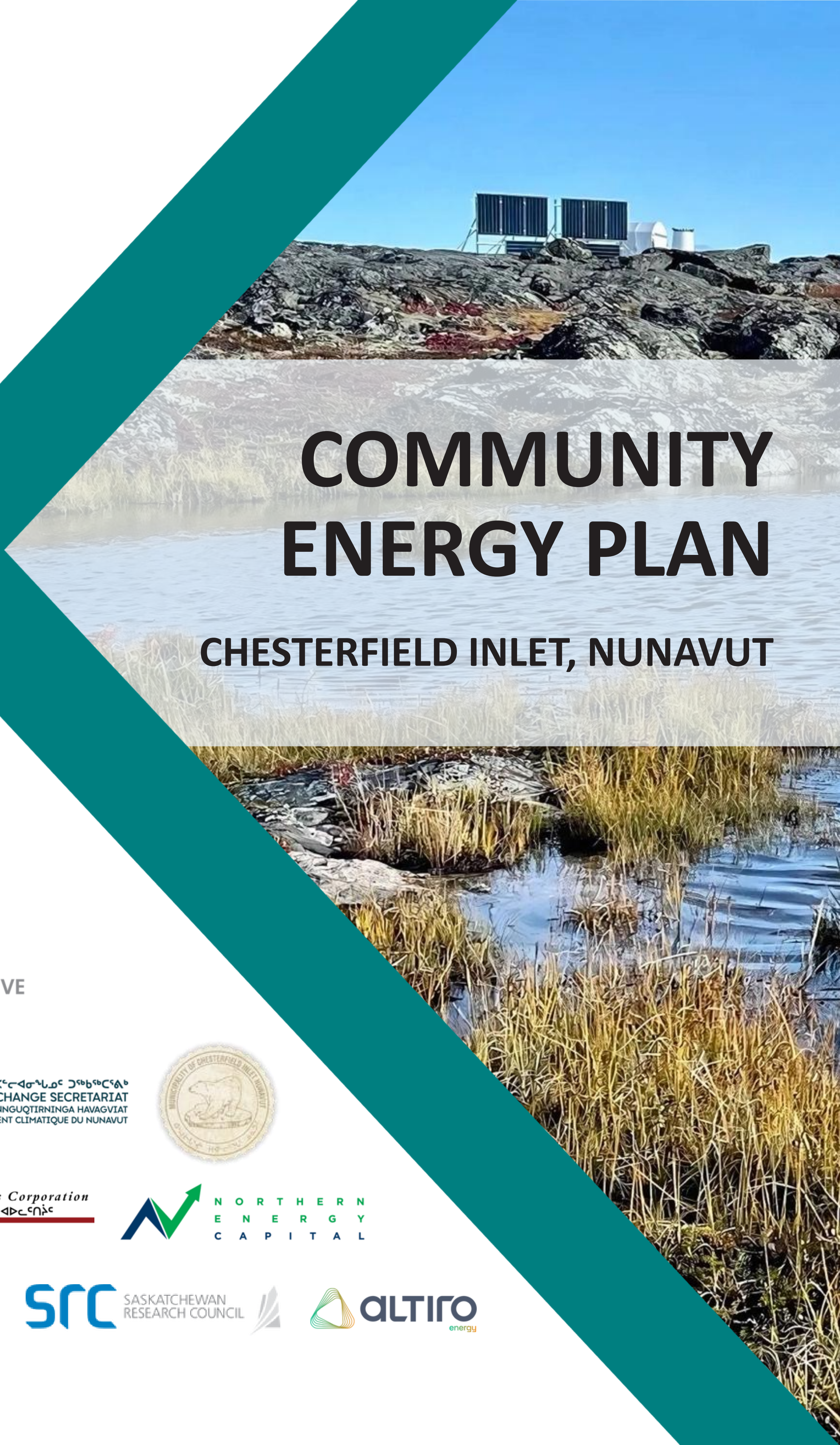


COMMUNITY ENERGY PLAN

CHESTERFIELD INLET, NUNAVUT

KIVALLIQ ALTERNATIVE ENERGY

NUNAVUT CLIMATE CHANGE SECRETARIAT
NUNAVUNMI HILAUP AALANNGUQTIRNINGA HAVAGVIAT
SECRÉTARIAT DU CHANGEMENT CLIMATIQUE DU NUNAVUT

Sakku Investments Corporation

NORTHERN ENERGY CAPITAL

greencat Renewables

SRC SASKATCHEWAN RESEARCH COUNCIL

altiro energy

CONTENTS

EXECUTIVE SUMMARY

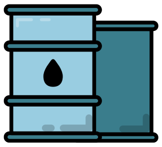
The Chesterfield Inlet **Community Energy Plan** (CEP) serves as a roadmap to reduce diesel dependency, promote energy efficiency, and transition to a Net Zero energy future for Chesterfield Inlet, Nunavut. The plan addresses the critical need for energy security, reduced greenhouse gas (GHG) emissions, and economic development consistent with the community's traditional knowledge and values.

1.1 KEY OBJECTIVES OF THE CEP

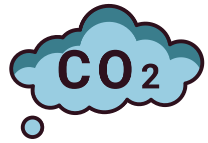
1. **Establish a Baseline for Energy Usage:** Assess the community's current energy sources, usage patterns, associated costs, and GHGs.
2. **Engage the Community:** Involve community members in dialogue to understand energy-related priorities such as cost, environmental impact, and reliability.
3. **Promote Energy Efficiency:** Identify strategies to improve energy efficiency across homes, community buildings, and municipal infrastructure.
4. **Explore Clean Energy Alternatives:** Evaluate the feasibility of solar, wind, and other clean energy resources to supplement or replace diesel.
5. **Support Capacity Building:** Empower local community members with the knowledge and tools needed to implement sustainable energy solutions.

1.2 CURRENT ENERGY CONTEXT

Chesterfield Inlet, like many remote northern communities, is heavily dependent on diesel fuel for electricity, heating, and transportation. This dependency results in high energy costs, exposure to fuel price fluctuations, and significant GHG emissions.



In **2024** Chesterfield Inlet consumed approximately **1.82 million** litres of fossil fuel...



...generating an estimated **4,900 tonnes** of CO_2e each year.

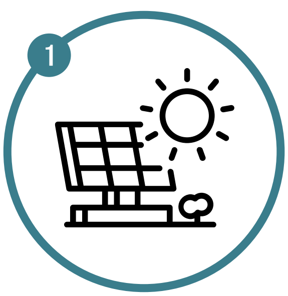
1.3 COMMUNITY FEEDBACK

The CEP Team conducted a survey of residents to learn information and opinions regarding energy, and **29** households (approx. **25%** of Chesterfield Inlet's households) responded.

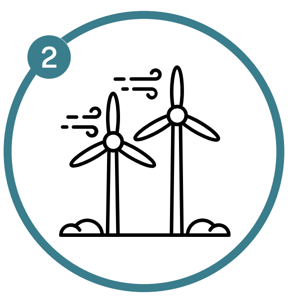
SURVEY RESPONDENTS EXPRESSED THE HIGHEST CONCERN FOR (IN ORDER):

1. Cost of electricity and fuel
2. Reliable energy with no outages
3. Clean fuels with low environmental impacts
4. Reducing greenhouse gas emissions and addressing climate change
5. Generating energy locally and reducing reliance on imported fuels

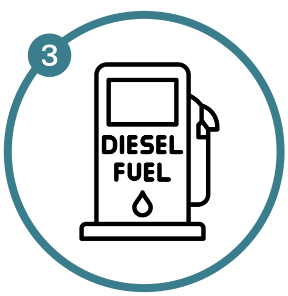
SURVEY RESPONDENTS EXPRESSED SUPPORT FOR (IN ORDER):



SOLAR ENERGY



WIND ENERGY



CONTINUED USE OF DIESEL

RUN-OF-RIVER HYDROPOWER

93% **of survey respondents said they would be proud if Chesterfield Inlet were to pursue clean energy solutions.**

1.4 RECOMMENDATION FOR TRANSITIONING TO NET ZERO

The CEP outlines a pathway to transition Chesterfield Inlet to a Net Zero electricity grid. Although a 100% renewable energy option is possible, it is currently prohibitively expensive, so this plan recommends actions based on the optimal cost-benefit outcome.

Energy Efficiency: Reducing energy demand in buildings by upgrading insulation, switching to LED lights, and installing programmable thermostats. Building can will help identify the most effective specific measures.

Wind Energy: Wind energy offers year-round clean energy. A **1 MW** wind energy project can provide the bulk of the energy needed to achieve a Net Zero electrical grid.

Solar Energy: A ground-mounted solar photovoltaic (PV) system can significantly reduce diesel consumption in summer. A **2.38 MW** solar energy project would complement the wind energy project and help achieve a Net Zero electrical grid.

Load Management and Energy Storage: Battery energy storage systems (BESS) will be critical to keep QEC's electricity grid stable during times of variable wind and solar generation. Other technologies like electric thermal storage (ETS) can also shift energy demand to non-peak times, reducing stress on the grid and maximizing the capture of clean energy.

THE CEP TEAM RECOMMENDS THE FOLLOWING NEAR-TERM ACTIONS:

1. Develop implementation plans for the proposed wind, solar, and battery storage projects.
2. Conduct a **Connection Impact Assessment** (CIA) study with QEC to obtain approval for the proposed mix of wind, solar, and battery storage capacity.
3. Build local capacity and create employment opportunities related to the energy transition.
4. Secure funding for key projects through federal programs and partnerships with organizations like QEC and the Government of Nunavut.

By following this plan, the residents of Chesterfield Inlet can realize the following benefits:

- Fewer diesel fuel spills
- Lower GHG emissions which contribute to climate change.
- Protection from global commodity markets and ever-increasing fuel prices.
- More local involvement in energy operations, including some jobs.
- Potential improvements to buildings through energy efficiency measures that could help to address related concerns such as mold and air quality.
- Opportunities for education and capacity building within the community.

GLOSSARY OF TERMS

Active Solar Heating	A system that uses mechanical means to circulate a heat-absorbing fluid through collectors.
Adaptation	In the context of climate change, this refers to adjustments in natural or human systems in response to actual or expected climatic effects.
Air Source Heat Pump	A type of heat pump that transfers heat between a building and the outside air.
Ambient Temperature	The temperature of the surrounding environment.
Arctic Energy Alliance (AEA)	An organization promoting energy efficiency and clean energy solutions in Arctic communities.
Baseline	A reference point against which changes can be measured. In an energy context, this often refers to the current energy consumption or emissions level.
Battery Energy Storage System (BESS)	A technology used to store electrical energy for later use, improving grid stability and integrating renewable energy sources.
Bioenergy	Energy derived from organic matter, such as wood, crops, and waste.
Building Envelope	The physical separator between the interior and exterior of a building, including the walls, roof, and foundation.
Carbon Dioxide (CO_2)	A greenhouse gas produced by burning fossil fuels and organic matter, contributing to climate change.
Carbon Dioxide Equivalent (CO_2e)	A measure that expresses the impact of different greenhouse gases in terms of the equivalent amount of CO_2 emissions.
Carbon Footprint	The total amount of greenhouse gases generated by our actions.
Carbon Neutral	Achieving net-zero carbon emissions by balancing emissions with an equivalent amount of removal or offsetting.
Chesterfield Inlet Development Corporation (CIDC)	A local business entity that manages various community-based services and infrastructure projects.
Climate Change Mitigation	Actions taken to reduce or prevent greenhouse gas emissions, thereby lessening the severity of climate change.
Community Energy Plan (CEP)	A strategic plan developed to help communities transition to sustainable energy, improve efficiency, and reduce greenhouse gas emissions.
Connection Impact Assessment (CIA)	A study to evaluate how new energy projects, such as wind or solar farms, will affect the existing electrical grid.

Demand-Side Management (DSM)	Measures taken to reduce or shift electricity demand, often during peak periods.
Distributed Generation	Electricity generation from many smaller energy sources located close to the end-users.
Electric Thermal Storage (ETS)	A heating technology that stores excess electricity in high-density ceramic bricks and releases heat when needed.
Energy Audit	An assessment of a building's energy consumption and identification of areas for improvement.
Energy Conservation	Reducing energy consumption through behavioral changes or efficient use of technology.
Energy Security	The reliable availability of energy sources at an affordable price.
Government of Nunavut (GN)	The territorial government responsible for public policy and administration in Nunavut.
Green Cat Renewables (GCR)	A renewable energy consultancy involved in feasibility studies, project design, and implementation.
Greenhouse Gas (GHG)	Gases that trap heat in the atmosphere, contributing to climate change.
Ground Source Heat Pump	A type of heat pump that transfers heat between a building and the ground.
Hybrid Optimization Model for Electric Renewables (HOMER)	A software tool used to model and optimize renewable energy microgrids.
Hydrokinetic Energy	Energy derived from the movement of water, such as in rivers or tides.
Hunters and Trappers Organization (HTO)	A local organization representing Inuit hunters and trappers, involved in community resource management.
HVAC	Heating, ventilation, and air conditioning systems.
Independent Power Producer (IPP)	A private entity that generates electricity for sale to utilities or the public grid.
Keewatin Regional Land Use Plan (KRLUP)	A regulatory framework guiding land use and development in the Keewatin region, including Chesterfield Inlet.
Kilowatt (kW)	A unit of power equivalent to 1,000 watts.
Kilowatt-hour (kWh)	A unit of energy representing the consumption of one kilowatt over one hour.
Kivalliq Alternative Energy (KAE)	An organization supporting clean energy development in the Kivalliq region of Nunavut.
Kivalliq Inuit Association (KIA)	A regional Inuit organization representing Inuit interests in economic and environmental matters.

Life Cycle Assessment (LCA)	A method for evaluating the environmental impacts of a product, process, or service throughout its entire life cycle.
Megawatt (MW)	A unit of power equivalent to 1,000 kilowatts.
Megawatt-hour (MWh)	A unit of energy representing the consumption of one megawatt over one hour.
Microgrid	A localized energy grid that can operate independently or in conjunction with the main electrical grid.
Net Metering	A billing mechanism that allows customers who generate their own electricity to feed excess power back into the grid and offset their electricity consumption.
Northern Power Systems (NPS)	A manufacturer of wind turbines suitable for remote and northern communities.
Nunavut Impact Review Board (NIRB)	The regulatory body responsible for assessing the environmental and socio-economic impacts of development projects in Nunavut.
Ocean Renewable Power Company (ORPC)	A company specializing in tidal and hydrokinetic energy technologies.
Off-Grid	Not connected to a main utility grid.
Peak Demand	The maximum amount of electricity required at any one time.
Petroleum Products Division (PPD)	A division responsible for fuel supply and distribution in Nunavut communities.
Photovoltaic (PV)	A technology that converts sunlight directly into electricity using solar cells.
Qulliq Energy Corporation (QEC)	The territorial utility responsible for generating and distributing electricity in Nunavut.
Resilience	The ability of a system or community to withstand and recover from shocks or stresses.
Royal Canadian Mounted Police (RCMP)	The national police force of Canada, providing law enforcement in Chesterfield Inlet.
Saskatchewan Research Council (SRC)	A research and technology organization supporting energy and environmental projects.
Smart Grid	A modernized electrical grid that uses digital communications technology to optimize the delivery of electricity.
SODAR	Sonic Detection and Ranging: A remote sensing technology used to measure wind speed and atmospheric conditions for wind energy projects.
Sustainability	Meeting the needs of the present without compromising the ability of future generations to meet their own needs.
University of Victoria (UVic)	A university involved in renewable energy research and projects in northern Canada.

SECTION 03

INTRODUCTION & ACKNOWLEDGEMENTS

The **Chesterfield Inlet Community Energy Plan (CEP)** represents a collaborative effort to chart a sustainable and resilient energy future for the community.

This plan aims to reduce reliance on imported diesel fuel, improve local energy efficiency, and explore clean energy opportunities that align with Chesterfield Inlet's unique climate, geography, and community values. Guided by community input, this CEP will serve as a roadmap to enhance local energy security, reduce greenhouse gas emissions, and promote economic development.

This CEP is designed as a living document, adaptable to evolving community needs, technological advances, and policy changes. By taking these initial steps, Chesterfield Inlet can progress toward a cleaner, more secure energy future that aligns with both traditional and modern community values.

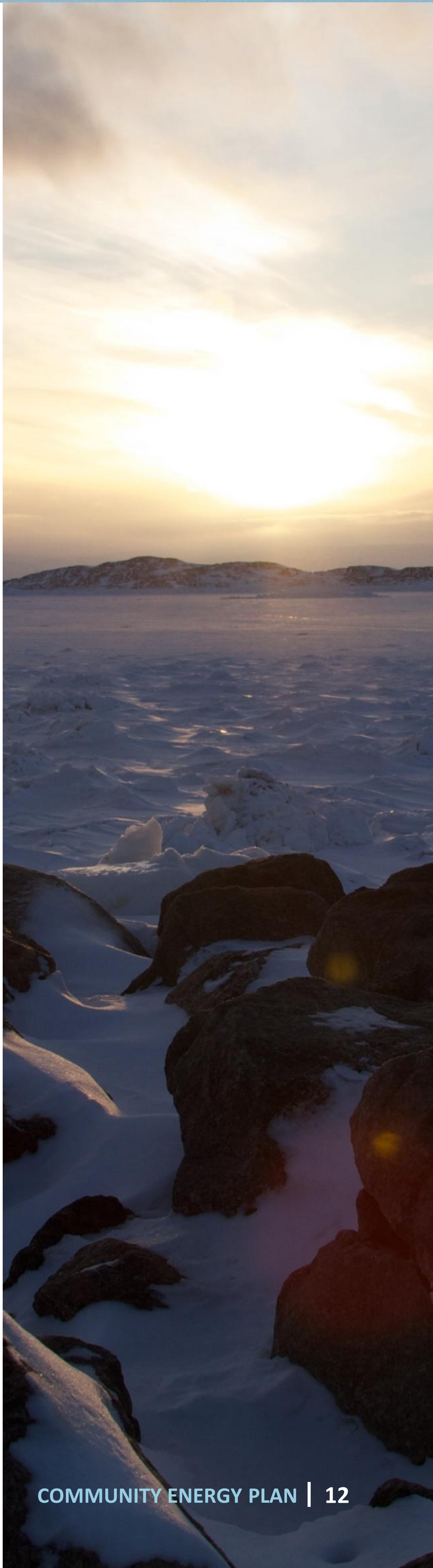
3.1 OBJECTIVES OF THE COMMUNITY ENERGY PLAN

The primary objectives of the Chesterfield Inlet CEP are to:

- **Assess Current Energy Usage**: Establish a baseline for Chesterfield Inlet's current energy sources, usage patterns, and associated costs, with a focus on identifying major energy demands in electricity, heating, and transportation.
- **Incorporate Community Perspectives**: Engage Chesterfield Inlet residents, leaders, and stakeholders in a meaningful dialogue to understand community priorities related to energy, including the cost, environmental impact, and reliability of current systems.
- **Promote Energy Efficiency**: Identify strategies to increase energy efficiency in homes, community buildings, and local infrastructure to reduce overall energy demand.
- **Explore Clean Energy Alternatives**: Evaluate the feasibility of local clean energy resources, such as solar, wind, and biomass, that could supplement or eventually replace diesel.
- **Support Capacity Building**: Empower Chesterfield Inlet with the knowledge and tools needed to implement and maintain sustainable energy solutions through local training and resource sharing.

The overall goal of this CEP is to guide Chesterfield Inlet towards a **net-zero electricity grid**, where the carbon emissions from electricity production are offset by an equivalent amount of carbon removal. To achieve this, the Plan focuses on integrating clean (non-carbon emitting) energy sources like solar and wind, along with energy storage and efficiency improvements, to replace (carbon emitting) diesel-generated power.

More detail is provided in this CEP regarding the specific mix of technologies that the CEP Team recommends for this transition to Net Zero electricity. Less detail is given regarding opportunities to de-carbonize the heating system in Chesterfield Inlet. Project economics are evaluated, but only in the context of a Net Zero electricity system.



