:

We note that heating with a high efficiency stove is the least expensive method compared to heating with fossil fuels or electricity. Assuming 1 cord of mixed hardwood and softwood costs $150 and contains 5500 kWh of energy (NRCan), a 70% efficient wood stove runs 50% cheaper than heating with electricity. Cutting, splitting and seasoning the wood on one's own can reduce the cost even more, depending on what price one's own labor is valued at.

The downside of wood heating is that burning wood inside the home can be unhealthy for occupants, due to the smoke and other toxic gases released during burning (Canadian Lung Association).

4.0 Residential Lighting – Compact Fluorescent Light Bulbs

Assumptions and Calculations

The average life of an incandescent bulb is 750 hours and 8,000 hours for a CFL (BC Hydro). The cost of a 75-watt incandescent bulb is estimated at $0.70 (BC Hydro) and $6.98 for a 20 watt CFL (Home Depot's price).

A CFL is assumed to consume 26.7% the energy of an incandescent bulb based on Manufacturer's data. (Some bulbs are even more efficient.)

The estimated number of light bulbs, wattages and time of usage were taken from the Energy Baseline Spreadsheet, which represents 21 surveyed homes. The calculated total annual energy consumption for 21 homes is 25,025 annual kWh for kitchen, living room and general indoor locations, and 43,415 annual kWh for entire homes.

Financial Parameters:

Energy cost escalation rate	3.5%
Inflation	2.0%
Discount rate	5.0%
Project life	Based on CFL bulb lifetime of 8000 hours

5.0 Low-Flow Showerheads

Assumptions and Calculations

The average number of occupants reported in the community was 3 people per home. Our estimate of average shower duration is 7 minutes. BC Hydro uses an estimate of 10

minutes for shower duration (see
http://www.bchydro.com/powersmart/elibrary/elibrary699.html).
21 minutes of total daily showering is assumed as an average per home with three occupants each.

The average annual cold city water temperature assumed to be 10˚ Celsius. The average hot water tank temperature assumed to be 60˚ Celsius. The heat capacity of water is 4.2 kJ/kg -˚ C.

Financial Parameters:

Energy cost escalation rate	3.5%
Inflation	2.0%
Discount rate	5.0%
Project life	10 yr (assumed lifetime of low flow showerhead)

6.0 Front-Loading Clothes Washers

Assumptions and Calculations

Our estimate of Annual Energy Consumption for typical 1990 and 1996 clothes washers are the published average EnerGuide ratings
(See http://oee.nrcan.gc.ca/Equipment/english/page27.cfm?PrintView=N&Text=N)

The new 2003 front-loading washer models used as examples for the analysis were:
Frigidaire 3.1 cu. ft. Gallery™ Series I.E.C. Extra-Large Capacity Front Load Washer - $876
or
Kenmore 3.1 cu. ft. IEC Extra-Large Capacity Front Load Washer - $900.00

The conventional 2003 top-loading model used for example was the:
Kenmore 'MORE VALUE' Top Load Washer 3.2 cu.ft. - $699.

All three models are available at Sears.

Front load washers use up to 2/3 less soap (see http://www.bchydro.com/rx_files/pshome/pshome1584.pdf). We have assumed 50% less soap. The price of soap based on a 2.2kg box of Sunlight costing $7.99 or $0.35 per load. EnerGuide energy ratings for washers are based on 392 loads per year.

Front loading washers spin approximately 40% faster than top-loading machines and therefore have been proven to remove more moisture from clothes. No data was available so we arbitrarily estimated that dryer time is reduced by 20% compared to using a top-loading washer.

Financial Parameters:

Energy cost escalation rate	3.5%
Inflation	2.0%
Discount rate	5.0%
Project life	14 Years (BC Hydro average lifetime estimate for washers)

7.0 Fridges and Freezers

Assumptions and Calculations

Typical Annual Energy Consumption estimates for pre-1998 and 1998 models are BC Hydro estimates (see http://www.bchydro.com/powersmart/elibrary/elibrary704.html). The 2003 model used for example is the "Kenmore 18.4 cu. Top freezer with ice maker" available at Sears.

Financial Parameters:

Energy cost escalation rate	3.5%
Inflation	2.0%
Discount rate	5.0%
Project life	17 Years (BC Hydro average lifetime estimate for fridges)

8.0 Hot Water Tank Insulation

Assumptions and Calculations

Typical annual hot water energy consumption is 5770 kWh based on 225 liters of 60˚ C hot water per home per day (NRCan's standard day estimate). The average annual cold city water temperature is assumed to be 10˚ Celsius. The heat capacity of water is 4.2 kJ/kg -˚ C. The average hot water tank "Energy Factor" (the annual efficiency) is 83% based on EnerGuide for Houses.

BC Hydro estimates that tank wrap can reduce hot water heating energy consumption by 9% (see http://www.bchydro.com/powersmart/shop/shop720.html). Therefore potential annual savings is 9% of 5770 or 520 kWh.

The price of a package of pre-cut hot water tank reflective insulation for a 60-gallon hot water tank is $35.00 from Home Depot.

Financial Parameters:

Energy cost escalation rate	3.5%
Inflation	2.0%
Discount rate	5.0%
Project life	7 years

8.0 Fuel Switching

Oil Furnace to Natural Gas Furnace

Assumptions and Calculations

Oil – assumed winter price of $0.60/litre, energy content is 0.0385 GJ/liter, assumed furnace efficiency is 69% based on the EnerGuide for Houses audits.

Natural Gas – current cost is $12.55/GJ. The 94% efficiency estimate for condensing furnaces is from Terasen.

The estimated space-heating load of 76 GJ is based on NRCan's published estimate of 85 GJ for an "Old Detached 2000 sq. ft. House in Vancouver/Victoria". The homes using Oil heating in the community are older homes, which are approximately 1800 square feet in size.

Natural Gas Furnace Installation Cost

New Condensing Gas Furnace	$3,500
Provincial Government Greenchoice Grant	$600
Terasen Grant	$300
Total Cost	**$2,600**

The installation cost estimate was provided by Alberni Valley Refrigeration (250-723-1335).

Financial Parameters:

Energy cost escalation rate	3.5%
Inflation	2.0%
Discount rate	5.0%
Project life	12 years (estimated lifetime of natural gas furnace)

<u>Appendix B:</u>

Hupacasath First Nation Community Energy Plan
Hupacasath First Nation Energy Planning Newsletter #1

Hello Community Members

This newsletter is intended for all Hupacasath band members and will contain information about the Hupacasath First Nation Community Energy Plan as well as the energy planning process, and timelines.

This is issue number one of possibly 4 or 5, and is meant to serve as an introduction of where we are now, as highlighted below. I will also be including descriptions of various renewable energy options in order to better prepare ourselves for when it comes time to choose what options we want to pursue in our territory. These newsletters will also contain ways (both free and with $$) in which we can make our homes more energy efficient, which in the long and short run will save your household money, and help better our environment.

COMMUNITY ENERGY PLAN

- The reasons for entering into this project are:
    - We wanted a positive response to the GSX controversy

- To obtain "green" energy to power our needs
- To create economic development options with the excess power that we can then sell

- The goals of the Community energy plan are as follows:
  - To create a greater awareness of energy efficiency and green energy solutions to climate change
  - To meet a majority or all of the reserves energy needs
  - To be a model for the community, Port Alberni, as well as other communities
  - To leverage financing for the China Creek small hydro project
  - To achieve a moderate Greenhouse Gas emissions reduction target of "1-tonne challenge"
  - To build expertise within the community, which can be exported to other communities

COMMUNITY ENERGY ADVISORY GROUP

- HFN Community Energy Advisory Group has been formed and has already had their first meeting. This group consists of representatives from:
  - Chief and Council
  - Pembina Institute
  - Youth
  - INAC
  - Terasen Gas
  - City of Port Alberni
  - Regional District of Alberni-Clayoqout
  - Community Energy Association

- The purpose of this advisory group is to identify economic, environmental and social objectives for the project and work with the project partners to ensure that those objectives are met and various stakeholder interests are considered.

ENERGUIDE AUDITS &
ENERGY DEMAND SURVEY

- The purpose of these is to:
  - Educate homeowners on the purpose of the CEP program
  - Create a baseline account of:
    - Energy consumption
    - GHG emissions
    - Pollutant emissions
  - Understand members' attitudes towards energy and usage.
  - Identify ways to help members save energy in their homes.

