Project Review: Report on Bella Bella Heat Pump Project

November 2019

Contents

Acknowledgements

Ecotrust Canada would like to thank Heiltsuk Councillors, band staff, and community members for their support in this project review. Specifically, the help of Jaimie Harris, Leo Lawson, and Loretta Humchitt is greatly appreciated. Lastly, thank you to community members for welcoming us in your homes and sharing your experiences. You were all very gracious with your time. Contributors to this report from Ecotrust Canada include Graham Anderson, Rudri Bhatt, and Phil Climie. This report is produced for Heiltsuk Tribal Council and a selection of findings will also be included in a public-facing research report in early 2020.

Community & Project Background

Bella Bella is a remote community on the Central Coast of British Columbia. The community is home to the Haíłzaqv who have lived throughout the region for tens of thousands of years. There are currently around 1,200 residents and 410 homes in Bella Bella. In 2017, Heiltsuk Nation and Ecotrust Canada engaged in a pilot project that replaced diesel furnaces with ductless air-source heat pumps in 37 homes. A requirement for heat pump installation was the removal of an existing diesel furnace. Electricity is supplied to the community primarily by the Ocean Falls Hydroelectric Dam. Funding for the pilot project was generated through the Province of British Columbia's Oil to Heat Pump and Rural Dividend programs.

Purpose

The purpose of this report is to assess the performance of the heat pumps to date, and to identify any opportunities to improve the project in full implementation. The findings will be used to inform Heiltsuk Tribal Council's decisions around expanding the project to the rest of the homes in the community.

Approach

The review used a mixed-methods approach to effectively assess the performance of the heat pumps.

The primary approach involved a 19-question survey that sought the perspectives of band members who had received heat pumps through the pilot program. Of the 37 homes that installed heat pumps, 16 surveys were completed representing 43% of the participants.

The second approach involved reviewing BC Hydro electricity bill data for members who installed a heat pump. This was done by receiving consent from the community member to review their bill history. The review included five years of cost ($) and electricity use (kWh) data from 2015 to 2019. Bill reviews were conducted for five participating households, representing 14% of the participants.

For the final approach, central air and ductless heat pumps were modelled in RETScreen Expert (a Natural Resources Canada software). This updated modeling provides an assessment of installtion costs, energy efficiency and potential return on investment for two heat pump system options.

Report Highlights

Surveys

93% of residents are 'happy' or 'very happy' with their heat pump system

87% of residents would recommend a heat pump to other members in the community

75% of residents feel better knowing they are heating their home without fossil fuels

Estimated Cost Savings

Estimated Annual Cost Savings Per Household: **$1,658**

Estimated savings on diesel fuel (5 responses): **$1,370**

BC Hydro bill savings (5 households): **$288**

BC Hydro consumption reduction (5 households): **17%**

Heat Pump System Comparison

	Ductless Unit (Pilot System)	**Central Air Unit (Ducted)**
Net Install Cost (with rebate)	~$6,000 - $8,000 per unit	~$11,000 - $12,000 per unit
Rated Efficiency @ -5°C	255%	309%
Estimated Payback Period	2.5 Years	4.3 Years

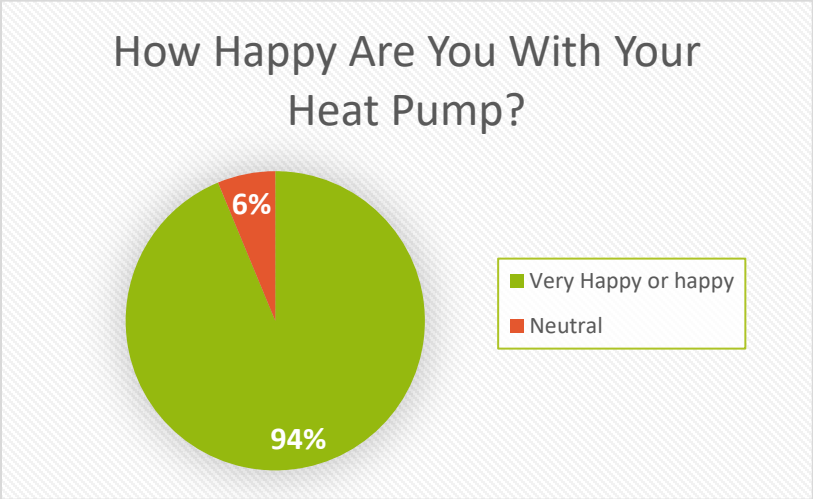
Key Recommendations

1. Continue providing user education to participating households to ensure effective system operation.
2. Consider Central Air heating systems for larger homes with many rooms and existing ducting.
3. Continue exploring building envelope and ventilation upgrades (insulation, air sealing etc.) to improve heat retention and air quality across community homes.
4. Complete bathroom fan upgrades simultaneously with heat pump installation where possible and necessary.
5. Request that participating households provide consent to track Hydro billing data before installation, in order to effectively monitor project results and build momentum for full implementation.
6. Apply to the Indigenous Clean Energy Initiative Fund for $150,000 in implementation support (Funding Confirmed Summer 2019).
7. Apply to the FCM Green Municipal Fund for Pilot Funding to leverage existing resources for a $1 Million next phase budget.
8. Inquire with staff contacts at Indigenous Services Canada about current funding opportunities and consider including in future requests with ISC and other federal agencies.

Survey Highlights

Responses and analysis are provided for 8 of the survey questions. 'Written responses' include comments band members added to each question. Information on survey participants can be found in Appendix I: Participants in Project Review. The full survey in its original form can be found in Appendix II: Survey. Responses to all survey questions can be found in Appendix IV: Survey Responses by Question.

Question 1



Results:

- 15 of 16 (93.75%) of respondents we 'happy' or 'very happy' with their heat pump
- 0 respondents were 'unhappy' or 'very unhappy.' One respondent was neutral.

