Cambridge Bay Energy and Emissions Inventory

A partnership project by the Yukon Research Centre, the Hamlet of Cambridge Bay and the Canadian High Arctic Research Station, 2014

YUKON RESEARCH CENTRE
Yukon College

Project Team

Brianne Angohiatok grew up in Cambridge Bay and recently completed the Adult Basic Education Program at Nunavut Arctic College. She enjoys living in Cambridge Bay, because of all the hunting places to go to. She has a step son, a three year old daughter and a 4 month old son–all of whom she enjoys camping with. Brianne conducted interviews on the Cambridge Bay Energy and Emissions Project.

Paula Mowat grew up in Whitehorse, Yukon and was thrilled to have the opportunity to go even further north to Cambridge Bay to work with the community. Being involved in this research on the sustainability and accessibility of energy in Nunavut inspired her to return to university in the fall of 2013. She looks forward to returning to the Yukon, once she completes her studies, to hike, paddle and work on policy and program development.

Rhiannon Klein grew up in Edmonton, Alberta, and has been living in Whitehorse, Yukon since 2010. She is currently completing a PhD degree in public policy at the University of Saskatchewan and has a background in political science and cultural anthropology. Rhiannon enjoys conducting community-based research, and having the opportunity to work with diverse groups of people. In her free time she enjoys spending time outdoors, skiing, hiking, and biking.

Patty Jane Kamoayok grew up in Cambridge Bay and is currently attending Nunavut Arctic College, finishing off her second year of Adult Basic Education. She has a 5 year old son. She loves spending most of her time with her son, sewing, going out hunting, fishing, and camping. Patty conducted interviews on the Cambridge Bay Energy and Emission Project.

Lisa Christensen is from Whitehorse, Yukon, a place she has called home since 2002. She works as a social scientist at the Yukon Research Centre, Yukon College. Her interests include community-based research, natural resource management, food security, and energy. Outside of work, Lisa loves to spend time in the great Yukon outdoors with her son and partner; playing the banjo, felt-making and gardening also keep her quite busy.

Merran Smith was born and raised in Whitehorse, Yukon. Merran studied Geography and Indigenous Studies in Quebec, Visual Arts in Dawson City and is planning to continue her studies this fall. Merran greatly enjoys learning about different cultures and working with communities. She also loves skiing, horseback riding, cooking and dancing.

Acknowledgements

Instrumental in coordinating and carrying out numerous aspects of this project were YRC researchers Rhiannon Klein, Paula Mowat, Lisa Christensen and Merran Smith, Nunavut Arctic College students Patty Kamoayok and Brianne Angohiatok, Jim MacEachern (Hamlet of Cambridge Bay), and Meaghan Bennett (Canadian High Arctic Research Station). The local research review committee, comprised of Fiona Buchan-Corey and Marg Epp was also key in that it ensured the needs and interests of the community were met over the course of the project. And without the willingness of community members from Cambridge Bay to share household information and perspectives on energy consumption, the project itself would not have been possible.

Many other individuals and agencies/organizations played a role in the successful completion of this work, including: Nunavut Arctic College staff Mary Ellen Thomas and Gordon Bligh, Nunavut Research Institute staff member Mosha Cote, Nunavut Housing Corporation (Government of Nunavut), Community Government Services (Government of Nunavut), Cambridge Bay Housing Association, Kitikmeot Inuit Association, Qulliq Energy Corporation, and the Nunavut Energy Secretariat (Government of Nunavut).

Researchers on this project and the residents of Cambridge Bay would also like to thank Aboriginal Affairs and Northern Development Canada for funding this project.

Foreword

This work in Cambridge Bay, NT is based on a Yukon Research Centre (YRC) project with the Kluane First Nation of Yukon. The objective of this research partnership was to develop a community-based approach to understanding energy usage and how savings could be implemented and reliance on diesel reduced. From the Kluane First Nation's perspective, the partnership provided an opportunity to strengthen understanding of the resources required to keep the community strong and build upon their role as stewards for future generations.

From the YRC's perspective, the value of the Cambridge Bay project is that it establishes an energy baseline for future reference and planning. It also highlights energy success stories within the Hamlet, which can be used, modified and enhanced by others. The energy values, concerns, and strategies for addressing those concerns identified by the community will also bring great value to the way in which energy is managed. One mechanism is energy education for schools, which the YRC was able to contribute to through the delivery of energy curricula to two classes of grade five and six students and one class of grade nine students in April 2014.

We hope the results of this work will contribute to the way in which energy is understood and managed in Cambridge Bay. Without the participation and commitment of community members, the local research review committee, Nunavut Arctic College, the Hamlet of Cambridge Bay, and the Canadian High Arctic Research Station this project would not have been possible, so thank you.

Chris Hawkins,
Vice President of Research and Community Engagement
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Executive Summary

In 2013/2014, a community-based approach to inventorying energy and greenhouse gas emissions in Cambridge Bay, Nunavut was carried out by the Yukon Research Centre (YRC), the Hamlet of Cambridge Bay and the Canadian High Arctic Research Station (CHARS). Project goals were to 1) inventory energy use and greenhouse gas emissions, 2) understand views on energy success stories and concerns and how to address those concerns, 3) identify opportunities for reducing energy consumption, and 4) inform CHARS' planning process. This approach to understanding energy use and emissions at the community scale is unique in that it draws upon the strengths of both quantitative and qualitative information to show current and potential energy states.

Interviews were conducted with residents, commercial operators, and three levels of government. Through these interviews, an important baseline of information has been established on energy consumption in Cambridge Bay, including how much energy is used, how much it costs, and the associated greenhouse gas emissions. In terms of identified concerns, the high and increasing cost of diesel used for the generation of heat and electricity was identified as the most pressing; interviewees elaborated on contributing factors, current impacts, and groups most affected by energy costs. Strategies that support energy cost and consumption reductions were also identified by the community:

- use less energy,
- enhance energy subsidy/incentive programs,
- use renewable energy,
- consider other energy production systems,
- improve heat recovery ventilator usage,
- improve building quality,
- improve operations and maintenance capacity,
- engage in energy efficiency education and research, and
- ensure energy leadership in the community.

The last strategy, ensuring energy leadership in the community, is perhaps the most key to creating change, because specific roles for individuals and organizations are identified. A first step towards building energy leadership capacity in Cambridge Bay could be the establishment of an energy working group that meets a few times a year to discuss potential solutions to energy issues. A guide on how to use less energy in the day-to-day sense may be found on page 27-28 of the report.

Energy values were also distilled from project results, which may be used in a number of ways to support energy planning in the Cambridge Bay region, such as when developing new energy infrastructure or energy conservation initiatives. Energy values may also inform impact assessment and research initiatives in the region.

Other suggestions on how community members may utilize project results are provided in the strategies for reducing energy costs and consumption (page 25-46) and the moving forward sections (page 49).

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ᑕᐃᑲᓂ 2013-2014, ᓄᓇᓕᖕᓂᑦ ᐱᒋᐊᕈᑕᐅᔪᖅ ᑭᓲᓂᖏᑦ ᐱᖁᑎᒋᔭᑦ ᐆᒪᖁᑎᓕᕆᓂᕐᒥᑦ ᐊᒻᒪᓗ ᒫᓯᑦ ᐊᓂᐅᕋᖅᑐᑦ ᓱᑭᖅᓴᐃᔪᑦ ᓯᓚᒥᒃ ᑕᐃᑲᓂ ᐃᖃᓗᒃᑑᑦᑎᐊᖅ, ᓄᓇᕗᑦ ᐱᓕᕆᔭᐅᓚᐅᖅᑐᖅ ᑖᒃᑯᓇᖓᑦ ᔫᑲᓐ ᖃᐅᔨᓴᕐᕕᖓᓂᑦ, Hᐋᒻᓚᒃᑯᑦ ᐃᖃᓗᒃᑑᑦᑎᐊᖅ ᐊᒻᒪᓗ ᑲᓇᑕᐅᑉ ᖁᑎᒃᑐᕐᒥᐅᓂ ᖃᐅᔨᓴᕐᕕᖓᑦ. ᐱᓕᕆᐊᖑᔪᒪᔪᑦ ᑐᕌᓇᔭᖓᑦ ᐅᑯᐊᖑᓚᐅᖅᑐᑦ 1) ᑭᓲᖕᒪᖕᒫᑕ ᐆᒪᖁᑎᒥ ᖃᐅᒻᒪᖁᑏᑦ ᐊᑐᖅᑕᐅᔪᓂᑦ ᐊᒻᒪᓗ ᓯᓚᑦᑎᓐᓂᒃ ᒫᓯᒧᑦ ᐊᓂᐊᔪᑦ ᓱᑭᖅᓴᐃᔪᑦ, 2) ᑐᑭᓯᓗᒋᑦ ᑕᐅᑦᑐᖏᑦ ᐆᒪᖁᑎᖃᕐᓂᕐᒧᑦ ᖃᐅᒻᒪᖁᑎᓕᕆᔾᔪᑕᐅᔪᓄᑦ ᑲᔪᓯᑦᑎᐊᖅᑎᑕᐅᓯᒪᔪᑦ ᐅᓂᒃᑳᑦ ᐊᒻᒪᓗ ᐃᓱᒫᓘᑎᑦ ᐊᒻᒪᓗ ᖃᓄᖅ ᐱᓕᕆᔭᐅᔪᓐᓇᖅᐸᑦ ᐅᑯᐊ ᐃᓱᒫᓘᑎᑦ, 3) ᓇᓗᓇᐃᕐᓗᒋᑦ ᐱᕕᖃᕐᑎᑦᑎᔪᑦ ᐊᑦᑎᒃᓯᓯᒪᑎᑦᑎᐊᕐᓗᒋᑦ ᖃᐅᒻᒪᖁᑎᓂᒃ ᐊᑐᓗᐊᖅᑕᐃᓕᒪᑎᑦᑎᓂᖅ, ᐊᒻᒪᓗ 4) ᑐᓴᑦᑎᓪᓗᒋᑦ ᑲᓇᑕᐅᑉ ᖁᑎᒃᑐᕐᒥᐅᓂ ᖃᐅᔨᓴᕐᕕᖓᑦ ᐸᕐᓇᒃᐸᓪᓕᐊᔭᑦᑎᓐᓂᒃ. ᐅᓇ ᐱᒋᐊᕈᑖᑦ ᑐᑭᓯᔪᒪᓪᓗᒍ ᖃᐅᒻᒪᖁᑎᓂᒃ ᐊᑐᖅᓂᖅ ᐊᒻᒪᓗ ᓯᓚᑦᑎᓂᒃ ᓱᑭᖅᓴᐃᔪᑦ ᑕᒪᒃᑯᓇᖓᑦ ᐊᓂᐊᔪᓂᑦ ᐳᔫᖅᑕᐅᔪᓂᑦ ᒫᓯᓂᑦ ᓄᓇᓕᖕᓂ ᐅᓇ ᐊᔾᔨᐅᙱᑑᔪᖅ ᓴᙱᒃᑎᑦᑎᐸᓪᓕᐊᑎᑦᑎᔪᖅ ᑕᒪᐃᓐᓂᒃ ᐅᖓᕐᓂᖏᓐᓂᒃ ᐊᒻᒪᓗ ᖃᓄᓇᑦᑐᑐᐃᓐᓇᐅᓂᖏᓐᓂᒃ ᖃᐅᔨᒪᔾᔪᑕᐅᔪᑦ ᑕᑯᑎᑦᑎᔪᑦ ᒫᓐᓇᐅᔪᖅ ᐊᒻᒪᓗ ᐆᒪᖁᑕᐅᔪᓐᓇᖅᑐᓂᒃ ᐅᖃᖅᓯᒪᔪᓂᒃ.

ᐊᐱᖅᓱᖅᑕᐅᔪᖃᓚᐅᖅᐳᖅ ᖃᐅᔨᓇᓱᒃᑐᓂᒃ ᓄᓇᖃᖅᑐᓄᑦ, ᑮᓇᐅᔭᓕᐅᕈᑎᖃᖅᑐᓄᑦ ᑕᒪᑐᒥᖓ, ᐊᒻᒪᓗ ᐱᖓᓱᑦ ᖃᓕᓃᓖᑦ ᒐᕙᒪᒃᑯᑦ. ᑖᒃᑯᑎᒍᑦ ᐊᐱᖅᓲᖅᑕᐅᓯᒪᔪᑎᒍᑦ ᑐᑭᓯᕕᐅᓇᓱᒃᖢᑎᒃ, ᐅᓇ ᐱᒻᒪᕆᐅᕗᖅ ᑐᙵᕕᒋᓂᐊᕋᑦᑎᒍᑦ ᖃᐅᔨᒪᓕᕈᑎᒋᓂᐊᖅᑕᑦᑎᓄᑦ ᐱᓪᓗᒍ ᖃᐅᒻᒪᖁᑎᓂᒃ ᐊᑐᕐᓂᖅ ᐃᖃᓗᒃᑑᑦᑎᐊᕐᒥ, ᑕᒪᒃᑯᐊᓗᑦᑕᐅᖅ ᖃᓅᑎᒋᔪᖅ ᖃᐅᒻᒪᖁᑎᖃᕐᕕᑦ ᐊᑐᖅᑕᐅᖕᒪᖕᒫᑕ, ᖃᑦᓯᑖᓚᖃᕐᒪᖕᒫᑕ, ᐊᒻᒪᓗ ᐱᓪᓗᒍ ᓯᓚᒧᑦ ᒫᓯᑦ ᐊᓂᐊᔪᑦ ᓱᑭᖅᓯᕙᓪᓕᐊᔪᑦ. ᑕᒪᒃᑯᓄᖓᑦᑕᐅᖅ ᓇᓗᓇᐃᖅᑕᐅᓯᒪᔪᓄᑦ ᐃᓱᒫᓘᑎᓂᒃ, ᐊᑭᑐᓗᐊᖅᑑᓂᖓ ᐊᒻᒪᓗ ᐊᑭᑦᑐᕐᐸᓪᓕᐊᓂᖓ ᑏᓯ ᐅᖅᓱᐊᓗᒃ ᐊᑐᖅᑕᐅᔪᖅ ᐅᕐᑰᔾᔪᑕᐅᓪᓗᓂ ᐊᒻᒪᓗ ᖃᐅᒻᒪᖁᑎᓄᑦ ᓇᓗᓇᐃᖅᑕᐅᓚᐅᖅᑐᖅ ᐊᒃᓱᕈᓐᓇᖅᑑᔪᖅ; ᐊᐱᖅᓱᖅᑕᐅᔪᑦ ᑐᑭᓯᓇᖅᓯᑎᑦᑎᓚᐅᖅᑐᑦ ᐃᑲᔫᑎᔪᓂᒃ ᑕᒪᔾᔭᐅᔪᓂᒃ, ᒫᓐᓇᐅᔪᖅ ᐊᒃᑐᐃᔪᓂᒃ, ᐊᒻᒪᓗ ᐊᒥᓱᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᔪᑦ ᖃᐅᒻᒪᖁᑎᖏᓐᓄᑦ ᐊᑭᖏᓐᓄᑦ. ᐅᑯᐊ ᓄᓇᓕᖕᓂ ᐊᒥᓱᑦ ᓇᓗᓇᐃᖅᓯᓚᐅᖅᑐᑦ ᐋᕿᒃᓯᒪᔾᔪᑎᒃᓴᓂᒃ ᐃᑲᔫᑎᓄᑦ ᐊᑭᑐᓗᐊᖅᑎᓪᓗᒋᑦ ᖃᐅᒻᒪᖁᑎᑦ ᐊᑭᖏᑦ ᐊᒻᒪᓗ ᐊᑐᓗᐊᖅᑕᐃᓕᒪᑎᑦᑎᔾᔪᑏᑦ ᓲᕐᓗ ᐃᒪᓐᓇ:

- ᖃᐅᒻᒪᖁᑎᓂᒃ ᐊᑐᓗᐊᖅᑕᐃᓕᒪᓗᓂ
- ᐱᐅᓯᕚᓪᓕᖅᑎᓪᓗᒍ ᐆᒪᖁᑎᓄᑦ ᐊᑭᒃᑭᓕᒋᐊᕈᑕᐅᔪᓐᓇᖅᑐᑦ - ᓱᖏᐅᓴᐃᔪᑦ ᐱᓕᕆᑎᑦᑎᔾᔪᑕᐅᔪᑦ
- ᐊᑐᖅᓯᓗᑎᒃ ᐊᕙᑎᒥᒃ ᓱᕋᐃᙱᑦᑐᓂᒃ
- ᐃᓱᒪᒋᓗᒍ ᐊᓯᖏᑦ ᐆᒪᖁᑎᖃᕈᑎᒋᔪᓐᓇᖅᑕᑎᑦ
- ᐱᐅᓯᕚᓪᓕᖅᑎᓪᓗᒍ ᐅᖁᔾᔪᓐᓇᐅᑖᑦ ᐊᑐᖅᑕᐅᓂᖓ
- ᐱᐅᓯᕚᓪᓕᖅᑎᓪᓗᒍ ᐃᒡᓗ ᓴᓇᑦᑎᐊᖅᓯᒪᓂᖅᓴᐅᓕᖅᓗᒍ
- ᐱᐅᓯᕚᓪᓕᖅᑎᓪᓗᒍ ᐊᐅᓚᑦᑕᓇᐊᓕᑦ ᐊᒻᒪᓗ ᓴᓇᖅᑦᑕᓇᐊᓕᑦ ᐃᓗᓪᓕᖅᐹᓪᓕᖅᓗᒋᑦ
- ᐱᓕᕆᕕᒋᓗᒍ ᐆᒪᖁᑎᖃᑦᑎᐊᕈᓐᓇᕐᓂᕐᒥᒃ ᐃᓕᓐᓂᐊᖅᑎᓯᒪᓗᒋᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᖅᓯᖃᑦᑕᕐᓗᓯ
- ᐆᒪᖁᑎᓕᕆᓂᕐᒧᑦ ᐊᖓᔪᖄᖃᑦᑎᐊᕐᓗᓂ ᓄᓇᓕᖕᓂ

ᐅᓇ ᑭᖑᓪᓕᖅᐹᖅ ᐸᕐᓇᐅᑎᓂ, ᐆᒪᖁᑎᓕᕆᓂᕐᒧᑦ ᐊᖓᔪᖄᖃᑦᑎᐊᕐᓗᓂ ᓄᓇᓕᖕᓂ, ᐃᒻᒪᖄ ᐊᓯᑦᔩᕙᓪᓕᐊᑎᐊᕈᓐᓇᕐᓂᐊᕐᒪᑕ, ᐱᔾᔪᑎᒋᓪᓗᒋᑦ ᓄᓇᓕᖕᓂ ᐃᓂᒋᔭᐅᔪᑦ ᐃᓄᖕᒥᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᔨᓂᑦ ᓇᓗᓇᐃᖅᓯᒪᓪᓗᑎᒃ. ᓯᕗᓪᓕᖅᐹᖅ ᐱᒋᐊᖅᓯᔾᔪᑖᑦ ᓴᓇᕙᓪᓕᐊᓂᐊᕐᓗᒋᑦ ᐆᒪᖁᑎᓕᕆᓂᕐᒧᑦ ᐊᖓᔪᖅᑳᖃᑦᑎᐊᕐᓂᐊᕐᓗᓂ ᐃᖃᓗᒃᑑᑦᑎᐊᕐᒥ ᓴᕿᑦᑎᓯᒪᓪᓗᑎᒃ ᐆᒪᖁᑎᓄᑦ ᓴᓇᖅᑲᑎᒌᑦ ᑲᑎᒪᖃᑦᑕᖅᖢᑎᒃ ᐅᑯᐊᓗ ᑲᑎᑉᐸᒃᑐᑦ ᐊᒥᓱᐃᕋᑎᒃ ᐊᕐᕌᒍᒥ ᐅᖃᖃᑎᒌᒍᑎᒋᓪᓗᒋᑦ ᑭᓱᑦ ᐋᕿᐅᔪᓐᓇᖅᑐᑦ ᐆᒪᖁᑎᓕᕆᓂᕐᒥ ᐱᔾᔪᑕᐅᔪᓂᒃ. ᑐᑭᒧᐊᒍᑎ ᖃᓄᖅ ᐊᑐᖅᑕᐅᔪᓐᓇᕐᓂᖏᑦ

ᖃᐅᕆᒧᑦ ᖃᐅᔨᒪᔭᐩᑎᓂᐅ ᐊᑐᓗᐊᖅᑕᐃᓕᓕᑎᑎᓂᕐᒧᑦ ᐅᖃᓕᒧᑦᑕᐅᔪᓐᓇᖅᑐᖅ ᒪᐅᐱᖅ 27 ᐅᕙᓂ ᐅᓂᐢᑲᒥ.