    - Obtain community member's traditional information on climate change within the Hupacasath traditional territory, and how it has affected them.
- These audits are set to begin on Thursday May 22, 2003 and are going to continue on May 23rd, May 27th, and May 30th.
- All of the houses were selected through a cross-section of all houses on our reserves, and the owners have already been contacted to set up dates and times.

Community Forum

- The purpose of the community forum is to present the community members with all of the information that we have gathered over the past few months, along with any of the sustainable energy options that the Hupacasath First Nation could pursue within their traditional territory. These "options" will then be graded by those in attendance on how important they are to the whole community.
- This forum will also provide various educational materials for the community members to go over and look at.
- The forum will follow the same general format as the community development plan, whereas everybody in attendance has the opportunity to provide input into the Community Energy Plan
- The community will then steer us in the direction that they see fit, and we will then start work on the final draft.
- The forum is scheduled to take place in either late September or early October.

My thanks are extended to all those who have been so co-operative in letting us in their homes, therefore, making this whole process that much easier. I will be in contact with all households over the next week in order to see how progress is coming with regards to the energy demand survey that was distributed to all houses on May 18th.

I will be available for any questions at either of the following numbers:

Work: 724-4041 ext. 22
Cell: 720-5972
Home: 723-1269
E-mail: hamiltona@shaw.ca

The following is some suggested reading from the Pembina Institute, who are aiding us in the community planning process. It has been used from and is available via internet at:

www.re-energy.ca

Also worth checking out is the Pembina Institute web page at:

www.pembina.org

Water Power

All around planet Earth, water is on the move. In rivers and creeks, water flows downhill under the force of gravity. It starts off as rain or snow falling on the highlands and mountains. Running water forms tiny rivulets and streams, which gather to form large rivers. Most rivers find their way to the edges of the continents, where they dump massive loads of fresh water and sediments into the oceans. Evaporation from the surface of rivers, lakes, and oceans brings the water back into the atmosphere as invisible water vapor. Under the right conditions, unseen water vapor condenses from the air to form clouds and possibly rain, snow, or hail. Seasonal rain and snowfalls bring fresh water back to the headwaters of streams, completing a very important ecological system called the "hydrologic cycle." By bringing fresh supplies of water to the highlands, the Hydrologic cycle ensures that we always have energy available from flowing water.

Rivers and streams are among nature's most powerful forces. The force of water moving down a moderately sized river can exceed several million horsepower. Over time, this force can slice through mountain ranges, and haul billions of tons of soil and debris to the oceans. This is the force humans attempt to harness when they build dams to generate electricity.

Rivers are the most familiar form of water in motion, but there are others. Ocean waves, tides, and currents move unimaginable amounts of water around every day. Currents and waves are usually caused by winds blowing over the surface of the ocean, while tides are caused by the moon's gravity pulling gently on the earth. The action of waves, tides, and currents is especially noticeable near coastlines and islands, where they cause significant erosion.

Moving water is an important source of mechanical energy. Water is very dense compared to air, and flowing water carries with it far more energy than a similar volume of moving air. Humans have long appreciated the power of moving water, and have been using it for thousands of years.

The oldest machines for capturing the energy of moving water were waterwheels. In the days before electricity, it was common to use water wheels to provide the power for mills that ground grain or cut lumber. To start the mill, the miller simply opened a gate to let the water flow over the top of the wheel. The water wheel was connected to a massive millstone or metal saw blade through a system of gears. Water for the wheel usually came from a small dam and reservoir, called the millpond. Canada has more fresh water in its lakes and rivers than any other country in the world. Many of Canada's largest rivers have been used to produce electricity. In fact, 61% of Canada's electricity comes from the energy of falling water. Electricity generated this way is called **hydroelectricity**.

Hydroelectric facilities often depend on a dam to raise the level of the water in the reservoir. Water from this reservoir is allowed to fall through huge pipes to a building that houses water-driven turbines. Pressure from the falling water spins the turbines at high speed. The turbines are connected to huge generators that make electricity as they turn. This electricity is carried to cities and towns that may be located hundreds or even thousands of kilometers away.

Large-scale hydro usually has a big impact on the ecology of the river upstream from the dam. When the reservoir is filled, areas of forest or farmland are covered by water. Dams block the natural migration of fish and other creatures up and down the river, and replace a flowing water ecosystem with an artificial lake. Salmon, which travel up rivers to spawn, are particularly affected by this ecosystem change. To reduce the impact of dams on salmon, some dams are equipped with "fish ladders"-narrow artificial streams up which the salmon can swim to get around the dam.

There can also be environmental problems downstream from the dam. Operations of the dam and generating station often cause the water level in the river to rise and fall drastically on a daily basis. Many organisms including most fish are not well adapted to such frequent and severe changes in water levels. Rivers that experience these changes usually contain far fewer organisms than they would without the dam and reservoir.

One of the most environmentally friendly ways to make electricity is with a device called micro-hydro turbine. The turbine itself may be as small as 10 centimeters in diameter, and consists of spoon-shaped cups arranged around the center of a wheel. The wheel is mounted on a shaft that turns smoothly on sealed bearings. Jets of high-pressure water cause the wheel to spin at high speed. The spinning shaft can be used to power a variety of machines, including electrical generators, woodworking tools, pumps, fans, and more.

For communities in remote mountainous regions, small-scale hydro systems have a number of important environmental and social advantages:

• Micro-hydro is simple to install and maintain. The pipes, generators, and other parts are usually cheap and easy to find, and are small enough to be handled without heavy equipment. This is especially helpful in areas where the terrain makes it expensive and difficult to build complex structures.
• Micro-hydro is environmentally friendly. It produces no pollution, and requires only very slight changes to the flow of a small stream. No large dam or reservoir is necessary.
• Because the electricity is produced very close to where it is used, there is no need for an expensive electrical transmission line to carry the electricity to the community from far away.
• Micro-hydro systems are built with simple technology, making it possible for local people with basic training to maintain their own power systems. This reduces the

community's dependency on outside sources of energy, and provides valuable local jobs.

Wind Energy

The sun has a lot to do with creating winds. Winds above continents and oceans occur because of temperature differences around the world. Some places, especially those near the Equator, receive far more direct sunlight than those closer to the Earth's north and south poles. As a result, the air over these areas warms up and air from the surrounding area rushes in to fill the space left by the rising air, creating a surface wind. Air is constantly on the move. In some places, especially along coastlines and in mountains, it provides a highly reliable source of mechanical energy. Humans have invented an amazing array of devices that can harness the energy of the wind and put it to practical use.

One of the oldest uses of wind energy is transportation. The first primitive sails were probably made from woven mats held aloft by wooden poles or human hands. Modern sailboats have very efficient sails and masts constructed from strong, lightweight materials such as Kevlar (the material used in bulletproof vests) and titanium. They work like aircraft wings to generate forces that pull the boat in the desired direction.

Long before the invention of electricity, early wind turbines did very useful work. Windmills were used in many places in Europe over the last several centuries to turn heavy granite disks called millstones. The millstones were used to crush dry grains such as wheat, barley, and corn to make flour or meal. The Netherlands is famous for its windmills. In truth, most of these structures are not mills at all, but water pumps. The Dutch created new farmland along the coast by building dikes around low-lying estuaries and mudflats and pumping out all the seawater. The "windmills" provided a steady supply of mechanical energy to lift seawater into the canals, allowing the new farmland to dry out.

In the past, windmills were common on farmsteads across Canada. They were often used to pump water from wells to watering troughs for cattle and to generate electricity at the farmhouse. When rural areas finally received electricity, many of these windmills fell into disuse and disrepair. Recently however, small windmills are becoming popular once again for bringing water to livestock.

One of the most popular uses of wind turbines is to generate electricity. To make electricity, the shaft of the turbine must be connected to an electrical generator. Through gearboxes, the generator converts the mechanical energy of the spinning turbine shaft into electricity. Generators are small and light enough that they can be housed under an aerodynamically designed cover at the top of the pole or tower. Wires running down the tower carry electricity to the grid, batteries or other appliances, where it is stored, and/or used.

