



ASSESSMENT OF SUSTAINABLE AND CULTURAL HOUSING DESIGN IN THE CLAYOQUOT SOUND FIRST NATIONS

A Decision Framework for Residential Housing Developments

Spring 2011

Photo Credit: Sam Beebe

GEOFF TAYLOR

ISIS, Sauder School of Business, University of British Columbia



Opening Worlds

THE UNIVERSITY OF BRITISH COLUMBIA

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EXECUTIVE SUMMARY

First Nation communities across Canada are benefitting from increased funding from the Government of Canada. The Tla-o-qui-aht Nation, one of the beneficiaries of this funding, is in the midst of building over 150 homes in its new community of Ty-Histanis. The Ahousaht Nation is likewise in the early stages of a 4-phase construction project that will add over 120 homes to its own building stock. A partnership was developed between Ecotrust Canada, The Vancouver Foundation, ISIS at the Sauder School of Business, and the Real Estate Foundation to investigate ways that First Nation members could build affordable homes that are green while also addressing their distinct cultural needs. Both of these opportunities require focused dialogue with community members leading up to and during the construction process. This community engagement will not only communicate the value of 'green' technology to the homeowners but also help to determine how homes can be built in a way that makes their day-to-day living more comfortable.

A practical approach to making home ownership more affordable is by incorporating sustainable building technologies into building design, thereby encouraging energy and water conservation. Given that the variable cost of operating a home is largely dependent on utility bills, this will help to minimize the amount of income dedicated to homeownership as well as the added benefit of reducing the home's environmental footprint.

The cultural distinctness of First Nation communities in Canada requires that homes be designed in a way that satisfies their day-to-day and long-term living needs. Accommodating these needs is best accomplished through engagement sessions with a broad cross-section of each community involved in a construction project. By listening to these voices, new homes can move beyond the ill-suited ones that have been historically constructed to more livable ones that represent each community's First Nation culture and heritage.

These large-scale and long-term building projects also present the Nations with the opportunity to create jobs for their respective Nation members. 'Standing Tree to Standing Home', an initiative being developed by Ecotrust Canada, attempts to leverage the construction projects to develop the skills necessary for Nation members to take an active role in the building process by partnering with organizations capable of offering the necessary training. This will create long-term economic benefits that can be augmented by the inclusion of local materials in the homes.

The final section of this report is designed to assist in the community development strategy. This tool can be used by the Band Council to facilitate the long-term community development that accompanies a large-scale housing program or, alternatively, by the individual homeowner to make informed and considered decisions on the inherent benefits of including sustainable building design principles and technologies in the home. The Planning Framework is intended to be the foundation for future work as part of the on-going 16-month project undertaken by the aforementioned stakeholders, with the intended goals of 1) ensuring that engagement is rich and productive in determining the needs of community, 2) informing Nation members on the value of 'green' building design, 3) harnessing the training and employment opportunities that stem from housing development, and 4) creating a resilient local economy that takes advantage of the Nation's natural resources and human capital.

1. INTRODUCTION

The current reality in First Nation communities in the Clayoquot Sound area of Vancouver Island is that there is a very real and desperate need for both more¹ and adequate homes.² The First Nation population living on reserve is growing at a rate far in excess of those observed in the rest of Canada, owing to a lower average age,³ a higher birth rate,⁴ and the influx of Nation members returning to their communities from other locations such as urban centres. In recent years a considerable amount of funding has been made available to the Nations through a series of federal government agency initiatives to address these social and financial housing issues.⁵ Representative of how First Nations are seizing upon these opportunities are the Tla-o-qui-aht Nation, which has embarked on an ambitious housing development, called Ty-Histanis, through CMHC's EQUilibrium Communities Initiative⁶ that will see over 150 homes built over the next 10 years. At the same time, the Ahousaht Nation is in the early stages of expanding their total housing stock by over 100 homes.

With the latitude that these funds create there is an opportunity to employ sustainable housing design features to accomplish several goals, one of which is the reduction of each home's environmental footprint during and after construction. A second, particularly important goal is to reduce the month-to-month operating costs of each home, thereby making home ownership more accessible to Nation members. In turn, home ownership also opens up the possibility of building homes that address the cultural needs of First Nation members. The combination of these possibilities suggests that there is an opportunity to make homes in First Nation communities more livable to their occupants and increase the quality of life amongst an incredibly valuable demographic within the Canadian social fabric.

The quality of homes in First Nation communities in Canada since the advent of the *Indian Act* is widely regarded as substandard, even to the extent that it is plainly acknowledged on the Indian and Northern Affairs departmental website.⁷ A variety of issues are at play that complicate the livability of First Nation homes, including:

- 1) Limited financial resources available through Government agencies such as INAC and the CMHC;⁸

¹ Indian and Northern Affairs Canada (INAC) estimates a growth in new households on reserve at 4,500 per year between 2008-2018. First Nations Housing. Indian and Northern Affairs Canada (2008) <http://www.ainc-inac.gc.ca/ai/mr/is/info104-eng.asp>.

² INAC further estimates that, as of March 31, 2005, the total number of homes in need of replacement or major repairs was roughly 27.6% of the total First Nations housing stock. Indian and Northern Affairs Canada. (2008). First Nations Housing <http://www.ainc-inac.gc.ca/ai/mr/is/info104-eng.asp>.

³ Health Canada (2005) First Nations, Inuit, and Aboriginal Health. Highlights of First Nations Health Statistics http://www.hc-sc.gc.ca/fniah-spnia/pubs/aborig-autoch/stats_profil-eng.php.

⁴ Ibid (2005) http://www.hc-sc.gc.ca/fniah-spnia/pubs/aborig-autoch/stats_profil-eng.php.

⁵ Anecdotal estimates place this value at more than \$1 billion to be allocated to First Nations across Canada by agencies such as Indian and Northern Affairs Canada (INAC) and the Canadian Mortgage and Housing Corporation.

⁶ The Equilibrium Communities Initiative is part of the Federal Government's Economic Action Plan and is distributing \$4.2-million to 6 low-income sustainably-designed housing projects, of which Ty-Histanis is one. Canadian Mortgage and Housing Corporation. (2011) *Government of Canada Announces Funding to Equilibrium Communities Project near Tofino*. (November 10, 2010) <http://www.cmhc-schl.gc.ca/en/corp/nero/nere/2010/2010-11-10-1200.cfm>.

⁷ Indian and Northern Affairs Canada (2008). First Nations Housing <http://www.ainc-inac.gc.ca/ai/mr/is/info104-eng.asp>.

⁸ As an example, the Government of Canada annually commits \$272 million per year total through INAC and the CMHC to assist in house building and remediation, a predetermined and finite amount of resources that must be allocated to First Nations housing

- 2) Entrenched systematic difficulty for First Nation members to possess/own their own property on reserve,⁹ resulting in a general apathy toward the maintenance and care of a home;
- 3) Limited job opportunities available to First Nation members living on reserve, particularly those living in remote communities;¹⁰
- 4) Excessive demand for housing relative to the supply available, resulting in overcrowded living conditions that place stress on the physical structure of the home and lead to its premature decline.¹¹

These factors, in addition to others, results in housing conditions that are commonly likened to those observed in the Developing World.

across all Nations in Canada. Indian and Northern Affairs Canada. (2008). First Nation On-Reserve Housing Program. (<http://www.ainc-inac.gc.ca/ih/fnh/orh-eng.asp>).

⁹ First Nations members are unable to own their land outright, instead petitioning INAC for an approximate equivalent called a Certificate of Possession, should they so choose.

¹⁰ Gionet, Linda. Statistics Canada Website. (2009). First Nations people: Selected findings of the 2006 Census. (<http://www.statcan.gc.ca/pub/11-008-x/2009001/article/10864-eng.htm>).

¹¹ Anecdotal evidence suggests that in the Ahousaht Nation the average life of newly-built homes ranges between five and eight years, in part because of the stress placed on the structure by unanticipated occupants over and above the number for which the home was originally intended.

2. PROJECT BACKGROUND AND PURPOSE

Working with the Tla-o-qui-aht and Ahousaht First Nations, Ecotrust Canada, a not-for-profit organization with offices in Clayoquot Sound, recognized an opportunity to design and develop a new way to build affordable residential housing in these communities. Partnering with ISIS, Ecotrust Canada submitted a proposal to the Vancouver Foundation and the Real Estate Foundation to research and design green and culturally appropriate housing options for Tla-o-qui-aht and Ahousaht. This report is the product of a 4 month MITACS funded research project which is the first stage of a larger, 16 month project. Future stages will include a community engagement component, a budget process that looks to leverage all available financial funding opportunities and the design of one or more blueprints for a home that will then be built in the two communities.

The purpose of this project is to leverage existing knowledge of green building design features to better inform the evolution of First Nation developments in the Nuuchahnulth region, paying particular attention to the lessons learned during the early stages of the Tla-o-qui-aht community housing project of Ty-Histanis in order to harness its successes and to avoid replication of those efforts. Further, the information gathered through dialogue with Tla-o-qui-aht and Ahousaht Nation members and through secondary research of existing literature will provide insights into what culturally-relevant housing and community design aspects are most significant to the members of the Tla-o-qui-aht and Ahousaht Nations.



Figure 1- A 2-bedroom home being built in the new Tla-o-qui-aht community of Ty-Histanis, 10 kilometres south of Tofino, British Columbia. January, 2011

The proposed house planning framework will provide later stages of the Ecotrust Canada / ISIS / Tla-o-qui-aht / Ahousaht 16-month project with a guide for implementing sustainable and culturally-appropriate building design into community planning. The ultimate goal of the project is to ensure that newly constructed houses provide the healthiest living environment possible, reduce long term costs required for heating and water usage, reduce impact on the environment, remain healthy living spaces for longer than current designs and incorporate cultural features that increase pride of ownership. The intention is to create tangible examples and building designs that can be replicated or adapted throughout First Nation coastal communities.

3. DEMONSTRATING THE VALUE OF INVESTING IN ‘GREEN’ HOUSING FEATURES

Although the intent of this project is to design sustainable and culturally appropriate homes within the practical financial constraints of existing and limited budgets, it is possible to quickly determine the financial implications on a monthly mortgage payment of increasing the total value of that mortgage.