Written Responses:

Positive:

'very happy with heat pump, easy to use, save $, keeps my place warm'
'happy with heat pump. he is an elder, easier for him than the furnace. Don't have to worry about it'
'very easy to use, keep my home warm, and good on hydro'
'don't have to worry about oil and the furnace breaking down'
'works fast, very happy 😊'
'it's great with the hydro bill and performs well for weather conditions'

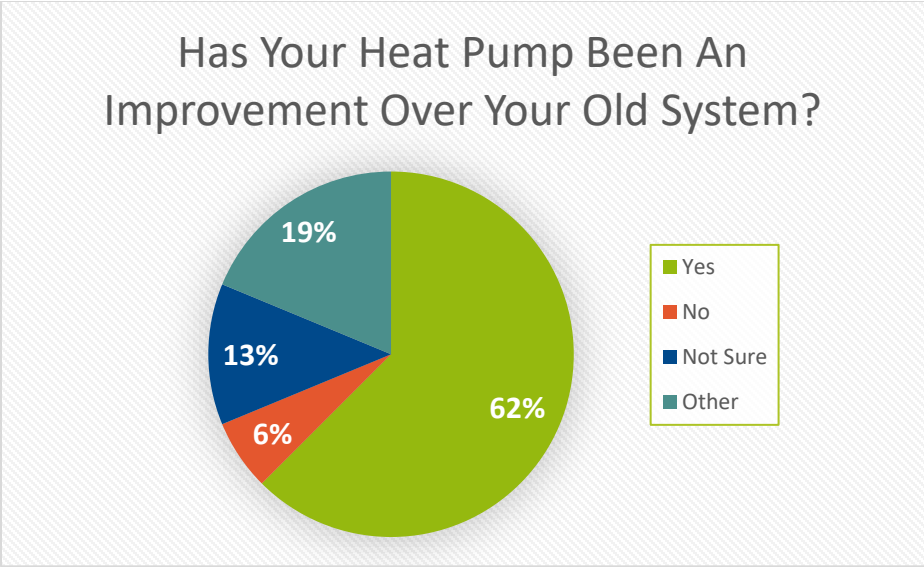
Negative:

'it only heats up the living room, where it is installed'

Ecotrust Canada Comments:

This is an overwhelmingly positive response in support of heat pump installations. The comment about the system only heating the room it is installed in is a valid concern and was raised by other members. This should be considered for any new installations.

Question 2



Results:

- 10 of 16 (62.5%) of responses believe the heat pump is better than their previous system
- 1 respondent did not think so, 2 were 'not sure,' and 3 chose 'other.' (see below)

Written Responses:

Members who responded 'other':

'yes and no, we use the heat pump a lot but notice it doesn't heat up the house like a wood furnace would'
'does not work in power outage'
'somewhat'

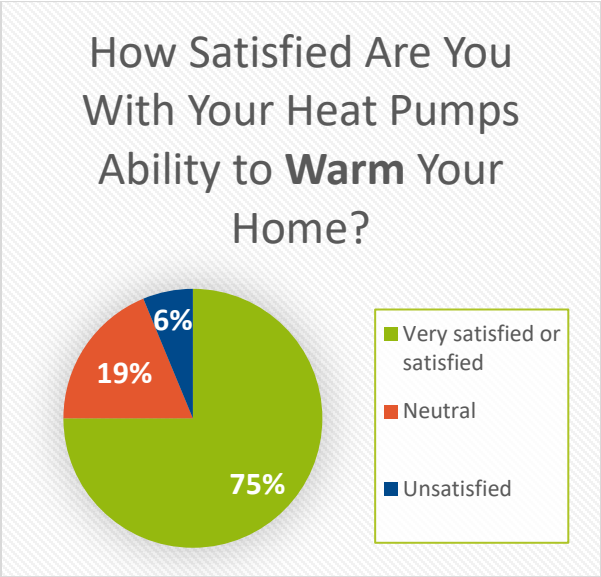
Member who responded 'no':

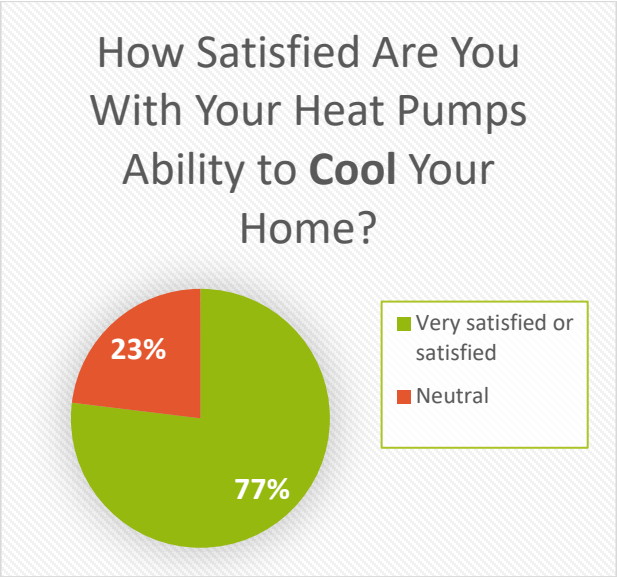
'the bedrooms are still cold, have to use heaters, the bathroom gets moldy'

Ecotrust Canada Comments:

With only one individual stating it was not a better system, this is a very positive response. A strong majority of members believe heat pumps are an improvement over their old system. The 'not sure' and 'other' responses highlight questions around power outages and lack of heat to back rooms.

Question 3 & 4





Results:

- 12 of 16 residents are 'satisfied' or 'very satisfied' with their heat pumps ***warming*** abilities.
    - 1 resident was 'unsatisfied' and 0 residents were 'very unsatisfied.'

- 10 of 13 residents are 'satisfied' or 'very satisfied' with their heat pump's ***cooling*** abilities.
    - 3 residents felt 'neutral' and 0 felt negatively.

Written Responses:

Satisfied Residents

'fast heating, keep my place warm longer'
'it does not take long to heat up our house'
'it warms up in here very fast. It also cools down the house hast with the AC part'
'mom loves the heat pump for exactly this reason' (referring to cooling)

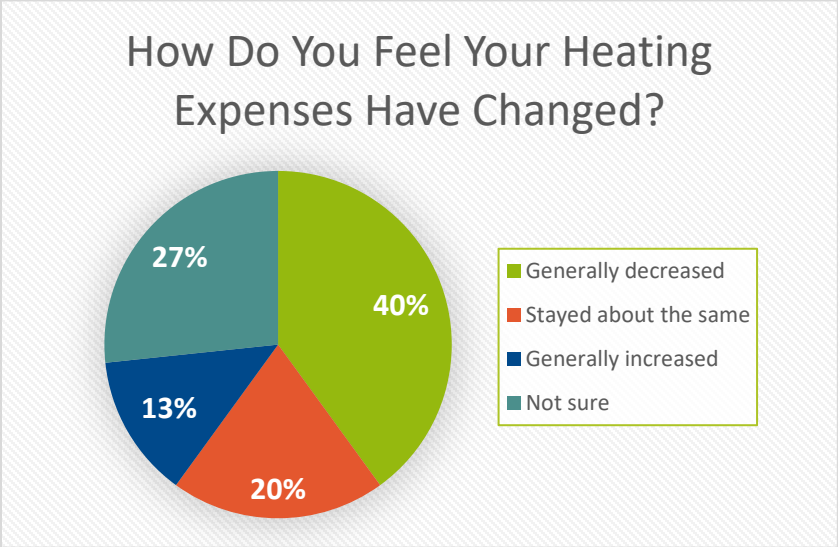
Unsatisfied Resident

'only cools where installed'

Ecotrust Canada Comments:

Generally, residents are happy with the heat pumps warming and cooling abilities. The cooling ability came up a number of times as an unforeseen positive for residents.