Electricity is now being generated on a commercial scale at large installations called "wind farms" in several places around the world. Wind farms consist of rows of towers, sometimes 90 meters high, equipped with giant wind turbines for producing electricity. In Canada, the first commercial wind farm was built in southern Alberta near the town of Cowley, in a region famous for its strong, steady winds. Commercial wind farms have also been established in Germany, Denmark, the United States, Spain and India. Denmark and Germany have pioneered the development of commercial wind power, one of their fastest-growing industries.

Some companies are now installing wind farms in shallow waters near coastlines in small countries with little available land area. These "offshore wind farms" are a promising new source of electricity. Toronto Hydro is installing such a turbine offshore on Lake Ontario.

Commercial wind energy is one of the most economical sources of new electricity available today. Wind turbines can be set up quickly and cheaply compared with building new coal-fired generating stations or hydroelectric facilities. Modern wind generating equipment is efficient, highly reliable, and becoming cheaper to purchase. The environmental impact of large wind turbines is negligible compared with an open-pit coal mine or a reservoir, and during their operation produce no air pollution. Because of these factors, wind energy is recognized as the world's fastest-growing new energy source. Small, highly efficient wind turbines are becoming popular as a source of electricity for rural homes. The cost of installing one comes close to that of putting up poles, overhead power lines and other equipment necessary to connect to the electrical grid. The advantage is that the homeowner owns the generating equipment and is freed from paying monthly electrical bills.

Appendix C:

Hupacasath First Nation Community Energy Plan
Hupacasath First Nation Energy Planning Newsletter #2

August 25, 2003

Part I – Hupacasath First Nation Community Energy Plan Progress

Hello Community members!!

This is the second installment of the HFN Energy Planning Newsletter. Its purpose is to update and inform all Hupacasath band members on the Community Energy Plan (CEP) process to date, as well as highlight key events that have occurred, or are planned for the future. The main goal of the newsletter is to convey all of the information that we have gathered and present it in a brief and compact form. In this issue I will be updating the community on:

- Energy Demand Surveys
- EnerGuide Audits
- HFN CEP Advisory Group

- Education Programs
- Community Forum

I will also be including once again descriptions of various renewable energy options in order to better prepare ourselves for when it comes time to choose what options we want to pursue in our territory. And finally there will be ways (some that are free and some require some money upfront) in which we can make our homes more energy efficient, which in the long and short run will save your household money, and help better our environment.

ENERGY DEMAND SURVEYS

Surveys were sent to all 45 Hupacasath on-reserve households in May 2003, and 23 households were returned. Thank you to those that returned this survey, as the information that you provided has helped greatly. The information that we were able to obtain allows us to get a good amount of knowledge about the energy distribution, what the loads are, and which appliances consume the most energy.

ENERGUIDE AUDITS

These audits took place during the last two weeks of May 2003. A cross-section of buildings on reserve were selected for the audits including thirteen residential and two administration buildings. This allowed us to get a more comprehensive assortment of house types, fuel types, age, etc. The information that was gathered through the audits provides good quality information on the state of energy efficiency of the homes and what opportunities there are for improvements. The audits and the surveys combined provide us with information that can be used to estimate the total energy use of the home. The audits measure:

- Energy Performance
- Energy Savings Opportunities
- Your Homes Heat Loss

These audits were performed by Doug McNell and Rick Williamson from *Pride Home Improvements* based out of Ladysmith. I also accompanied them on each audit, to get some experience and to also have members fill out the afore-mentioned energy survey. These audits can be used towards a government Kyoto-program that has recently been announced in which the federal government will contribute up to $1000 towards retrofitting your home once you have “before” and “after” EnerGuide Audits completed.

COMMUNITY ENERGY ADVISORY GROUP

The HFN Community Energy Advisory Group has now met twice in the last three months. The purpose of this advisory group is to identify economic, environmental and social objectives for the project and work with the project partners to ensure that those objectives are met and various stakeholder interests are considered. The advisory group is currently seeking a Nuu-chah-nulth name for the group and the overall process.

BC HYDRO + TERASEN GAS CONSENT FORMS

As part of the HFN CEP process we sent out a form for households to sign in which, the energy planning manager (myself) would be sent the consumption data for the previous two years from those households willing to authorize such a procedure. Of the 45 households on-reserve, 26 people allowed for such a procedure to take place, and I would like to thank those for their co-operation and for helping this process move along rather quickly. This type of data is known as "top-down" information and provides us with the amounts for total energy used annually, but does not state how the energy was consumed (like the survey or "bottom-up" information). This information is critical in performing the Assessment of Options for the CEP process.

DATA ENTRY AND ANALYSIS

During the months of July and August the information that was obtained through both the Energy Demand survey as well as the BC Hydro consent forms was entered into an analysis spreadsheet. The spreadsheet was designed by Tim Weis of the Pembina Institute for Appropriate Development. The spreadsheet allows us to generate a comprehensive overview of how much energy we use, what it's used on, as well as various other functions. The spreadsheet also will illustrate through graphs the fore-mentioned as well as: Total Electrical Demands, Total Heating Demands, Energy Costs, Green House Gas Emissions, Air Pollution and Future Electrical Demand to name a few of the operations that the spreadsheet can provide. Outputs from this spreadsheet analysis will be presented at the community forum (see below).

EDUCATION PROGRAMS

The education programs for the CEP process comprise of:

- Community campaign – designed to address why the project is happening and to raise awareness about climate change
- School campaign – mostly to raise awareness about climate change and will build a link from the curriculum to the project,
- Community Newsletter – designed to keep the community informed of the process and to provide materials to help members understand the process, as well as attain a grasp of what available renewable energy options are out there for the community to decide upon.

Dave Mussel from the Pembina Institute, along with myself and the Education Liaison Angie Miller will be bringing in Energy Efficiency and Renewable Energy ideas into the curriculum of classes from each level of schooling in Port Alberni (except college level). The schools that will be targeted will be the ones with the most HFN students in them. Once the schools are established, there will be some sort of project put in place in which the students may be asked to present their project to all those in attendance at the Community Forum.

COMMUNITY FORUM

The purpose of the community forum is to present the community members with all of the information that we have gathered over the past few months, along with any of the sustainable energy options that the Hupacasath First Nation could pursue within their traditional territory. These options will then be graded by those in attendance on how important they feel they are to the whole community. As stated in the first installment of this newsletter, the community will steer us in the direction that they see fit, and we will then start work on the final draft of the HFN Community Energy Plan. As of writing this newsletter, there has yet to be a firm date in place, but a date in the last two weeks of October has been tentatively selected. A notice will go out to inform members well in advance of the Forum to request their participation. At the forum there will be presentations on the following:

- Energy baseline study
- Assessment of Energy Options
- China Creek Micro-Hydro Project Update
- Transportation Options

In closing, I would like to once again thank the membership for being so co-operative in providing all of the necessary information that they could, allowing us access to their homes when such an action was needed to aide in the process, providing their consent to obtain personal information (BC Hydro Consent Forms) for the betterment of the community through the CEP process, allowing us to explain what the process is and what the goals we hope to achieve from this, and keeping themselves informed about the process and relaying interest through conversations with the Hupacasath Energy Planning Manager.

If you have any questions about this newsletter or the progress of the Community Energy Planning process, please feel free to contact me.

Thank you for your time and cooperation in this process.

Aaron Hamilton
Energy Planning Manager
Hupacasath First Nation
Box 211
Port Alberni, B.C.
V9Y 7M7
724-4041 ext. 22
720-5972 Cell
723-1269 Home
hamiltona@shaw.ca

Part II – Sustainable Energy Alternatives

The following is the second part of the suggested reading from the Pembina Institute. It gives membership some information on different renewable energy technologies. It is also available on the internet at:

www.re-energy.ca

Also worth checking out is the Pembina Institute web page at:

www.pembina.org

SOLAR HEAT

The Sun: Permanent Power

The sun is the ultimate renewable energy source. Every day for the past 10 billion years or so, the sun has been pouring out unimaginable amounts of energy. The Earth, orbiting at a distance of 150 million kilometers from the sun, intercepts a tiny fraction of this solar output. At the Earth's surface, incoming energy from the sun is absorbed by the land, water and atmosphere, and converted into measurable heat. This heat acts like a giant engine, creating winds and currents in our atmosphere, oceans, and rivers. The sun's energy also keeps the Earth hospitably warm, a balmy plus 15o C on average.