ᖃᐅᔨᒪᔭᐩᑎᓕᕆᓂᕐᒥ ᐱᓕᓕᕆᐅᓯᒪᔪᖓᑦ ᐱᓐᓇᕆᔪᐅᔪᑦ ᐱᓯᒪᕆᐅᕈᑐᐅᓕᕐᒥᖓᒪᑕ ᑕᒪᐢᐩᔭᕆᓚ ᐱᔪᓕᕆᐅᑐᔪᐅᓕᐅᕐᒥᖓᒪᑕ ᑕᒪᐢᐩᔭᕆᓚᐅᕐᓂᒃ ᖃᐅᔨᒪᔭᐩᑎᓕᕆᓂᕐᒥ ᐊᐃᖅᑐᓂᔨᐅᑕᐅᓕᓕᑎᑎᓂᕐᒧᑦ ᐱᐃᖅᑐᓂᔨᐅᑕᐅᓕᓕᑎᑎᓂᕐᒧᑦ ᐃᖅᓗᓂᐅᕐᓇᖅ ᐃᐢᓗᓂᐢᑐᕐᒪᑦ ᐊᕐᕌᒍᖅᓯᒪᔨᖏᓐᓂ, ᓯᐅᓗ ᐱᓕᕐᓂᐊᑎᕆᑎᓂᕐᕋᖏᑦᑐᒃ ᐊᐃᖅᑐᓯᓂᖅᖏᑦᑐᒃ ᓄᑕᓂᐅ ᖃᐅᔨᒪᔭᐩᑎᓕᕆᓂᕐᓂᓂᒧᑦ ᐅᒪᔭᐩᑎᖃᕐᕕᖏᓂᖅ ᓇᐸᐃᓐᓇᑎᑐᖅ ᐊᑐᒍᕋᕐᒍᓂᑐᖅ ᐊᕐᕌᒍᖅᑕᐃᓕᒪᑎᑎᓂᕐᖅᐸᑎᑐᖅᓴᓂᒃ. ᐅᒪᑎᓕᕆᓂᕐᒥ ᐱᓕᕆᐅᑐᐅᔪᑦ ᐅᓂᖅᐅᓂᔨᓕᕆᔨᑦ ᖃᖅᐅᓇᓯᑎᐊᕈᑕᐅᓚᑎᑐᖅ ᐊᕐᒍᕋᕐᒍᓂᖅᒍᓂᐅᓂᖅ ᐊᕐᕌᒍᖅᓯᒪᔨᖏᓐᓄᓂᒃ.

ᐊᓯᖏᑦ ᐃᓯᒪᓕᕈᑎᑦ ᖃᐅᓂᖅ ᓄᓇᓕ ᐊᑐᕈᓐᓇᓚᑎᑐᖅ ᐱᓕᕆᐊᖏᓴᓂᒃ ᐋᖅᑭᐅᑎᑎᓕᐊᕐᒪᖓᓂᖅ ᑐᓂᓯᓯᒪᓚᑎᑐᖅ ᖃᐅᔨᒪᔭᐩᑎᓂᒃ ᐊᕈᖏᑦᑕ ᐊᒻᒪᓗ ᖃᐅᔨᒪᔭᐩᑎᓂᕐᒧᑦ (ᒪᐅᐱᖅ 25) ᐊᒻᒪᓗ ᓯᕗᓪᓕᐊᖏᑦᑐᑦᓯᐊᓂᐊᕐᒥᖓ ᑎᑎᕋᖏᓯᒪᔪᑦ (ᒪᐅᐱᖅ 49).

Unipkaak Naittuq

Ukiungani 2013 -14mi tahamna ingniqutit iglutlu aulatjutait unalu puyuuq akhaluutinit, iglunit aulaniata puyuunga lIqaluktuutiangmi ukuat ilituqhiuqtauvaktut hapkununa Yukon Research Centredkunit (YRC) Iqaluktutiap Hamletkunitlu ukuatlu Canadian High Arctic Researchtationkunitlu (CHARS). Ilituqhiurutaita hivuniurutait, hivuliq) ingniqutit iglutlu aulatjutait unalu puyuuq akhaluutinit, iglunit aulaniata puyuunga ,Tuglia) Ihumaliungniit angiqhitiaqhugit haffumuna ingniqutit iglutlu aulatjutait unalu puyuuq akhaluutinit nakkurutauplutik unipkangit ihumaaluutauyutlu haffuma mikhaagut qanuqlu ikayuutikhanik ihumaliurutigilugit. Pingahuat) Naunaiyailutik iglutlu akhaluutitlu aulatjutait mikhitqublugit atungnirit aulaniit hatja akkittuqpalaangmatta, Hitamaat) Kanadap Ukiuqtaqtup Ilittuqhiurviat Havakviatlu (CHARS) hivunikhainik ilitturipkarlugit una taimaatut havaktauyuq kangiqhitjutauniq aulatjut puyuutlu Iqaluktuutaip nunani taamnainaq taimaatut havaktauhimayuq ikayuutauqpiangniaqtuq aulaniit ilittuqhiuqtainni atungningatigutlu uuktuutaatlu mihingningalu naunaiyaqtaungmat ublumimut hivunikhaptingnilu atuqtauyukhakhanik.

Iqaluktuutiangmiut ukuatlu havaktitiyut havakvingni, pingahutlu gavamangit Iqaluktuutiangmi (Territorial, Municipal, Hamletkutlu), appiqhuqpaktait ilittuqhiuqhugit. Appiqhuutainni ihumagiluaqtauyut akhut ilittuqhiungniq hamna aulatjutip atungnia Iqaluktuutiangmi aulatjutip atungnia qanuq atungniqarvagiakhanganik akitutilanga, hamnalu puyuunga qanuq aulaniqaqpahilaptingnut. Ukuat ihumaaluutait ilitturiyauyut, uqhuryuap akitunia, akittuqpalaaqhunilu atuaqtaugiplunilu igluni uunaqutauplunilu, unalu iglumi aulatjutaa pauwatuut akituqpairami ihumagiyautqiyauyuq hivuliqpangmik, appiqhuqtauyut uqarivaktait hapkuat imailitjutingit hapkuat imailitjutingit , hatja mihingnarniit, kituluatlu ayuqhaqpagiakhaangatta aulatjutiita akitutilanginit. Iqaluktuutiaqmiut hivuniurutikhanik aulaniup akitutilanganutlu atungnianutlu hapkuninga:

- aulaniup atungia mikhilaaqlugu,
- aulaaningmut ikayuutit/ ikayuutikhatlu hulilukaarutikhat ilitturiyauqublugit inungnut,
- use renewable energy aulaniq inmiguaqtuq aturlugu,
- aulaniit alatqivaluit ihumaliurutigilugit,
- uunaqutit qingait atuqtauyut ihuaqharlugit nakuniqhaqpianginnut aulaqubglugit,
- iglut hanahimaniit ihuaqharlugit,
- havauhiitlu haviitlut nakuuniqpaanginut havaktitlugit,
- iglut aulatjutaitigut nakuyumik ilihaqtitlugit ilitturhiurlugitlu,
- nunaanni aulanikkut hivuniurutikhanik naunaiyailutik munaqhiyukhanik hanaiqhilutik.

Kinguliq atugakhaq una, nunani aulanikkut hivuniurutikhanik naunauyailutik munaqhiyukhanik pukulutik, hakugitqiyauniaqtuq allanguqtirinahuaqtaannut, inuk atauhiqluniit katimayiitluniit hivuniurutikhait naunaiyaqtauhimangmatta atuqtauliqublugit alanguqtirutikhat. Tahamna hivuliuyuq atugukhaq aulaniup mikhaagut hivuliurutainni Iqaluktuutiami katimayiliuqhutik aulaniup havaqqatigiiktukhanik ukiumi atauhingmi qaffiiqturlutik katimayukhanik ihumaliurutigilugu tahamnaaulatjut. Qanuaq ubluq tamaat maligakhaq iglu aulania mikhilaangnia hivuniurut naniyautaaqtuq ataani 27 unipkaangmi. Appiqhuutinit hapkuat naunaiyaqtauyut aulaniup ihumayautqiyainit akhut., qaffinik atungniqaqhutik Iqaluktuuutingmi,

aulaniup mikhaagut ihumaliurutikhainnut, ima nutaanik aulaniup ihumaliurutikhainik pitquhikhait. Aulaniu naunaiyangningit atuqtautaaqtut ilihautaulutik ilihimapkaitjutaulutiklu naunaiyayinut nunalaani.

Allatkiit ikayuutikhat nunaqtigiingut haffuma ilittuqhiurutaitigut hivuniurutikhat uvani unipangmi nauniyautaaqtut (ataani 25) Hivuniungmutlu aulaniq (ataani 49).

Key Terms

eCO_2	Carbon dioxide equivalent
ICLEI	Local Governments for Sustainability
IEAP	International Local Government GHG Emissions Analysis Protocol
GHG	Greenhouse gas
GWP	Global warming potential
GJ	Gigajoules
YRC	Yukon Research Centre
GN	Government of Nunavut
CHARS	Canadian High Arctic Research Station
YRC	Yukon Research Centre

Definitions

Greenhouse gas emissions: natural and man-made gases in the air, including carbon dioxide, methane, water, water vapour, nitrous oxide, and others, that trap energy from the sun. This causes the greenhouse effect, which is a warming of the Earth's surface and the air above.

Stationary energy: includes purchased electricity and fuels associated with heating/powering buildings as well as street lighting, traffic signals and purchased fuels associated with pumping sewage.

Transport energy: includes travel serving the needs of residents, commercial operators and government employees, regardless of whether or not travel originated in the community from the community. Transport energy also includes fuels associated with the operation/maintenance of owned and operated on and off-road vehicles.

Heat recovery ventilation (HRV) systems: units that provides fresh air and improved climate control, while also saving energy by reducing heating and cooling requirements in a building.

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1.0 Introduction

Climate change is one of the most significant contemporary concerns and stressors facing Aboriginal and northern communities across Canada. This stressor is all the more extreme in Canada's Arctic where "in the Northern hemisphere [generally speaking], 1983-2012 was likely the warmest 30-year period of the last 1400 years" (Working Group IPCC 2013: 3). There has already been an acceleration of trends such as more frequent and erratic weather events, multi-year sea ice diminishing, coastal erosion, thawing permafrost, and later freeze ups and earlier thaws (The Davidson Group 2011). According to the International Panel on Climate Change 5th Assessment Report "it is very likely that the Arctic sea ice cover will continue to shrink and thin and that the Northern Hemisphere spring snow cover will decrease during the 21st century as global mean surface temperature rises" (2013: 3).

These trends are having profound impacts on Arctic societies, such as to traditional culture, where difficulties in sharing traditional knowledge because of changing environmental conditions are more common than before. For instance, the ability to teach certain ice hunting skills has become more challenging with changing ice conditions (Unikkaaqatigiit; Perspectives from Inuit in Canada 2006). Feelings of being less connected to place or less able to predict weather patterns are also more prevalent *(Ibid).* Some impacts to health stem from altered travel routes as animal migration routes change, which means hunters often need to travel farther, and often along riskier routes, to harvest country foods. This has led to increased household expenditures and an increased reliance on store-bought foods, which often have fewer nutrients *(Ibid).* A diminished sense of security is also apparent, with many households experiencing issues with thawing permafrost, erosion and flooding, which sometimes necessitates community relocations *(Ibid).*

Concurrent with climate change impacts are community responses to them. Arctic peoples have long depended on and adapted to their changing environments (Huntington and Fox 2004). In the contemporary context of global climate change—in which the rate of change is rapid—Arctic peoples continue to adapt with an increasing role for resource management and institutional governance to play (Nuttall *et al.* 2008). Management of energy resources with a focus on energy conservation and the development of renewable energy is just one example of how northern and indigenous peoples are adapting to climate change.

In Nunavut, a number of energy initiatives are underway. One of these is the Government of Nunavut's (GN) plan to reduce their dependency on external fossil fuels through development of renewable energy sources. In addition, a recent partnership between the GN and Canada's Mortgage and Housing Corporation was developed to design and build energy efficient housing that is mindful of local culture and building standards (David Suzuki Foundation 2012). Lastly, the Canadian High Arctic Research Station's (CHARS)[1] renewable energy program will accelerate the uptake of existing renewable technologies in the North by providing a platform and funding for testing and refining renewable energy technologies used south of 60 degrees to work under Northern conditions. The CHARS program will also carry out research into renewable/diesel integration systems and storage from variable

[1] CHARS is the Government of Canada's planned centre for science and technology in Canada's North.

renewable sources. The CHARS facility in Cambridge Bay is being designed specifically for experimentation in energy and building technologies and systems. It will provide a real world vehicle for testing and adapting alternative and renewable technologies.

Stemming from one of CHARS' short term goals to pilot alternative and renewable energy development is a desire to understand more about the current energy situation in Cambridge Bay. This desire marked the beginnings of this community-scale energy and emissions inventory project. Inventories like these are useful, because they help communities track their progress in reducing energy consumption and emissions over time. In addition, inventory results may aid communities with identifying areas of energy concern, opportunity, and action (Pembina Institute 2008), and make comparisons with other jurisdictions (Community Energy Association 2008). Many governments around the world have engaged in community energy and emissions inventorying to inform decision making as well as to support legislated targets for reducing emissions.

2.0 Project Goals and Objectives

In the fall of 2012, the Yukon Research Centre (YRC) of Yukon College, the Hamlet of Cambridge Bay, and the Canadian High Arctic Research Station partnered to undertake an energy and emissions inventory of Cambridge Bay to support energy-related decision making in the community. The research was based on a 2012 pilot project completed by the YRC and the Kluane First Nation in Burwash Landing, Destruction Bay and Silver City, Yukon.

Specific objectives of the project in Cambridge Bay were to:

- administer a community-based approach to measuring energy usage and greenhouse gas (GHG) emissions by involving local citizens in interviewing local residents,
- conduct the inventory (i.e. establish a comprehensive baseline of information on the types of energy people rely on, how much they use, how much it costs them, and the associated GHG emissions),
- understand more about community perspectives on energy concerns and success stories in order to provide insight into inventory results and future directions that could be taken with local energy production/consumption,
- identify opportunities for reducing energy consumption and greenhouse gas emissions, and
- inform the Canadian High Arctic Research Station's (CHARS) planning process.

3.0 Project Partners

The Hamlet of Cambridge Bay

The Hamlet of Cambridge Bay is located on the southern end of Victoria Island in the Kitikmeot Region of Western Nunavut. According to Statistics Canada (2013), the population is 1585. Cambridge Bay serves as the region's administrative centre; Cambridge Bay is also the maintenance hub of the former Dew-Line sites.

Canadian High Arctic Research Station

The Canadian High Arctic Research Station (CHARS), located in Cambridge Bay, will provide a world-class hub for science and technology in Canada's North that complements and anchors the network of smaller regional facilities across the North. The new Station will provide a suite of services for science and technology in Canada's North including a technology development centre, traditional knowledge centre, and advanced laboratories.

The project was first announced in 2007 with the Government of Canada's Speech from the Throne. Under the rubric of Strengthening Canada's Sovereignty and Place in the World, the Government committed to "build a world-class Arctic research station that will be on the cutting edge of Arctic issues, including environmental science and resource development. This station will be built by Canadians, in Canada's Arctic, and it will be there to serve the world." (Canadian High Arctic Research Station 2014).

Yukon Research Centre

The Yukon Research Centre is located in Whitehorse, Yukon, and is part of Yukon College. It was established in 2009, under the direction of the Yukon Territorial Government, with the broad maxim to take innovative steps to address climate change and build the Yukon knowledge economy. The YRC's approach to facilitating these objectives involves a collaborative, multi-disciplinary approach of traditional knowledge, social, natural, and physical sciences.

Supporting research with First Nations, developing alternative energy technologies, and reducing the dependency on fossil fuels are examples of some of the YRC's more targeted goals. This project demonstrates our commitment to these goals.

Principles that guide the YRC's work are:

- our research will address northern issues and opportunities in an ethical, objective and relevant manner,
- our research will be conducted in a collaborative manner with our partners, building upon each other's strengths and capabilities by combining science with First Nations Traditional Knowledge and with respect for their culture,
- our research will be conducted in the north, addressing the needs of Yukoners and engaging them in the process; it will demonstrate positive benefits for the North, benefits which will be effectively communicated to the Yukon and its communities in order to improve living conditions,
- our research will be both applied and basic, providing quality information for

informed decision making, and

- our research will be financially sustainable, yielding social, economic and environmental benefits by engaging in multidisciplinary approaches to research and development.

The Yukon Research Centre's year-round greenhouse. Photo credit: YRC.

4.0 Methods

4.1. An Inventory Framework

After project goals were identified, a framework for conducting the energy and greenhouse gas emissions inventory was selected. After reviewing several frameworks such as British Columbia's Community Energy and Emissions Inventory, the Climate Registry, and the Arctic Energy Alliance's Community Energy Planning Toolkit, The Local Governments for Sustainability's International Local Government Greenhouse Gas Emissions Analysis Protocol (IEAP) was chosen. This framework was selected because the community is taken as the unit of focus (as opposed to the corporation, as with the Climate Registry), as well as units within the community, including residents, commercial and government operators, thereby assigning control over energy consumption and emissions. This structure was seen as important because of the way in which it can foster the identification of group- specific actions and opportunities to reduce energy consumption and GHG emissions over time. Principles used by the Local Government Greenhouse Gas Emissions Analysis Protocol (ICLEI 2009: 6) to ensure accurate accounting and reporting may be found in appendix 5.

4.1.2 Gases Considered

Gases Considered

Greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulfurhexafluoride (SF_6). As PFCs, HFCs, and SF_6 emissions are considered relatively insignificant for community-level emissions analyses (IEAP 2009; BC Community Energy and Emissions Inventory 2010) only CO_2, CH_4, and N_2O were considered in this study. The 2 main sources of GHG emissions were:

- emissions from the burning of fossil fuels, such as diesel, gasoline, and propane, and
- emissions from the production of electricity from diesel generated electricity.

The decomposition of biomass to GHGs in landfills and wastewater treatment facilities were not considered because the information was not available.

To track GHG emissions, individual gases are converted to carbon dioxide equivalent (CO2e) to calculate a single number that represents the total amount of GHGs being released. CO2e is the standard unit that allows amounts of GHGs of different strengths to be added together based on each gas' impact on climate change (ICLEI 2009). For example, one unit of N2O is 310 times more potent than carbon dioxide as a global warming gas, which means that one unit of N2O is equivalent to 310 units of CO2e (ICLEI 2009). This conversion factor is known as the gas's global warming potential. Global warming potentials (GWPs) for common gases are shown in table 1.0.

Table 1.0 GWPs from the IPCC Second Assessment Report (ICLEI 2009: 10)

Gas	GWP
Carbon Dioxide (CO2)	1
Methane (CH4)	21
Nitrous oxide (N2O)	310
HFC-23	11,700
HFC – 125	2,800
HFC – 134a	1,300
HFC – 143a	3,800
HFC – 152a	140
HFC – 227ea	2,900
HFC – 236fa	6,300
HFC – 43-10mee	1,300
Perfluoromethane (CF4)	6,500
Perfluoroethane (C2F6)	9,200
C3F8	7,000
C4F10	7,000
C5F12	7,500
C6F14	7,400
Sulfur Hexafluoride (SF6)	23,900

In order to make sense of emissions, they are usually expressed in terms of emissions/energy used: C02e/gigajoule, for example. To convert energy usage into emissions, the following equation (ICLEI 2009) is used:

Fuel consumed (measurement of energy use) x emissions factor=emissions

Emissions factors from Environment Canada's National Inventory Report (1990- 2011) were used to calculate emissions in this study.