Question 14



Results:

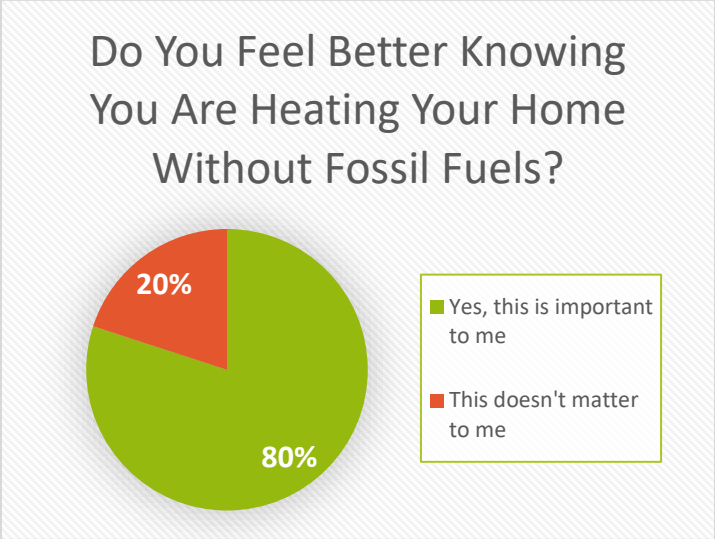
- 6 residents felt their heating costs 'generally decreased.'
- 3 residents felt their heating costs 'stayed about the same.'
- 2 residents felt their heating costs 'generally increased.'
- 4 residents were not sure.

Ecotrust Canada Comments:

There are important considerations to this question. Residents who were not using electricity for heating are likely to consume more electricity with the heat pump, and thus experience higher electricity costs. Additionally, residents who were using diesel before may find it hard to compare changes in heating costs for diesel and electricity.

With these factors in mind, it is positive that most residents (9 of 15, 60%) feel their costs stayed the same or decreased. This decrease aligns with the small sample of BC Hydro bill's that were reviewed. More detail on electricity use and cost can be found in 'BC Hydro Bill Analysis' on page 11.

Question 16



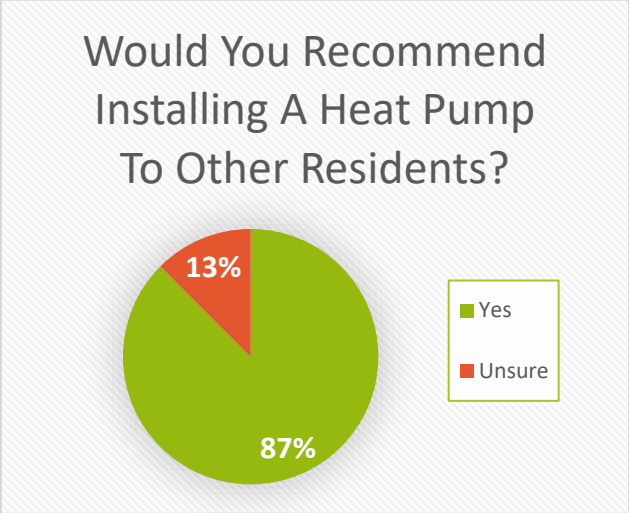
Results:

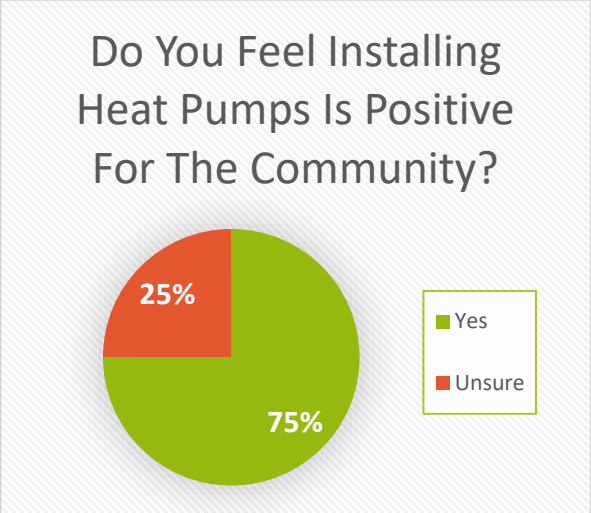
- 12 of 15 residents feel better knowing they are heating their homes without fossil fuels.
- 3 residents feel it does not matter to them.

Ecotrust Canada Comments:

It is positive to know that most residents feel better using clean energy for heating. This aligns with Heiltsuk Tribal Council's desire to reduce the community's diesel dependency.

Question 17 & 18





Results:

- 14 of 16 residents would recommend heat pumps to other community members.
    - 2 residents were 'unsure.'
    - 0 residents would not recommend.

- 12 of 16 residents felt heat pumps are positive for the community.
    - 4 residents were 'unsure.'
    - 0 said it was not positive.

Written Responses:

'very happy with mine, save money'
'amazing system'
'especially for the elders and single mothers'
'if it will heat the whole house'

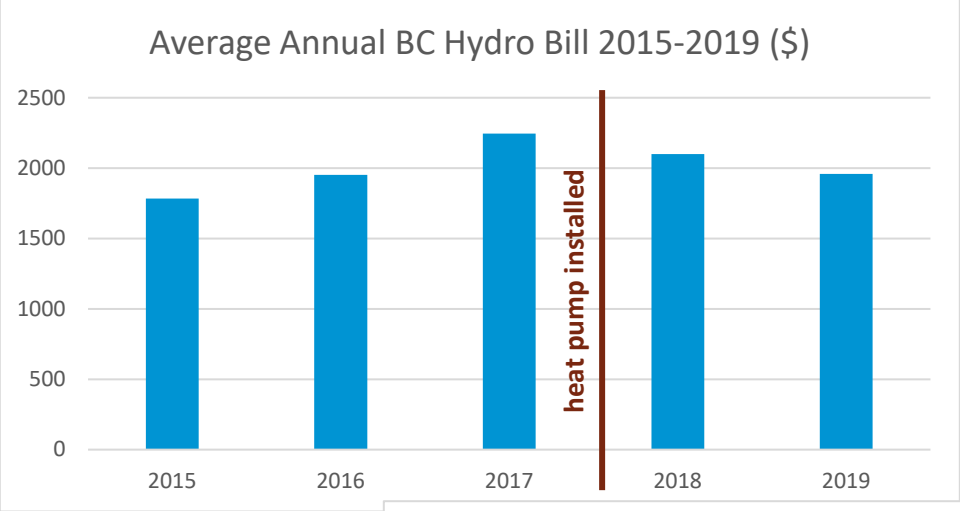
Ecotrust Canada Comments:

This is a strong representation of resident's feelings about their heating systems overall. During household visits, some community members brought up specific households that would greatly benefit from a heat pump installation.