Most of the sun's energy is emitted as visible light. The trick to using it as an energy source is being able to convert it from visible light into heat, electricity, or some other useful form. Most systems that capture solar energy convert it to heat or electricity, the two forms of energy we use the most.

As an energy source, the sun has a few limitations. Obviously, sunlight is available only during the daytime. And when it is available, sunlight may be hindered by clouds, dust, or pollution in the atmosphere, or by trees, buildings, or other physical obstructions. Nonetheless, sunlight is a highly practical and clean source of energy in many places around the world.

Getting Heat from Sunlight

If you want to capture heat from sunlight, you will need three things: bright light, a surface or fluid that can absorb the light and change it into heat, and a way to store and use the heat once it has been produced. Most solar heating systems depend on at least two of these factors working together.

A good example is a greenhouse. Greenhouses are designed to allow sunlight in, and then trap heat so that young plants can get a head start in the growing season. The glass of the greenhouse lets in lots of sunlight, which is absorbed by the plants, floor, soil, and other dark surfaces inside. As these surfaces absorb sunlight, they warm up, causing the air above them to get hotter. Because the greenhouse is an enclosed space, the heat accumulates inside the building. Most greenhouses can get so hot in the summer that, without ventilation, the heat would eventually kill all the plants.

Concentrating Sunlight
To get the high temperatures needed to heat water or cook food, it is sometimes necessary to concentrate large amounts of sunlight on a small light-absorbing area. The most common approach is to use some kind of curved reflective panel. A reflector with a parabolic curve can easily concentrate enough sunlight on a very small spot to start a fire.

Practical Uses for Solar Heat
Solar heat is one of the cheapest and most practical forms of renewable energy. Here are few of the most common applications:

- Solar hot water heaters: The sun's light is an excellent source of hot water for home or commercial use, such as swimming pools, car washes and laundromats.
- Cooking: Simple solar ovens and cookers are used around the world in both commercial kitchens and in people's homes. Solar cookers can be made with everyday materials such as cardboard and tinfoil.
- Home heating: Many homes are designed to take advantage of the sun to provide at least part of the heat required over the course of a year.

Solar Hot Water Heating
Each of our homes uses quite a lot of hot water, usually supplied by a gas or electric hot water heater. These appliances can be expensive to run and they cause environmental impacts. A great way to make lots of free hot water for the home is with a solar-powered hot water heater. A solar hot water heater consists of a large, flat metal box mounted on the roof of a building. It contains a network of water pipes connected to the home's plumbing system. The metal lining and the pipes generate heat when sunshine falls on the box. The heat is carried away by water that flows through the pipes and is then stored in an insulated tank for later use. The hot water can be used for laundry or showers, or it can be sent through pipes under the floor to heat a room or building. This system can supply some or all of the hot water needed by the home, which can make a big difference in monthly energy costs!

Solar Cookers
If you have ever stepped into a car that was parked outside on a hot sunny day, you already know something about solar cookers! A solar oven works much like a mini-greenhouse, but with a few differences. The light-absorbing surface is enclosed in a tightly sealed, well-insulated box. Sunlight comes in through a pane of glass and is then absorbed and changed into heat by the black surfaces inside the box. Insulation around the box keeps the heat in. Reflective panels increase the amount of sunlight entering the box. When pointed at the sun, the temperature in a solar cooker can easily rise high enough to bake bread.

Home Heating
Many homes are designed so they can meet at least some of their heating requirements from the sun's energy. Such homes have large south-facing windows (or north-facing if located in the southern hemisphere) that allow sunlight to heat up a room. The house's

insulation helps keep the heat in. This is called passive solar heating, because no pumps, fans, or other types of equipment are used. For example, the Toronto Healthy House derives 75% of its space heating needs from the sun.

BIOMASS ENERGY

Bio-energy is energy stored in materials made with the help of living things. An everyday example of bio-energy is wood heat. Wood is produced by growing trees, and contains highly flammable substances. Wood heat is probably humanity's oldest energy source. Other sources of bio-energy include alcohol and biogas. Alcohol is a flammable liquid made by certain yeasts, and biogas is a flammable gas similar to natural gas, made by bacteria. The difference between getting fuel from living things such as trees and getting it from something like coal or oil is that bio-energy is *renewable*. Although fossil fuels were formed by organisms that lived eons ago, it takes so long to replace fossil fuels (millions of years) that for practical purposes, they are considered non-renewable. Peat (a brown or black material found in bogs) is another resource that is not easily replaced, taking hundreds of thousands of years to renew itself. To be considered renewable, the resources must be replaceable within our lifespan. For example, the wood used in your campfire replaces itself as the forest grows. Coal on the other hand can be taken from the earth only once, and cannot be replaced. If a forest is managed properly, it will provide wood forever. It is the same with other forms of bio-energy, including biogas and alcohols.

Fibre Fuel
Most green plants have large amounts of a stiff material called cellulose. Cellulose is one of the main ingredients in wood, and is extracted for use in papermaking. Green plants manufacture cellulose from sugars, which they make during photosynthesis. Because cellulose is made from sugar, it contains a lot of stored chemical energy, energy that originally came from the sun. This chemical energy can be released as heat when wood is burned. Wood has been used as a fuel far longer than any fossil fuel. In some countries, wood is still the main fuel for heating and cooking. In places where wood is scarce, other forms of plant fibre are burned. Grass, peat, and even cow manure can be used as a fuel, but these materials make very smoky fires!

As long as these materials are allowed to grow back as soon as they are used, they are considered a source of renewable energy. However, if too much wood is harvested too rapidly or in a way that damages the soil or other parts of the ecosystem, severe environmental problems can result.

Ethanol and Methanol
Ethanol and methanol are alcohols and are highly flammable. They can be made from plant sugars or plant fibres. Alcohol is produced by feeding plant materials into large heated tanks called digesters. Inside the tanks, chemicals or yeasts are added to change the plant materials into alcohol. The alcohol is extracted, purified, and prepared for use as a fuel.

Both ethanol and methanol make excellent fuels for cars and trucks. In fact, ethanol is used in the engines of Formula 1 racing cars. It burns very cleanly, and delivers more power than gasoline. Many service stations now sell fuels that contain a blend of gasoline and an alcohol, usually ethanol. Methanol and ethanol can be deadly poisons, especially in the amounts used to make transportation fuels. Methanol is especially toxic. Even small amounts breathed in as fumes or accidentally swallowed can cause blindness, severe liver damage, and death.

Biogas

Most mammals-humans included-produce a flammable gas called "biogas" as they digest their food. Bacteria living in their digestive systems produce methane as they break down cellulose present in the food. Biogas is also produced in bogs and wetlands where large amounts of rotting vegetation may accumulate. Biogas consists mostly of a gas called methane, which is the same as "natural gas", commonly burned in our furnaces and barbecues. Biogas can be used instead of natural gas for heating and cooking.

Humans have learned to duplicate this process in large tanks called biogas generators. To start the process, shredded plant materials and animal wastes are mixed with water in the biogas generator. Many kinds of naturally occurring bacteria arrive with the shredded plant material. The tank is then sealed so no air can get in. Within days, a special kind of bacteria in the tank will begin to produce biogas. These bacteria are known as "methanogenic", because they produce methane, the main ingredient in biogas. The biogas forms bubbles in the mixture, and collects at the top of the tank. It is piped to a large balloon-like bag where it is stored until needed. Eventually, the production of biogas in the generator starts to slow down. The mixture of water and manure is replaced with a fresh supply to start the process again. The old material is unable to produce any more biogas, but still contains large amounts of plant material and other organic matter. It is dried to form a rich black soil, and is spread on fields as a fertilizer.

Another source of biogas is landfills. At the landfill site, large mounds of garbage are buried under the surface. Bacteria break some of the garbage down and can produce large amounts of biogas. This is sometimes collected and burned to heat buildings near the landfill. Biogas can contain traces of hydrogen sulphide (H_2S) gas, particularly in the case of landfill gas. Care must be taken to deal safely with this gas because H2S can be fatal in small amounts

Part III – What you can do to save money

“MAKING YOUR HOME MORE ENERGY EFFICIENT”

Free—Things That Cost Nothing and Save Cash

- Turn down water heater thermostat to 120°F
- Turn off lights when leaving a room.
- Set thermostats to 68°F in winter when you're home and down to 55°F when you go to bed or when you're away. (Programmable thermostats do this automatically —see below).
- Use energy-saving settings on washing machines, clothes dryers, dishwashers, and refrigerators.

