Aboriginal Affairs and Northern Development Canada
Affaires autochtones et Développement du Nord Canada

Final Report

Evaluation of the ecoENERGY for Aboriginal and Northern Communities Program

Project Number: 1570-7/14091

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Evaluation, Performance Measurement and Review Branch
Audit and Evaluation Sector

Canada

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List of Acronyms

AANDC	Aboriginal Affairs and Northern Development Canada
CHARS	Canadian High Arctic Research Station
CIB	Community Infrastructure Branch, AANDC
EPMRB	Evaluations, Performance Measurement and Review Branch
EPMRC	Evaluations, Performance Measurement and Review Committee
GHG	Greenhouse Gas
kW	Kilowatt
Mt	Megatonne
mW	Megawatt

Executive Summary

This evaluation of the ecoENERGY for Aboriginal and Northern Communities Program (hereafter referred to as ecoENERGY) was conducted in accordance with the Treasury Board's *Policy on Evaluation* and in time for consideration of program renewal in 2014-15. The evaluation expands upon the program's 2010 impact evaluation, and examines ecoENERGY's relevance (continued need), and program performance (effectiveness, economy and program design and delivery), from April 2011 to December 2014. The evaluation was conducted by the Evaluation, Performance Measurement and Review Branch at Aboriginal Affairs and Northern Development Canada (AANDC).

The ecoENERGY program was renewed in 2011, and received $20 million over five years (2011-12 to 2015-16). It supports Aboriginal and northern communities in their attempt to reduce greenhouse gas (GHG) emissions by funding the integration of proven renewable energy technologies such as residual heat recovery, biomass, geothermal, wind, solar and small hydro. The program provides two streams of funding support, including:

- Stream A: Funding to support feasibility studies of larger renewable energy projects (up to $250,000 funding for projects that result in greater than 4000 tonnes of GHG reductions over the projects' lifecycle).

- Stream B: Funding to support the design and construction of renewable energy projects integrated with new and existing community buildings (up to $100,000 per project).

The evaluation generated 19 findings, six recommendations for program management, and four considerations for AANDC's Senior Management Team as represented by members of the Operations Committee:

Program Need:

Finding 1: There is a continued need for the Government of Canada to reduce GHG emissions.

Finding 2: There is a continued need to fund renewable energy and energy efficient projects in Aboriginal and northern communities that: 1) replace diesel systems; 2) off-set high energy costs; and 3) support economic development.

Finding 3: International examples demonstrate that there is a continued need for an ecoENERGY program that focuses on off-grid and northern communities.

Alignment with Roles and Responsibilities:

Finding 4: The ecoENERGY program is aligned with roles and responsibilities of the federal government, and specifically, the mandate of the Department of Aboriginal Affairs and Northern Development Canada.

Recommendation 1: It is recommended that the ecoENERGY program clearly define its niche, focusing on funding renewable energy projects in off-grid Aboriginal and northern communities.

Recommendation 2: It is recommended that as ecoENERGY establishes a focus on off-grid and northern communities, program staff should provide lessons learned, best practices and relevant Stream A project proposals to Lands and Economic Development Sector (i.e., Community Opportunity Readiness Program), which already funds such projects. Program staff should also communicate their change in focus to communities and provide information concerning potential Lands and Economic Development funding opportunities.

Alignment with Federal, Departmental and Community Objectives:

Finding 5: The ecoENERGY program is aligned with federal priorities, AANDC's priorities and the needs and priorities of Aboriginal and northern communities.

Program Effectiveness:

Finding 6: ecoENERGY is delivering on its expected results of developing and constructing viable renewable energy projects.

Finding 7: ecoENERGY is delivering on its expected result of reducing greenhouse gas emissions in Aboriginal and northern communities.

Finding 8: ecoENERGY is delivering on its expected result that communities have a base of infrastructure that protects the health and safety and enables engagement in the economy.

Finding 9: Proposal-based design encourages a vendor-driven funding model instead of targeting communities with the greatest needs.

Finding 10: Although some work to align ecoENERGY with existing AANDC, Natural Resources Canada and Canadian Northern Economic Development Agency programming is occurring, there is a need for partners to better coordinate their renewable energy investments and support provided to off-grid Aboriginal and northern communities.

Finding 11: The Headquarters centralized program delivery approach could be improved by coordinating the development and implementation of targeted projects with regional staff in the Community Infrastructure Branch.

Finding 12: Streams A and B provided funding for necessary studies and projects; however, opportunities exist to move away from rigid funding categories to funding the right stage on the renewable energy development continuum that promotes the movement from studies to tangible infrastructure.

Finding 13: Opportunities exist to increase communities' knowledge, capacity and confidence to undertake projects by promoting knowledge-sharing initiatives and mentorships.

Recommendation 3: It is recommended that the ecoENERGY program consider the following in any future program re-design:

a) Review the effectiveness and desirability of maintaining separate funding streams and maximum project allotments.
b) Review the effectiveness and desirability of the proposal based approach.
c) Develop an approach for targeting communities with the greatest need.
d) Support projects that integrate renewable energy systems into existing diesel systems to reduce the consumption of diesel fuel.
e) Provide active and appropriate support to communities in their assessment and advancement of potential renewable energy and/ or efficiency projects.

Recommendation 4: It is recommended that ecoENERGY establish a process for developing an *Engagement and Collaboration Strategy* for each off-grid community it targets, ensuring that activities and investments by AANDC, federal partners (e.g., Canadian Northern Economic Development Agency, Natural Resources Canada, Canadian High Arctic Research Station (CHARS) and other levels of government, are coordinated to allow for communities to seamlessly go from research, to pilot project, to final, completed project.

Recommendation 5: It is recommended that the Assistant Deputy Minister of Northern Affairs work with the Senior Assistant Deputy Minister of Regional Operations to improve coordination of funding renewable energy projects in Aboriginal communities occurring within the Community Infrastructure Branch and the ecoENERGY program.

Considerations for Operations Committee 1: The Department, in partnership with federal partners (e.g., Canadian Northern Economic Development Agency, Natural Resources Canada, CHARS) and other levels of government, explore developing a central five year tracking system to identify activities and investments in all off-grid Aboriginal and northern communities to increase strategic collaboration.

Considerations for Operations Committee 2: The Department explore developing a departmental Sustainable Energy Policy that:

a) Supports the design, construction and implementation of renewable energy systems that supply energy to communities within AANDC's mandate; and
b) Promotes the funding of small-scale infrastructure projects that increase energy efficiency in order to decrease energy demand (i.e. replacing windows, boiler systems, insulation, etc.)

Considerations for Operations Committee 3: The Department explore developing a system for tracking and organizing funded community planning documents and feasibility studies (e.g. Energy Audits, Infrastructure Plans, Emergency Management Plans, Climate Change Adaptation studies, Comprehensive Community Plans, etc.) in order to better preserve funded work and support future infrastructure development decisions. AANDC's Strategic Research Branch may be in a position to develop such a centralized database as one of their departmental research tools.

Program Efficiency:

Finding 14: Internal project approval process results in funding often being provided during inappropriate construction seasons.

Finding 15: There is an opportunity for the ecoENERGY program to improve its Performance Measurement Strategy to track program efficiency and to more efficiently track all AANDC renewable energy projects.

Finding 16: Potential risk of projects not achieving their full GHG reduction potential when communities do not have an operation and maintenance plan in place for completed renewable energy projects.

Recommendation 6: It is recommended that the ecoENERGY program update its Performance Measurement Strategy and Risk Assessment to reflect program re-design considerations and to determine an approach for monitoring the completion of renewable energy projects funded across the Department.

Program Economy - Cost Benefit:

Finding 17: The proportion of program funding dedicated to salary and operation and maintenance costs are in large measure due to the technical reviews and expertise required to assess project proposals as well as the necessity to coordinate funding with other federal, provincial and territorial departments.

Finding 18: While large renewable energy systems can have dramatic environmental and financial benefits for communities, in off-grid scenarios diesel energy generation often remains the most cost-effective approach.

Finding 19: Projects that incorporate renewable technology into new construction projects are more cost effective than replacing older systems.

Considerations for Operations Committee 4: The Department explores pursuing partnerships with provincial utilities to develop a supportive environment for the growth of the renewable energy industry in off-grid Aboriginal and northern communities.

Management Response and Action Plan

Project Title: Evaluation of the ecoENERGY for Aboriginal and Northern Communities Program
Project #: 1570-7/14091

1. Management Response

This Management Response and Action Plan has been developed to address recommendations resulting from the ecoENERGY for Aboriginal and Northern Communities Program evaluation, which was conducted by the Evaluation, Performance Measurement, and Review Branch. The program is entering its fifth and final year of operation (2015-2016). The timing of this evaluation is well aligned to inform the development of related future programming under consideration for implementation beyond the March 2016 program sunset date.

Overall, the evaluation was positive and confirmed the ecoENERGY program's continued relevance, effectiveness, and value. Specifically, the program is:

- Aligned with roles and responsibilities of the federal government, the mandate and priorities of AANDC, and the needs and priorities of Aboriginal and northern communities;
- Delivering on its expected results of developing and constructing viable renewable energy projects and reducing greenhouse gas emissions in Aboriginal and northern communities; and
- Fulfilling a demonstrated continued need to fund renewable energy and energy efficient projects in Aboriginal and northern communities.

The evaluation provided **six recommendations** to improve the design and delivery of a future program. All recommendations are accepted by the program and the attached Action Plan identifies specific activities by which to address these.

The first recommendation speaks to refocusing funding support *solely* for projects in off-grid Aboriginal and northern communities (i.e., communities facing the greatest energy challenges as a result of their diesel dependence). For project funding in 2015-16, priority has already been accorded to projects in northern communities (in the territories) and projects in off-grid communities (those not connected to a provincial or regional electrical grid).

This shift in focus signifies that the program, if renewed, would no longer be available to support renewable energy projects in First Nation communities south of 60 that are grid-connected. As a result, and as discussed under the second recommendation, the program will work with the Lands and Economic Development Sector to transfer knowledge with respect to past, ongoing, and potential future renewable energy projects in grid-connected communities south of 60.

Similarly, the program will also continue work with the Regional Operations Sector and the Lands and Economic Development Sector to maintain awareness and increase coordination, and to maximize results in all investments, should the program be renewed.

Other recommendations speak further to broader collaboration outside of AANDC and to operational program improvements, including strengthening support for targeted communities. These recommendations are being considered for integration into proposed future programming.

Actions to address the recommendations will continue over the next 12-18 months although at this time, a decision on any future programming is still pending. The timeline for program renewal is unclear and may impact on the planned implementation and completion dates identified in the table below. Where necessary, the program has set aside resources to deliver on the identified action items.

2. Action Plan

Recommendations	Actions	Responsible Manager (Title/Sector)	Planned Implementation and Completion Dates
1. It is recommended that the ecoENERGY program clearly define its niche, focusing on funding renewable energy projects in off-grid Aboriginal and northern communities.	The program accepts this recommendation. a) The program has identified targeting projects in off-grid and northern communities as the focus of any future funding program.	Director – Environment and Renewable Resources, Northern Affairs Organization	a) Completed for 2015-16. Priority for funding has been accorded to projects in northern and off-grid communities. In-progress for future programming – decision pending.
2. It is recommended that as ecoENERGY establishes a focus on off-grid and northern communities, program staff should provide lessons learned, best practices and relevant Stream A project proposals to the Land and Economic Development Sector (i.e., Community Opportunity Readiness Program), which already funds such projects. Program staff should also communicate their change in focus to communities and provide information concerning potential Land and Economic Development funding opportunities.	The program accepts this recommendation. a) For 2015-16 projects, a member of the Community Opportunity Readiness Program has participated on the ecoENERGY Project Review Committee. b) Over a transition period, the program will meet with and share past and current proposals and project information for *renewable energy projects* in on-grid communities, as well as available technology information, with the Community Opportunity Readiness Program.	Director – Environment and Renewable Resources, Northern Affairs Organization	a) Completed April/May 2015. b) and c) Completed by December 2016, assuming program renewal implementation in April 2016.

	c) The program will work with Communications and with the Lands and Economic Development Sector to develop appropriate materials to share with communities on ongoing or new funding opportunities.		
3. It is recommended that the ecoENERGY program consider the following in any future program re-design: a) Review the effectiveness and desirability of maintaining separate funding streams and maximum project allotments. b) Review the effectiveness and desirability of the proposal based approach. c) Develop an approach for targeting communities with the greatest need. d) Support projects that integrate renewable energy systems into existing diesel systems to reduce the consumption of diesel fuel. e) Provide active and appropriate support to communities in their assessment and advancement of potential renewable energy and/ or efficiency projects.	The program accepts this recommendation. a) The program has considered these elements in the proposed approach for any future funding program.	Director – Environment and Renewable Resources, Northern Affairs Organization	a) In-progress for future programming – decision pending.

4. It is recommended that ecoENERGY establish a process for developing an Engagement and Collaboration Strategy for each off-grid community it targets, ensuring that activities and investments by AANDC, federal partners (e.g., CanNOR, NRCan, CHARS) and other levels of government, are coordinated to allow for communities to seamlessly go from research, to pilot project, to final, completed project.	The program accepts this recommendation. a) The program has integrated this concept into the proposed program approach for any future funding, and will work on refining specific details at a regional level throughout the development of the program Management Control Framework. b) Where necessary to ensure productive and ongoing collaboration with other federal partners and other levels of government, the program will host official meetings and/or seek to develop a formal Engagement and Collaboration Approach with key organizations.	Director – Environment and Renewable Resources, Northern Affairs Organization	a) In-progress for future programming – decision pending. Management Control Framework to be completed by December 2016. b) In-progress for future programming – decision pending. Meetings and formal Engagement and Collaboration Approach to be completed by December 2016.
5. It is recommended that the ADM of the Northern Affairs Organization work with the Senior ADM of Regional Operations to improve coordination of funding renewable energy projects in Aboriginal communities occurring within the Community Infrastructure Branch and the ecoENERGY program.	The program accepts this recommendation. a) The ADM of the Northern Affairs Organization will work with the Senior ADM of Regional Operations to ensure that any future Northern Affairs Organization energy program will align, where feasible, with existing regional and/ or headquarters processes to ensure better coordination of funding for renewable energy projects in communities to maximize investments.	Assistant Deputy Minister, Northern Affairs Organization	a) In-progress for future programming – decision pending. Management Control Framework to be completed by December 2016.
6. It is recommended that the ecoENERGY program update its Performance Measurement Strategy and Risk Assessment to reflect program re-design considerations and to determine an approach for monitoring the completion of renewable energy projects funded across the Department.	The program accepts this recommendation. a) The program has updated its Performance Measurement Strategy and Risk Assessment to reflect program redesign considerations. b) The program has established a concept for monitoring projects funded by the program which will be further refined through the development of the	Director – Environment and Renewable Resources, Northern Affairs Organization	a) A draft Performance Measurement Strategy was approved by EPMRC on April 24, 2015. b) In-progress for future programming – decision pending. Management Control

	program Management Control Framework. c) The program will work with Regional Operations and the Lands and Economic Development Sector to determine options for tracking renewable energy projects across the Department.		Framework to be completed by December 2016. c) In-progress for future programming – decision pending. Options completed by December 2016.

I recommend this Management Response and Action Plan for approval by the Evaluation, Performance Measurement and Review Committee

Original signed on June 15, 2015, by:

Michel Burrowes
Director, Evaluation, Performance Measurement and Review Branch

I approve the above Management Response / Action Plan

Original signed on June 16, 2015, by:

Wayne Walsh for:

Stephen M. Van Dine
Assistant Deputy Minister of the Northern Affairs Organization

1. Introduction

1.1 Overview

This evaluation of the ecoENERGY for Aboriginal and Northern Communities Program (hereafter referred to as ecoENERGY) was conducted in accordance with the Treasury Board's *Policy on Evaluation* and in time for consideration of program renewal in 2014-15. The evaluation expands upon the program's 2010 impact evaluation, and examines ecoENERGY's relevance (continued need), and program performance (effectiveness, economy and program design and delivery), from April 2011 to December 2014. The evaluation was conducted by the Evaluation, Performance Measurement and Review Branch at Aboriginal Affairs and Northern Development Canada (AANDC).

The ecoENERGY program was first established in 2007, building upon the pre-existing 2003-2006 Aboriginal and Northern Community Action Program. The program is operated by the Northern Affairs Organization (Sector) and is centrally run out of AANDC Headquarters, with a support network of regional staff to amend contribution agreements that allow the flow of Headquarters funding to communities with approved project proposals. The program was renewed in 2011, for five years.

At the departmental level, ecoENERGY is one of six sub-programs under AANDC's broader Infrastructure and Capacity program area[1], which is situated within AANDC's Land and Economy Strategic Outcome area. Within the broader context of the federal government, ecoENERGY is part of the Clean Energy suite of programs, under Canada's Clean Air Agenda, led by Natural Resources Canada.

The Clean Air Agenda is a fundamental component of the Government of Canada's broader efforts to address the challenges of climate change and air pollution, in order to build a clean and healthy environment for all Canadians. The Clean Air Agenda supports eleven departments and agencies, with programming under five themes:

- Clean Air Regulatory Agenda
- Clean Energy
- Clean Transportation
- International Actions
- Adaptation

The Clean Energy Theme is a suite of seven programs aimed at reducing greenhouse gas emissions. Partner departments and agencies are responsible for evaluating their respective programs and contributing their results to a Clean Energy Thematic Evaluation led by Natural Resources Canada in fiscal year 2014-2015.

[1] AANDC's six Infrastructure and Capacity sub-programs: (1) Water and Wastewater; (2) Education Facilities; (3) Housing; (4) Other Community Infrastructure and Activities; (5) Renewable Energy and Energy Efficiency; and (6) Emergency Management Assistance.

The following evaluation provides an objective and independent analysis of the ecoENERGY for Aboriginal and Northern Communities Program. It also provides specific analysis of the program's current design and implementation. Evaluation findings were based on the triangulation of document and literature reviews, key informant interviews, and community case studies. The evaluation generated 19 key findings and six recommendations.

1.2 Program Profile

1.2.1 Background and Description

AANDC has a long history of supporting the development of renewable energy and energy efficiency for on-reserve Aboriginal and northern communities.

The ecoENERGY program, introduced in 2007, grew out of the previous 2003-2006 Aboriginal and Northern Community Action Program. From 2007-2011, the ecoENERGY program supported over 96 communities and funded over 110 projects. Within the 110 funded projects, 41 were undertaken in remote "off-grid" communities that are not connected to a larger, region-wide grid, but rather have small micro-grids that disperse energy from a power source (usually a diesel generator) to buildings in the community. It is anticipated that the 110 projects will result in the displacement of a minimum of 1.3 megatonnes (Mt or million tonnes) of greenhouse gas (GHG) emissions over their 20-year lifecycle.

The 2010 Clean Energy Review, led by Natural Resources Canada, supported the continuation of the ecoENERGY program, finding that it had successfully enabled the identification of local energy resources to deliver economic and environmental benefits within Aboriginal and northern communities. The program was subsequently renewed from 2011-2016. Its primary objective was to reduce GHG emissions by over 1.5 megatonnes. The program intended to do so by supporting the development and implementation of renewable energy projects that reduced or displaced the natural gas, coal and diesel generation of electricity and heat.

The renewed program was intended to address major energy challenges for Aboriginal and northern communities, including high and fluctuating costs of energy, occasional brown-outs, aging and inefficient infrastructure, and off-grid isolated communities reliant upon emissions-intensive diesel fuel systems. To address these challenges, ecoENERGY has supported Aboriginal and northern communities in their attempt to reduce greenhouse gas emissions by funding the integration of proven renewable energy technologies such as residual heat recovery, biomass, geothermal, wind, solar and small hydro. The program provides two streams of funding support, including:

- Stream A: Funding to support feasibility studies of larger renewable energy projects (up to $250,000 funding for projects that result in greater than 4000 tonnes of GHG reductions over the projects' lifecycle).

- Stream B: Funding to support the design and construction of renewable energy projects integrated with new and existing community buildings (up to $100,000 per project).

The program is delivered centrally in the National Capital Region by staff in the Environment and Renewable Resources Directorate, within AANDC's Northern Affairs Organization. Public Servants review applications using eligibility criteria and then fund a third party technical review of eligible projects to determine potential GHG reductions. Following these assessments, a Project Review Committee comprised of representatives from Northern Affairs Organization, other departmental sectors, and external advisors consider all eligible projects and recommend the most appropriate projects for funding. The Director of the Climate Change Division then approves projects for completion, based on funding levels available.

1.2.2 Objectives and Expected Outcomes

At the departmental level, ecoENERGY is one of six sub-programs[2] under AANDC's broader Infrastructure and Capacity program area. These six sub-programs have a collective expected result that "First Nations communities have a base of infrastructure that protects the health and safety and enables engagement in the economy". The programs support the Land and Economy Strategic Outcome: "Full participation of First Nations, Métis, Non-Status Indians and Inuit individuals and communities in the economy".

The ecoENERGY program seeks to achieve the following results:

Immediate Outcomes:

1. Aboriginal and northern communities have viable renewable energy projects that are under development (Stream A)

2. Aboriginal and northern communities have energy projects integrated with new and existing community buildings (Stream B)

Intermediate Outcomes:

3. Reduced greenhouse gas emissions in Aboriginal and northern communities

Ultimate Outcome:

4. First Nations communities have a base of infrastructure that protects the health and safety and enables engagement in the economy

Strategic Outcome:

5. Full participation of First Nations, Métis, Non-Status Indians and Inuit individuals and communities in the economy.

This evaluation assessed the extent to which the ecoENERGY program is achieving these results.

[2] AANDC's six Infrastructure and Capacity sub-programs: (1) Water and Wastewater; (2) Education Facilities; (3) Housing; (4) Other Community Infrastructure and Activities; (5) Renewable Energy and Energy Efficiency and (6) Emergency Management Assistance.

1.2.3 Program Resources

Through the Aboriginal and Northern Community Action Program, AANDC provided $30 million over three years (2003-04 to 2005-06) to build the capacity of Aboriginal and northern communities to undertake energy efficiency and renewable energy projects. In 2007, through Government of Canada's Clean Air Agenda, AANDC received $15 million over four years (2007-08 to 2010-11) to implement the ecoENERGY for Aboriginal and Northern Communities Program. The program funded community energy planning, integration of small renewable technologies into community buildings and feasibility work for larger renewable energy projects.

The current ecoENERGY program was renewed in 2011, and received $20 million over five years (2011-12 to 2015-16). The program funds the integration of small renewable technologies into community buildings and feasibility work for larger renewable energy projects. As the ecoENERGY program has developed, it has increasingly focused on funding off-grid Aboriginal and northern communities.

From 2011 to 2014, the program spent an average of $850,000 per year on salaries and employee benefits, and $330,000 on operation and maintenance,[3] in order to distribute $2.8 million in grants and contributions to approved recipient communities.

As of April 1, 2014, program activities are supported by the Terms and Conditions of two Transfer Payment Program Authorities:

- *Contribution for promoting the safe use, development, conservation and protection of the North's natural resources and promoting scientific development;* and

- *Contributions to support the construction and maintenance of community infrastructure*.[4]

Project funding is allocated to approved recipients using Contribution Agreements. Any ecoENERGY-funded project is included in existing agreements. Contribution Agreements are prepared by the program staff at Headquarters for any recipient community that does not already have one in place.

[3] Operation and Maintenance funding refers to the internal departmental costs of delivering a program, including third party contracting costs for assessing GHG reductions and reviewing technical proposals as well any additional funding for policy research and database management.

[4] Prior to April 1, 2014, this program was supported by two Transfer Payment (contribution) authorities: *Payments to support Indians, Inuit and Innu for the purpose of supplying public services in capital facilities and maintenance* (377) and *Contribution for promoting the safe use, development, conservation and protection of the North's natural resources* (334).

2. Evaluation Methodology

2.1 Evaluation Scope and Timing

The evaluation examined ecoENERGY program activities undertaken from April 2011 to December 2014. The evaluation's Terms of Reference were approved by AANDC's Evaluation, Performance Measurement and Review Committee in June 2014. Field work was conducted between July and December 2014.

In accordance with Treasury Board Secretariat requirements, the evaluation provides credible and neutral information on the relevance and performance of the ecoENERGY program. It also provides information to support future programming development, including possible alternatives, best practices and lessons learned. The evaluation builds upon the results of the 2010 Impact Evaluation and analyzes the results of actions taken to address the 2010 evaluation recommendations.

2.2 Evaluation Methodology

This evaluation focused on the following evaluation issues:

Program Relevance
Issue 1: Continued Need
Issue 2: Alignment with Government Priorities
Issue 3: Alignment with Federal Roles and Responsibilities

Program Performance
Issue 4: Effectiveness

a) Aboriginal and northern communities have viable renewable energy projects that are under development (Stream A);
b) Aboriginal and northern communities have energy projects integrated with new and existing community buildings (Stream B);
c) Reduced GHG emissions in Aboriginal and northern communities; and
d) First Nations communities have a base of infrastructure that protects the health and safety and enables engagement in the economy.

Issue 5: Efficiency and Economy

The evaluation's findings and conclusions concerning the five core issues are based on the analysis and triangulation of the following lines of evidence.

Literature Review
A review of relevant and recent academic literature was completed by the external consulting firm, Kishk Anaquot Health Research. The purpose of the review was to define the term "renewable energy," highlight national and international policy drivers of renewable energy, outline Canadian federal roles and responsibilities, compare the need for renewable energy technologies in on-grid versus off-grid communities, compare the utility of funding various types

of renewable energy technologies, highlight best practices for developing a successful policy and program from national and international examples, and provide direction for the evolution of AANDC's ecoENERGY program, based on an assessment of these findings.

Document and File Review
Program documentation and project files were reviewed, including core program design, delivery and financial authority documentation, meeting minutes, strategic planning documents, performance measurement documents and analysis, GHG reduction analyses, presentations to Parliament, and a sample of project proposals and final reports.

Database Analysis
An analysis of the program's project database was conducted. The database tracked the types of projects funded each year, the community location, whether the community was on or off-grid, project costs, estimated GHG reductions and the status of previously-funded stream A projects, such as feasibility studies.

Key Informant Interviews
A total of twenty-six interviews were conducted; eight with AANDC employees in the National Capital Region, eight with regional AANDC employees, and ten with external experts, including academics, consultants and other federal government departments.

Case Studies/Community Site Visits
Nine case studies were completed in British Columbia, Yukon and in Atlantic Canada, which included site visits to Kluane First Nation, Eel Ground First Nation, Abegweit First Nation, Penelakut First Nation, Taku River Tlingit First Nation, Tla-o-qui-aht First Nation and two other funding recipients where the ecoENERGY project was not successful. The case studies were chosen based on the following criteria:

- Examples of Stream A and Stream B completed projects;
- Regional spread;
- Regions with the highest number of funded projects;
- Where possible, focus on northern and off-grid communities to support the current evolution of the program;
- Recipients that were funded over multiple years;
- Highest ecoENERGY financial investments;
- Sample of communities funded under the previous program to demonstrate long-term impacts and lessons learned due to the fact that projects typically take at least five years to develop; and
- Sample of recipients where project was deemed a failure and/or money was returned.