BC Hydro Bill Analysis

Overview

BC Hydro bills were analyzed for five residents who received a heat pump installation in 2018. 3 of 5 accounts received installations in February 2018. 2 of 5 received installations later in 2018. Cost savings for homes using diesel are calculated in the discussion on page 12. More details on household electricity consumption and cost can be found in Appendix V: BC Hydro Bill Analysis.

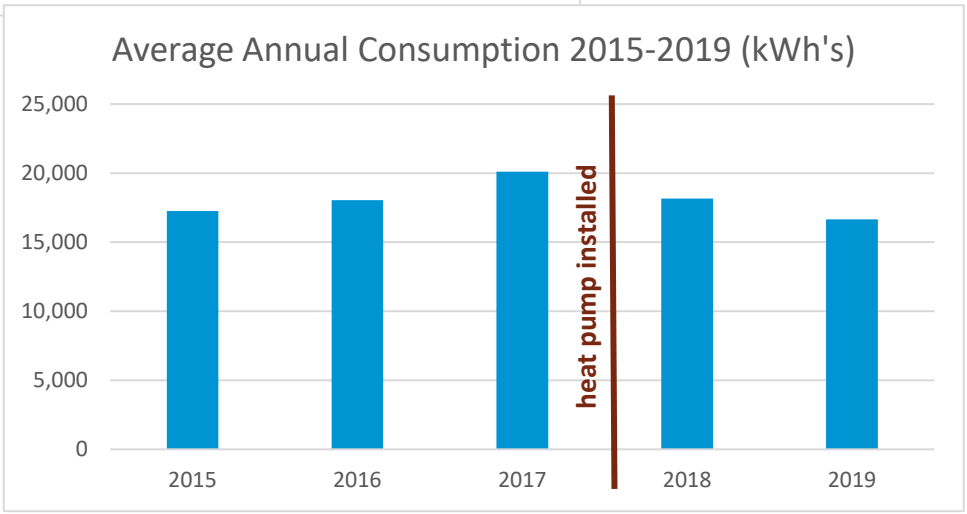


From 2017 to 2019, household **electricity costs are projected* to decline $288** annually.

Over the two-year period this is a **projected savings of 14% annually.**

From 2017 to 2019, household electricity **consumption is projected* to decline 3,460 kWh's**.

Over the two-year period this is a **projected reduction of 17%.**



***** Full 2017 and 2018 cost and consumption data is available. 2019 data is available for the first 6 months. Annual projections for 2019 were based on electricity consumption patterns in Bella Bella. Historically, 60% of annual electricity costs are incurred in the first 6 months of the year. More on this calculation can be found in the limitations section.

Discussion

The results show a positive correlation between heat pump installations and reductions in electricity use. These reductions align with survey responses on bill impacts where 61% of residents felt their costs had decreased or stayed the same. We cross-referenced these results with weather conditions for the study period and confirmed that there was a genuine reduction in energy use over this period for the homes that provided data.

Participating residents were required to remove their previous oil furnace in order to receive rebates through the Oil to Heat Pump incentive program. This means that for residents who used their oil furnaces before they were removed, additional costs savings have been realized. Survey responses indicated annual costs for homes using oil for heat to be between $450 and $2,000 per year, resulting in an average savings of $1,370.

As identified in the survey, the cooling ability of heat pumps was also a significant benefit for many residents. It is possible that this could lead to increased uses of electricity in the summer months, however the number of days where air conditioning is required in the Bella Bella climate is minimal and therefore significant impacts on electricity consumption are not expected.

Limitations

Five accounts (14%) is a very small sample and may not be truly representative of the 37 homes that received heat pump installations. Additionally, the project review timeline (1.5 years since installation) is short. For more accurate analysis, Ecotrust Canada recommends establishing a secondary review point in the future.

While 57% of pilot households installed their heat pumps in February 2018, 43% installed their heat pump sometime later in 2018. In the case of the five accounts reviewed in this study, consumption data from three homes received heat pump installations and two homes received installations later than February 2018. For these two homes, a larger proportion of annual consumption would be from lower efficiency systems. Given that the cost and consumption impacts were assed at the annual level, this would mean benefits from the higher efficiency heat pump aren't fully realized in the analysis.

Estimated reduction in diesel costs per household was based on a small sample size of 5 survey results. A sixth result was reported at $4500 but was removed in order to account for possible error and to ensure cost changes were estimated conservatively.

Lastly, BC Hydro cost and consumption data was only available for the first 6 months of 2019. 2019 annual cost and consumption projections are based on 2017 and 2018 monthly consumption data of all 5 accounts. In the first six months of 2017 and 2018, residents incurred 60% of their total annual costs – likely due to colder temperatures in the beginning of the calendar year. This percentage was used to calculate projected 2019 consumption.

System Review and Modeling

Background

Heiltsuk Tribal Council has implemented a successful heat pump pilot project with installations in 37 community homes. Capital Projects Manager Leo Lawson has requested an updated exploration of options for a ducted heat pump model and an assessment of costs and benefits in comparison to the ductless systems that were installed in the pilot.

Central Air Heat Pump

Central Air heat pumps are the most established heat pump technology option. These units are designed to deliver heat throughout an existing central air ducting system. With this method, air is delivered through existing ducts instead of adding additional units within the ducts or mounted on walls.

Ductless Heat Pump

Ductless Heat Pumps are increasingly becoming a more common heat pump technology choice. In this method, heat is transferred using refrigeration coils to an indoor unit that is used to deliver heat inside the home. Ductless heat pumps deliver heat inside through a narrow refrigerant tube to a number of indoor units throughout the home. Each indoor unit can be wall-mounted, floor-mounted, or placed inside existing ducting. The small diameter of refrigeration tubes makes Ductless heat pumps relatively easy and economical to install.

Summary of Modeling Results

We have compared two pieces of Fujitsu Equipment with similar performance and heating capacity that meet the needs of typical Heiltsuk homes[1]. Results are summarized in the table below with positive attributes highlighted in green:

	Ductless Unit (Pilot System)	**Central Air Unit (Ducted)**
Total Equipment & Install Cost	~$9,000	~$14,000
Purchase Incentives Available	$3,000 when replacing oil furnace; $1,000 otherwise	$3,000 when replacing oil furnace; $2,000 otherwise
Net Install Cost	~$6,000 - $8,000 per unit	~$11,000 - $12,000 per unit
Heat Delivery	In rooms with wall mounted units	Throughout the home with existing ducting
Rated Efficiency @ -5˚C	255%	309%
Rated Output	2 tons (24,000 BTU/hr)	3 tons (36,000 BTU/hr)
Estimated Electric Load	About 10 Amps	About 16 Amps
Estimated Payback Period	2.5 Years	4.3 Years
Opportunity for Local Employment	Considerable	Minimal

It is likely that the Central Air unit will provide a higher level of comfort for participating households, with heat distributed more effectively throughout the home. Technology has advanced since the completion of our initial heat pump study, and a backup electrical heater is no longer required with the installation of a central air heat pump. Therefore, electrical upgrade requirements no longer significantly differ between systems. However, the ductless heat pump is available at a lower cost and with greater opportunity for local employment in installations. The ductless system also shows a faster return on investment, primarily resulting from the reduced cost of initial installations. The decision on the best system for Bella Bella going forward depends on resources and priorities.