3.2 GLOBAL AND LOCAL CONTEXT

The transition toward sustainable energy is an essential step in addressing global climate challenges and ensuring energy resilience in remote communities like **Chesterfield Inlet**.[1] Currently, Chesterfield Inlet relies on diesel fuel for nearly all energy needs[2]—a dependency that comes with significant economic, environmental, and logistical challenges. Diesel reliance contributes to greenhouse gas emissions, environmental risks, and exposes the community to fluctuations in fuel prices and supply chains.

The Government of Canada has committed to supporting Indigenous and northern communities in reducing diesel dependency through initiatives like the **Pan-Canadian Framework on Clean Growth and Climate Change**,[3] and the **Indigenous Off-Diesel Initiative**.[4] These programs, alongside emerging clean energy technologies, provide Chesterfield Inlet with new opportunities to enhance its energy security, decrease pollution, and foster community resilience.

In addition, the Government of Nunavut (GN) in its **Ikummatiit Energy Strategy**[5] focuses on creating a sustainable, secure, and environmentally responsible energy system. The strategy emphasizes reducing imported oil by improving energy efficiency and increasing the use of domestic renewable energy.

[1] https://www.pembina.org/programs/remote-communities and https://natural-resources.canada.ca/funding-partnerships/clean-energy-rural-remote-communities-program
[2] Qulliq Energy Corporation
[3] https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html
[4] https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/reduce-emissions/reducing-reliance-diesel/indigenous-off-diesel-initiative.html
[5] http://www.energy.gov.nu.ca/en/ikummatiit.aspx

3.3 CEP TEAM

This CEP was made possible by the contributions of various parties:

- Kivalliq Alternative Energy (KAE)
- Green Cat Renewables (GCR)
- Saskatchewan Research Council (SRC)
- GN Department of Environment, Climate Change Secretariat (CCS)
- Hamlet of Chesterfield Inlet

3.4 ACKNOWLEDGEMENTS

Other contributors:

- Sakku Investments Corporation (SIC)
- Northern Energy Capital (NEC)
- University of Victoria (UVic)
- Altiro Energy
- EWT
- Northern Power Systems (NPS)
- Ocean Renewable Power Company (ORPC)

This CEP was funded through the support of the following organizations:

- Canadian Northern Economic Development Agency (CanNor)
- Indigenous Green Economy
- Northern Responsible Energy Approach for Community Heat and Electricity (REACHE) program

Land Acknowledgement

This Community Energy Plan for Chesterfield Inlet, Nunavut, was primarily drafted in Vancouver, British Columbia. We acknowledge that Vancouver is located on the traditional, ancestral, and unceded territories of the xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish), and səl̓ilwətaɬ (Tsleil-Waututh) Nations.

This document pertains to the community of Chesterfield Inlet, Nunavut, and its residents. We respectfully acknowledge that Chesterfield Inlet is located on the traditional territory of the Inuit of Nunavut, and we recognize their deep connection to the land and their traditional knowledge.

SECTION 04

METHODOLOGY

4.1 THE COMMUNITY ENERGY PLANNING PROCESS

This CEP was developed following the framework provided by the **Arctic Community Energy Planning and Implementation (ACEPI) Toolkit**. This framework emphasizes a comprehensive approach to energy planning that includes setting objectives, establishing an energy baseline, engaging stakeholders, evaluating energy efficiency and renewable opportunities, and setting strategic recommendations.

The plan's findings and recommendations are organized to help Chesterfield Inlet achieve short-term energy improvements, with a view also toward longer-term, sustainable changes. Each recommendation has been evaluated based on its alignment with the community's priorities, feasibility, and potential to reduce diesel dependency and greenhouse gas emissions.

Moving forward, this CEP will be revisited periodically to track progress, adapt strategies, and continue fostering a clean energy future for Chesterfield Inlet.

4.2 STEPS IN A CEP

The CEP Team has worked with the community of Chesterfield Inlet with the intention of performing Stages 1 through 7 of this process. The findings of this work are presented in this CEP as follows:

- **STAGE 1** “Understanding Your Energy Landscape” → See Section 5 Community Profile
- **STAGE 2** "Convening Stakeholders & Building Your Energy Team” → See Section 3.3 CEP Team
- **STAGE 3** "Community Engagement & Energy Education” → See Section 6 Community Engagement
- **STAGE 4** "Developing a Community Energy Vision” → This work has not yet been performed
- **STAGE 5** "Assessing Energy Needs & Resources” → See Section 5.8 Sources of Energy & Section 7 Opportunities for Transition to Net Zero
- **STAGE 6** “Identifying Specific Energy Goals & Project” → See Section 8 HOMER Microgrid Modeling
- **STAGE 7** "Creating the Business Case” → See Section 7 Opportunities for Transition to Net Zero
- A final section is provided to summarize the highest priority recommendations resulting from the CEP work; → see Section 9 Recommendations

The community of Chesterfield Inlet is therefore, as of this date, ready to embark on **STAGE 8** of the ACEPI process: “Implementing Energy Project Plans”. The CEP team is prepared to continue supporting the Hamlet of Chesterfield Inlet in realizing its energy-related goals.

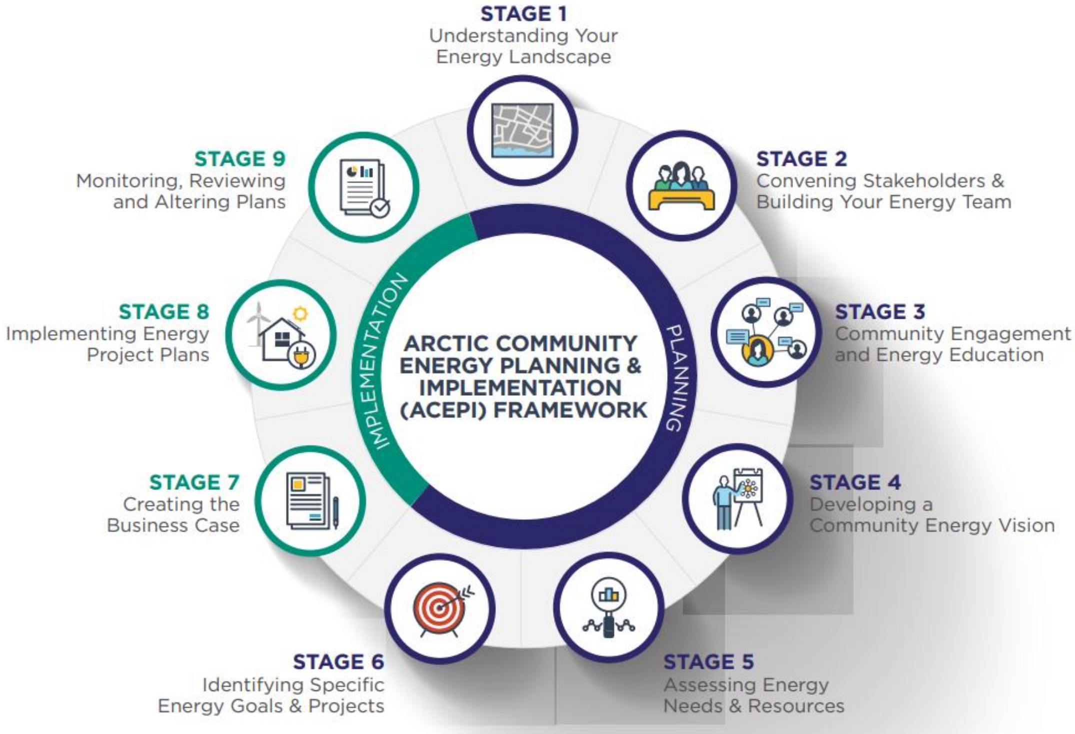


Figure 1: Stages in the CEP Process[6]

[6] Arctic Community Energy Planning & Implementation Framework (ACEP Toolkit)

4.3 EVALUATION CRITERIA

The CEP Team established basic criteria to guide the identification of a viable clean energy project. These criteria can be specific to each technology, but should always include the following:

TECHNICAL AND OPERATIONAL FEASIBILITY

- **Authorization from QEC**. Technologies should be capable of demonstrating through technical studies their compatibility with the continued reliable operation of the local electrical grid, resulting in authorization from QEC to interconnect.
- **Interconnection suitability**. Cost and complexity of safely and reliably interconnecting with an end user or the QEC electrical grid. Small projects might interconnect cheaply behind the meter of an existing electricity user. Larger projects can require stepping up the voltage to connect to distribution lines, along with protections and controls to protect the generator and the grid.
- **Energy resource**. The strength and quality of the wind resource, solar irradiation, hydrological flow, tidal exchange, geothermal gradient, etc. This can be estimated based on computer modeling, and then verified using field measurements.
- **Level of complexity**, with a preference for simpler projects where possible.

ECONOMIC AND FINANCIAL VIABILITY

- **Capital cost**. Estimated cost of developing and constructing the project.
- **Financial pay-back period**. A calculation of how quickly the project savings can be used to repay the project costs,
- **Alignment with federal funding programs**. Due to the high costs of building infrastructure in Nunavut, federal funding is commonly used to cover some or all of the capital cost of new projects. Even under QEC's IPP program, grant funding is typically required to create a viable business. At present, projects that demonstrate a high rate of diesel reduction per dollar of grant funding are generally well received by funding decision makers.

LOGISTICAL AND ACCESS CONSIDERATIONS

- **Distance from grid**. Projects that are farther afield will require longer transmission lines to connect with the Chesterfield Inlet electrical grid, with resulting costs and environmental impacts.
- **Road access**. Sites with good road access will be more affordable to build.
- **Logistics**. There is no deep-water port in the community, nor cranes for unloading heavy or specialized equipment. Therefore, solutions that are logistically simpler may be more affordable.

SOCIO-ECONOMIC CONSIDERATIONS

- **Alignment with planning**. Consistency with existing community planning objectives and land use designations. Avoidance of any areas legally designated as off limits to energy generation projects.
- **Environmental impact**. Consultation with the Hamlet government and government regulators can reveal environmental factors that should be avoided through careful siting of a clean energy project.
- **Human use.** Ability to co-existing alongside human uses such as recreation, hunting, trapping, gathering, harvesting, or spiritual use.[7] Additionally, larger generators such as large wind turbines can make sound and are not appropriate within **~500m** of a residence. Medium-sized turbines can be placed up to approximately **200m** from a residence.
- **Jobs and training**. Opportunities associated with project construction or operation.
- **Alignment with community feedback**. A preference for fuel types or locations that receive strong public support in the community energy survey.

[7] **Photo:** Technicians carry solar panels to install on rooftop of Pangnirtung's school https://nunatsiaq.com/stories/article/pangnirtung-solar-panel-project-aims-to-cut-hamlets-diesel-use/

4.4 MODELING THE PATH TO NET ZERO

The CEP Team performed modeling using **HOMER** software to explore various configurations of wind energy, solar energy, and energy storage. Various potential projects were ranked in relation to project cost, diesel fuel reductions (between **80 – 100%**), resilience, logistical simplicity, etc. This HOMER modeling relied on the following assumptions:

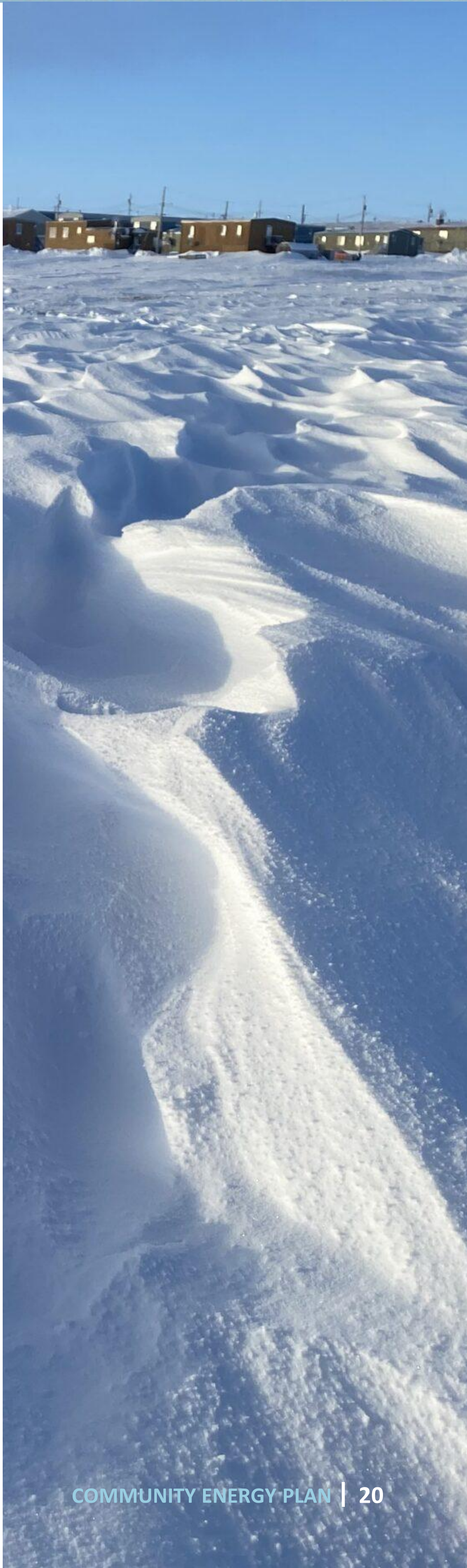
Table 1: HOMER Modeling Assumptions

Assumption	Value
Discount Rate	6%
Inflation Rate	3%
Project Lifetime	25 years
Replacement Costs	Yes, for batteries

4.5 RECOMMENDATIONS

Recommendations in this CEP (presented in Section 9) are considered in two-time categories:

- **Near-term opportunities**: which are viable today, and which could realistically be implemented within the next 5 years. This includes smaller, simpler projects with a high return ("low hanging fruit") as well as larger, more complex projects that are more impactful ("high impact projects").
- **Longer-term opportunities**: which are not viable based on today's economic conditions, but which could be expected to become viable 5+ years into the future (e.g. an emerging new technology that is currently too expensive), or projects which should not be pursued until an earlier step is completed (e.g. adding electric vehicles could become a project, but only after the electric grid has been largely converted to clean energy).



4.6 SOURCES OF DATA

The CEP Team has relied on the following sources of data to inform the CEP analyses:

- **Climate data:**
    - → Environment Canada. URL: https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=1712&autofwd=1
- **Demographics data:**
    - → Census Canada. URL: https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/page.cfm?lang=E&topic=9&dguid=2021A00056205019
    - → Census Canada URL: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=6205019&Geo2=PR&Code2=62&SearchText=Chesterfield%20Inlet&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=6205019&TABID=1&type=0
- **Housing stock:**
    - → Personal communications with Chesterfield Inlet SAO
    - → Census Canada. URL: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=6205019&Geo2=PR&Code2=62&SearchText=Chesterfield%20Inlet&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=6205019&TABID=1&type=0
- **Electricity consumption:**
    - → Data from QEC.
- **Fuel consumption data:**
    - → Data from PPD with support from CCS.
- **Clean energy resource data and estimates:**
    - → Solar data from Meteonorm 8.1.
    - → Wind data from direct SODAR measurement taken by the CEP Team.
    - → Other clean energy resources: Government of Canada (2018). The Atlas of Canada: Clean Energy Resources and Projects [CERP]. URL: https://atlas.gc.ca/cerp-rpep/en/
- **Government programs, policies, and incentives:**
    - → GN Publication: Government of Nunavut. (2020). Nunavut Energy Management Program Policy. Department of Community and Government Services.
- **Public opinion data:**
    - → Survey conducted by the CEP Team.

COMMUNITY PROFILE: CHESTERFIELD INLET

Figure 2: Map of Chesterfield Inlet, Nunavut, on the eastern coast of Hudson Bay

5.1 HISTORY

Chesterfield Inlet, known as **Igluligaarjuk** or **ᐃᒡᓗᓕᒑᕐᔪᒃ** in Inuktitut, meaning "place with a few houses," is one of the oldest continuously inhabited settlements in the Kivalliq region of Nunavut. Historically, the area was home to Inuit people who relied on marine and land-based resources for their survival. The community benefited from the rich wildlife in the region, including caribou, seals, fish, and whales, which were essential for food, clothing, and tools.

European contact began in the late 18th century, with the establishment of trading posts by the Hudson's Bay Company. In 1924, Chesterfield Inlet became home to the first Roman Catholic mission in the Canadian Arctic, and a residential school was built in the 1930s.

During the mid-20th century, the Government of Canada expanded its presence in Chesterfield Inlet by building essential infrastructure, including a nursing station and a federal day school. The construction of an airstrip improved access to the community and facilitated medical services and the transport of goods. Public housing programs in the 1960s and 1970s resulted in more permanent settlement in the area.

In 1993, the signing of the Nunavut Land Claims Agreement marked a turning point for Chesterfield Inlet and other communities in the region. Nunavut was officially established as a separate territory in 1999, giving Inuit people greater control over their land, resources, and governance.

Today, Chesterfield Inlet is a vibrant community with a strong connection to its cultural heritage. Traditional activities such as hunting, fishing, and crafting remain an important part of life. The community continues to attract visitors interested in its history and the opportunity to experience Arctic wildlife and the natural beauty of the surrounding landscape.

Figure 3: Chesterfield Inlet Thule Sites, where nomadic 'Dorset' and 'Thule' people lived for 1000s of years.[8]

[8] **Photo**: https://chesterfield-inlet.ca/about-us/

5.2 GOVERNANCE & PLANNING

The Hamlet of Chesterfield Inlet operates under an elected municipal council structure, comprising a Mayor and Councilors. Elections are held every four years, with the most recent election occurring in October, 2023. The council is responsible for overseeing essential municipal services, including water delivery, sewage pump-outs, garbage collection, snow clearing, and by-law enforcement. Decisions made by the council are implemented by the Senior Administrative Officer (SAO) and supporting staff.

The Kivalliq Inuit Association (KIA) represents Inuit people in the Kivalliq Region, including Chesterfield Inlet. KIA's mission is to "represent, in a fair and democratic manner, Inuit of the Kivalliq Region in the development, protection, administration and advancement of their rights and benefits as an aboriginal people; as well as to promote their economic, social, political and cultural well-being through succeeding generations."[9]

KEY PLANNING DOCUMENTS GUIDING DEVELOPMENT & INFRASTRUCTURE IN CHESTERFIELD INLET:

1. **Community Plan By-law No. 148**: Outlines Hamlet policies for managing physical development over a 20-year period, emphasizing orderly growth, a mix of land uses, and the protection of natural areas.[10] Objectives of this By-law that could affect energy-related decisions include:
    - To develop in an orderly fashion creating a healthy, safe, functional, and attractive community that reflects community values and culture.
    - To promote the Plan as a tool for making effective and consistent decisions regarding land use and development in the community.
    - To build upon community values of participation and unity to support community projects and local economic development.
    - To protect the natural beauty of "Nuna", protect viewpoints to the water, and retain waterfront and lakeshore areas for public uses and traditional activities.

2. **Infrastructure Plan for 2024/2025**: Focuses on improving and maintaining community infrastructure, prioritizing a new municipal quarry and acquiring necessary equipment to support capital projects.[11] Objectives in this Plan that could affect energy-related decisions include:
    - Establishing power transmission from Manitoba as an alternative source, since the "current power is costly and produces high levels of greenhouse gases".
    - Acquiring a new larger crusher to support infrastructure projects like housing development and essential barge landing construction.

3. Chesterfield Inlet falls under the **Keewatin Regional Land Use Plan (KRLUP),** which provides broader regional planning guidelines.[12]

---

9 www.kivalliqinuit.ca
10 https://chesterfield-inlet.ca/community-services/planning-lands/
11 toolkit.buildingnunavut.com
12 www.nunavut.ca

5.3 CLIMATE

Chesterfield Inlet experiences cold temperatures with little sunlight in winter, and warmer temperatures with lots of sunlight in summer.

Wintertime also brings frozen conditions for local sea, lake, and river waters.