4.1.3 Inventory Scope

Following the IEAP, this inventory consists of separate analyses of the energy consumption and emissions generated by local governments (Municipality of Cambridge Bay, Government of Nunavut, and the Government of Canada) and the community of Cambridge Bay (residents and commercial operators). Based on government operations, community activities, and available information, stationary energy and transport energy were considered; fugitive emissions, industrial processes, agriculture, land use, land use change, and forestry were not.

For governments, the analyses included energy used and emissions arising from the use of all significant assets and services, no matter where those emissions occurred (ICLEI 2009). Sources of emissions considered for all three levels of government included:

- Operated buildings and facilities
    - Purchased fuels associated with heating buildings (stationary energy).
    - Purchased fuels associated with pumping sewage (stationary energy).
    - Purchased electricity information (stationary energy) was not available.

- Travel serving the needs of staff, regardless of whether or not travel originated from the community
    - Fuels associated with the operation/maintenance of owned and operated on and off-road vehicles including boats (transport energy).
    - Air travel serving the needs of staff regardless of whether or not travel originated from the community (transport energy).

For residents and commercial operators, energy used and GHG emissions associated with activities occurring within the local government's geopolitical boundary were considered (ICLEI 2009). Emissions sources included:

- Street lighting (stationary energy)
    - This information is included in the overall amount of electricity consumed by the community in 2012.
- Homes and buildings occupied by residents and commercial operators
    - Purchased fuels associated with heating buildings such as homes, garages, etc. (stationary energy)
    - Purchased electricity information was available in an average form, for residents only.
- Travel serving the needs of residents and commercial operators, regardless of whether or not travel originated from the community
    - Fuels associated with the operation/maintenance of owned and operated on and off-road vehicles (transport energy)
    - Air travel serving the needs of community members regardless of whether or not travel originated from the community (transport energy).

The inventory year selected was 2012, as it was the most recent year for which accurate records across all governments were held for emissions sources included in the study. In addition, 2012 was the most recent year in memory for participants in general, which was important for optimizing recall ability.

4.2 Adding Depth to the Inventory

4.2.1 Perspectives on the State of Energy

In addition to understanding energy consumption and emissions in the stationary and transport energy sectors, we sought community perspectives on the state of energy so that insight could be gained into the inventory itself as well as energy issues of importance to local people. The questions we posed to the community about the state of energy are shown in table 1.1.

Table 1.1 State of energy questions

1. What kinds of energy success stories are you aware of in your community?
2. Do you have any concerns about energy in your community, now or into the future?
3. How do you think these concerns could be best addressed?

4.2.2 Energy Use Indicators

Information on basic building characteristics—such as home insulation values, hot water tank temperature/insulation, window types, condition of door seals, etc.—was also gathered so that the reasons underlying energy consumption could be better understood and so that opportunities for improving energy efficiency in buildings could be identified. Questions on these characteristics may be found in the survey instruments (in appendix 1), in sections 1-3.

4.3 The Survey Instrument

The survey instrument used to gather information for this project was originally developed by the Yukon Research Centre in collaboration with the Kluane First Nation. In 2012, these two organizations developed the first community energy and emissions inventorying tool used in Canada's North to understand energy use and perceptions on the state of energy. The instrument was drafted by the Yukon Research Centre and sent to the Climate Change Secretariat (Government of Yukon), the Institute of Social and Economic Research (University of Alaska Anchorage), and the Kluane project's local research review committee (appointed to guide the research process in the Kluane First Nation Traditional Territory) for review.

In Cambridge Bay, survey information was gathered using in-person, structured interviews in which a specific set of questions was used to guide the interview process[2]. Separate survey instruments were created for the residential sector and government/commercial sectors (see appendix 1).

Informed consent forms, reviewed with participants prior to the interviews, had two purposes, 1) to obtain participant permission to participate in the study, and 2) to communicate the intent of the project, how the information would be used, as well as how confidentiality/anonymity would be addressed (informed consent forms may be found in appendix 2). Rhiannon Klein, Paula Mowat, Patty Kamoayok, and Brianne Angohiatok organized and conducted project interviews between May 15th and June 6th 2013.

All interviews were conducted in English and Inuinnaqtun surveys were available upon request. Responses were entered directly into an Access database. Completed surveys were returned to respondents at their request. Survey data will not be released for future purposes without the express permission of the YRC, the Hamlet of Cambridge Bay, and residents.

[2] Before surveys were administered in Cambridge Bay, an application was submitted to the Nunavut Research Institute to obtain a Nunavut Scientific Research License, which was approved and granted under the *Nunavut Scientists Act.*

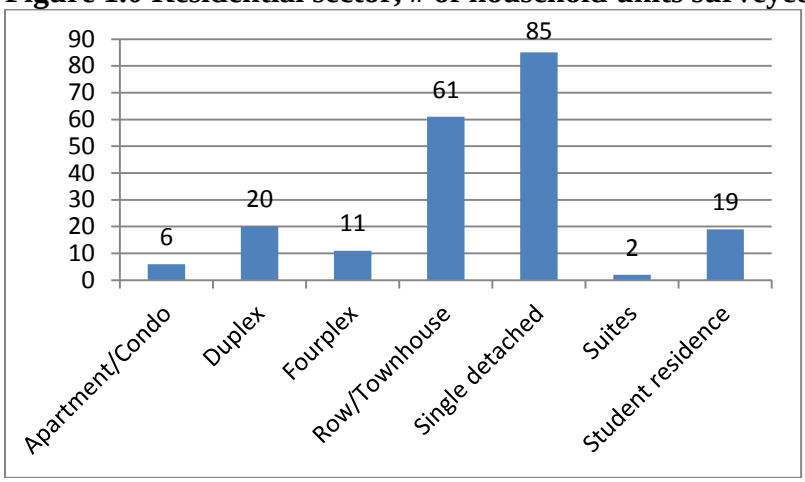
4.4 Completeness and Accuracy of the Data

4.4.1 Energy Consumption/Energy Use Indicator Data, by Sector

Residential Sector

Figure 1.0 shows the number of households surveyed in Cambridge Bay.

Figure 1.0 Residential sector, # of household units surveyed



We acquired energy consumption/energy use indicator information for 204 out of approximately 584 households. Due to the number of omitted households, several incomplete records on heating fuel consumption, and the range in home size for completed interviews, projections across the sector were not possible. Thus, total stationary energy consumed for the sector is unavailable.

The following stationary energy consumption information was available:

- Total heating fuel consumption/cost/emissions data for 73 semi-detached homes, including the average consumption and cost as well as the range. Note: Only 63 homes indicated both oil consumption and total oil cost in their surveys – the remaining indicated *either* oil consumed or total cost. From the 63 homes with complete data, an average cost/litre of oil was determined and applied to the households with either total oil consumed or total cost incurred to complete the dataset. 35 out of the 63 semi-detached homes did not receive a heating subsidy and 38 received the subsidy.
    - For all other home types, data was too sparse to report on.
- Average electricity consumption for a residential nonsubsidized household was made available by Qulliq Energy.

In terms of transport energy consumption,

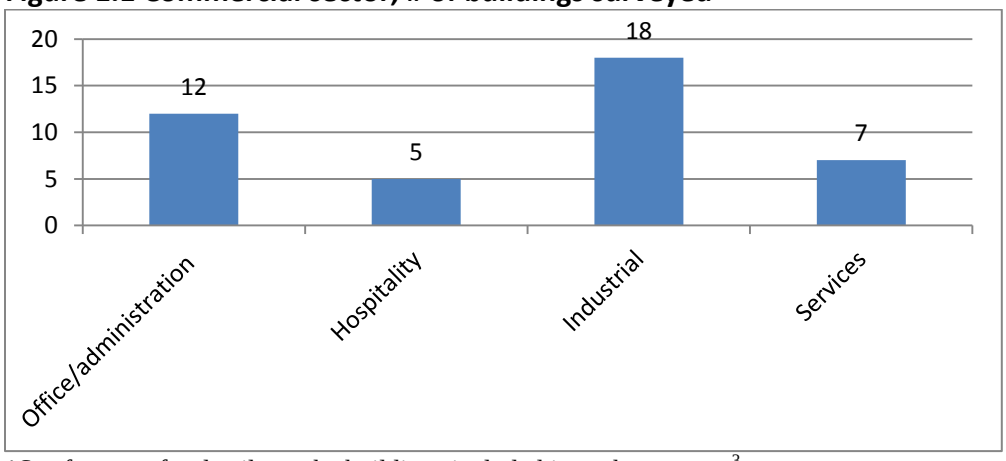
- For 106 households that provided cost and fuel consumption data on vehicles, average consumption and cost data is provided. These figures do not account for the fact that there are some households in Cambridge Bay without vehicles.
- We obtained flight information (number of flights, including destination and stopover points) from 168 households. Total and average carbon emissions (per person) were

calculated using the International Civil Aviation Organization's calculator at http://www2.icao.int/en/carbonoffset/Pages/default.aspx. This calculator was chosen over others, such as the Greenhouse Gas Protocol, because emissions are calculated based on actual flight distances rather than short, medium, and long haul flights.

Commercial Sector

Figure 1.1 shows the total number of commercial buildings surveyed in Cambridge Bay.

Figure 1.1 Commercial sector, # of buildings surveyed



*See footnote for details on the buildings included in each category.[3]

A total of 42 commercial buildings were surveyed on energy consumption and energy use indicator information. Due to the number of omitted buildings in this sector and several incomplete records on heating fuel consumption for the completed interviews, projections across the sector were not possible, as was the case with the residential sector. Thus, total stationary energy consumed for the sector in 2012 is unavailable.

The following stationary energy consumption information *was* available:

- The range and average heating fuel consumption/cost for 14 commercial operators.

In terms of transport energy consumption,

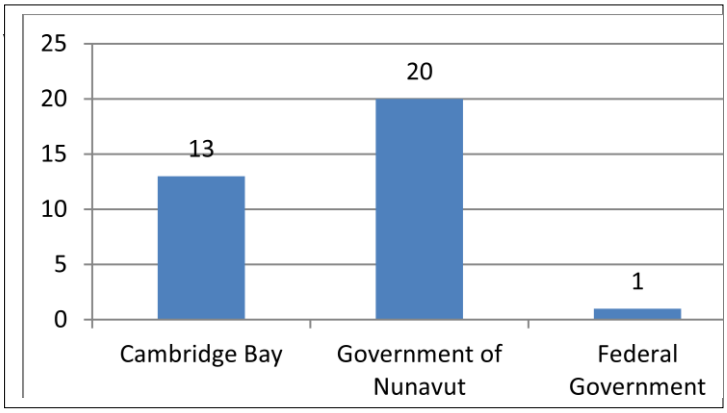
- Total gas and diesel consumption was available for 18 commercial operations, including average consumption and cost (cars, trucks, ATVs, snowmachines).
- We obtained flight information (number of flights, including destination and stopover points) from 21 commercial operators. Total and average carbon emissions (per operation) were calculated using the International Civil Aviation Organization's calculator at http://www2.icao.int/en/carbonoffset/Pages/default.aspx.

[3] Office and administration buildings; hospitality included hotels and bunkhouses; industrial included hangars, warehouses, combined warehouse/office spaces, garages, parking bays, commercial/industrial supply shops, carpentry/electrical/industrial shops, processing plants, combined carpenter shops/residences; service buildings included banks, pharmacies, church, combined church/residences, stores, radio stations.

Government Sector

Figure 1.2 shows the number of government buildings surveyed.

Figure 1.2 Government sector, # of buildings surveyed



13 Government of Cambridge Bay buildings, 20 Government of Nunavut buildings, and 1 Federal Government building were surveyed. Projections across these government sectors were not possible, due to a lack of data, making total stationary energy consumed for government sectors unavailable.

The following stationary energy consumption information was available:

- The range and average heating fuel consumption and cost for 12 Government of Cambridge Bay buildings.
- The range and average heating fuel consumption and cost for 10 Government of Nunavut buildings.
- Total diesel fuel consumption and cost for pumping municipal sewage.

Photos: top left: Nunavut Arctic College; top centre: Kiilinik High School; top right: residential row houses; bottom left: a residential home; bottom centre: Nunavut Arctic College student residences; bottom right: Kitikmeot Inuit Association building that is still under construction. YRC photos.

The following transport data was available:

- Total gas and diesel consumption for 2 Hamlet operations (trucks, snowmachines, and ARVs), including average consumption and cost.
- Total gas and diesel consumption for 5 GN Government operations (trucks and cars), including average consumption and cost.
- We obtained flight information (number of flights, including destination and stopover points) from 3 municipal government operations, 9 Government of Nunavut operations, and 2 Federal Government operations. Total and average carbon emissions (per operation) were calculated using the International Civil Aviation Organization's calculator at http://www2.icao.int/en/carbonoffset/Pages/default.aspx.

Accuracy of the Data

GN data on fuel consumption for stationary energy purposes was sourced from records maintained by the Department of Community Government Services. Fuel consumption for transport energy purposes was sourced from records maintained by individual departments. Hamlet of Cambridge Bay data on fuel consumption for stationary and transport energy purposes was sourced from records maintained by the Finance Department. The remaining stationary and transport energy data, in the residential and commercial sectors, was sourced from a combination of financial records maintained by participants and memory recall, the majority being the latter.

4.4.2 Energy Perception Data

We successfully completed 191 interviews with individuals across the residential, commercial, and governments sectors. The reason this number does not match the total number of buildings/household units surveyed is, because in some cases, building managers sent us fuel consumption/building characteristic information for units they manage—that is, full interviews were not conducted for each building/household we have data for.

4.5 How Data was Analyzed

Stationary and transport energy consumption data were entered directly into an Access database, from which Excel summary tables were produced. Emissions data were analyzed using Excel.

Responses to the three perception-based questions on energy were transcribed and then grouped into categories and themes using qualitative data analysis software (QSR NVivo). Statements of relationships in the data were then proposed. This technique is commonly used in qualitative research (Merriam 1988). The residential, commercial, and government sectors were combined in the analysis to protect anonymity.

Merran Smith and Lisa Christensen identifying relationships in the data. Qualitative data was first grouped into categories and themes using NVivo software. YRC photo.

To verify quantitative and qualitative findings, a selection of key findings was presented to project participants and the wider community on Wednesday April 30, 2014 at the Cambridge Bay community hall. The presentation occurred over a catered arctic char and quaq dinner which drew approximately 250 people, with roughly 75 staying through to the end. The event took place from 530pm until 800pm. Energy efficiency door prizes such as ghost energy meters, weather stripping/window kits, handmade mitts, and solar panels were awarded over the course of the evening. Participants ranged in age from the very young to the very elderly and Inuit and non-Inuit persons.

Extensive advertising in the community through radio, radio-bingo, the Nunatsiaq newspaper, Facebook and television, poster, word of mouth and emails helped ensure a strong turnout. We did not plan for an Inuinnaqtun translator because we anticipated a smaller turnout, but we later learned that this would have been appreciated by our audience.

Participants were generally in agreement with the findings presented; additional points that brought greater understanding to key findings were recorded and are included throughout the report. Feedback was sought by participants at regular intervals throughout the presentation. Small break-out sessions moderated by facilitators were the planned mode of seeking feedback; however, based on participant turnout we were advised by our committee to remain as one large group. Participation was good based on this format, although we were unable to hear questions and comments from everyone. A diverse range of audience members participated (again, from the very young to the very elderly). Several people in attendance commented that they were grateful for the opportunity to voice their opinions and concerns, but at the same time, felt doubtful that change would result from the research, especially considering the planned 18% rate increase for purchased electricity. Others expressed a keen interest in having more opportunities to learn more about energy efficiency.

Findings presentation, April 30, 2014. YRC photo.

4.6 Community-Based Approach

A key aspect of our inventory project was the community-based approach taken. Community-based research—which is sometimes referred to as action research, participatory research, or participatory action research—is collaborative research involving community members that aims to address a community problem or effect social change (Strand 2003). This project may be categorized in this way, because it was initiated on the basis of a shared interest in energy management by CHARS, the Hamlet of Cambridge Bay and the YRC. Discussions between CHARS and the YRC catalyzed the project's beginnings and project coordination and communication were maintained by each of the three parties over the course of the project.

A local research review committee was appointed in order to guide the research process and ensure the work was relevant to the community. Meetings with the committee were held as necessary to assess interview progress, review outreach/communications materials, plan the findings verification workshop, and ensure comprehensive review of the draft report. We also shared the draft report with the Government of Nunavut Energy Secretariat, the Nunavut Research Institute, Nunavut Arctic College, Qulliq Energy Corporation, Nunavut Housing Corporation, the Hamlet of Cambridge Bay, and CHARS.

5.0 Findings

This section presents the three types of information gathered in this study: 1) energy consumption, cost, and greenhouse gas emissions data, 2) energy use indicators (building characteristics), and 3) perspectives on the state of energy. Results are organized according to major concerns identified by community members. Related quantitative data on energy consumption, emissions, and energy use indicators are incorporated, where relevant to the concerns, in order to bring greater depth and context to the meanings people attached to their energy experiences. For comprehensive data on energy consumption/emissions/energy use indicator results refer to appendices 3 and 4. To begin, the energy context in Cambridge Bay is described below.

5.1 Energy Context

Heating and Electricity

For stationary energy, i.e. heating and electricity generation, Cambridge Bay relies almost exclusively on ultra-low-sulphur diesel fuel. The Government of Nunavut (GN) purchases diesel fuel from southern refineries, which is then shipped up the coast during the ice-free months of July-October. The Financial Management Board sets the fuel price for Nunavut, and the Petroleum Products Division (PPD)[4] with the Government of Nunavut sells the fuel to Kitnuna Corporation in Cambridge Bay, which then sells the fuel to customers in Cambridge Bay. Kitnuna is currently selling diesel for $1.408/litre and heating fuel diesel for $1.25/litre. On January 1st, 2014, the GN raised diesel fuel by 10 cents/litre, gasoline by 20 cents/litre, and jet fuel by 0.025 cents/litre in all Nunavut communities (Department of Community and Government Services 2013).

Kitikmeot Supplies also sells propane to individuals and to the Co-op, which along with the Northern Store sells propane to individuals for cooking purposes. Propane is brought into the community by barge once per year (Department of Community Services 2013). At the moment, Kitikmeot Supplies orders enough propane for three years.

Qulliq Energy Corporation used 2.6 million litres of diesel fuel to run the power plant in 2012: 9,533,172 kWh were generated and 9,528,815 kWh consumed. Some people with cabins in the region utilize alternative energy sources, such as wind and solar energy resources for electricity generation.

[4] The Petroleum Products Division (PPD) supplies heating, diesel, aviation fuel products and gasoline to all Nunavut consumers (Government of Nunavut 2002). PPD operations are financed through the Petroleum Products Revolving Fund (PPRF) and the Petroleum Products Stabilization Fund (PPSF) *(Ibid).* In 2014, the Revolving Fund amounted to a total of $200 million (Government of Nunavut, 2014) for the PPD to operate and the Stabilization Fund—$10 million in 2014 (*Ibid.*)—allows for room if there is a mismatch between costs and revenues with fluctuating fuel costs.

Transportation

For ground and water transportation (vehicles, off-road vehicles, and boat use) a combination of gasoline and diesel fuel is used, though gasoline use is more common. Kitikmeot Supplies currently sells gasoline and diesel for $1.299/L and $1.408/L respectively (Department of Community and Government Services 2013). The Co-op sells gasoline for $1.38/L, because they must purchase it first from Kitnuna (Ikaluktutiak Co-op Ltd 2014).

Waste Water

For other energy needs, such as processing wastewater, diesel fuel is used. For a three week period in 2012, 6300 litres of diesel fuel were used to run the sewage pump.

Fuel Supplied to Cambridge Bay in 2012

The following table shows the range of fuels and their quantity supplied to Cambridge Bay by the Petroleum Products Division, Government of Nunavut, in 2012 (Government of Nunavut, 2014). Emissions information is also provided—this assumes all fuel was consumed, which may not be the case.

Table 1.2. Fuels supplied to Cambridge Bay, 2012

Fuel Type	Total Litres	Emission Coefficient (t C02e/base unit)*	C02e (tonnes)
Low-sulphur diesel	7,488,688	.002790	20, 893
Gasoline	1,173,949	.002440	2, 864
Jet A-1	2,519,524	0.002544 (for kerosene)**	6,410
Avgas	20,500	Unavailable	--
Naphtha	2,000	Unavailable	--

*Emissions coefficients were taken from Canada's National Inventory Report, 1990-2011.
**The emission coefficient for jet A-1 fuel was unavailable. Kerosene is considered a proxy for jet A-1 fuel for this emission calculation, because the fuel contents are very similar.