The case studies included interviews with 25 project stakeholders, such as community members, external project contractors, engineers, project managers, plant operators, and Chief and council members. Key project documentation, including original proposals, project designs, status reports and final reports was also reviewed during these case studies.

2.2.1 Considerations, Strengths and Limitations

The program tracked the necessary data to support its Performance Measurement Strategy. This allowed evaluators to assess the program's performance over the last three years. Recent evaluation work completed for AANDC's First Nation Infrastructure Fund, the Strategic Partnership Initiative, and Investments in Economic Development also allowed evaluators to utilize additional interview notes and case study notes where the ecoENERGY program was specifically mentioned to support this evaluation.

2.3 Roles, Responsibilities and Quality Assurance

The Evaluation, Performance Measurement and Review Branch (EPMRB) of the AANDC Audit and Evaluation Sector managed and completed the evaluation according to EPMRB's Engagement Policy and Quality Control Process, which is aligned with the Treasury Board Policy on Evaluation. External consulting firm, Kishk Anaquot Health Research completed a literature review to inform the evaluation. Quality control was also performed by the advisory role of the Evaluation Working Group consisting of ecoENERGY program managers, analysts, regional program stakeholders and representatives from AANDC's other infrastructure program, which was established to ensure the quality and relevance of the evaluation approach, research instruments and to review the draft deliverables. A quality review of the final evaluation report was also completed by AANDC's Strategic Research Branch.

3. Evaluation Findings - Relevance

3.1 Program Need

Finding 1: ***There is a continued need for the Government of Canada to reduce GHG emissions.***

The ecoENERGY for Aboriginal and Northern Communities program was developed to facilitate the integration of proven renewable energy technologies in Aboriginal and northern communities in order to reduce GHG emissions.

Renewable energy is secured from natural resources that are perpetually replenished: it is inexhaustible, sustainable energy that comes in many forms such as moving water (e.g., rivers and tides), wind, the earth and sunshine.[5] Some of the more recognizable forms of renewable energy include:

- Solar: solar photovoltaic, solar heating and concentrated solar power;
- Wind: on- and off-shore;
- Hydro: run-of-the-river and reservoir;
- Ocean/marine: including wave and tidal energy[6];
- Geothermal; and
- Bioenergy: includes biofuels and biomass that can be open-loop (i.e., generated from forests and wastes) or closed loop (i.e., generated from dedicated energy crops); biofuels and biomass are renewable resources only if the rate of their consumption does not exceed the rate of their regeneration.[7,8]

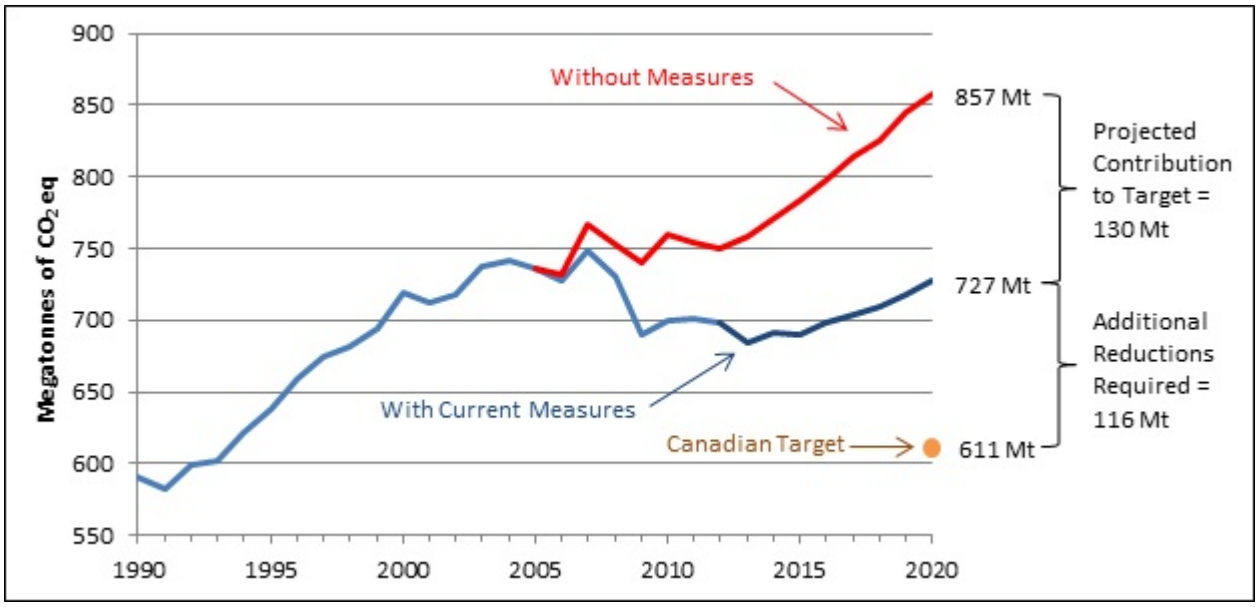
The ultimate objective of the ecoENERGY program is to harness the above mentioned renewable energy technologies in order to decrease GHG emissions. This objective is consistent with the internationally accepted conclusion that GHG emissions negatively impact global climates and therefore need to be reduced. According to the most recent Climate Change Performance Index (2014) published by GermanWatch and the Climate Action Network in Europe, no single country is on track to prevent dangerous climate change.[9] Despite significant

[5] Natural Resources Canada, Accessed from http://www.nrcan.gc.ca/energy/renewable-electricity/7295, on November 3, 2014.
[6] This type of renewable energy has not yet been funded by AANDC as research and technology development is still being assessed by NRCan
[7] United Nations Intergovernmental Panel on Climate Change (2014) *Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
[8] International Energy Agency (2011), *Renewable Energy Markets and Prospects by Technology*, Accessed from http://www.iea.org/publications/freepublications/publication/renew_tech.pdf, on December 9, 2014.
[9] The Climate Change Performance Index is calculated based on objective indicators and is composed primarily of emissions levels (80%), efficiency (10%) and existing and developing RETs (10%). Source: Burck, J, Marten., F, Bals, C. (2014) The Climate Change Performance Index Results 2014, Climate Action Network Europe and Germanwatch.

investments in renewable energy, Canada, China and the United States rank poorly on the Index, with Canada faring the worst of western industrialized states.[10]

According to Canada's Emissions Trends 2014 report, Canada's emissions of CO_2 have been steadily increasing since 1990 and, if no regulated action is taken, are expected to reach 727 megatonnes by 2020.[11] The remaining gap between the projection for 2020 and Canada's GHG emissions target under the 2009 Copenhagen Accord is estimated to be 116 Mt CO2 eq as demonstrated in the following historical graph.[12]

Figure 1: Canada's historical greenhouse gas emissions and projections to 2020[13]



The following consequences are highlighted as potentially impacting Canadian communities if GHG emissions are not curtailed:[14]

[10] Burck, J, Marten., F, Bals, C. (2014) The Climate Change Performance Index Results 2014, Climate Action Network Europe and Germanwatch.
[11] Environment Canada (2014) "Progress Toward Canada's Greenhouse Gas Emissions Reduction Target." Available at: https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=CCED3397-1. Accessed: February 16, 2015.
[12] Environment Canada (2014) "Progress Toward Canada's Greenhouse Gas Emissions Reduction Target." Available at: https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=CCED3397-1. Accessed: February 16, 2015.
[13] Environment Canada (2014) "Progress Toward Canada's Greenhouse Gas Emissions Reduction Target." Available at: https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=CCED3397-1. Accessed: February 16, 2015.
[14] Environment Canada (2013) "Impacts of Greenhouse Gas Emissions." Available at: http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=D4C4DBAB-1. Accessed February 19, 2015.

Environmental impacts

- Overall average annual temperatures are expected to increase.
- Global warming will decrease snow, sea ice and glacier coverage, resulting in rising sea levels and increased coastal flooding. Rising temperatures will also thaw permafrost in the Arctic.
- Storms and heat waves are likely to increase in frequency and severity.
- Many wild species will have difficulty adapting to a warmer climate and will likely experience greater stress from diseases and invasive species.

Human health impacts

- People living in Canada's northern communities, and vulnerable populations such as children and the elderly, are expected to be the most affected by the changes.
- Increased temperatures and more frequent and severe extreme weather events could lead to increased risks of death from dehydration and heat stroke, and injuries from intense local weather changes.
- There may be an increased risk of respiratory and cardiovascular problems and certain types of cancers, as temperatures rise and exacerbate air pollution.
- The risk of water-, food-, vector- and rodent-borne diseases may increase.

Economic impacts

- Agriculture, forestry, tourism and recreation could be affected by changing weather patterns.
- Human health impacts are expected to place additional economic stress on health and social support systems.
- Damage to infrastructure (e.g., roads and bridges) from extreme weather events is expected to increase.

As such, at a national level, there is a definite need for programs like ecoENERGY that contribute towards the reduction of GHG emissions in Canadian communities.

Finding 2: ***There is a continued need to fund renewable energy and energy efficient projects in Aboriginal and northern communities that: 1) replace diesel systems; 2) off-set high energy costs; and 3) support economic development.***

Although the main objective of the ecoENERGY program has been to reduce GHG emissions, for communities that have submitted project proposals, the need for developing renewable energy technology is more personal. Communities are less concerned about an overall reduction of GHG emissions and instead are highlighting that there is a need for renewable energy solutions that reduce their dependence on diesel systems, that off-sets their high energy costs and that supports economic development.

1) *Off-grid communities undertaking renewable energy projects to reduce their reliance on diesel generators*

As reported by the Department, there are 292 off-grid communities in Canada, and more than half (167) are Aboriginal or northern communities, with 77 off-grid communities and diesel dependent communities[15] above the 60th parallel and 90 off-grid communities south of the 60th parallel.[16] For these communities, renewable energy technology is being harnessed to reduce their dependence on diesel as the transportation, storage and consumption of diesel is expensive, poses risks for contamination, creates noise pollution and negatively impacts local air quality. The costs are well beyond what most Canadians pay for a kilowatt hour of electricity. Additionally, Aboriginal and northern off-grid communities are particularly vulnerable to climate change. Their incomes tend to rely on the land, water and other natural resources, and rising temperatures have increased the cost and difficulty of diesel generation for communities who use ice roads as the primary method of diesel transportation.[17] [18] [19] [20] [21] [22]

"Energy is obscenely expensive for off-grid communities." – Interviewee

AANDC funds the supply of diesel to off-grid reserves to support electricity and heat generation. Although the exact numbers could not be calculated due to financial coding restraints, these costs are estimated to be high due to the need for transporting fuel by air, sea and winter roads. For example, the Ontario regional office estimates that since 2005-06 the fuel freight differential, provided to communities to address fuel pressures related to remote electricity generation, totaled $46.8 million dispersed to 25 off-grid communities. Although the price of fuel has fluctuated over the years, AANDC has experienced a particularly large funding pressure from 2006 to 2009 when off-grid communities needed to request additional funds to support the rising

[15] There are 22 communities that are serviced by a regional hydro-grid in the territories that are not connected to the North American Grid and are dependent on diesel for winter peaking power, during droughts, for back-up power during outages and maintenance shut-downs, and to meet all heating needs.
[16] Aboriginal Affairs and Northern Development Canada. 2014 calculations. Note that of the 90 communities, 44 receive ongoing funding for capital and/or operation and maintenance of infrastructure.
[17] Aboriginal Affairs and Northern Development Canada. 2013. ecoEnergy for Aboriginal and Northern Communities Program Communications Plan 2013-2014.
[18] James Ford, Lea Berrang-Ford, Malcolm King and Chris Furgal, "Vulnerability of Aboriginal Health Systems in Canada to climate change," *Global Environmental Change* 20 (2010), 669.
[19] Christopher Furgal and Jacinthe Seguin, "Climate Change, Health, and Vulnerability in Canadian Northern Aboriginal Communities," *Environmental Health Perspectives* 114 no. 12 (2006), 1968
[20] Centre for Indigenous Environmental Resources (CIER) and the University of British Columbia (UBC), *Climate Change and Adaptive Capacity in Aboriginal Communities South of 60 Assessment Report*, 2011. http://www.yourcier.org/climate-change-and-adaptive-capacity-in-aboriginal-communities-south-of-60-assessment-report-2011.html, 5.
[21] Chris Henderson and Judith Sayers for the University of Waterloo Climate Change Adaptation Project (CCAP), *Climate Change Adaptation: A Priorities Plan for Canada,* 2012. http://uwaterloo.ca/environment/sites/ca.environment/files/uploads/files/CCAP-Report-30May-Final.pdf, 65-66.
[22] Lemmen et al, *From Impacts to Adaptation*, 260, 305.

cost of diesel fuel. These funding pressures may continue into the future as the cost of diesel in northern Ontario is projected to increase by 40 percent in the next 10 years.[23]

In addition, provincial/territorial utilities also experience high costs to provide power to off-grid communities within their service area. These costs are particularly high in the North. According to the National Energy Board, "the North accounts for only about 0.3 percent of Canada's population and energy use," but "with a population of just over 100,000 dispersed over 3.5 million square kilometers, the costs and logistics of energy distribution is a major issue."[24] For example, Nunavut is completely dependent on imported diesel to support everyday living. The Nunavut power utility, Qulliq Energy Corporation, provides power to over 33,000 people in 25 communities, all of which are serviced by isolated diesel grids spread out across approximately two million square kilometers.[25] In 2009-10, in order to provide energy to its customers, Qulliq Energy Corporation utilized 45 million litres of diesel fuel at a cost of $39 million, or $1,181 per person.[26] The significant volume and cost of diesel fuel consumed in the generation of energy for Aboriginal and northern off-grid communities demonstrate a continued need to fund renewable energy projects that have the potential to dramatically reduce communities' use of diesel generators.

Diesel fuel is shipped to remote off-grid communities in the summer months and stored in tank farms for distribution and use throughout the year. The transportation and storage of diesel in communities also creates significant environmental issues as spills and leaks can cause contamination and impact local water sources and waterways.[27] Although the purchase and maintenance of fuel tanks are the responsibility of each community, when fuel tanks leak the contaminated site and potential environmental and health risks associated with the leak, it becomes the responsibility of AANDC. As a result of this risk, AANDC supports fuel tank upgrades and has provided an additional $80 million over the last five years to support the upgrade of older fuel tanks on-reserve and an additional $75 million will be allocated over the next four years.

Further compounding the energy issues facing off-grid communities is the growth in their electricity demand. Natural Resources Canada estimates that electricity demand in Canada's northern regions is growing at 1.5-2.0 percent per capita per year.[28] Increasing demand for electricity results in larger quantities of diesel being required by diesel-dependent communities in order to meet the needs of the community. Difficulties transporting diesel to remote diesel-dependent communities impact the ability of communities to meet increasing electricity

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[23] Mario Arriaga, Claudio Cañizares and Merhdad Kazerani, "Renewable Energy Alternatives for Remote Communities in Northern Ontario, Canada," Institute of Electrical and Electronics Engineers Transactions on Sustainable Energy 4 no. 3 (2013), 661-663.
[24] National Energy Board. 2011. Energy Facts. Available at https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/archive/2011nrgsncndnrthfct/nrgsncndnrthfct-eng.pdf
[25] Standing Senate Committee on Energy, the Environment and Natural Resources. Senate Committee Meeting, April 29, 2014.
[26] Standing Senate Committee on Energy, the Environment and Natural Resources. Senate Committee Meeting, April 29, 2014.
[27] Lumos Energy and Delphi Group. 2013. Wataynikaneyap Power Project Impacts and Benefits Analysis.
[28] Christopher Henderson. 2013. Aboriginal Power: Clean Energy and the Future of Canada's First Peoples. Erin, Ontario, Rainforest Editions.

demands and can result in power outages.[29] In many communities, the diesel-powered system cannot meet the demand placed on it, and fails, resulting in power outages. These power outages can last for a few hours or a few weeks and make the operation of community infrastructure such as schools, band offices and health centres very challenging.[30] Such power outages also restrict economic development in off-grid Aboriginal and northern communities as high energy costs and unreliable provision of power limits the effective operation of businesses and makes attracting investors particularly difficult.[31]

2) On-grid communities undertaking renewable energy projects to reduce electricity costs

Electricity prices for residential customers vary significantly across Canada. In regions such as Alberta, Saskatchewan and Atlantic Canada, residential electricity rates can be approximately double the cost charged in regions with significant hydro-electric resources, such as British Columbia, Manitoba and Quebec. For example, the average prices for residential customers for a monthly consumption of 1,000 kWh from 2010-2014 was 6.88¢/kWh provided by Hydro Quebec, 7.47 ¢/kWh provided by Manitoba Hydro and 8.57¢/kWh provided by BC Hydro.[32] In contrast, the average price for residential customers over the same period and with the same usage was 13.32 ¢/kWh provided by SaskPower, 14.60¢/kWh provided by Nova Scotia Power and 15.06 ¢/kWh provided by Maritime Electric in Prince Edward Island.[33] In addition, both SaskPower and Maritime Electric have higher service charges and/or energy charges for rural customers, making costs higher for rural customers, including many First Nations.[34]

"It's about bringing energy costs down." – Interviewee

These higher costs are consistent with information provided by case study interviewees, particularly those from Atlantic Canada who were able to significantly reduce their energy bills by utilizing solar panel technology. Interviewees identified that a key reason for communities to participate in the ecoENERGY program was to use renewable energy systems to reduce their electricity and heating costs. It became evident to evaluators that even on-grid Aboriginal and northern communities struggle with significant electricity and heating costs

"…our remote communities are in the most trouble, they are also most aware of the true cost of energy. [This program] helps them learn more about the value of energy… that there are choices and costs and pros and cons and how important it is to choose wisely." – Interviewee

of Canada's First Peoples. Erin,

[30] Lumos Energy and Delphi Group. 2013. Wataynikaneyap Power Project Impacts and Benefits Analysis.
[31] Lumos Energy and Delphi Group. 2013. Wataynikaneyap Power Project Impacts and Benefits Analysis.
[32] Hydro Quebec. Comparison of Electricity Prices in Major North American Cities. Reports from 2010 – 2014 used. All reports available at http://www.hydroquebec.com/publications/en/corporate-documents/comparaison-electricity-prices.html
[33] Hydro Quebec. Comparison of Electricity Prices in Major North American Cities. Reports from 2010 – 2014 used. All reports available at http://www.hydroquebec.com/publications/en/corporate-documents/comparaison-electricity-prices.html
[34] Saskpower. 2014. Residential Rates. Available athttp://www.saskpower.com/wp-content/uploads/residential_rates.pdf, Maritime Electric. 2014. Rate Schedules and Rate Application Guidelines. Available at http://www.maritimeelectric.com/about_us/regulation/reg_irac_regulations_det.aspx?id=607&pagenumber=63&sview=AP

for band-owned and operated buildings. Many of these buildings are used extensively by community members and therefore draw electricity and heat for a substantial number of hours annually. For some communities, the high electricity costs in certain regions have severely impacted the community's operating budget limiting their ability to address other community priorities. Therefore, for some on-grid communities in regions with higher energy costs, there is a need for renewable energy systems to help off-set energy costs.

3) On-grid communities who are undertaking renewable energy projects as an economic development opportunity

The ecoENERGY program also provided a valuable opportunity for Aboriginal and northern communities who possess territory, or have access to crown land, that has the natural features necessary for larger renewable energy projects. For example, several large renewable energy projects, such as micro-hydro facilities and solar/wind farms, have been developed by communities with funding from ecoENERGY. These projects often provide on-grid communities with an opportunity to develop power purchase agreements with provincial/territorial utilities to sell the power they produce to the grid. These projects can provide significant income for communities that can be reinvested into other economic development opportunities or used to address other community needs. According to a Lumos Energy report completed for AANDC in 2012, "Large hydro also represents one of the most substantive types of economic development opportunity for First Nation, Métis and Inuit communities, during construction and in operation. Such developments tend to kick-start a range of spinoff economic activities, often in more remote and rural regions of the country. For [these reasons] it is timely and important for AANDC to study large hydro developments across Canada."[35]

"On the economic development side, energy as a whole in the region is a huge topic for First Nations." – Interviewee

However, these projects require significant funding to complete. The early stages of developing large renewable energy projects are particularly challenging as a large number of studies are required to establish the viability of the project. Communities often struggle to find funding sources for the exploratory phase, which is integral, as it produces the results that are used to attract additional funding partners.

Overall, the evaluation has found that there is a continued need for ecoENERGY funding for renewable energy projects to support the provision of energy and heat to reduce GHG emissions as well as to reduce diesel consumption and associated risks, to reduce costs and as an opportunity for economic development.

<u>Finding 3:</u> ***International examples demonstrate that there is a continued need for an ecoENERGY program that focuses on off-grid and northern communities.***

Interviews with program management made it clear that the ecoENERGY program needs to shift its focus from funding a wide variety of projects across Canada to instead targeting communities

[35] Aboriginal Clean Energy Market Trends and Potential Impacts on & Consideration for AANDC Programming" (Lumos Energy, March 2012.)

with the greatest need for renewable energy solutions. As such, the program has been moving toward prioritizing project proposals received from remote, off-grid, diesel-dependent communities, which are located both in the northern portions of provinces and north of the 60th parallel. In order to identify whether this program evolution meets a need that the program should continue to address, evaluators relied on the literature review to provide best practices and lessons learned from the international arena.

The literature review found that since 2008, the United States government has made it a priority to develop a substantial renewable energy environment in the northern state of Alaska. It has infused significant financial and human resources, including $202.5 million for 227 projects since 2008 into the Alaskan state to advance renewable energy technology.[36] The Government completed a full assessment of each community, with a high-level snapshot of the least-cost options for electricity, space heating, and transportation for each community.[37] Additionally, in June 2008, a Diesel Efficiency Workgroup was formed to focus on reducing diesel fuel consumption in rural communities through generation and distribution efficiency measures.[38] A third-party evaluation of Alaska's Renewable Energy Fund in 2012 estimated that the first 62 projects funded will ultimately provide a net present value benefit of more than $1 billion over their lifetime. These projects cost $508 million.[39]

The key area to note from Alaska's experience is that the coordination of research and projects was completed on-location, by Alaska Energy Authority personnel. This was done to develop the capacity and accountability of the staff on-site, and to ensure that "Alaskans have access to energy information and a single location they can work with to resolve their energy challenges and opportunities." The intent of the Alaskan State government is to use the information collected by Alaska Energy Authority staff to inform future decision making. By encouraging the development of on-site staff, the Alaska Energy Authority "…concentrate[d] expertise in the governing bodies to allow years of well-informed policy and programming development."[40] A major partner in this work was the United States Office of Indian Energy, which focuses exclusively on the advancement of energy security in Indigenous American communities. The partnership of these stakeholders at the community-level allowed tribal governments to improve energy efficiency and facilitated their transition to renewable energy systems.[41]

[36] Alaska's Renewable Energy Fund was created by the Alaska Legislature in 2008 with the intent to appropriate $50 million a year for five years to develop renewable energy projects across the state, particularly in areas with the highest energy costs. In 2012, the Legislature extended the program for another 10 years until 2023. The fund is administered by the Alaska Energy Authority. Further information available at:

[37] Alaska Energy Authority. "Alaska Energy." 2009. Available at: http://www.akenergyauthority.org/PDF%20files/AK%20Energy%20Final.pdf

[38] Alaska Energy Authority. "Alaska Energy." 2009. Available at: http://www.akenergyauthority.org/PDF%20files/AK%20Energy%20Final.pdf. Pg. 73

[39] Alaska Energy Authority. Evaluation of the Renewable Energy Fund. 2012.

[40] Alaska Energy Authority. "Alaska Energy." 2009. Available at: http://www.akenergyauthority.org/PDF%20files/AK%20Energy%20Final.pdf. Pg. 4.

[41] US Department of Energy, Office of Indian Energy (nd), accessed from on December 29, 2014.

The Alaskan government also forged strong partnerships with academic institutions and research centers, such as the Alaska Building Science Network,[42] to advance its renewable energy agenda.[43] The Alaska Center for Energy and Power at the University of Alaska in particular developed a comparative database that identifies technologies options and limitations for each identified resource. Going forward, AANDC may be able to develop a similar database to identify appropriate technology options for Canada's northern communities in order to provide recommendations to communities seeking support.

Parallel to the Alaska experience, AANDC's remote and northern communities have had many high-quality energy plans developed over the years, but few have come to fruition. For Alaska, the answer was to "engage Alaskans in the solution and invite their active participation in the selection and ownership of their alternative energy sources."[44] Although AANDC has a significantly smaller budget than Alaska ($20 million over five years for all of Canada compared to $50 million per year for the state of Alaska alone), Canada could use the lessons learned from Alaska's experience, and better engage local stakeholders in the research and investments in targeted northern communities.

The literature review also confirmed that a focus on off-grid or rural communities for renewable energy system development is an international best practice, which has been followed by Australia, China, and Germany. In Australia, renewable energy programming[45] is predominately focused on off-grid communities that include indigenous communities.[46] [47] [48]

Historically China has preferred grid extensions, but has more recently focused on stand-alone (i.e. not grid-connected) systems that have gained favour as their reliability and affordability have improved. A particular focus has been on targeting remote and poverty-stricken minority settlements with a combination of hydro, solar, wind, geothermal, biomass and other technologies. China's reported key to success (99 percent of rural residents with electricity) is the Government's commitment to community-based planning and long-term funding.[49] [50]

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[42] http://www.absn.com/
[43] http://www.absn.com/
[44] Alaska Energy Authority. "Alaska Energy." 2009. Available at: http://www.akenergyauthority.org/PDF%20files/AK%20Energy%20Final.pdf. Pg. 4.
[45] Australia's off grid investments in Renewable Energy also includes households; pastoral stations; rural communities; tourist facilities; small industrial projects; pumping and irrigation; mine sites and mini-grids or islands.
[46] Government of Australia (2014), Clean Energy Finance Corporation Annual Report (2013- 2014), accessed from http://www.cleanenergyfinancecorp.com.au/annualreport/content/CEFC_Annual_Report_2013-2014.pdf, on November 10, 2014.
[47] Government of Australia (nd), November 7, 2014
[48] Clean Energy Council, accessed http://www.cleanenergycouncil.org.au/technologies/off-grid-renewables.html, November 7, 2014.
[49] Niez, Alexandra (2010) *Comparative Study on Rural Electrification Policies in Emerging Economies: Key to Successful Polices*, International Energy Agency. http://www.iea.org/publications/freepublications/publication/rural_elect.pdf
[50] Chen Lei, Minister of Water Resources (2009). Developing the small hydropower actively with a focus on people's well-being, protection and improvement. The 5th Hydropower for Today Forum. Hangzhou as cited in Niez, Alexandra (2010).