Figure 4 shows monthly temperature and precipitation values for Chesterfield Inlet.[13]

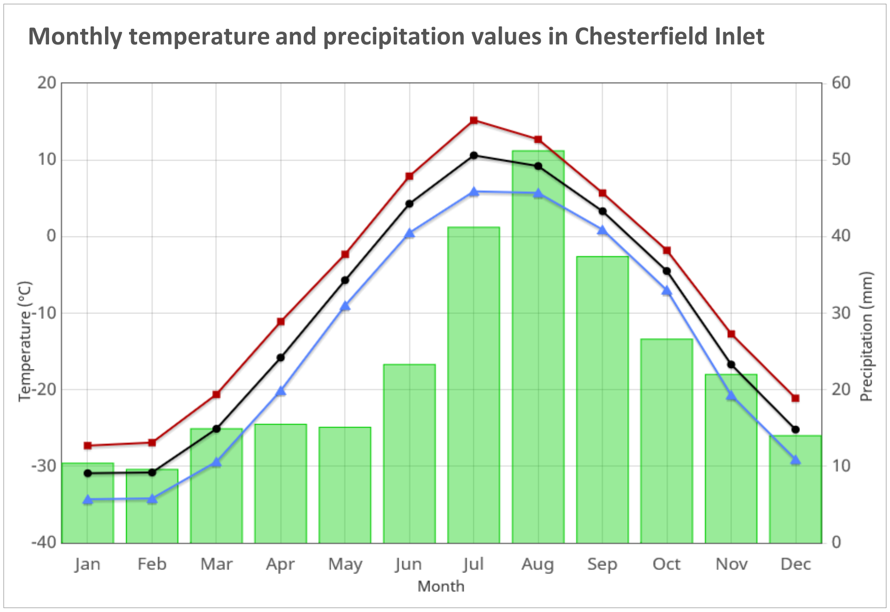


Figure 4: Monthly temperature and precipitation in Chesterfield Inlet

In a survey conducted by the CEP team the majority of residents reported that they have observed impacts of climate change, most commonly "changes in ice conditions", "changes in wildlife patterns", "more extreme weather events", and "permafrost thawing"—as depicted in **Figure 5** below.

Question: "What changes have you noticed in Chesterfield Inlet that you think are related to Climate Change?"

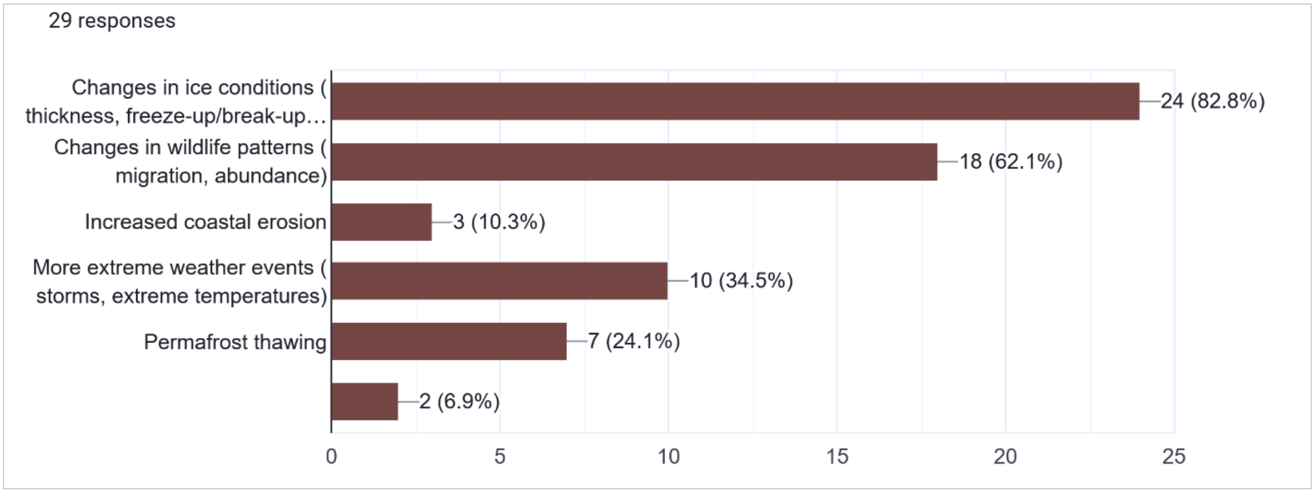


Figure 5: Survey responses regarding the observed impacts of climate change.

[13] https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=1712&autofwd=1

5.4 DEMOGRAPHICS

According to Statistics Canada data from the 2021 Census,[14] Chesterfield Inlet has a population of **397 residents**, reflecting a 9.2% decrease from the 2016 population of 437.

The median age in Chesterfield Inlet is 26.7 years, younger than the national median age of 41. Youth under the age of 20 constitute a significant portion of the population, while only 6% are aged 65 and over.

The community is predominantly **Inuit**, with 65.0% to 89.9% of residents reporting Inuktitut as their mother tongue.

Economic data specific to Chesterfield Inlet is limited. However, in the broader Kivalliq Region, which includes Chesterfield Inlet, **traditional activities such as hunting, fishing, and gathering remain integral to the local economy and culture**. Challenges related to income levels and food insecurity persist across many communities in Nunavut.

Employment statistics for Chesterfield Inlet are not readily available. In the Kivalliq Region, common occupations include roles in public administration, education, social services, trades, transport, and equipment operation.

Approximately **41%** of adults in Chesterfield Inlet have completed high school, and **27%** have pursued post-secondary education, including trades or college programs. Approximately **4%** of the population holds a bachelor's degree or higher. Many college-educated residents complete their studies outside Nunavut and later return to contribute their skills to the community.

[14] https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=E&GENDERlist=1,2,3&STATISTIClist=1,4&HEADERlist=0&DGUIDlist=2021A00056205019&SearchText=Chesterfield%20Inlet

5.5 BUILDING STOCK

According to Statistics Canada,[15] Chesterfield Inlet has approximately **397 residents living in 116 habitable dwellings (approx. 4.2 people per home).** The housing stock primarily consists of single-family detached homes, many of which are constructed using wood-frame techniques. However, detailed data on the specific construction types and ages of these buildings are limited.

In a survey conducted by the CEP team, respondents reported living primarily in detached homes, with some in multi-plex buildings and a small fraction in mobile homes—as illustrated in **Figure 6**. Most survey respondents reported between 4 and 6 residents living in their home—as illustrated in **Figure 7**. Many survey respondents did not know whether their home has insulation above the ceiling—as illustrated in **Figure 8**. Note that the **29 survey results (25% of households)** may not accurately represent the community as a whole.

Question: "What kind of home do you live in?"

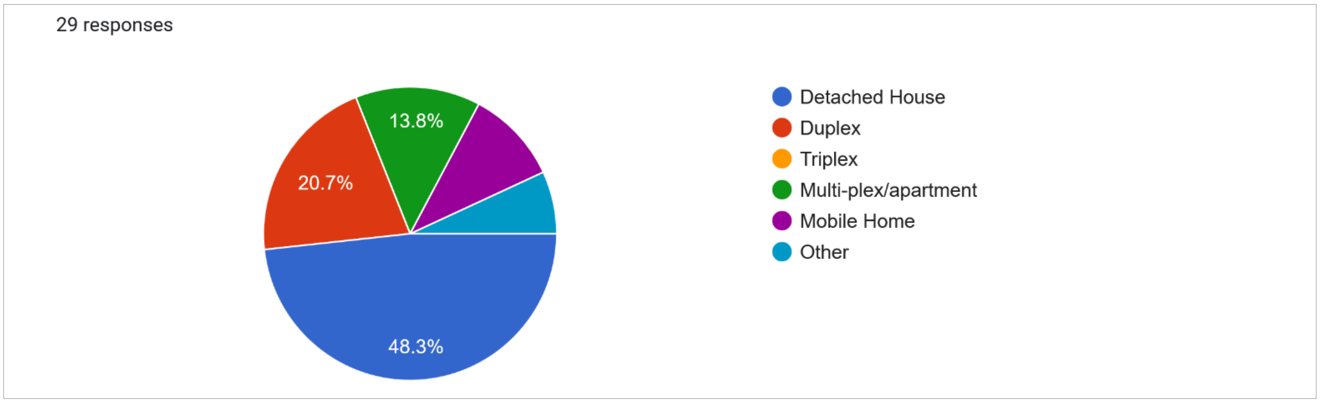


Figure 6: Survey responses regarding the type of home

Question: "How many people live in your home?"

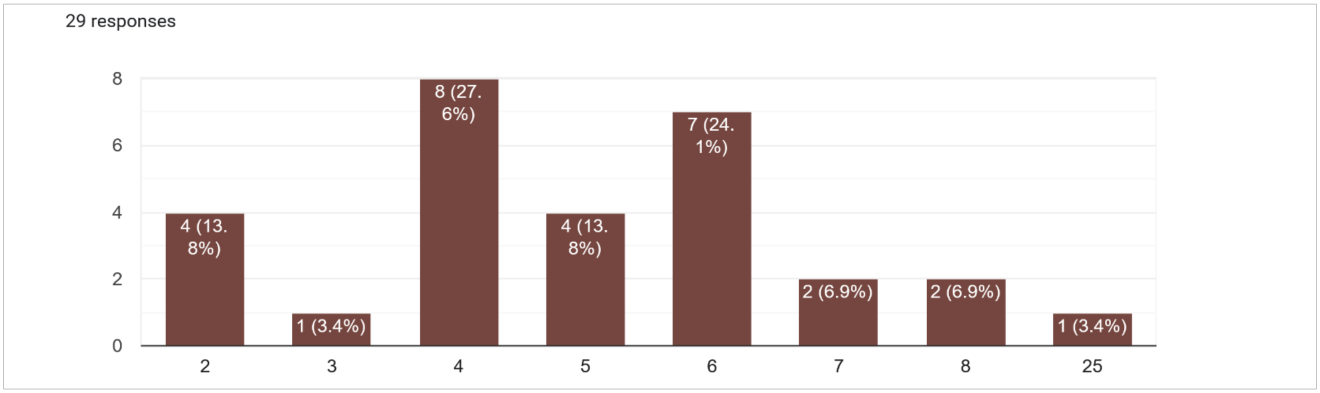


Figure 7: Survey responses regarding the number of people living in a home

[15] https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=E&GENDERlist=1,2,3&STATISTIClist=1,4&HEADERlist=0&DGUIDlist=2021A00056205019&SearchText=Chesterfield%20Inlet

Question: "Does your home have insulation above the entire ceiling?"

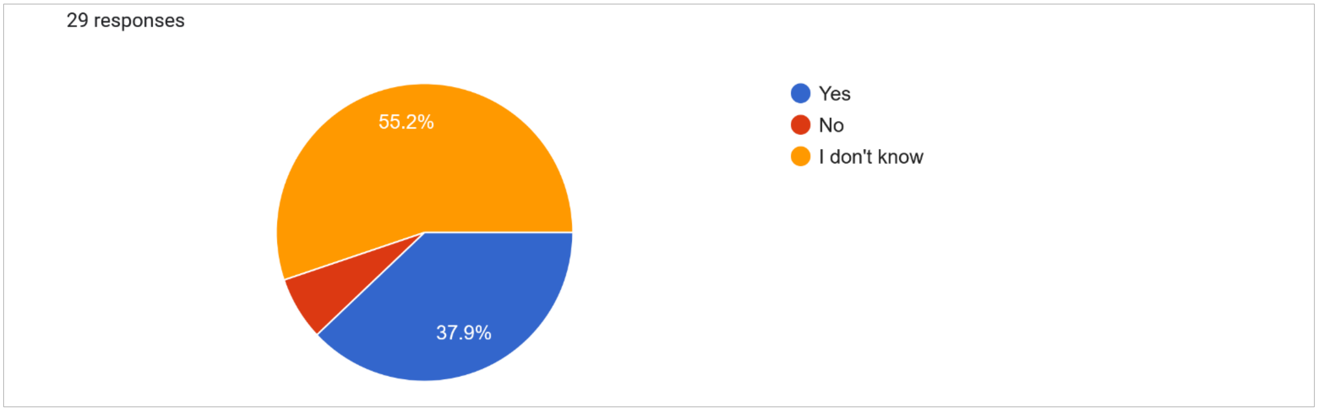


Figure 8: Survey responses regarding insultation above the ceiling.

Question: "What type of improvements has your household made to help reduce energy costs?"

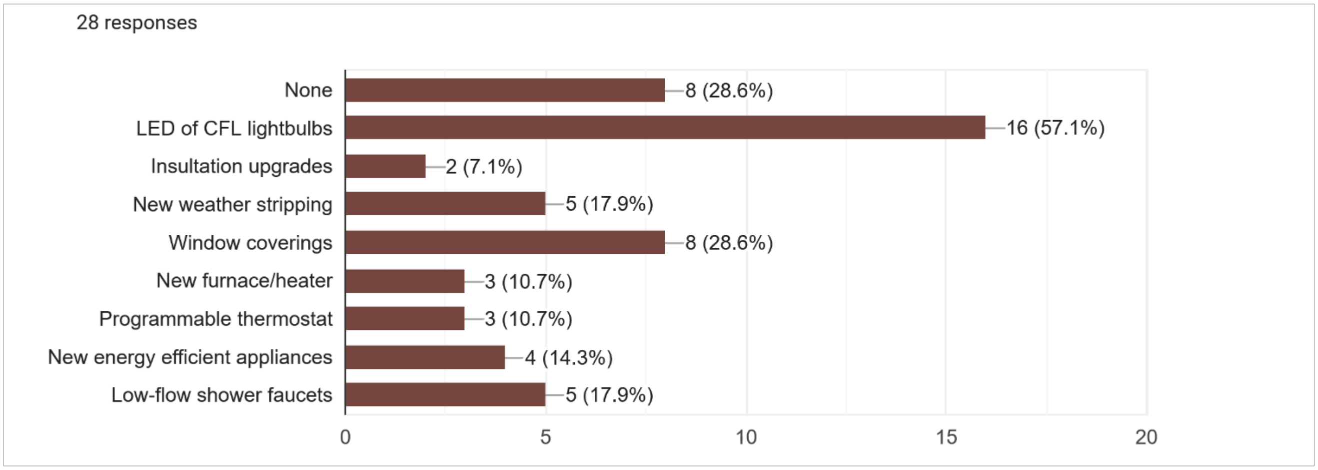


Figure 9: Survey responses regarding improvements made in the household to save energy costs.

Community Building Stock

Chesterfield Inlet includes the community buildings listed below.[16] Community-scale buildings represent the majority of electricity demand in Chesterfield Inlet (QEC's "commercial" rate class), larger than the residential ("domestic") demand.[17]

- Hamlet Office
- Health Center
- School
- Daycare
- Arctic College
- Cultural Center
- Noel Nuvak Arena
- Co-op Store
- Northern Store
- CIDC (private business)
- QEC Power Plant
- Public works garage
- RCMP Office
- Airport

[16] Pers. comm. SAO.
[17] Electricity sales data from QEC. See further details in **Section 5.9**

5.6 CAPACITY IN THE COMMUNITY

Implementing clean energy projects will require both experienced external experts combined with local knowledge, expertise and labour from Chesterfield Inlet.

Chesterfield Inlet could rely upon the following resources in pursuing its energy transition:

- Local labour can be hired to assist in construction projects,
- Chesterfield Inlet Development Corporation (CIDC) operates a store, a freight business, a vehicle rental business, and also owns a backhoe.
- The Hamlet owns a dump truck, grader, loaders, and an excavator.
- The community's Energy Champion, **Blaine Chislett**,[18] has been trained as a Residential Energy Advisor. Blaine lives in Rankin Inlet.

Figures 10-12: CIDC headquarters (top); heavy machinery owned by Hamlet or Aulajuq Ltd.[19]

[18] https://indigenouscleanenergy.com/catalyst/blaine/
[19] **Photos:** https://chesterfield-inlet.ca/community-services/business-services/

5.7 LOGISTICS IN THE COMMUNITY

Most human travel to and from Chesterfield Inlet is by scheduled flights several times per week, although some people will travel to/from Rankin Inlet by skidoo (in winter) or boat (in summer). Most cargo arrives by barge.[20]

Chesterfield Inlet does not have a deep-water port to offload cargo from ships. Therefore, "**sea lift**" ships arriving in port must anchor in the harbour and tie up a barge alongside the ship. Cargo up to 12,700 kg (40' container, inclusive of container) or 15,000 kg (20' container, inclusive of container) can be safely transferred from ship to barge using the ship's crane.[21] The barge is then brought to the port where cargo is offloaded using a fork loader.

Most projects considered in this CEP can be implemented using sea cans for transport. However, the wind energy projects discussed in [Section 7.5](#) will require careful consideration of logistics and associated costs.

Figure 13: Cargo arriving in Chesterfield Inlet is transferred from the sea-lift ship to a barge and offloaded at the port.[22]

[20] Pers. comm. SAO.
[21] Pers. Comm. Arctic Buying Co.
[22] **Photo:** https://chesterfield-inlet.ca/community-services/business-services/

5.8 SOURCES OF ENERGY

At this time, Chesterfield Inlet acquires virtually all of its energy from imported fossil fuels. The majority of fuel sales are managed by PPD. Total fuel sales in 2024 included the following amounts:[23]

Table 2: 2024 Fuel Sales in Chesterfield Inlet

Fuel Type	Amount (Litres)
Heating Fuel	780,000
Fuel for Electricity	595,000
Gasoline	336,000 L
Motive Diesel	110,000 L
Naphtha	1,000 L
Total	1,821,000 L

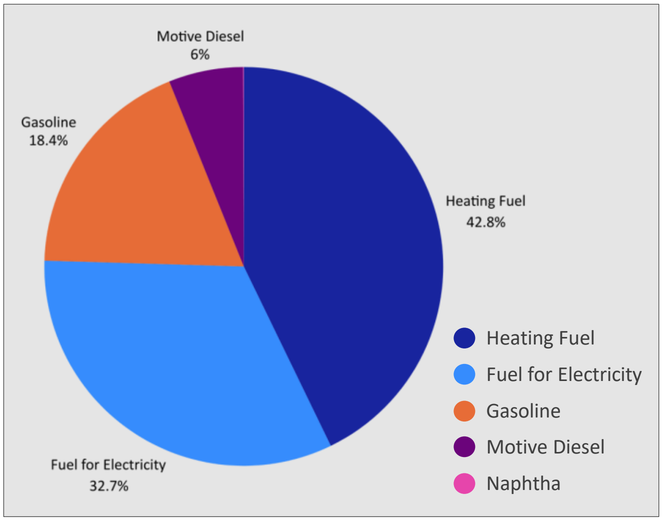


Figure 14: 2024 Fuel Sales in Chesterfield Inlet

Solar panels have been installed on the roof of the Noel Nuvak Arena in Chesterfield Inlet (capacity unknown); however, this system has not yet been connected to the grid and allowed to generate.

Figure 15: Solar panels being installed on the roof of the Noel Nuvak Arena in Chesterfield Inlet

[23] Data from PPD, analysis by CCS.

5.9 USES OF ENERGY

HEATING

Heating (both space heating and water heating) is the most common use for fossil fuels in Chesterfield Inlet. As illustrated in **Figure 16**, the majority of heating fuel is used in homes, followed by commercial and government uses.