5.2 The High Cost of Energy in Cambridge Bay

The high and increasing cost of diesel fuel used for the generation of heat and electricity was made abundantly clear as the most pressing energy-related concern in Cambridge Bay (74 out of 191 participants expressed energy cost concerns). Table 1.3 shows the heating costs incurred by various sectors.

Table 1.3 Heating fuel costs, Cambridge Bay, 2012

Sector	**Lowest amount spent in 2012**	**Highest amount spent in 2012**	**Average spent in 2012**
Residential Sector -single detached homes or cabins n=73	$425	$11,126	$4957
Commercial Sector n=14	$1343	$120,000	$28,294
Government-GN n=11	$680	$116,713	$26,544
Government-CB n=12	$1400	$14,968	$6,809
Government-Federal	No information available		

*38/73 single detached homes received a heating subsidy in 2012.
*No commercial operators received a heating subsidy in 2012.
*1/10 GN operators received a heating subsidy in 2012.
*No Cambridge Bay or Federal Government operators received heating subsidies in 2012.

Electricity costs across all sectors for 2012 were not available, but based on Qulliq Energy's records on electricity costs for a residential, nonsubsidized home in Cambridge Bay from April 1, 2013 to March 31, 2014, $4,308 was spent on 6408 kilowatt hours of usage (or $359 per month on 534 kilowatt hours). One of our interviewees from the residential sector, and 3 other homeowners we heard from during our follow-up visit to Cambridge Bay, said they paid between $7000 and $8000 for electricity in 2012, proving electricity costs can range far from the average depending on home size. The following quotes demonstrate residents' concerns over the cost of electricity:

I know it's expensive, the electricity. We pay the electric here and this winter it was so expensive! We paid close to $500/month. They say it averages about $13-$15/day to have your vehicle plugged in. We have to have a battery blanket plugged in as well, which adds up.

The cost of power is outrageous. Outrageous. The average power bill is anywhere, like for private home owners who only get the basic subsidy, from $200 to $400 per month.

If the 2010 average Canadian cost for electricity (0.07 cents/kWh) were applied to the average electricity usage for a residential home in Cambridge Bay, residents would pay $38 per month instead of $359, or $456 per year rather than $4308. That is almost a 10-fold difference[5]

Transportation fuels also add to energy costs. Cambridge Bay residents with on/off-road vehicles spent $3096, on average, for 2980 litres of gasoline in 2012. This figure is based on 106 households that indicated vehicle use; the average number of vehicles per household, of these 106 households, was 2.5 (vehicles included cars, trucks, snowmachines, ATVs, and boats).

Considering the average cost of heating fuel for single-detached home dwellers in Cambridge Bay, $4957, the average cost of electricity for a single-detached home dweller, $4308, and the average spent on transportation fuel by a household in Cambridge Bay ($3096, not including flights), single-detached home dwellers in Cambridge Bay spend approximately $ 12,361 per year on stationary and transportation energy.

And energy is just *part* of the cost-of-living picture in Cambridge Bay. Besides fuel, interviewees said that rent/mortgage costs[6], home insurance (which can be higher if pellet stoves are used as a heat source), food (including all the associated infrastructure and transportation costs to bring food to Cambridge Bay), water, shipping, flights, and land and leasing costs all contribute to an extraordinarily high cost of living. Food costs are combined with energy costs in the following section to provide an estimate of basic costs of living in Cambridge Bay.

[5] The average Canadian electricity price is an average of 11 major Canadian cities and may not represent an exact national average (calculated by the Canadian Electricity Association, 2010, based on data provided by Hydro Quebec, 2010. Accessed at http://www.electricity.ca/media/Presentations/Electricity%20Pricing%20Presentation.pdf on June 25, 2014.

[6] Statistics Canada (2013) indicates that the average home price in Cambridge Bay is $279,000; the average rental cost is $653 per month.

Average yearly food costs in Nunavut, the Inuvialuit Settlement Region, and Nunatsiavut were recently found to be $19,760 or $380 per week—these figures are based on 2007-2008 prices (Rosol *et al.* 2011). Using the average yearly food cost from Rosol et al. (2011) and the amount single-detached home dwellers in Cambridge Bay spent on stationary and transportation energy ($12,361) as a proxy for Cambridge Bay households, we could estimate that approximately $32,121 is spent, annually, on energy and food combined. Considering the average, after-tax income for private households in Cambridge Bay in 2010 was $90,082—although 180 out of 495, or 36% of, households indicated an after-tax income of $40,000 or less[7]—at least 35% of many housesholds' annual income is spent on food and energy.

Table 1.4 shows the average heating, electricity, and transportation consumption/costs for residents. Compared to the Canadian household average in 2011, Cambridge Bay households consumed more than twice as much heating fuel in 2012 (170 GJ as opposed to 62 GJ). In terms of electricity, the average Canadian household consumed 40 GJ in 2011, which is more than Cambridge Bay households consumed (33 GJ), but that is because Canadian households used electricity for lighting, powering electronics and appliances, *and* heating—Cambridge Bay households do not heat homes with electricity. Data on average Canadian household energy consumption is from Statistics Canada's 2013 report called Households and the Environment: Energy Use (11-52-S). For a complete listing of energy consumed in Cambridge Bay and the associated greenhouse gas emissions, refer to appendix 3.

Table 1.4 Average household energy consumption/costs, Cambridge Bay, 2012

Energy Type	Cost ($)	Quantity Consumed (Gigajoules)
Heating Fuel	4957	170
Electricity	4308	33
Transportation Fuel (Gas)*	3096	104
TOTAL	**12,361**	**307**

*Includes on/off-road vehicles; does not include flights.

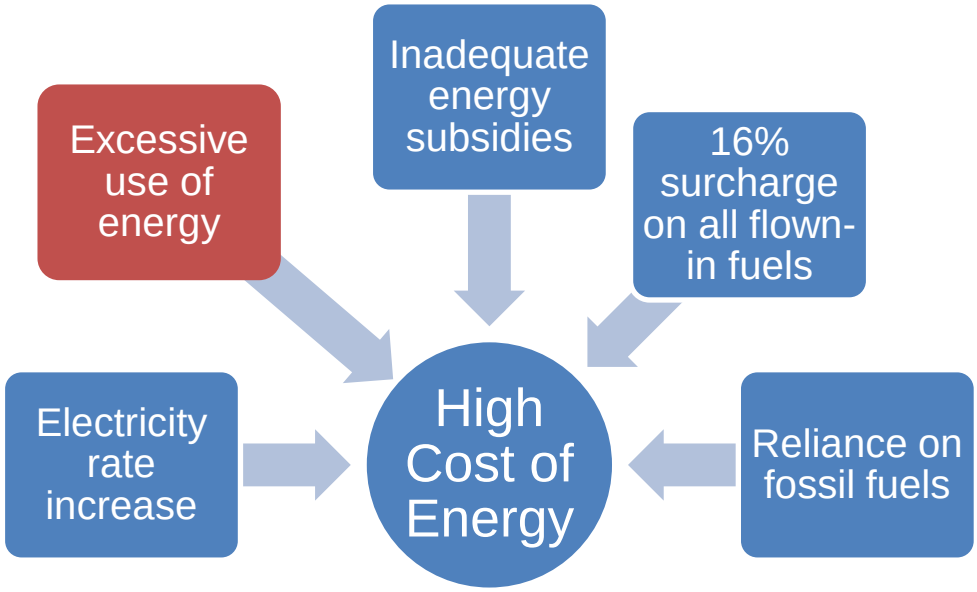
5.2.1 Why are Energy Costs so High?

Interviewees identified a number of concerns that help explain why energy costs are so high in Cambridge Bay. These are explained below, and shown in figure 1.3:

- reliance on fossil fuels. Diesel and gasoline are the only sources for energy in Cambridge Bay, and their costs are high,
- there is a 16% surcharge on all fuels flown into Cambridge Bay,
- electricity rate increases,
- inadequate energy subsidies, and
    - many interviewees felt the electricity subsidy is inadequate (see pages 29-30 for more information on electricity subsidies)
- excessive use of energy.

[7] Statistics Canada (2013).

Figure 1.3 Factors that contribute to high energy costs

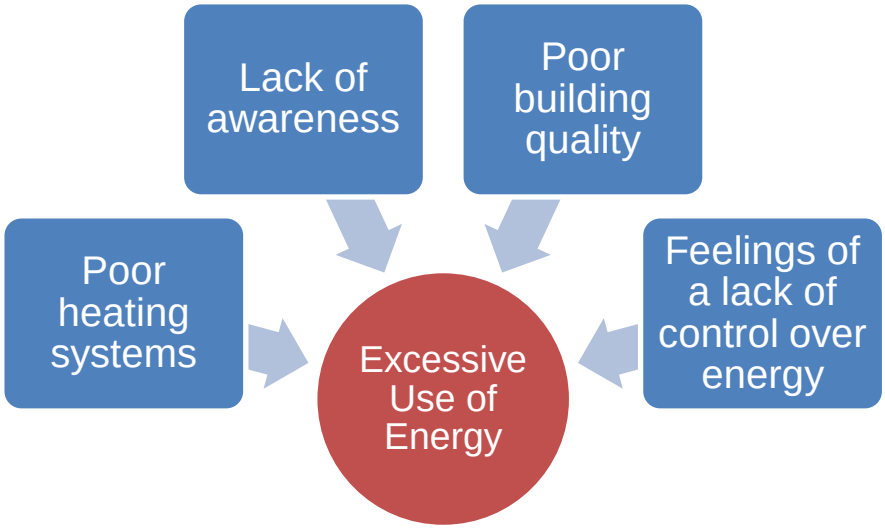


Of these factors, the excessive use of energy contributes to the high cost of energy in a complex and more nuanced way than the others. It was also a key energy concern identified amongst many interviewees (35 out of 191 people said excessive energy use was a concern). Interviewees explained that the excessive use of energy relates to:

- cold weather, meaning that high energy costs are simply a reality in Cambridge Bay's arctic setting,
- electronics (i.e. there are many of them and electronics such as cell phones require constant charging),
- appliances (leaving them plugged in/on, and the over drying of clothes in the dryer),
- lighting (i.e. use of SAD lights, generally leaving lights on, including at the hamlet office and the school—although participants explained that the latter was because of security issues), and
- home heating (heating empty houses, heating buildings in the summer season and generally "blasting the heat," and the need to open windows due to smoking indoors and sewage backups, which results in higher use of heating fuel).

Further compounding excessive energy use in Cambridge Bay are other more systemic factors, shown in figure 1.4.

Figure 1.4 Factors that compound excessive energy use in Cambridge Bay



Poor heating systems. One of the main issues with heating systems in Cambridge Bay is the lack of control over building temperatures. Several people said they need to open windows or doors to regulate exceedingly warm temperatures in their homes because thermostats are unresponsive.

> *The thermostats don't really work. If it's warm outside, it's warm in here, if it's cold, it's cold.*

Even with the thermostat turned to low or off, many people see temperatures between 25 and 30 degrees Celsius. In addition, two-level homes with one thermostat on the main floor seem to have the most difficulty regulating temperatures: even though it may be hot upstairs the heat must remain on to keep the main floor warm. Facing cold temperatures on the other hand, one person has resorted to using a cook stove to heat their home. Similar problems are found in multi-unit housing and the Cambridge Bay High School: it is cold on one side of the building and hot on the other and the heat cannot be turned down at night. Some people say that boilers, one of the main heating systems used in Cambridge Bay buildings, explain some of the excessive use of energy because they require a long heat up/cool down period. In addition, many say their boilers are either old, inefficient or in need of maintenance. However, because boilers must be turned off for servicing—and there are no back-up heating systems in place—the cold weather precludes any maintenance from taking place.

Lack of awareness and education. The idea that people don't often think about energy conservation, or that they waste energy or don't care about energy was put forward by a few interviewees. Other participants explained that the apathy observed around energy conservation is because there has been very little education on the topic. Contributing to this issue is that heating and electricity costs are blended on many residents' monthly bills—tenants in particular are often faced with such blended bills. And some institutions don't even see their heating bills. Without knowing what actual heating and electricity costs are and the difference

energy conservation efforts might make, it is likely that excessive energy use would result.

Poor building quality. Many people commented on the inadequacies around building construction in Cambridge Bay. They said buildings are not well built, or built with arctic conditions in mind, insulation is absent, low in value, or cracked (insulation around windows, exterior walls, and floors in particular). According to interviewees, this is partly to do with contractors not following proper building protocols —weather stripping around doors is poor or absent to the degree that people are hanging blankets up over the doors to keep drafts out, new buildings are so air tight they are icing up, the wiring is poor, electrical plugins lack cover plates in some cases, and there is no skirting around many homes; others reported the presence of mold.

In addition, some buildings are sinking and shifting due to permafrost – this was reported to contribute to draft issues in homes through the creation of holes and cracks in buildings. Permafrost is ground that has been frozen for two or more years and ice-rich permafrost (which is found in silt and clay soils) is known to be the most critical for causing shifting and settling of building foundations (Government of Nunavut 2013). For example, permafrost causes problems for multi-plex housing units in particular during freeze/thaw periods: four out of five multiplex buildings have cracks on one of the walls near the cathedral ceiling (Cambridge Bay Housing Association 2014). Cracking on long joints and corner joints are also common as a result of thawing permafrost *(Ibid).* With newer buildings, heat loss as a result of this cracking is not a big concern, but it is a concern with older buildings (Cambridge Bay Housing Association 2014).

Box 1.0 Homeowner's Guide to Permafrost in Nunavut

According to the Government of Nunavut's Climate Change Section (2013), "this guide provides homeowners in Nunavut with knowledge and resources to make simple changes around their home to help the permafrost stay frozen beneath it. It explains what permafrost is, how climate change is affecting it, the impacts to houses from thawing permafrost, and the importance of preventing thaw. The guide will also help local decision makers with adaptation actions that are relevant to the communities they serve." To locate this guide, go to: http://climatechangenunavut.ca/en/resources/news/homeowners-guide-permafrost-nunavut-just-releasedhttp://climatechangenunavut.ca/en/resources/news/homeowners-guide-permafrost-nunavut-just-released.

Lastly, many vapour barriers were not installed properly, as some people feel cold air coming in through plugs. Tables 1.5 through 2.1 on pages 32-35 show the extent of many of the building quality issues that pertain to energy efficiency in Cambridge Bay. The connection between poor building quality and high energy costs is discussed in the following quote:

> *The back door- you can see a gap in the door. And it's just freezing. We brought in a fireplace to offset how cold it is. In a number of units in the winter time, because of the wind, we have to have blankets over the windows and back doors because they didn't properly insulate the windows and exterior walls. And we have troubles in the kitchens, where they definitely didn't insulate the floors properly. It's criminal that we've had to have additional power on and heat sources because the home wasn't built or insulated properly.*

Lack of control over energy consumption. A few comments, like the next one, were made about expensive energy bills in Cambridge Bay despite efforts to conserve energy,

> *I'm trying to save energy as much as I can, but we have to pay the bills so I can't really be concerned about cost. There is not much I can do about it.*

At the results-sharing dinner participants elaborated on this point, explaining that sometimes families or individuals are limited to living in homes larger than they would normally choose due to availability, which results in higher energy consumption. One person felt resigned to using diesel heating fuel, despite the high cost, because it is reliable, an important characteristic of energy when temperatures can plummet to -60 degrees Celsius. Part of this resignation involves being "at the mercy of world markets in terms of fuel prices," as another interviewee said.

Though not necessarily systemic, letting vehicles idle is a behavior that also results in excessive energy use. This occurs because people want to drive warm vehicles in winter, and there is a fear that severe maintenance costs will be incurred on engines if they do not idle.

5.2.2 Who is most Affected?

An important element of the cost of energy/living discussion that arose during interviews was *who* faces the most difficulty paying for energy. Interviewees identified four main groups of people in Cambridge Bay who struggle with making ends meet as a result of energy costs: young families, low/non-income families, business operators, and homeowners. Figure 1.5 contains quotes that illustrate the nature of the struggles each of these groups face.

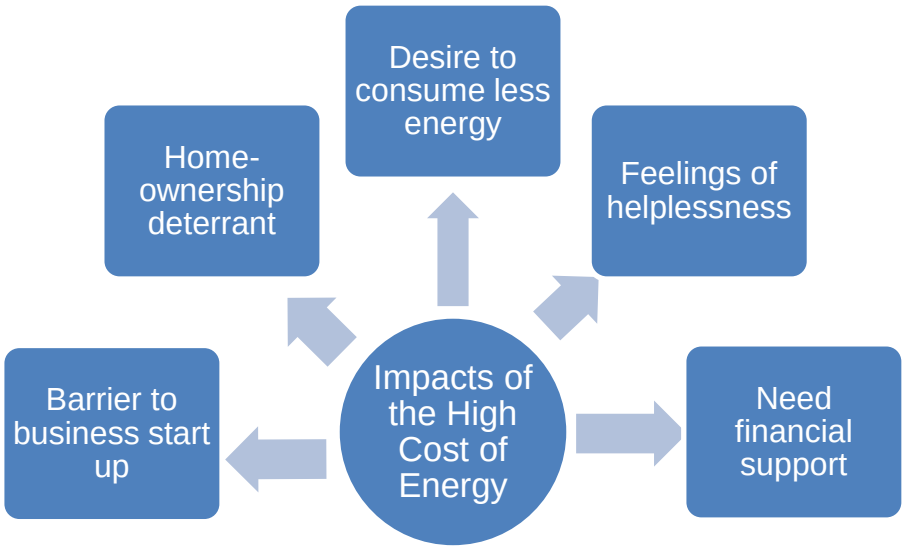
Figure 1.5 High energy costs are especially hard on business operators, young families, low income families, and homeowners in Cambridge Bay

Business Operators	Young Families	Low/Non Income Families	Homeowners
• "The cost of doing business here, with energy, it's so expensive."	• "My daughters and my great-grand son, they will probably be paying more [for energy] than when I was first here, when I was their age. When I came here everything was free."	• "I am a single parent, one income, so, you know, its pricey." • "I guess one of my concerns would be the lower-income or non-income people. I don't know their set-up but I'm concerned they don't have what they need because they can't afford it. I worry about the underpriviledged." • "I could see if someone was relying mainly on retirement income, they'd have a really hard time making ends meet."	• "Since 1999 our power rates have gone up 60% and no one has really addressed that at all Fuel, we are not getting any subsidies on fuel and its very costly. Espcially being a homeowner, compared to renting from Housing, where everything is subsidized. It's not easy being a homeowner in Cambridge Bay. We manage, but all of your time is spent saying, 'how are we going to do this?' It's very expensive."

5.2.3 Impacts

Beyond the financial strain a number of social groups face as a result of energy costs, interviewees identified other impacts that result from the high cost of energy. These are shown in figure 1.6.

Figure 1.6 Impacts of the high cost of energy



The following quotes illustrate concerns over impacts:

> *I know the cost of energy is a hindrance to new businesses opening here. There is a lack of businesses and restaurants. The cost of doing business here, with energy, is so expensive.*
>
> *I think energy costs here are a concern. That's part of the reason why we don't want to have our own house. Some people say the fuel just breaks you. My friends just built a house, and they put aside $700 for it a month. Some months they pay up to $1500. The government gives you $400 a month.*
>
> *I need to cut back a bit more [on energy use]. The price is going up.*
>
> *I know it's a real problem with my beast of a truck, I wish there was something different I could do but there isn't anything I can think of. It's something I am conscious of and I unplug things when I can for the most part.*
>
> *I think there is a need for greater subsidies. We are given the subsidy rate for Yellowknife, and we are not Yellowknife. The rates here are pretty steep. I am very energy conscious, and we are still paying large bills. I mean, if we are talking about sovereignty here, in the North, then we have a purpose here. And the government needs to think about how they are supporting us in being here.*

The last quote about the need for greater energy subsidies is something that a few people commented on, but when framed as a broader sovereignty issue, the need takes on a more poignant meaning. Despite the concern that energy subsidies fall short when it comes to helping people pay energy costs, several people felt that energy subsidies create a disconnect between the use and cost of energy. That is, there is a perception that those with subsidized energy costs or fixed electricity/heating payments have no incentive to turn the heat down.