- Don't waste water, hot or cold, inside or outside your home.
- Clean your refrigerator's condenser coils (the tubing on the back) once a year.
- Air-dry your clothes.
- Close heating vents in unused rooms.
- Repair leaky faucets and toilets (5 percent of water "use" is leakage).

- Close drapes after sunset and open them to sunny weather for heat and lighting

Simple and Inexpensive—Things That Will Pay for Themselves in Lower Energy Bills in Less Than a Year

- Install a water-saving 2.5-gallon-per-minute showerhead ($15).
- Install water-efficient faucet heads for your kitchen and bathroom sinks ($2 each).
- Install a programmable thermostat ($26).
- In the attic and basement, plug the air leaks a cat could crawl through, and replace and re-putty broken window panes (about $20).
- Clean or change the air filter on your warm-air heating system during winter and on air conditioning units in the summer ($2).
- Install an R-7 or R-11 hot water tank wrap ($12).
- Insulate the first three feet of hot and inlet cold water pipes ($6).
- Install a compact fluorescent light bulb in the fixture you use the most ($15). (they provide the same light for ¼ the power, and last much longer)

Appendix D:
Hupacasath First Nation Community Energy Plan
Hupacasath First Nation Energy Planning Newsletter #3

November 24, 2003

Part I – Hupacasath First Nation Community Energy Plan Progress

Hello Community members!!

This is now the third version of the Hupacasath Energy Planning Newsletter, which is to serve as a tool to update and inform all Hupacasath band members on the Community Energy Plan (CEP) process to date, as well as highlight key events that have occurred, or are planned for the future. The main goal of this newsletter is to convey all of the information that we have gathered within the time since the last newsletter and present it in a brief and compact form to all members. In this issue I will be updating the community on:

- HFN CEP Advisory Group
- B C Hydro Bills

- Education Programs
- Community Forum
  - HFN Baseline Report
  - HFN Energy Options
  - Implementation of Options

I will also be including once again descriptions of various renewable energy options in order to further educate everybody on the various sources of renewable energy that are out there. These two options will be the last two relayed to you through this newsletter, and I encourage all of you to check out the websites that I provide for you. It is also worth noting that not all of these options are necessarily feasible for our current situation, but could be looked at some point in the future.

COMMUNITY ENERGY ADVISORY GROUP

The HFN Community Energy Advisory Group met prior to the Community Forum on Nov. 4th, 2003 in which the information that was going to be presented at the forum was reviewed. The next planned meeting will be to review and analyze the final draft of the Community Energy Plan. The purpose of this advisory group is to identify economic, environmental and social objectives for the project and work with the project partners to ensure that those objectives are met and various stakeholder interests are considered.

BC HYDRO BILLS

It has come to my attention that some community members are paying GST and PST on their hydro bills. Through conversations with B C Hydro I have been informed that they will provide people with GST and PST tax exempt status if the individual phones in with the request. The phone number is 1-800-224-9376. ***(You have to live on-reserve for this to apply to you!)***

Also if you have been paying the PST, you can get a rebate from BC Hydro from up to the last six years of being billed the PST, through phoning the Consumer Taxation Branch at 1-877-388-4440 and filling out a form, that is attached at the end of this newsletter. I do not currently know if the same applies for GST, but I am looking into it, however I do believe BC Hydro will still grant GST exempt status if you phone in.

EDUCATION PROGRAMS

The education programs of the CEP have been on-going since the beginning of the project. There has been a presentation at the kick-off of the project at a band meeting in May of 2003, various informal and formal discussions during the household surveys that were completed from May to July of 2003 as well as during the later stages of May when the EnerGuide audits were being completed, relaying of information via a Energy Planning newsletter (this is issue #3), as well as a detailed analysis of where we stand and what directions we should go during our Community Forum which was held on November 8th, 2003.

During the Community Forum, we had Michael Cooke from SunWindSolar (who was sponsored by the Pembina Institute) come in to lead those children in attendance into building their own power generators. During the forum, roughly 12-15 children were educated, in the administrative wing of the House of Gathering, about renewable energy and energy efficiency. Through hands-on demonstrations these children were able to construct their own generators, which produced electricity. The children were then shown different ways in which they could produce own electricity including:

- Shafts that could be turned by either a hand crank or hub
- Hubs that held small water blades (micro-hydro)
- Hubs that held wind vanes (wind energy)

With these generators the children applied them to LED lamps, sound buzzers, and to turn motors from a distance. Each child was also given a "SunnySide Up" solar car kit to bring home before they left. Overall the presentation was a success, judging by the interested and smiling faces that I saw that night, and I'm sure if any of your kid's were there you've already heard about it. Thank you to all of the kids that showed up, as you are the starting block for new ways of thinking and ensuring that we become more energy efficient and focus on renewable energy for your generation to come.

COMMUNITY FORUM

The Community Energy Planning Forum took place on Saturday November 8th at the Hupacasath House of Gathering. Attendance was nearly 25-30 people in attendance throughout the day. The forum started off with a video (Voices from the Forest) in which Climate Change and its effects on First Nation communities were discussed. Following the video there was a discussion on how we too are affected by climate change within our community and surroundings. We then went into discussion on how our energy is used, where we use it, and how much it costs, which is also known as a baseline report. Through this report we were able to see how much energy we use (in gasoline, electricity, propane, natural gas, etc.) and how much it costs us. We seen the sources of where our greenhouse gases come from and quantified how much it represented. The report also looked at what the largest electrical consuming appliances were and created discussion on how we can reduce the consumption of such appliances. Finally the report illustrated the projected future Hupacasath First Nation electricity demand for the next 20 years if we were to continue operate how we do now.

Next, Chief Councilor Judith Sayers gave an overview of the progress that the China Creek Small Hydro Project. She stated that the Electricity Purchase Agreement was signed within the prior two weeks, and that we are currently in the process of obtaining the water license (to insure about fisheries impacts). Also, the HFN is negotiating an agreement with the City of Port Alberni to have them become more of an equity partner. It was stated that the construction is hoped to begin in 2004 with production in 2005 and the power sold directly to BC Hydro. There will also be monitoring of other streams within our territory for similar projects in the future.

Following Judith was Steve Watson from BC Hydro, which presented us with a presentation on PowerSmart. In his opening remarks Steve noted that PowerSmart is about making new technology available. Steve then went into his presentation into what types of products are energy efficient (such as compact fluorescent light bulbs, energy efficient appliances, LED Christmas lights, etc.) The presentation then shifted to the types of programs that BC Hydro administers including:

- Old fridge buyback program - BC Hydro buys second "old" fridge for $30, and disposes of it
- Insulation rebate - $1 per square foot for argon windows

It was also suggested to check out the BC Hydro website (www.bchydro.com) where various other resources can be accessed.

Following a break we resumed with the presentation of energy options that were achieved through looking at our Baseline Report, which was derived from the process of the surveys, energy consumption bills, and EnerGuide audits. The options were separated into three categories, package A, B, and C.

With Package A the focus was quick and easy steps that we could take to strive towards energy efficiency and included:

- Using compact fluorescent light bulbs
- Install low-flow showerheads
- Insulation of hot water tank
- Changing personal habits (turn off lights in un-occupied rooms, turn down heaters when going to bed, etc.)
- Education and awareness of compact development and transportation opportunities

In Package B the costs became higher, but the savings were bigger as well. Package B involved a more intense focus on energy efficiency. It included:

- EnerGuide for Houses Evaluations for all homes on-reserve (hopefully free of charge) in 2004
- Draft proofing and weather stripping of the entire house
- Insulation of the attic and crawlspace (floor joists)
- Energy-efficient windows
- Replacing inefficient woodstoves
- Replacing oil furnaces with natural gas furnaces
- Front loading washing machines
- Getting rid of old fridges and freezers
- HFN car co-op
- Develop and commit to R-2000, solar orientation, water-wise, compact development policies

Finally in Package C we saw energy efficiency become the main focal point of any new buildings that may arise on Hupacasath land in the future. This would include:

- Compact development / redevelopment at 20 units per hectare
- Intensively develop lands closest to Port Alberni
- Locate residential areas within 500 meters of as many daily destinations as possible (schools, shops, work)
- R-2000 energy efficiency standard for new development
- Comprehensive land use bylaw for HFN lands guiding all development on all HFN land in which all of the previously mentioned would be taken into account

After the presentation of the options there was a discussion on what was presented. The decision that was unanimously supported by those in the room was to pursue Package C with Package A and B being the building blocks to achieve such an option. These two options are currently being pursued as this newsletter is being written and I will be informing everyone as to the progress of these options.