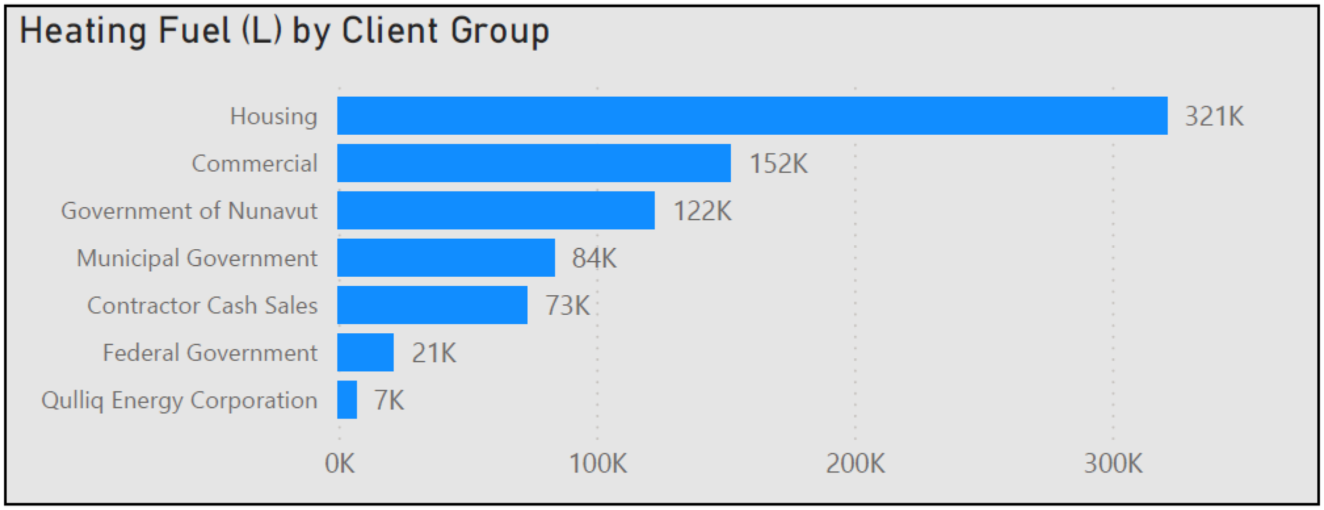


Figure 16: Annual heating fuel consumption broken down by user group.

In a survey conducted by the CEP team most residents reported heating the home using "heating oil" or "diesel" – as depicted in **Figure 17**.

Question: "What is the main source of energy used in your home?"

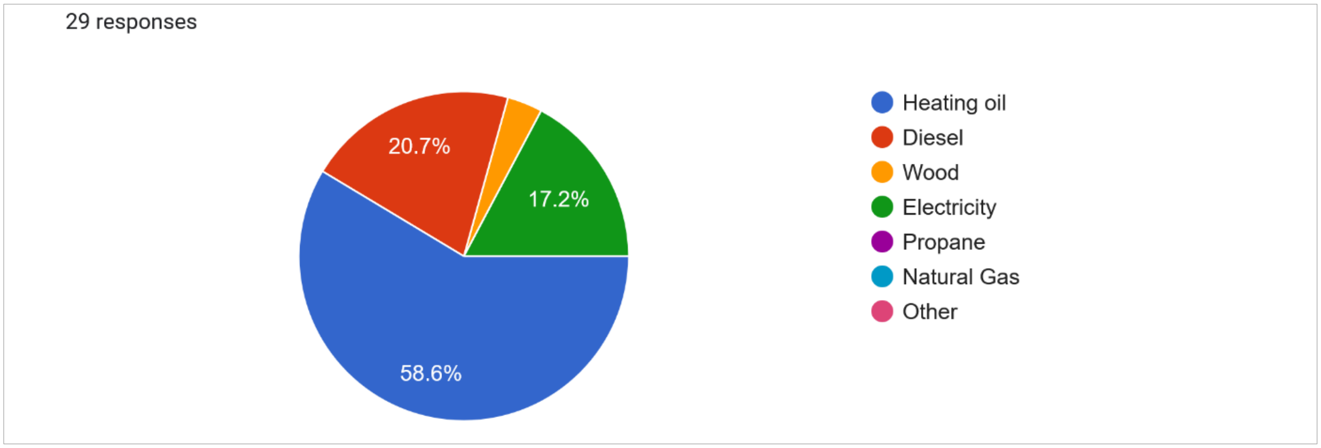


Figure 17: Survey responses regarding the source of heating energy used in the home.

ELECTRICITY

Electricity is the second-most common use for fossil fuels, to power lights, appliances, electronics, and some heating. Heating by electricity is atypical due to its high cost, as backed up by survey responses depicted in **Figure 17**.

QEC's power plant employs four diesel generators with a total capacity of 1.540 MW to convert diesel fuel to electricity, as listed in **Table 3**.

In 2024 these generators produced approximately **2.03 GWh** of electricity to serve local demand, with a peak load of 480 kW. By 2030 annual electricity demand is expected to increase to 2.17 GWh with a peak of 496 kW.

Table 3: List of QEC diesel generators in Chesterfield Inlet

GENERATORS (as of 2024)			
Brand	Model	Capacity (kW)	Condition
Detroit	Series 60	320	2010
Detroit	Series 60	320	2013
Volvo	TWD 1643 GE	400	2019
Volvo	D16	500	2019

Electricity demand is greatest in **wintertime** when residents spend more time indoors and require more lighting, as illustrated in **Figure 18**.

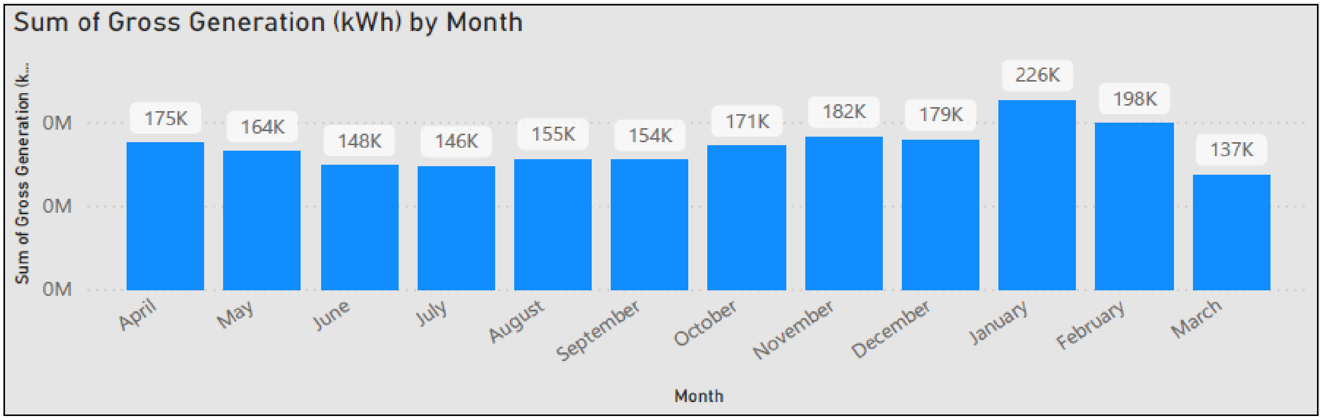


Figure 18: 2024 electricity demand broken down by month.

Figure 19 also illustrates annual electricity use in Chesterfield broken down by rate class. Electricity consumption is greatest among the "commercial" sector (both government and non-government) while domestic non-government (residential) consumption represents only approx. 10% of the total.

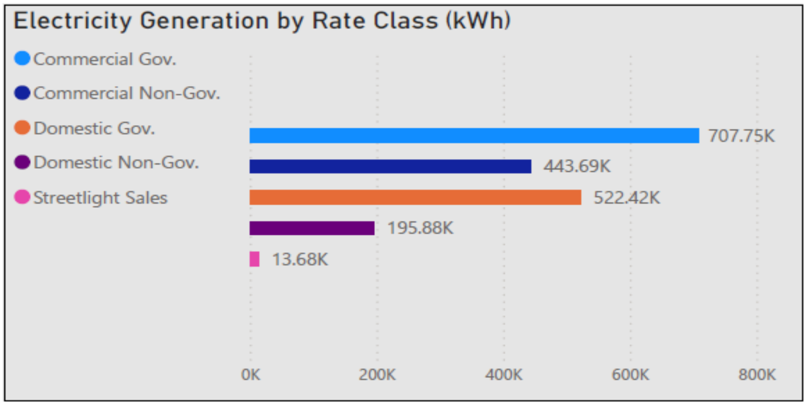


Figure 19: 2024 electricity demand broken down by rate class.

TRANSPORTATION

Transportation is the third large use of fossil fuel, including both gasoline and motor-grade diesel, as depicted in **Figure 20** and **Figure 21**, respectively. Over half of all motor-grade fuels are sold to residents at the local gas station.

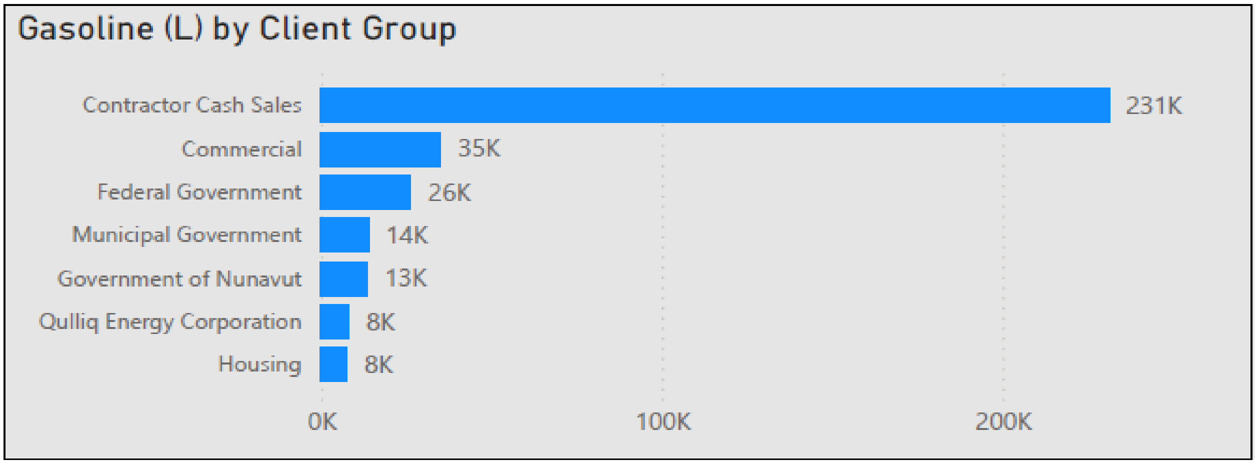


Figure 20: 2024 gasoline sales broken down by user group

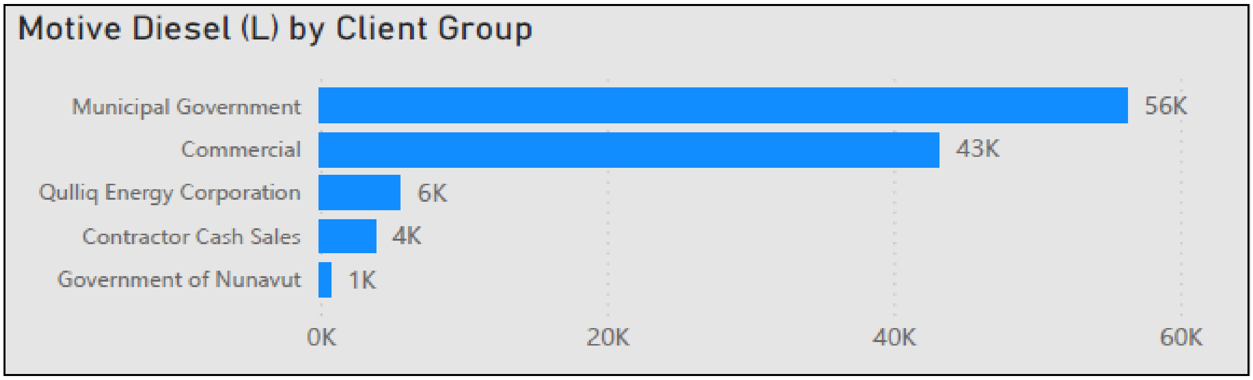


Figure 21: 2024 motor-grade diesel consumption broken down by user group

The majority (24 of 29) survey respondents indicated that they own a motor vehicle, most commonly ATV and snowmobiles, followed by trucks – as depicted in **Figure 22**.

Question: "How many vehicles are there in your household?"

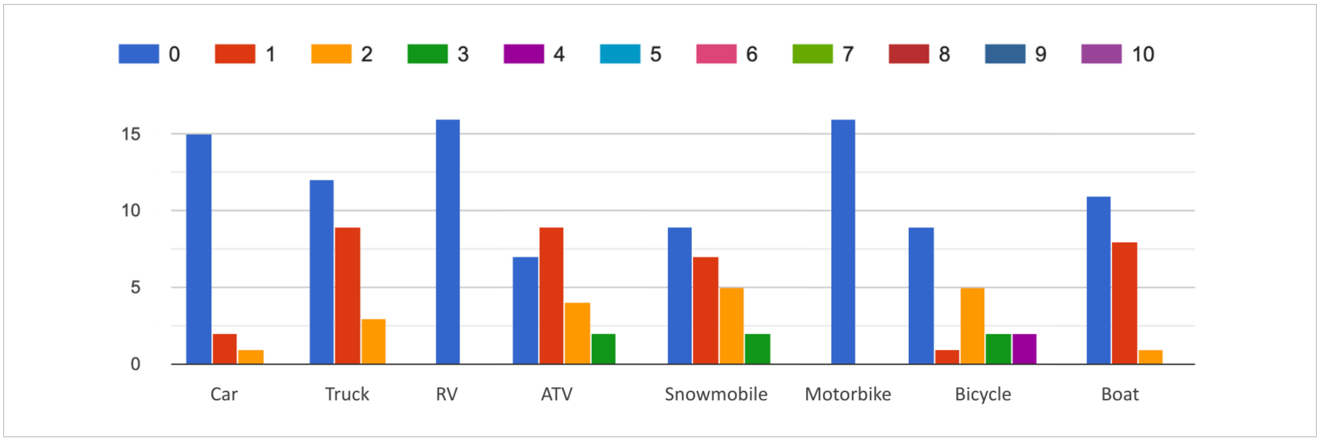


Figure 22: Survey responses indicating vehicle ownership.

NAPHTHA

PPD tracks naphtha fuel sales, which are used predominantly to power portable heaters / stoves while away from town. Total sales are small.

JET FUEL

Chesterfield Inlet's contribution to jet fuel sales is currently impossible to calculate as airplanes typically re-fuel in Rankin Inlet.

5.10 GHG EMISSIONS

A calculation of the GHG emissions in Chesterfield Inlet is made simple by the fact virtually all energy is derived from combustion of fossil fuels. The CEP Team has used different emissions factors (g CO_2e/L) for different fuel types, as listed in **Table 4**. For example, for every litre of P50 Heating oil that is burned for heat, we calculate that 2,755 g CO_2e are emitted into the atmosphere.

Table 4: Emissions factors (g CO_2e/L) for various types of fuel[24]

Emission Source	CO_2 (g/L)	CH4 (g/L)	N20 (g/L)	Total CO_2e (g/L)
P50 Heating	2,753	0.026	0.006	**2,755**
P50 Motive	2,681	0.068	0.21	**2,745**
P50 Aviation	2,560	0.029	0.0711	**2,582**
P50 Non-Motive (Heating)	2,753	0.18	0.031	**2,767**
P50 Non-Motive (Electricity)	2,753	0.18	0.031	**2,767**
Gasoline	2,307	2.61	0.043	**2,385**
Aviation Gasoline	2,325	2.19	0.23	**2,449**
Naphtha	2,307	0.1	0.02	**2,315**
Jet A-1	2,510	0.029	0.0711	**2,582**

In total, Chesterfield Inlet recorded fossil fuel purchases of **1.821 Million L in 2024**. Combustion of these fuels produces GHG emissions totaling 4,900 tonnes CO_2e per year. Assuming a current population of 397 residents, this amounts to an average of 12.3 tonnes CO_2e /person /yr.

Major contributors to GHG are the same fuels and uses as described in **Section 5.9** above: heating, electricity, and transportation, as illustrated in **Figure 23**.

HEATING is the largest contributor to the GHG emissions with 2,151.9 tonnes of CO_2eq (44%), followed by ***ELECTRICITY*** with 1,645.7 tonnes of CO_2eq (34%), with the rest being contributed by ***TRANSPORTATION***, 1,103.0 tonnes of CO_2eq (23%).

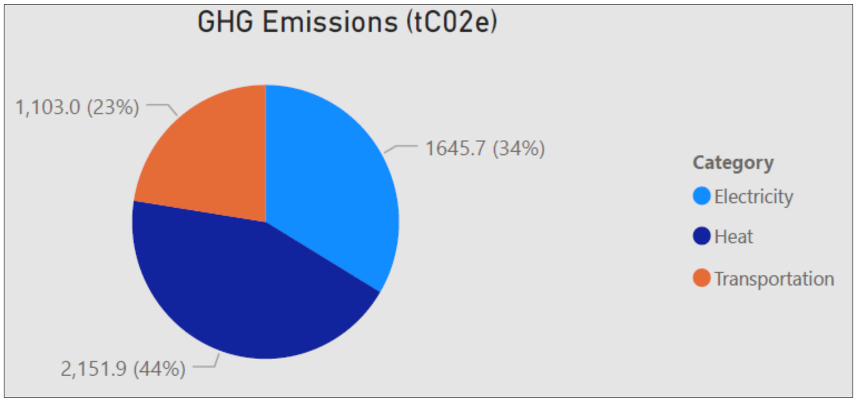


Figure 23: 2024 GHG emissions broken down by use

[24] **Source:** National inventory report: greenhouse gas sources and sinks in Canada (2020). URL: https://publications.gc.ca/site/eng/9.506002/publication.html

Factors that cause an upward trend (increase) in GHG emissions in Chesterfield Inlet include:

- the majority of energy is derived from diesel fuels,
- fuels must be transported from faraway,
- cold wintertime temperatures,
- fairly low population density,
- poor energy performance in much of the housing stock, and

Factors that cause a downward trend (decrease) in GHG emissions in Chesterfield Inlet include:

- low levels of consumption
- local ingenuity as residents find creative ways to conserve energy and live within their means.

The per capita emissions in Chesterfield Inlet are typical of northern/remote communities. For example, Coral Harbour (NU), Naujaat (NU), and Tulita (NWT) both reported an intensity of 10-12 tonnes CO_2e /person /yr in recent CEPs.[25 26 27] **Figure 24** provides a comparison of GHG emissions per capital across all Nunavut communities. We note that Grise Fiord and Resolute Bay have high values due to their very low population (144 and 187, respectively). Rankin Inlet has a high value likely due to the contribution from transportation-related activity in this travel hub for the Kivalliq region.