In 2010, Germany developed the *Renewable Energy Sources Act* that provided for a full suite of incentives and subsidies supporting the deployment of renewable energy; this made Germany a leader in the transition to renewable energy. Although none of Germany's communities are "remote", the country's reported key to successful policy implementation was a focus on community ownership through cooperative initiatives.[51] Profits from community-owned renewable energy systems were directed into kindergartens, sport facilities, and gathering places.[52] Germany's experience affirms the utility for AANDC to continue to invest in supporting the development of renewable energy systems in community buildings as cost savings from public expenditures can be leveraged to provide additional community programs and services.

Further, the International Energy Agency highlighted that a successful renewable energy strategy must include a stable and enabling policy framework that allows for community engagement and ownership, favourable markets, including providing subsidies to encourage use, building community capacity and facilitating understanding and awareness of renewable energy.

3.2 Alignment with Roles and Responsibilities

Finding 4: ***The ecoENERGY program is aligned with roles and responsibilities of the federal government, and specifically, the mandate of the Department of Aboriginal Affairs and Northern Development Canada.***

This evaluation found that the roles and responsibilities of the federal government and AANDC are complex and interconnected with provincial and territorial responsibilities. Numerous federal, provincial and territorial funding programs have existed and continue to evolve to facilitate the development of technologies, adapt technologies to northern conditions, increase capacity related to renewable energy generation in communities, and to implement renewable energy projects.

Provinces and territories have the predominant role and responsibility to provide energy to communities while the federal government supports the integration of the renewable energy sector nationally.

To date, the provinces and territories have been the primary promoters of energy conservation, while the federal government has tended to provide support to the provinces and territories in identifying and then promoting proven renewable energy technologies through a consistent national approach. The role of the federal government in supporting provincial and territorial governments in developing renewable energy powers is supported in the literature. Specifically, according to the International Energy Agency, a national renewable energy policy thrives when there is a government framework to facilitate industry-led research and development, until the

[51] International Renewable Energy Association (nd) Renewable Energy Profiles – Germany, accessed from on December 27, 2014.
[52] In communication with Dr. Andreas Wieg, Director of the Executive Staff Department at German Cooperative and Raiffeisen (Deutscher Genossenschafts – und Raiffesenverand e, V.; DGRV), Head of the German Office for Energy Co-operatives, November 19, 2014. DGRV – German Co-operative and Raiffeisen Confederation, November 18, 2014.

renewable energy sector expands to become predictable, nimble, and credible. Efforts must also include actions to reduce economic barriers to facilitate the implementation of renewable energy technology. Once renewable energy policies are developed, and renewable technology is both publically accepted and highly integrated into the existing infrastructure, the federal government may phase out its targeted government support.[53] At this stage, AANDC's role is therefore to facilitate the visibility and viability of renewable energy technologies in on-reserve and northern communities until the time comes when these technologies are easily accessible and accepted as mainstream public investments as well as when provincial and territorial policy frameworks can ensure the sustainability of such systems.

> **"Diesel energy is preferred in the North, because it is consistent. This is the concern: Consistency. Spending money on feasibility studies is what helps move the mindset and give confidence in pursuing renewable energy technology. People are afraid to take the risk to switch from diesel to a less confident source. There needs to be a gradual switching over of technologies. It's going to take a lot of time to get out of diesel completely… that's why [the government] needs to demonstrate results." – Interviewee**

Having a federal program that is aimed at promoting the adoption of renewable energy technologies to reduce GHG emissions is also aligned with international trends. The percentage of countries in every income bracket with national renewable energy policies has steadily increased over the past decade. The United Nations General Assembly declared the upcoming decade (i.e., 2014-2024) as the "Decade of Sustainable Energy for All,"[54] the Intergovernmental Panel on Climate Change has warned that an immediate transition to cleaner energy is imperative to mitigating catastrophic consequences;[55] and the world's largest economies and most intensive GHG emitters (accounting for more than a third of all global GHG emissions), China and the United States have announced plans to dramatically reduce carbon emissions. The United States has pledged to cut GHG emissions to 26-28 percent below 2005 levels by 2025, while China targets to peak CO_2 emissions around 2030 or earlier by increasing non-fossil fuel emitting energy production to 20 percent of total production by 2030. These commitments are recognized as foundational to more rigorous efforts world-wide. More formalized commitments are expected to be negotiated in advance of the 2015 United Nation's Climate Change Conference (COP 21) in Paris, France.[56]

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[53] International Energy Agency (2011) *Renewable Energy Markets and Policies: Deploying Renewables Best and Future Policy Practice*, Organization for Economic Cooperation and Development (OECD)

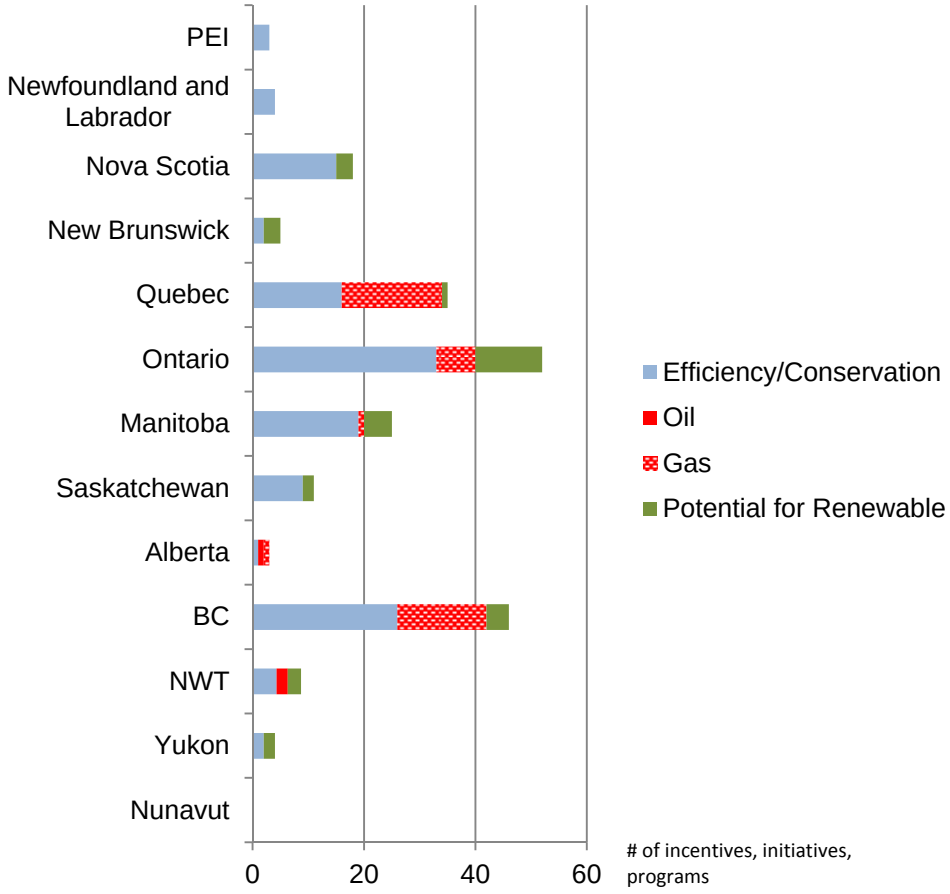
[54] International Renewable Energy Association (2012) *International Off-Grid Renewable Energy Conference: Key Findings and Recommendations.*

[55] Fischedick, M., R. Schaeffer, A. Adedoyin, M. Akai, T. Bruckner, L. Clarke, V. Krey, I. Savolainen, S. Teske, D. Ürge-Vorsatz, R. Wright, 2011: Mitigation Potential and Costs. In IPCC *Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[56] White House Fact Sheet (2014) Accessed from http://www.whitehouse.gov/the-press-office/2014/11/11/fact-sheet-us-china-joint-announcement-climate-change-and-clean-energy-c, on December 15, 2014.

Provincial and territorial governments have jurisdiction and regulation over electrical production, transmission and distribution. Each province and territory also has a *Public Utilities Act* establishing a board or council to provide decisions and recommendations with respect to the operation of public or private utilities that are responsible for power generation and distribution. This evaluation found that each province and territory has been implementing a spectrum of energy efficiency/conservation investments as well as providing incentives for encouraging the introduction of renewable energy systems. The following graph identifies the total number of incentives, initiatives or programs (*not the total investment*) in each province and territory.

Figure 2: Energy Incentives in Canadian Provinces and Territories[57]



[57] Graph developed for the literature review by Kishk Anaquot Heath Research, January 2015.

As demonstrated in the above graph, the main focus for provincial and territorial governments has been to support energy conservation and improve efficiency of existing energy technology. Beyond programs and incentives, provincial and territorial governments across Canada also have a variety of regulatory instruments to promote the use of renewable energy systems, including:

- offset programs where a premium rate can be paid on your utility bill to create new renewable energy systems that would replace or 'off set' your home or building consumption with renewable sources;
- procurement through requests for proposals or actually seeking to amplify the amount of renewable energy by requesting bids from renewable energy suppliers;
- standard offering, feed in tariff and subsidy programs that offer a premium rate for renewable energy;
- legislated renewable portfolio standards or an obligation for utilities to produce a set amount of renewable energy;
- net billing that allows producers of renewable energy to sell their excess energy to the utility grid; and
- net metering that provides consumers who are also generating renewable energy the option to connect to the utility grid to offset their consumption, stay connected to the utility and meet their energy needs with their own systems if the utility is unable to provide.

Alberta has an off-set program and all other provinces have requests for proposals. Nova Scotia, New Brunswick and Prince Edward Island have legislated renewable portfolio standards. Ontario, Nova Scotia, Prince Edward Island and British Columbia have standard offer and subsidy programs. The following table highlights the suite of renewable energy policies by province and territory.

Table 1: Renewable Energy Policy by Province and Territory[58,59,60]

Province	Renewable Energy target	Off Set	Procurement of Renewable Energy	Standard offer and Feed in Tariff	Renewable Portfolio Standards	Net bill	Net meter
British Columbia			yes	yes			
Alberta	yes	yes				yes	
Saskatchewan	yes		yes				yes
Manitoba			yes				
Ontario	yes		yes	yes			yes
Québec	yes		yes				yes
New Brunswick	yes		yes		yes		yes
Nova Scotia			yes	yes	yes		yes
Prince Edward Island	yes		yes	yes *(Wind only)*	yes		yes

Yukon	Energy Strategy, a commitment to increase the supply and use of renewable energy 20% by 2020
Northwest Territories	Renewable Energy Fund to subsidize renewable energy generation: Hydro, biomass and solar energy strategies
Nunavut	Ikummatiit, a territorial energy strategy that focuses on alternative energy sources and efficient use of energy was planned but never implemented

As many as one hundred Canadian municipalities also have GHG emission reduction plans.[61] [62]

Although these provincial and territorial programs are often made available to on-reserve communities, they are primarily implemented in off-reserve communities. AANDC provides similar programming to on-reserve communities.

[58] Table developed for literature review by Kishk Anaquot Heath Research, January 2015.
[59] Adapted from NRCAN (2013) *Canada - A Global Leader in Renewable Energy: Enhancing Collaboration on Renewable Energy Technologies*, Energy and Mines Minister's Conference, Yellowknife NWT August 2013 Accessed from https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/www/pdf/publications/emmc/renewable_energy_e.pdf, on November 14, 2014.
[60] International Energy Agency and International Renewable Energy Association, Policies and Measures Database, accessed from http://www.iea.org/policiesandmeasures/renewableenergy/?country=Canada on December 29, 2014.
[61] Government of Canada (nd) *Climate Change: Achieving our Commitments Together – Climate Change Plan for Canada*, Accessed from http://lakehuron.ca/resources/Climate_Change_plan_for_Canada.pdf, on December 1, 2014.
[62] For a full directory of energy efficiency and alternative energy programs in Canada, the reader is referred to http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/policy_e/results.cfm?amp;searchType=default&sectoranditems=all%7C0&max=10&categoryID=all&regionalDeliveryId=all&programTypes=4&keywords=&pageId=3.

It is evident from these examples that there is a clear role for the federal government to advance the adoption of renewable energy technologies while provincial and territorial governments focus on increasing the efficiencies of existing energy infrastructure and developing a supportive investment environment. However, it is also evident that the roles and responsibilities of various federal departments can overlap, especially in the North where AANDC is less bound by its *Indian Act* commitments and where other federal departments provide significant support.

Although, as shown above, AANDC does not have a direct mandate to invest in supporting renewable energy technologies, the Department has made the policy decision to invest in renewable energy technologies in Aboriginal and northern communities across Canada in order to further its social and economic mandate. The Literature Review confirmed that there are social, political and economic reasons to advance the use of renewable energy technology beyond reducing greenhouse gas emissions. Renewable energy technology can have far-reaching impacts on community health, education, and the environment. It can also provide improved energy access and security, assist with poverty reduction, tackle gender equality, and provide job creation and rural economic development.[63,64,65] The Aboriginal and northern communities that fall under AANDC's mandate, require sustainable and reliable energy to enable them to participate fully in Canada's political, social and economic development. By focusing on integrating renewable energy technologies into off-grid communities, AANDC can reduce diesel operating costs, prolong the life of existing energy production assets, support community growth, and build sustainable communities.[66]

In addition, there are economic, social, and environmental programming areas that fall under AANDC's mandate that are impacted by energy challenges. Challenges from underperforming energy infrastructure and disruptions in energy supply limit the impacts of AANDC's economic development programming. The fluctuating costs of fuel, the increasing cost of transporting fuel and increasing demand from a rapidly increasing population are putting pressure on AANDC's budget while also increasing air pollutants from the burning of diesel. Environmental challenges also include fuel spills associated with transportation, local storage and fuel transfers resulting in environmental damage to sensitive habitats where clean-up responsibilities falls under AANDC's mandate. By resolving these energy challenges through sustainable energy solutions, AANDC programming areas can flourish. Thus, AANDC's role in the support for renewable energy technology projects is multi-dimensional.

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[63] International Energy Agency (2011) *Renewable Energy Markets and Policies: Deploying Renewables Best and Future Policy Practice*, Organization for Economic Cooperation and Development.

[64] Sathaye, J., O. Lucon, A. Rahman, J. Christensen, F. Denton, J. Fujino, G. Heath, S. Kadner, M. Mirza, H. Rudnick, A. Schlaepfer, A. Shmakin, 2011: Renewable Energy in the Context of Sustainable Development. In IPCC *Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds)], Cambridge UniversityPress, Cambridge, United Kingdom and New York, NY, USA.

[65] Fischedick, M., R. Schaeffer, A. Adedoyin, M. Akai, T. Bruckner, L. Clarke, V. Krey, I. Savolainen, S. Teske, D. Ürge-Vorsatz, R. Wright, 2011: Mitigation Potential and Costs. In IPCC *Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[66] Standing Senate Committee on Energy, the Environment and Natural Resources. Senate Committee Meeting, April 29, 2014.

By choosing to invest in renewable energy technologies, AANDC is contributing to greater energy security and sustainability for Aboriginal and northern communities in Canada.[67] Once established and operational, locally-managed energy systems will promote local economic development opportunities, facilitate private sector partnerships, increase employment and skills development, and meet the demands of growing populations. Increasing renewable energy supply will reduce air pollutants and reduce fuel spills and contamination, thus improving human health and preserving the local environment. A reduced reliance on imported fossil fuels coupled with improved energy efficiency reduces energy costs. In general, improved energy infrastructure will result in more sustainable and secure energy sources, diversified economic opportunities and stronger, more self-sufficient communities, fulfilling AANDC's mandate.

Overlapping roles and responsibilities exist north of the 60th parallel between AANDC and Canadian Northern Economic Development Agency with respect to the development of renewable energy projects

South of the 60th parallel, AANDC has a clear role in providing support to on-reserve communities for renewable energy projects, in line with Canadian and international commitments to reduce GHG emissions. In the North, AANDC's specific roles and responsibilities associated with energy generation, storage and distribution are complex as energy regimes differ in each of the three territories.[68] Energy regimes vary according to: the level of devolution of responsibilities from federal to territorial governments; Aboriginal rights negotiated through treaties, land claims and self-government agreements; and territorial authority over licensing and permitting requirements on energy service providers. The territories' legislated roles, mandates, and their proximity to northern citizens, call for territorial governments to play the most direct role of any jurisdiction in ensuring the availability of the local energy supply as part of the overall social and economic well-being of their regions. Each of the territorial governments has established public utilities that are charged with developing energy supplies for their territory, and investing in generation, transmission, and distribution of energy when private corporations will not. Yukon and the Northwest Territories also have privately-owned utilities.[69]

In the North where there are few reserve communities, AANDC has a less structured role in enabling the development and implementation of infrastructure, including energy projects. AANDC's mandate is in fact to support Northerners in their efforts to improve social well-being and economic prosperity, develop healthier and more self-sufficient communities and participate more fully in Canada's political, social and economic development to the benefit of all Canadians – which could arguably include supporting renewable energy projects. In Nunavut specifically where work is still being conducted to complete a final devolution agreement and

[67] Standing Senate Committee on Energy, the Environment and Natural Resources. Senate Committee Meeting, April 29, 2014.
[68] Note: Concerning the definition of "The North" AANDC defines "The North" as Land in Canada located north of the 60th parallel. AANDC's responsibilities for land and resources in the Canadian North relate only to Nunavut, Northwest Territories and Yukon. However, two of the four Inuit territories that are not covered under the *Indian Act* and fall south of the 60th parallel, including Nunatsiavut and Nunavik. These territories are governed by a land claim agreement with Nunatsiavut and shared responsibilities with the provinces of Quebec and Newfoundland.
[69] Standing Senate Committee on Energy, the Environment and Natural Resources. Senate Committee Meeting, April 29, 2014.

where a Nunavut Energy Strategy has not yet been implemented, AANDC has a clear role to support the development and implementation of energy projects. However, in the devolved territories of the Yukon and Northwest Territories, the territorial governments, like provincial governments, have a clear role in providing energy services. AANDC's role is further complicated by other departments and agencies that also share in responsibilities related to energy generation in the North. The Energy Sector of Natural Resources Canada is the lead on energy policy, clean energy research and technology development; and Natural Resources Canada is also the knowledge centre for scientific expertise on clean energy technologies for the Government for Canada.[70] The National Energy Board has a goal to promote safety and security, environmental protection and efficient energy infrastructure and markets in the Canadian public interest within the mandate set by Parliament in the regulation of pipelines, energy development and trade. The newly established Canadian High Arctic Research Station will focus on introducing renewable energy systems to Canada's North, which includes not only north of the 60th parallel, but the northern portions of territories as well.[71] Finally, the Canadian Northern Economic Development Agency has responsibilities for improving the economic base of the North (north of the 60th parallel), which can include harnessing renewable energy technologies.[72]

"In the North, the needs are basic: jobs, cost savings, energy security." – Interviewee

Although many federal partners are involved in the research, development and implementation of renewable energy technologies, Canadian Northern Economic Development Agency's mandate directly overlaps with AANDC's north of the 60th parallel. Canadian Northern Economic Development Agency, once a component of AANDC, is now a regional development agency that works with partners and stakeholders to advance sustainable economic diversification in Canada's three territories by funding programs and by undertaking policy development and research. Although Canadian Northern Economic Development Agency does not support renewable energy specifically, it can and has funded renewable energy projects, which often fit within the terms and conditions of Canadian Northern Economic Development Agency's Strategic Investments in Northern Economic Development program.[73,74] Canadian Northern Economic Development Agency has funded several large, renewable energy programs in the Northwest Territories and in the Yukon.[75]

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[70] Standing Senate Committee on Energy, the Environment and Natural Resources. Senate Committee Meeting, April 29, 2014.
[71] Note that Canadian High Arctic Research Station's jurisdiction is defined as the land and ocean based territory that lies north of the southern limit of discontinuous permafrost from northern British Columbia to northern Labrador.
[72] Standing Senate Committee on Energy, the Environment and Natural Resources. Senate Committee Meeting, April 29, 2014.
[73] Canadian Northern Economic Development Agency Accessed November 14, 2014 http://www.cannor.gc.ca/eng/1386595964935/1386595991230
[74] Canadian Northern Economic Development Agency Accessed November 14, 2014 http://www.cannor.gc.ca/eng/1386604882100/1386604944752
[75] Email communication received December 5, 2014 from YTInfo Canadian Northern Economic Development Agency Regional Office 215-305 Main St Whitehorse, Yukon Y1A 2B3

Overlapping roles and responsibilities exists between multiple sectors within AANDC who provide funding for the development of renewable energy projects

The assessment of evaluators regarding the various stakeholders and funders for renewable energy projects in Aboriginal and northern communities, as well as international examples, have demonstrated that the ecoENERGY program needs to find a niche role. Currently, ecoENERGY provides funding for feasibility studies for large renewable energy projects through Stream A and for the integration of renewable energy technology into band owned buildings through Stream B. However, as demonstrated in ***Appendix A***, the evaluation found that renewable energy projects that fall within the eligibility for both Stream A and Stream B are eligible for other funding sources within AANDC. Specifically, feasibility studies are eligible for, and have received funding from, AANDC's economic development programming. Additionally, the integration of renewable technology with existing community buildings has been supported by AANDC's Community Infrastructure Branch.[76] In many respects, these other funders are more appropriate sources for renewable energy projects in on-grid communities as they have greater amounts of funding, fewer restrictions and in-house economic development and infrastructure expertise.

However, in the case of remote off-grid and northern communities, the economic potential for renewable energy projects is low, as communities are small and have few customers available. As a result, such projects do not fall within the eligibility criteria for AANDC economic development programming. Additionally, the size and complexity of the renewable energy projects ensure they fall outside of the scope of AANDC's infrastructure programming. In recent years, the ecoENERGY program has increasingly focused on remote and northern communities due to the substantial need for support.

As a result, the evolution of the ecoENERGY program in choosing to focus solely on remote, northern and off-grid communities could reduce duplication and overlap within AANDC. However, in order to ensure that funding gaps are minimized, it is necessary that the responsibilities for the funding of feasibility studies in on-grid communities as well as the integration of renewable technology with existing buildings in on-grid communities be transferred to the Lands and Economic Development Sector and Community Infrastructure Branch (CIB) respectively. This evaluation found that promising economic development opportunities exist for on-grid communities by harnessing renewable energy technology. Similarly, community demand for feasibility studies for large scale renewable energy projects is high as the ecoENERGY program was only able to fund $2.1 million out of the approximately $20 million requested by on-grid communities. As will be demonstrated further on, these opportunities should continue to be promoted by AANDC.

Recommendation 1: It is recommended that the ecoENERGY program clearly define its niche, focusing on funding renewable energy projects in off-grid Aboriginal and northern communities.

[76] Note that the Community Infrastructure Branch provides funding to *Indian Act* First nations.

Recommendation 2: It is recommended that as ecoENERGY establishes a focus on off-grid and northern communities, program staff should provide lessons learned, best practices and relevant Stream A project proposals to Land and Economic Development Sector (i.e., Community Opportunity Readiness Program), which already funds such projects. Program staff should also communicate their change in focus to communities and provide information concerning potential Lands and Economic Development funding opportunities.

3.3 Alignment with Federal, Departmental and Community Objectives

Finding 5: ***The ecoENERGY program is aligned with federal priorities, AANDC's priorities and the needs and priorities of Aboriginal and northern Communities.***

The ecoENERGY program is aligned with and supports the priorities of the Government of Canada, Aboriginal Affairs and Northern Development Canada as well as Aboriginal and northern communities. Specifically, the Government of Canada has demonstrated its commitment to combating global warming by signing the United Nations Framework Convention on Climate Change, and participating in the United States-Canada Clean Energy Dialogue.[77] Canada is also a signatory to the Copenhagen Accord, for which it has a goal of reducing national GHG emissions by 17 percent below 2005 levels by 2020.[78]

The Government of Canada has established the development of renewable energy technology and the implementation of this technology in Aboriginal and northern communities as a priority through critical documents and public statements. Specifically, in the 2011 Speech from the Throne, the Government stated that it will support "the deployment of clean energy technology in Aboriginal and northern communities."[79] Additionally, in the 2011 Economic Action Plan, it was noted that "the Next Phase of Canada's Economic Action Plan advances Canadian leadership in the development and promotion of clean energy technologies."[80] In August 2011, then Minister of Aboriginal Affairs and Northern Development, John Duncan, noted that investments in clean energy projects "reinforces Canada's commitment to working with communities to address the effects of climate change;" and the Minister of Foreign Affairs John Baird stated that "the Government of Canada is committed to improving energy efficiency across the country."[81] These statements clearly show that promoting renewable energy projects in Aboriginal and northern communities has been a priority for the Government of Canada.

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[77] "Clean Air Agenda" (Government of Canada.) Available at http://actionplan.gc.ca/en/initiative/clean-air-agenda

[78] "The Clean Air Agenda" (Treasury Board of Canada Secretariat, July 16, 2014.) Available at http://www.tbs-sct.gc.ca/hidb-bdih/initiative-eng.aspx?Hi=12

[79] Government of Canada.2011. Speech from the Throne to open the First Session Forty First Parliament of Canada. Available at http://www.parl.gc.ca/Parlinfo/Documents/ThroneSpeech/41-1-e.html

[80] James M. Flaherty, Minister of Finance. The Next Phase of Canada's Economic Action Plan: A Low-Tax Plan for Jobs and Growth (The Budget in Brief, June 6, 2011). Available at http://www.budget.gc.ca/2011/glance-apercu/brief-bref-eng.html

[81] Aboriginal Affairs and Northern Development Canada. 2011. Minister Duncan Announces More Support for Clean Energy Projects in Aboriginal and Northern Communities. Available at http://www.aadnc-aandc.gc.ca/eng/1314794535694/1314794741066

Promoting renewable energy technology and improving the reliability and sustainability of energy provided to Aboriginal and northern communities are also a clear priority for AANDC. The ecoENERGY program aligns with the Land and Economy Strategic Outcome by supporting First Nation communities in acquiring, constructing, owning, operating and maintaining a base of infrastructure that protects their health and safety and enables their engagement in the economy.[82] Additionally, the 2010-11, 2011-12, 2012-13 and 2013-14 AANDC Reports on Plans and Priorities identify a commitment to reducing greenhouse gas emissions in Aboriginal and northern communities by supporting the development of renewable energy and energy efficiency projects. The ecoENERGY program also directly supports the goal of addressing Climate Change and Air Quality, reflected in the 2013-2016 Federal Sustainable Development Strategy, as well as the goals of the Federal Framework on Aboriginal Economic Development and AANDC's Northern Strategy.