Following this discussion we took a break to go and explore what the kids had been learning as we were discussing the fore-mentioned. Dinner was to follow and I would really like to thank the cooks that did a wonderful job with dinner, it was very much enjoyed by everyone in attendance. After dinner we closed with the giving out of door prizes, congratulations to all of the winners. Also a big thank you goes to Carolina and Joanne for organizing the whole dinner aspect of the evening, and for helping round up children for the event, and saving me a lot of time and energy.

In closing, I would like to thank the whole membership for being so co-operative in every aspect of this community energy planning process to date. This plan is to serve the community and your input has been greatly appreciated and has been used extensively throughout this whole process. Thank you for all of the courtesy and cooperation you have all shown me during the Community Energy Plan Process.

If you have any questions about this newsletter or the progress of the Community Energy Planning process, please feel free to contact me.

Thank you for your time and cooperation in this process.

Aaron Hamilton
Energy Planning Manager
Hupacasath First Nation
Box 211
Port Alberni, B.C.
V9Y 7M7
724-4041 ext. 22
720-5972 Cell
723-1269 Home
hamiltona@shaw.ca

Part II – Sustainable Energy Alternatives

The following is the third and last part of the suggested reading from the Pembina Institute. It gives membership some information on different renewable energy technologies. It is also available on the Internet at:

www.re-energy.ca

Also worth checking out is the Pembina Institute web page at:

www.pembina.org

SOLAR ENERGY

Solar Energy

On planet Earth, sunlight is an incredibly important form of energy. Every day, the sun pours unimaginable amounts of energy into space. Some of it is in the form of infrared and ultraviolet light, but most of it is in the form of visible light. Some of this energy falls on the Earth, where it warms our planet's surface, drives ocean currents, rivers, and winds, and is used by plants to make food. Life on Earth depends totally on the sun.

Photovoltaic Cells

Visible light can be converted directly to electricity by a space-age technology called a photovoltaic cell, also called a solar cell. Most photovoltaic cells are made from a crystalline substance called silicon, one of the Earth's most common materials. Solar cells are typically made by slicing a large crystal of silicon into thin wafers and putting two separate wafers with different electrical properties together, along with wires to enable electrons to travel between layers. When sunlight strikes the solar cell, electrons naturally travel from one layer to the other through the wire because of the different properties of the two silicon wafers.

A single cell can produce only very tiny amounts of electricity-barely enough to light up a small light bulb or power a calculator. Nonetheless, single photovoltaic cells are used in many small electronic appliances such as watches and calculators.

Photovoltaic Arrays

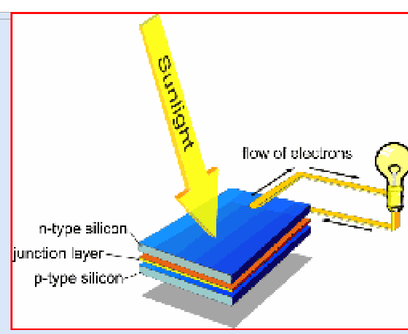
To capture and convert more energy from the sun, photovoltaic cells are linked to form photovoltaic arrays. An array is simply a large number of single cells connected by wires. Linked together in an array, solar cells can produce enough electricity to do some serious work! Many buildings generate most of their electrical needs from solar photovoltaic arrays, including the Toronto Healthy House, which gets 80% of its power from the sun. Photovoltaic arrays are becoming a familiar sight along roadsides, on farms, and in the city, wherever portable electricity is needed. They are commonly used to provide power for portable construction signs, emergency telephones, and remote industrial facilities. They are also becoming popular as a way of supplying electricity for remote power applications such as homes and cabins that are located away from power lines, for sailboats, recreational vehicles, telecommunications facilities, oil and gas operations, and sometimes entire villages-in tropical countries, for example.

Storing Electricity
Solar panels make electricity in all kinds of conditions, from cloudy skies to full sunlight, in all seasons of the year. But they don't work at all during the nighttime! To make electricity available after sundown, the energy must be stored during the day for later use. The usual storage device is a rechargeable battery. The batteries used with solar arrays must be able to discharge and recharge again many times. They contain special parts and chemicals not found in disposable batteries. They are also usually larger and more expensive than their disposable cousins.

Besides solar panels and rechargeable batteries, modern photovoltaic systems are usually equipped with some kind of electronic charge controller. The main job of the charge controller is to feed electricity from the solar panel to the battery in the most efficient manner and to prevent the solar panel from overcharging the battery. The charge controller also protects the solar panels from electrical damage. In many cases, people need the electricity stored in the rechargeable batteries for use with normal household appliances. The problem is that most of those appliances require 110 volts of alternating current (110V AC), whereas the battery puts out only direct current (DC), usually at a much lower voltage. A device called a power inverter solves this problem by converting the battery's low-voltage direct current to 110 volts of alternating current. Modern charge controllers often come equipped with their own built-in power inverters.

Solar Electricity in Everyday Use
Photovoltaic panels, like computers and other technologies, are getting cheaper and easier to buy. In fact, many people consider them a great alternative to gas-powered generators or connections to the regular electricity supply. Some countries such as Japan have encouraged businesses and communities to install solar panels on the roofs of new buildings to reduce the need for electricity from other sources. Many homes and businesses have both a connection to the commercial electrical supply system (often called the "electricity grid"). The solar panels can provide all or most of the building's electrical supply during the day, and the grid supplies whatever other electricity may be needed during the night. In some cases, the panel's make more electricity than is needed in the building, and the excess is sold to the power company. This results in the power company sending the building owner a cheque instead of a bill!

How Photovoltaic Panels Work:
Photovoltaic cells are marvels of sub-atomic physics. They are constructed by layering special materials called semiconductors into thin, flat sandwiches, called solar cells. These are linked by electrical wires and arranged on a panel of a stiff, non-conducting material such as glass. The panel itself is called a module.



The Pembina Institute

A ray of light consists of a stream of photons-tiny packets of light energy-moving along at around 300,000 kilometres per second. When these energy packets strike the top layer of a solar panel, they bump electrically charged particles called electrons away from their "parent" atoms. These electrons are collected by another layer in the sandwich and passed along to wires that connect to batteries and other appliances. The amount of electricity the panel can produce depends on the intensity of the light.

OTHER CLEAN ENERGY TECHNOLOGIES

Clean Energy Sources
Wind, solar, biomass, and water are not the only sources of clean, environmentally friendly energy. Other energy sources can also provide heat, light, and electricity without polluting the air or disturbing large areas of land or water. This backgrounder covers a few of these new technologies, some of which are likely to become mainstream sources of energy in the approaching decades.

Geothermal heat has been used to heat homes and businesses on a commercial scale since the 1920s. In most cases, communities take advantage of naturally occurring geysers, hot springs, and steam vents (called fumaroles) to gather hot water and steam for heating. Geysers and fumaroles occur when ground water seeps through cracks and comes in contact with volcanically heated rocks. In Iceland for instance, wells are drilled into volcanic rocks to extract hot water and steam. The hot water or steam is carried to communities in insulated pipes and used to heat homes and businesses. In some cases, the water is superheated (heated under pressure to temperatures greater than 100º C). Superheated water quickly turns to high-pressure steam, which can turn high-speed turbines that drive electrical generators.

Ground Source Heat Pumps
The temperature of the soil below about 2 metres remains constant regardless of the weather or season. In most places throughout southern Canada, soil temperatures at this depth hover between 5 and 10o C. The difference between air and deep soil temperatures can be used for heating and cooling in a very efficient manner, with a ground source heat pump, also called a geothermal heat pump.