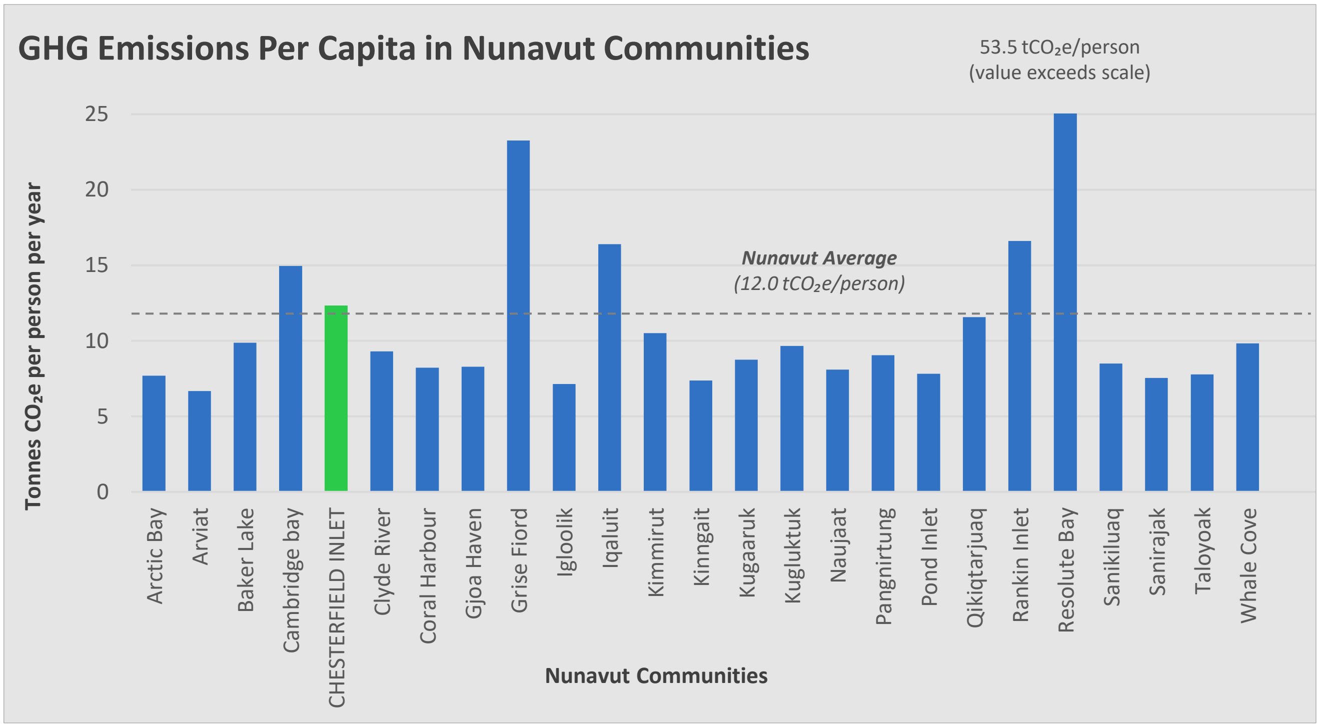


Figure 24: Comparison of Per Capital GHG Emissions Across Nunavut Communities

[25] Arctic Energy Alliance (2020). *Tulita Energy Profile 2018*. URL: https://aea.nt.ca/document/4347/
[26] Community Energy Plan: Coral Harbour, Nunavut. 2021.
[27] Community Energy Plan: Naujaat, Nunavut. 2021.

As a further comparison, the **Canadian national average is approximately 21 tonnes CO_2e /person /yr.** Per capita emissions in some provinces (BC, ON, PEI) are as low as 12-13 tonnes CO_2e /person /yr, while other provinces (AB, SK) are as high as 67 tonnes CO_2e /person /yr.[28] Chesterfield Inlet's per capita emissions are lower than the national average, mostly due to lack of industry in the community.

In addition to GHG emissions, combustion of fossil fuels in Chesterfield Inlet also produces local air pollution (particulates, NOx, SOx) as well as noise pollution, both of which can have an impact on local people and ecosystems.

In addition to GHG emissions, the combustion of fossil fuels in Chesterfield Inlet produces local air pollution, including particulate matter (PM), nitrogen oxides (NOx), and sulfur oxides (SOx). These pollutants contribute to respiratory issues, environmental degradation, and acid deposition. Studies indicate that exposure to PM2.5 and NOx is linked to increased risks of cardiovascular and respiratory diseases.[29] However, exact quantities of these pollutants in Chesterfield Inlet are not directly measured.

Figure 25: Chesterfield Inlet's current power plant (2022).[30]

[28] The Conference Board of Canada. (2016). *Provincial and Territorial Ranking: Greenhouse Gas Emissions.* https://www.conferenceboard.ca/hcp/provincial/environment/ghg-emissions.aspx/

[29] **Source:** Health Canada. *Health impacts of air pollution from transportation: a report by Health Canada*. Ottawa (ON): Health Canada; 2023 Feb. Report No.: H144-112-2022. URL: https://publications.gc.ca/collections/collection_2023/sc-hc/H144-112-2022-eng.pdf

[30] **Photo:** https://www.nunavutnews.com/news/nunavut-power-plant-plans-surge-ahead-with-a-focus-on-efficiency-7281405

SECTION 06

COMMUNITY ENGAGEMENT

Information and opinions were gathered from the community using an online survey in **February of 2025**. In total **29** responses were gathered, representing approximately **25%** of the **116** dwellings in town.

The survey was promoted using a flyer posted around town, local radio announcements, KAE's website, KAE's Facebook Page, Chesterfield Inlet Community Facebook Page (Igluligaarjuk Tusagaksat), and word of mouth via community leaders (HTO, CLO, Hamlet office).

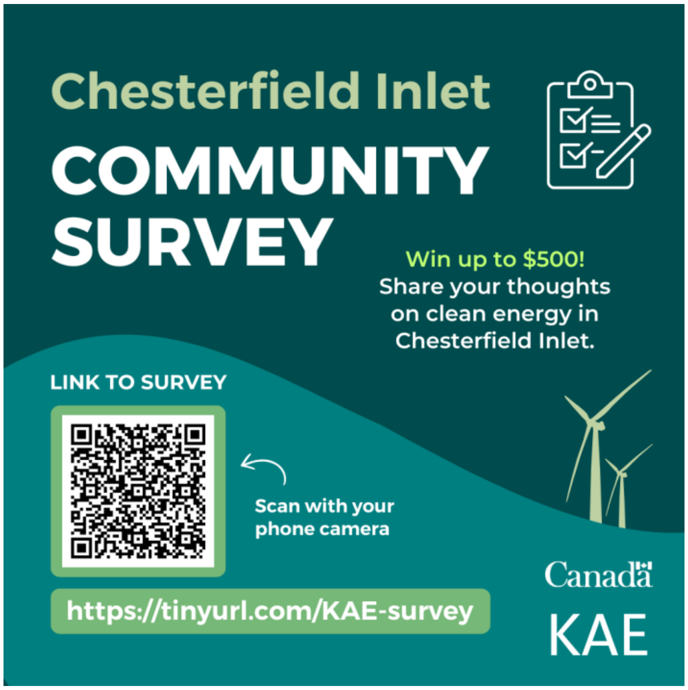


Figure 26: Facebook Ad for Chesterfield Inlet Community Survey

Survey respondents the highest concern for the following issues (in order)—as shown in Figure 27:

1. Cost of electricity and fuel
2. Reliable energy with no outages
3. Clean fuels with low environmental impacts
4. Reducing greenhouse gas emissions and addressing climate change
5. Generating energy locally and reducing reliance on imported fuels

Question: "How important are the following energy issues to you and your household?"

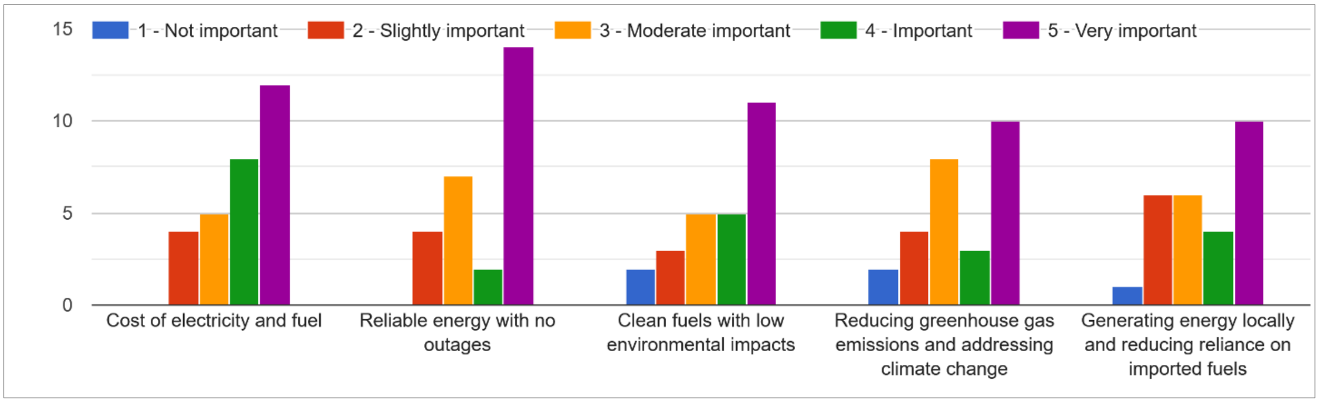


Figure 27: Survey responses indicating the importance of issues to the household

Survey respondents expressed support for (in order)—as illustrated in Figure 28:

1. Solar energy
2. Wind energy
3. Continued use of diesel
4. Run-of-river hydro

Question: "Which of the following energy sources would you (most) like to see developed in Chesterfield Inlet?"

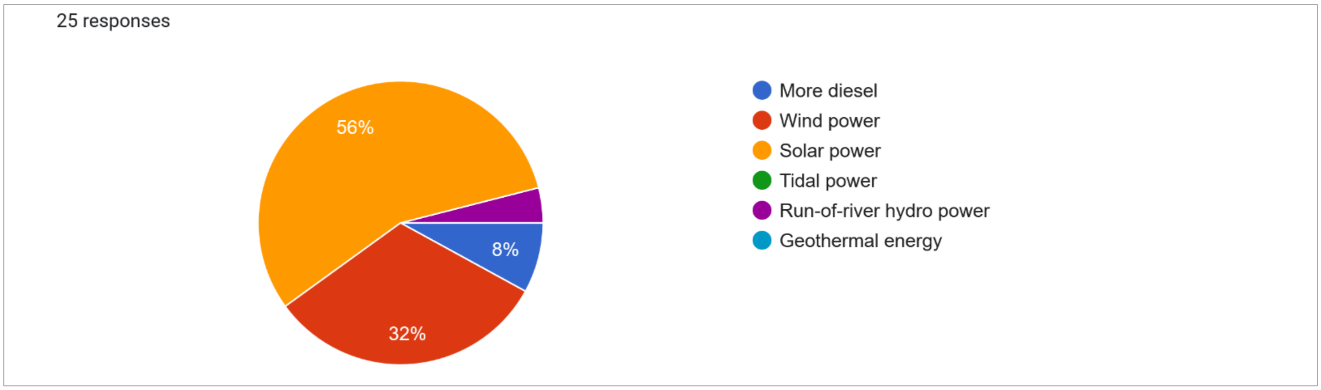


Figure 28: Survey responses indicating the energy sources Chesterfield Inlet residents would most like to see developed

93% of survey respondents said they would be proud if Chesterfield Inlet were to pursue clean energy solutions—as illustrated in Figure 29:

Question: "Which Statement fits your views best?"

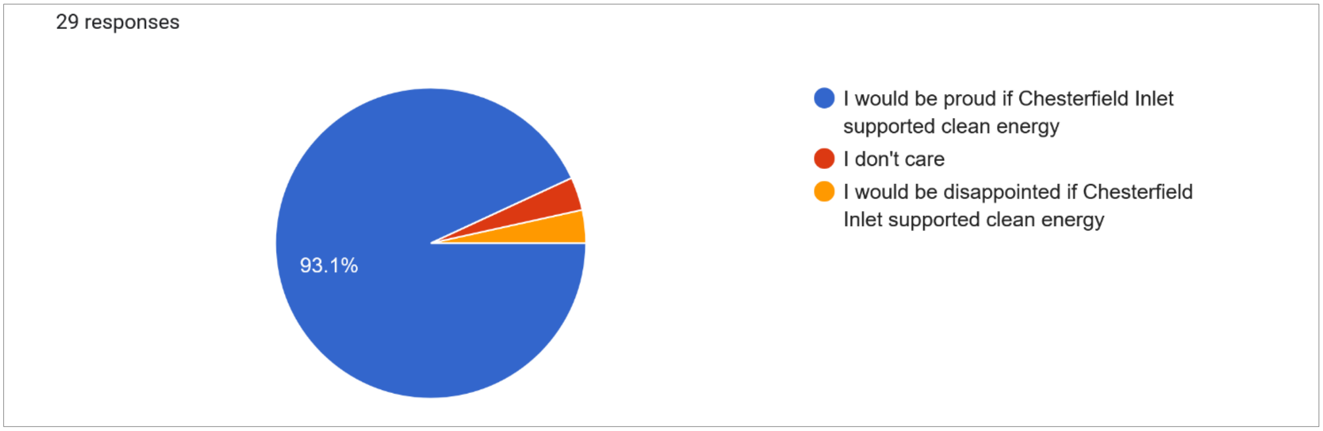


Figure 29: Survey responses indicating the respondent's views regarding clean energy.

Survey respondents were clear that the top three benefits they would like to see from a clean energy project are (as illustrated in Figure 30):

1. Solar energy
2. Wind energy
3. Continued use of diesel
4. Run-of-river hydro

Question: "What are the top three benefits you would like to see from a community clean energy project in Chesterfield Inlet?"

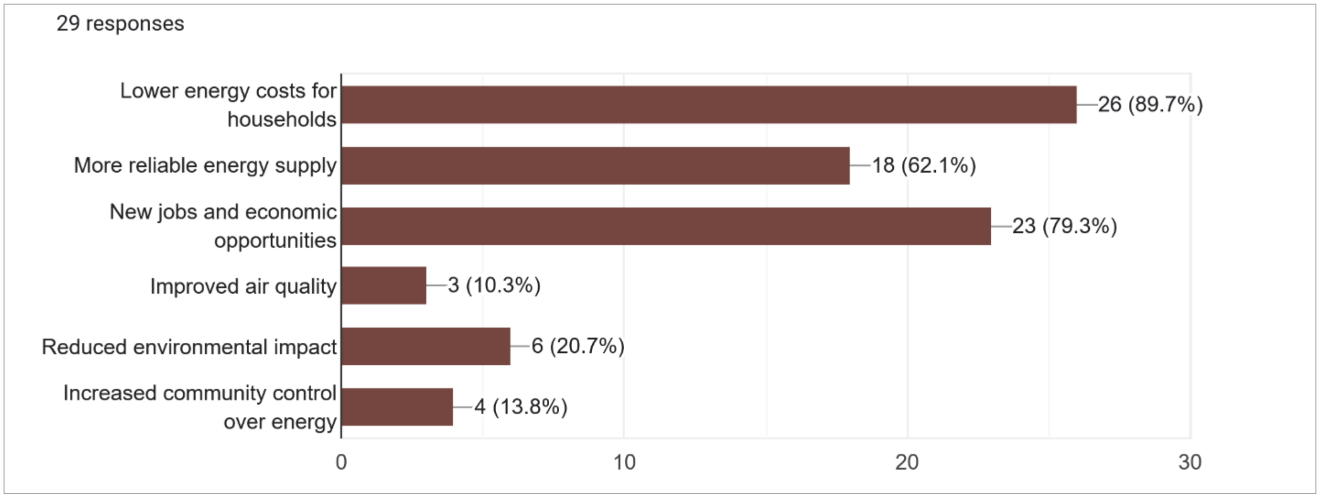


Figure 30: Survey responses indicating the energy sources Chesterfield Inlet residents would most like to see developed

Survey respondents expressed the greatest concern regarding (as illustrated in Figure 31):

1. Impacts on wildlife and their habitats, and
2. Impacts on traditional land use and cultural practices

Question: "We want to understand your concerns about developing clean energy projects. Which of the following are you most concerned about?"

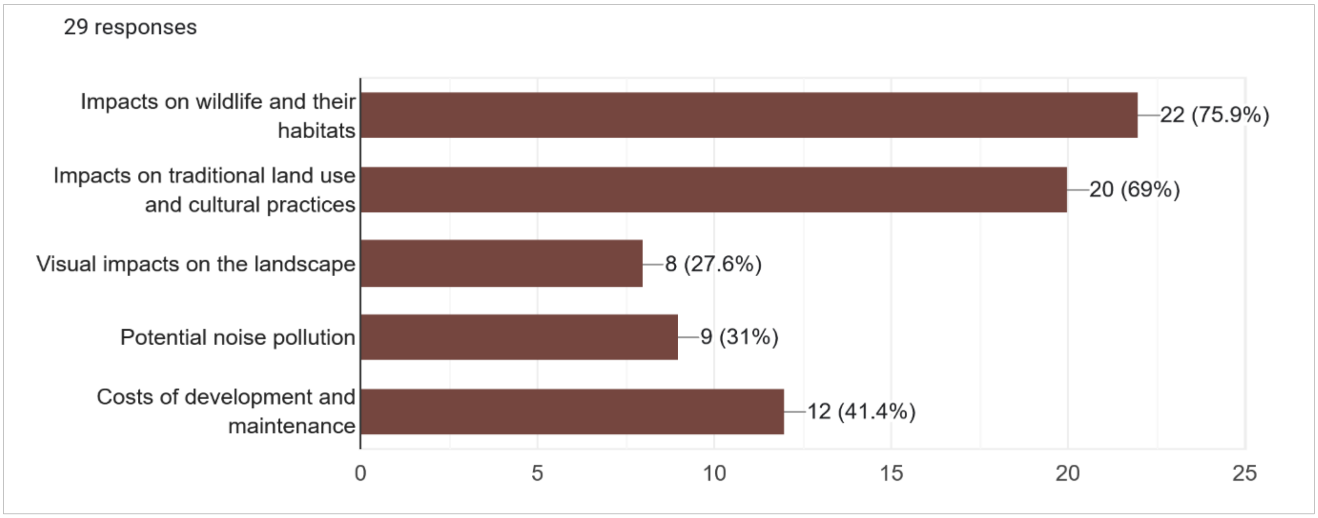


Figure 31: Survey responses indicating the topics of greatest concern regarding development of a clean energy project.

In future engagement and development work related to clean energy in Chesterfield Inlet, survey respondents are willing to participate in planning and development in a variety of ways, including the following (in order). Future planning and development work related to clean energy should make use of these preferred methods and media:

1. Solar energy
2. Wind energy
3. Continued use of diesel
4. Run-of-river hydro

Question: "How would you prefer to be involved in the planning & development of this clean energy project?"

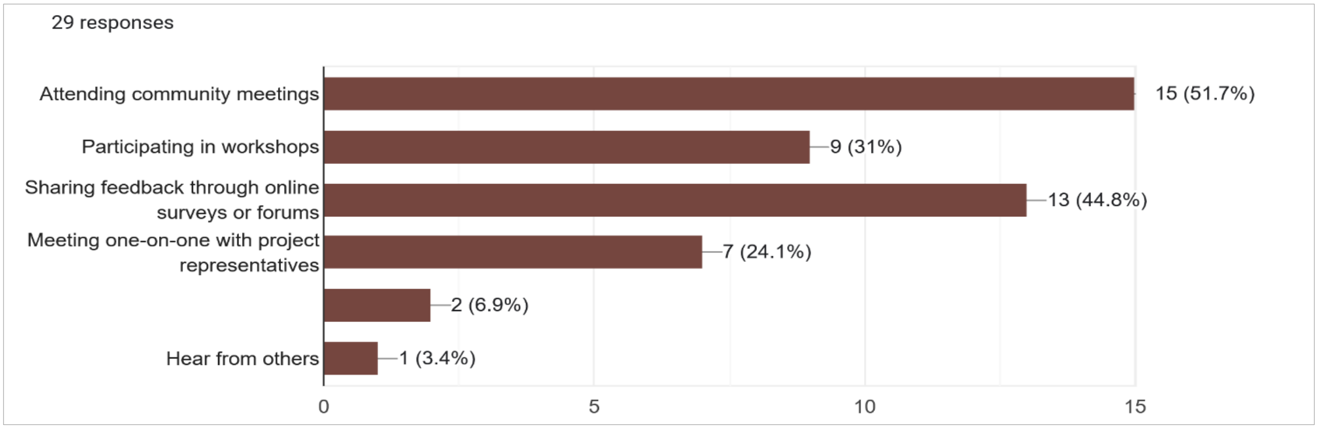


Figure 32: Survey responses indicating preferences for involvement in project planning and development

Finally, future planning and development work should consider the media used by survey respondents to access the survey, as these same media may prove most powerful for reaching people in Chesterfield Inlet:

Question: "How have you heard about this survey?"