Investing in renewable energy systems is also a priority for many Aboriginal and northern communities who want to reduce their reliance on diesel (in the case of off-grid communities), decrease their energy costs and promote economic development opportunities. For example, according to Chief Mathieye Alatini from the Kluane First Nation, their wind-diesel project, "fits with everything that a First Nation embodies...low footprint; always making decisions for future generations; taking care of the earth...responsible energy is common sense."[83]

"We are seen as the stewards of the environment." – Community Leadership Interviewee

[82] Aboriginal Affairs and Northern Development Canada and Canadian Polar Commission. 2013-2014 Report on Plans and Priorities. Available at https://www.aadnc-aandc.gc.ca/eng/1359484143774/1359484194228

[83] Josh O'Kane. 2013. Remote Communities Struggle to Finance Wind Power. The Globe and Mail, Tuesday Dec.03 2013. Available at http://www.theglobeandmail.com/report-on-business/breakthrough/remote-communities-struggle-to-finance-wind-power/article15741016/

Figure 3: Testing site for Kluane First Nation's three wind turbines.

Other communities' leaders have affirmed that renewable energy projects that reduce the use of diesel and provide a source of economic development are "game changing" projects for communities. One Chief interviewed during the evaluation noted that the community wanted its project to be an example for other communities and to show that green energy is worth the investment. This evaluation has found that Aboriginal and northern communities are committed to the successful implementation of renewable energy projects in their communities and in this respect the ecoENERGY program strongly aligns with the priorities of the program's recipients.

3.4 Program Effectiveness

Finding 6: ***ecoENERGY is delivering on its expected results of developing and constructing viable renewable energy projects.***

Through Stream A of ecoENERGY's funding AANDC is contributing to projects with substantial capacity to reduce greenhouse gas emissions

From April 2011 to March 2014, the ecoENERGY program funded 111 projects across Canada; these included 57 Stream A projects (feasibility studies) in 43 communities, and 54 Stream B projects (renewable energy projects integrated with new and existing community buildings). Since April 2014, the program has also approved the funding of an additional 14 Stream A projects and 18 Stream B projects.

Through follow-ups of Stream A projects conducted by the ecoENERGY program, it is reported that as of November 2014, of the 43 communities that completed feasibility studies, 12 percent have progressed to implementation, with three projects under construction and three projects now in operation. Operational projects include the Alderville First Nation Solar Farm, and Behdzi Ahda First Nation's (Colville Lake) solar and battery storage project integrated into their diesel generator.

Figure 4: Alderville First Nation Solar Farm (accessed from http://www.aldervillefirstnation.ca/solarfarm.html)

The evaluation found that 65 percent of funded studies are still undergoing additional assessments and project development. Only 23 percent of completed Stream A studies were found to either not be feasible, terminated or of unknown project status. Of the 43 communities that received funding for feasibility studies, the majority were in British Columbia (51 percent of projects) and in Ontario (23 percent of projects). Most of the projects funded (42 percent of projects) were feasibility assessments of hydro projects.

"Most funders are too risk adverse. It's really important to have that seed funding [for feasibility studies]." – Project Contractor

Interviewees and project leaders noted that the feasibility and design stage of a renewable energy project presented the greatest investment risk as the risk of a project not coming to fruition is high. Despite AANDC choosing to engage in this high risk investment, the program is still realizing its expected result of developing and constructing viable renewable energy projects. Twelve percent of stream A projects are now completed and another 65 percent of projects are still moving towards implementation. However, challenges persist for those communities that received ecoENERGY funding for the feasibility stage of larger scale renewable energy projects. In order to construct large scale projects, such as micro hydro facilities and solar/wind farms, without further ecoENERGY support, challenges include:

- Locating the necessary funding to finish any additional studies and environmental assessments required to make the project attractive to investors/ commercially viable.
- Securing capital funding to build the energy technology. This is especially difficult for off-grid communities when the business case may not be strong enough if costs exceed current diesel prices and there is a low possibility of private investment. Even when some projects are found to be feasible, they may not be economically viable.[84]
- Lack of supporting provincial policies and programs.
- Lack of administrative capacity in the community to manage the project and work through the myriad of permits and approvals required to begin construction, especially in communities with frequent changes in leadership.
- Lack of operational capacity in the community to operate and maintain large projects if they are implemented.

Stream B projects provided tangible results for Aboriginal and northern communities

Of the 54 completed Stream B projects, 61 percent (33 projects) were solar projects, as a result of the ease of construction and the availability of proven technologies. Other projects included eight geothermal projects, eight biomass projects, three projects that utilized multiple technologies, and two wind turbine projects. The majority of Stream B projects were constructed in British Columbia (26 percent of projects) and in Ontario (23 percent of projects).

In contrast to Stream A projects, which did not usually see the construction of an operational energy technology project, Stream B projects tended to be completed and leave tangible improvements in communities. However, Stream B projects did not necessarily receive widespread community attention or significantly reduce GHG emissions.

[84] *The Landscape of Prospective Future Aboriginal Clean Energy Projects: Informing the Planning and Implementation of the ecoEnergy Program Over the Short and Medium Term* (Lumos Energy, in association)

Comparison of Stream A and Stream B

Experts in the field were adamant that large scale strategic projects (Stream A) will go much further than one-off small projects across the country (Stream B) to reduce diesel dependence, to reduce GHG emissions, and to encourage mainstream consumption of renewable energy technologies. This assertion was confirmed by the few operational Stream A projects funded in the previous ecoENERGY program and the current program, when compared with the operational projects in Stream B. The communities of Taku River Tlingit First Nation, Tla-o-qui-aht First Nation and T'Souke First Nation were able to use their Stream A ecoENERGY-funded feasibility studies to develop solid business cases for the construction of large scale projects that resulted in significant GHG reductions. These same projects also enabled the communities to secure large economic benefits, engage the community in renewable energy discussions, engage with surrounding communities and improve relations, provide training and long-term employment, and provide a level of pride in community members that cannot be quantified.

Finding 7: ***ecoENERGY is delivering on its expected result of reducing greenhouse gas emissions in Aboriginal and northern communities.***

The reduction of greenhouse gas emissions is the ultimate expected outcome of the ecoENERGY program. It is also the primary goal of the Clean Energy suite of programs under the Clean Air Agenda, led by Natural Resources Canada. In order to assess the extent of GHG reductions in Stream A and B projects, project proposals required a calculation utilizing NRCAN's Renewable Energy Technology Screen (RETScreen). A third-party analysis was then conducted to verify potential reductions. Based on the third-party analyses for each of ecoENERGY's approved projects, funded projects are expected to off-set GHG emissions as follows:

Table 2: Expected Annual GHG Reductions for Funded Projects from 2011-12 to 2013-14[85]

	Expected Annual GHG Reductions of Funded Projects (t)	Expected Life Cycle GHG Reductions of Funded Projects (t)
Stream A Projects	184,108	3,671,380
Stream B Projects	3,039	60,803
Total	187,147	3,732,183

According to these calculations, *completed* Stream A projects will yield approximately 60 times the GHG reductions of completed Stream B projects. However, Stream A typically funds just the feasibility studies for large scale renewable energy systems with budgets that far exceed the funding available from ecoENERGY to complete.[86] As such, it is difficult to properly compare Stream A and B projects, because only a portion of Stream A funded projects will be developed and completed. As a result, Stream A projects' GHG reductions are expected and rarely realized at this early stage, whereas, the projected Stream B GHG reductions are comparable to actual reductions.

[85] Note: Program calculates the total potential GHG emissions that are estimated to occur and this estimation is done when the project is funded not when a project becomes operational.
[86] Stream A projects, if completed, typically cost over $300 million.

The number of projects funded and dollar amount funded are roughly equal for both streams, but Stream A seems to present the potential for drastically higher returns on GHG reductions per dollar funded by ecoENERGY than Stream B. In order to calculate the likely actual reductions of funded Stream A projects, given the challenges stated above for large scale projects, each of the funded studies was reviewed to identify the current construction stage of the project. Evaluators then calculated the expected GHG reductions of funded studies that are now operational or under construction as of November 2014. These figures are compared to the GHG reductions for the lifecycle of projects at each stage of completion, in the table below.

Table 3: Expected Annual GHG Reductions for Completed Stream A Projects

Current State of Project as of November 2014	Expected Annual GHG Savings of Stream A Projects (t)	Expected Life Cycle GHG Savings of Stream A Projects (t)
Construction Imminent	3,880.3	77,619.9
Under Construction	30,068.4	601,357.7
Operational	1,301.0	26,032.0
Total	35,249.7	705,009.6

In order to contextualize what these reductions mean for Canadians, evaluators used the United States Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator to calculate comparable scenarios. Assuming that projected GHG reductions are correct, Stream B projects funded from 2011-12 to 2013-14 will contribute to annual GHG reductions equivalent to removing approximately 640 passenger vehicles from the road each year for 20 years (i.e. the estimated life cycle of the systems).[87] When evaluators calculated the cost of Stream B projects compared to the GHG reductions, the result is a total dollar value of spending approximately $329.50 per car taken off the road per year.[88]

Of the funded Stream A projects that are now operational, two large renewable energy projects alone will reduce GHG emissions by over a third of all Stream B projects combined. Although the majority of Stream A reductions cannot be calculated, because most of the funded projects are not yet at the construction stage, a number of probable projects to be completed should yield significant GHG reductions. For example, the Kluane First Nation Wind-Diesel Project, which is still at the feasibility/development stage, is projected to result in 504 tonnes in annual GHG reductions, which is equivalent to removing approximately 106 passenger vehicles from the road each year for 20 years (i.e. the estimated life cycle of the wind project) for a total of 2120 vehicles.[89]

While AANDC's funding of the feasibility studies for large renewable energy systems will yield exponentially more GHG reductions if these projects are able to come to fruition, contractors and construction experts noted that projected GHG reductions should not be the main criterion for funding. Many other important factors such as upfront construction costs, operation and maintenance expertise and funding, environmental considerations such as bird migration paths,

[87] "Greenhouse Gas Equivalencies Calculator" (U.S. Environmental Protection Agency, April 16, 2014.) Available at http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
[88] Methodology: 640 vehicles x 20 years = 12800 Total $ funded for Stream B = $4,217,949 $4,217,949/12800 = ~$329.50/car/year
[89] Ibid.

and the costs per kilowatt hour to produce energy compared to efficient diesel systems need to be considered first to ensure that projects are ultimately economically viable. Additionally, project interviewees noted that the by-products of reducing GHGs, including increased energy reliability, reduced costs and economic development potential were in fact the most important outcomes of funded projects.

Finding 8: ***ecoENERGY is delivering on its expected result that communities have a base of infrastructure that protects the health and safety and enables engagement in the economy***

In addition to the main goal of reducing greenhouse gas emissions, the program was also found to have the following impacts upon recipient communities:

Economic Impacts

Reliable energy and reduced energy costs promote economic development in Aboriginal and northern communities

The lack of a stable and reliable energy supply in many remote and northern communities hinders economic development and job creation. Many off-grid communities experience brown-outs and black-outs, which can range in duration from several hours to a few weeks.[90] These power outages severely impact the functioning of the community, including schools and band offices, as the community often comes to a standstill and focuses only on basic operations.[91] Reliable electricity is among the most important factors for economic development and as a result, the potential for power outages discourage investment and development of businesses and industry.[92]

The high cost of electricity in many off-grid communities is also a significant deterrent for many would-be investors and industries. For example, the joint report *Status of Remote/Off-Grid Communities in Canada* completed by AANDC and Natural Resources Canada in August 2011 noted that "the cost of producing off-grid electricity from diesel generators can be up to 10 times higher than electricity generated on the main grid" and "the high cost of electricity in off-grid communities is a significant deterrent to economic opportunities for any industry consuming even a moderate amount of electricity."[93] The high cost of energy raises the cost for companies to explore opportunities, such as test sites for mining, as well as the operation of industrial activity, including the construction and maintenance of work camps.[94] Development of reliable energy, either through connection to a grid or development of reliable renewable sources, allows for increased stability for businesses.

[90] Lumos Energy and the Delphi Group. 2013. Wataynikaneyap Power Project Impacts and Benefits Analysis.
[91] Lumos Energy and the Delphi Group. 2013. Wataynikaneyap Power Project Impacts and Benefits Analysis.
[92] Lumos Energy and the Delphi Group. 2013. Wataynikaneyap Power Project Impacts and Benefits Analysis.
[93] Aboriginal Affairs and Northern Development Canada and Natural Resources Canada. 2011. Status of Remote/Off Grid Communities in Canada.
[94] Lumos Energy and the Delphi Group. 2013. Wataynikaneyap Power Project Impacts and Benefits Analysis.

Renewable energy projects can provide a significant source of revenue for a community.

As stated above, the ecoENERGY program, through Stream A, provides funding for the development of feasibility studies for large renewable energy projects. This funding is vital for communities' ability to engage in the assessment of projects that provide lower or no emission energy, and potential revenue from power purchase agreements with local utilities.[95] Numerous communities have used the initial support provided by ecoENERGY to develop large renewable energy projects, which are owned wholly or partially by the communities themselves.[96] These communities have also entered into power purchase agreements to sell the energy to the local grid, providing their communities with a new source of long-term income.[97]

These projects provide a significant, stable and long-term source of income for the communities. For example, the Alderville First Nation in Ontario has constructed a 5.7 MW solar farm that began producing power in October 2013.[98] Through a 20 year feed-in-tariff contract with the Ontario Power Authority, the project will provide Alderville First Nation with a long-term source of sustainable revenue.[99] Additionally, the Alderville First Nation solar Farm is the first alternate energy project in Ontario to be 100 percent owned by a First Nation.[100] In British Columbia, the Tla-o-qui-aht First Nation partnered with the Barkley Project Group to construct two micro-hydro facilities that are now in operation. The projects undertaken by the Tla-o-qui-aht First Nation were funded by the ecoENERGY program prior to its renewal in 2011 but provides a dramatic example of the community impacts from completed Stream A projects. In fact, the Tla-o-qui-aht First Nation is in the process of developing a third facility, and is the majority owner of these facilities.

The income provided through large renewable energy technology projects, such as micro-hydro facilities, provide First Nations and northern communities with a steady source of income that can support other economic development opportunities for their communities. Communities are often reliant on government grants, which can fluctuate from year-to-year, creating uncertainty. The long-term income generated through power purchase agreements provide communities with a reliable source of alternative funding for economic development or other community projects

[95] Natural Resources Canada, Strategic Energy Policy Division. 2014. Supporting Energy Innovation and Responsible Energy Use in Canada: An Assessment of Natural Resources Canada and Aboriginal Affairs and Northern Development Canada's ecoEnergy Programs and Enabling Policy.
[96] Natural Resources Canada, Strategic Energy Policy Division. 2014. Supporting Energy Innovation and Responsible Energy Use in Canada: An Assessment of Natural Resources Canada and Aboriginal Affairs and Northern Development Canada's ecoEnergy Programs and Enabling Policy.
[97] Natural Resources Canada, Strategic Energy Policy Division. 2014. Supporting Energy Innovation and Responsible Energy Use in Canada: An Assessment of Natural Resources Canada and Aboriginal Affairs and Northern Development Canada's ecoEnergy Programs and Enabling Policy.
[98] Natural Resources Canada, Strategic Energy Policy Division. 2014. Supporting Energy Innovation and Responsible Energy Use in Canada: An Assessment of Natural Resources Canada and Aboriginal Affairs and Northern Development Canada's ecoEnergy Programs and Enabling Policy.
[99] Natural Resources Canada, Strategic Energy Policy Division. 2014. Supporting Energy Innovation and Responsible Energy Use in Canada: An Assessment of Natural Resources Canada and Aboriginal Affairs and Northern Development Canada's ecoEnergy Programs and Enabling Policy.
[100] Natural Resources Canada, Strategic Energy Policy Division. 2014. Supporting Energy Innovation and Responsible Energy Use in Canada: An Assessment of Natural Resources Canada and Aboriginal Affairs and Northern Development Canada's ecoEnergy Programs and Enabling Policy.

that will not reduce the ability of the community to address other needs. Communities visited as part of evaluation case studies saw the power purchase agreements as a significant step towards economic self-sufficiency.

Renewable energy projects can significantly reduce energy costs for communities

Aboriginal communities in Canada, both on-grid and off-grid, experience significant costs related to heating and electricity for band-owned buildings. For example, Nunavut is completely dependent on imported fuels to provide energy for communities and as a result imports extremely large amounts of fuel at a significant cost.[101] In addition, some on-grid communities also struggle with high energy bills, particularly for large band-owned buildings such as schools and band offices.

"Most buildings are run by electric here costing about $2,500 to $3,000 a month for a small band office." – Atlantic Case Study Interviewee

The ecoENERGY program has funded renewable energy projects that will reduce diesel fuel use for electricity generation; reduce heating fuel use; lower operating costs; and improve energy efficiency for many different communities. For example, in Abegweit First Nation, solar panels installed on the band office reduced energy bills for the office by 35 percent in the first month of operation (April), by 23 percent in the second month (May) and 35 percent in the third month (June). This reduction in energy costs allowed administrators to contribute a larger amount of money towards high residential heating bills. The experiences of Abegweit First Nation show that projects undertaken through Stream B have small but immediate positive impacts on a community.

Additionally, one community visited during the evaluation was struggling to pay heating bills for its school that exceeded $30,000 dollars annually. As a result, the community undertook a geothermal heating project, funded by ecoENERGY, which was projected to reduce the school's energy cost by 40 percent (approximately $12,000). Another community visited during the evaluation installed a biomass boiler that in its first six months of use, from January 2014 until the summer months, reduced heating costs for buildings serviced by the boiler by approximately 50 percent.

[101] Senate Standing Committee on Energy. The Environment and Natural Resources. Senate Standing Committee Meeting, April 29, 2014

Figure 5: Nakzadil First Nation's biomass project heating the community centre.

In the Yukon, the Kluane First Nation is undertaking a wind-diesel project that it plans to commission in 2015. The project will produce 650 MWH per year and displace approximately 27 percent of the diesel fuel consumed by two communities, resulting in an estimated savings of over $200,000 dollars per year in fuel costs.[102,103] Finally, a solar project partially supported by ecoENERGY for the Deer Lake First Nation, is reportedly resulted is savings of $10,000 per month by the Keewaytinook Okimakanak Tribal Council.

[102] Standing Senate Committee on Energy, the Environment and Natural Resources. Senate Committee Meeting, April 29, 2014.
[103] Natural Resources Canada, Strategic Energy Policy Division. 2014. Supporting Energy Innovation and Responsible Energy Use in Canada: An Assessment of Natural Resources Canada and Aboriginal Affairs and Northern Development Canada's ecoEnergy Programs and Enabling Policy.

Figure 6: Photos of Deer Lake Solar Project from CBC News[104]

Some communities were inspired by the cost savings to undertake additional renewable energy projects. For example, one community visited during the evaluation received funding to install solar panels for their band office and after seeing the resultant cost savings, installed additional solar panels on other community buildings (without ecoENERGY funding) to reduce energy costs for the community.

Multiple communities utilized their ecoENERGY funded renewable energy project to build capacity and create employment

Renewable energy projects can, in some circumstances, result in temporary employment opportunities during construction phases and limited permanent employment during the operation of the renewable energy system. Evidence compiled through case studies, anecdotal examples provided by interviewees, and media articles detailing successful projects show that multiple ecoENERGY funded renewable energy projects have resulted in both short- and long-term employment for community members. For example, the Alderville First Nation Solar Farm, detailed above, provided temporary employment for over 20 community members during its construction phase and is expected to provide the community with long-term employment during its operation.[105] Likewise, the Nak'azdli First Nation, who implemented a biomass

[104] CBC News, "Deer Lake First Nation installs ground breaking solar power." Available at http://www.cbc.ca/news/aboriginal/deer-lake-first-nation-installs-ground-breaking-solar-power-1.2612179. Accessed February 9, 2015.
[105] Natural Resources Canada, Strategic Energy Policy Division. 2014. Supporting Energy Innovation and Responsible Energy Use in Canada: An Assessment of Natural Resources Canada and Aboriginal Affairs and Northern Development Canada's ecoEnergy Programs and Enabling Policy.

renewable energy system with funding from ecoENERGY trained and hired (on a part-time basis) five community members to maintain and operate the system. Interviews suggest that this project will implement additional biomass facilities and eventually make these positions full-time. While these positions are few in number, they are located within the community and involve training and skill development, which increased the capacity of the community to independently maintain and operate these facilities.

In multiple communities, the construction of renewable energy projects also resulted in new opportunities for mentorship, skills development and the acquisition of new qualifications for individuals. For example, the Taku River Tlingit First Nation, although funded under the previous ecoENERGY program, provided a good example of how the construction of a renewable energy project could be leveraged to increase community employment opportunities. During the micro-hydro facility's construction, community members were trained in hydrology and stream flow, soil testing, concrete testing, welding inspection, general project management, field inspections, contract management, construction and trades. Project leaders also provided opportunities for community youth to job shadow contractors on-the-job; this opportunity, according to interviewees, provided local youth with valuable job experience and encouraged them to consider different career paths.

Also funded under the previous ecoENERGY program, the T'Souke First Nation while installing its solar panel project ensured that its community members were trained in the installation and maintenance of solar panels. The training that its community members received has resulted in employment for these community members, who now install and maintain solar panels in neighboring communities. The Eel Ground First Nation in New Brunswick, while constructing a new school with a geothermal heating system funded by ecoENERGY, ensured that its contractor implemented a mentorship program for community members hired to work on the project. As a result, multiple Eel Ground First Nation community members received valuable training, certifications and experience that could improve future employment opportunities.

Opportunities to utilize infrastructure projects, including the construction of renewable energy systems, to build capacity and create employment was noted as a best practice in the Evaluation of the First Nations Infrastructure Fund, completed in April 2014. Similar to the examples included above, the evaluation noted that there were First Nations Infrastructure Fund projects that invested in building the knowledge and skills of First Nation community members.[106] However, for successful projects, both in First Nations Infrastructure Fund and ecoENERGY, the drive to utilize the opportunity presented by the construction/operation of a renewable energy system to develop capacity and increase community employment came from the communities themselves. The Evaluation of the First Nation Infrastructure Fund noted that "the projects demonstrated the opportunity for AANDC to support future infrastructure investments that incorporate sophisticated training components into project contracts."[107] A similar opportunity exists for the ecoENERGY program to encourage communities to ensure renewable energy projects result in employment and skills development opportunities for community members.

[106] Aboriginal Affairs and Northern Development Canada. 2014. Evaluation of the First Nation Infrastructure Fund. Accessed at http://www.aadnc-aandc.gc.ca/eng/1414522582745/1414522638694. P57

[107] Aboriginal Affairs and Northern Development Canada. 2014. Evaluation of the First Nation Infrastructure Fund. Accessed at http://www.aadnc-aandc.gc.ca/eng/1414522582745/1414522638694. P57

Social Impacts

Completed projects are a source of pride and inspiration for taking on other economic development opportunities.

Communities visited during the evaluation noted that Stream A renewable energy projects were daunting challenges that became a great source of pride for the community, once they were completed. These large-scale renewable energy systems were described by one project leader as "game-changing projects," because they provided communities with the knowledge that they were capable of taking on projects of this scale. As a result, many communities who have successfully completed Stream A renewable energy projects are now using the skills they have developed during such projects to pursue new development projects, including some outside of their community. Completed ecoENERGY projects also resulted in increased pride and capacity for individual community members who had received training and employment in the construction or operation of the renewable energy system. In one community, a project leader stated that a community member who had become a plant operator had become a more involved member of the local community: prouder, more engaged, more willing to share of themselves, and more willing to train youth in the community.

Larger projects tended to engage more of the local community and to garner more attention from neighboring municipalities, provincial governments, the private sector and other Aboriginal and northern communities. In some cases, other nearby Aboriginal and northern communities have been inspired to investigate possible renewable energy systems for their communities.

Renewable energy projects have resulted in discussions and educational initiatives regarding energy use and climate change.

The renewable energy projects undertaken by Aboriginal and northern ecoENERGY recipient communities have brought greater prominence and visibility to energy consumption and climate change within many communities. In multiple instances, communities have used their projects to initiate discussions regarding energy usage and to develop educational programs for community youth. For example, the Nak'azdli First Nation constructed a tower to monitor wind speed in the area to determine if a wind project would be viable. The project leader engaged students from the community school to monitor the findings of the wind tower for a class project. Both Lennox Island First Nation and the T'Souke First Nation have also used their solar panel projects to provoke discussions about sustainability in the community, and have used their projects to educate students about solar energy and climate change.

Health and Safety Impacts

Renewable energy projects in diesel-dependent communities reduce the likelihood of contamination and associated liabilities

The use of diesel powered generators comes with significant risks for contamination from fuel spills and leakages. Large amounts of diesel are transported to off-grid Aboriginal and northern communities where it is stored in community owned fuel tanks prior to use. The transportation

and storage of diesel fuel can result in contamination through accidents during transportation as well as leaks from improper storage. In fact, the storage of diesel in off-grid Aboriginal and northern communities has increased in risk to the point that Canada's Commissioner of the Environment and Sustainable Development has identified spill clean ups as a major, and largely unacknowledged federal liability.[108] When diesel spills occur, the entire community can be impacted as the contamination spreads and can migrate to the water table, which can create risks to health from ingestion of toxins.[109] Additionally, oil contamination can kill wildlife and damage the local ecosystem, which can result in economic hardship for communities who rely on the land for food and/or income.[110] While fuel tanks are owned and operated by Aboriginal and northern communities', responsibility for sites contaminated by diesel fuel rests with AANDC. As a result of the high number of diesel spills, the Department has undertaken steps to replace diesel fuel tanks to reduce the number of spills that occur.

The transition to renewable energy sources will reduce these environmental and health risks for remote and northern off-grid communities. For example, one community that implemented a renewable energy system to replace their diesel powered generator as the main power source for the community noted that the reduced need to transport, store and burn diesel in the community is a positive outcome for the community. Further, Natural Resources Canada notes that "the environmental risks related to diesel fuel transportation and storage, such as diesel fuel spills in arctic and inland waters, or accidents on ice roads and air pollution from diesel generators, will be decreased within communities that are able to reduce or displace significant amounts of the fuel as a result of implemented renewable energy and energy efficiency measures."[111]

Finding 9: ***The current proposal-based design encourages a vendor-driven funding model instead of targeting communities with the greatest needs.***

The ecoENERGY program accepts applications from communities between February and March each year. The program announces this request for proposals on AANDC's website and through letters sent to band offices. To apply for project funding, proponents must submit a Funding Application, a Project Budget, a Letter of Support (such as a Band Council Resolution showing a quorum of support for the project), and a RETScreen analysis, which provides an assessment of the proposed renewable energy system, including a cost analysis and emissions analysis.

[108] Christopher Henderson. 2013. Aboriginal Power: Clean Energy and the Future of Canada's First Peoples. Erin, Ontario, Rainforest Editions.
[109] Lumos Energy and Delphi Group. 2013. Wataynikaneyap Power Project Impacts and Benefits Analysis.
[110] Lumos Energy and Delphi Group. 2013. Wataynikaneyap Power Project Impacts and Benefits Analysis.
[111] Natural Resources Canada, Strategic Energy Policy Division. 2014. Supporting Energy Innovation and Responsible Energy Use in Canada: An Assessment of Natural Resources Canada and Aboriginal Affairs and Northern Development Canada's ecoEnergy Programs and Enabling Policy.