A ground source heat pump works the same way your refrigerator does. Like your fridge, a heat pump uses a compressor, lengths of sealed tubing for gathering and dispersing heat (heat exchangers), and a gas called the refrigerant. An essential part of the heat pump is the network of tubes buried deep in the soil near the home. The compressor motor, located inside the house, circulates refrigerant around this network. Heat from the surrounding soil warms the liquid refrigerant in the buried tubes, changing it to a gas. The refrigerant gas enters the compressor, which squeezes it, raising its pressure and temperature. The hot refrigerant circulates through radiators inside the house, releasing the heat collected from the soil to the inside of the house. This process changes the refrigerant back into a liquid and the process starts again. By reversing the flow of the refrigerant, the heat pump system can cool the house in summertime. Heat collected from inside the house can be released back into the cool soil, resulting in a highly efficient air conditioning system for the home. A ground source heat pump requires some electricity to run the compressor. In an efficient, well-insulated home, this electricity could be easily supplied by a rooftop solar panel.

Hydrogen Fuel Cells

One of the main problems with fossil fuels is that they release large quantities of carbon dioxide when they are burned. But what if there was a fuel you could burn that produced no carbon dioxide at all? In fact, there is such a fuel, namely hydrogen. Hydrogen is a flammable gas, which, when burned with oxygen, produces harmless water vapour. Combining oxygen with hydrogen is a clean, efficient way to make huge amounts of both heat and electricity!

Instead of burning the hydrogen in the presence of oxygen, fuel cells allow the two gases to pass near each other on opposite sides of a thin membrane. The chemical interaction of oxygen and hydrogen across this membrane produces an electric charge, similar to that produced by a regular alkaline battery. But unlike the battery, which goes dead after the chemicals inside it are used up, the fuel cell continues to produce electricity as long as it receives fresh supplies of air and hydrogen. The only by-product of the process is water, which the fuel cell releases as steam.

The biggest difficulty faced by engineers designing fuel cells is figuring out how to store and handle the hydrogen gas safely. Hydrogen is composed of extremely tiny molecules that can squeeze out of most materials normally used to contain gases. Hydrogen is also highly explosive and flammable. For efficient storage, it must be compressed and cooled to minus 253o C to form a liquid. Liquid hydrogen must be stored in specialized containers and pumped through high-tech valves and tubes, all of which make hydrogen expensive and tricky to handle.

Another technical problem is in making the hydrogen gas. Currently, hydrogen is made by "stripping" methane or natural gas-a fossil fuel. This process produces carbon dioxide, one of the greenhouse gases associated with climate change. In the future, hydrogen gas may be manufactured in large quantities from ordinary water at solar-powered production facilities. The only by-product of this process would be oxygen, a gas with many practical uses that is already present in the atmosphere in large amounts. Hydrogen fuel cells are now being used to produce electricity in remote settings such as in Canada's Arctic, and at mountaintop communications installations. They are also being tested for use in city buses and cars, and may soon be used to power everything from wristwatches to golf carts.

Appendix E:

Hupacasath First Nation Community Energy Plan
HFN Community Energy Forum - Children's Report

CHILDREN'S WORKSHOP REPORT - HUPACASATH ENERGY FORUM
NOVEMBER 8, PORT ALBERNI

At the Hupacasath Energy Forum held at the Hupacasath Gathering House near Port Alberni, November 8, a renewable energy educator sponsored by the Pembina Institute led attending children in a workshop. While the main hall events were taking place, in a separate area of the Gathering House, Michael Cooke, of SunWind Solar, led a dozen children aged, 9 – 17, in building their own generators to produce electricity from wind, micro-hydro, or human energy.

Michael Cooke has spent the last ten years in renewable energy education and currently hosts a Web site (www.sunwind.ca) with a large section of free solar energy educational notes and links, free solar energy lessons, and several solar car and inventor's kits. He took this opportunity to field test the complete renewable energy kit, "Sun, Wind, Rain, and Cereal", that he has been working on. These Hupacasath children were the **first children** to build the multi-functional generators described.

Michael brought with him educational display materials filling one eight foot table, and workshop materials filling another table. The dozen children attending, equally mixed, boys and girls, ranging in school grades from grade 4 to grade 11, were seated at two tables between the display and workshop tables. Prior to the workshop starting the children were encouraged to look at and interact with the display items.

WORKSHOP

With the aid of an Earthball, it was presented to the children that this is a solar-driven planet, sunlight playing with gravity, and that water evaporation (requiring energy) raises water into the air, which leads to clouds, blown by winds (again, caused by solar energy unevenly heating the atmosphere) to other places, sometimes over land. When rain falls against the hills, and is on its way back to the Ocean in streams, we can capture some of that "solar energy" by having the force of the gravity-pulled water turn a dynamo.

With magnets, and disassembled motors, the children were shown how generators rely on turning coils of wire in a magnetic field to produce a flow of electrons. We cannot get any more energy out than we put in.

The point was made that electricity is a medium for the transfer of applied forces, and that we can choose which source of energy we use to turn the dynamo's shaft. We can choose to use steam turbines, driven by fossil fuels or nuclear fission or wood waste or hydrogen, to spin the shaft, or we can choose to use renewable energies directly to spin the shaft.

The children were given bags of materials and a couple of completed models as examples. With child-easy materials, five simple generators were made, with shafts that could be turned by either hand-crank or hub. [See pictures attached.] The hubs hold either small water blades for micro-hydro, or larger wind vanes for wind-charging. Applied energy transferred through a series of pulleys or gears to the shaft of a permanent magnet DC motor causes the motor to spin as a generator, producing electricity. The children now have several ways to produce their own electricity, all of them using renewable energies.

The children's power generators can be employed to light LED lamps, sound buzzers, and to turn motors at a distance through wires - in this, case, on small cars that run along the floor. (Cranking forward, the car runs forward. Cranking backward, the car runs backwards. Cranking faster, the car runs faster.)

The children were also introduced to another form of electrical power generation, solar cells, through displays and demonstrations. Each was given a SunnySide Up solar car kit, which they built and took home. These kits have 1 volt 400 mAmp solar panels, which have alligator clip test leads attached, encouraging further experimentation.

OUTCOMES

Several weeks after the event, we spoke to Carolina Katush, who works with children in the band on a daily basis. She reported that the workshop had been a great success with the children, who made comments like, “It was completely worth it!”, and

“Thanks for making me go!” This last remark was apparently made because several of the children had been afraid that because it was “Science” they wouldn’t be able to do it.

When asked whether the children were excited by the possibilities, and whether there were indications they were sharing their enthusiasm with others, her response was: “Oh Yeah!”

“They came home and showed their parents…they were showing it off to other children…they took (the renewable energy generators they'd built) to their three different schools for "Show-and-Tell.”

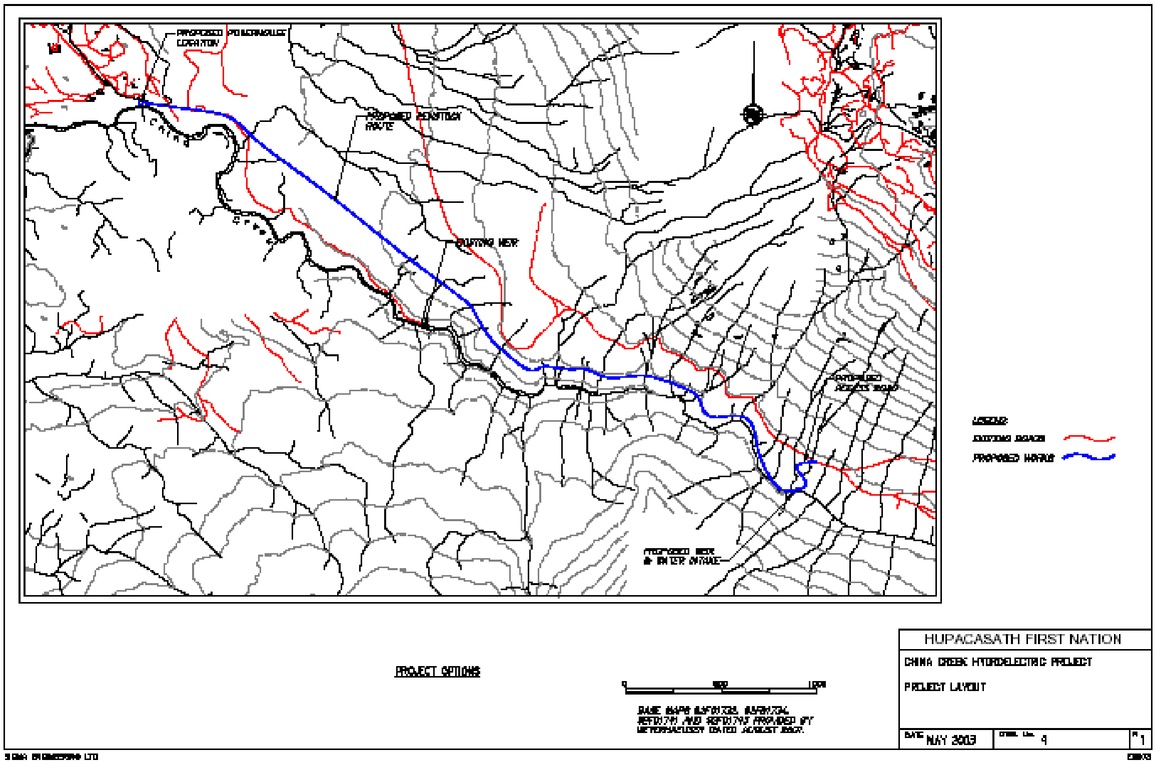
"They were more aware of what's happening in their surroundings. They went home and were showing their parents energy movement in the house."