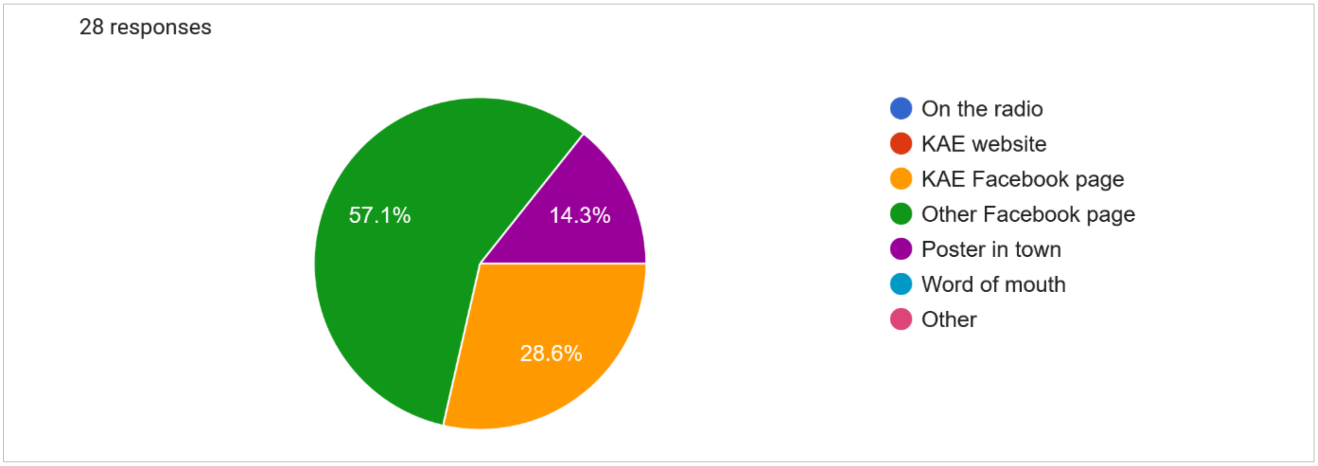


Figure 33: Survey responses indicating preferences for involvement in project planning and development

OPPORTUNITIES FOR NET ZERO TRANSITION

This CEP Report focused on the pathway to achieving a Net Zero electricity system at Chesterfield Inlet.[31] Therefore, more detail is provided regarding the specific mix of technologies that the CEP Team recommends for this transition to Net Zero electricity. Opportunities to de-carbonize the heating system in Chesterfield Inlet are also discussed, although in less detail. Project economics are evaluated, but only in the context of a Net Zero electricity system. The transition to Net Zero can be achieved through a combination of the following measures, as listed in **Table 5.**

Table 5: Opportunities for Transition to Net Zero

Energy Efficiency	Building retrofits
	Standards for new buildings
	Heat pumps
	Waste heat capture
Load Management	Timing of demand
	Energy storage
Clean Energy	Solar energy
	Wind energy
	Geothermal energy

Each of these measures is discussed in further detail in **Section 7**.

This CEP does not examine the following technologies:

- Nuclear energy
- Expanded diesel use

[31] We have defined "Net Zero" as a state where the amount of greenhouse gas emissions produced is balanced by an equivalent number of emissions removed from the atmosphere.

7.1 ENERGY EFFICIENCY

It is prudent to include energy efficiency in any plan for transition to Net Zero.

The most common use of fuel in Chesterfield Inlet is for heating, with 43% of all fuel sales being in the form of heating oil.[32]

However, considering the average efficiency of an oil-fueled furnace of 80-90%, we can estimate that approximately 25 billion BTU of heat is used, or 25,000 GJ of energy per year.[33]

Considering that the community consumes approximately 7,300 GJ of electrical energy in a year (2.03 GWh as per data from QEC), it is evident that the heating system represents the largest component of the energy system Chesterfield Inlet.

Since most heating in Chesterfield Inlet is by fuel oil / diesel,[34] such energy efficiency measures will not contribute meaningfully toward the goal of Net Zero electricity. Nevertheless, the costs of energy savings are typically cheaper than new clean energy sources.

Energy efficiency measures can include:

- Building retrofits,
- Standards for new buildings,
- Heat pumps, and
- Waste heat capture.

[32] **Source:** Data from CCS.
[33] Natural Resources Canada. (2007). *Heating with oil.* Office of Energy Efficiency, Natural Resources Canada. URL: https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/energystar/Heating-with-Oil_EN.pdf
[34] See CEP survey results presented in **Section 6**

ENERGY EFFICIENCY IN BUILDINGS

Buildings represent the best opportunity for energy efficiency improvements; however, each building must be studied to identify the optimal measures. Since detailed information on Chesterfield Inlet's building stock is not available, we make estimates of the improvement potential across the community.

When the **Arctic Energy Alliance** (AEA) conducted energy assessment of buildings in other Nunavut communities (52 houses and 7 commercial buildings)[35] they arrived at the following conclusions:

> A large potential for the implementation of **energy efficiency and conservation measures** exists in the buildings assessed.

> In **residential housing**, the 52 houses assessed could save a total of 19% of their energy use (47,000 litres of oil & 70,000 kWh of electricity) and reduce annual greenhouse gas (GHG) emissions by 17% (175 tonnes).

> **Commercial buildings**, on average, could save 20% of their annual energy bills ($140,000 total for the seven buildings assessed) and 230 tonnes of GHG emissions annually by implementing the recommended measures, which have a payback of less than 5 years.

> In general, Nunavummiut seem energy-conscious and conserve energy where possible; about 25% of the homes assessed had supplemental **biomass heating systems**.

> The **local stores**, for the most part, do not carry many energy efficient products such as window insulation kits, weather stripping, LED bulbs and ENERGY STAR® appliances.

> There is a lack of easily accessible funding for homeowners, businesses and community governments to implement **energy efficiency and renewable energy upgrades** and people seemed unsure of where to go to get answers to their energy-related questions.

> Most local **Housing maintenance** staff have a general lack of comfort with higher-efficiency heating equipment

[35] Arctic Energy Alliance (2017). *Community Energy Services Summary Report*.

The five most common recommendations from the AEA assessments were related to:

- Ventilation and indoor air quality,
- LED light bulbs,
- Higher wall insulation levels, with 40-50% of the total on the exterior,
- High-efficiency oil heating equipment (and no electric hot water tanks), and
- Programmable thermostats.

The CEP Team expects that most of these recommendations will apply well to Chesterfield Inlet. It is likely that many buildings in Chesterfield Inlet would benefit from upgrades to ventilation, lighting, insulation, furnaces, and thermostats with a payback typically in the range of 5 years, similar to the AEA findings. Until more detailed audit/assessment information is available, we estimate that these energy efficiency upgrades could likely result in **diesel savings on the order of 20%**, or 156,000 L of diesel per year, similar to the AEA findings.

With any building upgrades, it will be important to also consider maintenance needs associated with any new equipment. Some upgrades (e.g. weather stripping, window coverings) need to be replaced regularly for energy savings to persist.

Economies of scale can be achieved by addressing energy efficiency across a large portion of the building fleet simultaneously. A program of building audits is recommended to determine the scope, cost, and expected savings for each building. Building audits conducted according to the **ASHRAE Level 2** standard will result in scopes that can be tendered to contractors for implementation. Grant funding can often be accessed to support such energy efficiency improvements at scale.

GOVERNMENT OF NUNAVUT ENERGY EFFICIENCY PROGRAMS

The Government of Nunavut (GN) has implemented a range of energy efficiency initiatives to reduce energy costs and improve building performance. These initiatives fall predominantly under the **Nunavut Energy Management Program** (NEMP), which supports the use of energy conservation, retrofits, and renewable energy adoption across GN departments and agencies.[36]

The NEMP includes the following three core components:

- **Nunavut Energy Retrofit Program**. The GN enters into long-term agreements with qualified energy management firms to finance, develop, and implement energy retrofit projects. Eligible measures include efficient lighting, low-flow water fixtures, insulation, building automation systems, and modern heating systems. Projects are expected to generate at least 20% energy savings while reducing GHG emissions and improving occupant comfort.
- **Energy Awareness and Training**. Through newsletters, seminars, and a Building Manager Training Program (delivered in partnership with Nunavut Arctic College), this component aims to help building operators and occupants adopt more energy-efficient behaviors. This program emphasizes operational practices (e.g. adjusting temperature set points or shutting off unused equipment) that can lead to substantial savings.
- **Building Energy Efficiency Review Program for New Construction**. Future GN building projects must adhere to the GN's Good Building Practices Guideline, which incorporates energy-efficient design and technology to reduce energy consumption and lower life cycle costs.

The GN's public-facing energy website also promotes community involvement in energy conservation. Campaigns like the "**Save 10**" initiative encourage residents and building occupants to take simple actions (e.g. turning off lights and electronics) to reduce consumption.[37]

[36] Government of Nunavut. (2020). Nunavut Energy Management Program Policy. Department of Community and Government Services.
[37] http://www.energy.gov.nu.ca/en/savings.aspx

HEAT PUMPS

As long as the electricity grid in Chesterfield Inlet is powered by diesel fuel, high-efficiency technologies such as heat pumps are not recommended—this high efficiency is negated by the inefficient diesel generators. However, in a future where the electricity grid has been successfully transitioned to Net Zero, then heat pumps could be a very efficient method of converting clean electricity into heating.

Heat pumps leverage the difference between the interior air temperature and an outside source (e.g. air, water, ground) to provide heating and cooling with an efficiency of > 100%. Heat pumps can provide efficiencies of approx. 300%, meaning that heating or cooling is provided using 1/3 of the electricity compared to traditional electric baseboard heaters or air condition units.[38]

In recent years the effectiveness of heat pumps has improved for cold climate applications, e.g. down to -30 ⁰C.[39] Heat pump technology has also become more robust, and models are available that can be retrofitted into existing homes without the need for heating ducts. Heat pumps can also be implemented at the scale of a community building or even at the district scale.

Figure 34: Example of air-source heat pump[40]

WASTE HEAT CAPTURE

Capture of waste heat (e.g. industrial waste heat) can be challenging in Nunavut given the cold ambient temperatures during winter when heating is needed (resulting in high heat losses) as well as the low density of buildings in the community (long distances between buildings).

One project that the CEP recommends to investigate further is construction of a new facility adjacent to the QEC powerhouse that is intended to operate using waste heat from QEC's diesel generators. Candidate uses could include a greenhouse, swimming pool, store, or garage.

[38] https://en.wikipedia.org/wiki/Heat_pump
[39] https://grist.org/housing/heat-pumps-do-work-in-the-cold-americans-just-dont-know-it-yet/
[40] https://www.energysage.com/heat-pumps/heat-pumps-cold-climates/

7.2 LOAD MANAGEMENT

In addition to reducing energy use via the efficiency measures in **Section 7.1**, managing the magnitude and timing of **energy loads** can also support the transition to Net Zero. Shifting loads from peak to non-peak times can reduce the magnitude of the daily energy peak, easing constraints on the transmission grid, and improving the efficiency of the grid's diesel generators.

CONTROLLABLE LOADS

Controlling the timing of loads can help to integrate more clean energy into the grid by using excess energy when it is available instead of wasting it. For example, laundry machines can be programmed to run during the daytime to better consume solar energy, and programmable lighting can reduce electrical demand at night when solar energy is absent.

ELECTRIC THERMAL STORAGE

Likewise, controllable heating devices can be programmed to draw power during windy periods, thus consuming more wind energy. A promising technology is Electric Thermal Storage (ETS), which uses **electric heaters to warm ceramic bricks** during off-peak hours, when electricity is cheapest or in excess. When space heating is needed, the stored heat is diffused from the bricks into the home. ETS systems can replace space heaters, baseboard heaters, forced air furnaces, or hydronic furnaces. The lifespan of all of these systems is 20-25 years.

ETS systems have been employed in the following cases:

- The Yukon Conservation Society conducted a pilot project involving 42 homes in Whitehorse, YT
- Summerside PEI's "Heat Now For Less" program offers discounted ETS systems to homeowners[41]
- Nova Scotia Power has made ETS systems available to residential customers. Options include a furnace replacement and an in-floor radiant heating system for concrete floors.[42]
- ETS has also been used in urban settings in Germany, Sweden, and Denmark, and in rural settings in three communities in southeast Alaska.[43]

The Whitehorse pilot project saw installed costs of $20,000–30,000 for a 180 kWh energy storage system.[44] ETS maintenance costs are expected to be similar to traditional heating systems.

An estimated 58 homes in Chesterfield Inlet currently have forced air ducting (assume 50%). If each of these homes had an ETS unit similar to those being deployed in Whitehorse, the result would be **10,400 kWh in energy storage**. At an average cost of $25,000 for 180 kWh of storage, ETS would be cheaper than batteries today. Since the benefits of ETS systems are primarily experienced by the electrical utility, QEC's involvement would be critical for such an undertaking.

---

[41] Source: https://summerside.ca/residents/electricity/conserving_energy/heat_for_less_now
[42] Source: https://www.nspower.ca/your-home/energy-products/electric-thermal-storage
[43] Source: https://www.energy.gov/sites/prod/files/2015/12/f27/chaninik_final_report_ee00002497_july_2013.pdf
[44] Pers. comm. J. P. Pinard, 2001.

7.3 ENERGY STORAGE

Electricity demand on a microgrid like Chesterfield Inlet is always fluctuating as people turn their devices on and off. Diesel generators can adjust to these fluctuations by ramping up and down to match demand. However, large-scale clean energy projects can cause fluctuations that are too large for a microgrid, such as when a cloud blocks the sun, or the wind stops blowing, or vice versa.

Therefore, it is generally accepted that large-scale clean energy projects on a microgrid must also incorporate energy storage. Energy storage systems absorb excess energy (e.g. when there is too much wind), and release it when needed (e.g. when there is no wind), in order to deliver energy that is smoother and more grid-friendly, while reducing wasted energy from a clean energy project.

Various energy storage technologies exist today, including the following:

- Mechanical flywheels,
- Compressed air,
- Pumped water,
- Chemical batteries,
- Altiro Energy storage system,
- Hydrogen storage.

Many of these have been tested in northern Canada at medium-to-large scale.[45]

Energy storage systems are expensive, and they don't deliver any new energy—they just store it. Therefore, they should be sized to the minimum required to keep the grid safe and stable.

Figure 35: Battery Energy Storage System, Colville Lake, NWT[46]

[45] News article entitled "Compressed air, flywheels and more: Energy storage solutions being tested in Canada." www.cbc.ca/amp/1.5945923
[46] **Photo:** https://www.cima.ca/en/project/battery-based-energy-storage-system/

BATTERY ENERGY STORAGE SYSTEMS (BESS)

Chemical batteries are generally considered to be the default choice for most remote community applications today, and some battery technologies have recently become commercially competitive.

COMMON BATTERY CHEMISTRIES INCLUDE THE FOLLOWING:

- **Lithium-Ion (Li-Ion):** High energy density, fast response, widely commercialized.
- **Lead-Acid:** lower upfront cost, shorter lifespan, heavy.
- **Nickel-Cadmium (NiCd):** Durable in extreme conditions, but costly and toxic.
- **Flow Batteries:** Long-duration storage potential, lower energy density.
- **Sodium-Ion:** Emerging alternative, still under development.

The CEP Team has chosen to model **LITHIUM-ION BATTERIES** for the clean energy (wind and solar) projects presented in this CEP for the following reasons:

- Proven track record in cold climates,
- High round-trip efficiency (85–95%),
- Scalable from small to large applications,
- Commercial availability with competitive pricing,
- Compact size suitable for limited space and logistics.

A **BESS** is typically characterized by its maximum output capacity (in kW) and by how long a period it can supply this output (in hours). Battery systems typically require replacement every 5–20 years, depending on the technology and usage. It is important to note that used battery fluids must be transported offsite during battery replacements, as there are no recycling facilities in the community.

Figure 36: A lithium-ion (Li-ion) energy storage system at Glencore's Raglan Mine, Nunavik, QC[47]

[47] **Photo:** https://tugliq.com/nouvelle/energy-storage-optimizes-wind-power-for-remote-arctic-mine/

ALTIRO ENERGY STORAGE SYSTEMS

The CEP Team has identified **Altiro Energy** as a potentially suitable technology to provide energy storage at Chesterfield Inlet. The Altiro Energy system is a novel energy storage solution that operates similarly to a battery but stores energy in the form of **iron fuel**.[48] It is designed to charge using surplus clean electricity and later discharge high-grade heat (close to 2,000°C), which can be used for industrial heating or electricity generation.

Key performance characteristics of the Altiro energy systems include:

- **Charging efficiency:** 60–80% depending on the process.
- **Heat recovery efficiency:** Over 90%.
- **Power generation efficiency:** Approximately 50%.
- **Overall roundtrip efficiency:** Estimated at 55–75% for thermal applications, and 30–40% for electricity generation.
- **The system is very compact:** A 1 MW-scale burner can be housed in 1–2 standard shipping containers. The fuel (iron) is stored separately from the burner, which allows for flexible scaling by stockpiling additional fuel.
- **Altiro offers long-term storage:** Preliminary specifications suggest the ability to deliver 150 kW of electrical power for up to 100 hours at rated capacity.

While the Altiro system may not yet be fully mature or compatible with Chesterfield Inlet's immediate energy transition plans, it represents a promising long-duration storage option for the future—particularly if high-temperature heat or industrial energy use cases emerge in the community. Further evaluation is required to determine if and how the Altiro system could be integrated into Chesterfield Inlet's energy strategy.

Figure 37: The Altiro System stores energy in the form of iron fuel[49]

[48] https://www.altiroenergy.com/technology
[49] **Photo:** https://reporter.mcgill.ca/from-studying-clean-tech-to-running-an-award-winning-startup/

HYDROGEN STORAGE

Unlike chemical batteries, hydrogen storage offers the potential for long-duration energy storage, e.g. saving solar-generated energy from the summer for use in the winter.

BENEFITS	RISKS AND CONSIDERATIONS
• **Long-Duration Storage**: Hydrogen systems can store energy for much longer periods compared to batteries. • **Increased Renewable Energy Penetration**: Integrating hydrogen storage allows for the capture and storage of excess renewable energy that would have otherwise been "spilled". • **Energy Portfolio Diversification**: Introducing hydrogen storage diversifies the community's energy portfolio, enhancing energy security and resilience. • **Flexibility in System Design**: Hydrogen systems offer greater flexibility in sizing individual components (electrolyzer, storage tank, fuel cell).	• **Safety Concerns**: Handling high-pressure combustible hydrogen gas requires careful engineering and adherence to safety protocols. • **Technological Complexity**: Hydrogen storage systems involve multiple components (electrolyzer, storage, fuel cell, compression, water filtration), making them more complex than BESS and potentially increasing the risk of system failures. • **Maintenance Capacity**: The novelty of hydrogen technology may require specialized maintenance and expertise, potentially leading to challenges in local capacity and reliance on external support. • **Cost and System Health Uncertainties**: Due to the limited number of live hydrogen systems, there are uncertainties regarding actual costs and component lifetimes. • **Fuel Cell Operational Considerations**: Large fuel cell systems have operational considerations such as ramp rate (time to reach full capacity) and heat generation, which require careful management and potentially additional buffering systems (e.g., batteries). • **Low Efficiency**: The process of electrolysis, hydrogen storage, and fuel cell generation has a roundtrip efficiency of approx. 30%. • **Water Demand**: Hydrogen production requires a source of water.

7.4 SOLAR ENERGY

Solar photovoltaic (PV) technologies use silicon membranes to capture sunlight and convert it to electricity. Solar PV systems can be installed on buildings/rooftops (small scale) or deployed on ground-mounted racks (large scale). These mature systems are now cost-competitive with traditional energy sources in many parts of the world. Solar PV can be viable at any scale, from very small to very large, however larger projects generally have a higher financial performance.

A typical solar energy project is comprised of three main components:

- **Solar Panels:** Delicate silicon membranes, usually called cells, are assembled into larger modules or panels that are robust and can be exposed to the elements (see **Figure 38**).
- **Mounting or Racking System:** For building installations, racking is fixed to the roof. For ground-mounted systems, frames or racks are mounted on supporting structures (see **Figure 40**) either pile driven into the ground (see **Figure 39**) or set on concrete footings. Ground-mounted arrays can be fixed tilt (i.e. the panels will be fixed at a specific angle), or a tracker system (i.e. the mounting system tilts throughout the day to track the sun).
- **Inverters:** These electrical devices convert direct current (DC) electricity to alternating current (AC) which is typical of the local grid (see **Figure 41**).