In the current funding model, communities present an application for a project and if approved, are provided the funding to complete the project with no requirements to engage in a tendering process. Of the site visits completed by evaluators, it was evident that proposals for ecoENERGY projects were often developed by the vendors themselves rather than the recipient communities. In many instances, a vendor who was knowledgeable about AANDC's ecoENERGY program approached a First Nations or northern community with an idea for a specific renewable energy project that it thought would be suitable. Upon gaining the community's support, the vendor then applied for ecoENERGY funding on behalf of the Band Council. Although evaluators were originally concerned that this environment would be conducive for vendors to take advantage of communities and the federal funding available, site visits demonstrated that the opposite was true. Even where project ideas and the project proposal were developed by a vendor who specialized in a particular area of renewable energy technology, evaluators noted that contractors were extremely invested in the projects. Smaller companies were particularly concerned with ensuring a positive experience for the recipient First Nation community in order to promote their businesses to other First Nation communities. Evaluators saw examples of training and mentorships being provided to community members as well as contractors arranging for community meetings in order to engage all stakeholders in the projects. In one large scale project, the contractor even became a project share-holder.

"We completed the proposals for the First Nation… The nations are focused on other things. They want to move forward on these things, but they just don't have the capacity. No one wants to pay a consultant to complete a proposal. But the community needs the capacity – it would be poor applications without it." – Project Contractor

In one particular region, it was evident that the same contractor was seeking to complete the same type of renewable energy project in all First Nation communities in the area utilizing ecoENERGY funding. In reaction, program management carefully screened the similar project proposals and implemented a new policy that requires all contractors to let communities know when they are working with several communities at the same time. Evaluators interviewed multiple contractors who were currently providing services to First Nation communities and were satisfied that they were genuinely passionate about renewable energy technologies and respectfully engaged with the communities. However, the proposal-based design could be vulnerable to manipulation by contractors in the future. In one community visited by evaluators, it was clear that a particular type of renewable energy technology was being pushed by the interested contractor without considerations of alternative designs. In such instances, the best-fit technology may not always be provided to communities, especially if the contractor that completed the proposal on behalf of the community is invested in one particular kind of renewable energy.

Due to the technical aspect of the ecoENERGY program, band office interviewees indicated that they often feel isolated and vulnerable when trying to choose the right contractor and the right project for their community due to their lack of technical expertise. Similarly, since the ecoENERGY program is centralized at Headquarters, AANDC regional staff have not been involved in providing advice in this area. For this reason, many communities have utilized a third party project management firm to complete project proposals. This reality arguably discourages

low-capacity communities from applying for projects. One First Nation Economic Development Officer interviewee went into great detail to explain the research he needed to complete to understand the renewable energy technology available, the firms in the area, the costs associated with construction and the return on investment in order to select the right project for his community. For him, the research and knowledge that was necessary for completing a project proposal was overwhelming. Other interviewees also noted that communities with the greatest need (typically remote, off-grid communities), may not have the capacity to complete a RETscreen analysis and may not have access to third party project management firms or renewable energy construction companies to take-on the project. This feedback suggests that small and more remote communities with less access to contractors and equipment would find the ecoENERGY application process challenging to complete, putting them at a disadvantage.

Furthermore, the proposal-based design of the ecoENERGY program limits the ability of the program to fund multiple components or phases of larger scale projects. Instead, different project components or phases must be submitted as separate projects with no guarantee all will be funded. When only one project is considered at a time, within restrictive funding criteria, it does not allow for more efficient funding allocations, such as funding multiple project stages. For example, in one community, only a small portion of the school could be heated by the geothermal project because the project proposal was tailored to meet the funding cap of the program. Although the project will provide substantial cost savings for the school, a larger investment would have secured a much greater return on investment if the entire school was heated by the geothermal design. The ecoENERGY program does encourage communities to seek funding from other sources in order to increase the funding available for renewable energy projects, however, in this case, the community was either unable or unwilling to find other funding. Similarly, after speaking with the contractors on-site, evaluators were informed that although the geothermal project was an excellent investment, the return on investment would have been higher if options such as a more efficient boiler and the installment of new windows had been considered instead. Although the contractors wanted to provide the community with the best option to decrease their school's heating costs, this was the only funding source they could find and the use of renewable energy technology was required. In this instance, the contractors picked the more expensive construction option in order to fit within the funding available and the associated funding criteria.

"Communities usually don't have experience in energy and clean energy development. They need project management support to build that capacity." – Project Contractor

For one community visited by evaluators, the project management firm that has been working with the community for years on multiple construction initiatives was able to manage a Request for Proposals process for the construction of a school that included a geothermal heating component funded by the ecoENERGY program. In this instance, the project management firm was able to pick the highest-ranked proposal instead of the cheapest proposal, which allowed for a large mentoring component as well as the training and certification of hired community members. As noted in a previous evaluation of AANDC's First Nation Infrastructure Fund, the ability to incorporate a project ranking tendering process based on the quality of the contractor and the additional

benefits available to the community is a best practice for maximizing project outcomes. However, such a best practice can only be applied to larger scale projects to ensure that it does not become a tedious and bureaucratic funding mechanism.

Based on these insights and best practices, evaluators recommend that the current proposal-based design be reviewed and modified to allow for a targeted funding strategy, and assistance be provided to communities to undertake a purposeful selection of projects and contractors that will provide training and mentoring for community members. Similar to best practice noted in the 2010 impact evaluation that developing community energy plans before embarking on large renewable energy and energy efficiency projects allows for more effective projects,[112] this evaluation encourages an even greater breadth of coordination. Specifically, the ecoENERGY program may benefit from moving away from funding ad hoc projects to funding communities to move along an energy development continuum that first ensures existing infrastructure is as efficient as possible, to completing studies and related assessments for choosing a renewable energy system to finally implementing the most viable renewable energy option.

Recommendation 3: It is recommended that the ecoENERGY program consider the following in any future program re-design:

a) Remove restrictive funding streams and maximum project allotments.
b) Review the proposal based approach.
c) Develop an approach for targeting communities with the greatest need.
d) Support projects that integrate renewable energy systems into existing diesel systems to reduce the consumption of diesel fuel.
e) Provide the needed support to communities in assessing and advancing the suitable renewable energy and/ or efficiency project.

<u>Finding 10:</u> ***Although some work to align ecoENERGY with existing AANDC, Natural Resources Canada and Canadian Northern Economic Development Agency programming is occurring, there is a need for partners to better coordinate their renewable energy investments and support provided to off-grid Aboriginal and northern communities.***

AANDC has acknowledged for years that "What is needed for [renewable energy projects] to be successful in Canada is for Natural Resources Canada, ecoENERGY for Aboriginal and northern communities, the federal government, northern governments, northern utilities, and the communities themselves to have clearly defined roles in the process."[113] Previous evaluations of ecoENERGY and similar targeted energy funding programs such as AANDC's First Nation Infrastructure Fund have noted the necessity for infrastructure programs within AANDC and across the federal government to be better coordinated to achieve common objectives.[114]

"We would like to explore doing something off-reserve with the neighbouring municipalities." – Atlantic Case Study Interviewee

[112] AANDC (2010) "Impact Evaluation of the ecoENERGY for Aboriginal and Northern Communities." Available at: https://www.aadnc-aandc.gc.ca/eng/1324568257836/1324568315205. Accessed June 5, 2014.
[113] "Discussion on Wind-Diesel Projects in Remote Communities in Canada" (AANDC, October 2012
[114] Notable recommendations from the AANDC 2014 Evaluation of the First Nations Infrastructure Fund (FNIF):

Departmental interviewees acknowledged that the Department has made an effort to better align its programming through the creation of working groups, which share and discuss approved projects. However, some interviewees and experts in the field indicated that information sharing is not enough, and that a practical approach to coordinating the various stakeholders, programs and funding sources is necessary.

Similarly, evaluators noted that there are many stakeholders working in remote Canadian communities to complete research and to develop innovative renewable energy technologies. The challenge is that although activities and efforts are overlapping, the need remains high, the funding available is comparatively low, and the coordination between stakeholders is typically limited to merely sharing information. To demonstrate this finding, evaluators developed a chart to highlight related stakeholders and programming and to identify practical opportunities to further align activities to promote the development and use of renewable energy technology in Canada. This chart is included in Appendix A.

In addition to the various renewable energy government research and funding programs available, Canada's academic institutions are also highly focused on researching renewable energy technologies and how to adapt proven technology to Canada's northern environment. Evaluators came across a number of educational institutions and research centers, which are noteworthy for the ways in which their networks and partnerships with other academics, private industry, and government programs encourage innovative research projects and provoke momentum in the field of renewable resource technologies across Canada. A chart detailing the work of these institutions is included in Appendix A.

Through its three iterations, the ecoENERGY program at AANDC was found to not only have longevity but to have attracted highly-qualified staff that are engaged in pursuing partnerships with many of the above-mentioned stakeholders. Similarly, many of the above-mentioned programs have used the lessons learned and best practices modeled by the ecoENERGY program to identify their own objectives and formulate their own programming. Over time, the ecoENERGY program has worked with and supported other stakeholders in developing a coordinated approach to providing programming.

Unfortunately, despite valiant efforts, practical coordination of programming has been ad-hoc and predominately focused on information sharing. Evaluators were made aware of AANDC's long history of trying to bring partners together to solidify a departmental strategy for off-grid communities; this history is summarized in the following historical timeline:

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(1) The FNIF proposal-based program design posed numerous challenges which could be mitigated by incorporating FNIF project proposals into the Department's annual National Capital Planning Process and strengthening the priority ranking criteria of the First Nations Infrastructure Investment Plan's "Community Infrastructure" component.
(2) Performance Measurement is a continuing challenge for infrastructure programming. There is a need for a concerted effort to rectify the shortfalls of the Information Technology tracking applications to encourage their consistent use.
(3) Strategic relationships with University Planning and Engineering Departments has allowed for important partnerships when designing and implementing infrastructure projects.
(4) The regional delivery method of using existing Capital Facilities and Maintenance Program human resources to implement FNIF projects was found to be the most effective and efficient approach.
(5) Opportunities exist for improved departmental programming collaboration in the areas of community planning, disaster mitigation, completing energy feasibility studies, and engaging in infrastructure and physical land use planning to support economic development.

Table 4: History of AANDC's Action on Off-Grid Community Strategy

Date	Activity
2005	AANDC and Natural Resources Canada deputy ministers developed a work plan to address off-grid, remote communities
September 2009	*INAC Off-Grid Framework: An Action Plan within INAC to Address Sustainable Energy in Aboriginal and Northern Off-Grid Communities*, prepared by ecoENERGY
2009 – 2011	*AANDC Off-Grid Framework Working Group* developed and led by ecoENERGY Participants included staff from AANDC-related programs, regional offices, Defence Research Development Canada, Natural Resources Canada, including the Canada Centre for Mineral and Energy Technology – Varennes, National Research Council, Nunavut Government, Government of British Columbia, Government of Ontario
June 22, 2011	**Aboriginal Participation in the Clean Energy Sector – Arm Chair Discussion** National meeting of departmental officials convened to explore options for improving coordination with respect to opportunities for Aboriginal communities in the clean energy sector
June 29, 2011	***Sustainable Energy Project Development in Aboriginal Off-Grid Communities: Analysis of Long Term Costs and Benefits,* SGA Energy Ltd and Green Eagle Services** funded by Strategic Initiatives and Program Integrity Directorate and Environment and Renewable Resources Directorate
August 2011 (document last updated March 2012)	***AANDC Off-Grid Strategy: Addressing Sustainable Energy in Aboriginal and Northern Off-Grid Communities*** developed by ecoENERGY
May 10, 2012	***Off-Grid Energy Strategy*** updated: ***A Sustainable Solution to the Challenges Faced by Diesel Communities (Phase I)***
March 28, 2014	***Off-Grid First Nation Communities – Energy Infrastructure Strategy*** prepared by the Community Infrastructure Branch

As demonstrated in the above table, AANDC has been working both internally and with key federal partners since 2005 to define a strategy for targeting funding in off-grid Aboriginal and northern communities. However, initiatives have been led by multiple stakeholders, including the ecoENERGY program, the Environment and Renewable Resources Directorate, the Strategic Initiatives and Program Integrity Directorate and the Community Infrastructure Branch. The

most recent work to formalize an Off-Grid First Nation Communities Energy Infrastructure Strategy remains in draft form, and there is little momentum left to finalize the strategy. Similarly, interviewees stated that the renewable energy industry, especially in off-grid communities, is crowded with stakeholders that have minimal funding, and are unable to coordinate funding, capacity and knowledge to bolster more efficient joint projects. Evaluators have noted that AANDC has struggled to develop a practical action plan on how to support and fund energy projects in the 175 off-grid communities under its mandate.

"The Department needs a reason to be bold." - Interviewee

In light of these findings, evaluators recommend that the ecoENERGY program, in partnership with the off-grid infrastructure team in AANDC's Community Infrastructure Branch, develop a rubric for ranking the 175 off-grid communities under AANDC's mandate. Based on the results of this ranking exercise, the highest priority communities could be targeted to develop a practical five-year work plan that brings together the expertise and investments of previous planning exercises and all current stakeholders. The intended result would be a strategically-staged research and funding approach involving relevant federal funding sources, such as Natural Resources Canada and Canadian High Arctic Research Station (CHARS), to support communities so that they can move seamlessly from research, to pilot project, to the operation of a renewable energy system.

"The next step [for AANDC] is trying to leverage timing and funding to better support community priorities." – Interviewee

Evaluators recognize that this recommendation is neither new nor is it a simple undertaking. However, a manageable and practical approach with sustained momentum is necessary to gain traction in these communities. Evaluators are particularly keen to encourage a strategic action plan, because AANDC's ecoENERGY program has limited funding and a small team. The program's large mandate will only become more daunting as the program looks to focus on more projects in off-grid communities, which due to their geographic remoteness require greater resources, especially those situated in the North. Industry experts confirm that completing renewable energy projects in the North will be at least three times the cost of typical southern projects because experts and necessary equipment are rarely available up North. Experience has demonstrated that it is extremely difficult to implement renewable energy technologies in off-grid First Nation communities. There is the need for technologies to be adapted to the northern climate, and the need to cultivate a high level of expertise in the community so that the new energy system can be maintained or fixed, if it should malfunction or fail. Similarly, each project will need a different approach and a more hands-on role from program staff.[115] As the program shifts to target off-grid communities often located in severe northern climates, it will be even more essential to rely on partnerships and a highly coordinated approach that is supported by senior management, to ensure momentum in finalizing a sustainable work plan.

Recommendation 4: It is recommended that ecoENERGY establish a process for developing an *Engagement and Collaboration Strategy* for each off-grid community it targets, ensuring that

[115] "ecoEnergy Program: Stakeholder Interview Results" (The Delphi Group, assisted by Lumos Energy, March 2014.)

activities and investments by AANDC, federal partners (e.g., Canadian Northern Economic Development Agency, Natural Resources Canada, CHARS) and other levels of government, are coordinated to allow for communities to seamlessly go from research, to pilot project, to final, completed project.

Considerations for Operations Committee 1: The Department, in partnership with federal partners (e.g., Canadian Northern Economic Development Agency, Natural Resources Canada, CHARS) and other levels of governments, explore developing a central five year tracking system to identify activities and investments in all off-grid Aboriginal and northern communities to increase strategic collaboration.

Considerations for Operations Committee 2: The Department explore developing a departmental Sustainable Energy Policy that:

a) Supports the design, construction and implementation of renewable energy systems that supply energy to communities within AANDC's mandate; and
b) Promote the funding of small-scale infrastructure projects that increase energy efficiency in order to decrease energy demand (i.e. replacing windows, boiler systems, insulation, etc.)

Considerations for Operations Committee 3: The Department explore developing a system for tracking and organizing funded community planning documents and feasibility studies (e.g. Energy Audits, Infrastructure Plans, Emergency Management Plans, Climate Change Adaptation studies, Comprehensive Community Plans, etc.) in order to better preserve funded work and support future infrastructure development decisions. AANDC's Strategic Research Branch may be in a position to develop such a centralized database as one of their departmental Research Tools.

<u>Finding 11:</u> ***The Headquarters centralized program delivery approach could be improved by coordinating the development and implementation of targeted projects with regional staff in the Community Infrastructure Branch.***

Under the ecoENERGY program's current design, ecoENERGY staff at AANDC Headquarters review community applications and make funding decisions, with contribution amendments made by a network of contacts in AANDC's regional offices. ecoENERGY regional contacts work in a variety of branches throughout the Department, including Lands and Economic Development and the Community Infrastructure Branch. The relationship between ecoENERGY Headquarters staff and their regional contacts varies; some regional contacts are very involved with ecoENERGY projects and others focus solely on transferring program funds. Where strong relationships exist, Headquarters staff often consult with regional contacts on potential projects and seek their opinions on which projects offer the greatest potential for success.

Ultimately, the inconsistency of regional involvement results in a lack of detailed regional knowledge being taken into consideration during the project approval stage; this can impact the management of funding agreements in the affected region. The ecoENERGY Program Risk Profile from 2011 identified this lack of consistency as a Risk Driver, noting that "consistent processes do not exist for the regions to manage their flow-through funding and make related decisions to release funds. Lag times are evident between project approval and the signing of the

formal funding agreements."[116] The potential consequences of this risk could be "delays in setting up funding agreements, as well as making any required adjustments" and it "may cause project delays and could result in cash management issues for those recipients without sufficient cash flow."[117] This issue was also noted by a project management consultant involved with multiple ecoENERGY projects who felt that the disjointed process between Ottawa and the regions was a real hindrance to the success of renewable energy projects because they are time sensitive.

This evaluation found that the regional contacts in the Community Infrastructure Branch were most involved in the regional delivery of ecoENERGY projects. The natural linkages between the construction of renewable energy projects in communities and the work of the CIB meant that the regional contacts were able to make effective linkages between current infrastructure developments and ecoENERGY projects. Additionally, the technical expertise residing in the CIB allowed regional contacts to provide effective support to communities undertaking renewable energy projects through ecoENERGY. By solidifying and expanding this approach of providing regional support in the development of ecoENERGY projects, AANDC would be able to maximize its return on investments by ensuring projects received the right guidance. In order to capitalize on this capacity, evaluators note two possible courses of action: 1) develop an agreement with Regional Operations so that CIB staff will formally support ecoENERGY project development; or 2) relocate the ecoENERGY program under the Regional Operations Sector as already articulated in AANDC's Program Alignment Architecture.

In support of the first option, multiple regional coordinators expressed that while their current role was simply to transfer funds to projects, they would be interested in a greater role and greater communication with Headquarters staff regarding the project approval stage. In their view, greater communication and coordination between Headquarters and the regions would lead to better project selection and more tailored support to recipient communities. The Aboriginal and Northern Community Action Program, which operated from 2003 - 2006 and preceded the development of the ecoENERGY program, had dedicated program staff in regional offices. However, this system was determined to be inefficient and unsustainable, considering limited program funding, and was eliminated in the current iteration of the ecoENERGY program. To address these concerns, the ecoENERGY program could develop a hybrid model of regional participation with CIB, by formalizing a regional network of CIB staff members, including existing engineers and infrastructure project management specialists, to support ecoENERGY project designs.

Alternatively, the coordination between ecoENERGY Headquarters staff and their regional contacts could be dramatically improved by relocating the ecoENERGY program from the Northern Affairs Office to the Regional Operations Sector under the CIB while maintaining funding authorities that allow the program to still operate both north and south of the 60th parallel. ecoENERGY's current location in the Northern Affairs Organization isolates it from other sectors in the Department as well as the regional offices, limiting its ability to partner with other sectors and leverage additional funding. In contrast, the CIB undertakes infrastructure projects and has the technical expertise at the regional level that could facilitate the incorporation

[116] Aboriginal Affairs and Northern Development Canada. 2011. ecoENERGY Program Risk Profile.
[117] Aboriginal Affairs and Northern Development Canada. 2011. ecoENERGY Program Risk Profile.

of renewable energy technology into a greater number of priority infrastructure projects already approved for funding. Further, the CIB has regional staff throughout Canada who could play a vital role in promoting the ecoENERGY program to communities and supporting project management on-location.

If this second option was pursued, it must also be noted that the CIB only operates south of the 60th parallel and the ecoENERGY program would need to rely heavily on the Canadian Northern Economic Development Agency to support the administration of the northern portion of the ecoENERGY program. Canadian Northern Economic Development Agency would be an appropriate partner for the ecoENERGY program because the Terms and Conditions of Canadian Northern Economic Development Agency's Strategic Investments In Northern Economic Development Program allows for communities to access funding for studying and constructing renewable energy projects.

Recommendation 5: It is recommended that the Assistant Deputy Minister of Northern Affairs work with the Assistant Deputy Minister of Regional Operations to improve coordination of funding renewable energy projects in Aboriginal communities occurring within the Community Infrastructure Branch and the ecoENERGY program.

Finding 12: ***Streams A and B provided funding for necessary studies and projects; however, opportunities exist to move away from rigid funding categories to funding the right stage on the renewable energy development continuum that promotes the movement from studies to tangible infrastructure.***

AANDC's first iteration of the ecoENERGY program commenced in April 2003 and since that time, recipient communities have implemented various types of projects, including Community Energy Plans, feasibility studies, and the installation of small scale renewable energy projects to support a portion of a community building's electricity or heating needs. Site visits to numerous ecoENERGY- supported communities demonstrated to evaluators that the renewable energy field of study is vast, and with regards to Stream A projects many preliminary studies and environmental assessments are necessary to get a project from conception to implementation. Communities have little guarantee that a project will ever be completed and provide the energy and cost savings desired.

The small ecoENERGY Headquarters staff working within the set one-year funding parameters, have carefully distributed funding agreements to a wide breadth of projects across Canada. At the same time, they have recognized that some communities need multi-year funding to secure the success of a large scale renewable energy project.

However, despite these efforts, the substantial number of studies and assessments that are necessary to develop a large scale renewable energy project means that communities can become stuck and lose momentum in the project development phase.[118] Of the 43 communities that received Stream A funding between April 2011 and November 2014, three communities have operational projects, three have projects under construction, three are intending to begin construction imminently, and 28 communities are still conducting further assessments or waiting

[118] Views expressed by firms working in the field of conducting feasibility studies for communities.

for another funding source. Stream A projects commonly take approximately five to ten years to develop and as a result, the 28 communities, without sustained funding sources, are at risk of losing momentum and stalling at the pre-assessment phase. In some cases, the renewable energy technology proposed for these communities may not be the most economical solution; in others, the additional costs associated with getting a project ready for securing private financial investment for construction presents a significant challenge.

Similarly, for communities that complete a feasibility study, only to discover that the project they envisioned is not feasible, the results can be discouraging. In one of the communities visited by evaluators, the ecoENERGY funded project was found to not be feasible. As a result, the community was discouraged and ceased its pursuit of a renewable energy system, including other viable options. After discussions with the Chief, evaluators noted that the ecoENERGY program is in need of a risk mitigation strategy for when projects are found to not be feasible, in order to maintain positive departmental relationships with those affected communities. Evaluators have also noted that a potential program re-design that focuses on supporting communities to move along a renewable energy continuum may help to mitigate these difficult scenarios.

According to the International Energy Agency, a renewable energy program can only thrive if it is operating within a policy environment that promotes a full spectrum of support from the research stage through to project implementation.[119] Yet, ecoENERGY's current proposal-based approach, as well as a lack of capital funding for large project construction, does not allow for the Department to support communities in moving along this continuum. AANDC's British Columbia region's emerging Community Development Strategy and AANDC's commitment to the Indigenous Community Development Framework should encourage ecoENERGY to consider the benefits of moving away from a project-focused design to a community-focused approach that supports communities' movement along the renewable energy development continuum. A targeted community-based approach may also help to mitigate the current relationship risks involved when a feasibility study finds a project not feasible, because it would ensure that the program remains involved in identifying alternative solutions for the affected community. Using a greatest-need ranking rubric that would take into consideration communities' remoteness, energy costs, dependence on diesel, age and quality of current diesel infrastructure, potential economic development opportunities, and how favorable provincial policies are for renewable energy development, the program could provide larger investments to fewer communities each year. This more strategic approach could kindle project development while coordinating other federal and provincial partners to ensure that a successful renewable energy solution is underway before funding the next community with the greatest need and a desire to pursue renewable energy solutions.

"I would like to see a more targeted approach for program. I want to see the Department targeting communities and supporting them through the process." – Community Leadership Interviewee

[119] International Energy Agency (2011) *Renewable Energy Markets and Policies: Deploying Renewables Best and Future Policy Practice*, Organization for Economic Cooperation and Development (OECD)

Although some interviewees argued that small investments across Canada through a proposal-based design program allow motivated communities to access funding and a larger number of communities to participate in the program, evaluators noted that there are many small funding opportunities for communities to take advantage of at the provincial level, as demonstrated in Appendix B. A targeted niche approach would ensure clearer roles and responsibilities between the main active players in the field and reduce the potential for program duplication (as demonstrated in Appendix A).

Additionally, the current proposal-based design forces a community to first determine what type of project they would like to pursue before completing a proposal to secure funding.[120] This can be problematic as interviews with community members demonstrated that project managers in band offices can often feel overwhelmed by the choices available, which include: solar, wind, micro hydro, geothermal, biomass, heat recovery systems, fuel cells, energy storage devices, smart meters etc. Due to the availability of resources, technology costs, potential cost-savings and the experiences of other communities, a particular renewable energy technology may appeal to a community. However, as demonstrated by the literature review (refer to Appendix C: *Cost Benefits of Renewable Energy Technologies*), the best choice often depends on a wide spectrum of considerations that are unique to each community, and may also involve a combination of technologies. Additionally, the best solution may be to first engage a funding partner to monitor the recipient community's energy usage through the installation of smart meters, and then consider small building upgrades to address energy wastage and maximize energy conservation before commencing the development of a renewable energy project.

The ecoENERGY program may benefit from moving away from specific streams to a three step process: first, determining priority communities; second, fund the assessment of best-fit renewable energy options for those targeted communities; and finally implement the most viable renewable energy option. A similar program design was utilized by Alaska's Energy Authority. The first step was to complete an assessment that considered various renewable technologies and how different combinations of technology and storage sources might be combined to maximize the energy potential according to each community's unique environmental and economic conditions. A number of scenarios were evaluated for each community to determine the highest renewable energy penetration level that would be technically and economically viable. If ecoENERGY were to emulate this approach, it would have to move away from funding studies that determine the viability and cost of a *single* particular renewable technology option, and instead fund an assessment of different technology scenarios to determine the optimal technical and economic solution for each community. The availability of proven computer modeling such as HOMER software[121] allows communities to design hybrid renewable micro-grids whether remote or attached to a larger grid.