5.3 Strategies for Reducing Energy Costs and Consumption

As we have learned, the high cost of energy in Cambridge Bay is a complex concern of great importance to people. Strategies that support energy cost reductions, as discussed in project interviews, are outlined below.

5.3.1 Use Less Energy: a Success Story in Cambridge Bay

People in Cambridge Bay *are* trying to use less power and this was noted by many as an important success story to share. Success stories ranged from innovative ways in which people are modifying their home and business infrastructure to be more energy efficient, behavior changes that involve using energy more efficiently, to strides made in the transportation sector. These stories are detailed in the Cambridge Bay Energy Guide alongside energy efficiency tips gathered from a range of sources[8] (in the guide, these are differentiated from success stories

[8] Including "Save 10", Nunavut's resource for energy efficiency information (http://www.gov.nu.ca/save10/English/save10.html; "Easy$ Tip Sheet, Energy Solutions Centre,

with an asterisk).

www.energy.gov.yk.ca/energy_efficiency.html; Ikummatiit: The Government of Nunavut Energy Strategy, http://www.eia.gov.nu.ca/PDF/Ikummatiit%20Energy%20strategy_sept%202007_eng.pdf; Arctic Energy Alliance, http://aea.net.ca/; Office of Energy Efficiency, Natural Resource Canada, http://oee.nrcan.gc.ca/home.

Energy Guide:

Tips for reducing energy costs and consumption

APPLIANCES

Unplug appliances when not in use or use them in off-peak times. Appliances like coffee makers and DVD players use power even when they are not turned on.

I unplug everything unless I need to use it. When I got my power bill, I was so surprised at how much I saved. –Cambridge Bay resident

Plug appliances into power bars so they can easily be turned off; power bars also protect your appliances against damage from power surges.

Switch appliances to energy efficient ones if possible. Energy efficient appliances are generally labeled.

Unplug freezers or fridges that are not being used. This could save you $100 per year.

Run the dishwasher only with a full load of dishes. Let dishes air dry instead of using the machine to dry them.

Use a microwave or toaster oven instead of the stove because it will use less electricity.

Use an electric kettle instead of the stovetop. Electric kettles use less electricity than heating water on a stovetop. Boil only as much water as you need.

Use a clothes line in the summer to dry your clothes.

Use cold water instead of hot to do your laundry.

Keep the oven door closed during use and look through the window instead. You lose 20% of the heat each time you open the oven.

Limit the number of times and length of time you open the fridge door.

Use a laptop computer if you can. They consume 90% less energy than a standard desktop computer.

Turn off your computer when not in use. Most computer electricity waste occurs when computers are left on at night and on weekends.

BUILDING

Keep the Cambridge Bay context in mind when building homes or other structures (where snow drifts tend to occur, wind direction, light, etc.).

Use passive solar building designs to distribute solar energy throughout buildings in winter; ensure they can expel heat in summer.

TRANSPORTATION

Warm up car engine during breaks, instead of letting it idle during the day

Use timers when plugging in your vehicle to reduce energy use. Plugging in your vehicle for more than 2 hours is a waste of energy.

Replace two-stroke snowmobile engines with four-stroke.

Think about walking somewhere before deciding to drive.

Keep the tires on your vehicle and ATVs inflated and avoid rapid acceleration and braking. These measures will reduce fuel consumption.

WINDOWS/DOORS

Cover windows with plastic, thick curtains or blankets to keep heat in and save on energy costs.

Replace old windows with triple pane windows if you can and insulate frames with spray foam.

OTHER CONSIDERATIONS

Go camping more and use lanterns/Coleman stoves/seal oil more often.

Plant a garden or build a greenhouse to become less reliant on costly diesel-imported foods and to eat healthier.

> *"I have a greenhouse out at my cabin…It is framed with poly around it and the sun is all around it."*
> *- Cambridge Bay resident*

Compost your food remains to limit waste – you can also fertilize your garden with compost.

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5.3.2 Enhance Energy Subsidy/Incentive Offerings

A number of ideas for potential energy subsidies and programs emerged from the survey. Focal areas for subsidy development identified by interviewees include:

- pellet stove freight costs,
- alternative energy infrastructure funding for residents,
    - some people said the GN should fund alternative energy, generally
- energy efficiency improvements for homes, and
    - Some people requested a return of the Federal Home Improvement Plan
- dog teams as a mode of transportation to motivate residents to use non-fossil fuel modes of transportation.

Related program development/other suggestions include:

- Qulliq Energy Corporation should reward customers who save energy and create programs for big users to consume less energy,
- there should be incentives for industry to use alternative energy,
- there should be competition for energy providers,
- renew the energy management officer position that used to exist – there was a budget for upgrades to territorial buildings and home energy audits, and
- create an appliance retrofit program so that people can afford to switch to more energy efficient appliances.

In terms of access to subsidies, some respondents said subsidies should be available to everyone, annual income limit aside, whereas others said subsidies should be designed for homeowners and single mothers —groups hit particularly hard by energy costs. The range of energy subsidies currently offered are described below.

Electricity Subsidies

Qulliq Energy Corp has 10 different classification types - 2 are subsidized (Doucette 2014):

<u>Housing (domestic customers living in public housing units)</u>

This subsidy is for tenants living in homes owned by the Local Housing Association or Nunavut Housing Corporation. Tenants have a subsidy for the base charge and meter usage (this amounts to six cents per KWh with no tax). Nunavut Housing Corporation pays for the amount of the subsidy, the fuel rider charge and the administration fee of $6.08 per meter (*Ibid)*.

Residential Territorial (domestic customers who are not in a public housing unit and who are not receiving a subsidy on any other accounts)

Private residential customers are entitled to receive a subsidy on the first 700KWh a month between April 1st –September 30th and the first 1000 KWh a month between October 1st and March 31st. Subsidized rates for all communities are calculated at 50% of the Iqaluit base rate. The customer is billed the regular residential rate after the threshold has been reached. Residents that own two homes or more are only eligible for the subsidy on the first home; subsequent ones are charged at the residential rate (*Ibid*).

The GN offers one electricity subsidy for commercial customers:

Nunavut Electricity Subsidy Program: Contribution Policy (commercial customers)

Commercial customers who have annual gross revenue of $2 million or less can, with proof, apply to the Comptroller General for a maximum subsidy on the first 1000 KWh a month. The base charge however, is not subsidized *(Ibid).*

Fuel Subsidies

The Petroleum Products Division (PPD) supplies heating, diesel, aviation fuel products and gasoline to all Nunavut consumers (Government of Nunavut, 2002). PPD operations are financed through the Petroleum Products Revolving Fund (PPRF) and the Petroluem Products Stabilization Fund (PPSF) *(Ibid).* In 2002, the Revolving Fund amounted to a total of $200 million for the PPD to operate on a "break even" basis *(Ibid).* The Stabilization Fund (of $10 million) allows for room if there is a mismatch between costs and revenues with fluctuating fuel costs *(Ibid).* For 2/25 Nunavut communities (including Iqaluit and Cambridge Bay) however, this service has become highly privatized; Kitnuna Corporation for the most part takes on the role of the PPD in Cambridge Bay, for example *(Ibid)*. PPD still has a role of selling bulk fuel to the owner at re-supply and regulating the fuel selling prices *(Ibid).* The agreement serves as a means to subsidize Cambridge Bay consumers *(Ibid).* However, the cost of re-supplying Cambridge Bay with fuel is expensive with the lack of competition in the transportation sector. In terms of subsidies, they are "neither budgeted nor disclosed and neither the GN nor its customers are aware of the value of these subsidies *(Ibid).*

Homeowners Fuel Rebate

It was announced March 12th, 2014 that Nunavut homeowners are eligible for a one-time payment of $500.00 to help finance increasing heating fuel costs that went up on January 1st, 2014. The deadline is September 30th, 2014 to apply. Go to http://gov.nu.ca/sites/default/files/files/Finance/NEWS/2014HomeownerFuelRebate_FAQ_EN.pdf for more information (Government of Nunavut 2014).

Transportation Subsidies

The GN offers a transportation fuel subsidy:

Fuel Tax Rebate Program

This rebate is for harvesters, outfitters, tourism operators and quarrying. This program allows individuals to obtain a fuel tax rebate for fuel oil or liquid petroleum gas consumed in vehicles engaged in off-road activities. These vehicles include snowmobiles, all-terrain vehicles (ATVs), boat motors, motorcycles and licensed vehicles. To qualify the fuel must have been purchased in Nunavut and been subject to tax under the *Petroleum Products Tax Act*. Taxes paid on fuel used for personal or recreational use are not eligible for a rebate (Government of Nunavut 2014). It is 6.4 cents per liter of gas for eligible activities (CBC News 2014).

General transportation-related subsidy:

First Air offers a 30% freight discount to beneficiaries endorsed by Kitikmeot Inuit Association (KIA) and Canadian North has an ATV/snowmobile freight rate that applies to everyone and they also offer a special freight rate to KIA employees.

5.3.3 Improve Building Quality

We know from an earlier section of the report (figure 1.4 on systemic factors that compound excessive energy use in Cambridge Bay) that many buildings require improvements. In fact, the Nunavut Housing Needs Survey (2011) indicated that 57% of Cambridge Bay residents are living in crowded dwellings and/or dwellings in need of major repairs.

In terms of repairs related to energy efficiency, a selection of building characteristics from commercial and government buildings and houses in Cambridge Bay show the extent to which energy efficiency improvements could be made (information on insulation value and presence, window types/condition, door seal condition, wall construction type and vapour barrier presence are presented in tables 1.5 through 1.8). Recommendations for improvements to buildings or new builds are provided below each table, and are based on materials accessible to the Nunavut Housing Corporation. These materials are based on a cost point of view, as well as adaptability to standard construction methods.

Table 1.5 Insulation presence and value

Sector	Ceiling Insulation	Ceiling Insulation Value	Floor Insulation	Value	Exterior Insulation	Value
Residential	183/205 = 89%	N=182 (2@R12, 69@R20, 109@R40, 1@R52, 1@R60)	182/205 =88%	N=181 (1@R12, 164@R20 2@R30, 13@R40, 1 @R60)	182/205 = 88%	N=182 (61@R12, 49@R20, 1@R24, 40@R27.5, 1@R28, 1@R30, 8@R40)
Commercial	25/41 =61%	N=17 (4@R20, 1@R30, 1@R32, 9@R40, 2@R72)	24/40 =60%	N=15 (1@R15, 5@R20, 1@R30, 1@R32, 5@R40, 2@R60)	25/40 =63%	n=18 (4@R12, 6@R20, 1@R27.5, 1@R30, 1@R32, 3@R40, 2@R54)
Municipal Government	10/13 =77%	N=9 (4@R12, 1@R20, 4@R40)	10/13 =77%	N=9 (8@R20, 1@R40)	10/13 =77%	N=9 (1@R12, 7@R20, 1@R27.5)
Government of Nunavut	15/20 =75%	N=14 (3@12, 2@20, 8@40, 1@52)	15/20 =75%	N=13 (12@20, 1@40)	13/17 =76%	N=15 (1@R12, 7@R20, 4@R27.5, 1@R40, 2@R52,
Federal Government	1/1 False	No response	1/1 False	No response	1/1 False	No response

As table 1.5 shows, ceiling insulation was present in most cases. In most cases where ceiling insulation was indicated, R40 is the value of the insulation; however, there are several cases where it is less than that. Ceiling insulation should be present in all buildings. R40 (R20 batts, doubled up) is the ceiling insulation value that appears in Nunavut Housing Corporation's building guidelines.

With respect to floor insulation, a few interviewees reported that it was not present, as was the case with ceiling insulation. Most buildings have R20 or R40 insulation in the floor, but a few reported floor insulation values lower than this. Floor insulation should be present in all buildings. In Nunavut Housing Corporation's building guidelines, R40 (R20 batts doubled up) is recommended for floor insulation.

For exterior wall insulation, not everyone reported that it was present. Most buildings have an insulation value of R20 or higher, although some reported R12. All buildings should have exterior wall insulation. R27 (an R20 batt plus R7 rigid insulation) is the wall insulation value recommended for new Nunavut Housing Corporation building projects.

Table 1.6 Window types

Sector	# of Double Pane	# of Triple Pane	Total # of Windows
Residential	918, N=159	323, N=60	1248, N=203
Commercial	227, N=27	89, N=8	356, N=33
Municipal Government	53, N=5	26, N=2	81, N=12
Government of Nunavut	115, N=11	174, N=8	289, N=17
Federal Government	4, N=1	N/A, N=0	4, N=1

With the exception of the Government of Nunavut, the majority of windows in all other sectors' buildings are double pane. When planning new builds or renovations, it is recommended to upgrade to argon-filled triple pane windows if possible.

Table 1.7 Window condition

Issue	Residential	Commercial	Municipal Government	Government of Nunavut	Federal Government
Good Condition	27	1			
Poor Condition	9	2			
Well Insulated	1				
Cracked/Broken	65	6	2	1	
Drafty	36	3		2	
Seals worn out/ gone	7				
Condensation build up (often ice)	11				
Problems opening and closing (often because of freezing	11	1			
Warped	1				
Missing screens	1				
Moldy	1				
Locks not unlocking	1		1		
Hinges broken	1				
Frames not good	1				
Has been replaced	13	3			

*Some people explained that crank-operated windows do not function in homes that shift due to weather. Interviewees explained that because these windows do not function, they worry about getting out of the house in the event of a fire. Several people noted window vandalism as an issue.

Of those who reported poor window condition on the survey, the residential sector reported the highest number of cracked, broken, or drafty windows. Interim measures individuals have taken for dealing with windows in poor condition are noted in table 1.8

Table 1.8 Homeowner temporary window solutions

Solution	Residential	Commercial	Municipal Government	Government of Nunavut	Federal Government
Covered with plywood	4	1	1	1	
Covered with plastic	16	4			
Duct tape used	2				
Sheets/pillows used as covering	3				
Holes/cracks plugged	3				

Covering windows with plastic is a good temporary solution to tame drafty or cracked windows, although some people noted that it does not make a difference. Covering windows with plastic may enhance window insulation value by 1 pane.

Table 1.9 Door seal condition

Sector	Absent	Poor	Good	Total Answered
Residential	10	96	83	189
Commercial	1	6	27	34
Municipal Government	1	1	9	
Government of Nunavut	0	5	10	15
Federal Government	1	0	0	1

*Seven residents explained that house shifting results in poor door seals.

As with window condition, door-seal condition was noted to be absent or poor most often in the residential sector (of those who reported on door seal condition). For the best insulation value possible with doors, use fiberglass or steel doors with a minimum R value of R12 (these are the door types used by the Nunavut Housing Corporation), and replace weather stripping every year so that seals perform properly. Animal hides were noted as highly efficient door-seal materials – weather stripping wears out very quickly. Related to door seals are door frames: door frames that adjust to thawing permafrost conditions, and minimize heat loss, may be available for use in Cambridge Bay (Nunavut Housing Corporation, 2014). The relationship between permafrost and heat loss in Cambridge Bay buildings, more generally, is an area that could receive greater research attention.

Table 2.0 Wall construction and vapor barrier

Sector	Wall Construction	Vapor Barrier Presence
Residential	N=182 (77@2x4; 113@2x6; 4@2x6 enhanced)	182/205 =88%
Commercial	N=41 (5@2x4; 14@2X6; 2@2X6 enhanced)	24/40=60%
Municipal Government	N=9 (6@2x6, 3@2X4)	10/13=77%
Government of Nunavut	N=14 (4@2x4, 10@2x6)	16/20=80%
Federal Government	No response	--

Most buildings reported 2x6 wall construction, which is conducive to a good basic R27 exterior wall insulation value. Several buildings have older 2x4 wall construction, which means that a lower wall insulation value is the only option. The Nunavut Housing Corporation's guidelines state that 2x6 wall construction is standard.

Most buildings reported vapour barrier presence, but several did not (see table 2.0). Vapour barriers should be present in all buildings. Properly installed vapour barriers that minimize the direct diffusion of moisture into the structure fabric work to control moisture loss from a home (to prevent damage to the structure) and minimize heating costs (Yukon Housing Corporation

2014).

Table 2.1 Water heater use

Sector	Type			Average Temperature	Tank Insulated
	Oil	Boiler	Electrical		
Residential	32	105	22	56 C (N=100)	21/205 = 10%
Commercial	1	9	8	52 C (N=13)	2/40=5%
Municipal Government	1	8	1	67 C (N=7)	No responses
Government of Nunavut	2	8	1	59 C (N=5)	2/20=10%
Federal Government	No response	No response	No response	No response	No response

A hot water tank setting of 55C is considered energy efficient (Yukon Energy 2014). With the exception of the commercial sector, the average hot water tank temperature in Cambridge Bay homes and buildings was reported to be greater than 55C—so turning down hot water tank temperature is a widespread opportunity for energy conservation. In addition, the minority of tanks are insulated. In Silver City, Yukon, where a similar energy inventory was completed in 2012 by the Yukon Research Centre, one off-grid household reported that they insulated their hot water tank with fiberglass insulation and put it on a timer so that it runs only 4 hours per night. This tank modification was sufficient to provide hot water for a 2-person household throughout the day. Experimenting with tank insulation and timers could also work well in Cambridge Bay homes and buildings.

If Cambridge Bay residents are able to consider energy efficiency renovations, the Nunavut Housing Corporation has a Home Renovation Program, which makes funding opportunities available for energy efficiency improvements to Nunavut homes (see box 1.1). In addition, energy efficient housing models in the Nunatsiavut region of Labrador may be referred to, should energy efficiency modifications be considered into the future. On a related note, the community could explore different home ownership models that support energy efficiency.

Box 1.1 Nunavut Housing Corporations' (NHC) Home Renovation Program

Nunavut Housing Corporations' (NHC) Home Renovation Program
NHC's Home Renovation Program offers a variety of funding opportunities for energy efficiency related home improvements. The Heating Oil Tank Replacement, Home Renovation, and Senior Citizens Home Repair Programs can be accessed at:
http://www.nunavuthousing.ca/apps/authoring/dspPage.aspx?page=hrrmp

Box 1.2 An Energy Efficient Housing Model

The Sustainable Communities Initiative (SCI) in the Nunatsiavut region of Labrador has recently launched an Energy Security Project that entails regional energy and community development strategies, including ones related to housing (Sustainable Communities Initiative 2014). SCI is currently working on a specific Housing Project which involved a housing design charrette in early 2014 and the soon-to-be pilot of a sustainable home built to suit the Labrador environment and culture. The home will be monitored to see whether implementing future housing developments of its kind will benefit the communities. More information can be found at:
http://nainresearchcentre.com/research-projects/the-sustainable-communities-initiative/inosikatigekagiamik-illumi-healthy-homes-in-nunatsiavut-project-description/

5.3.4 Improve HRV usage

Heat Recovery Ventilation is an energy recovery ventilation system that provides fresh air and improved climate control, while also saving energy by reducing heating and cooling requirements. HRVs work by expelling stale indoor air to the outside and then drawing in fresh air from outside to be distributed throughout the building (A Certified Living Breathing Home 2014). HRVs have an aluminum core that in the winter captures the heat from the warm stale air that is exiting the building to then warm the cold fresh air entering the building. Typical heat recovery from HRV systems is 70-90% (Sustainable North 2014). Increasingly, HRVs are used in the construction of northern buildings. In some cases, HRV installation is part of municipal building codes. HRVs were found in less than 25% of commercial and government buildings in Cambridge Bay, and in 41% of residential homes. In a number of homes and buildings with HRV units installed, they are not used, as shown in table 2.2.

Table 2.2 HRV presence and use

Sector	HRV Presence	HRV Use (for buildings/households with HRV units installed)	Had HRV Instruction
Residential	85/205 =41%	69/85=81%	33/205=16%
Commercial	7/41=17%	7/7=100%	6/41=15%
Municipal Government	2/13=15%	1/2=50%	1/13=8%
Government of Nunavut	4/20=20%	1/4=25%	0/20=0%
Federal Government	0/1=0%	0/0=0%	0/0=0%

Part of the reason HRV units are underutilized in some cases, and not present in others, is the lack of instruction on HRV operation—this was the most common HRV issue identified by interviewees.