TOTAL VALUE OF MORTGAGE	\$160,000	\$175,000
TOTAL MONTHLY MORTGAGE PAYMENT	\$931	\$1,018

Table 1: Monthly Payments on Secured Mortgage

In the current situation in Ahousaht, each new 1,300 square foot home as designed has a budget of roughly \$220,000.¹² Of this \$220,000, roughly \$160,000 is secured via a mortgage from a financial institution while the remaining funds comes from INAC funding (\$40,000), an Ahousaht fund (\$10,000),¹³ and sweat equity (\$10,000). If an additional \$15,000 is secured for the mortgage (bringing its value to \$175,000), the total cost of the monthly payments increases by \$87, as demonstrated in Table 1.¹⁴ If this additional \$15,000 is contributed toward technologies that reduce the monthly operating costs by greater than \$87 then the homeowner not only reduces the environmental footprint of the home but also saves money in the process.

3.1. STAKEHOLDER NATIONS AND CONTEXT

Tla-o-qui-aht - background

Roughly 10 years ago, the Tla-o-qui-aht Nation (detailed in Figure 2) began the process of petitioning the Government of Canada for access to a portion of Pacific Rim National Park to create a new community development roughly 10 kilometres south of Tofino, British Columbia (BC). The new community of Ty-Histanis, representing roughly 150 homes, will be developed on half of the 80-acre site, adjacent to one of the Nation's two existing communities, Esowista Reserve. Each of the roughly 150 homes to be developed over the next 10 years will be linked to a central District-wide geothermal exchange system that was developed through funding from Natural Resources Canada. The Nation will operate it as a utility, gaining revenue from billing its Nation members for their electricity.



Figure 2: A relief map of the Tla-o-qui-aht Nation's territories in the Nuu-chah-nulth Region of Vancouver Island, BC (Source: <http://de.wikipedia.org/wiki/Tla-o-qui-aht>)

¹² Jerry Boyko, Ahousaht Construction Manager (personal communication, March 1, 2011)

¹³ The Ahousaht Nation received additional financing to address particularly deplorable living conditions. Jerry Boyko, Ahousaht Construction Manager (personal communication, March 1, 2011)

¹⁴ Monthly mortgage payments for the two scenarios were calculated using a 5% fixed interest rate, over a 25-year amortization period without credit protection.

The Ty-Histanis development is one of six sustainable housing projects stemming from the Equilibrium Communities Initiative, part of the Government of Canada's \$4.2 million Economic Action Plan.¹⁵ While each community is designed in ways to make occupancy financially viable, Ty-Histanis is the only one designed expressly for a low-income community. Additionally, it is both the only First Nation and the only rural community to be developed as part of the program.

Ahousaht - background

The Ahousaht Nation (detailed in Figure 3), a remote community 45 minutes by water taxi from Tofino, BC, is in the midst of an extensive community development plan. The first of four total phases has resulted in the construction of a municipal works system as well as the preparation of housing lots – although no construction of physical buildings has yet begun. Several individuals within the community have expressed an interest to the Housing Committee in acquiring a lot for construction. Others have expressed a longer-term interest in doing the same. The remaining three phases will be developed as necessary.



Figure 3: A relief map of the Ahousaht Nation's territories in the Nuu-chah-nulth Region of Vancouver Island, British Columbia.

Standing Tree to Standing Home - background

'Standing Tree to Standing Home'¹⁶ is an initiative launched by Ecotrust Canada to create a lasting 'circle of wealth' in First Nation communities in Clayoquot Sound. Recognizing the inherent wealth that First Nations possess in terms of natural resources and the intrinsic need for sustainable employment opportunities, the goal of 'Standing Tree to Standing Home' is to develop business opportunities and complementary skills necessary to provide lasting improvements to the quality of life for Nation members. Through training programs, Nation members develop the skills to create a resilient and self-sufficient community that will build on the opportunity to become part of the housing developments currently underway in the Sound. This study lays the groundwork for identifying how 'Standing Tree to Standing Home' can be woven into the community housing projects underway in the Tla-o-qui-aht and Ahousaht Nations.

3.2. THE GOAL OF THIS FRAMEWORK

This document and its accompanying Decision Framework is intended to inform First Nation Band Councils and Nation members on necessary steps to ensure that new homes are designed and built according to:

¹⁵ Canada Mortgage and Housing Corporation. (2011). Equilibrium Communities Initiative. (http://www.cmhc-schl.gc.ca/en/inpr/su/eqsucoin/eqsucoin_001.cfm)

¹⁶ Ecotrust Canada. (2011) *Five First Nation communities join forces for \$4.5 million grant application*. (<http://ecotrust.ca/five-first-nation-communities-join-forces-45-million-grant-application>).

- Design techniques best suited for a home, technology-dependent or otherwise, that improves the quality of life for its occupants;
- Sustainable design features currently available in the marketplace that seek to reduce the environmental footprint without dramatically increasing the total value of the mortgage, which will ultimately make homes more affordable by reducing monthly living costs;
- Design features that speak to cultural needs and desires of the community as a whole and on an individual level;
- Comprehensive community-wide strategy developments for the creation of homes where sustainable building design logically intersects with the cultural needs of their inhabitants.

3.3. DOCUMENT LAYOUT

This document follows an intuitive path. It begins by highlighting the principles of sustainable building design and the commonly available technologies that accompany these principles. This is followed by the identification of culturally relevant community and housing design aspects as identified by two Nations from the Nuuchahnulth Region of Vancouver Island.¹⁷ To conclude the document, the Framework is introduced as a tool for informing the decision-making process involved in new community and home development in a way that ties the cultural needs of a Nation to the opportunity for improving home ownership accessibility through sustainable house design.

¹⁷ The Tla-o-qui-aht and Ahousaht Nations were extensively engaged between January-May, 2011, both on an individual basis and in broader demographic segments to identify key design elements that speak to their cultural needs as a distinct culture within Canadian Society.

4. SUSTAINABLE DESIGN FEATURES

4.1. PASSIVE HOUSE DESIGN

Passive house design is perhaps the most effective way to minimize operational costs, however it can add a significant amount to the overall construction cost of the home if the intent is to strictly conform to the PassivHaus Institute's design platform. PassivHaus uses rigorous criteria to ensure that energy efficiency in buildings is achieved by paying particular attention to the building envelope and to the location's prevailing environmental and geographic conditions.¹⁸

These include:

1. Using **passive solar power** to harness and/or mitigate the natural light and heat imparted on a building through passive solar heat accumulation;
2. Considering **building and site orientation and shape** when creating the house design, as each affects the amount of heat loss from the building, thereby affecting energy consumption and costs;
3. Designing the **interior layout of the home** to passively increase the amount of natural light to specific rooms during the day based on how each room is used, which can reduce the need for active heating of that space. An additional consideration in this regard is the logical locating of mechanical systems within the building (i.e. locating rooms requiring hot water close together to minimize heat loss as hot water moves away from the hot water heater);
4. Selecting **appropriate insulating materials** to reduce heat loss across the building envelope while simultaneously remaining mindful that different insulating materials perform better than others due to their method of application;
5. Selecting the **style and shape of the building's windows** to increase the energy efficiency of a building by allowing for passive air flow throughout the structure. Operable windows provide an opportunity to create airflow within the building, which will mitigate its risk of developing mould.

Homes in compliance with PassivHaus design certification add roughly 10% to the cost of the building,¹⁹ which would add substantial costs to the modest per square foot budgets in Ty-Histanis and Ahousaht (which currently rest at between \$120/ft² and \$130/ft²). These price premiums are a result of the increased attention paid to the quality of the materials selected for different aspects of the house design. For example, PassivHaus requires that the entire building (including the area beneath the foundation) be insulated, which is not a requirement set forth by other organizations such as LEED or by regulators such as the City of Vancouver. That being said, the overarching principles of passive house design can be embraced in ways that still maximize energy efficiency without pursuing actual certification from the Institute. These practical observations of natural design techniques help to minimize operational costs without exceeding the construction budget allocated to the projects and could represent the greatest opportunity to reduce

¹⁸ A more thorough explanation of the PassivHaus Institutes design principles, along with additional resources, can be found at The PassivHaus Institute website (<http://www.passiv.de/>) or (<http://vancouver.ca/sustainability/documents/58346PassiveKitBookPrt9.pdf>).

¹⁹ Waterman, Anthony. Sustainable Costs- the Future is Passive. Published in Building.co.uk. July 28, 2006 (<http://www.building.co.uk/sustainable-costs-%E2%80%93-the-future-is-passive/3071345.article>).

monthly operating costs while minimizing the amount of money spent on conservation technology. The creation of a secure building envelope is of great financial importance and is essential to supporting passive house design; all interior design should be seen as supporting the envelope. That being said, optimizing the combination of the building envelope and its interior design will ultimately increase the energy efficiency of the building.

4.2. SUSTAINABLE HOUSE DESIGN TECHNOLOGIES

The environmental benefits, financial gains and quality-of-life improvements that passive house design principles offer can be augmented and added to - through the use of modern technology. This technology can lessen the overall impact of the home by specifically reducing energy consumption and improving water conservation. Many of these technologies do this while also improving the indoor air quality of the home, something particularly relevant in First Nation communities suffering from black mould infestations, allergies, and other respiratory ailments. There are several ways of categorizing these opportunities available to perspective homeowners but perhaps the most effective is to consider them in terms of their most relevant impacts on the occupants' day-to-day lives.

There are different criteria that can be considered in evaluating the desirability of green technologies, but ultimately the value of a given technology should be measured against the particular goals of the homeowner, be it energy efficiency, water conservation, quality of life improvements or capital cost. The value of a particular technology is heightened by improving on more than one of the categories, and such a technology should be given particular consideration.