[120] Note: Although the previous ANCAP program as well as additional federal and provincial programs have historically funded the development of community energy plans, often these plans are lost by the community.
[121] HOMER Software analysis is required for approval for all projects funded through Alaska Energy Authority (see http://www.akenergyauthority.org/programwindreports.html)

By promoting a community-focused approach and funding the assessment of the best-fit technology for a targeted community, the ecoENERGY program would be able to support communities in moving from studies to operational renewable energy projects. During these stages of support, the program could also provide additional community-enhancing benefits such as educational information to spread awareness of renewable energy technologies and engaging community members in the design and development of projects. For example, education initiatives like those undertaken by the Nakzadil First Nation, which allowed elementary school students to participate in the collection of solar and wind data, or the training and mentoring of community workers, as seen in Eel Ground and T'Souke First Nations, could be expanded to all ecoENERGY projects. Using the development of renewable energy technologies as a springboard for job and knowledge creation was also highlighted in the literature review.[122,123]

<u>Finding 13:</u> ***Opportunities exist to increase communities' knowledge, capacity and confidence to undertake projects by promoting knowledge-sharing initiatives and mentorships.***

As communities undertake renewable energy projects, with the current limited support from AANDC's regional office staff, they can encounter significant challenges related to managing such large and technical projects. Case study interviewees revealed that they felt nervous and isolated when undertaking renewable energy projects, particularly at key steps in the process such as: finding contractors, identifying the right renewable energy technology to fit their needs and overseeing project management.

In the case of many renewable energy projects, such as micro-hydro or large wind/solar farms, communities have to navigate the challenging environment of pre-feasibility/feasibility studies, obtaining environmental regulatory approval, facility engineering/design and securing private sector financing for the construction of the project. Communities who have achieved success in developing such projects have, in many cases, gone through a long and intensive process of learning on the job. The project leaders have often worked tirelessly to continually champion the development of the projects and manage the projects through the many steps and hurdles of project fulfillment. As many communities are interested in pursuing projects using similar renewable energy technologies, the experience and knowledge developed by communities who have completed such projects could be extremely

> **"It is critical to have a champion. Even if the community doesn't have the capacity, they can still have a champion to communicate with community members. A lot of federal applications look for a chief name on the form, but the champion that's engaged with the community is the most important name. These projects are too complicated to achieve without these people. [The Department] needs to be nurturing these individuals." – Project Contractor**

[122] European Union, International Labour Office (2011), *Skills and Occupational Needs in Renewable Energy*, accessed from http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---ifp_skills/documents/publication/wcms_166823.pdf, on December 1, 2014.
[123] Farrell, J. (2014) *Why Local Energy Ownership Matters*. Institute for Local Self Reliance, accessed from http://www.ilsr.org/wp-content/uploads/downloads/2014/09/Advantage_Local-FINAL.pdf, on November 15, 2014.

valuable in assisting communities throughout the project development process to benefit from lessons learned and avoid common mistakes.

There is an opportunity for ecoENERGY to develop a mentorship component that connects previous ecoENERGY project managers with communities starting to develop similar projects. A mentorship component could enable the transfer of information and experience regarding the development of renewable energy projects. Investments in mentoring should be made where community interest and readiness is apparent and where uptake is strong to magnify the success of renewable energy projects.[124] Successful past participant communities, particularly those who own or co-own their energy systems, can play a critical mentorship role and exchange knowledge about the development process as well as identify key partners who can advance the reliable and clean supply of energy for remote communities.[125]

The concept of developing mentorships within programs is a growing area of success for AANDC. For example, the AANDC British Columbia regional office has partnered with the Nautsa mawt Tribal Council to implement a mentorship initiative to assist the development of Comprehensive Community Plans by First Nations in the province. The mentorship initiative provides support, tools, frameworks, and the sharing of best practices between experienced communities and communities that are just beginning the process of developing a Comprehensive Community Plan.[126] In some cases, project managers for successful renewable energy projects have been enlisted by a charitable non-profit organization to provide mentorship to communities that are in the initial stages of developing projects. However, communities participating in this mentorship opportunity felt that their impact could be improved by participating in a more developed mentorship program that would allow them to visit mentee communities and play a larger role in supporting the development of the communities' renewable energy projects.

Additionally, some provincial utilities offer workshops and training for community leaders engaged in the development of renewable energy projects.[127] Others in the industry have imagined an intensive, comprehensive training program that would change the landscape for Aboriginal leaders and communities to develop and manage their own renewable energy systems.[128]

In addition to the need for increased capacity building through a mentorship program, further sources of knowledge sharing for communities undertaking renewable energy projects is necessary. Although the majority of interviewees discussed their participation in various working groups, energy summits, forums,

"If I was a community now just starting off, then I would want to know what happened in other communities." – Project Lead in a Community

[124] Kishk Anaquot Heath Research Literature Review
[125] Kishk Anaquot Heath Research Literature Review
[126] Aboriginal Affairs and Northern Development Canada. 2014. Evaluation of the First Nation Infrastructure Fund. Available at https://www.aadnc-aandc.gc.ca/eng/1414522582745/1414522638694
[127] Kishk Anaquot Heath Research Literature Review
[128] Kishk Anaquot Heath Research Literature Review

conferences and workshops, all interviewees expressed the need for more information as renewable energy technology is constantly changing. In many cases, communities feel as though they lack the technical expertise to pick the right consulting firm, properly supervise the project, and assess the final product. Developing tools for knowledge sharing could increase the ability of communities to determine what renewable technology is most appropriate for their community and what consulting firms they could contract with to effectively implement the technology. Additional support from regional office staff may also mitigate this challenge.

Such knowledge sharing could link communities to resources and training materials that already exist, such as those at the Office of Indian Energy within the United States Department of Energy, the Alliance for Rural Electrification, Clean Energy Canada, Canadian Electrification Association, International Renewable Energy Association and other energy agencies. Similarly, the simple pursuit of creating a social media site that allows participants to engage in these conversations would assist project leads, who often expressed being overwhelmed and alone in developing projects, to tap into experiences across communities. The Facebook site for British Columbia's Comprehensive Community Planners in First Nation communities is a leading example.[129]

3.5 Program Efficiency

Finding 14: ***Internal project approval process results in funding often being provided during inappropriate construction seasons.***

Case study interviewees noted that the ecoENERGY approval process and the timing of funding being provided created challenges for communities to complete renewable energy projects. In particular, it was noted that the provision of funding for approved projects in fall and winter months caused large and unnecessary project costs or delays. For example, one project management group undertook a feasibility study where ecoENERGY provided funding during the winter months with the provision that the study be completed by the end of the fiscal year. As a result, the project management group had no choice but to hire consultants to study a frozen river and make assumptions about the feasibility of a hydro project without being able to study the river's actual flow in the spring or summer time.

Another related challenge experienced by recipient communities was that cash transfers could be slow and require communities to cash manage in order to continue progress on their projects. This put communities with less financial resources in a difficult position and could lead to project delays. Consultants working in such a scenario often had to be patient while waiting to be paid and some even paid for project expenses independently until funding arrived. However, it was noted that the timeliness of the approval process had improved over the past two years, since the program began sending out an earlier call for proposals. Delayed approval and funding issues are common for federal government infrastructure-funding programs due to the fiscal year funding deadlines; however, this challenge could be better mitigated by moving toward a hands-on community-based program design. When program staff work with communities to

[129] Available at https://www.facebook.com/groups/209383889118512/?fref=ts
Accessed January 28, 2015.

develop project proposals, their in-depth knowledge of specific communities would help to ensure that project development and subsequent funding agreements are completed at the appropriate time of year.

Finding 15: ***There is an opportunity for the ecoENERGY program to improve its Performance Measurement Strategy to track program efficiency and to more efficiently track all AANDC renewable energy projects.***

The Performance Measurement Strategy of the ecoENERGY program was found to be appropriately scoped and well-implemented. The performance information gathered was also found to be regularly used for decision making by program management.

A performance measurement strategy for the program was first approved by the Evaluation, Performance Measurement and Review Committee in May 2011 at program conception (the ideal time for creating a performance management regime.) The Performance Measurement Strategy was again updated and approved in February 2014 to conform to updated guidance information provided by the Treasury Board Secretariat. To manage program performance, the strategy specifically called for a third-party assessment of projected GHG reductions in order to track the main goal of the program and to allow the program to choose the projects that will yield the highest GHG reduction potential. Evaluators were able to determine that program goals are being achieved as a result of the quality data provided by the Performance Measurement Strategy.

Although the program has been sufficiently tracking its performance indicators, evaluators noted several opportunities for improvement. First, there is opportunity to improve the GHG reduction indicator. This indicator could also measure the liters of diesel displaced to demonstrate the efficiency of the program in reducing applicable communities' diesel dependence. Second, the program's information management regime could be made more efficient. Although program data was adequately available, it was difficult to analyse results from the 2011 to 2015 program and to compare those results to similar programming since 2003. Finally, by having an isolated information management system, the program is limited to tracking only the renewable energy studies and projects supported by ecoENERGY funding while the Department also engages in supporting similar studies and projects through different funding sources. Therefore, in order to allow the historical tracking of renewable energy projects supported by ecoENERGY and to be able to assess the complete picture of AANDC supported renewable energy projects, there is an opportunity to input ecoENERGY project status and performance information into the Department's existing Integrated Capital Management System. By potentially integrating the program into the Department's sole capital projects database, projects such as T'Souke's solar energy project that was supported by both ecoENERGY and the First Nation Infrastructure Fund could be tracked as a single capital project in the system instead of under multiple databases.

Recommendation 6: It is recommended that the ecoENERGY program update its Performance Measurement Strategy and Risk Assessment to reflect program re-design considerations and to determine an approach for monitoring the completion of renewable energy projects funded across the Department.

<u>Finding 16:</u> ***Potential risk of projects not achieving their full GHG reduction potential when communities do not have an operation and maintenance plan in place for completed renewable energy projects.***

Case study interviewees revealed that while renewable energy projects are seen as valuable contributions to the increased economic and environmental sustainability of communities, few have developed plans for the future maintenance and repairs of the equipment and/or facilities. Most interviewees noted that they expected, or were told by the renewable technology vendors to expect maintenance costs to be low and infrequent. Several communities expressed concern that due to the technical nature of the renewable energy projects, the community facilities maintenance staff would be unable to undertake any necessary repairs or maintenance. As a result, communities were concerned that any repairs would require the involvement of the renewable technology vendors, and could result in significant costs. As AANDC is not responsible for providing operations and maintenance funds to communities for renewable energy projects undertaken through the ecoENERGY program, any repair or maintenance cost is a community's responsibility.

"I haven't done any maintenance yet. I'm not sure what needs to be done." – Project Lead in a Community

The lack of plans for the operation and maintenance of renewable energy projects could impact the overall success of the project at producing clean energy for the community, if the equipment malfunctions and the community is unable to fix or replace it. For example, one community that installed solar panels on a band-owned building with funding from ecoENERGY noted that they had done no maintenance on the panels since they had been installed, including cleaning or clearing snow from the panels in the winter. This lack of maintenance conflicts with the United States Department of Energy recommendations for the maintenance of solar panels. The recommendations state that solar electric or photovoltaic (PV) systems require routine, periodic maintenance.[130] The lack of maintenance being conducted on completed projects funded by ecoENERGY may result in projects not reducing greenhouse gas emissions to their full extent due to decreased functioning of renewable energy equipment, which in turn affects AANDC overall return on investment.

The literature review also noted the wide range of potential skills necessary to maintain renewable energy systems, as outlined in the following table, where H, M, and L refer respectively to High, Medium, and Low skill sets.

[130] United States Department of Energy. 2012. Installing and Maintaining a Home Solar Electric System. Accessed at http://energy.gov/energysaver/articles/installing-and-maintaining-home-solar-electric-system

Table 5: Operations and Maintenance Capacity Requirements by Renewable Energy Technologies[131]

Renewable Energy	Operations and Maintenance Capacity Requirements
Wind	• Windsmith, millwright, mechanical technician or fitter/wind service mechatronics technician (M, some H) • Operations and maintenance specialists (M) • Power line technician (M) • Field electricians (M)
Solar (photovoltaic, solar thermal, concentrated solar, pump systems)	• Photovoltaic maintenance specialists (electricians specializing in solar) (M) • Solar thermal maintenance specialists (plumbers specializing in solar) (M) • Concentrated solar power maintenance specialists (M) • Inspectors (M,L) • Recycling specialists (H)
Hydro	• Engineers (civil, mechanical, electrical) (H) • Operations and maintenance technicians (M) • Physical and environmental scientists (hydrologists, ecologists) (H) • Tradespersons (M)
Geothermal	• Plant managers (H) • Measurement and control engineers (H) • Welders (M) • Pipe Fitters (M) • Plumbers (M) • Machinists (M) • Electricians (M) • Construction equipment operator (M) • HVAC technicians (M)
Bioenergy	• Biochemists and microbiologists (H) • Laboratory technicians and assistants (M) • Operations and maintenance specialists (M,L)
Biomass production	• Agricultural scientists (H) • Biomass production managers (H,M) • Plant breeders and foresters (H,M) • Agricultural/forestry workers (L) • Transportation workers (L)

[131] European Union, International Labour Office (2011), *Skills and Occupational Needs in Renewable Energy*, accessed from http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---ifp_skills/documents/publication/wcms_166823.pdf, on December 1, 2014, page xxii.

As demonstrated in the chart above, many of the positions required to operate and maintain systems demand a medium level of capacity, which may often not exist in remote communities. To ensure the sustainability of implemented ecoENERGY projects, a community capacity development and mentorship component becomes a greater necessity when working with these communities to develop a renewable energy system.

3.6 Program Economy - Cost Benefit

Finding 17: ***The proportion of program funding dedicated to salary and operation and maintenance costs are in large measure due to the technical reviews and expertise required to assess project proposals as well as the necessity to coordinate funding with other federal, provincial and territorial departments.***

In 2011, the ecoENERGY program received $20 million over five years (2011-12 to 2015-16). As demonstrated in the charts below,[132] from April 1, 2011, to March 31, 2014, the program spent an average of $42 in Salary, Operations and Maintenance, and Employee Benefits for every $100 spent on approved projects. Put in a different way, it costs on average $12,073 to assess and either approve or deny each project proposal received from communities.[133]

Table 6: Program Costs

Actual	11/12	12/13	13/14	Total
AANDC SALARY	718,046.22	702,314.58	807,862.38	**2,228,223.18**
AANDC NON SALARY	353,636.28	255,041.49	266,334.88	**875,012.65**
GRANTS AND CONTRIBUTIONS	2,819,787.00	2,894,045.00	2,710,976.00	**8,424,808.00**
Total	**3,891,469.50**	**3,851,401.07**	**3,785,173.26**	**11,528,043.83**

Table 7: Program Costs for Disseminating Grants and Contribution Funding

	2011/2012	2012/2013	2013/2014
Vote 1 +Employee Benefit Plan (EBP)	1,215,291.74	1,097,818.99	1,235,769.74
(Vote1 +EBP)/vote 10	0.431	0.379	0.456
Cost per $100 of Grants & Contributions	**43.10**	**37.93**	**45.58**

[132] Financial charts and efficiency calculations were developed by AANDC's Policy and Strategic Direction Sector in collaboration with the program and AANDC's Chief Financial Officer in an internal 2014/15 assessment of the department's efficiency indicators (as per the MRRS policy requirement).
[133] Method of calculation: The program's total salary, operation and maintenance and employee benefits was divided by the total number of proposals received for processing.

Table 8: Number of Proposals Received, Approved and Associated Costs

	2011/2012	2012/2013	2013/2014
Number of proposals received	81	110	110
Number of proposals approved and funded	36	39	32
Cost per proposal received	15,004	9,980	11,234
Cost per proposal funded	33,758	28,149	38,618

At first glance, the program's operating costs are higher than typically expected in a Grants and Contributions program at AANDC. This is due to the reality that the program receives a significant number of proposals, most of which cannot be approved due to limited program funding but which still require a full assessment. Although only 36 percent of proposals are funded by the program, all proposals must be assessed and ranked in order of priority. Similarly, highly qualified personnel who possess scientific and technical backgrounds are necessary to assess all aspects of project proposals. In addition to the high costs of reviewing project proposals, program personnel are actively involved in liaising with provinces, territories, utilities and communities to identify projects that will have the greatest impact.

Overall, the costs to operating this program are necessary to ensure project proposals are properly assessed and ranked; that communities have the support they need; and that federal, provincial and territorial partners are actively engaged. Relationship building, a key priority for this Department, requires more resources than simply providing communities with a check for the approved project amount. However, the high operating costs are also an issue of economies of scale. The ecoENERGY program does not have a high amount of Grants and Contribution funding to provide to communities and a certain staff complement is necessary to operate even a small program. If the program was moved to operate under AANDC's larger Community Infrastructure Branch, the program could operate under existing support systems thereby reducing the overhead operating costs. Additionally, by modifying the proposal-based design, the sunk costs of assessing proposals that are not approved could be reduced. For example, in 2013-2014, 78 proposals were assessed at an internal operating cost of approximately $12,073 per proposal, which totals $941,694 of internal operating costs that could be better directed toward targeting and supporting the development of feasible projects in communities with the greatest need.

Finding 18: ***While large renewable energy systems can have dramatic environmental and financial benefits for communities, in off-grid scenarios diesel energy generation often remains the most cost-effective approach.***

While large renewable energy projects undertaken by on-grid communities (through Stream A of the ecoENERGY program) have produced substantial results, the situation is much different for off-grid communities. Specifically, off-grid communities are often very small and therefore have correspondingly small energy needs thereby eliminating much of the economic development potential of a renewable energy project. Key informant interviewees expressed concerns that for off-grid communities undertaking large renewable energy projects, the completed projects may produce energy at a more expensive rate per kilowatt hour than the existing diesel powered

systems. For these communities, diesel systems are the most cost-effective option, although they are not the most sustainable or environmentally-appropriate option. In particular, the need to transport diesel to remote off-grid communities can be difficult and costly and if the necessary volume of diesel is not properly calculated, the result may be brown-outs or black-outs when amounts are rationed. To reduce the negative environmental consequences of diesel generation and to increase the consistency of the community energy supply, some communities will pursue the development of renewable energy systems, despite a higher price per kilowatt hour. In these cases, the project managers hope and some expect to receive subsidies from utilities to compensate for the increase in cost per kilowatt hour.

An example of the higher price per kilowatt hour for renewable energy systems is provided by the chart below, which details the costs for energy supply options in the Northwest Territories. As the chart demonstrates, diesel generation is still the most cost effective option, with the exception of large hydro projects.

Table 9: Costs for Energy Supply Options in Northwest Territories (NWT)

Economics of Energy for NWT

Electricity Resource Option	Heat By - product	Cost of Energy ($/kWh)	Installation Cost ($/kW)	Local Resource Required	Environmental Considerations	Other Comments
Diesel	Yes	$0.35	$3,000	No	Non-Renewable, emits GHGs	Current standard for reliability in the North
Small Hydro (1 MW)	No	$0.375-$0.625	$4,000 - $30,000	Critical	Renewable, Low GHGs	Can provide capacity and energy to displace diesel
Large Hydro (100 MW)	No	>$0.050 + transmission	>$2,500 + transmission	Critical	Renewable, Low GHGs	Can provide capacity and energy to displace diesel
Biomass CHP	Yes	varies	varies	Cost Factor	Renewable, GHGs similar to diesel	Economics most attractive when heat byproduct can be used.
Solar	No	$0.59-$0.83	$9,000 - $14,000	No	Renewable, Low GHGs	Without storage, install capacity limited to 20-30% average load.
Wind	No	$0.36-$0.77	$3,500 - $23,000	Critical	Renewable, Low GHGs	Without storage, install capacity limited to 20-30% average load.
Geothermal CHP	Yes	Unknown	Unknown	Critical	Renewable, Low GHGs	Can provide capacity and energy to displace diesel
LNG	Yes	<$0.35	$1,000 (bi-fuel conversion)	No	Non-Renewable, Reduced GHGs compared to diesel	Can provide capacity and energy to displace diesel

2014 Northwest Territories Energy Charrette [134]
The increased price per kilowatt hour was identified by interviewees, as well as the literature review, as a barrier to further development of renewable energy systems in off-grid communities.[135] In many cases, the cost to construct a renewable energy system in an off-grid community and the price offered by utilities, through a potential power purchase agreement, means that the financial risk is too great for potential funders to participate. According to the Literature Review, capital subsidies or rebates have been essential for successful renewable energy policies and subsequent programs. For example, the BC Hydro Remote Community Electrification Program was established to help remote communities receive off-grid electricity service from BC Hydro, often through a switch from diesel generation to clean energy.[136] Through this program, BC Hydro would pay up to the maximum price of the avoided diesel through power purchase agreements, which helped communities meet the debt costs associated with building large renewable energy facilities. This practice facilitated the development of projects that substantially reduced the diesel usage by some off-grid communities.

While the subsidies provided by utilities are outside the purview of the ecoENERGY program, it should be recognized by senior management that additional steps could be taken to secure partnerships with provincial utilities to develop a supportive environment for the growth of the renewable energy industry.

Considerations for Operations Committee 4: The Department explore pursuing partnerships with provincial utilities to develop a supportive environment for the growth of the renewable energy industry in off-grid Aboriginal and northern communities.

Finding 19: ***Projects that incorporate renewable technology into new construction projects are more cost-effective than replacing older systems.***

Interviewed experts in the field noted that it is more efficient to incorporate renewable energy systems into new construction projects instead of working to retrofit older infrastructure where the key energy issue is not about improving energy supply, but reducing energy demand. In these scenarios, often the best course of action is to mend the key causes of energy loss such as modernizing light fixtures, installing timers, refreshing insulation and replacing windows. Comparing two site visits, it was noted by contractors that a geothermal installation in a pre-existing school was a less efficient project than the installation of a geothermal into a new school. Based on previous experiences, one contractor was adamant that it is often more expensive to retrofit existing structures. Although evaluators were only given anecdotal examples, it was evident that in a new build design, the positive impacts of a renewable energy system are often augmented by combining the system with additional standards laid out by certifications such as LEEDS and Green Globes.[137]

[134] Andrew McLaren. 2014. 2014 Northwest Territories Energy Charrette. Presentation delivered at the 2014 NWT Energy Charrette. Available at http://www.iti.gov.nt.ca/sites/default/files/andrew_mclaren_0.pdf
[135] Kishk Anaquot Heath Research Literature Review – p56
[136] BC Hydro. 2015. Remote Community Electrification Program.
[137] Leadership in Energy and Environmental Design (LEED) is a rating system for green building in 150 countries. The Green Globes system is a similar building environmental design and management tool.

At one of the sites visited by evaluators, the geothermal project manager indicated that although the geothermal component was part of the original design of the new school build, due to cost-containment measures, it would have been eliminated from the project design if the ecoENERGY funding had not been provided. This example demonstrated to evaluators the importance of the ecoENERGY program working in partnership with AANDC's Community Infrastructure Branch to ensure renewable energy systems are a key consideration when developing new infrastructure on-reserve. Similarly, although programming to improve energy efficiency is essential prior to considering the development of a renewable energy technology, funding energy efficiency projects should not be the role of the ecoENERGY program as outlined in Section 3.2. Instead, the program may consider encouraging communities to partner with other funders to first increase their efficiencies before working with the ecoENERGY program to develop a renewable energy technology.

4. Conclusions and Recommendations

4.1 Conclusions

This evaluation of the ecoENERGY for Aboriginal and Northern Communities Program was conducted in accordance with the Treasury Board's *Policy on Evaluation* and in time for consideration of program renewal in 2014-15. The evaluation generated nineteen findings, six recommendations for program management, and four considerations for AANDC's Senior Management Team as represented by members of the Evaluation Committee.

The evaluation concludes that:

a) There is a continued need to fund renewable energy and energy efficient projects in Aboriginal and northern communities while encouraging that the program focus on off-grid and northern communities.
b) The program is aligned with roles and responsibilities of the federal government, and specifically, the mandate of the Department of Aboriginal Affairs and Northern Development Canada.
c) The program is aligned with federal priorities, AANDC's priorities and the needs and priorities of Aboriginal and northern communities.
d) The program is delivering on its expected results.
e) The program would benefit from considering design and delivery improvements such as improving coordination with the Community Infrastructure Branch within Regional Operations, reviewing the proposal-based design, providing direct support in project development, coordinating program funding with the activities of stakeholders, and ensuring project funds are provided during the construction season.

4.2 Considerations for Operations Committee

Considerations for Operations Committee 1: The Department, in partnership with federal partners (e.g., Canadian Northern Economic Development Agency, Natural Resources Canada, CHARS) and other levels of governments, explore developing a central five year tracking system to identify activities and investments in all off-grid Aboriginal and northern communities to increase strategic collaboration.

Considerations for Operations Committee 2: The Department explore developing a departmental Sustainable Energy Policy that:

a) Supports the design, construction and implementation of renewable energy systems that supply energy to communities within AANDC's mandate; and
b) Promote the funding of small-scale infrastructure projects that increase energy efficiency in order to decrease energy demand (i.e. replacing windows, boiler systems, insulation, etc.)

Considerations for Operations Committee 3: The Department explore developing a system for tracking and organizing funded community planning documents and feasibility studies (e.g. Energy Audits, Infrastructure Plans, Emergency Management Plans, Climate Change Adaptation studies, Comprehensive Community Plans, etc.) in order to better preserve funded work and support future infrastructure development decisions. AANDC's Strategic Research Branch may be in a position to develop such a centralized database as one of their departmental research tools.

Considerations for Operations Committee 4: The Department explore pursuing partnerships with provincial utilities to develop a supportive environment for the growth of the renewable energy industry in off-grid Aboriginal and northern communities.

4.3 Recommendations

Recommendation 1: It is recommended that the ecoENERGY program clearly define its niche, focusing on funding renewable energy projects in off-grid Aboriginal and northern communities.

Recommendation 2: It is recommended that as ecoENERGY establishes a focus on off-grid and northern communities, program staff should provide lessons learned, best practices and relevant Stream A project proposals to Land and Economic Development Sector (i.e., Community Opportunity Readiness Program), which already funds such projects. Program staff should also communicate their change in focus to communities and provide information concerning potential Lands and Economic Development funding opportunities.

Recommendation 3: It is recommended that the ecoENERGY program consider the following in any future program re-design:

a) Remove restrictive funding streams and maximum project allotments.
b) Review the proposal based approach.
c) Develop an approach for targeting communities with the greatest need.
d) Support projects that integrate renewable energy systems into existing diesel systems to reduce the consumption of diesel fuel.
e) Provide the needed support to communities in assessing and advancing the suitable renewable energy and/ or efficiency project.

Recommendation 4: It is recommended that ecoENERGY establish a process for developing an *Engagement and Collaboration Strategy* for each off-grid community it targets, ensuring that activities and investments by AANDC, federal partners (e.g., Canadian Northern Economic Development Agency, Natural Resources Canada, CHARS) and other levels of government, are coordinated to allow for communities to seamlessly go from research, to pilot project, to final, completed project.