[1]Results are based on a comparison between two Fujitsu 12RLS3 1-ton ductless units (24,000 BTU Heating Capacity) and one central Fujitsu Airstage J-IIS AOU36RLAVS 3-ton unit and matching indoor unit(36,000 BTU Heating Capacity).

System Options & Budget Impact

The original budget for project implementation focused exclusively on installation of Ductless Heat Pumps. In response to a request from HTC Staff, we have prepared an alternate budget for the project that incorporates Central Air Heat Pumps in appropriate community homes. This alternate budget assumes that Central Air systems are installed in all two story single family homes and duplexes, while Ductless systems are still used in single-story homes and duplexes, as well as all multi-unit buildings.

Unit Distribution – Two Options

Original Budget

	# of Units	% of Units	Cost/Unit	Total Cost	Total Rebates	Net Cost
Ductless One Story	122	33%	$ 5,380	$ 658,561	$ 312,227	$ 346,334
Ductless Two Story	250	67%	$ 9,820	$ 2,458,422	$ 644,045	$1,814,377
Central Air			$ 13,900	$ -	$ -	$ -
Total	**373**	**100%**		**$ 3,116,983**	**$ 956,273**	**$2,160,710**

Revised Budget

	# of Units	% of Units	Cost/Unit	Total Cost	Total Rebates	Net Cost
Ductless One Story	122	33%	$ 5,380	$ 658,561	$ 312,227	$ 346,334
Ductless Two Story	30	8%	$ 9,820	$ 295,642	$ 79,318	$ 216,323
Central Air	220	59%	$ 13,900	$ 3,061,370	$ 612,727	$2,448,642
Total	**373**	**100%**		**$ 4,015,572**	**$ 1,004,273**	**$3,011,299**

Potential FCM Application Budget

Heiltsuk Staff have also requested the development of a possible budget for an application to the FCM Green Municipal Fund for a Pilot Retrofit Project. This source provides up to $500,000 in funding to projects that can demonstrate reductions in energy use and potential for replication and scale. This fund requires 50% matching, so a total budget of about $1 Million is ideal to make use of the funding available.

Potential FCM Application Budget

Type of Heat Pump	# of Homes	Cost/Home	Total Cost of Item
Central Air	50	$ 13,900	$ 695,000
1 Story Ductless	40	$ 5,400	$ 216,000
2 Story Ductless	10	$ 9,900	$ 99,000
Total	100		$ 1,010,000

Potential FCM Matching Sources

Potential Funding Sources		Amount
Green Municipal Fund	$	500,000
BC Indigenous Clean Energy Initiative	$	150,000
Better Homes Incentives	$	300,000
Heiltsuk or Other Contribution	$	60,000
Total	$	1,010,000

Key Recommendations

This review has identified a number of challenges that can be more effectively addressed in the next stage of project implementation. The challenges and recommended actions are indicated in the table below:

Challenge Identified	*Recommended Action*
Not all participating households were confident in their operation of the installed heat pump.	1. Continue providing user education to participating households to ensure effective system operation.
Some participating households mentioned that heat was concentrated in the room where the ductless unit was installed.	2. Consider Central Air heating systems for larger homes with many rooms and existing ducting.
Heat pumps will reduce overall energy demand but will not reduce heat loss in the home through windows, doors and air leakage. Additional measures will be required in each of these areas to achieve further progress in health, comfort, and building efficiency.	3. Continue exploring building envelope and ventilation upgrades (insulation, air sealing etc.) to improve heat retention and air quality across community homes. 4. Complete bathroom fan upgrades simultaneously with heat pump installation where possible and necessary.
It was difficult to gather consent to review billing data from residents who already received a heat pump. It may be more effective to request this consent before or at the time of install. Data is an asset to the project and allows us to more effectively make the case for additional funding.	5. Request that participating households provide consent to track Hydro billing data before installation, in order to effectively monitor project results and build momentum for full implementation.
Project implementation will require the identification of additional financial resources.	6. Apply to the Indigenous Clean Energy Initiative Fund for $150,000 in implementation support (Funding Confirmed Summer 2019). 7. Apply to the FCM Green Municipal Fund for Pilot Funding to leverage existing resources for a $1 Million next phase budget. 8. Inquire with staff contacts at Indigenous Services Canada about current funding opportunities, and consider including heat pump installation costs in future requests to ISC or other federal agencies.

Appendices

Appendix I: Participants in Project Review

Below is a list of the survey responses and BC Hydro account access forms that were received. Some of the BC Hydro forms that were signed were not able to be accessed due to BC Hydro requiring more or different info (ex. Account number or non-account owner signature).

House #	Resident	Survey	Hydro Form
14	Janine Newman		
21	Roxanne Humchitt	Yes	
22	Basil Windsor Sr.	Yes	Yes
40	Marilyn & Michael Hall		
41	Delores Campbell		
47	Susan Paul	Yes	Yes
51	Marvin Brown	Yes	Yes
114	Alex Jackson		
151	Dennis T. Wilson		
163	Ted Chamberlain	Yes	Yes
171	Larene & Steve Chamberlain		
210	Daycare	Yes	
216	Clyde Hopkins		
249	Chris White Sr.	Yes	Yes
252	Danny Reid		
253	Maude (Maggie) Vickers		
262	Reg Moody-Humchitt		
278	Margaret Brown		
302	Frank Brown		
308	Angel Wilson	Yes	Yes
323	Kathleen Peers		
347	Albert & Barb Thompson		
355	Leona Humchitt		
408	Monica (Tammy) Gladstone		
409	Mark White	Yes	
419	April Windsor-Reid	Yes	Yes
427	Daniel & Doriana Hopkins	Yes	
509	Beth Humchitt		
511	Marion & Garron Brown	Yes	
371A	June Campbell & Reynard Brown	Yes	Yes
371B	Melody Brown		
508A	Bertha Campbell		
508B	Kim Gladstone		
510A	Lucille Humchitt (Lawson)	Yes	Yes
510B	Vanessa & Leon Brown	Yes	
513A	Bessie Paul & Johnny Starr		
513B	Ruby McKay	Yes	Yes

Appendix II: Survey

Below is the survey that was shared with Heiltsuk members who had received a heat pump installation sometime in 2017.

Haíƛzaqv Survey on Heat Pump Installations in Wáglísla

The purpose of this survey is to find out how community members feel about the heat pump project. This survey was designed by Ecotrust Canada with support from HTC and HEDC. Thank you for sharing information about your home.