The second most common issue relates to operation: many respondents reported that their units do not work efficiently in buildings that are drafty (or the units do not work at all), they are not adjustable or were not installed correctly. Interviewees articulated a number of other concerns about their HRVs including:

- the units are noisy when operating at full blast,
- the units recirculate very cold air, which means the boiler must compensate for that, which adds to the electricity bill,
- icing up,
- poor quality units are expensive,
- specific to multi-housing complexes, some people said HRVs do not function equally across all units, and that, on occasion, smoke from neighbours' units transfers to other units. In some multi-housing units, HRVs were reported to function well.

In light of these issues, respondents noted that they only use HRVs when they want fresh air in the winter, when their home is smelly, or when there is too much moisture. In order to turn off

HRVs, some people use their breakers. Many others use passive ventilation instead of HRVs – the Old Hostel was noted to have an exceptionally good passive ventilation system.

Interviewees noted that they would like to see more repairs on existing HRV units and training for households on how to use them. In addition, building quality must be improved in order for HRVs to function properly. If Nunavut Housing staff were properly trained on HRV units and if HRV maintenance efforts were coordinated, HRV use would improve a great deal, as this person points out:

> *No one has ever showed us how to use the HRV. We've tried to play with it but no one has ever shown us. In 9 years that we have been here, there have been about 20 people helping us from housing…They don't train the staff on the new technologies. There are separate companies working on these issues, and they don't work together on the new housing technologies that are being used up here.*

Beyond more training and repairs on existing systems, respondents noted that it would be helpful to compare HRVs in Cambridge Bay with others across the North to see how they function so that lessons learned may be shared. Box 1.3 details a tri-territorial HRV monitoring project that may be of great value to HRV users in Cambridge Bay.

Box 1.3 Cambridge Bay HRV monitoring project

In 2009, all three territorial housing corporations agreed that HRVs are the primary housing concern in the north; design, installation, maintenance issues and lack of operative know-how all contribute to this (Technical advice to Task Force on Northern Mechanical Ventilation Equipment Design and Testing, Peter Edwards, September 16, 2010). Currently, the Yukon Research Centre of Yukon College, the Hamlet of Cambridge Bay, the Canadian High Arctic Research Station, the Canada Mortgage and Housing Corporation and the Yukon, Northwest, and Nunavut Territorial Housing corporations are conducting an HRV monitoring program to understand how different types of HRVs perform and if they can be modified to function more efficiently in northern climates. To date, six test units have been installed in Cambridge Bay, three in the Yukon and two in Ottawa. For more information, contact the Yukon Research Center at 867.668.8895 or yrc@yukoncollege@yk.ca.

5.3.5 Establish Renewable Energy Systems

Northern communities, including Cambridge Bay, are expressing a high level of interest in renewable energy technologies. In part, this is due to the rising cost of diesel fuel and general dissatisfaction with fossil fuel reliance. Interviewees are dissatisfied with diesel for the following reasons:

- there is no other back up power system in place, which poses safety concerns in the event of a diesel fuel shortage—especially in the middle of winter when temperatures can plummet to minus 60 degrees Celsius,
- reliance on diesel contributes to feelings of energy insecurity. Many people said that

with plans for CHARS and the growth of the college and mining sectors, Cambridge Bay will outgrow its current energy supply,
- fossil fuels are not reliable in the long term,
- fossil fuels are inefficient and dirty,
- Cambridge Bay's generator infrastructure, including power lines, is aging, and
- pollution concerns (from vehicle exhaust as well as soil and ocean contamination from tank-farm infrastructure).

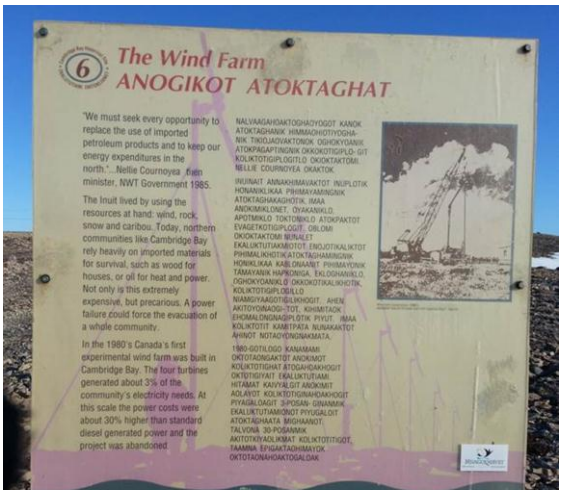
Tank farm, Cambridge Bay. Photo credit: YRC.

Part of the response to this dissatisfaction with diesel fuel is the use of renewable energy infrastructure, namely wind, by some residents. In addition, many said renewable energy should be investigated as a solution to the concerns around diesel fuel outlined previously. Viable renewable energy sources mentioned during interviews included wind and solar. These are elaborated on below.

Wind Energy

Cambridge Bay residents expressed the most interest in wind energy, because it is in ample supply in the region (this was noted by 37 interviewees), some people are already successfully using wind technology at their cabins/homes/businesses, and it has an historical presence in the community (see box 1.4 for more information on the old wind farm in Cambridge Bay). In fact, the old wind farm was perceived by several respondents as an energy success story in Cambridge Bay, because of the large amount of diesel fuel displaced by the turbines at the time.

Box 1.4 The Cambridge Bay wind farm project



The Northwest Territories Power Corporation (NTPC) supported a wind farm program in 1996 which included installing three different wind operations in Cambridge Bay, Kugluktuk, and Rankin Inlet, all operated by Dutch Industries Ltd (Qulliq Energy Corporation 2002). The idea was to test wind energy generation in the North so that when wind energy became cost effective, the corporation would be ready to adopt it on a large-scale basis for customers (QEC 2002: 1). At one point two of the Kugluktuk wind turbines supplied 60% of the community's energy needs and in Cambridge Bay, wind production ranged from 57,080 to 155,364 kWh (between 1994-1999) and displaced up to 41,877 liters of fuel in 1995 (*Ibid).* Following the program, it was acknowledged that wind turbine operations must become more reliable, especially in cold temperatures, and that control systems for diesel integration must be improved.

If wind energy resources are developed in Cambridge Bay again, interviewees cautioned that installation and maintenance capacities receive adequate attention—a lack of these is part of why the old project failed, as this interviewee explains:

> *I think there should be wind mills, we had them in the past and that's something that needs to come back. We had 4 windmills here 10, 20 years ago and they aren't here anymore. I think they took about 3-4% off the total energy used by Cambridge Bay. I was on the council when we brought those in, did the photo ops with them. But the issue was the maintenance; there was no one there to fix them, and they stopped being used when they fell apart, collapsed.*

In addition, wind turbines must be chosen with the Cambridge Bay climate in mind, and with support of the local utility, as this person explains:

> *There used to be wind turbines here, and when we came back we were expecting them to be here, and they weren't. It was very disappointing. We were told it was because, for one, the mechanical components didn't work and here, and the other one was that the power corporation has a vested interest in not having the wind power work, so they fought to take them out. It doesn't make sense in a community where there is so much wind.*

Other considerations for wind technology included:

- small turbines may work better in Cambridge Bay – they were noted to be easier to maintain and more cost effective in comparison to the larger, taller turbines,
- consult with elders in the region when considering turbine placement because they have extensive knowledge of wind resources (directions, seasonality, etc.), and
- concerns about bird mortality and noise impacts on people were noted by a few interviewees.

Personal use of wind mills in Cambridge Bay. Photo credits: YRC.

Solar Energy

Interview participants also expressed strong interest in solar energy (approximately 37 interviewees referred to solar as a potential energy source in Cambridge Bay). A few people perceived local use of solar panels on cabins as success stories. Many people said the abundance of light in the summertime is a strong asset for solar energy generation, but that storage would be necessary for dark winter months. Some of the benefits of solar panel technology extolled by interviewees are that they are easy to use and install and are cost effective.

Box 1.5 Old Crow, Yukon, solar-diesel hybrid project

At present, a solar-diesel hybrid energy project is proposed for Old Crow, Yukon (located at a slightly lower latitude than Cambridge Bay). According to Sanjin (Sonny) Banjac (personal communication 2014), solar PVs installed in the north benefit from: cold temperature efficiencies (increased PV efficiency due to cold climates), snow reflectivity (snow can reflect 80-90% of sunlight which is absorbed by the PV modules in addition to direct sunlight), and civil twilight generation (during polar nights there is enough diffused and reflected light to generate a small amount of power). It is worthy to note that the Arctic has greater annual solar irradiance than Germany, which in 2013 broke the world solar power generation record. At Old Crow, solar energy is anticipated to annually reduce up to 17% of the community's diesel consumption. In the summertime, solar energy combined with battery storage has the potential to fully satisfy Old Crow's afternoon power demand. According to Banjac (2014), solar energy projects have a long lifespan and require little maintenance. Fort Simpson and Colville Lake, both in the Northwest Territories, also have solar energy projects.

Box 1.6 Renewable energy funding

Several programs and grants are available to communities to help develop renewable energy projects. Funds may be accessed from a number of federal organizations and can be used to leverage additional funding.

- ***ecoEnergy Program*** provides up to $250,000 of funding support for the development stages of renewable energy projects and for the engineering and implementation of renewable energy projects integrated with community buildings (Aboriginal Affairs and Northern Development Canada, 2014)
- ***Major Projects and Investment Funds Program*** is designed to help Aboriginal businesses partner with some of the most important economic development and energy projects in the country by providing increased access to capital for leveraging and developing partnerships (Aboriginal Affairs and Northern Development Canada 2014)
- ***Community Economic Opportunities Program*** provides project-based support (up to $3 000 000) to those First Nations and Inuit communities that have the best opportunities for public services in economic development (Aboriginal Affairs and Northern Development Canada 2014)
- ***First Nations Infrastructure Fund*** considers clean energy projects if they are integrated into a community's capital plan and support infrastructure projects such as houses, schools and community facilities (Aboriginal Affairs and Northern Development Canada 2014)
- ***Strategic Partnerships Initiative*** supports Aboriginal participation in the economy, with specific opportunities in the natural resources sector. In 2010 the Federal Government committed up to $ 71.4 million over 5 years (Aboriginal Affairs and Northern Development Canada 2014).
- ***Clean Energy Fund*** is investing in large-scale demonstration projects of renewable energy (including bioenergy, smart grid, hybrid, geothermal, marine/hydrology, wind, and energy storage), and clean systems technologies (Natural Resources Canada 2014)

5.3.6 Consider other forms of Energy Production

A number of other forms of energy were suggested for consideration by interviewees, these included:

- Biomass and gasification
    - Interest was expressed in burning garbage or biomass to produce oil, while taking the proper health precautions (air filters, etc.).
    - Burn methane from sewage waste (this is called biogas or landfill gas) to generate electricity.
- Geothermal energy
    - Lessons can be learned from the Iceland model.
- Tidal energy
- Hydro energy
    - Although it was pointed out that there is no hydro capability on Victoria Island.

- Heat pumps and heat exchange units
- Supplement diesel-powered boiler with wood heat
    - One resident has connected a wood stove to their boiler system, to reduce the reliance on diesel fuel.
- Waste-oil furnace
    - One business in Cambridge Bay is currently utilizing a waste-oil furnace, which reduces diesel consumption by recycling diesel fuel.
- Natural gas
- Fuel-cell technology
- Pellet stoves/wood stoves
    - With respect to woodstoves, it was noted that waste construction materials could be burned in woodstoves. And as mentioned previously, one resident has connected their woodstove to their diesel-powered boiler system in order to reduce reliance on diesel.
    - Pellet stoves can be expensive to insure in Cambridge Bay, but were noted by a few interviewees as a cleaner form of energy compared to diesel.
- Nuclear energy
    - 5 individuals expressed an interest in micro-nuclear plants as an alternative to the current energy regime.
- Capture waste heat from Qulliq's diesel generation plant
    - One interviewee said the energy could be used for heating a greenhouse. The model of using waste heat from a diesel generator is being tested by the Aleutian Pribilof Islands Association in Alaska. See Box 1.7 for details.
- Jet fuel-run generator for community power grid
    - This suggestion did not arise from project interviews, but was noted by a community member, because of its use in Clyde River, Nunavut, where diesel generator infrastructure was switched to accommodate jet fuel. Jet fuel is cheaper and has a lower emissions value than diesel.
- Electric snowmachine
    - This technology was not mentioned in project interviews, but represents an interesting area of research.

Box 1.7 A greenhouse model in Alaska that utilizes the power plant's waste heat

In the Aleut region of Alaska, the Aleutian Pribilof Islands Association has been boosting local food production via the development of community gardens and greenhouses. One of the models they are testing is a 33-foot diameter greenhouse located in close proximitiy to the power plant so they can access waste heat to heat the greenhouse, making it viable year round. (Aleutian Pribilof Islands Association 2014).

5.3.7 Energy Efficiency Education and Research

30 interviewees expressed a great need for more education and awareness around how to use energy more efficiently in Cambridge Bay homes. As one interviewee pointed out, Cambridge

Bay residents are only the first or second generation living in North American style homes, so the need to know more about energy management in that context is great. Understanding the impacts of fossil fuel consumption was noted as foundational to promoting less energy consumption. Other education topics noted by participants included HRV use, how to install solar panels, energy efficiency home improvements, and how to reduce heating and electricity bills.

Some of the tools/modes of delivery suggested for the above topics included:

- SimCity (a city building and urban planning simulation game) to teach kids how to stay within a budget,
- visual or audio modes of delivery (written materials may not be the best educational tool in Cambridge Bay),
- energy efficiency curricula in the schools. As one person points out, "even basic teaching of energy conservation, about the different light bulbs etc.…there is no knowledge about it in the schools." See box 1.8 for details on the Energy Teacher Kit, prepared by the Government of Nunavut in 2009 – this kit may be used by Nunavut educators for teaching the fundamentals of energy conservation,
- Qulliq could host meetings with residents once a year to share energy-saving tips; people also suggested that energy-saving tips be distributed via mail,
- Nunavut Housing Corporation could communicate with tenants that the amount they save on heating could go towards operation and maintenance and/or GN programming, and
- at the results-sharing dinner event, strong interest was expressed in seeing establishment of a local group or local person who may be contacted by community members with energy-related questions.

Delivering education to a variety of groups was seen as important for widespread uptake of energy education. The next few quotes demonstrate this point:

> *Up here you can't target one population for education. It's not the same as down South. You need to take a variety of approaches: school, bylaw, the Hamlet, health. Targeting a range. Down South education is done in the schools. Here it needs to be from a variety of directions.*
>
> *I think if you start teaching it in school, and some people do it, the kids are going to follow.*
>
> *It needs to come, repeatedly, from a variety of different sources. Drop the Pop worked great for the grades they targeted, but only in those groups, no one else. Those kids don't drink it at all, 90% of them.*
>
> *Put on some kind of message for GN employees: ways to conserve energy, simple things like turn off your computer, walk to work, etc.*

A few interviewees also noted the importance of renewable energy research in the territory. Interest was expressed in feasibility studies on solar, wind, and geothermal energy in Cambridge Bay. One person said that cabins, where demands for energy are often low, are good test cases for renewable energy. In addition, by having local test cases for renewable energy that people can see, willingness to use the technology would improve, according to one respondent.

Box 1.8 Teacher's Energy Resource Kit (Government of Nunavut, Energy Secretariat and the Department of Community and Government Services, 2009)

Dear Teacher,

Welcome to the Teacher's Resource kit on energy efficiency, conservation, alternative energy and green projects for students in grades K-12.

The fun and engaging resources in this package can be used to educate students on various forms of renewable and nonrenewable energy, energy efficiency and conservation initiatives, and what impacts energy has on their community today and in the future.

This package is designed to provide support materials for diverse teaching and learning styles to help Teachers with planning and evaluation of energy curriculum for their students. With age appropriate research materials for students, handouts, and Teachers guides this package would be appropriate for subjects such as social studies, science, health, career education and information technology.

We have included a secondary school green project package to help secondary school teachers start green projects; as well as a special kit developed to provide lesson plans and resources that are Nunavut-specific, as well information about some of the Government of Nunavut's energy initiatives!

We hope that you enjoy these resources!

Sincerely,

The Energy Secretariat and Community and Government Services, Government of Nunavut

5.3.8 Energy Leadership

Several interview participants felt that certain governments and institutions in the community should play a leadership role with respect to energy so that energy conservation and renewable energy goals may be realized with greater success. Specific roles outlined for governments/institutions include the following:

- Hamlet of Cambridge Bay
    - Take the lead in promoting energy conservation
- Government of Nunavut
    - Promote energy conservation and improve infrastructure
    - Negotiate better rates for purchasing fuels for all communities in Nunavut

- Qulliq Energy
    - Examine alternative modes of electricity generation
    - Help customers reduce their electricity consumption
    - Capture waste energy from diesel generator
    - Host a town meeting to discuss energy
- CHARS
    - Hopes and expectations with respect to energy:
        - Pilot renewable energy technologies, including wind and solar specifically.
    - Hopes and expectations with respect to community infrastructure:
        - Expand recreation facility (larger pool and squash courts)
        - Build a community greenhouse
        - Bring in more qualified maintenance staff, such as electricians and mechanics, who can serve the community at large
        - Teach the community new maintenance skills
        - Job creation

In addition to governments and institutions, participants described roles for individuals and the larger community to play with respect to energy:

- voice your views/concerns around energy to the mayor/your MLA as well as through the proper government departments (contact social housing or health if there are mold issues in your home, for example),
- use your voting power to elect politicians with an energy mandate, and
- gather with your community to discuss energy needs and concerns, as these individuals point out:

> *I think if people get together as a community and address things, like the things we could deal with as a group, rather than on our own, and waiting for politicians. We should try and deal with things as a community. I don't see too many town meetings here happening.*
>
> *It would be great if we had a grassroots energy group who looked at these issues. We need to all work together to reduce our energy use and look at alternatives. It can't just be an afterthought, it should be one of the big things that we're doing, I think.*

5.3.9 Improve Operation and Maintenance Capacity

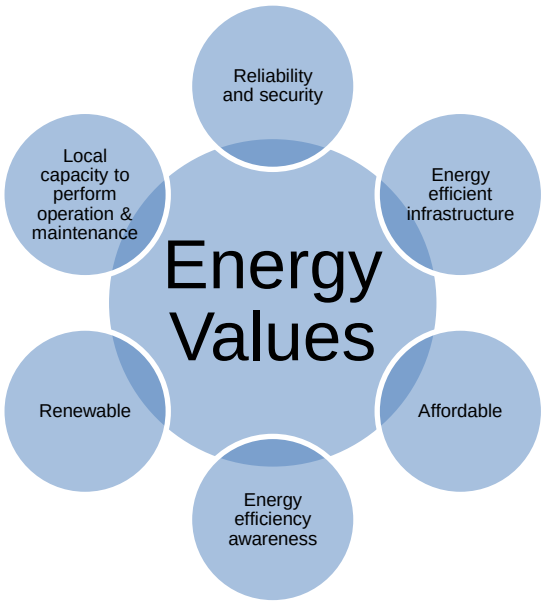
One of the most important issues with current and past energy systems in Cambridge Bay is the lack of operation and maintenance capacity. This problem cuts across many different elements of the energy system, as survey participants pointed out, including:

- Boilers and furnaces
    - Some interviewees said they do not know who to call for maintenance
    - Others said no regular maintenance is performed on furnaces
    - One person said that personnel are needed to set boilers to a winter and summer setting
- Wind turbines
    - Several respondents cited the lack of local operation and maintenance capacity and poor installation as some of the reasons for the wind farm failure in Cambridge Bay.
- HRVs
    - Many households with HRV units installed do not know how to operate them, because of the lack of HRV training.
    - In addition, few staff are knowledgeable enough or available to fix broken units.
- Diesel generator
    - *There are times when the power generators have broken down and there is no one here that can fix them, so they have to fly people in to fix it. There have been times that there is no electricity, and therefore there is also no heat in the house. Literally, the power plants were built 40 years ago, and there have been no upgrades to them since.*
- Buildings
    - Several people said there is no regular building maintenance, which creates problems for energy efficiency in homes; the lack of thermostat adjustability is one of the main problems.

6.0 Energy Values

Although creating a set of values and principles around energy consumption and production was not part of the original project objectives, they were clearly evident in the results. Energy values may be used in a number of ways to support energy planning activities in the Cambridge Bay region, such as when developing new energy infrastructure or energy conservation initiatives. Energy values may also inform impact assessment and research initiatives in the region.