Recommendation 5: It is recommended that the Assistant Deputy Minister of Northern Affairs work with the Assistant Deputy Minister of Regional Operations to improve coordination of funding renewable energy projects in Aboriginal communities occurring within the Community Infrastructure Branch and the ecoENERGY program.

Recommendation 6: It is recommended that the ecoENERGY program update its Performance Measurement Strategy and Risk Assessment to reflect program re-design considerations and to determine an approach for monitoring the completion of renewable energy projects funded across the Department.

Appendix A – Complimentary Government Programs and Opportunities for Leveraging other Funding for Improved Results

AANDC's Capital Facilitates and Maintenance Program / First Nation Infrastructure Fund
Areas of Complimentary Program Activities
The First Nations Infrastructure Fund, now integrated into the Capital Facilitates and Maintenance Program, provides targeted funding for energy projects. For example, First Nations Infrastructure Fund and ecoENERGY both provided funding for the same solar project in British Columbia. From 2007-2013, First Nations Infrastructure Fund invested $11,931,526 in 37 energy projects on-reserve. The median amount invested in projects was $136,800, similar to the amounts provided for ecoENERGY projects.[138] The 2014 Evaluation of the First Nations Infrastructure Fund recommended that the Community Infrastructure Branch of AANDC engage with the ecoENERGY program in order to identify a strategy for sharing completed feasibility studies. By sharing these studies, this partnership would support potential First Nations Infrastructure Fund-funded energy projects and ensure that critical information is accessible to regional front-line officers.[139]
Opportunities to leverage other funding for improved results
• Opportunity for ecoENERGY to use the Community Infrastructure Branch's (CIB) First Nation Infrastructure Investment Plan to fund applicable community-identified energy projects. • Opportunity for ecoENERGY and CIB to jointly fund new construction projects that integrate a renewable energy component. • Opportunity for ecoENERGY to utilize Capital Facilitates and Maintenance Program/First Nations Infrastructure Fund regional staff to provide advice and expertise in the development of renewable energy projects. • Opportunity to develop a Sustainable Energy Policy that focuses on implementing renewable energy to supply energy while also promoting energy efficiency, which serves to decrease energy demand. Potential for CIB to provide investments for updating existing infrastructure such as installing smart meters, updating light fixtures, using timers, updating windows and boilers, etc. • Also an opportunity for CIB to encourage following LEED and Green Globe standards for building as a component of an AANDC Sustainable Energy Policy.

[138] AANDC. Evaluation of the First Nations Infrastructure Fund. 2014. Table 8: Energy Systems Overview 2007-2013.
[139] AANDC. Evaluation of the First Nations Infrastructure Fund. 2014. Management Response and Action Plan.

AANDC's Capital Facilitates and Maintenance Program and Strategic Partnership Initiative's joint project with Manitoba Hydro
Areas of Complimentary Program Activities
Partners are working to identify the ideal combination of renewable energy systems and storage sources for four First Nation off-grid communities in Manitoba. The partners' intention is to off-set diesel consumption and lower the cost of generation.
Opportunities to leverage other funding for improved results
Opportunity for ecoENERGY to work with the Manitoba project stakeholders to complete similar best-fit technology assessments in other off-grid communities and to disseminate best practices/lessons learned from the Manitoba experience.
Provincial and Territorial Government Policies and Programs
Areas of Complimentary Program Activities
As highlighted in Section 3.2, provincial and territorial governments are actively promoting renewable energy projects in municipalities and in First Nation communities.
Opportunities to leverage other funding for improved results
Opportunities to engage in joint projects to encourage First Nation communities to partner with municipalities to develop renewable energy systems support First Nation and northern communities to take advantage of programs that promote connecting to the grid and selling renewable energy.
AANDC's Community Opportunity Readiness Program
Areas of Complimentary Program Activities
The Community Opportunity Readiness Program addresses the financial needs of Aboriginal communities when they are in pursuit of, and wish to participate in, an economic opportunity, including renewable development projects. The program is a consolidation of the former Community Economic Opportunities Program and the Major Projects Investment Fund (both of which funded feasibility studies for large renewable energy projects) as well as the Aboriginal Business Development program. First Nations and Inuit communities and their governments, including Tribal Councils, are eligible for funding through CORP. Funding is available to support communities to pursue economic opportunities and attract private sector funding, including conducting feasibility studies. As a result, on-grid communities pursuing large renewable energy projects for the purposes of economic development are able to receive funding from the CORP program for feasibility studies. This overlaps with funding for feasibility studies provided through Stream A of the ecoENERGY program.
Opportunities to leverage other funding for improved results
As stated in Section 3.2, it is recommended that the ecoENERGY program's current role of funding large scale feasibility studies undertaken by on-grid communities for the purposes of economic development be transferred to the CORP program within AANDC's Land and Economic Development Sector.

AANDC's Lands and Economic Development Services Program
Areas of Complimentary Program Activities
A suite of funding, including an environmental funding component, is available to on-reserve communities. The Lands and Economic Development Services Program provides funding allocations to First Nation and Inuit communities (and the organizations they mandate) to deliver economic development services on their behalf, such as community economic development planning and capacity development initiatives or proposal developments. The expected results of this program are for First Nation and Inuit communities to pursue greater independence/self-sufficiency and sustainable economic development.
Opportunities to leverage other funding for improved results
There may be opportunities to coordinate ecoENERGY funding support with the targeted environmental funding component that supports training and feasibility studies in on-reserve communities.
Arctic Council
Areas of Complimentary Program Activities
Canada will be concluding its two year chairmanship in 2015. Working with the seven additional Arctic countries, the council operates six working groups dealing with Arctic issues such as the environment and climate change. The Arctic Council continues to be the leading multilateral forum through which Canada advances its Arctic foreign policy and promotes Canadian Arctic interests internationally.[140] Influenced by its involvement on the Council, Canada announced the development of the Canadian High Arctic Research Station in 2015. Interviewees suggested that the Arctic Council could be further engaged in renewable energy development in the North during Canada's final year as Chair.
Opportunities to leverage other funding for improved results
Opportunities for ecoENERGY to support the AANDC Arctic Council support team and further the council members' common objective of developing and using renewable energy resources in the Arctic.[141]
Canadian High Arctic Research Station (CHARS)
Areas of Complimentary Program Activities
A key priority area for CHARS is to develop and promote renewable energy in the North. One program component is to pilot unproven renewable energy technologies. In the future, the program will likely focus on adapting proven southern technologies to the northern environment with a particular focus on remote/ off-grid communities.
Opportunities to leverage other funding for improved results
Opportunity for coordinating a staged funding approach so that CHARS research activities are first completed in targeted communities and then followed by ecoENERGY programming to promote the implementation of the proven technology.

[140] Arctic Council, available at http://www.arctic-council.org/index.php/en/about-us/member-states/canada, accessed November 9, 2014.
[141] Arctic Council (2013), "The Norwegian, Danish, Swedish common objectives for their Arctic Council chairmanships 2006-2013." Accessed on January 29, 2015.

Various AANDC funding opportunities for Community Planning, Physical Land Use Planning and Energy Planning
Areas of Complimentary Program Activities
AANDC - through various programs (including the first ecoENERGY program) and recent pilot initiatives, has funded the development of Comprehensive Community Plans, Community Energy Plans, and Physical Land Use Plans, which often identify opportunities for renewable energy technology in communities.
Opportunities to leverage other funding for improved results
Opportunity for ecoENERGY to fund community-identified renewable projects that fit into a broader strategic plan for community development and well-being. Regional office staff supporting Community Planning initiatives and completed Regional First Nation Infrastructure Plans are a good starting point for identifying communities that are eager to engage in projects related to renewable energy technology.

Natural Resource Canada's suite of ecoENERGY Initiatives:	
• **ecoENERGY Efficiency for Buildings,** • **ecoENERGY Efficiency for Industry,** • **ecoENERGY Efficiency for Equipment Standards and Labelling,** • **ecoENERGY Efficiency for Housing,** • **ecoENERGY Efficiency for Vehicles,** • **ecoENERGY Retrofit-Homes,**	• **ecoENERGY Innovation Initiative,** • **ecoENERGY Technology Initiative,** • **ecoENERGY for Biofuels,** • **ecoENERGY for Renewable Power,** • **Equilibrium Communities Initiative,** • **ecoTechnology for Vehicles**
Areas of Complimentary Program Activities	
The defining point of separation between Natural Resources Canada's programs and AANDC's program is that Natural Resources Canada funds the design and testing of unproven technology, whereas AANDC funds commercial-ready or proven technology. Natural Resources Canada typically focuses on off-reserve communities; however, contributions are sometimes provided to First Nation communities. For example, the Innovation Initiative funded research on smart meters and on integrating solar into micro grid projects in Aboriginal communities. Natural Resources Canada also funded a first-of-a-kind demonstration in a Saskatchewan First Nation that combined various wind technologies. Natural Resources Canada program staff and AANDC program staff participate on project selection committees to ensure duplication of funding does not occur.	
Opportunities to leverage other funding for improved results	
Interviewees identified opportunities where Natural Resources Canada expertise could be better utilized to support AANDC's project development. For example, Natural Resources Canada's Canada Centre for Mineral and Energy Technology Renewable Energy Laboratory is particularly well-positioned to support communities in designing better project proposals and conducting assessments to determine the best-fit technology for their environmental reality.	

Defense Research Development Canada
Areas of Complimentary Program Activities
Defense Research Development Canada's energy-related R&D activities are very separate (little evidence of collaboration outside of the department) and focused on security; however, the Armed Forces have an increasing presence in the Arctic, which means that department is becoming increasingly familiar and attuned to the challenges associated with conditions that are characteristic of remote northern communities. This could work to the advantage of northern communities under AANDC's mandate. An example of a recent solution developed by Defense Research Development Canada: In March 2014, the Canadian Armed Forces developed a mini electric power station to fuel communications equipment, using a combination of wind and solar power. The station was developed to reduce Canadian Armed Forces' reliance on shipped fuel, in case inclement weather made shipment impossible. The station is portable and will be used in remote areas.[142]
Opportunities to leverage other funding for improved results
Opportunity for ecoENERGY to use lessons learned from Defense Research Development Canada's research and development of renewable energy technologies for the Arctic
National Research Council
Areas of Complimentary Program Activities
The National Research Council is the Government of Canada's premier research and technology organization. Working with clients and partners, they provide innovation support, strategic research, scientific and technical services. National Research Council Energy, Mining and Environment delivers advanced technology solutions to Canada's resource and utility sectors. National Research Council Energy, Mining and Environment works with clients and stakeholders along the value chain to tackle complex problems through targeted initiatives.[143]
Opportunities to leverage other funding for improved results
Opportunities for sharing information and coordinating projects in northern communities through the National Research Council Arctic Program, which is developing technologies to ensure sustainable, low impact development of the North while increasing the quality of life for Northerners.

[142] National Defence and Canadian Armed Forces (2014). "First renewable energy mini electric power station." Available at http://www.forces.gc.ca/en/news/article.page?doc=first-renewable-energy-mini-electric-power-station/humd3dga Accessed on February 3, 2015.
[143] National Research Council. Energy, Mining and Environment. Available at: http://www.nrc-cnrc.gc.ca/eng/rd/eme/index.html

Canadian Northern Economic Development Agency
Areas of Complimentary Program Activities
The terms and conditions of Canadian Northern Economic Development Agency's Strategic Investments in Northern Economic Development (SINED) Program allows for communities to access funding for studying and constructing renewable energy projects. Investments in renewable energy were $2,798,147, representing three percent of SINED's total funding from 2007-08 to 2011-12.[144] Evaluators noted one instance where SINED and ecoENERGY funded the same hydro feasibility study in two neighbouring communities. The departments were unaware of each other's investment.
Opportunities to leverage other funding for improved results
There is an opportunity for AANDC to rely on the expertise of Canadian Northern Economic Development Agency SINED staff to recommend joint projects for ecoENERGY participation in northern off-grid communities.
Environment Canada
Areas of Complimentary Program Activities
The Horizontal Programs Section at Environment Canada coordinates the Department's participation in federal government technology programs that have a sustainable/ environmental focus. The ecoENERGY Innovation Initiative is a horizontal program that the Science and Technology Branch of Environment Canada is involved in. The program's five priority areas are: • Energy Efficiency • Clean Electricity and Renewables • Bioenergy • Electrification of Transportation • Unconventional Oil and Gas[145] The EcoAction Community Funding Program is a Grants and Contributions program, providing funding to eligible groups, including Aboriginal organizations to initiate community-based projects aimed at the protection, rehabilitation and enhancement of the natural environment and to build the capacity of communities to sustain these activities into the future. On an annual basis, the program provides approximately $4.5 million in funding and supports approximately 100 new projects each year. Examples of funded activities include projects aimed at reducing individual greenhouse gas emissions by reducing consumption and taking steps to improve home energy efficiency; improving water quality by reducing the amount of pesticides or household hazardous substances entering streams and lakes; working to reduce air emissions that contribute to air pollution; and restoring and protecting natural habitat.[146]
Opportunities to leverage other funding for improved results
Opportunity to coordinate EcoAction Community Funding Program with the funding of ecoENERGY projects in Aboriginal and Northern communities.

[144] AANDC. "Evaluation of the Strategic Investments in Northern Economic Development Program" 2014.
[145] Environment Canada (2014). "ecoENERGY Innovation Initiative." Available at http://www.ec.gc.ca/scitech/default.asp?lang=en&n=6B0DDD9F-1 Accessed on February, 3, 2015.
[146] Environment Canada (2013) "Evaluation of the ecoAction Community Funding Program." Accessed March 2, 2014. Available at http://ec.gc.ca/ae-ve/82F2991C-8730-41D1-A321-F6314509C1D5/EcoAction%20Evaluation%20Report.2013.11.14%20FINAL-s.pdf.

P3 Canada
Areas of Complimentary Program Activities
The P3 Canada Fund provides funding for provincial territorial, municipal, and First Nations public private partnership infrastructure projects. Eligible projects will be for the construction, renewal or material enhancement of public infrastructure within several sectors, including green energy projects. Projects tend to be large to attract private sector interest and financing.
Opportunities to leverage other funding for improved results
Opportunity for ecoENERGY to bring P3 Canada as a partner in developing selected projects.
Federation of Canadian Municipalities
Areas of Complimentary Program Activities
The Green Municipal Fund, through a competitive funding approval process, provides support for retrofits and new construction projects aimed at energy efficiency.
Opportunities to leverage other funding for improved results
Opportunity to encourage partnerships between Aboriginal communities and neighbouring municipalities to pursue green energy projects.

Appendix B: Related Academic/Research Activities

The following table lists a selection of the many academic institutions that offer energy-related degree programs and related research centres in which cutting-edge research on eco-technologies is being conducted across Canada. These centers of expertise could be better engaged by AANDC to harness existing research, studies and expertise.

Academic Institutions	Research and Renewable Energy Activities
Yukon College (Yukon Territory)	Yukon College houses the Yukon Research Centre, which is funded by the Yukon Government and Canadian Northern Economic Development Agency's Cold Climate Innovation program. [147] Energy-related projects include the piloting of a solar/diesel hybrid power station in remote northern stations owned by Northwestel.[148]
Ottawa University[149] (Ontario)	In March 2015, the university is hosting an invitation-only conference for industry leaders, government officials, academics, non-profit organizations, and representatives of Aboriginal groups with interests in the energy sector. The conference's goal is to open dialogue concerning the importance of research into eco-technologies.[150]
Carleton University (Ontario)	Carleton Sustainable Energy Research Centre. One of the current research projects underway at Carleton is an investigation of the policy challenges surrounding smart grid development in Canada. Partners include researcher teams at the University of Waterloo, York University, Simon Fraser University, and the Université du Québec à Montréal.[151]

[147] Yukon College (2014). Government announces $6.3 million for Yukon Research Centre." Available at http://www.yukoncollege.yk.ca/research/post/government_announces_6.3_million_for_yukon_research_centre Accessed on February 4, 2015; Yukon College (2014). "Harper Government announces support for Cold Climate Research." Available at http://www.yukoncollege.yk.ca/research/post/harper_government_announces_support_for_cold_climate_research Accessed on February 4, 2015.

[148] Yukon College. "Northwestel Remote Station Solar/Diesel Hybrid Power Generation." Available at http://www.yukoncollege.yk.ca/research/project/northwestel_remote_station_solar_diesel_hybrid_power_generation Accessed on February 4, 2015.

[149] Institute of the Environment, University of Ottawa. "About the Program." Available at http://www.ie.uottawa.ca/MastersProgram#about-the-program Accessed on February 4, 2015.

[150] University of Ottawa (2015), "Positive Energy: Building A Path to Social Acceptance and Support of Energy Development in Canada." Available at http://research.uottawa.ca/conferences/positiveenergy Accessed on February 3, 2015.

[151] Carleton University. "Unlocking the Potential of Smart Grids: a partnership to explore policy dimensions." Available at http://carleton.ca/cserc/carletons-research-in-sustainable-energy/highlights-of-carletons-sustainable-energy-research/unlocking-the-potential-of-smart-grids/ Accessed on February 5, 2015.

Academic Institutions	Research and Renewable Energy Activities
Lethbridge College (Alberta)	The International Wind Energy Academy is a consortium of over twenty partners, including Lethbridge College.[152] The International Wind Energy Academy trains workers for the wind and solar energy industry, in order to develop the capacity and sustainability of southern Alberta's economy. The International Wind Energy Academy also acts as a repository and educator for best practices in wind and solar energy innovation. And it engages in demonstrations of small wind projects.[153]
Northern Alberta Institute of Technology (Alberta)	Researchers at the new Northern Alberta Institute of Technology Centre for Sustainable Energy Technology's Boreal Research Institute are investigating ways to "reclaim abandoned oil and gas well sites in northwest Alberta."[154]
McMaster University (Québec)	McMaster Institute for Energy Studies is currently engaged in research into solar power and wind power, in partnership with Cleanfield Energy Corp. and the Ontario Centres of Excellence.[155] The NSERC Photovoltaic Innovation Network, trains students and researchers, and is currently conducting 14 research projects on solar technologies in 16 Canadian universities.[156]
The Sechelt Centre of Excellence (British Columbia)	Sechelt Centre of Excellence runs a First Nations Hydro Plant Training Initiative for Aboriginal people who want to work in the renewable energy field. Partners are First Nations Employment Society, Regional Power. Located at the Sechelt Creek generating station in shíshálh territory[157]

[152] Lethbridge College, "IWEA Sponsors and Partners." Available at http://www.lethbridgecollege.ca/externalapps/oldsite/iwea//index.php?option=com_content&task=view&id=527&Itemid=722 Accessed February 3, 2015.
[153] "Renewable Energy – Powering Our Future." Available at http://www.lethbridgecollege.ca/externalapps/oldsite/iwea//index.php?option=com_frontpage&Itemid=1 Accessed on February 3, 2015.
[154] NAIT (2014). "NAIT Ranked as one of Canada's Top Research Colleges." Available at http://www.nait.ca/44779_95864.htm Accessed on February 9, 2015.
[155] McMaster University (2015). McMaster Institute for Energy Studies. Available at http://energy.mcmaster.ca/ Accessed on February 3, 2015.
[156] Photovoltaic Innovation Network. "Our Research." Available at http://pvinnovation.ca/our-research/ Accessed on February 9, 2015.
[157] Regional Power (2012). "Sechelt Indian Band makes presentation to Suzuki." Available at http://www.regionalpower.com/press/sechelt-indian-band-makes-presentation-to-suzuki Accessed February 4, 2015.

Academic Institutions	Research and Renewable Energy Activities
University of British Columbia (British Columbia)	Researchers at the Clean Energy Research Centre are involved in studying solar, wind, and biomass energy.[158] The University of British Columbia Bioenergy Research and Demonstration Project is projected to power 1,500 homes and decrease the University's "natural gas consumption by up to 12 percent."[159]
University of Victoria (British Columbia)	Researchers at the Institute for Integrated Energy Systems are focused on developing wind, wave, tidal, and solar photovoltaic energy solutions.[160] The University also hosts the Pacific Institute for Climate Solutions. The international network of researchers produces publications, research articles, and policy recommendations concerning mitigation and adaptation to the impacts of climate change.[161]
University of New Brunswick (New Brunswick)	The University's Fredericton campus's Facilities Energy Management branch, acquires waste wood from provincial industry, which has resulted in a reduction of carbon dioxide emissions "by as much as 15,000 tonnes annually."[162] The University has partnered with the province on several wind energy projects, including research for the Maritime-wide PowerShift Atlantic project.[163] The University of New Brunswick is also a partner in the Atlantica Centre for Energy, which facilitates partnerships between government, educational institutions, researchers, and communities of Atlantic Canada, working on projects in the energy sector.[164]

[158] University of British Columbia. "News and Events for CERC." Accessed on February 4, 2015
[159] University of British Columbia. "Research at CERC." Available at http://www.cerc.ubc.ca/research/index.php Accessed on February 4, 2015.
[160] Institute for Integrated Energy Systems. University of Victoria. "Renewable Energy Systems Research." Available at http://www.uvic.ca/research/centres/iesvic/research/renewable-energy/index.php Accessed on February 4, 2015
[161] Pacific Institute for Climate Solutions. "About." Available at http://pics.uvic.ca/about Accessed February 4, 2015.
[162] UNB. "Energy Management. Available at http://www.unb.ca/fredericton/fm/energy/index.html Accessed on February 4, 2015.
[163] UNB (2014). "UNB and NB Power Partner on Wind Energy Initiative." Available at http://blogs.unb.ca/newsroom/2014/05/13/unb-and-nb-power-partner-on-wind-energy-initiative/#sthash.5on8Kz6z.dpuf Accessed on February 4, 2015.
[164] Atlantica Centre for Energy. "Welcome." Available at http://www.atlanticaenergy.org/index.php Accessed on February 4, 2015.

Appendix C: Costs and Benefits of Renewable Energy Technologies

Excerpt from the Literature Review completed by the Kishk Anaquot Health Research consulting firm.

Evaluating the costs of renewable energy technologies is highly complicated and dependent upon utilization rates, available resource mix and the capacity value associated with regional variation. Some of the variables taken into consideration in investment decisions include, but are not limited to:

- ***projected utilization rate*** or energy demand and existing energy sources where more energy capacity is needed;
- ***existing resource mix*** or the current energy sources that might be displaced by new sources; and
- ***capacity value*** depends upon a system's ability to meet fluctuating regional demands in a balanced way with output that can follow demand (i.e., dispatchable technologies such as geothermal or biomass that have more value than more intermittent sources or non-dispatchable technologies such as solar and wind).[165]

While levelized costs of energy are helpful, they can also mislead. Levelized costs of energy includes developmental or upstream costs and excludes the cost of energy transport; integration with other systems, environmental costs or subsidies and tax credits that might offset costs. With each transition to a new source of energy there are also the *avoided* costs of continuing with old energy sources. In other words, the levelized *avoided* costs of new energy sources must be taken into account when looking at the economic viability of any prospective energy technologies. For example, it isn't enough to look at the capital or lifetime cost of a solar system without considering how much expensive, carbon intensive energy it could replace.[166]

All variables are in constant flux, costs change regionally, technologies evolve and fuel prices change;[167] therefore, these estimates are to be analyzed with caution. They do not replace feasibility assessments.[168] In short, all costs are time and space dependent and should be interpreted as such. The dramatic drop (by 83 percent in the last five years) in solar photovoltaics is a key example.

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[165] U.S. Energy Information Administration (2014) *Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2014*, 7 May 2014, Accessed from http://www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf, on November 20, 2014.

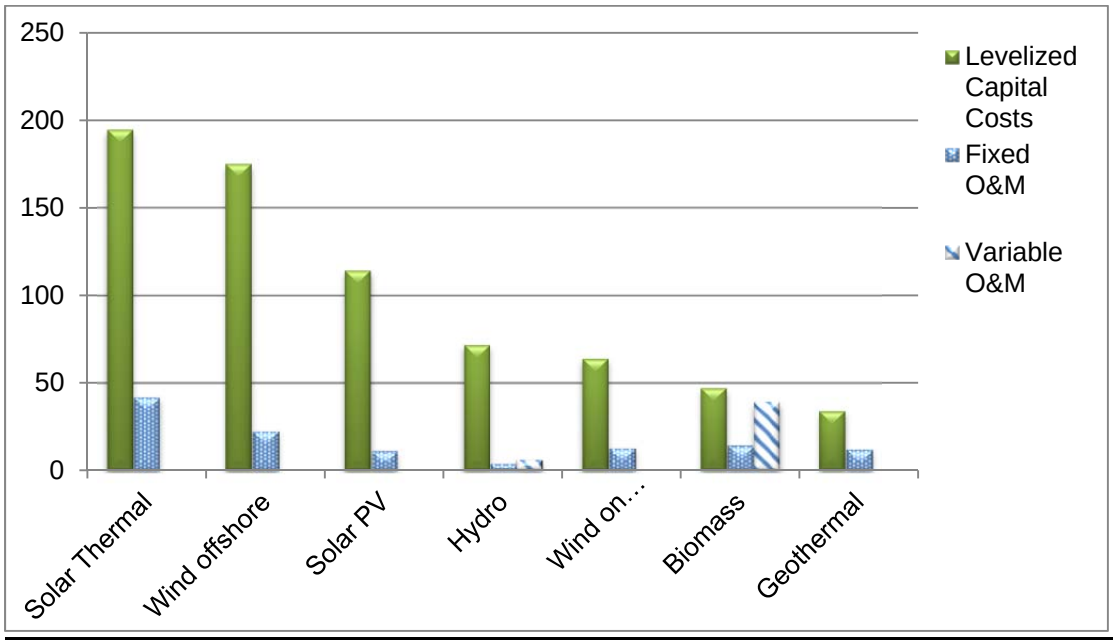
[166] For a fuller explanation of the methodologies used to calculate levelized avoided costs, see http://www.eia.gov/renewable/workshop/gencosts/pdf/lace-lcoe_070213.pdf

[167] For a fuller view of the range of LCOE for select RETs see Figure SPM.5 | Range in recent levelized cost of energy for selected commercially available Renewable Energy technologies in comparison to recent non-renewable energy costs, page 14 in IPCC's Renewable Energy Sources and Climate Mitigation https://www.ipcc.ch/pdf/special-reports/srren/SRREN_FD_SPM_final.pdf

[168] U.S. Energy Information Administration, *Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2014*, 7 May 2014. Accessed from http://www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf, on November 10, 2014.