1. How happy are you with your new heat pump system?

- ☐ Very Happy
- ☐ Happy
- ☐ Neutral
- ☐ Unhappy
- ☐ Very Unhappy
- ☐ Other: _____

Why: _____
_____
_____

2. Do you feel your heat pump has been an improvement over your old heating system?

- ☐ Yes
- ☐ No
- ☐ Not sure/Don't know
- ☐ Other: _____

3. How satisfied are you about your heat pumps ability to ***warm*** your home?

- ☐ Very Satisfied
- ☐ Satisfied
- ☐ Neutral
- ☐ Unsatisfied
- ☐ Very Unsatisfied
- ☐ Other: _____

Why: _____
_____
_____

4. How satisfied are you about your heat pumps ability to ***cool*** your home?

- ☐ Very Satisfied
- ☐ Satisfied
- ☐ Neutral
- ☐ Unsatisfied
- ☐ Very Unsatisfied
- ☐ Other: _____

Why: _____
_____
_____

5. Have you or others in your home noticed any health changes in the following areas since installing your heat pump? (Check all that apply)

- ☐ Improved Breathing
- ☐ Better Sleeping
- ☐ More Comfortable
- ☐ Better Mood
- ☐ Other: _____
- ☐ No Changes

Share details: _____
_____
_____

6. Since installing your heat pump, have you noticed changes in air quality in your home?

- ☐ Air quality is better
- ☐ Air quality is worse
- ☐ Haven't noticed a change
- ☐ Not sure/Don't know

Share details: _____
_____
_____

7. Since installing your heat pump, have you noticed changes in mould in your home?

- ☐ There is more mould
- ☐ There is less mould
- ☐ Haven't noticed a change
- ☐ Not sure/Don't know

Share details: _____

_____

_____

8. What heating systems did you use ***before*** installing your heat pump in your home? (Check all that apply)

- ☐ Oil or Diesel Furnace
- ☐ Plug-in Electric Heaters
- ☐ Wood Stove / Fireplace
- ☐ Electric Furnace
- ☐ Other: _____
- ☐ None

9. If you used an oil or diesel furnace, about how much money did you spend per year? (Provide your best guess if you don't know the exact amount)

$ _____

10. What heating systems are you ***now*** using in your home? (Check all that apply)

- ☐ Heat Pump
- ☐ Oil or Diesel Furnace
- ☐ Plug-in Electric Heater
- ☐ Wood Stove / Fireplace
- ☐ Electric Furnace
- ☐ Other: _____
- ☐ None

11. How many plug-in electric heaters did you use in your home this winter?

- ☐ None
- ☐ One
- ☐ Two
- ☐ Three or more

12. If you use a wood stove for heating, has your use changed since installing your heat pump?

- ☐ I use the wood stove more
- ☐ I use the wood stove less
- ☐ My use stayed the same
- ☐ Not sure/Don't know
- ☐ I don't use a wood stove for heating

13. If you use wood for heating, how do you get it? (Provide your best guess if you don't know the exact amount)

- ☐ I buy it
  - How much do you spend per year? _____
- ☐ I collect it
  - How many hours do you spend per year? _____
- ☐ Other: _____
- ☐ I don't use wood for heating

14. In general, how do you feel your monthly heating expenses have changed since installing your heat pump?

- ☐ My expenses have generally increased
- ☐ My expenses have stayed about the same
- ☐ My expenses have generally decreased
- ☐ Not sure/Don't know

More detail (if you have it): _____

_____

_____

15. Have you ever been unable to use your heat pump?

- ☐ Yes, it stopped working
- ☐ Yes, there wasn't enough electricity
- ☐ No, it has always worked
- ☐ Not sure/Don't know

Why: _____

_____

_____

16. Do you feel better knowing you are heating your home without fossil fuels?

- ☐ Yes, this is important to me
- ☐ No, I don't feel better
- ☐ This doesn't matter to me

Why: _____

_____

_____

17. Would you recommend installing a heat pump to other community members?

- ☐ Yes
- ☐ No
- ☐ Unsure

Why: _____

_____

18. Do you feel that installing heat pumps is positive for the community?

- ☐ Yes
- ☐ No
- ☐ Unsure

Why: _____

_____

19. Is there anything around heat pumps that you would recommend/change/do differently? Is there anything that you really like or has worked very well? Is there anything that has changed since your old system was replaced?

Share anything you want about your heat pump or the project here.

_____

_____

_____

_____

_____

_____

If you have any questions about this survey or want to share more you can contact Phil at Ecotrust Canada. phil@ecotrust.ca or 604-789-4626.

List of Survey Questions

1. How happy are you with your heat pump system?
2. Do you feel your heat pump has been an improvement over your old heating system?
3. How satisfied are you about your heat pumps ability to warm your home?
4. How satisfied are you about your heat pumps ability to cool your home?
5. Have you or others in your home noticed any health changes in the following areas since installing your heat pump?
6. Since installing your heat pump, have you noticed changes in air quality in your home?
7. Since installing your heat pump, have you noticed changes in mould in your home?
8. What heating systems did you use before installing your heat pump in your home?
9. If you used an oil or diesel furnace, about how much money did you spend per year?
10. What heating systems are you now using in your home? (Check all that apply)
11. How many plug-in electric heaters did you use in your home this winter?
12. If you use a wood stove for heating, has your heating changes since installing your heat pump?
13. If you used wood for heating, how do you get it? (Provide your best guess if you don't know the exact amount)
14. In general, how do you feel your monthly heating expenses have changes since installing your heat pump?
15. Have you ever been unable to use your heat pump?
16. Do you feel better knowing you are heating your home without fossil fuels?
17. Would you recommend installing a heat pump to other community members?
18. Do you feel that installing heat pumps is positive for the community?
19. Is there anything around heat pumps that you would recommend/change/do differently ?

Appendix III: Survey Responses in Grid View

Below are the survey responses in grid view. Comments highlighted in grey were additional notes residents added for the respective question.