“Their parents were quite impressed with what they got."

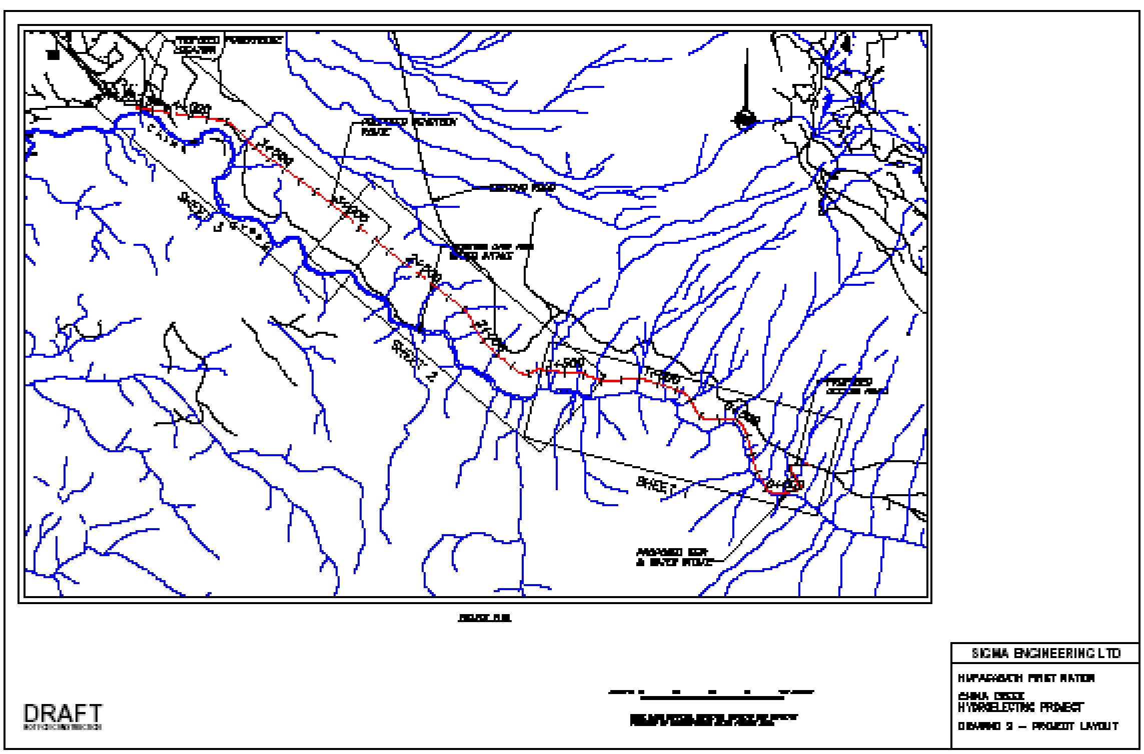
In showing their parents and friends: "THIS IS WHAT WE DID, AND THIS IS HOW IT WORKS!"

So the outcome was enthusiastic empowered children delighting in showing others "how it works!” and wanting to do more. They enthusiastically shared their new knowledge with their parents, other children, and three schools.

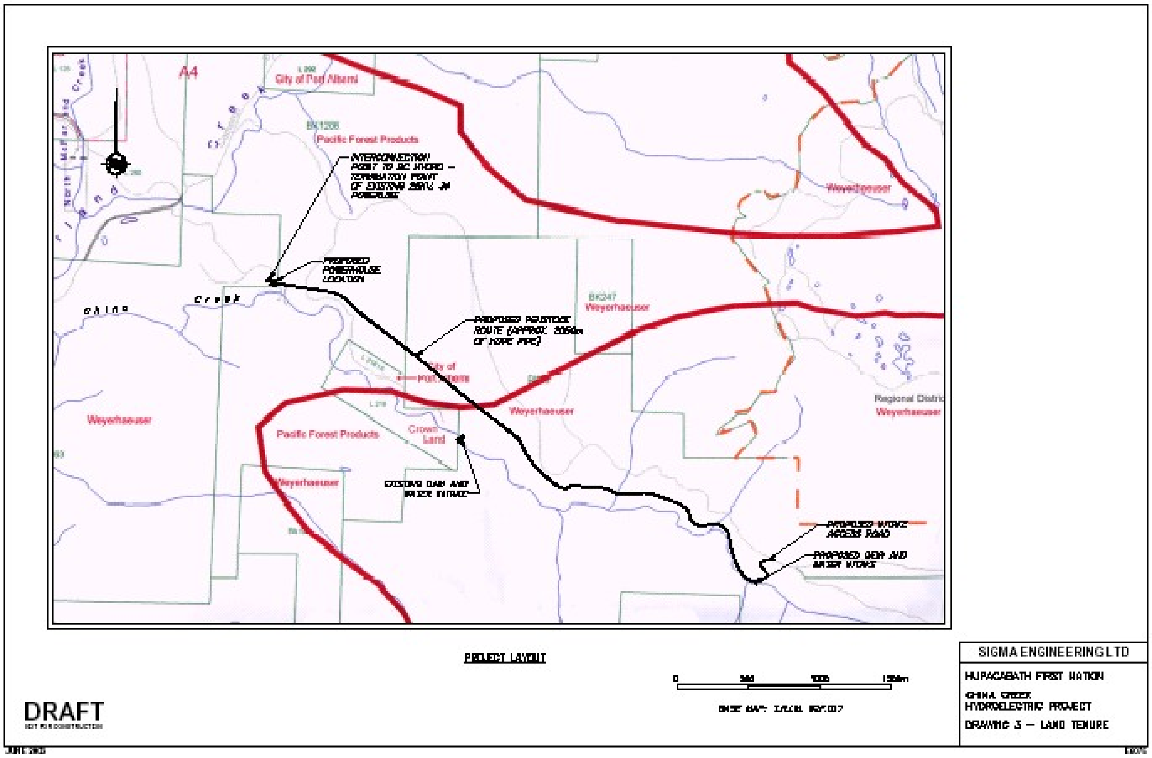
Appendix F:
Hupacasath First Nation Community Energy Plan
China Creek Micro Hydro Project Drawings



PROPOSED POWERHOUSE LOCATION
PROPOSED PENSTOCK ROUTE
EXISTING WEIR
PROPOSED ACCESS ROAD
PROPOSED WEIR & WATER INTAKE
LEGEND
EXISTING ROADS
PROPOSED WORKS
PROJECT OPTIONS
HUPACASATH FIRST NATION
CHINA CREEK HYDROELECTRIC PROJECT
PROJECT LAYOUT
MAY 2003
SIGMA ENGINEERING LTD



PROPOSED POWERHOUSE LOCATION
PROPOSED PENSTOCK ROUTE
EXISTING ROAD
1+500
PROPOSED ACCESS ROAD
PROPOSED WEIR & WATER INTAKE
SIGMA ENGINEERING LTD
HUPACASATH FIRST NATION
CHINA CREEK HYDROELECTRIC PROJECT
DRAWING 2 – PROJECT LAYOUT
DRAFT


A4
City of Port Alberni
Pacific Forest Products
Weyerhaeuser
Crown
Land
Regional Distric
DRAFT
PROJECT LAYOUT
SIGMA ENGINEERING LTD
HUPACASATH FIRST NATION
HYDROELECTRIC PROJECT
DRAWING 3 — LAND TENURE