Energy Consumption

The month-to-month operating costs of a residential building are, by in large, reflective of the amount of electricity necessary to live. Energy consumption in residential buildings is significant both in terms of the amount of money spent on electricity on a monthly basis and also in terms of the impact on the environment in order to generate that electricity. Figure 4²⁰ profiles the different relative amounts of energy consumption by end use in residential buildings. As can be seen, the bulk of a home's energy consumption is devoted to space heating and cooling, representing roughly 54% of the total consumed. In First Nation homes, characterized by poor construction, this proportion is potentially higher. Households in Canada with a median income of under \$30,000 carry an individual energy burden of 6%,²¹ meaning 6% of their income is allocated to providing electricity to their homes. This supposes *adequate housing*, however First Nations have average energy bills of roughly \$500/month,²² which translates to \$6,000/year. Given that the median income of First Nation members living on reserve is \$11,224 in 2005,²³ a family's median income (\$22,442) carries an energy burden of roughly 26.74%. On-reserve Nation members, therefore, spend a disproportionately high amount of annual incomes on their electricity bills, relative to the rest of the Canadian population. Improving energy efficiency of

²⁰ Buildings Energy Data Book. (2011). Chapter 2: Introduction- Residential Sector
<http://buildingsdatabook.eren.doe.gov/ChapterIntro2.aspx>

²¹ Buildings Energy Data Book. (2011). Chapter 2, Section 2.3 Residential Sector Expenditures
<http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=2.3.15>

²² Community engagement session. (Ahousaht Nation, March 30, 2011)

²³ Gionet, Linda. Statistics Canada website. (2009). Selected findings of the 2006 Census <http://www.statcan.gc.ca/pub/11-008-x/2009001/article/10864-eng.htm#a7>

homes in First Nation communities will minimize the environmental impact of these new homes, which represents an inordinately large opportunity to improve the quality of life for Nation members by freeing up large amounts of their income.

What follows is a broad list of design considerations. While by no means exhaustive, each appendix provides a useful introduction to its respective subject matter. Each category and accompanying appendix will inform the homeowner on sustainable technologies, capital costs, impact on monthly operating costs as well as energy and water conservation and the potential impact of each technology on the occupant's health and quality of life.

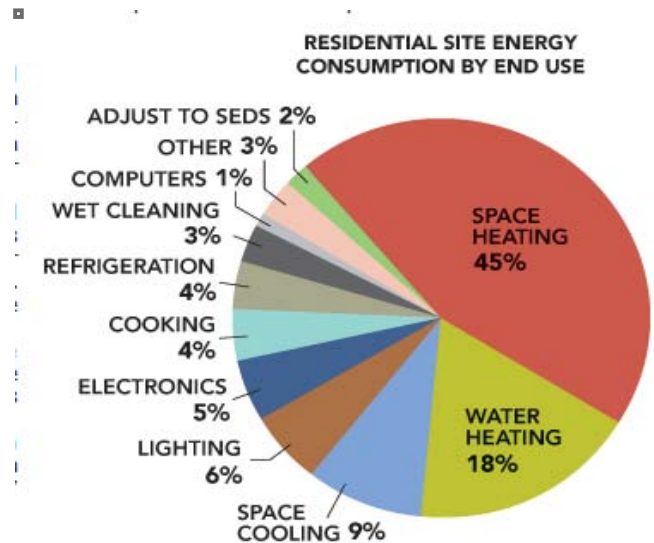


Figure 4. A profile of energy consumption in residential homes. <http://buildingsdatabook.eren.doe.gov/ChapterIntro2.aspx>

1) Building Envelope- Siding (Appendix 1)

The integrity of the building envelope will ultimately determine how energy efficient a home is as its ability to mitigate internal and external temperature differences dictates how much energy technologies within the building have to use to maintain a constant temperature. The greater the integrity of the building envelope, the less reliant the homeowner has to be on technology to heat or cool the house. Certain types of siding provide better opportunities for insulating a home, which directly affects the amount of thermal energy lost across the walls of the building. Some types of siding, like insulated vinyl siding, provide additional insulation while others, such as wood fibre composite forms have an increased capacity to retain heat/cold, meaning that the internal temperature of the home adjusts over time based on how much energy the walls absorb/lose.

2) Insulation (Appendix 2)

Different types of insulation have different impacts on maintenance of internal house temperature. Traditional fiberglass batt insulation is widely accepted as industry standard because of its affordability and the ease with which it can be cut and utilized. Generally-speaking, newer technologies are more efficient at maintaining temperatures and are more durable and effective in the long-run. Additionally, certain technologies, such as blown/foamed through membrane insulation, have the potential to reduce interior wall moisture, which contributes to humidity. Despite these benefits, newer technologies typically carry a price premium, are more difficult to install, and are at least as expensive, if not considerably more so. There is therefore a very real trade-off between the cost and efficacy of traditional insulation and newer technologies.

3) Space heating and cooling (Appendix 3)

There are several different ways of moderating the cost of space heating and cooling in a home through the use of technology. One way is to increase the energy efficiency of the heating/cooling process, such as with high-efficiency

forced air furnaces, which offer considerable energy savings. Alternatively, radiant heating (in-floor or panel) can be used to heat an entire space by heating the air, rather than exchanging the entire volume of cold air for warmer air.

Another tactic that is commonly employed is the use of technology that automatically maintains a constant temperature based on pre-set parameters. These parameters are decided upon by the occupants. In managing the temperature this way, furnaces (and other technologies) are called upon more frequently but for less time, meaning that operating time and costs are reduced.

4) Water heating (Appendix 4)

The cost of heating water for home use is a considerable portion of the cost of operating a home. There are technologies available that help to reduce this cost. These operate in a variety of different ways, such as by pre-heating water before it enters the water heater (i.e. solar water heaters). A contrasting method of heating water is with a tankless water heater, which heats water on demand rather than maintaining the entire volume of the hot water heater at a constant temperature. Of particular interest are technologies that either reduce the amount of heat lost as water travels to the faucet/shower from the water heater or reclaim heat lost as warmed water goes down the drain, eliminating the need to constantly heat new volumes of water.

5) Lighting (Appendix 5)

As previously mentioned, the use of natural light will reduce the operating costs of a home by minimizing the need for electricity-dependent lighting. Skylights are a very practical way of increasing the amount of natural light inside a home. The benefits of tubular and traditional skylights are not restricted to energy consumption, but also include the health benefits that natural light have on a building's occupants. Failing these options, homeowners can turn to more efficient types of lighting, such as compact fluorescent lights (CFL) or light-emitting diode (LED) lighting, both of which use considerably less energy than traditional incandescent lights, although they do demand a price premium at the time of purchase.

6) Windows and Window Frames (Appendices 5 & 6)

Windows offer much less insulating capacity than walls, which is why passive house design prescribes preferential window locations to specific sides of a home to capture the maximum solar heat gain possible. There are several different ways in which the design of windows has been modified to increase insulating capacity. While each of these changes has brought about reduced operating costs for the home by reducing heat loss, it has also resulted in increased capital costs. Window frames are being built with materials that have a greater insulating capacity while also decreasing drafts as vinyl and composite window frames, for example, are an improvement over aluminum. Manufacturers are also now increasing a window's glass pane count in order to create more insulating layers between the outside and inside of a home – a move that fills the space between panes with inert gases to conduct less heat than traditional windows. An added benefit of traditional and tubular skylight windows is that the need for artificial lighting via light bulbs is reduced.

7) Appliances (Appendix 7)

Energy efficient appliances typically require a price premium, however this premium is generally marginal compared to the lifespan of the appliance and offer relatively quick payback periods. Some appliances, such as front-loading washing machines, also offer considerable water savings over traditional styles, meaning multiple benefits to the individual and environment are generated.

Water Consumption

Canada's fresh water supply represents one of its biggest assets, now and into the future. Despite this, in a recent study of 16 developed countries Canada ranked 15th in water consumption,²⁴ consuming 329 litres per person per day in 2004.²⁵ Water consumption in residential buildings is used for a variety of purposes, as indicated by Figure 5.²⁶ Part of this is explained by the limited price consumers pay for fresh water; 43% of domestic water users pay a flat rate, and a further 12% pay a declining rate, meaning the price of water decreases as more is purchased and/or used.²⁷ The other 57% of homes do not pay for their water consumption.

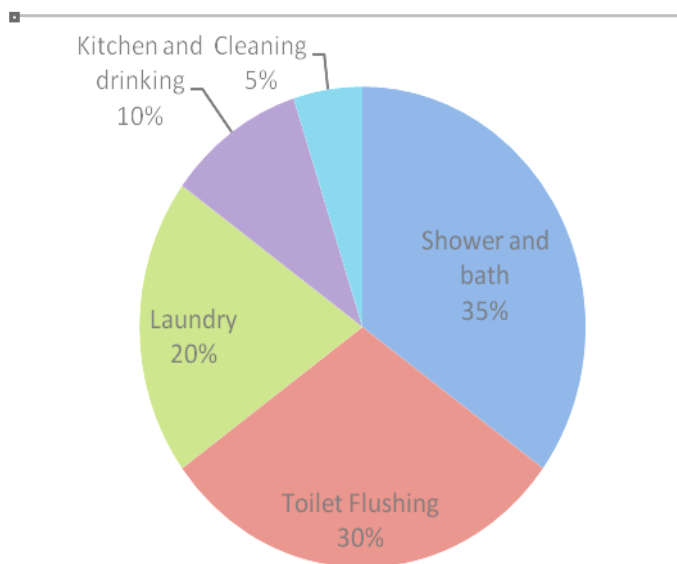


Figure 5. A profile of water consumption in residential homes. Adapted from Natural Resources Canada (1999): http://atlas.nrcan.gc.ca/site/english/maps/freshwater/consumption/wateruse_home.gif/image_view

Depending on the billing practices in a community, there is potentially no real reason to practice water conservation. This undervaluing of water as a resource is actually built into the Canadian infrastructure; only 57% of urban communities in Canada have metered water and consumption habits are greater in smaller and non-urban communities, suggesting links between awareness, responsibility and consumption.²⁸ Indeed, the Ahousaht Nation members do not pay for the water consumed within homes.²⁹ With no real financial return on water conservation, therefore, it is potentially difficult to motivate an individual to invest in technology that accomplishes conservation. Heightened consideration should therefore be given to energy-saving technologies that also achieve water conservation.