Figure 1.7 Energy values



7.0 Project Benefits

When project interviews were conducted in the spring of 2013, residents voiced that they would like to see more energy education either through the schools or through workshops and/or house visits. When the YRC shared project results with the community in April 2014, school presentations on energy efficiency were planned as part of that trip. One presentation on general energy concepts, fossil fuels, and alternative energy was shared with three classes of grade 5/6 splits. Another presentation with the grade 9 class focused on similar curriculum, but with more focus on wind as a renewable energy source. The grade 5/6 split classes produced artwork about energy saving tips—this artwork was displayed at the community dinner event.

Energy education workshops, Cambridge Bay. YRC photos.

8.0 Moving Forward

Through this work, an important baseline of information has been established on how much energy is used by the community of Cambridge Bay, how much it costs, and the associated greenhouse gas emissions. Even though we were unable to gather energy consumption information from all residents, businesses, and government operators, we have subsets of information that may be considered representative for each sector. We also gathered sector-specific information on building characteristics that highlight where opportunities for energy consumption reductions may be made. Individuals, businesses, and governments may wish to keep track of energy consumption, costs, and the state of building characteristics in the coming years so that comparisons with the inventory year, 2012, may be made, and changes or reductions in energy consumption noted.

Another important contribution of this work is the documentation of energy success stories and concerns in the community—including ideas on how to address those concerns. Notably, the cost of energy is considered the greatest concern in Cambridge Bay. Nine strategies for reducing energy costs were identified in project interviews—these represent viable community-based actions that are and may be used to address the high cost of energy observed in Cambridge Bay. The strategies are:

- use less energy,
- enhance energy subsidy/incentive programs,
- consider renewable energy,
- explore other energy systems,
- improve HRV usage,
- improve building quality,
- improve operation and maintenance capacity,
- engage in energy efficiency education and research, and
- ensure energy leadership in the community.

The last strategy, ensuring energy leadership in the community, is perhaps the most key to creating change, because specific roles for individuals and organizations are identified.

A first step towards building energy leadership capacity in Cambridge Bay could be the establishment of an energy working group that meets a few times a year to discuss solutions to energy issues in the community. Examples of tasks the group could take on include: apply for renewable energy funding for community infrastructure (several types of funding are listed in box 1.6 on page 41), organize energy efficiency workshops (using the energy guide on pages 27-28 and results from the HRV monitoring project as resources, for example) organize renewable energy demonstrations in collaboration with community members who utilize such technology, hire an energy coordinator to serve the community, and organize energy efficiency workshops in collaboration with the local energy provider.

Energy values were also identified through this project. Energy values may be used in a number of ways to support energy planning activities in the Cambridge Bay region, such as when

developing new energy infrastructure or developing energy conservation initiatives. Energy values may also inform impact assessment processes in the region. These values are:

- consistent supply,
- local capacity to perform operation and maintenance,
- renewable energy,
- energy efficiency awareness,
- affordable energy, and
- energy efficient infrastructure.

Additional outcomes from this work were suggestions for future research. These are included throughout the report. To note, is that renewable energy research—on wind and solar in particular, because they are viewed as feasible by community members—and research into other modes of energy generation were considered important by many interviewees, under the condition that local people are trained to operate and maintain the infrastructure. In the context of research then, energy values also serve a meaningful purpose.

There are currently no plans to conduct another energy and emissions inventory of this nature, but the community may wish to consider it after actions have been taken to address energy concerns identified through this work. This way, progress may be monitored and changes to the overall energy system made as necessary. In light of some of the sampling challenges faced in the study, it is recommended that targeted sampling (i.e. sampling a number of specific household/building types), rather than census sampling (i.e. sampling the entire community), be done so that projections may be made across the whole community.

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Appendix 1 Survey Instruments

Cambridge Bay Energy Use and Emissions Inventory
Commercial/Industrial/Government Survey

Building ID:_____
Sector (commercial/industrial/government): _____Community:_____
Date: _____ Interviewer(s):_____
Interview start time: _____End time:_____ Location: _____

Building—General Characteristics
This first set of questions covers general characteristics of the building.

1. Type of building:_____
   _____
   _____

2. When was the building built? _____(year)
   Notes: _____
3. # Stories:_____
4. # Rooms (including all heated spaces):_____
5. # Rooms heated in 2012:_____

6. What temperature was the building kept at during the day in 2012? _____(◦C/◦F)
7. Overnight? _____(◦C/◦F)
8. Is the temperature set-back automatic? □ Yes □ No □ N/A
9. How many people worked here in 2012? _____(# part-time); _____(#full-time)
   Other notes:
   _____
   _____
   _____

10. How many hours a day would you say the building was unoccupied in 2012?_____

11. This building is:
    □ Owned
    □ Rented (even if no rent is paid)
    □ Other (specify) _____
    □ Declined to answer

12. Other than power-cost equalization, are this building's electricity bills subsidized?
    □ Yes □ No □ Don't know □ Declined to answer

13. What about the heating bills, are they subsidized?
    □ Yes □ No □ Don't know □ Declined to answer

Building—Detailed Characteristics
The next few questions are about the building and how it was constructed.

14. Total floor space: _____(m^2 or ft^2)
15. Is there a crawl space? □ Yes (area: _____m^2/ft^2) □ No
16. Wall construction type:
    □ 2x4 □ 2x6 □ 2x6 enhanced □ R-2000 □ Supergreen □
    Other_____
17. Presence of an HRV air exchanger: □ Yes □ No
    a) If yes, is the HRV used? □ Yes □ No
    b) If yes, do you know how to use it? Yes No
18. Ceiling is insulated:
    □ Yes (type: _____; thickness: _____OR R value:_____) □ No
19. The floor is insulated:
    □ Yes (type:_____; thickness: _____OR R value:_____) □ No
20. The exterior walls are insulated:
    □ Yes (type:_____; thickness: _____OR R value:_____) □ No
21. The basement is insulated:
    □ Yes (type:_____; thickness: _____OR R value: _____) □ No □ N/A
    a) Do you use Heat Tape? *If no, skip to question 23.*
        □ Yes (length_____; average temperature :_____) □No
    b) Do you regulate it through the year?
        □ Yes (How many months per year do you have it on? _____) No
22. Vapor barrier in place: □ Yes □ No
23. Building's ceiling height: _____(m/ft)
24. # windows _____;# double pane_____# triple pane_____# other_____
    Notes (*any windows in poor condition, for e.g.?*):_____
    _____
    _____
25. # of entry ways, including ones not used: _____
26. # of arctic entries (must have 2 doors): _____
27. What is the condition of the seals on the doors? □ Good □ Poor □ Absent

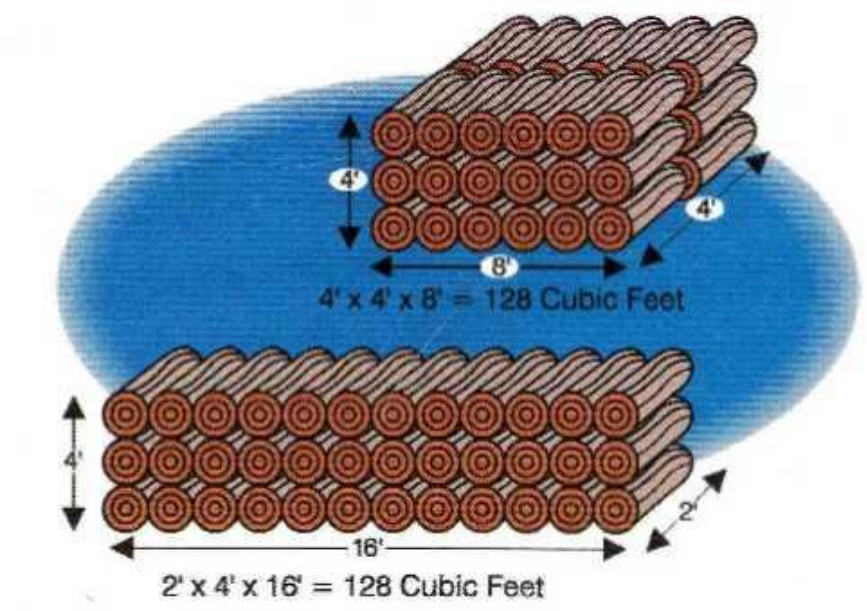
Energy Consumption in the Building
These next questions are about what kind of energy and how much of it is used in the building – so we'll be asking you questions like, "what kind of energy do you use to heat the building?" "How much is used?" and "How much does it cost?"

28. Can you tell us all the ways the building was heated in 2012? *Check all that apply*.
    □ Oil-fired furnace (normal/high efficiency burner); year of unit _____(yrs)
    □ Oil-fired boiler (normal/high efficiency burner); year of unit _____(yrs)
    □ Propane-fired furnace (normal/high efficiency); year of unit _____(yrs)

□ Propane-fired boiler (normal/high efficiency); year of unit _____(yrs)
□ Wood-fired furnace (normal/high efficiency); year of unit _____(yrs)
□ Wood-fired boiler (normal/high efficiency); year of unit _____(yrs)
□ Electric baseboard
□ Electric fireplace
□ Woodstove (conventional/advanced tech./catalytic control); model_____
□ Wood pellet stove; model_____
□ Heat pump (air source/ground source)
□ Portable heater (# and type_____)
□ Propane fireplace
□ Other (specify)_____

29. Which of these was the primary heat source?_____

If the building was heated with wood (if not skip to #36)…
30. How many cords of wood were burned in 2012?_____



Source: http://alaska.inetgiant.com/anchorage/addetails/cord-of-wood/2623176

31. What type of fuel wood was used?
% Pine____; type (standing dead/firekill/other_____)
% Spruce ____; type (standing dead/firekill/other_____)
% Birch ____; type (standing dead/firekill/other_____)
% Aspen/Poplar ____; type (standing dead/firekill/other_____)
32. Is it difficult to maintain a consistent temperature with the woodstove? □ Yes□ No
33. If the wood was purchased last year, how much was spent? _____($)
34. If you gathered the wood yourself, how much chainsaw fuel (gas and oil) was used?

	Amount used (L/Gal)	Dollars Spent (indicate rate per litre for 2012 if recalled OR average NT price in 2012 OR other)
Chainsaw		
Gas (Reg/Prem)		
Oil		
Truck		
Gas (Reg/Prem)		

35. How much time was spent gathering the wood? _____(hours)
If the building was heated with oil…(if not skip to #39)

36. What is the capacity of the oil tank? _____(L/Gal)
37. How much oil was consumed in 2012? _____(L/Gal)
38. And what did it cost? _____($)

39. How is the building's hot water tank heated?
□ Boiler □ Wood stove □ Electricity □ Propane/gas □ Oil
□ Other (specify) _____ □ No hot water tank (on demand) - *skip to #44*.
40. What is its capacity? _____(L/Gal)
41. What year was the unit manufactured? _____
42. What was the temperature set at? _____(◦C/◦F)
43. Did the system have an insulating blanket in 2012? □ Yes □ No
44. Can you tell us about the appliances in the building in 2012?

Appliances	Number
Washer	
Dryer	
Fridge (can include small freezer)	
Large freezer	
Microwave	
Game system (xbox, for e.g.)	
TV	
Video/DVD player	
Cable/satellite box	
Stereo system	
Desktop computer	
Laptop computer	
Cell phone	
Landline	
Toaster	
Toaster oven	
Coffee maker	
Other	
Other	

45. Are power bars used to turn appliances on and off with? □ Yes □ No
Indicate systems managed by power bar*:* _____
Other notes: _____
_____

46. Are there other fuels (propane, kerosene, others) used for heating the building, or for other purposes that we didn't cover?
Explain (amount and cost):_____
_____
_____
_____
_____
_____

Transportation
To get a picture of how much energy is used for transportation purposes, we would now like to ask you about company vehicles and equipment and the associated fuel use.

47. If fuel consumption records were kept for company vehicles (on and off-road, including heavy equipment) in 2012 fill out the following table:

Vehicle	**Fuel type consumed in (regular gas/ premium gas/diesel)**	**Amount (litres/gallons)**	**Dollars spent (indicate rate per litre for 2012 if recalled/average NT price in 2012/other)**
#1			
#2			
#3			
#4			
#5			
#6			
#7			
#8			
#9			
#10			
#11			
#12			
#13			
#14			
#15			
#16			
#17			
#18			
#19			
#20			

OR if mileage known, calculate fuel consumption with NRCan's energy efficiency ratings and the following information:

Vehicle	Make/ Model	Year	Engine Size (L)	Trans Type (manual or automatic)	Fuel Type (reg. gas/prem.gas/diesel)	Total Km (in 2012)
#1						
#2						
#3						
#4						
#5						
#6						
#7						
#8						
#9						
#10						
#11						
#12						
#13						
#14						
#15						
#16						
#17						
#18						
#19						
#20						

*If snowmachine or ATV, need to know: engine type (2 or 4 stroke); make/model; year; fuel type.
*If boat, need to know: boat type (river or ocean skiff); boat length (ft/m); hull year built; outboard HP/jet HP; engine yr. built; 4 stroke or 2 stroke; fuel type.

48. Is an engine block heater used for any of the vehicles?
□ Yes □ No► *Go to #50*
▼
49. How was your engine block heater used in 2012?
□ Plugged in for a few hours as needed □ Plugged in all the time □ Timer used

50. Now we're going to talk about air travel. Can you tell us about the company plane trips made by yourself and/or staff in 2012, including the place of departure and arrival, and stopover points, if any? This will help us determine the total distance travelled.

Trip	Departure location	Arrival location	Stopovers
#1			
#2			
#3			

#4			
#5			
#6			
#7			
#8			
#9			
#10			
#11			
#12			
#13			
#14			
#15			
#16			
#17			
#18			
#19			
#20			
#21			
#22			
#23			
#24			
#25			
#26			
#27			
#28			
#29			
#30			

51. Do you think this building's energy use in 2012 differed significantly from that of 2011?
Explain:_____
_____
_____
_____

Energy Now and Into the Future
We're almost finished the survey now. There are just three questions left, and they are opinion questions on the state of energy in your community. There are no right or wrong answers here.

52. What kinds of energy success stories are you aware of in your community?
_____
_____
_____
_____
_____
_____

53. Do you have any concerns about energy in your community, now or into the future?

□ Yes □ No

▼

What can you tell us about your concerns? (*Probe: are they financial? Perhaps they're environmental or community-based concerns?)*

54. How do you think these concerns could best be addressed?

55. Would you like to make any other comments on what we've discussed?

Cambridge Bay Energy Use and Emissions Inventory
Resident Survey

Building ID:_____
Community:_____
Date: _____Interviewer(s):_____
Interview start time: _____End time:_____ Location: _____

Home—General Characteristics
This first set of questions covers general characteristics of the home you live in.

1. Type of home:
   □ Single-detached house or cabin □ Single detached house/cabin with suite
   □ Suite in a single detached house/cabin □ Duplex □ Four-plex
   □ Row or townhouse □ Apt/Condo □ Mobile home
   □Other

2. When was this home built? _____(year)

3. # Stories:_____
4. # Rooms (including kitchen, living, bedrooms, bathrooms):_____
5. # Rooms heated in 2012:_____

6. What temperature was the house kept at during the day last year? _____(◦C/◦F)
7. Overnight? _____(◦C/◦F)
8. Is the temperature set-back automatic? □ Yes □ No □ N/A

9. To help us understand energy needs on a per-person basis, can you tell us how many people lived here last year (adults and children)? _____
10. How many hours a day would you say the home went unoccupied?_____

11. This home is:
    □ Owned by you or a member of this household
    □ Rented (even if no rent is paid)
    □ Coop
    □ Social housing
    □ Other (specify) _____
    □ Declined to answer

12. Other than power-cost equalization, are your electricity bills subsidized at all?
    □ Yes □ No □ Don't know □ Declined to answer
13. What about your heating bills, are they subsidized?
    □ Yes □ No □ Don't know □ Declined to answer

Home—Detailed Characteristics
The next few questions are about your home and how it was constructed.

14. Total floor space: _____(m^2/ft^2)
15. Is there a heated garage? □ Yes (area: _____ m^2/ft^2) □ No
16. Is there a crawl space? □ Yes (area: _____ m^2/ft^2) □ No

17. Wall construction type:
□ 2x4 □ 2x6 □ 2x6 enhanced □ R-2000 □ Supergreen
□ Log □ Other _____

18. Presence of an HRV air exchanger: Yes No
a) If yes, is the HRV used? Yes No
b) If yes, do you know how to use it? Yes □ No

19. Ceiling is insulated:
□ Yes (type: _____; thickness: _____OR R value:_____) □ No
20. The floor is insulated:
□ Yes (type:_____ ; thickness: _____OR R value:_____) □ No
21. The exterior walls are insulated:
□ Yes (type:_____; thickness: _____OR R value:_____) □ No
22. The basement is insulated:
□ Yes (type:_____; thickness: _____OR R value: _____) □ No □ N/A
a) Do you use Heat Tape? If no, skip to question 23.
□ Yes (length_____; average temperature :_____) □No
b)Do you regulate it through the year?
□ Yes (How many months per year do you have it on? _____) □ No

23. Vapor barrier in place: □ Yes □ No

24. Home's ceiling height: _____(m/ft)

25. # windows _____;# double pane_____# triple pane_____# other_____
Notes (any windows in poor condition, for e.g.?):_____
_____

26. # of entry ways, including ones not used: _____
27. # of arctic entries (must have 2 doors): _____
28. What is the condition of the seals on the doors? □ Good □ Poor □ Absent

Energy Consumption in the Home
These next questions are about what kind of energy and how much of it is used in your home – so we'll be asking you questions like, "what kind of energy do you use to heat your home?" "How much do you use?" and "How much does it cost you?"

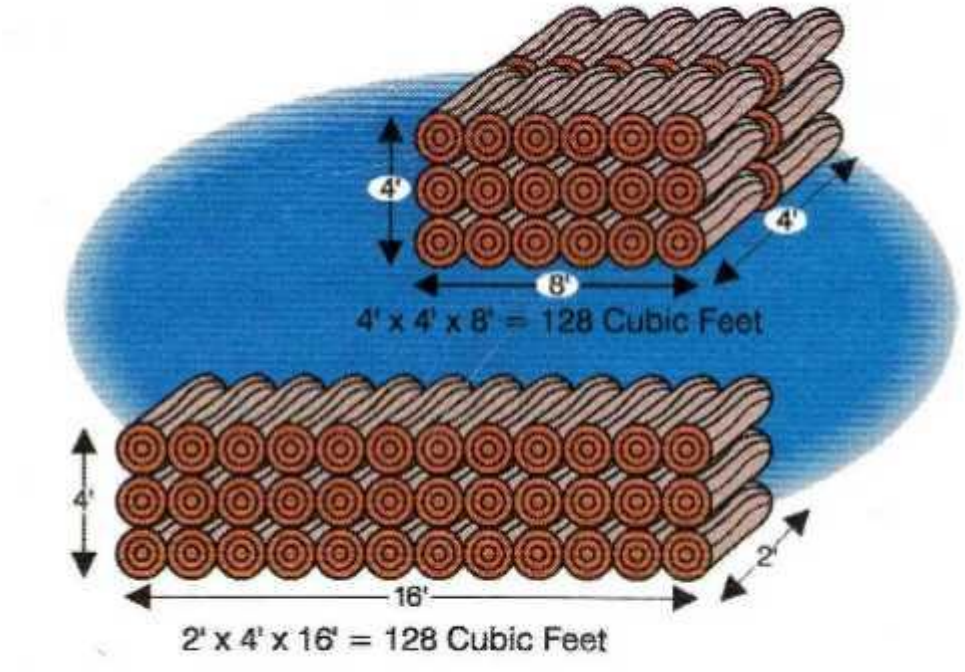
29. Can you tell us all the ways your home was heated in 2012? *Check all that apply*.