Figure 38: Solar panels or 'modules' on a ground-mounted system[50]

Figure 41: Inverter for a large-scale solar array

Figure 40: Racking on a ground-mounted system[50]

Figure 39: Installing pile foundations to support a solar array[50]

[50] **Photos 38-40:** Construction photos from KAE's Ikayuut Solar and Energy Storage Project in Naujaat, NU (2024)

Solar energy projects on a micro-grid such as Chesterfield Inlet typically include these components:

- **Battery Energy Storage System:** To help smooth out the electrical grid during times when the solar resource drops unexpectedly (see Section 7.3).
- **Microgrid Controller:** Governs when solar energy is sent to the grid, vs. the BESS, vs. curtailed.
- **Fencing:** For ground-mounted systems near populated areas, solar arrays are often enclosed by a fence around the site perimeter for security and safety (see **Figure 42**).

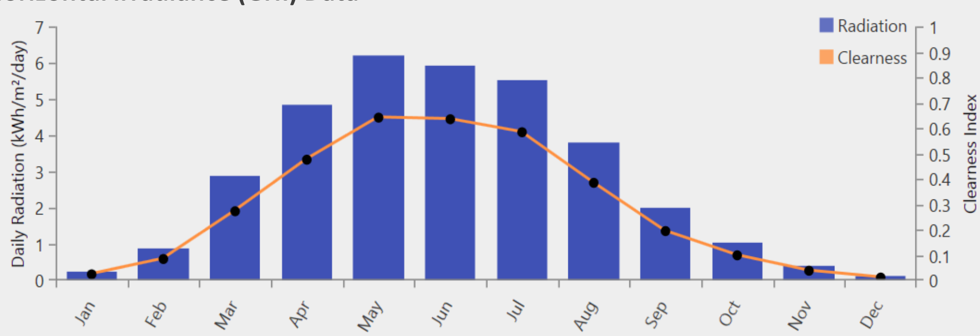
Figure 42: Typical fencing around a large-scale solar array[51]

SOLAR RESOURCE

We assume a solar irradiance value in Chesterfield Inlet of **2.81 kWh/m²/day** based on best available desktop modeling.[52] **Figure 43** below illustrates the concentration of the solar resource mostly in the summer months.

Monthly Average Solar Global Horizontal Irradiance (GHI) Data

Month	Clearness Index	Daily Radiation (kWh/m²/day)
Jan	0.024	0.239
Feb	0.084	0.874
Mar	0.272	2.861
Apr	0.476	4.852
May	0.641	6.190
Jun	0.635	5.906
Jul	0.583	5.503
Aug	0.384	3.810
Sep	0.194	2.006
Oct	0.099	1.023
Nov	0.038	0.384



Annual Average (kWh/m²/day): 2.81

Figure 43: Solar resource in Chesterfield Inlet by month

[51] **Photo:** Construction photo from KAE's Ikayuut Solar and Energy Storage Project in Naujaat, NU (2024)
[52] Source for solar data: Meteonorm 8.1)

SOLAR SITING

Micro-siting of a solar energy array should be done carefully with input from all stakeholders, and is beyond the scope of this CEP. Optimal solar energy sites would have the following characteristics:

- Land area of at least 3 ha per MW(AC)
- Proximity to the electrical grid, or to the QEC powerhouse for larger projects,
- Flat ground to facilitate construction and staging,
- Near to access roads,
- Free from conflict with other land uses or cultural values.

SOLAR TECHNOLOGIES

The CEP Team has examined three potential configurations for a solar array in the Kivalliq Region.

1. **South-Facing Fixed Tilt System (see Figure 44):**
   - Panels are mounted at a fixed angle (optimal range: 45°–55°).
   - Simple, durable design with lower maintenance requirements.
   - Moderate energy yield, with peak production during midday.
2. **East-West Fixed Tilt System**
   - Panels are split between east- and west-facing orientations.
   - Provides a more stable generation curve throughout the day.
   - Lower overall energy yield than south-facing configurations.
3. **East-West Single-Axis Tracking System (see Figure 45):**
   - Panels rotate throughout the day to maximize exposure.
   - Highest energy yield (up to 25% more than fixed systems).
   - Increased cost and maintenance due to moving parts.

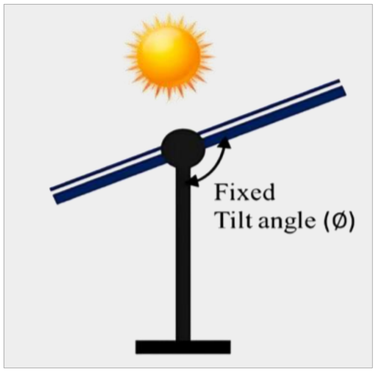


Figure 44: Fixed tilt PV system

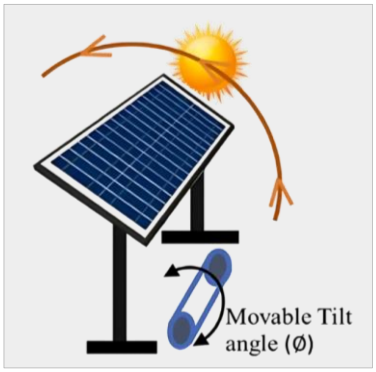


Figure 45: Single-axis tracking solar PV system

Considering local conditions, logistics, and cost-effectiveness, the CEP team recommends a **south-facing fixed tilt system with bi-facial modules** for Chesterfield Inlet. This configuration provides a strong balance of high energy production and reliability while keeping maintenance requirements manageable.

Recommended Solar Array Design

Subject to more detailed study, the CEP Team provides the following recommended design parameters for a solar array in Chesterfield Inlet:

- **Tilt Angle:** 45° south facing
- **Panel Height:** Minimum 0.7m to account for snow accumulation
- **Row Spacing:** 17.5m to minimize shading losses
- **Bi-Facial Modules:** Capture additional reflected light from snow, increasing energy yield by 12%
- **DC-to-AC ratio:** Approximately 1.6.

FINANCIAL ANALYSIS

The CEP Team has estimated the following costs for a solar energy project in Chesterfield Inlet at various scales, based on industry experience and supported by contractor bids from similar projects in the Kivalliq region.

- **Capital Expenditure (CapEx).** Includes development, engineering, procurement, construction, and commissioning. Economies of scale affect cost estimates.
- **Annual Operating Expenditure (OpEx).** Includes scheduled and unscheduled maintenance, and overhead/office costs.

Table 6: CapEx/OpEx cost estimates for a Solar Energy Project in Chesterfield Inlet at various scales

Capacity	CapEx	OpEx
1 MW (AC)	$8.5 million ($8.5 /W)	$277,000 /yr
2.5 MW (AC)	$16.2 million ($6.5 /W)	$455,000 /yr
5 MW (AC)	$29 million ($5.8 /W)	$751,000 /yr

7.5 WIND ENERGY

Wind turbine technologies use large rotating blades to capture kinetic energy from the wind and convert it to electricity.

Community-scale wind energy projects include the following components:

- One or several wind turbines (see **Figure 46**) which can range in size from small scale (e.g. 5m blades on a 15m tower) to large scale (e.g. 70m blades on a 120m tower)
- Roads to access each turbine site
- A foundation for each turbine that is suitable for local ground conditions (see **Figure 47**)
- A transformer to convert the voltage of electricity coming from the turbine to match the local grid voltage (see **Figure 48**),
- Electrical lines/cables to collect electricity from each turbine and deliver it to the grid,
- Switchgear/substation as needed to ensure safe operation of the wind energy project without causing problems on the local grid.

The most affordable wind energy comes from large-scale wind turbines which reach high up into the atmosphere where winds flow fast and steadily, and with large rotors that can capture energy from a large area. However, large wind turbines require large cranes to construct, and in a remote community crane rentals can be expensive and logistically challenging. Therefore, we expect that a **medium-scale wind turbine (one or several) will be the optimal choice for Chesterfield Inlet.**

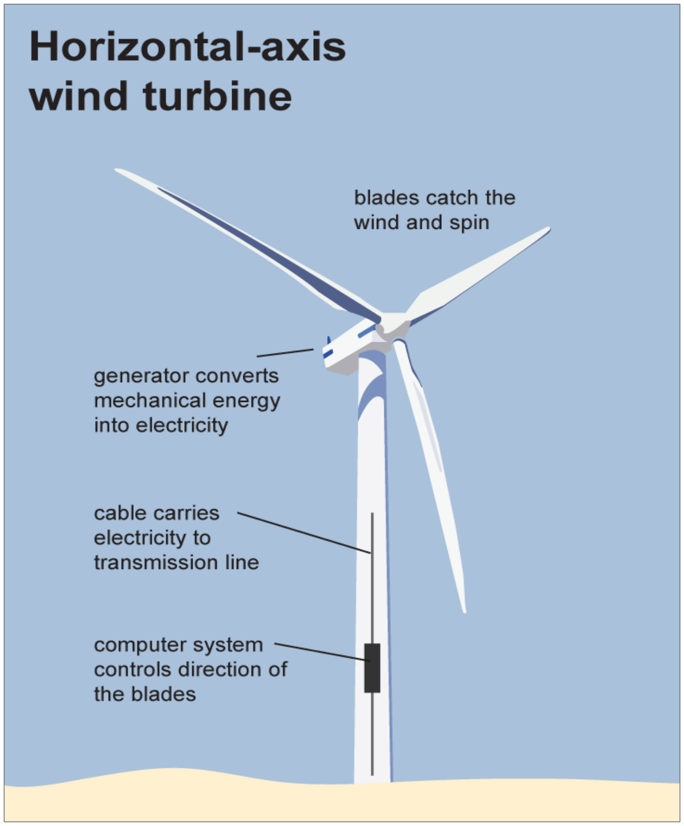


Figure 46: Schematic showing a typical modern wind turbine.[53]

[53] Source: National Energy Education Development Project.

Figure 47: Construction of a concrete wind turbine foundation in cold-climate[54]

Figure 48: Transporting a large wind turbine blade[54]

Figure 49: Installing the generator on an EWT DW61 1MW wind turbine[54]

Figure 50: Pad-mounted transformer associated with a wind turbine[54]

Figure 51: EWT D61 1 MW wind turbines operating at Thay T'äw (aka Haeckel Hill) in Whitehorse[54]

---

[54] **Photos 47-51:** Photos from Eagle Hill Energy's Haeckel Hill-Thay T'äw Wind Energy Project in Whitehorse, YT (2023-2024)

WIND SITING

A candidate wind energy site has been selected by the CEP Team based on the following criteria:

- Exposure to the wind resource,
- Proximity to good roads,
- Proximity to town (to minimize transmission distance to the QEC powerhouse),
- > 4km from the airstrip (NavCan / Transport Canada regulations),
- Local constructability factors.

This site is depicted in **Figure 52**. This site has been discussed with Hamlet Council and it appears to be a suitable area to host a wind energy project.

Figure 52: Candidate wind energy site in Chesterfield Inlet, where wind data was collected using a SODAR unit.

WIND RESOURCE

The CEP Team has directly measured the wind resource at this candidate site over a 12-month period using a Sound Detection and Ranging (SODAR) device as depicted in **Figure 53**.

Figure 53: SODAR device (left) along with solar energy array (right) and propane fuel cell station (tent at center).

SODAR results have revealed an average wind speed of approximately **7.5 – 8 m/s** at 46m above ground, and increasing with increasing height.

Figure 54 shows this wind resource modeled at various points in the vicinity of the SODAR site.

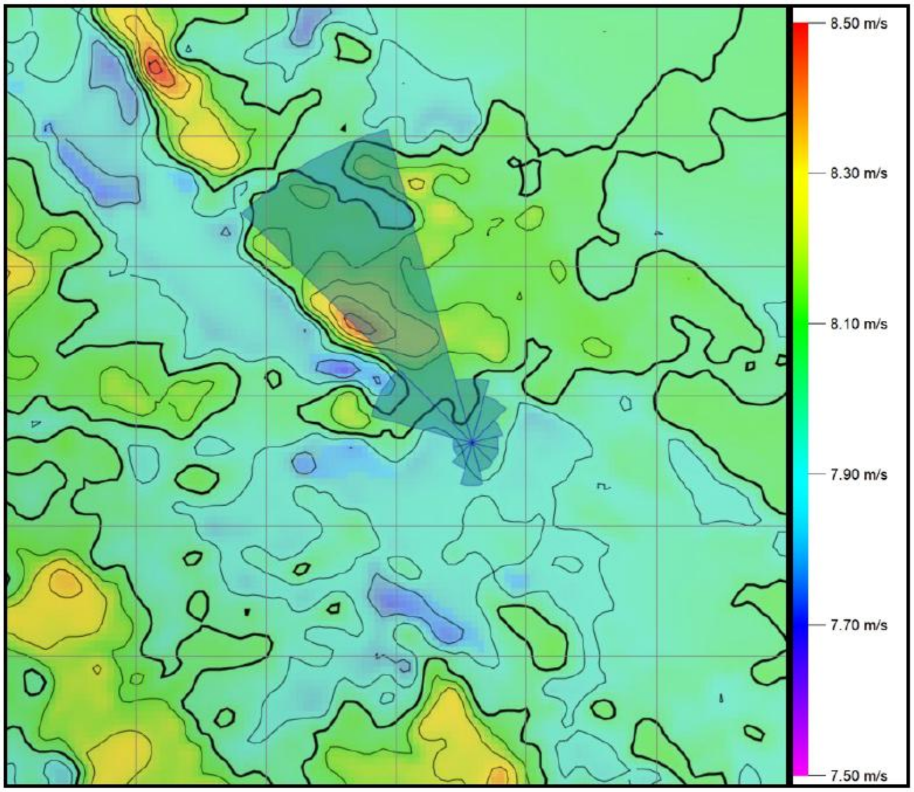


Figure 54: Wind speeds modeled in the vicinity of Chesterfield Inlet based on 12 months of SODAR data.

WIND TECHNOLOGIES

The following shortlist of wind turbine models has been considered for Chesterfield Inlet based on turbine capacity, suitability for northern/remote sites, and operational track record:

- **Emergya Wind Technologies** (EWT) DW61 1000kW (1MW) with 46m hub height[55]
- **Northern Power Systems** (NPS) 100C-24 100kW with 30m hub height

FINANCIAL ANALYSIS

The CEP Team has estimated the following costs for a wind energy project in Chesterfield Inlet at various scales, based on industry experience and supported by contractor bids from similar projects in northern Canada.

- **Capital Expenditure (CapEx).** Includes development, engineering, procurement construction, and commissioning. Economies of scale affect cost estimates.
- **Annual Operating Expenditure (OpEx).** Includes scheduled and unscheduled maintenance, including overhead / office costs:

Table 7: CapEx/OpEx cost estimates for a Wind Energy Project in Chesterfield Inlet at various scales

Capacity	CapEx	OpEx
1x NPS 100C (100 kW)	$6.3 million ($62.7 /W)	$321,000 /yr
4x NPS 100C (100 kW)	$11.6 million ($28.9 /W)	$668,000 /yr
1x EWT DW61 (1 MW)	$15.6 million ($15.6 /W)	$523,000 /yr
4x EWT DW61 (4 MW)	$40.5 million ($10.1 /W)	$1.43 million /yr

[55] At the time of writing EWT has recently entered a bankruptcy process and it is unclear EWT's future capacity to sell wind turbines.

7.6 GEOTHERMAL ENERGY

In 2018, QEC commissioned a study of geothermal resources across Nunavut.[56] This study aimed to gather existing data, identify data gaps, and conduct a geothermal resource assessment according to the guidelines set by the **Canadian Geothermal Energy Association**. Resulting geothermal potential mapping for Nunavut is depicted in **Figure 55**. It is apparent that the heat flow wells that inform the geothermal modeling (**Figure 56**) are primarily concentrated in the Yukon and NWT, often associated with oil and gas exploration/extraction.

Based on both of these mapping sources, most of Nunavut is modeled to have low geothermal potential, especially around Chesterfield Inlet.

Survey respondents were asked whether they are aware of any water springs in the vicinity of the community, as these can be signs of geothermal potential nearby; only 2 of the 29 survey respondents indicated "yes".

Additional testing could potentially reveal a stronger geothermal resource in Chesterfield Inlet than is currently predicted. The **RESPEC** study recommends such testing adjacent to Nunavut communities. However, compared to other clean energy forms, testing a geothermal resource is very expensive. Holes must be drilled to a sufficient depth, often hundreds of meters, and this testing can cost in the millions of dollars.

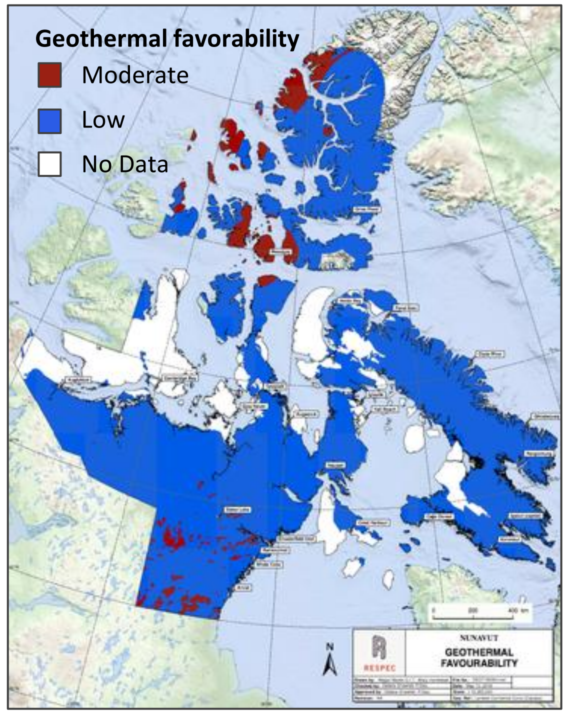


Figure 55: Nunavut geothermal favourability map[56]

Chesterfield Inlet would be better served by spending these dollars on realizing more suitable clean energy solutions today, using available means. Therefore, unless funding from government is earmarked for this purpose, **the CEP Team does not recommend further exploration of geothermal energy solutions for Chesterfield Inlet.**

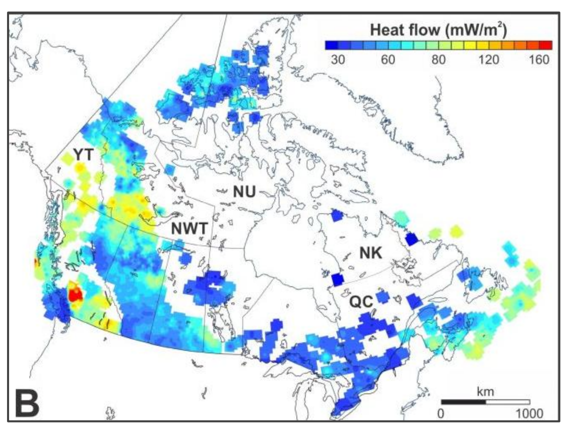


Figure 56: Heat flow map of Canada[57]

[56] RESPEC (2018). *NUNAVUT GEOTHERMAL FEASIBILITY STUDY, TOPICAL REPORT RSI-2828*. Prepared for QEC. June, 2018. URL: https://www.cangea.ca/nunavutgeothermal.html

[57] Miranda et al. (2022). *Geothermal resources for energy transition: A review of research undertaken for remote northern Canadian communities*. European Geologist, 54. https://doi.org/10.5281/zenodo.7882811

7.7 RIVER ENERGY

River energy projects capture energy from water as it flows downstream, forcing a turbine to rotate in an electric generator.

RUN-OF-RIVER

Unlike large-scale hydro-electric dams which typically create a large reservoir, run-of-river systems only generate electricity when the water is flowing. They are considered to have lower environmental impacts compared to large-scale projects because they don't flood land to create a new reservoir.

Run-of-river hydro projects typically have the following components (see Figure 57):

- **Weir:** (a type of very small dam) which creates a small headpond where some water is diverted from the river into the penstock,
- **Penstock:** a long pipe that carries water downhill to the powerhouse,
- **Powerhouse:** where this water forces a generator to turn, creating electricity,
- **Tailrace:** where the water is returned to the river
- **Transmission line:** carries electricity to user or grid.