²⁴ The Consumption Board of Canada. (2011). Environment: Water Consumption.

(<http://www.conferenceboard.ca/hcp/details/environment/water-consumption.aspx>).

²⁵ (Environment Canada, 2007 *Municipal Water Use Report: Municipal Water Use 2004 Statistics* (Ottawa: Author, 2007), p. 3.)

²⁶ Natural Resources Canada. (2004). Pie Chart of Residential Water Use in Canada, 1999.

(http://atlas.nrcan.gc.ca/site/english/maps/freshwater/consumption/wateruse_home.gif/image_view).

²⁷ The Consumption Board of Canada. (2011). Environment: Water Consumption.

(<http://www.conferenceboard.ca/hcp/details/environment/water-consumption.aspx>).

²⁸ Ibid. (2011). (<http://www.conferenceboard.ca/hcp/details/environment/water-consumption.aspx>).

²⁹ Pam Frank. Ahousaht Administrator. (personal communication, May 19, 2011).

1) Water Saving Technologies (Appendix 8)

These opportunities span a breadth of different areas in a home, and consist of active water saving features, like high-efficiency washing machines, to more passive water saving features, such as faucet aerators. Technologies that actively promote water conservation are typically those that also increase energy efficiency, such as the aforementioned high-efficiency washing machine and plumbing manifolds, which deliver water directly to individual faucets, rather than running through the entire network of piping. While these typically carry a larger cost premium, it also offers an opportunity for a greater decrease in operational costs. The benefit of passive water saving features is that lower costs are typically generated (i.e. laminar flow sink faucet fixtures range in price between \$3.50 and \$12.00, but reduce water consumption by 27-90%) and, once installed do not require further attention.

2) Water Collection (Appendix 9)

Water collection practices are a means by which a homeowner can reduce the amount of water taken from the municipal supply. In the current situation for Ty-Histanis and the Ahousaht Nation there would be no direct operational cost savings to the homeowner because water delivery is not a paid service. That being said, potential water scarcity in the future could lead to it becoming a paid service, which should prompt the homeowner to consider these techniques and technologies for future use and benefit. Rainwater harvesting, therefore, may be a consideration for homeowners and can be installed after construction.

3) Larger Infrastructure Considerations (Appendix 9)

Some technologies, such as wind turbine electricity generation, are best considered on a community-wide scale, as it requires considerable capital investment to install. Other technologies, such as photovoltaic solar cells, are simply not cost-effective in particular climates that don't receive sufficient amounts of sunlight. These technologies would require considerable government rebates in order for their payback periods to be attractive enough for the required capital investments.

5. CASE STUDIES AND INCLUSIONS

An analysis of pertinent green residential building case studies in the Cascadia region reveals important lessons that can be used by the Tla-o-qui-aht and Ahousaht Nations as they continue their respective housing developments. By observing these lessons, the Nations can build upon the successes of other organizations' experiences and avoid their shortcomings.

Based on case study analysis of multiple and current iterations of sustainable low-income housing, the popular tendency is to build apartment-style residences which reduce the unit cost associated with the more expensive technologies that promote sustainability. This style of development, however, is contrary to the homes being built at the Ty-Histanis site. Research has yielded few examples of single, two, three, and four room units, regardless of the sustainable building certifying body used to identify the projects (e.g. LEED *versus* PassivHaus, etc.). For a variety of reasons, therefore, the plans set forth for Ty-Histanis appear to be a departure from the trend for sustainable low-income housing to be built as multi-unit residential complexes in urban areas.

It is important to remember that Ty-Histanis benefits from additional funding independent of the Government of Canada's annual funding programs for First Nation housing. This additional funding is specifically ear-marked for its district geothermal exchange, a community-wide sustainable design feature that, other First Nation communities may not be able to replicate. In addition, a single geothermal well is simply not practical for a single unit low-income house based on the prohibitively expensive capital cost necessary to install it.

Rather than rely on expensive technology that, on a per unit basis, is inaccessible to most low-income housing, passive house design can, in some instances, reduce the need to rely on said technology. This approach lowers the operating costs of a home by utilizing prevailing environmental and climatic conditions for heating and cooling while simultaneously reducing the reliance on expensive technology.

Case Study #1: Helensview Heights (Portland, Oregon)³⁰

Helensview Heights is an affordable community housing development of 52 units in Portland, Oregon built by HOST Development, a not-for-profit organization. The homes, certified LEED-Silver, are partially funded by Enterprise Community Foundation's Green Communities and The Home Depot Foundation. The homes, ranging in price from \$186,000 to \$244,000 (based on 8 variable floor plans), are geared for potential homebuyers with family incomes of 70% to 100% of the area's median value. The sustainable design features of the homes are fairly common, closely reflecting the design features chosen for the Ty-Histanis community development.

Common features include:

- Low-Volatile Organic Compound (VOC) interior and exterior latex paint;

³⁰ Binasacca, R. 'Reaching New Heights'. June 2, 2009 (<http://www.ecohomemagazine.com/low-income-housing/reaching-new-heights.aspx?page=1>).

- Energy Star-qualified appliances (i.e. refrigerators, dishwashers, and laundry equipment);
- Heat Recovery Ventilators (HRV) to improve air quality and reduce excess humidity;
- Energy Star-qualified vinyl high-performance windows;
- HardiePlank fiber-cement lap siding;
- Formaldehyde-free batt insulation;
- Asphalt roofing shingles with recycled content.

Features not included in Ty-Histanis:

- Natural gas fireplaces with optional firebrick and blower;
- Recycled content carpeting;
- Laminate flooring that requires no adhesives and a pre-finish to eliminate off-gassing.

In this example, the builder was able to negotiate volume discounts based on the scale of the project. In leveraging the sheer size of the development, the per unit cost of specific features was reduced, dropping the overall capital cost necessary to build each home.³¹ Given the amount of funding currently available to First Nation communities in response to their housing crisis, the value of exploring these volume discounts would appear to be high.

Cast Study #2: High Point (Seattle, Washington)

High Point is an ambitious community redevelopment still under construction in West Seattle that will include 1,600 new homes, 50 per cent earmarked for rental to low-income households.³² The Seattle Housing Authority enlisted multiple stakeholders to redevelop the post-World War II-era community with sustainability in mind.

Of the 1,600 units, 60 will be built according to the specifications established by Breathe Easy Homes™, LLC, whose mission is to assist in the improvement of indoor environmental and air quality.³³ As such, a significant focus was placed on designing the homes in a way that helps to reduce the instance of respiratory ailments. Given the current air quality situation stemming from black mould infestations in the homes of First Nation communities on the Northwest Pacific Coast, the Breathe Easy Homes™, LLC model is an appealing consideration. Features in these 60 homes include:

- The inclusion of low-VOC or low off-gassing materials throughout (i.e. paint, linoleum, cabinet construction, carpeting, etc.);
- Whole-house fans to reduce internal moisture;
- Selection of materials with high recycled content (e.g. linoleum flooring);

³¹ As an aside, HOST Development is now insolvent, a victim of the 'housing bubble' in the United States, and the development is currently stalled as the City seeks another developer to continue with the community.³¹ This notwithstanding, residents of Helensview Heights are grateful for the opportunity that sustainable low-income housing has afforded them.

³² Mithun Website. (2011). (http://mithun.com/projects/project_detail/high_point/).

³³ Breathe Easy Homes. (2011). (<http://www.breathetheeasyhomes.com/>).

- A positive air pressure in the venting systems complete with air filtration, HRV units to improve indoor air quality, and a tempered fresh air supply;
- A comprehensive filtration system for air intake into all living and sleeping spaces;
- Observance of a specific construction sequence that includes steps to reduce the amount of particulate matter and moisture in the building and building materials during construction, including weather protection of on-site materials, regular flush-outs of the interior to ensure evaporation and off-gassing of all materials, and ductwork protection to minimize dust;
- Door mats to reduce tracking of dirt and allergens into the home.³⁴

Each of these items, while relatively small, helps to ensure that the occupants of the house are able to live with the greatest level of comfort possible to them. While the price premiums associated with pursuing all of these inclusions might make the entire list inaccessible to self-financed low-income homes, the pursuit of this ideal should be emphasized, particularly given the respiratory ailments that plague First Nation communities in Canada.

³⁴ Seattle Housing Authority Website. (2011) <http://www.seattlehousing.org/redevelopment/high-point/breathe-easy/>

6. CULTURAL DESIGN FEATURES

6.1. THE RELEVANCE OF TRADITIONAL ARCHITECTURAL FEATURES

Traditional architecture and design principles, while not physically evident in modern First Nation communities, are still intrinsically linked to the social and cultural needs of the communities, as expressed by the various Nation members.

The Longhouse of the Northwest Pacific Coast

Historically, the peoples of the Nuuchah-nulth region along the West Coast of Vancouver Island (and down into Northern Washington State) lived in large communal houses, each of which belonged to any of several Chiefs within the community. The population of each longhouse was a complex organization of multiple families which spanned several generations.

While the posts and beams remained static throughout the year, cedar planks used to create walls of the longhouse were removable, indicative of the seasonal relocations that the Nation undertook depending on the work and/or food sources necessary at the time.³⁵ In a more relevant context, these removable wall planks also allowed longhouses to be combined during times of celebration, meaning that a greater number of people could be accommodated for any festivities if necessary.³⁶ There was an expectation on the part of the Nation that homes would accommodate more than the nuclear family, something that remains true today.

Artistic Considerations

Artwork in First Nation culture is more than decorative; it is one of the foundations of their culture and is an intrinsic link to their history.³⁷ In their artistry, First Nations communicate the core values of their society, speak to other cultures, and maintain a link to their history. Traditionally, art was present throughout the longhouse.

The beams and poles of the typical longhouse were carved with the totems of the Nation,³⁸ a constant and permanent reminder of the family's and the Nation's history, culture and spirituality.