- □ Oil-fired furnace (normal/high efficiency burner); year of unit _____(yrs)
- □ Oil-fired boiler (normal/high efficiency burner); year of unit _____(yrs)
- □ Propane-fired furnace (normal/high efficiency); year of unit _____(yrs)
- □ Propane-fired boiler (normal/high efficiency); year of unit _____(yrs)
- □ Wood-fired furnace (normal/high efficiency); year of unit _____(yrs)
- □ Wood-fired boiler (normal/high efficiency); year of unit _____(yrs)
- □ Electric baseboard
- □ Electric fireplace
- □ Woodstove (conventional/advanced tech./catalytic control); model_____
- □ Wood pellet stove; model_____
- □ Heat pump (air source/ground source)
- □ Oil monitor (type _____)
- □ Portable heater (# and type_____)
- □ Propane fireplace
- □ Other (specify)_____

30. Which of these was your primary source of heat?_____

If the participant heated their home with wood (if not skip to #37)…

31. How many cords of wood did you burn in 2012? _____



Source: http://alaska.inetgiant.com/anchorage/addetails/cord-of-wood/2623176

32. What type of fuel wood did you use?

- % Pine_____; type (standing dead/firekill/other _____)
- % Spruce _____; type (standing dead/firekill/other _____)
- % Birch _____; type (standing dead/firekill/other _____)

% Aspen/Poplar _____; type (standing dead/firekill/other _____)

33. Is it difficult to maintain a consistent temperature with your woodstove? □ Yes□ No
34. If you purchased your wood last year, how much did you spend? _____($)
35. If you got the wood yourself, how much chainsaw fuel (gas and oil) did you use?

	Amount used (L/Gal)	**Dollars Spent (indicate rate per litre for 2012 if recalled OR average NT price in 2012 OR other)**
Chainsaw		
Gas (Reg/Prem)		
Oil		
Truck		
Gas (Reg/Prem)		

36. How much time was spent gathering the wood? _____(Hours)

If the participant used oil for home heating purposes….(if not skip to #40)
37. What is the capacity of your oil tank? _____(L/Gal)
38. How much oil did you use in 2012? _____L/Gal)
39. And what did it cost you? _____($)

40. How is your hot water tank heated?
□ Boiler □ Wood stove □ Electricity □ Propane/gas □ Oil
□ Other (specify) _____ □ No hot water tank (on demand) - *skip to #46.*
41. What is its capacity? _____(L/Gal)
42. What year was the unit manufactured? _____
43. What was the temperature set at? _____(◦C/◦F)
44. Did the system have an insulating blanket in 2012? □ Yes □ No

45. What kind of stove do you cook on? *Check all that apply.*
□ Microwave
□ Electric
□ Propane ► Amount used: _____ Cost: _____
□ Other _____

46. Can you tell us about the appliances you had in 2012? *Fill out table with participant.*

Appliances	**Number**
Washer	
Dryer	
Fridge (can include small freezer)	
Large freezer	
Microwave	
Game system (xbox, for e.g.)	
TV	
Video/DVD player	
Cable/satellite box	

Stereo system	
Desktop computer	
Laptop computer	
Cell phone	
Landline	
Toaster	
Toaster oven	
Coffee maker	
Kettle	
Other	
Other	

47. Do you use a power bar to turn your appliances on and off with? □ Yes □ No
Indicate systems managed by power bar*:*

_____
_____
_____

48. Are there other fuels (e.g. kerosene, propane, biofuels, others) you used for home heating or other household purposes (such as a greenhouse) in 2012 that we didn't cover?
Explain (amount and cost)_____
_____
_____
_____

Transportation
To get a picture of how much energy is used for transportation purposes, we would now like to ask you about the types of vehicles you had and the associated fuel use in 2012. We're on the homestretch of the interview now.

49. Does anyone in this household own a car or truck *(functioning)*?
□ Yes □ No ►*Go to #52*
▼

If participant recalls amount of fuel consumed or amount spent, fill out the following table:

	Fuel type consumed in (regular gas/ premium gas/diesel)	**Amount (litres/gallons)**	**Dollars spent (indicate rate per litre for 2012 if recalled/average NT price in 2012/other)**
Car#1			
Car#2			
Car#3			
Car #4			
Truck#1			
Truck#2			
Truck#3			
Truck#4			

OR if mileage known, calculate fuel consumption with NRCan's energy efficiency ratings and the following information:

	Make/ Model	**Year**	**Engine Size (L)**	**Trans Type (manual or automatic)**	**Fuel Type (reg. gas/prem.gas/diesel)**	**Total Km (in 2012)**
Car#1						
Car#2						
Car#3						
Car #4						
Truck#1						
Truck#2						
Truck#3						
Truck#4						

50. Do you have an engine block heater for any of your vehicles?

□ Yes □ No► *Go to #52*

▼

51. How was your engine block heater used in 2012?

□ Plugged in for a few hours as needed □ Plugged in all the time □ Timer used

52. Does anyone in this household own a snow machine *(functioning)*?

□ Yes □ No► *Go to #53*

▼

If participant recalls amount of fuel consumed or amount spent, fill out the following table:

	Fuel type consumed (regular gas/ premium gas/diesel)	**Amount (litres/gallons)**	**Dollars spent (indicate rate per litre in 2012 if recalled/average NT price in 2012/other)**
SM#1			
SM#2			
SM#3			
SM#4			

OR if mileage known, calculate fuel consumption with NRCan's energy efficiency ratings and the following information:

	Make/ Model	**Year**	**Engine Type (2 or 4 stroke)**	**Fuel Type (reg. gas/prem.gas/ diesel)**	**Total Km (in 2012)**
SM#1					
SM#2					
SM#3					
SM #4					

53. Does anyone in this household own an ATV *(functioning)*?

□ Yes □ No ► *Go to #55*

▼

If participant recalls amount of fuel consumed or amount spent, fill out the following table:

	Fuel type consumed (regular gas/ premium gas/diesel)	**Amount (litres/gallons)**	**Dollars spent (indicate rate per litre in 2012 if recalled/average NT price in 2012/other)**
ATV#1			
ATV#2			
ATV#3			
ATV#4			

OR if mileage known, calculate fuel consumption with NRCan's energy efficiency ratings and the following information:

	Make/ Model	**Year**	**Engine Type (2 or 4 stroke)**	**Fuel Type (reg gas/prem.gas /diesel)**	**Total Km (in 2012)**
ATV#1					
ATV#2					
ATV#3					
ATV#4					

54. Does anyone in this household own a boat *(functioning)*?

□ Yes □ No ► *Go to #55*

▼

If participant recalls amount of fuel consumed or amount spent, fill out the following table:

	Fuel type consumed (regular gas/ premium gas/diesel)	**Amount (litres/gallons)**	**Dollars spent (indicate rate per litre in 2012 if recalled/average NT price in 2012/other)**
BOAT#1			
BOAT#2			
BOAT#3			
BOAT#4			

OR *if mileage known, calculate fuel consumption with NRCan's energy efficiency ratings and:*

	Boat type (river or ocean skiff)	Boat length (ft/m)	Hull year built	Outboard HP/Jet HP	Engine yr built	4 stroke or 2 stroke	Fuel Type (reg gas/prem.gas/diesel)	Total Km (in 2012)
BOAT#1								
BOAT#2								
BOAT#3								
BOAT#4								

55. Do you own any other functioning on/off-road vehicles that we didn't cover?
□ Yes □ No ► *Go to #56*
▼

If participant recalls amount of fuel consumed or amount spent, fill out the following table:

	Fuel type consumed (regular gas/ premium gas/diesel)	Amount (litres/gallons)	Dollars spent (indicate rate per litre in 2012 if recalled/average NT price in 2012/other)
#1			
#2			
#3			
#4			

OR *if mileage known, calculate fuel consumption with NRCan's energy efficiency ratings and:*

	Make/Model	Year	Engine Type (2/4 stroke)	Fuel Type (reg gas/prem.gas/diesel)	Total Km (in 2012)
#1					
#2					
#3					
#4					

56. Now we're going to talk about air travel. To the best of your knowledge, can you tell us about all the plane trips made by members of this household in 2012, including the place of departure and arrival, and stopover points, if any? This will help us determine the total distance travelled.

Trip	Departure location	Arrival location	Stopovers
#1			
#2			
#3			
#4			
#5			
#6			
#7			
#8			
#9			
#10			
#11			
#12			
#13			
#14			
#15			
#16			
#17			
#18			
#19			
#20			

57. Do you think this household's energy use in 2012 differed significantly from that of 2011? Explain:_____
_____
_____
_____

Energy Now and Into the Future
We're almost finished the survey now. There are just three questions left, and they are opinion questions on the state of energy in your community. There are no right or wrong answers here.

58. What kinds of energy success stories are you aware of in your community?
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

59. Do you have any concerns about energy in your community, now or into the future?
□ Yes □ No► *Go to #61*
▼
What can you tell us about your concerns? (*Probe: are they financial? Perhaps they're environmental or community-based concerns? Related to energy reliability or security?)*

60. How do you think these concerns could best be addressed?

61. Would you like to make any other comments on what we've discussed?

Appendix 2 Informed Consent Forms

INFORMED CONSENT FORM – COMMERCIAL/INDUSTRIAL/GOV. SECTOR

What is the purpose of this project?

- The Municipality of Cambridge Bay, CHARS and the Yukon Research Centre (YRC) are conducting an energy use and greenhouse gas emissions inventory in Cambridge Bay.
- By interviewing residents, and commercial, industrial, and government operators about their energy use, we aim to understand how much energy is used and emissions produced at the community scale to support energy-related decision making and planning in Cambridge Bay.

What kinds of questions will you be asked?

- During the interview you will be asked questions about the building, how it was constructed, what kinds of energy and how much of it was consumed to heat the building and for transportation purposes associated with the business, as well as how much it cost you. We'll also ask you a few opinion questions about the state of energy in your community.
- If you do not feel comfortable with certain questions, you have no obligation to answer them. If after the interview is over you decide you do not want your answers used, you have up to two weeks after the time your interview was completed to ask that it be withdrawn from the study and destroyed; you can also decide if you don't want to participate after the interview has begun.
- With your permission, we will record your responses to the questions on our survey form.

Where will your name appear and who will know what you said?
What records are being kept or reports written, and how will they be used?

- All the results from this study will be presented according to residential, commercial, industrial, and government sectors so that energy use and emissions may *not* be associated with specific households, buildings, and/or operations. If participant numbers are low in any one sector, thus posing a risk to anonymity, the participants in that sector will be contacted for guidance on how to present sector data (i.e. by presenting it as is, or by combining it with another sector to protect anonymity).
- However, given others may see us with you or be able to identify your comments in reports and other products from this research, we cannot guarantee anonymity. We will contact you if we wish to use a comment that we think might be sensitive to ask for your permission to use it.

- Following completion of the study, your survey form will be identified with a number. The data from your form will then be entered into a spreadsheet in association with this number -

your name and address will not be identified. The original survey form will be destroyed. The spreadsheet will be stored securely with the Municipality of Cambridge Bay, CHARS and the YRC and will not be released for future purposes without permission of Cambridge Bay and CHARS.

- Results from the interviews will be compiled into a report on energy use and emissions and other products as identified by the community. Results may also be published in academic journals. Findings will be presented to the community and elsewhere (if we are asked to share our findings) as well as at academic conferences.
- Results from the interviews may be used for a number of community energy planning purposes, such as identifying the required capacities of new energy systems, tracking progress in reducing energy consumption and emissions, setting emissions targets, and identifying other opportunities for action, for example. There is no guarantee, however, that findings from the research will be used in decision making.

Where can you find out more about this project and the people involved?

- Jim MacEachren, Economic Development Coordinator, Municipality of Cambridge Bay, 867-983-4654, jmaceachern@cambridgebay.ca
- Georgina Lloyd, Arctic Science Policy Integration, Aboriginal Affairs and Northern Development Canada, 819-934-1201, Georgina.Lloyd@aadnc-aandc.gc.ca
- Clint Sawicki, Director Research Services, 867-668-8772, csawicki@yukoncollege.yk.ca, Yukon Research Centre, Yukon College.

Do you agree to this? _____ **Date** _____
(Signature)

_____
(Printed name)

May we record your responses to the survey questions on our form? □Yes □ No

Would you like us to send you a copy of your completed survey? □ Yes □ No

Would you like us to send you a copy of the final report? □ Yes □ No

Mailing Address: _____

This study was explained by:_____

INFORMED CONSENT FORM – RESIDENTIAL SECTOR

What is the purpose of this project?

- The Municipality of Cambridge Bay, CHARS and the Yukon Research Centre (YRC) are conducting an energy use and greenhouse gas emissions inventory in Cambridge Bay.
- By interviewing residents, and commercial, industrial, and government operators about their energy use, we aim to understand how much energy is used and emissions produced at the community scale to support energy-related decision making and planning in Cambridge Bay.

What kinds of questions will you be asked?

- During the interview you will be asked questions about the type of home you live in and how it was constructed, what kinds of energy and how much of it you consume in your home and for transportation purposes, and how much it costs you. We'll also ask you a few opinion questions about the state of energy in your community.
- If you do not feel comfortable with certain questions, you have no obligation to answer them. If after the interview is over you decide you do not want your answers used, you have up to two weeks after the time your interview was completed to ask that it be withdrawn from the study and destroyed; you can also decide if you don't want to participate after the interview has begun.
- With your permission, we will record your responses to the questions on our survey form.

Where will your name appear and who will know what you said?
What records are being kept or reports written, and how will they be used?

- All the results from this study will be presented according to residential, commercial, industrial, and government sectors so that energy use and emissions may *not* be associated with specific households, buildings, and/or operations. If participant numbers are low in any one sector, thus posing a risk to anonymity, the participants in that sector will be contacted for guidance on how to present sector data (i.e. by presenting it as is, or by combining it with another sector to protect anonymity).
- However, given others may see us with you or be able to identify your comments in reports and other products from this research, we cannot guarantee anonymity. We will contact you if we wish to use a comment that we think might be sensitive to ask for your permission to use it.
- Following completion of the study, your survey form will be identified with a number. The data from your form will then be entered into a spreadsheet in association with this number - your name and address will not be identified. The original survey form will be destroyed. The spreadsheet will be stored securely with the Municipality of Cambridge Bay, CHARS and the YRC and will not be released for future purposes without permission of Cambridge Bay and CHARS.

- Results from the interviews will be compiled into a report on energy use and emissions and other products as identified by the community. Results may also be published in academic journals. Findings will be presented to the community and elsewhere (if we are asked to share our findings) as well as at academic conferences.
- Results from the interviews may be used for a number of community energy planning purposes, such as identifying the required capacities of new energy systems, tracking progress in reducing energy consumption and emissions, setting emissions targets, and identifying other opportunities for action, for example. There is no guarantee, however, that findings from the research will be used in decision making.

Where can you find out more about this project and the people involved?

- Jim MacEachren, Economic Development Coordinator, Municipality of Cambridge Bay, 867-983-4654, jmaceachern@cambridgebay.ca
- Georgina Lloyd, Arctic Science Policy Integration, Aboriginal Affairs and Northern Development Canada, 819-934-1201, Georgina.Lloyd@aadnc-aandc.gc.ca
- Clint Sawicki, Director Research Services, 867-668-8772, csawicki@yukoncollege.yk.ca, Yukon Research Centre, Yukon College.

Do you agree to this? _____ **Date** _____
(Signature)

_____
(Printed name)

May we record your responses to the survey questions on our form? □Yes □ No

Would you like us to send you a copy of your completed survey? □ Yes □ No

Would you like us to send you a copy of the final report? □ Yes □ No

Mailing Address: _____

This study was explained by:_____

Draw: Participation in the survey is voluntary, but anyone completing the survey can enter into a draw for _____.

Appendix 3 Fuel Consumption and Greenhouse Gas Emissions

Qulliq Energy Corporation used 2.6 million litres of diesel fuel to run the power plant in 2012. 9,533,172 kWh were generated and 9,528,815 kWh were consumed. 6300 litres of diesel fuel were used to run the sewage pump for a 3 week period in 2012.

Table 2.3 Heating Fuel Consumption and Emissions, Cambridge Bay 2012

Sector	Total litres	Emission Coefficient	eC02	eC02 per unit
Residential (n=73)	321,728	0.002735	879.98	12
Commercial (n=14)	273,783	0.002735	749	53
Government, Cambridge Bay (n=12)	78,968	0.002735	216	18
Government of Nunavut (n=11)	251,923	0.002735	689	63
Federal Government	Not available			

*****The emissions factor for stationary diesel was taken from Canada's National Inventory Report, 1990-2011.

Table 2.4 Diesel Fuel Consumption for Electricity Generation and Pumping Sewage, Cambridge Bay, 2012

Purpose of diesel use	Total Litres	Emission Coefficient	eC02
Electricity generation	2,600,000	0.002790	7,253
Pumping sewage	6,300	0.002790	18

*****The emissions factor for stationary diesel was taken from Canada's National Inventory Report, 1990-2011.

Table 2.5 Transportation Fuel (Gasoline) Consumption and Emissions, Cambridge Bay, 2012

Sector	Total Litres	Emission Coefficient	eC02	eC02 per unit
Residential (n=106)	315,826	0.002440	770	7
Government, Cambridge Bay (n=2)	59,598	0.002440	145	73
Government of Nunavut (n=5)	14,331	0.002440	35	7
Commercial (n=17)	181,040	0.002440	442	26

*****The emissions factor for gasoline (mobile combustion) is taken from Canada's National Inventory Report (Annex 8). Assumes both light-duty gasoline vehicles (LDGVs) and light duty gasoline trucks (LDGTs) with 'Tier 1: 1994-2003'.

Table 2.6 Transportation Fuel (Diesel) Consumption and Emissions, Cambridge Bay, 2012

Sector	Total Litres	Emission Coefficient	eC02
Commercial (n=4)	**15,287**		

*****The emission factor for diesel (mobile combustion) is taken from Canada's National Inventory Report (Annex 8). Assumes light duty diesel vehicles (LDDVs) with 'Advanced Control' (i.e. Model years 1996-2003). [2,663g C02 + 0.051g CH4 + 0.22g N20=0.00268 tonnes C02e/L].

Table 2.7 Air Travel Emissions

Sector	Total C02 Emissions	Average C02 Emissions
Residential (n=168)	1395.09	8.304
Commercial (n=21)	1335.44	63.592
Municipal Government (n=3)	336.636	112.212
Government of Nunavut (n=9)	1367.89	151.987
Fed Government (n=2)	.522	.261
Total (n=203)	**4435.578**	**336.356**

Appendix 4 Building Characteristics

Table 2.8 Building Temperature and Occupation

Sector	Building Temperature - Day	Building Temperature - Night	Auto setbacks	Average # of hours buildings are un-occupied
Residential	20.41 N=205	20.01 N=205	9 YES, 22 NO, 169 N/A, N=205	5.90
Commercial	18.84 N=32	18.25 N=31	2 YES, 5 NO, 28 N/A, N=40	11.96
Municipal Government	20.13 N=12	20.13 N=12	1 NO, 10 N/A, N=12	17.50
Government of Nunavut	20.73 N=15	20.26 N=15	2 No, 14 N/A, N=16	13.36
Federal Government	22 N=1	22 N=1	1 NO, N=1	13.5

Table 2.9 Transportation

Sector	Block Heater Used
Residential	64/205=31%
Commercial	16/40=40%
Municipal Government	2/13=15%
Government of Nunavut	4/20=20%
Federal Government	0/1=0%

Table 3.0 Average building temperatures, Cambridge Bay

Sector	Average Building Temperature - Day	Average Building Temperature - Night
Residential	20.41 N=205	20.01 N=205
Commercial	18.84 N=32	18.25 N=31
Municipal Government	20.20 N=12	20.07 N=12
Government of Nunavut	20.7 N=15	20.2 N=15
Federal Government	22 N=1	22 N=1

Appendix 5 Local Government Greenhouse Gas Emissions Analysis Protocol, Guiding Principles

Relevance: The GHG inventory shall appropriately reflect the greenhouse gas emissions of the local government or the community within the local government area and should be organized to reflect the areas over which local governments exert control and hold responsibility in order to serve the decision-making needs of users.

Completeness: All GHG emission sources and activities within the chosen inventory boundary shall be accounted for. Any specific exclusion should be disclosed.

Consistency: Consistent methodologies to allow for meaningful comparisons of emissions over time shall be used. Any changes to the data, inventory boundary methods or any relevant factors in the time series, shall be disclosed.

Transparency: All relevant issues shall be addressed in a factual and coherent manner to provide a clear audit trail, should auditing be required. Any relevant assumptions shall be disclosed and include appropriate references to the accounting calculation methodologies and data sources used, which may include this Protocol and any relevant Supplements.

Accuracy: The quantification of GHG emissions should not be systematically over or under the actual emissions. Accuracy should be sufficient to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

This publication may be obtained from:

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