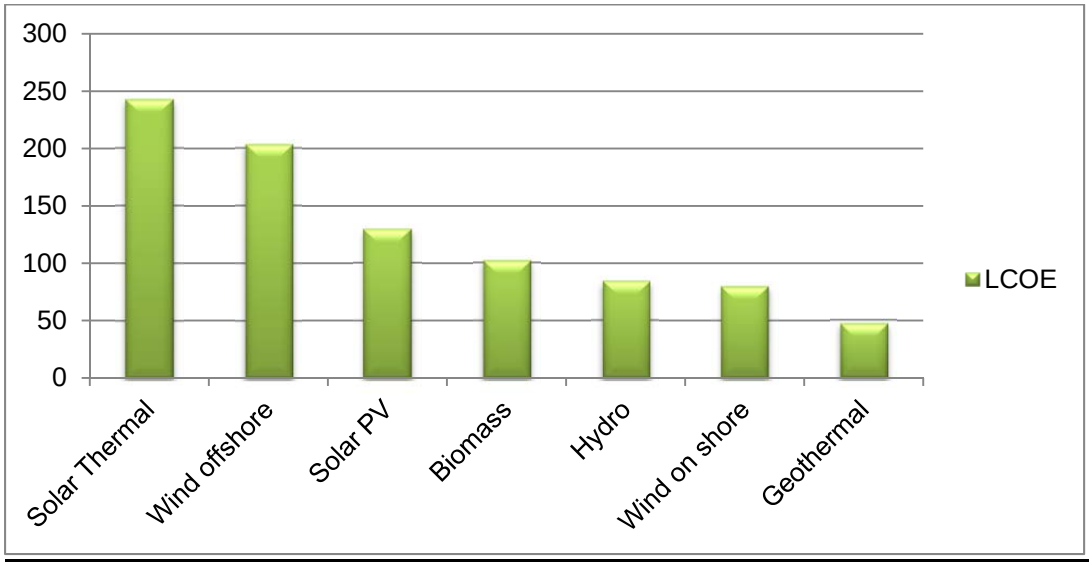
Levelized capital costs of solar thermal, wind (off-shore) and photo voltaic technologies are highest followed by hydro, wind (on-shore), biomass and geothermal. Once constructed, biomass has the potential to be the most costly to operate given variable operating and maintenance costs related to fuel sources. By contrast, many renewable energy technologies have *no cost* for fuel (e.g., wind, solar and geothermal). Figures 5 and 6 illustrate projected levelized costs of energy of renewable energy technologies for operations entering service in 2019 and Figure 7 takes into account the avoided costs of maintaining the status quo when the selected renewable energy sources are compared to coal. All estimates in Figures 5 through 7 are based upon the United States Energy Information Administration's Independent Statistics and Analysis Division and are projected for 2019.[169]

Levelized Capital, Operating and Maintenance Costs by Renewable Energy Technology (2012 USD/MWh)



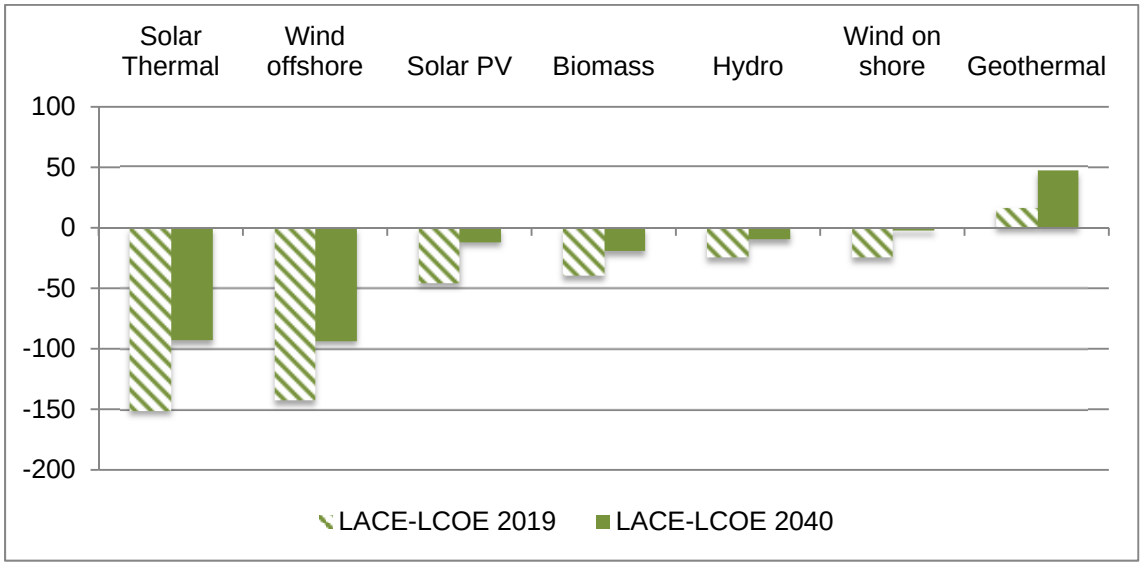
[169] U.S. Energy Information Administration, *Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2014*, 7 May 2014. Accessed from http://www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf, on November 10, 2014.

Total Levelized System Cost by Renewable Energy Technology (2012 USD/MWh)



When taking into account the avoided costs of maintaining energy generation based on coal, various renewable energy systems maintain roughly the same ranking with geothermal, wind onshore, hydro, biomass and solar PV being the most attractive options from a cost perspective. Projecting into the future for the years 2019 and 2040, all of the same options that are attractive considering levelized costs of energy alone hold their approximate rankings with geothermal showing outstanding value, particularly in the long term. While a levelized avoided costs of energy for renewable energy technologies based on diesel is most appropriate for this analysis, coal is used here as a proxy. Figure 7 illustrates the average difference of levelized costs of energy subtracted from levelized avoided costs of energy for various renewable energy technologies.

Average Difference of Levelized Avoided Costs of Energy – Levelized Costs of Energy by Renewable Energy Technology Compared to Coal (2012 USD/MWh) 2019 and 2040



To discern the full economic benefit of select renewable energy technologies, a life cycle assessment of each energy source would be needed. In other words, the impacts from "cradle to grave" (i.e., creation to disposal, commissioning and decommissioning) of a renewable energy technology as well as impacts related to material and energy flows during renewable energy technology operations are necessary.[170] Furthermore, the costs of water, air and noise pollution, loss of farmland, wetlands and primary forests, CO_2 emissions and the depletion of ozone and non-renewable resources must also be taken into consideration to understand the value proposition of transitioning from fossil fuels to renewable energy technologies.[171]

While these situation specific analyses are beyond the scope of this review, it is worth considering some of the more readily available comparators such as longevity and capacity of varies renewable energy systems. The capacity factor of an energy system is basically the proportion of energy produced by the system based upon its full capacity to operate. No system has a 100 percent capacity factor because all systems have shut down periods for maintenance schedules or breakdowns and some have variable availability of energy sources (e.g., solar and wind). Hydro, solar and geothermal systems appear to outlast other renewable energy systems but biomass and geothermal have the highest capacity factors. Table 9 shows the expected lifespan and capacity factor for selected renewable energy technologies.

[170] Price Waterhouse Coopers (2009) *Alberta Environment - Assessment of Selected Renewable Energy Technology and Potential in Alberta*, accessed on December 9, 2014.
[171] Talberth, J., Cobb, C., Slattery, N. (2006) *The Genuine Progress Indicator: A Tool for Sustainable Development*, Redefining Progress - The Nature of Economics, Oakland, California http://issuu.com/genuine-progress/docs/indicator-2006?e=7627340/1756730

Renewable Energy Systems by Lifetime and Capacity Factors [172,173,174,175,176,177,178,179]

Renewable Energy Systems	Longevity (years)	Capacity Factor
Hydro	70	47%
Wind	20	35%
Solar Thermal	20-40	25%
Solar Photo Voltaic and CSP	25-30	20%
Bioenergy	25	80%
Geothermal	25-30	75-90%

For a fuller review of various renewable energy technologies on their stage of technological development, dependence upon local resource availability, seasonal availability and ability to deliver base and peak load electricity, the reader is referred to Tables 1, 3 and 4 in Power Generation in Canada by the Canadian Electricity Association.

The manufacture, construction and decommissioning of various renewable energy technologies results in varying degrees of greenhouse gas emissions. With a particular focus on carbon dioxide, it is clear that solar and geothermal have the potential to produce the most CO_2 during their lifecycle whereas ocean, wind and hydro appear to have the least CO_2 impact during the lifecycle. Table 10 reveals the lifecycle CO_2 intensity of various renewable energy technologies.

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[172] Sathaye, J., O. Lucon, A. Rahman, J. Christensen, F. Denton, J. Fujino, G. Heath, S. Kadner, M. Mirza, H. Rudnick, A. Schlaepfer, A. Shmakin, 2011: Renewable Energy in the Context of Sustainable Development. In *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[173] National Renewable Energy Laboratory (2013) *Wind LCA Harmonization* June 2013 Accessed from http://www.nrel.gov/docs/fy13osti/57131.pdf, on November 10, 2014.

[174] National Renewable Energy Laboratory (2013) *Concentrating Solar Power Results: Life Cycle Assessment Harmonization* January 2013. http://www.nrel.gov/analysis/sustain_lca_csp.html.

[175] National Renewable Energy Laboratory (2013) *Crystallne Silicon and Thin Film Photovoltaic Results Assessment Harmonization* 2013. Accessed from http://www.nrel.gov/analysis/sustain_lca_pv.html, on November 1, 2014.

[176] International Renewable Energy Laboratory (2013) *Production of Liquid Biofuels: Technology Brief*, 2013. Accessed from http://www.irena.org/DocumentDownloads/Publications/IRENA-ETSAP%20Tech%20Brief%20P10%20Production_of_Liquid%20Biofuels.pdf, on November 10, 2014.

[177] US Energy Information Administration (2014) *Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2014* 7 May 2014. Accessed from http://www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf, on November 10, 2014

[178] Goldstein, B., G. Hiriart, R. Bertani, C. Bromley, L. Gutiérrez-Negrín, E. Huenges, H. Muraoka, A. Ragnarsson, J. Tester, V. Zui, 2011: Geothermal Energy. In *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Chapter 4 Geothermal Energy Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[179] United Nations Development Programme (2000) Bioenergy Primer: Modernized Biomass Energy For Sustainable Development, accessed from http://www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/sustainable-energy/bioenergy-primer-modernised-biomass-energy-for-sustainable-development/Bioenergy%20Primer_2000.pdf, on November 12, 2014.

Lifecycle Carbon Dioxide Emissions per kWh by Renewable Energy Source[180,181,182,183,184,185,186]

Renewable Energy	GHG per kWh
Hydro	4 and 14 g CO_2 [187]
Wind	8 to 20 g CO_2 (outliers at 80g CO_2)
Solar	30 and 80 g CO_2
Geothermal	<50g CO_2 for flash steam plants <80g CO_2 for projected enhanced geothermal
Ocean Energy	8g CO_2
Bioenergy	*4.3.1 There is a wide range of GHG balances dependent upon land use changes related to energy source: sugar cane and forestry residues produce the best GHG savings but increases can occur when natural land is converted. For example, negative GHG balances are the worst for biofuels produced from palm oil, soya beans and corn. Bioenergy has the potential for 80-90% GHG reductions compared to baseline fossil fuel in high quality land and forest management scenarios.*

[180] Kumar, A., T. Schei, A. Ahenkorah, R. Caceres Rodriguez, J.-M. Devernay, M. Freitas, D. Hall, Å. Killingtveit, Z. Liu, 2011: Hydropower. In *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[181] Chum, H., A. Faaij, J. Moreira, G. Berndes, P. Dhamija, H. Dong, B. Gabrielle, A. Goss Eng, W. Lucht, M. Mapako, O. Masera Cerutti, T. McIntyre, T. Minowa, K. Pingoud, 2011: Bioenergy. In *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[182] Goldstein, B., G. Hiriart, R. Bertani, C. Bromley, L. Gutierrez-Negrin, E. Huenges, H. Muraoka, A. Ragnarsson, J. Tester, V. Zui, 2011: Geothermal Energy. In *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel,P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[183] Wiser, R., Z. Yang, M. Hand, O. Hohmeyer, D. Infi eld, P. H. Jensen, V. Nikolaev, M. O'Malley, G. Sinden, A. Zervos, 2011: Wind Energy. In *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[184] Arvizu, D., P. Balaya, L. Cabeza, T. Hollands, A. Jager-Waldau, M. Kondo, C. Konseibo, V. Meleshko, W. Stein, Y. Tamaura, H. Xu, R. Zilles, 2011: Direct Solar Energy. In *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[185] Lewis, A., S. Estefen, J. Huckerby, W. Musial, T. Pontes, J. Torres-Martinez, 2011: Ocean Energy. In *IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlomer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[186] United Nations Environment Programme (2009), *Toward Sustainable Use and Production of Resources: Assessing biofuels*, accessed from http://www.unep.org/PDF/Assessing_Biofuels.pdf, on December 26, 2014.

[187] The potential for much greater emissions exists and this should be taken as a general rule.

When looking at GHG emissions produced by various renewable energy sources as well as water and waste impacts, it is clear that some are more benign than others. Geothermal and bioenergy both have waste impacts. Solar, geothermal, run of river and bioenergy all have water use impacts (albeit low impacts). Reservoir hydro has more dramatic water impacts and biomass conversion does not liberate users from GHG emissions. Table 11 outlines the GHG emissions from energy conversion, water use and waste impacts of various renewable energy sources.

GHG from Energy Conversion, Water Use and Waste Impacts of Renewable Energy Technologies[188]

Renewable Energy Source	GHG from energy conversion process	Water Use Impacts	Waste
Hydro	none	Reservoir hydro flow pattern changes Run of river minimal	no
Wind	none	none	no
Solar	none	low	no
Geothermal	none	low	yes
Ocean Energy	none	non-consumptive	no
Bioenergy	*4.3.2 low*	*4.3.3 low*	*4.3.4 yes*

Similarly, care must be taken to ensure that the consequences of trading CO2 for volatile organic compounds or nitrous oxide or any other by-product of the new energy source are considered carefully in feasibility assessments.

Last, but certainly not least, other environmental consequences of adopting new energy sources and technologies need to be taken into consideration. Community engagement is central in the renewable energy technology adoption process so that the impacts of favored renewable energy technologies are known in advance. Table 12 provides a summary of the challenges and considerations by renewable energy source.

[188] Adapted from Canadian Electricity Association (2006), *Power Generation in Canada,* accessed from http://www.electricity.ca/media/pdfs/EnvironmentallyPreferrablePower/2-powergenerationincanada.pdf, November 20, 2014.

Potential Environmental Impacts of Renewable Energy Technologies[189]

RET	Potential Impacts
Bioenergy (dedicated feedstocks)	Loss of high quality natural habitats by conversion to managed lands, pressure on conservation areas, effects on agro-biodiversity and wildlife by agricultural intensification, soil degradation, eutrophication and pesticide emissions to aquatic habitats, introduction of invasive or genetically modified species
Bioenergy (residues)	Residue removal may lead to soil degradation, loss of woody debris habitats in forestry systems
Solar PV (field installations)	Disturbance through installation stage, plant community change due to shading effects
Concentrated Solar Power	Disturbance of fragile desert ecosystems
Geothermal	Impacts of hazardous chemicals in brine fluids in case of surface disposal, modifications of habitats in conservation areas
Hydropower (general effects)	Alteration of littoral, riverine and lentic ecosystems, interference with fish migratory routes, reduced access to spawning grounds and rearing zones, change in sediment loads of the river
Hydropower (typical for reservoirs)	Habitat and special biotope loss through inundation (change of terrestrial to aquatic and riverine to lentic ecosystems), impacts of changes in chemical composition and water temperature (downstream), changes in seasonal flow and flooding regimes, extirpation of native species/introduction of non-native species, alteration of the hydrological cycle downstream
Ocean Tidal Barrage	Alteration of marine and coastal ecosystems, changes in water turbidity, salinity and sediment movements in estuary affecting vegetation, fish and bird breeding spaces
Ocean Salinity Gradient	Brackish waste water impacts on local marine and riverine environment
Ocean (Thermal Energy)	Up-welling effect of nutrient rich water to surface may impact aquatic life
Ocean (Wave energy, ocean and tidal current)	Rotating turbine blades, noise, vibration and electromagnetic fi elds may impact sensitive species (elasmobranchs, marine mammals), disturbance of pelagic habitats and benthic communities
Wind (Onshore)	Disturbance of air routes of migratory birds, collision fatalities of birds/raptors and bats, avoidance or displacement from an area, reduced reproduction
Wind (Offshore)	Sound waves during construction may negatively affect marine mammals, disturbance of benthic habitats

[189] Reproduced from J. Sathaye, O. Lucon, Rahman Atiq, J. Christensen, F. Denton, J. Fujino, G. Heath, M. Mirza, H. Rudnick, A. Schlaepfer and A. Shmakin, Renewable Energy in the Context of Sustainable Development in *IPCC Special Report on Renewable Energy and Climate Change* Mitigation 2011 accessed from http://www.ipcc.ch/pdf/special-reports/srren/Chapter%209%20Renewable%20Energy%20in%20the%20Context%20of%20Sustainable%20Development.pdf, page 745. More indepth discussion of RET specific impact and mitigation measures can also be found in Sections 2.5.5, 3.6.1, 4.5.3, 5.6.1, 6.5.2, 7.6.2 and 7.6.5 of this report.

For a fuller, more technical review of the contaminants associated with select renewable energy technologies, the reader is referred to section 3.3.4 Summary of Environmental Impacts in Price Waterhouse Coopers (2009) Alberta Environment - Assessment of Selected Renewable Energy Technology and Potential in Alberta and to Table 2 Environmental Impacts of Electricity Generation Technologies (page 17) in Power Generation in Canada by the Canadian Electricity Association.

Combined Heat and Power

Because combined heat and power is categorically different from renewable energy technologies, the analysis of its costs and benefits remains distinct. Combined heat and power is also known as residual or waste heat recovery, energy recovery generation and co-generation. Very basically, combined heat and power or cogeneration is the simultaneous production of electricity and heat. Heat that would otherwise be wasted in the production of electricity is recovered and used for heating and cooling air, heating water and for industrial processes.[190] Combined heat and power is much more energy efficient than the separated generation of electricity and heat.[191]

It is widely understood that energy efficiency[192] and conservation can be cost effective measures to undertake *before* moving to renewable energy technologies.[193,194] Instead of low hanging fruit, energy efficiency has been described as fruit lying all over the ground. However, given global pressure to reduce GHGs, efficiency measures that maintain dependence upon imported fossil fuels may be short term solutions. Considered on a life cycle basis, decision makers must factor in the costs of continued reliance upon imported fossil fuels in combined heat and power systems that increase in cost over time while generation costs of renewable energy technologies are fixed upfront and decrease over time.[195] Continued reliance on imported fossil fuels and their increasing costs over time may also have the unintended impact of deterring business and opportunity and lock northern communities into obsolete infrastructure with all the of concomitant social and environmental costs associated with diesel dependence (e.g., spills, leaks, transportation, noise, health consequences, GHGs, etc).[196] While efficiency measures will reduce GHG emissions, they are not emissions free.

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[190] Canadian Electricity Association (nd), Power for the Future Cogeneration Fact Sheet, accessed from http://powerforthefuture.ca/electricity-411/electricity-fuel-source-technical-papers/cogeneration/, on December 31, 2014.

[191] Center for Climate and Energy Solutions (nd), Cogeneration/Combined Heat and Power Fact Sheet, accessed from http://www.c2es.org/technology/factsheet/CogenerationCHP, on November 26, 2014.

[192] Energy efficiency (EE) refers to all activities that reduce energy consumed without affecting performance or service. The savings are usually gained by using improved technology or systems to consume or retain energy.

[193] Henderson, Christopher (2013), *Aboriginal Power – Clean Energy and the Future of Canada's First Peoples.*

[194] McDonald, N. C. and Pearce, J. M (2012, December) Renewable Energy Policies and Programs in Nunavut: Perspectives from the Federal and Territorial Governments, *Artic*, Vol. 65, No. 4, p. 465–475.

[195] Alliance for Rural Electrification (2011), Rural Electrification with Renewable Energy: Technologies, Standards and Business Models, accessed from http://www.ruralelec.org/fileadmin/DATA/Documents/06_Publications/ARE_TECHNOLOGICAL_PUBLICATION.pdf, on November 17, 2014.

[196] Government of Canada (2011) Status of Remote/Off-Grid Communities in Canada, August 2011 Accessed December 2, 2014 from https://www.bullfrogpower.com/remotemicrogrids/presentations/status_of_remote_off_grid_communiites_in_canada_2013-118_en.pdf.

The costs of residual heat recovery are highly dependent upon the thermal capacity of the power plants where poor thermal capacity means less feasibility for combined heat and power.[197]

> *. . ., residual heat projects in the NWT are far from cost-effective. Fort Liard required over 1.3 million in GNWT support and the Inuvik system will require a similar subside amount to be economic.*[198]

Still, from an efficiency perspective, combined heat and power is attractive and merits further scrutiny by policy makers. About two thirds of the energy expended in diesel dependent electricity generation can be captured in the form of heat and costs less than the oil currently used to heat neighboring buildings. Power corporations in Nunavut as well as several northern communities are using residual heat recovery although such systems are costly to construct and require close proximity to use areas and many want diesel plants moved away from homes. The advantage of residual heat systems is that they can be adapted to accept heat from oil *and renewable sources* necessary for the inevitable variations in heat that parallel electricity generation.[199] Residual heat recovery has the potential to save 30-100 percent of heating costs,[200] there are no GHG emissions from the energy conversion process, water impacts are low and there is no waste production.[201]

Combined heat and power is also generated from a number of technologies that each bring advantages and disadvantages.

> *It is sometimes assumed that all cogeneration is good, i.e., better than the alternative stand-alone electricity and thermal energy generation both from an economic and an environmental perspective. This is not always the case, particularly in systems with high H/P ratios and moderate system efficiencies or systems that operate at part load for significant portions of time*[202]

Table 14 reveals variation between several cogeneration systems (the reader is advised that not all cogeneration systems are represented here as no data were available for the fuller range of systems in the database of the Canadian Industrial Energy End-use Data and Analysis Centre).

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[197] Government of the Northwest Territories (2011), Northwest Territories Energy Report, accessed from http://www.assembly.gov.nt.ca/sites/default/files/11-05-20td36-166.pdf, on November 19, 2014.
[198] Government of the Northwest Territories (2011), Northwest Territories Energy Report, accessed from http://www.assembly.gov.nt.ca/sites/default/files/11-05-20td36-166.pdf, on November 19, 2014, page 45.
[199] Government of the Northwest Territories, Nunavut and the Yukon (nd) Paths to a Renewable North: A Pan-Territorial Renewable Energy Strategy.
[200] Legislative Assembly of the Northwest Territories, "Memorandum of Understanding on Development of Residual Heat Distribution Systems," 16 March 1998. [Online]. Available: http://www.assembly.gov.nt.ca/sites/default/files/09-06-04td65-163.pdf.
[201] Canadian Electricity Association, Power Generation in Canada
[202] Park, Hi-Chun, Kim, H. (2008) Heat supply systems using natural gas in the residential sector: the case of the agglomeration of Seoul. *Energy Policy* 36: 3843-3853 as cited in Canadian Industrial Energy End-use Data and Analysis Centre (2014) Cogeneration Facilities in Canada, Simon Fraser University, March 2014, accessed from file:///H:/Eco-Energy%20Jan%201%202015/Domestic%20Literature/CIEEDAC%20Cogeneration_Report_2014_Final.pdf, on November 19, 2014, page 7.

Cogeneration System Efficiencies, Heat to Power Ratios and Thermal Energy Quality[203]

Cogeneration System	Electrical Energy Output (% of fuel input)	Overall Efficiency (%)	Heat to Power Ratio	Thermal Qualities
Back-pressure steam turbine	14-28	84-92	4-22	High
Condensing steam turbine	22-40	60-80	2-10	High
Gas turbine	24-42	70-85	1.3-2	High
Reciprocating engine	33-53	75-85	0.5-2.5	Low
Combined cycle gas turbine	34-55	69-83	1-1.7	Medium
Fuel Cells	40-70	75-85	0.33-1	Low to High
Microturbines	15-33	60-75	1.3-2	Medium to Low

Ultimately, the largest potential for combined heat and power is in the industrial sector and other operations that need continuous, reliable power such as hospitals, data centres and universities. Estimates of Canadian co-generation production reveal that Alberta produces the most energy through combined heat and power (49.4 percent), followed by Ontario (39.8 percent), British Columbia (28.2 percent), Québec (11.2 percent), Saskatchewan and Manitoba (7.2 percent), Atlantic provinces (6.3 percent), and the territories (0.1 percent).[204]

The skills to install and maintain combined heat and power systems are normally provided by the supplier but the installation of combined heat and power systems also requires people skilled in plumbing and/or heating installation who may need some additional training.[205] The capital costs of a 50MW gas turbine cogeneration system might be $45 million dollars and take up to a year and half to install and a 1MW system might be $1.6 million depending upon the complexity of the systems under consideration.[206]

Sample estimates for project sizes (<400kW to > 5 MW) in a variety of sites with varying complexity are offered in Table 15). Capital costs are amortized over a 10 year period. Operating

[203] Canadian Industrial Energy End-use Data and Analysis Centre (2014) Cogeneration Facilities in Canada, Simon Fraser University, March 2014, accessed on file:///H:/Eco-Energy%20Jan%201%202015/Domestic%20Literature/CIEEDAC%20Cogeneration_Report_2014_Final.pdf, on November 19, 2014.

[204] Canadian Industrial Energy End-use Data and Analysis Centre (2014) Cogeneration Facilities in Canada, Simon Fraser University, March 2014, accessed on file:///H:/Eco-Energy%20Jan%201%202015/Domestic%20Literature/CIEEDAC%20Cogeneration_Report_2014_Final.pdf, on November 19, 2014

[205] International Labor Office and European Union (2011) *Skills and Occupational Needs and Green Building*, accessed from file:///H:/Eco-Energy%20Jan%201%202015/Global%20Literature/ILO%20Skills%20and%20Occupational%20needs%20in%20CHP%20wcms_166822.pdf, on December 22, 2014.

[206] Center for Climate and Energy Solutions (nd), *Cogeneration/Combined Heat and Power Fact Sheet*, accessed from http://www.c2es.org/technology/factsheet/CogenerationCHP, on November 26, 2014

and maintenance cost estimates can vary widely with Rankine cycle power systems having relatively low maintenance costs. However, the reader is cautioned that costs vary by technology and site conditions. Because waste heat is recovered, theoretically there are no fuel costs.

Cost Estimates of Combined Heat and Power Systems (<400kW to >5MW)

Waste Heat to Power Cost	
Installed Costs	USD $/kW $2,000 - $4,000
WHP Generating Costs	
Amortized Capital	$/kWh $0.055 - $0.125
O&M Costs	$/kWh $0.005 - $0.020
Total Power Cost	$/kWh $0.060 - $0.125

Because such a *high degree of variability* exists between combined heat and power systems, detailed information regarding lifecycle assessment, GHG emissions during energy conversion phases, capacity requirements during operations and maintenance and the fuller range of environmental concerns require careful consideration moving forward. Like renewable energy technologies, the decision to proceed with supporting combined heat and power is *situation and need specific* and should be made in community energy planning, pre-feasibility and feasibility phases of development.