6.2. CURRENT CULTURAL DESIRES & HUMAN NEEDS

Conversations with Ahousaht, Ucluelet,³⁹ and Tla-o-qui-aht Nations members yielded very similar sentiments surrounding the current needs of First Nation communities in the Northwest Pacific Coast. These thoughts can roughly

³⁵ Simon Fraser University: The Bill Reid Centre for Northwest Coast Art Studies. (2010). The Virtual Village Project: Nuuchah-nulth. (<http://www.sfu.ca/brc/virtualvillage/nuuchahnulth/>).

³⁶ Joe Martin, Tla-o-qui-aht Nation Member and Nation Historian (personal communication, April 11, 2011)

³⁷ Joe Martin, Tla-o-qui-aht Nation Member and Nation Historian (personal communication, January 17, 2011)

³⁸ Simon Fraser University: The Bill Reid Centre for Northwest Coast Art Studies. (2010). The Virtual Village Project: Nuuchah-nulth. (<http://www.sfu.ca/brc/virtualvillage/nuuchahnulth/>).

³⁹ One of the individuals interviewed during primary research was a member of the Ucluelet Nation, a neighbouring nation to the Tla-o-qui-aht and Ahousaht Nations and part of the Nuuchah-nulth Region.

be divided into two distinct and yet necessarily linked categories: 1) cultural desires and 2) fundamental and basic human needs.

Cultural Desires

The cultural desires of the Tla-o-qui-aht, Ahousaht, and Ucluelet Nations were expressed through a series of interviews with Nation members between January and May 2011, and represent design features that consistently came up as those that would make day-to-day life better for the homeowner and their family.

Multigenerational living: The middle (40-55) and elder (55 and over) generations each expressed a desire to revisit the opportunity for multigenerational living, or the inclusion of at least three generations all living within either a single home or a relatively short distance from each other. This close proximity satisfies a number of traditional cultural values that typical, non-aboriginal North American community styles do not. In particular:

- In Nuuchah-nulth history, oral tradition is how language, culture, and traditions have been passed from elders to their next generations.
- Having several generations living under one roof allows members of the extended family to care for the younger generation if parents are unable to do so, whether for a short or long-term duration. With the high incidence of drug and alcohol abuse in First Nation communities, multigenerational living would allow Elders to provide the younger generation with the stability and structure they could otherwise lack.

The Prominence of Elders: The role of Elders in First Nation communities is vital as they represent the link between the past, current and future generations. Facilitating the interaction between Elders and their grandchildren is invaluable to the preservation of First Nation culture, language, history, and knowledge. There are fundamental ways in which this interaction can be fostered. In the instance of Ty-Histanis, Elders residences were built near the future site of baseball fields and a community centre, which will maintain the prominence of the Elders within the community and preserve this important cultural role.

Larger food preparation and storage areas: the desire for larger food preparation areas stems from several different needs. The typically large number of occupants that results from the housing shortages prevalent in First Nation communities requires larger food preparation areas in the kitchen to accommodate the larger meals that are prepared. Similarly, because First Nation communities are often remote from urban centres, families tend to purchase non-perishable food items in bulk to minimize the frequency of trips from their communities, which requires additional large-scale storage.

Smokehouses and canning rooms: First Nations on the Northwest Pacific Coast are traditionally sea-faring and hunting communities, which has drawn interest for:

- i. **Smokehouses:** Historically, the best method of preservation for the catch and/or kill has been through smoking in smokehouses made from red cedar. At present, smokehouses are interspersed throughout the community but are privately owned and not for community use. A common sentiment in community engagement interviews was the desire to have either a smokehouse included in each new home or, alternatively smaller community-based smokehouses that multiple families could use.
- ii. **Canning Rooms:** With the introduction of Europeans to the region, the practice of canning as a means of food preservation has also become commonplace in First Nation communities. The inclusion of a canning room into the home design would increase a family's ability to can the item in a timely manner. According to conversations with community members, this could be supplemented with cold rooms that would make the canning process easier and allow for longer-term storage of unfinished catches.

Fundamental And Basic Needs

In addition to the inclusion of cultural desires within the design process, interviews with Nation members also yielded the desire for homes that better meet fundamental and basic needs.

Warmth: Many Nation members, both young and old, expressed sentiments that they are always cold when in their homes.⁴⁰ This suggests several things, all of which stem from poor construction quality. There are implications that:

- 1) Insulation used in the homes is insufficient to form an adequate seal within housing envelopes;
- 2) Stilted construction used in the past provides opportunities for heat loss as it exposes the underside of the home to the elements, despite the insulation used to prevent heat loss;⁴¹
- 3) Drafts originating from around the door and window frames are permitting heat loss, contributing to the poor living environment within the homes.

All of these scenarios also lead to higher month-to-month living expense. A Nation member confirmed monthly electricity bills of \$500 to \$600.⁴² In areas of high unemployment this represents a significant portion of the monthly allowance afforded the individual through social assistance. The end result is that defaulting on rental payments among Nation members is high, with the Band Council shouldering the burden of carrying the financial shortfall when making mortgage payments.⁴³

Mould-free: The common occurrence of mould leading to significant health complications has become symptomatic of the ongoing housing inadequacies facing First Nation communities. The incidence of asthma, pneumonia, tuberculosis, and other respiratory ailments is significantly higher than in urbanized locales. The degree of incidence is such that

⁴⁰ Community engagement session. (Ahousaht Nation, March 30, 2011)

⁴¹ This is confounded, community members say, by animals (cats, dogs, etc.) that tear away the insulation, leaving no barrier between the external environment and the interior of the house. Community engagement session. (Ahousaht Nation, March 30, 2011).

⁴² Community engagement session. (Ahousaht Nation, March 30, 2011)

⁴³ Jerry Boyko, Ahousaht Construction Manager (personal communication, March 1, 2011)

First Nation housing contractors are allocated a specific amount by INAC expressly for the purpose of mould remediation in existing homes. In the Ahousaht First Nation, homes under a cost threshold for mould remediation (\$65,000) are undertaken while those above it are considered condemned, meaning that demolition plans are undertaken. Until such time as new homes are built however, occupants of condemned homes continue to live within the structures.

Larger, more accommodating spaces: The current INAC and CMHC-approved house designs do not consider the propensity for having multiple generations or multiple families living under a single roof. The crowding that accompanies these scenarios results in trying living conditions as individuals struggle to find the space necessary for healthy living.

Opportunity for privacy within these larger structures: Accompanying this desire for larger, more accommodating spaces within the home is the additional need for privacy within each house. Overcrowding creates an environment where individuals desperately want privacy within their homes, especially among the teenage population. Their specific sentiments are a reflection of the personal independence that young adults crave and also a need to provide them with the opportunity to focus on academic studies and sleep. Conflicting sentiments of the younger generation is their stated desire to remain close to their extended family, suggesting that there is still a strong draw to the idea of a close-knit family within the community, but that the younger generation would like it tempered with the means to create some privacy.

These elements were all historically available to community members prior to the implementation of the Indian Act in 1864 by the Canadian Federal Government. With its advent, however, came restrictions on the manner in which First Nation communities could be organized and the imposition of North American and/or European values, which are often contrary to those of the First Nations. The result of this is a well-documented case of the decline of a population into poverty and unfulfilled potential.

7. COMMUNITY CAPACITY- FUTURE NEEDS

In addition to the cultural needs of the community with regard to the houses in which they live, interviews were conducted with specific community members to identify the current employment situation within the community in an effort to inform on how Nation members and businesses could be included in the future housing development. This work was preliminary research to facilitate future investigations in latter stages of the larger, umbrella project pertaining to 'Standing Tree to Standing Home'.

Current Levels Of Employability

It is difficult to quantify the capacity of the Clayoquot Sound First Nations in terms of their ability to participate in future housing design and construction. There are very few concrete numbers to indicate the number of individuals currently qualified to step into the process and take on a more active role.⁴⁴ Within the local communities there are individuals at various levels of skill currently employed in this field intermittently. In particular, the Ahousaht Nation has seven to eight people who have accrued enough hours to challenge for their journeyman carpentry certificate, although none have yet done so. The Ahousaht Construction Manager is currently in the midst of hiring a superintendent, where one task would be to equip these individuals with the knowledge to challenge these exams – through the coordination of course work.⁴⁵

Ahousaht also has an apprentice electrician, however beyond that there is limited capacity to fill out the work requirements for the new housing development currently underway. That being said, according to the Construction Manager, the Band Council has a policy in place that requires outside firms (hired to work within the community) also hire a Nation member as a learning opportunity.⁴⁶ This practice ensures community individuals gain valuable professional insight, as well as hours to be put toward the certification process should they choose to pursue their papers.

Further, Ahousaht has partnered with Discovery Island College as part of the Ahp-cii-uuk initiative. Under this agreement, the College offers a four-year program within the community to train Nation members interested in becoming certified carpenters. During the first year, students are trained in foundation and framing, with the curriculum in the second year focused on developing skills in exterior finishing. The first class of students is currently in its second year.

Contractors

Cover Creek Contractors, a contracting company owned and operated by an Ahousaht member that employs between four and five Nation members,⁴⁷ operates in Ahousaht and is capable of installing water and sewers for the new

⁴⁴ Conversations carried out during primary research yielded little information with regard to the number of qualified individuals, particularly in the Tla-o-qui-aht Nation.

⁴⁵ Jerry Boyko, Ahousaht Construction Manager (personal communication, April 7, 2011)

⁴⁶ Jerry Boyko, Ahousaht Construction Manager (personal communication, April 7, 2011)

⁴⁷ Jerry Boyko, Ahousaht Construction Manager (personal communication, April 7, 2011)

housing development that also includes activities such as the stripping of land and drainage. Cover Creek has not been part of Phase 1 of the construction due to the bidding process.

Timber For Housing

The two First Nation-owned sawmills in operation in Clayoquot Sound, Ahousaht and lisaak, are currently operating below capacity.