Q	House 1	House 2	House 3	House 4
1	very happy	happy	happy	very happy
	very easy to use, keep my home warm, and good on hydro			
2	yes	yes	yes	yes
3	very satisfied	very satisfied	very satisfied	very satisfied
	fast heating, keep my palce warm longer			
4			satisfied	very satisfied
	didn't use yet	never tried it yet		
5	no changes	no changes	More comfortable	Improved breathing, better sleeping, more comfortable, better mood
6	haven't noticed a change	air quality is better	air quality is better	air quality is better
	maybe if I try the cool air one			
7		not sure	there is less mould	there is less mould
	i had no mould			
8	plug-in electric heaters, wood/stove fireplace	plug-in electric heaters, stove	plug-in electric heaters	other
			3 furnace heaters throughout home	oven stove
9	about $1800	2000/year or 200/month		2 loads/month
10	heat pump, plug-in electric heater	heat pump	heat pump	Heat pump
11	three or more	two	three or more	none
12	I don't use a wood stove for heating	I don't use a wood stove for heating		I don't use a wood stove for heating
13	I buy it			I don't use wood for heating
	about 1200			did buy when had wood stove
14	my expenses have generally stayed the same	not sure	my expenses have generally decreased	my expenses have generally stayed the same
		daughter gets bills		
15	no, it has always worked	no, it has always worked	no, it has always worked	no, it has always worked
16	yes, this is important to me	yes, this is important to me	yes, this is important to me	yes, this is important to me
	clean air, warm house			
17	yes	yes	yes	yes
	very happy with mine, save money			
18	yes	yes	yes	yes
19	very happy with heat pump, easy to use, save $, keeps my place warm			

Q	House 5	House 6	House 7	House 8
1	happy	very happy	happy	happy
	it good at warm		so far it has been very good	works fast, very happy :)
2	yes	yes	yes	other
		used in conjunction with floor boiler heat		yes and no, we use the heat pump a lot but notice it doesn't heat up the house like a wood furnace would
3	unsatisfied	satisfied	satisfied	satisfied
	when blowing north wind or south east, it does warm whole house up		comfortable heat	
4		very satisfied	satisfied	satisfied
				mom loves the heat pump for exactly this reason
5		More comfortable	More comfortable	more comfortable, better mood
6		air quality is better	air quality is better	air quality is better
7				not sure
				I want to say I've noticed more of a mould smell coming from the far room
8		Other: boiler in-floor heating	Oil furnace, electric furnace (1981), plug-in electric heater	wood stove/fireplace
9			mostly burned wood	
10		heat pump, boiler	heat pump	heat pump
11	two	three or more	two	one
		we did last year		for dad when he was alive
12	I don't use a wood stove for heating	I don't use a wood stove for heating	I don't use a wood stove for heating	I use the wood stove less
				just to fully heat the house, and the rooms it doesn't reach
13	I don't use wood for heating	I don't use wood for heating	I don't use wood for heating	I collect it
				3 days?
14		not sure	not sure	not sure
	cost to much keep it warm all day			
15	not sure	no, it has always worked	no, it has always worked	yes, there wasn't enough electricity
				power outage defs affects it
16	me	me	this doesn't matter to me	yes, this is important to me
17	unsure	yes	yes	yes
18	unsure	yes	yes	yes
				especially for the elders and single mothers

Q	House 9	House 10	House 11	House 12
1	happy	very happy	happy	very happy
			has the odd smell here and there after cleaning the filter	its great with the hydro bill and performs well for weather conditions
2	yes	yes	other	yes
	don?t use heat pump in basement		does not work in power outage	
3	satisfied	very satisfied	satisfied	very satisfied
			it does not take long to heat up our house	it warms up in here very fast. It also cools down the house hast with the AC part
4	neutral	very satisfied	very satisfied	very satisfied
	set on auto		:)	because with the windows closed it will stay cool for a while
5	no changes	better sleeping		Improved Breating, Better Sleeping
			it bothers my son here and there, makes him cough after I notice I turned it on	
6	haven't noticed a change	air quality is better	haven't noticed a change	air quality is better
				air quality is not damp anymore
7	haven't noticed a change		haven't noticed a change	there is less mould
	no mould		a bit of mould in bathroom	
8	oil furnace, plug-in electric	plug-in electric heaters	Oil furnace, wood stove/fireplace	plug-in electric heaters, other: oven
		for 9 years		
9	$750/2 months?..		heat pump	
			3000	
10	heat pump, plug-in electric heater	heat pump, plug-in electric heater		heat pump
		$445 - 2 months		
11	one	three or more	one	none
	plug-ins			
12	I don?t use a wood stove for heating		I don?t use a wood stove for heating	I don?t use a wood stove for heating
13	heating	I buy it		I don?t use wood for heating
		$100 for a load		
14	my expenses have generally decreased	my expenses have generally decreased	my expenses have generally decreased	my expenses have generally decreased
15	no, it has always worked	not sure	yes, there wasn't enough electricity	no, it has always worked
			never worked in power outage, was VERY COLD	
16	yes, this is important to me	yes, this is important to me	this doesn't matter to me	this doesn't matter to me
17	yes	yes	yes	yes
				amazing system
18	yes	yes	unsure	yes
19	happy with heat pump. 'he is an elder, easier for him than the furnace. Don't have to worry about it'			

Q	House 13	House 14	House 15	House 16
1	neutral	happy	happy	happy
	it only heats up the living room, where it is installed	don't have to worry about oil and the furnace breaking down	good in hot weather	
2	other	no	not sure	not sure
	somewhat	cold, have to use heaters, the bathroom gets moldy		
3	neutral	neutral	satisfied	neutral
4	neutral	satisfied	very satisfied	neutral
	only cools where installed			
5	no changes		No Changes	More comfortable
		and put the heat on it smells		
6	haven't noticed a change	not sure	haven't noticed a change	air quality is better
		cause its mouldy in here		
7	haven't noticed a change	haven't noticed a change	haven't noticed a change	there is less mould
8	oil or diesel furnace, plug-in electric heaters	plug-in electric heaters, oil furnace	Oil furnace	plug-in electric heaters
		furnace always broke down		
9	600+?	2000	4/500	1800
		if the furnace works, but I use heater for 2 years		
10	heat pump, oil furnace, plug-in electric heater	heat pump, plug-in electric heater	heat pump	heat pump, oil furnace
11	one	two	one	three or more
12	I don't use a wood stove for heating		I don't use a wood stove for heating	I don't use a wood stove for heating
13	I don't use wood for heating		I don't use wood for heating	I don't use wood for heating
14	my expenses have generally increased	my expenses have generally decreased	my expenses have generally stayed the same	my expenses have generally increased
		not by much		
15	yes, it stopped working	no, it has always worked	no, it has always worked	not sure
	had a bad smell coming from it when switching from cool to heat??			
16		yes, this is important to me	yes, this is important to me	yes, this is important to me
17	unsure	yes	yes	yes
18	unsure	yes	yes	unsure
		if it will heat the whole house	does it need complete servicing? Health issues if not cleaned?	

Appendix IV: Survey Responses by Question

Below are the responses to all questions in the survey. Additional comments to questions are included in Appendix III: Surveys Responses in Grid View.

1. How happy are you with your heat pump system?

	Responses	%
Very Happy	5	31%
Happy	10	63%
Neutral	1	6%
Unhappy	0	0%
Very Unhappy	0	0%
Other	0	0%
	16	

2. Do you feel your heat pump has been an improvement over your old heating system?

	Responses	%
yes	10	63%
no	1	6%
not sure	2	13%
other	3	19%
	16	

3. How satisfied are you about your heat pumps ability to warm your home?

	Responses	%
very satisfied	6	38%
satisfied	6	38%
neutral	3	19%
unsatisfied	1	6%
very unsatisfied	0	0%
other	0	0%
	16	

4. How satisfied are you about your heat pumps ability to cool your home?

	Responses	%
very satisfied	6	46%
satisfied	4	31%
neutral	3	23%
unsatisfied	0	0%
very unsatisfied	0	0%
other	0	0%
	13	

5. Have you or others in your home noticed any health changes in the following areas since installing your heat pump? (Check all that apply.)