Ahousaht Sawmill: Virgil Frank, Head Sawyer at the Ahousaht Sawmill, suggested the saw is operating at roughly 50% capacity (producing roughly 1,500 board feet per day), and efficiency increases will be gained from recent introductions of additional machinery to move rough timber around the yard.⁴⁸ The mill currently lacks a kiln, which limits its ability to supply dried wood to the community development. At present, the mill employs four people in the yard, one of whom doubles as an administrative assistant⁴⁹ and apprenticeship opportunities exist.

lisaak Sawmill: Alan McCarthy, Head Sawyer at lisaak (a sawmill jointly owned by 5 Nations from the Nuu-chah-nulth Region), is currently producing approximately 3,000 board feet per day of clear cedar, while employing 8 individuals in the yard. This production could be increased to roughly 10,000 board feet per day based on demand and would require no additional employees to service this volume. This could conceivably require a capacity expansion of its current kiln. In addition to currently selling clear cedar 2X6 planks of up to 20 feet in length, the mill also builds some value-added products such as Adirondack chairs and picnic tables. The 2X6's are sold to companies outside the community, with no knowledge of the final destination.

While little consolidated and concrete information exists about the current level of training in the two Nations, there are ways of determining where general needs will arise. The most obvious roles are those involved in the actual building of the homes. Providing individuals with the skills necessary to work in the plumbing, carpentry, and electrical trades will create opportunities for long-lasting employment, both within the Nation and outside it.

Confounding Social Issues

There are social issues present in First Nation communities that complicate the participation of Nation members in the building process, including high rates of absenteeism. This creates situations in which those individuals responsible for managing projects within financial budgets are unable or are unwilling to employ First Nation members, and instead turn to workers from outside the Nation to accomplish their contracted task. With this, money that would otherwise stay within the community flows out of it, contributing to the ongoing social challenges that exist. To this end, it becomes vitally important to train First Nation members to a level that allows them to attain leadership roles within companies or, indeed, to start their own. Ultimately, this is the goal of Ecotrust's 'Standing Tree to Standing Home' initiative.

⁴⁸ Virgil Frank, Head Sawyer, Ahousaht Sawmill (personal communication, March 1, 2011).

⁴⁹ Virgil Frank, Head Sawyer, Ahousaht Sawmill (personal communication, March 1, 2011).

8. PLANNING FRAMEWORK

Introduction

The following pages propose a process for undertaking the design and construction of new residential housing on First Nation reserve lands. Its intention is to facilitate a comprehensive and engaging design and building process for both the Band's administrative arm and the Nation members that will ultimately develop homes that are both environmentally sustainable and culturally appropriate for the occupants. In this way, past successes and shortcomings can be addressed and/or built upon, refining future housing developments in First Nations to strengthen the community. The process itself is by no means complete, but rather a suggested foundation upon which housing developments can be based. As in the case of INAC's 1996 amendment that gave Band Councils more flexibility in the way government funding is used, this process should be carefully considered and re-evaluated as a better understanding of its applicability is gained. As housing in First Nation communities evolves so too will this framework.

This Planning Framework is made up of three distinct yet equally important processes, including 1) Community Planning and Inventory, 2) Green Strategies and Features, and 3) Culturally-appropriate Design.

PROCESS 1: COMMUNITY PLANNING & INVENTORY

The goal of this section is to facilitate the Band Council's community planning exercises. Integrated into this is the opportunity for the Nation's administrative arm to evaluate the local community capacity to participate in the design and construction process of the new housing development.

Community Strategy

This section proposes conducting a thorough inventory of the current housing stock, the future needs of the community, and assessment of Nation's ability to accommodate those needs.

The quality of the current housing stock

As part of the inventory process it is important to segment the current housing stock into its different components. This will inform the Housing Committee on homes that are:

- I. Condemned;
- II. In need of remediation;
- III. In good working order.

Determining the number of each will help the Band Council to allocate the appropriate amount of funds to each level of repair. It will also inform the Band Council on the purchasing power that they potentially have for buying supplies and materials in bulk.

The future needs of the community

Having a fundamental understanding of how the Nation's population on reserve is changing will allow the Band Council

to plan appropriately for future housing needs. Depending on the styles of homes to be built, this could result in design features that would otherwise be overlooked (i.e. more homes with nursery rooms). Aspects of population demographics to consider are:

- I. The number of individuals in a given age bracket, which will inform the specific sizes, styles, and features of homes;
- II. The birth rate and the likely birth rate in the upcoming years;
- III. The death rate, which will inform the rate of total population growth;
- IV. The number of individuals recently returned to the community from living off-reserve. The prospect of new and more houses at home is compelling individuals who have previously left the reserve for urban centres to return.

Availability of different financing mechanisms for:

First Nation housing- the Government of Canada commits a specific amount of money annually to housing in First Nation communities through a series of agencies. Knowing what funding mechanisms the Nation is eligible for helps to determine the total budget available per home.

‘Green’ community infrastructure- Government funding is available for a variety of initiatives that help develop sustainable community infrastructure.⁵⁰

Sustainable housing design- Governments, realizing the need to mitigate unpredictable and rising energy prices, offer intermittent government rebates and incentive programs to incentivize the purchase of a variety of green technologies.⁵¹

Alternate funding mechanisms for lowering the cost of the home

First Nation members have the opportunity to develop alternate means of financing the purchase of their homes. The practice of *sweat equity* has been employed with some success in some Nations across the Canada. Under this arrangement the future homeowner contributes to the construction of his/her home in exchange for a decrease in the cost equivalent to the time committed. This is particularly relevant if the proper training programs can be instituted in the community to train Nation members.

Exploratory interviews to determine the needs of the community

It is important that any community development undertaken by the Nation actually addresses the various needs of the Nation. Fully identifying these needs is best accomplished by consulting with individuals within the community. These

⁵⁰ As was the case in Ty-Histanis, which benefitted from Government funding for its District geoexchange system, which will allow the Nation to operate as a utility, thereby generating revenue by administering monthly utility bills to its members.

⁵¹ Programs facilitated by the Provincial and Federal Governments are continually changing. Being aware of how they are changing is critical to taking advantage of opportunities when they are available.

consultations can take several forms, whether it is through personal and private conversations with Nation members or through community-wide engagement sessions. Therefore, certain ideals should be pursued when engaging the community, such as:

I. *A representative cross-section of the community*

It is imperative that those involved in the dialogue represent a broad cross-section of the community and that one section of its make-up is not either overly represented or omitted. Different demographics within a community potentially have very different needs and/or desires and a representative sample of the community ensures that more of these needs and desires are identified.

II. *Agreement on the overall housing goals/development*

Once the community strategy has been developed, revisiting the original needs identified through the community engagement sessions will help ensure the value of the new community development to the Nation's members.

III. *The value of individual home 'ownership' to the Nation and the individual*

Exploring the different home 'ownership' options with Nation members will help communicate the value of certain options such as the Certificate of Possession. With this option the Nation member effectively takes full ownership of the property and its contents, with the right to distribute it as they see fit to direct family members. This creates a link to the home and ideally creates a pride in ownership that will help to ensure the building's longevity.

IV. *Communicating the value of 'green' building design been communicated to the community*

These community dialogue sessions provide a valuable opportunity to communicate the value of sustainable building design for the community and the individual homeowner. If properly done, communicating the intrinsic benefits of green design to the environment and on the individual's monthly utility bills and health at this early stage in the housing development will ideally inspire homeowners to investigate green options and create desire for sustainable home design in any future construction.

Community Inventory And Participation

This section demonstrates the steps that the Band's administration can take to evaluate the community's capacity to participate in the construction of the new homes. This inventorying step will allow the Band to identify skills development opportunities ahead of the construction process. In doing so, programs can be created that will assist in the training of Nation members with skills useful in both the immediate construction process and in future careers.

Evaluation of the long-term implications of spending more on local materials and the resulting contribution to the Nation's economy

While certain local materials may be more expensive in terms of absolute price, selecting less expensive materials from outside the Nation results in money leaving the community. Choosing local materials generates growth in the Nation's economy.

Potential opportunities for the community to participate in the construction process

Every opportunity should be made to include employment opportunities for community members in the housing development. Proper planning ahead of the construction process is vitally important to successfully integrating local employment because it allows training programs to be implemented in order to ensure that Nation members are employed from the outset.

Inventory of the current skill set already present in the community

In order to develop a comprehensive participation strategy it is important to know and understand what types of skills are already present in the community. This will inform which training programs are pursued and to what degree. Training programs can take time to develop so knowing which are necessary will ensure that they are running effectively ahead of time. Additionally, individuals who already have the necessary skills can act as mentors for those individuals enrolled in the training program.

An inventory of businesses owned and operated by First Nation members is also an important component of developing a participation strategy. These companies should be encouraged as soon as the Community Strategy is developed to consider how they can fit into the construction process, be it as exclusive provider of a particular service or as part of a team of organizations. This inventory will also serve in support of the previously mentioned skills inventory and also identify potential mentorship opportunities for members in training.

Exploring partnerships with trade schools to develop the necessary skills

There are a wealth of trade schools and professional organizations with the established track record of implementing and administering training programs, some specifically in First Nation communities. These organizations should be identified in order to explore the possibility of partnering with the Nation to administer the training programs necessary to participate in the new housing development project.

Companies demonstrating an interest/willingness to employ Nation members in the past

Companies embracing the employment and skill development of Nation members should be considered as prime candidates for future projects. These companies will have a working knowledge of conditions in the community and would be able to adapt along social and cultural lines to ensure that the First Nation members are folded into the workforce seamlessly.

New business opportunities exist for First Nation ownership

As construction progresses there is a very real opportunity to develop future business opportunities for Nation members by taking advantage of the skills developed over the course of the building projects. This experience can be leveraged into business opportunities such as a construction company, energy analyst, building inspectors - depending on what skills are developed through the established training programs and construction process. These business opportunities could also emerge to serve non-Aboriginal communities. Also, given the large amount of funding that has been made available to First Nation communities, there could be ways to leverage a First Nation-owned and operated

business. Similarly, it is conceivable that the same training programs that were implemented within the community could be administered by Nation members in other First Nation communities.

PROCESS 2: GREEN STRATEGIES & FEATURES

Both the housing committee AND the individual homeowner should consider sustainable building design features that minimize monthly operating costs. These include both structural design features that take advantage of the natural environment and also the 'green' technologies that best allow the respective parties to reduce the building's environmental footprint while positively impacting the day-to-day quality of life of the home's occupants.

Determining your 'green' strategy

Having a 'green' strategy, in which the homeowner has developed what sort of conservation goals are most important to them, will help determine which design features should be considered. Further, it will make the decision-making process easier in the future by giving the individual an idea of how to weight their decisions. Specifically, the homeowner should give thought to what they want to achieve with their investment, which could include (1) energy conservation, (2) water conservation, (3) waste reduction, and (4) improving indoor air quality.

Communicating the 'green' vision to a design team with a proven track record of building low-impact buildings.

Enlisting a design team that has a proven track record of successfully building 'green' homes can play a critical role in the success of new homes and housing developments. The intrinsic benefit of aligning with an experienced design team is that its ability to identify and apply the aforementioned 'green' strategy will result in a faster design process. The design team must not only be familiar with 'green' technology best-suited to achieve the owner's stated vision, but it must also be familiar with non-technological principles that minimize the environmental footprint of a home. That being said, it is vitally important that the communication of this 'green' vision is done clearly and concisely to avoid any miscommunication, which could lead to the home underperforming with respect to the owner's expectations.

Maximizing the opportunity to lower your monthly costs through comprehensive analysis of the proposed site

Careful analysis of the site and its physical attributes can inform the design and construction of the home in a way that minimizes the operational costs from the outset. Observing passive house design principles by taking advantage of opportunities such as passive solar gain and natural ventilation that will limit the need for potentially expensive technologies.

Investigating the technologies available to help achieve sustainable housing design

Each technology under consideration for inclusion in the design of the home/housing development should be evaluated to address key elements that directly impact the day-to-day life of the homeowner. Consider this return on investment for a variety of factors.

These include:

- I. 'Green' technology's role in minimizing the impact of the home and its occupants on the surrounding environment.
- II. Financial attributes, such as:
 - a. Capital cost, or the amount of money it will cost to purchase and install;
 - b. Cost to operate, or its impact on the monthly bills of the home;
 - c. Simple payback period, or the amount of time it will take to recoup the value of the technology's capital cost;
 - d. Potential impact on monthly utility bill savings, or the amount of money saved vs. not including the technology;
 - e. Impact on the overall affordability of the mortgage, or the increase in the amount of the monthly mortgage payment.
- III. Impact on the occupant's quality of life in a non-financial way. These attributes should be weighed against the financial costs.

PROCESS 3: CULTURALLY-APPROPRIATE DESIGN

Addressing day-to-day needs

As discussed, it is common for multiple generations of First Nations to live within a single dwelling. Thus, it is important to consider the home's ability to accommodate additional occupants - not only in common spaces, but also in semi-private areas such as bedrooms. Living rooms should be large enough to comfortably house a large number of the home's occupants, allowing interaction. Further, kitchens should be designed to allow the preparation of large meals. Similarly, bedrooms should be able to accommodate more than one to two sleepers. By planning for the eventuality of larger numbers of occupants the stress on the occupants will be minimized if numbers within the home increase.

9. CONCLUSION

An investigation of green building technologies and culturally appropriate housing design features are the first steps toward creating affordable and livable housing conditions in First Nation communities. Primary and secondary research yielded results that support the value and need for practical home designs that pay attention to the prevailing climatic and environmental conditions and also include sustainable building technologies. These two elements can ultimately reduce operating costs to a level that makes homeownership an achievable goal for low-income families. However, technology will only prove valuable to First Nation homeowners if the homes they live in truly represent their culture by addressing their distinct cultural needs. The next phases of the larger Ecotrust/ISIS/Tla-oqui-aht/Ahousaht 16-month project will address these issues by blending technology and culturally appropriate housing design to produce blueprints for First Nation homes designed by community members.

10. APPENDIX

Appendix 1: Building Envelope Options For Lowering Monthly Utility Bills

Item	Ease of Implementation	Capital Cost (Premium)	Operational Cost	Installation	Improves on			Additional
					Energy Efficiency	Water Conservation	Health	
Fibre-Cement Siding	Easy	More than Vinyl, equal to or less than wood	N/A	Installation can be hazardous	N/A	N/A	N/A	Can require painting over time Very durable Resists rot
Precast Concrete Passive Solar Home	Moderate	Comparable to frame and concrete block	N/A	Requires prefabricated walls and specialists	Yes- can reduce consumption by 70%	N/A	N/A	Walls must be built/delivered Fast installation time High envelope integrity
Wood Fiber Composite Forms	Moderate- requires greater coordination initially	Comparable to foam form and wood frame (\$2-\$4 depending on presence of interior insulation)	N/A	requires additional coordination and concrete placement equipment	Yes- no thermal bridging, acts as a thermal mass	N/A	Yes- does not support mould growth, no off-gassing	Limited availability in N. America Absorbs excess moisture in the air
Insulated Vinyl Siding	Easy	\$181/square (30% more than conventional siding)	N/A	Bulk of installation is same as conventional vinyl siding Trim requires some additional tools	Yes- adds additional insulation	N/A	N/A	Could have higher shipping costs due to increased size of units (and therefore smaller shipment volumes)

Appendix 2: Energy-Efficient Insulation Options For Lowering A Home's Monthly Utility Bills

Item	Ease of Implementation	Capital Cost (Premium)	Operational Cost	Installation	Improves on			Additional
					Energy Efficiency	Water Conservation	Health	
Blown/Foamed through Membrane	Easy	twice as much as fibreglass batt insulation (\$1.40/ft2)	N/A	More involved preparation of area Requires technicians for application	Yes	N/A	N/A	Reduces interior wall moisture, which contributes to humidity
Non-Fibreglass Batts	Moderate	Wool = \$2.40/ft2 Cotton = \$1.20/ft2	N/A	Comparable to fibreglass but doesn't require protective clothing	N/A	N/A	Yes- no off-gassing	Cotton batting is usually made up of roughly 75% post-industrial recycled content
Sprayed Fibre Insulation	Easy	Cellulose = \$1.20/ft2 (50% greater than fibreglass batt)	N/A	More involved preparation of area Requires technicians for application	Yes	N/A	Yes- no off-gassing	Reduces interior wall moisture, which contributes to humidity
Sprayed Foam Insulation	Moderate	\$1.25/ft2	N/A	More involved preparation of area Requires technicians for application	Yes	N/A	N/A	Environmentally-friendly materials are available

Appendix 3: Space Heating And Cooling Options For Lowering Monthly Utility Bills And/Or Reducing A Home's Environmental Footprint

Item	Ease of Implementation	Capital Cost (Premium)	Operational Cost Savings	Installation	Improves on			Additional
					Energy Efficiency	Water Conservation	Health	
Aerosol Duct Sealing	Easy	\$300-\$1800/home	\$300/yr	Easy, but by a qualified worker	Yes (30% increase)	N/A	Yes (improves distribution of acclimatized air)	Not available in BC however it is in WA, large projects may be enough incentive
Ductless (mini-split) Heat Pumps	Easy (similar to standard heat pump/AC system)	\$500-\$900	Yes, but dependent on equipment efficiency, rating and leakiness of ducts	Relatively easy but by a qualified work	Yes - Improves on efficiency of central AC by 25% (5% energy loss vs. conventional)	N/A		A less expensive alternative to air conditioning
Heat Recovery Ventilators (HRV)	Difficult (Installation is relatively straight-forward but may require additional ductwork, and O&M is essential)	\$700-\$2000, depending on size of unit and/or size of house	yes	Moderate	Yes- by reducing the amount of energy needed to heat/cool the house	N/A	Y (reduces interior humidity, reducing respiratory ailments)	
Geothermal Heat Pumps	Moderate (the interior equipment is relatively straightforward however the exterior is more complicate and costly)	Interior - \$1000-\$2000 (for a 3-ton system), Exterior - \$1000 - \$3000/ton	Yes- Heat = 30-70%, Cool = 20 - 50% (b/w \$356-\$1475)	Interior- Easy, Exterior- High	Yes	N/A	N/A	A thorough assessment should be conducted during the RFP to ensure accurate costing; remote access can add significant cost
High Efficiency Air Conditioner (w/o HCFC)	Easy	Yes	greater than existing units using R-22 refrigerant	Easy, by qualified individual	Yes	N/A	N/A	Higher pressure system, requiring special gauge equipment
High Efficiency Whole-House Air Filtration System	Easy	ESP- \$150-\$300 HEPA- \$500-\$900 Electronic Units- \$350-\$1500	ESP- +\$35-\$30 HEPA- +\$150 Electronic Units- +\$10-\$60	Easy, but w/ some consideration given to filter type	Each filter results in additional pressure needed for forced air, meaning efficiency goes down	N/A	Yes (by removing particulate matter from the air, reducing respiratory implications of poor air quality)	Electronic Units use the equivalent of a 60W bulb or less
Humidity-Sensing Control Device	Moderate	Fixed set point (FS)- \$79 Adjustable (AS)- \$89 Remote Sensing (RS)- \$89	N/A	Easy	N/A	N/A	Yes (helps control internal humidity, which contributes to respiratory ailments)	
Programmable Thermostats	Easy	Up to \$300/unit	N/A	Easy	Yes- 10%/year if T set to 10-15% of comfort level for this/day	N/A	N/A	Usefulness dependent on how long the home is empty for each day