	Responses
improved breathing	2
better sleeping	2
more comfortable	6
better mood	2
other	0
no changes	5
	17

6. Since installing your heat pump, have you noticed changes in air quality in your home?

	Responses	%
air quality is better	9	64%
air quality is worse	0	0%
haven't noticed a change	5	36%
not sure/don't know	0	0%
	14	

7. Since installing your heat pump, have you noticed any changes in mould in your home?

	Responses	%
There is more mould	0	0%
There is less mould	4	36%
Haven't noticed a change	5	45%
not sure/don't know	2	18%
	11	

8. What heating systems did you use before installing your heat pump? (Check all that apply.)

	Responses
Oil or Diesel Furnace	6
Plug-in Electric Heaters	10
Wood Stove/Fireplace	3
Electric Furnace	1
Other	3
None	0
	23

9. If you used an oil or diesel furnace, about how much money did you spend per year? (Provide your best guess)

All Responses
'about $1800'
'2000/year or 200/month'
'2 loads/month'
'mostly burned wood'
'$750/2months?'
'heat pump'
'600+'
'$2000'
'4/500'
'1800'

10. What heating systems are you now using in your home? (Check all that apply)

	Responses
Heat Pump	14
Oil or Diesel Furnace	2
Plug-in Electric Heater	5
Wood Stove/Fireplace	0
Electric Furnace	0
Other	1
None	0
	22

11. How many plug-in electric heaters did you use in your home this winter?

	Responses	%
None	2	13%
One	5	31%
Two	4	25%
Three or more	5	31%
	16	

12. If you use a wood stove for heating, has your use changed since installing your heat pump?

	Responses	%
I use wood more	0	0%
I use wood less	1	8%
Stayed the same	0	0%
Not sure/don't know	0	0%
I don't use wood	12	92%
	13	

13. If you used wood for heating, how do you get it? (Provide your best guess.)

	Responses	%
I buy it	2	17%
I collect it	1	8%
Other	0	0%
I don't use wood for heating	9	75%
	12	

14. In general, how do you feel your monthly heating have changed since installing your heat pump?

	Responses	%
Generally decreased	6	40%
Stayed about the same	3	20%
Generally increased	2	13%
Not sure/don't know	4	27%
	15	

15. Have you ever been unable to use your heat pump?

	Responses	%
Yes, it stopped working	1	6%
Yes, not enough electricity	2	13%
no, it has always worked	10	63%
not sure/don't know	3	19%
	16	

16. Do you feel better knowing you are heating your home without fossil fuels?

	Responses	%
Yes, this is important	12	80%
No, I don't feel better	0	0%
Doesn't matter to me	3	20%
	15	

17. Would you recommend installing a heat pump to other community members?		
	Responses	%
Yes	14	88%
No	0	0%
Unsure	2	13%
	16	

18. Do you feel that installing heat pumps is positive for the community?		
	Responses	%
Yes	12	75%
No	0	0%
Unsure	4	25%
	16	

19. Is there anything around heat pumps that you would recommend/change/do differently?
'very happy with heat pump, easy to use, save $, keeps my place warm'
'happy with heat pump. he is an elder, easier for him than the furnace, don't have to worry about it'

Appendix V: BC Hydro Bill Analysis

5 BC Hydro bill accounts were reviewed between the years 2015 and 2019. Average electricity consumption decreased 3,460 or 17.21% from 2017 to 2019 (projected) and average cost decreased $287.9 or 13.72%.

Average of 5 Households		
Year	Total Energy Consumption/Year	Total Cost/year
2015	17,265	1784.3
2016	18,047	1952.8
2017	20,107	2246.3
2018	18,160	2098.9
2019	16,647	1958.4

	Change in Consumption [KWh]	% Change	Change in Cost [$]	% Change
2017-2018	1,946	9.68%	147.4	6.56%
2017-2019	3,460	17.21%	287.9	13.72%

House	Year	Total Energy Consumption/Year	Total Cost/year
1	2015	18,148	1,853.25
	2016	16,603	1,780.50
	2017	19,676	2,174.00
	2018	12,839	1,487.14
	2019	12,298	1,446.77
2	2015	16,210	1,664.60
	2016	20,951	2,229.23
	2017	22,690	2,495.60
	2018	22,254	2,525.90
	2019	16,543	1,921.48
3	2015	19,907	2,118.02
	2016	23,283	2,586.26
	2017	26,006	2,984.73
	2018	23,342	2,775.90
	2019	22,213	2,678.12
4	2015	19,412	1,978.52
	2016	17,875	1,913.26
	2017	18,722	2,063.24
	2018	18,432	2,099.37
	2019	17,487	2,021.07
5	2015	12,649	1,307.02
	2016	11,524	1,254.62
	2017	13,439	1,514.05
	2018	13,934	1,606.42
	2019	14,693	1,724.55

Appendix VI: Home Electricity Load Calculations

Current Electricity Load in Bella Bella Homes (excluding heating system) *

Initial 90m^2 Area	5000	W
Additional 90m^2 Area	1000	W
Stove	6000	W
Dryer	1000	W
Hot Water Tank	750	W
Maximum Load	13750	W
Assumed Voltage	240	V
Calculated Maximum Current	**57**	**Amps**

Proposed Heating System Load

Central Heat Pump (CHP)	16	Amps
Total Maximum Current with CHP	**73**	**Amps**
Ductless Heat Pump (DHP)	10	Amps
Total Maximum Current with DHP	**67**	**Amps**
Current Panel Capacity	100	Amps

Methodology Source: Electrical Code Simplified House Wiring Guide

*Calculation completed with assistance from Bella Bella Electrician Steve Macleod

Appendix VII: Community Electricity Load Calculations

Maximum Load (Does not consider conservation):				
	Electric Furnace to Heat Pump		Oil Furnace to Heat Pump	
	Ductless	*Central*	*Ductless*	*Central*
Initial Current Draw Per System (Amps)	42	42	6	6
Resulting Current Draw Per Central System (Amps)	10	16	10	16
Net Household Change (Amps)	-32	-26	4	10
Number of units	33	48	120	172
Community Maximum Load Change (Amps)	-1056	-1248	480	1720
Net Community Change (Amps)				**-104**

Notes:

- Power draw for electric furnaces is estimated at 10kW
- Power draw for one electric radiant heater is estimated at 1.5 kW. Each oil-heated home is assumed to also use one radiant heater
- Unit count and heating type based on visual assessment performed on July 19, 2017