Item	Ease of Implementation	Capital Cost (Premium)	Operational Cost Savings	Installation	Improves on			Additional
					Energy Efficiency	Water Conservation	Health	
Radiant Ceiling Panels- Hydronic	Moderate-High	5%-10% over forced-air furnace	2/3's of in-floor heating 1/2 the cost of maintaining and running	requires tubular installation, which is labour intensive	Yes	N/A	N/A	requires hydronic boilers; life of a forced-air furnace is roughly 25-30 years whereas a hydronic boiler is 30-40 years
Radiant Ceiling Panels- Electric	Moderate	\$200-\$500/panel + \$40 for thermostat (per zone)	Yes	Easy	Yes (compared to baseboard heating)	N/A	N/A	Maintenance-free
Radiant Floor Heating- Dry System Hydronic	Moderate	Panels attached to subfloor = \$11-\$13 Accordian-style panels = \$74-\$87	20-40% reduction in heating bills	Involved, requiring professional installation	Yes	N/A	Y (by improving the ambient temperature distribution in a home)	Eliminates dust, draft, and noise associated with forced air systems
Ventilation Control Systems	Easy	\$50-\$150 depending on features and manufacturer. Whole systems w/ 2-3 fans cost more	no- dependent on the way it is programmed	Easy for new homes	No	N/A	Yes	Can be either exhaust-only, supply-only, or both Energy consumption is dependent on the size of the system and the way it is programmed Can be modified to accommodate additional individuals
High Efficiency Furnace	Easy	\$2000 over 'conventional' furnace	Yes- 35% per year	Easy by qualified individuals	Yes- 35% reduction in energy consumption	N/A	Yes (reduced noise)	
Advanced Combustion Wood Fireplaces	Easy	Depends on size of stove and whether it's intended as a primary or secondary heat source	Depends on availability of firewood	Easy by qualified individuals	Yes- more efficient than conventional fireplaces (up to 70%)	N/A	Yes- reduced pollutant emissions Reduces humidity	Need to consider the size of stove necessary
Programmable Thermostats	Easy	\$30-\$250	10% savings/yr depending on settings	Moderate- requires qualified electricians/HVAC contractors	Yes	N/A	N/A	Ease of use varies with model

Appendix 4: Energy-Efficient Plumbing Options For Lowering A Home's Monthly Utility Bills

Item	Ease of Implementation	Capital Cost (Premium)	Operational Cost	Installation	Improves on			Additional
					Energy Efficiency	Water Conservation	Health	
Drain Water Heat Recovery	Moderate	\$300-\$500 + installation	N/A	Requires experience Less expensive in new construction	Yes- significant savings on water heating bills depending on scale of use	N/A	N/A	Savings dependent on lifestyle of occupants (higher savings w/ greater use)
Heat Pump Water Heaters	Moderately difficult	\$600->\$2000 + installation (\$300-\$700)	1/3-1/2 of conventional water heaters	Requires trained contractors	Yes	N/A	N/A	Good for homes with high water use Requires additional space
Hot Water Recirculation Systems	Easy	\$400	Amount saved varies on system use and plumbing design	Easy	Yes	Yes	N/A	Uses less water and heats less water
Plumbing Manifolds	Easy-Moderate	\$35-\$200 depending on system Savings in labour costs	Simple servicing with leaks easily identified	Easy	Yes- less heat loss than in conventional systems	Yes- less heat loss	N/A	Used with PEX piping
Cross-linked Polyethylene Water Supply Piping	Easy	Savings in labour costs	N/A	Some training is required Requires some specialized tools	Yes- less heat loss than in conventional systems	Yes- less heat loss	Yes- no VOC's and can be recycled	Cost depends on system design, house size, etc.
Tankless Water Heaters	Moderate- best accomplished in new homes	\$200-\$1200 depending on size + installation	N/A	Requires experienced installers	Yes- 10-20% over conventional water heaters	N/A	N/A	Can be used to supplement solar water heaters (pre-heating)
Solar Water Heaters	Moderate	Active = \$2500-\$3500 for 300-400 litres	Marginal- the cost to run the circulating pump	Requires experienced installers	Yes BUT the payback period has to be short enough to make it worthwhile	N/A	N/A	Value is highly dependent on location and orientation of building, access to direct sunlight, and availability of Gov't subsidies

Appendix 5: Lighting And Electrical Options For Lowering Monthly Utility Bills

Item	Ease of implementation	Capital Cost (Premium)	Operational Cost	Installation	Improves on			Additional
					Energy Efficiency	Water Conservation	Health	
Compact Fluorescent Lighting	Easy	\$4-\$15/bulb	80% of incandescent	Easy	Yes (75% more efficient than incandescent)	N/A	No- contain mercury	Extreme longevity (5X's longer than incandescent)
LED Lighting	More difficult but getting easier	\$25-\$60/bulb	minimal	Easy	Yes	N/A	Yes- no mercury	Extreme longevity; Requires specific fixtures, which are limited at this point
Tubular Skylights	Easy	\$150-\$600	N/A	Relatively Simple	Reduces need for electrical lighting during daylight hours; >Traditional Skylight	N/A	Increased Natural Lighting	minimal heat loss through building envelope
Traditional Skylights	Easy	>Tubular	N/A	Additional Framing	Reduces need for electrical lighting during daylight hours; Heat Loss/Gain	N/A	Increased Natural Lighting	Framing, etc. increases cost of construction
Electrical Raceways	Easy	\$6-\$8/linear foot	No difference	Easier to install than running wiring through studs behind drywall	N/A	N/A	N/A	Easier to fix; Adaptable to change

Appendix 6: Energy-Efficient Window Options For Lowering Monthly Utility Bills

Item	Ease of Implementation	Capital Cost (Premium)	Operational Cost	Installation	Improves on			Additional
					Energy Efficiency	Water Conservation	Health	
Triple-pane windows	Easy	10%-25% (over double-pane)	N/A	N/A	Yes	N/A	N/A	Much better thermal performance than double-pane windows Cost to replace is extremely expensive
Double-pane windows	Easy	Industry standard for homes	N/A	N/A	Yes	N/A	N/A	
Vinyl (PVC) Window Frames	Easy		N/A	N/A	Yes	N/A	Some off-gassing is possible	Extremely durable Can be purchased with insulation in the cavity, increasing their energy efficiency
Fibreglass Window Frames	Easy	>Vinyl	N/A	N/A	Yes- best insulating capacity	N/A	N/A	Minimal maintenance
Aluminum Window Frames	Easy	<Vinyl	N/A	N/A	No- high thermal conductance relative to other options	N/A	N/A	
Composite Window Frames	Easy	>Vinyl	N/A	Easy	Increased thermal insulation and resistance to air infiltration	N/A	N/A	Increased durability; decreased maintenance
Insulated Headers	Easy	Competitive	N/A	Easy	Eliminates thermal bridging	N/A	N/A	creates thermal break; requires less labour, creating competitive pricing; potential challenges sourcing in Pacific Northwest

Appendix 7: Energy-Efficient Appliance Options For Lowering Monthly Utility Bills

Item	Ease of Implementation	Capital Cost (Premium)	Operational Cost	Installation	Improves on			Additional
					Energy Efficiency	Water Conservation	Health	
Refrigerator	Easy	\$70-\$250	\$100/yr on utility bills	Easy	Y	N/A	Reduced ambient noise	
Horizontal Axis Washer/Dryer Combination Unit	More Difficult to Source	range in price of \$800-\$1000 (plus delivery)	\$100/yr on utility bills	Easy (only requires plumbing)	Y	Y	Reduced ambient noise	space saving (cuts space needs in half)
Horizontal Axis Front-Loading Washing Machine	Easy	range in price of \$600-\$1500 (Y)	\$75-\$100/yr on utility bills	Easy	Y (50% better)	Y (40% better)	N/A	uses less detergent, better water extraction therefore less E for drying
Vertical Axis Top-Loading E-Saving Washing Machine	Easy	\$150-\$200 less than conventional top-loaders, \$200 less than front-loading machines	\$55/yr on utility bills	Easy	Y	Y	N/A	sensors enabling its efficiency present possible durability issues and/or additional maintenance costs
Induction Cooktops	Easy	3-4X's conventional electric ranges		Easy	Y (25% more efficient than electric; 35% more efficient than gas)	N/A	N/A	may not work with all pot and pan types (depending on materials)

Appendix 8: Energy-Efficient Plumbing Options For Lowering A Home's Monthly Utility Bills

Item	Ease of Implementation	Capital Cost (Premium)	Operational Cost	Installation	Improves on			Additional
					Energy Efficiency	Water Conservation	Health	
Air Admittance Valves	Easy	\$25-\$40	N/A BUT should eliminate possible damage from water penetration at traditional venting stacks	Easy w/ proper manufacturer's instructions	N/A	N/A	N/A	Capital cost of device offset by savings in venting materials Should be maintenance-free after installation
High Efficiency Toilets	Easy	Fall in the same range as conventional toilets	N/A	Easy	N/A	Yes (20% savings)	N/A	No savings on utilities if water is not paid for
Universal Design Bathtubs/showers	Easy	Variable	N/A	Easy with some structural modifications for grab bars	N/A	N/A	Yes- makes bathing universally accessible	Particularly useful in homes with older generations
Laminar Flow Fixtures	Easy	Individual sink = \$3.5-\$12	N/A	Easy	Yes	Yes (27-90%)	N/A	More pleasant than water-aerating fixtures

Appendix 9: Larger Infrastructure Options For Lowering A Home's Monthly Utility Bills

Item	Ease of Implementation	Capital Cost (Premium)	Operational Cost	Installation	Improves on			Additional
					Energy Efficiency	Water Conservation	Health	
Photovoltaic Systems	Moderate	72% higher than conventional	Reduces operational costs depending on size of system, building's location, and energy needs of the occupants	Complicated; requires professional assistance for installation and an electrician for wiring	Depends on location, solar aspect, etc.	N/A	N/A	Value is highly dependent on location and orientation of building, access to direct sunlight, and availability of Gov't subsidies
Wind Power Generator	Difficult	\$40K - \$50K for 10-kW system	reduction of up to \$200 (based on \$0.10 kWh electricity cost)	Complicated; requires professional assistance for installation and an electrician for wiring	N/A	N/A	Ambient noise (equivalent to a washing machine)	Must ensure adequate supply of wind
Aerobic Wastewater Treatment Systems	Moderate	Regulatory restrictions; \$3200-\$5000 depending on system	\$4/month + \$50-\$75/year maintenance contract	Above or below ground, requiring some additional site preparation	N/A	N/A	N/A	Takes place of traditional septic systems Allows site development where not normally possible
Greywater Reuse	Difficult	\$1,500-\$2500	Monthly service contract (\$35-\$60)	Easy in new construction	N/A	Yes (and \$ savings if water is paid for)	N/A	Requires additional servicing
Rainwater Harvesting	Easy	\$200 (plant watering) - \$20K (whole-house system)	N/A	Moderate	N/A	N/A	Yes- improved water quality in areas where water quality is low	Requires some considerations (such as water testing) to be carried out