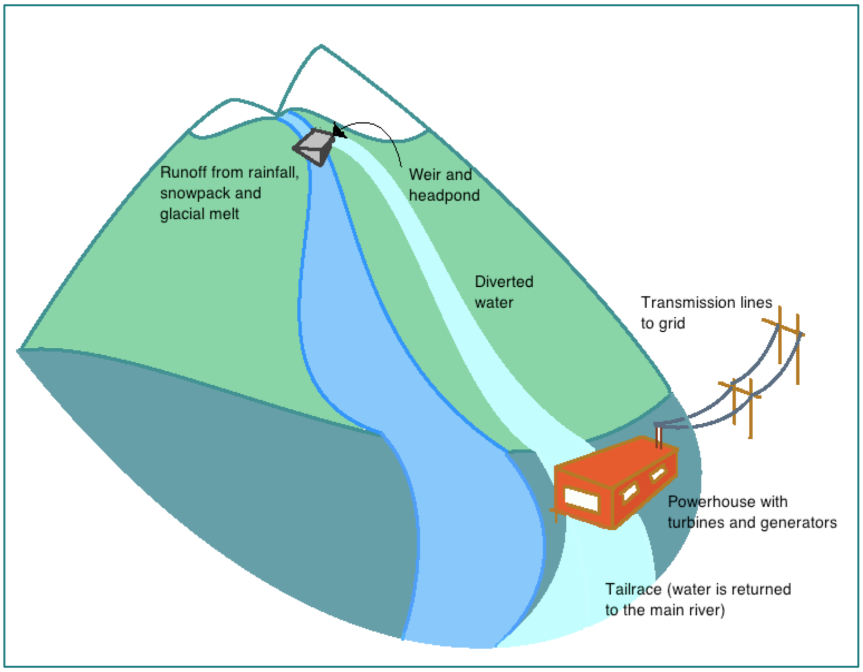


Figure 57: Diagram showing how many run-of-river generators function[58]

For streams that host fish, or which serve as navigation routes for watercraft, it is important to leave enough water in the stream. Therefore, only a portion is typically diverted into the penstock and powerhouse. Run-of-river hydro projects can come in any size, from several kW to over 100 MW, however most are between 25-kW and 25 MW.

[58] https://www.energybc.ca/runofriver.html

HYDRO-KINETIC

River hydro-kinetic systems involve placing a turbine directly into the river, which is forced to turn by the passing water. These systems can function with very low stream flow (>1 m3/s) and the turbines can be removed during the freezing season to preserve the equipment. Hydro-kinetic turbines are often several meters wide and require several meters of stream depth to function.

A hydro-kinetic energy system is currently operating on a river on the **Kvichak River near Igiugig, Alaska** and providing power to the community (see **Figure 58**).[59] This river flows year-round, however ice flows in the river in spring. Similar systems are also being tested at the Canadian Hydrokinetic Turbine Test Centre on the Winnipeg River in Manitoba.[60] Other northern communities may benefit from the lessons learned with these pilot projects.

Ocean Renewable Power Company (ORPC) is a well-established company producing hydro-kinetic models. They have a number of Canadian demonstration projects as well as commercial operations in the United States and South America. ORPC is actively working with the Canadian federal government on demonstrating the applicability of their technology in northern territories.

Figure 58: RivGen operating in the Kvichak River, near Igiugig, AK, in 2015 (ORPC)[58]

[59] News article entitled "Alaska village to test river-generated hydropower next winter". https://www.ktoo.org/2019/01/23/alaska-village-to-test-river-generated-hydropower-next-winter/
[60] Canadian Hydrokinetic Turbine Test Centre website. http://www.chttc.ca/

SITE SELECTION

Figure 59 shows a map of existing river energy projects in Canada. While some are at similar latitudes to Chesterfield Inlet, no projects have been installed in Nunavut yet. Run-of-river projects exist in the Yukon (40 MW), Northwest Territories (4–10 MW), and Nunavik, Quebec (up to 4 MW).

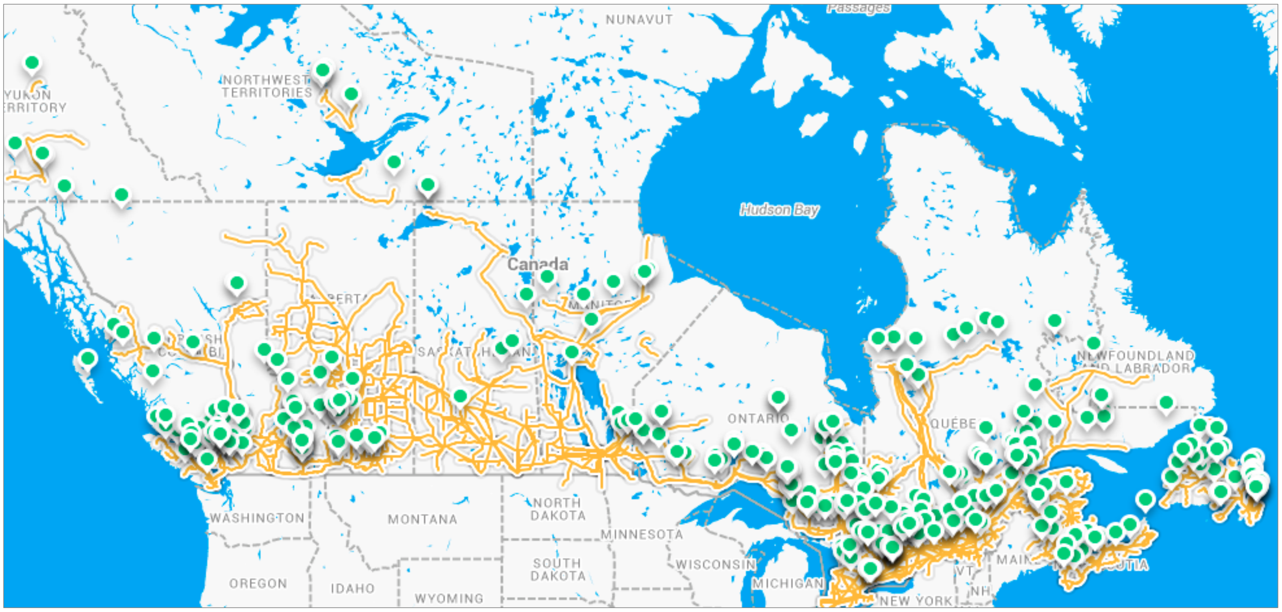


Figure 59: Map of existing hydroelectric generating facilities in Canada.[61]

Figure 60 map shows rivers near Chesterfield Inlet with potential for river energy based on hydrology modeling. No rivers with mapped potential were identified within approx. 80 km of Chesterfield Inlet.

No rivers with predicted energy potential have been mapped near Chesterfield Inlet. River energy in Nunavut is primarily limited to summer energy, except for large rivers that flow year-round. In contrast, solar PV offers summer energy at lower cost, and wind energy offers year-round energy. Therefore, **the CEP Team does not recommend pursuing river energy as a solution in Chesterfield Inlet.**

Figure 60: Map showing no mapped sites with river energy potential near Chesterfield Inlet.[62]

[61] Adapted from: Canadian Geographic (2016). Canadian Hydropower Interactive Map. https://hydro.canadiangeographic.ca/
[62] **Source:** Government of Canada (2018). The Atlas of Canada: Clean Energy Resources and Projects [CERP]. https://atlas.gc.ca/cerp-rpep/en/

7.8 TIDAL ENERGY

Several types of ocean energy technologies are currently under development, including various pilot projects and commercialization efforts around the world.

- **Tidal energy** technologies capture energy from ocean waters as they move in and out of a bay or marine channel, back and forth twice per day as the tides rise and fall. Tidal energy is very predictable, as substantial energy can be generated four times per day throughout the year. Due to the amount of energy in the ocean, a challenge is to protect equipment from strong currents and saltwater corrosion. Tidal is the most mature of the ocean energy technologies, and some equipment suppliers are making efforts to commercialize their systems.
- **Wave energy** technologies capture energy from the rising and falling surface of the ocean as waves pass by. Wave energy is driven by storms and typically higher in winter months. However, wave technologies are still pre-commercialization and therefore not suitable for energy solutions in remote communities in the short term.

Mapping from the Canadian Energy Atlas shows no mapped ocean energy sites within several hundred km of Chesterfield which, as depicted in **Figure 61**.

A further complicating factor in northern Canada is the effect of **sea ice**, and the spring ice floes, on human-built systems. The surface of the ocean surrounding Chesterfield Inlet is typically frozen from October to June.

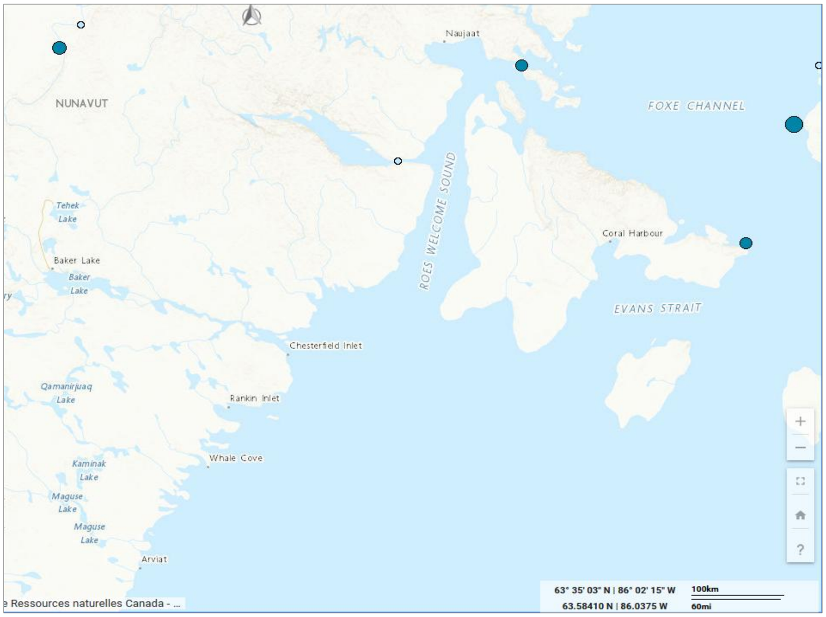


Figure 61: Map showing no mapped sites with river energy potential near Chesterfield Inlet.[63]

Because remote communities need to rely on their energy systems to meet basic human safety needs, and help is often far away, **the CEP Team does not consider ocean energy systems to be sufficiently proven at this time.** Ocean energy systems should be refined and proven in easier southern sites over the years to come. Only then should they be considered for application in a cold-climate site like Chesterfield Inlet.

[63] **Source:** Government of Canada (2018). The Atlas of Canada: Clean Energy Resources and Projects [CERP]. https://atlas.gc.ca/cerp-rpep/en/

7.9 CARBON OFFSETS

Carbon emission certificates (aka “**offsets**”) represent a way to offset greenhouse gas emissions, with each certificate typically representing one tonne of carbon dioxide equivalent that has been either reduced or removed from the atmosphere.

For a northern community aiming for Net Zero electricity, these certificates could be a tool to address the final, harder-to-eliminate emissions after building renewable energy and energy storage. The is both a regulatory market that focuses on heavy industry and a voluntary carbon market allows individuals and organizations to voluntarily purchase carbon credits from projects that reduce or remove emissions.

The price of regulatory markets differs across the world. In Canada there is the *Pan-Canadian Approach to Pricing Carbon Pollution* that had set the price on $95 CAD/tonne CO_2eq.[64][65]

The price of voluntary carbon credits can vary significantly based on the type of project, location, choice of standard, and any additional environmental or social benefits it offers. Global average prices in the voluntary market have fluctuated, with data from March 2025 showing prices ranging from $0.50 CAD to $10 CAD /tonne CO_2eq, with substantial variation from product to product.[66]

If offsets are to be used, thorough due diligence is important to ensure the integrity of the certificates. This includes verifying that the projects are additional (meaning they wouldn't have happened without carbon finance), that the emission reductions are permanent, and that they are verified by reputable third-party organizations.

When considering purchasing carbon emission certificates, the community should prioritize reducing its own emissions as much as possible before relying on offsets.

FINANCIAL ANALYSIS

For the analysis in this document, the $95 CAD/tonne CO_2eq from the Canadian federal government will be used. The current diesel-powered electricity system emits 1,645.7 tonnes of CO_2eq per year. **This would result in a yearly offset cost of 1,645.7 tonnes of CO_2eq x $95 CAD/tonne of CO_2eq = $156,341.5. Over a 25-year period, this would be about $3,900,000 CAD.**

[64] https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/carbon-pollution-pricing-federal-benchmark-information/federal-benchmark-2023-2030.html
[65] In March, 2025 the federal government announced its plan to change the federal carbon pollution pricing requirements, it being unknown how this will develop in the future.
[66] https://carboncredits.com/carbon-prices-today/

SECTION 08

HOMER MICROGRID MODELING

8.1 HOMER MODELING

The CEP Team performed modeling using HOMER software to investigate the cost of providing clean electricity to Chesterfield Inlet using various combinations of wind energy, solar energy, and energy storage. All of these scenarios were designed with the goal of achieving a Net Zero electricity grid, or very close to Net Zero.

HOMER scenarios were constructed using the following project component:

- One or several NPS 100C wind turbines with 100 kW capacity,
- One or several EWT DW61 wind turbines with 1 MW capacity,
- Solar arrays with 45-deg tilt in increments of 150 kW (AC),
- Energy storage systems of various sizes, and
- Existing diesel generators operating at lower capacity due to the above additions to the grid.

Dozens of scenarios were modeled in HOMER to examine construction costs, the amount of clean energy used on the grid over a typical year, and the amount of energy left to be served by diesel fuel.

As shown in **Figure 62** these scenarios achieved diesel reduction on the grid ranging from 80% all the way to 100% Net Zero electricity.

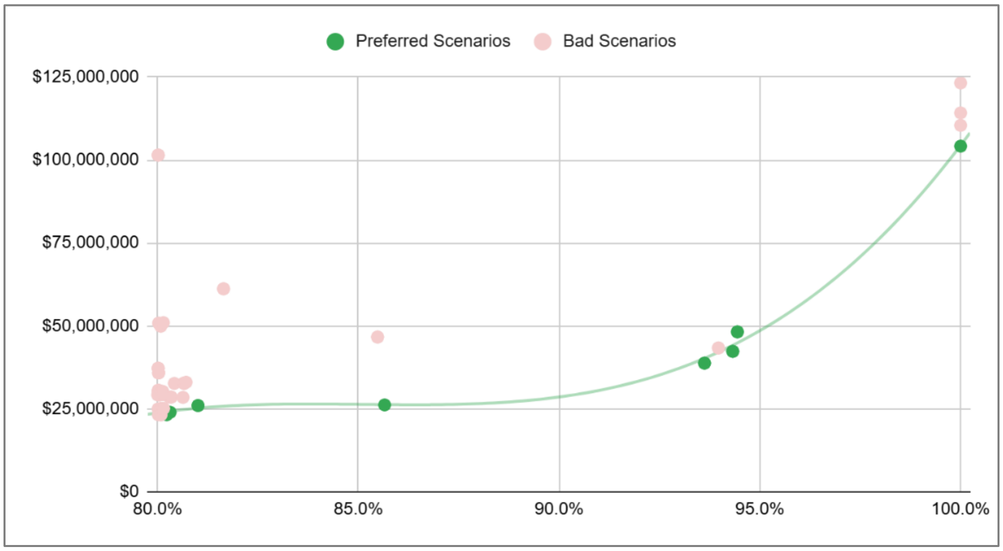


Figure 62: Modeled renewable energy scenarios for Chesterfield Inlet Net Zero electricity

100% NET ZERO SCENARIO

The **lowest-cost** scenario identified by HOMER to **achieve 100% Net Zero electricity** (diesel generators used only as backup) has the following characteristics:

- 3 x EWT DW61 wind turbines with 1 MW capacity each = 3 MW,
- 7.5 MW (AC) solar array
- BESS with 22.5 MWh storage capacity and an instantaneous capacity of at least 500 kW,
- Capital cost: estimated at $98.4million
- Diesel reduction: 100%

The above scenario achieves Net Zero! However, it does so at a **very high capital cost**. We note from **Figure 62** that the costs of scenarios modeled in HOMER up to and including 94% diesel reduction follow a fairly linear relationship (similar cost per unit of diesel reduction), and above 94% the costs begin to rise much more steeply.

94% DIESEL REDUCTION SCENARIO

Therefore, the CEP Team has identified the following scenario as being a **balance between affordable costs while still achieving a high level of diesel reduction:**

- 1 x EWT DW61 wind turbine with 1 MW capacity
- 2.38 MW(AC) solar array
- BESS with 5.7 MWh storage capacity and an instantaneous capacity of at least 500 kW
- Capital cost: estimated at $37.5 million
- Diesel reduction: 94%

Further detailed microgrid modeling is needed to identify the scenario that is truly optimal. However, **it is the recommendation of the CEP Team** that Chesterfield Inlet pursue the combination of clean energy technologies similar to the example above to achieve diesel reduction in the ballpark of 90-95%, and then purchase carbon offsets to address the remaining 5-10% gap to achieve a true Net Zero electrical grid. We note that the cost of purchasing offsets is much cheaper than building the 100% scenario described previously.

80% DIESEL REDUCTION SCENARIO

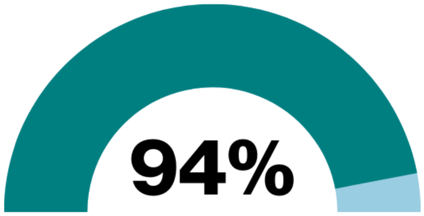
Alternatively, if funds are not available to build the recommended scenario, then a more **affordable** scenario could be pursued, with lower positive impact. For the sake of comparison, below is a scenario to achieve 80% diesel reduction at medium cost.

- 5x NPS 100C wind turbine with 100 kW capacity each = 500 kW
- 534 kW(AC) solar array
- BESS with 2.8 MWh storage capacity and instantaneous capacity of at least 500 kW
- Capital cost: estimated at $22.6 million
- Diesel reduction: 80%

FINANCIAL ANALYSIS

The example combination of clean energy technologies (wind, solar, and battery) recommended by the CEP Team (94% scenario) would have the following characteristics:

CapEx **$37.5 million**	**Annual Energy Production** **1.91 GWh/yr**
Wind Capacity Factor **39%**	**Solar Capacity Factor** **20%**
Annual Revenues **$954,000** *(IPP Model) based on an assumed electricity price of $0.50/kWh inclusive of Renewable Energy Support Policy	**Annual OpEx** **$1 million/yr** (approximately)



Renewable Energy Fraction on the Grid

To achieve a Net Zero electrical grid under this scenario, Chesterfield Inlet could purchase offsets for the remaining 6% of electricity demand met by diesel fuel.

Carbon offset costs:[67] **$9,400/yr**

In the scenario described above, project operating costs would be approximately equal to project revenues. More detailed study is needed to identify an optimal project whereby revenues would exceed operating costs. Such a project, if the CapEx were covered by government grant funding, could maintain itself using revenues generated by electricity sales to QEC.

[67] Assuming a $95 /tonne price for offsets and 140 tonnes of CO2e required to achieve a Net Zero electrical grid.

8.2 ADDING HYDROGEN ENERGY STORAGE

Research by UVic graduate student **Sophie Janke** has examined the role that hydrogen storage could play in Chesterfield Inlet to further maximize renewable energy capture and further reduce diesel fuel consumption.

One model performed by Ms. Janke examined a 92% penetration scenario, but with the addition of a hydrogen energy storage system (including electrolyzer, storage facility, fuel cell generator, etc.). Her findings suggest that the renewable energy factor could potentially be increased to approx. 95% by adding a hydrogen storage system with a CapEx of approx. $2.54 million.

However, a variation on this model also examined the optimal scale of the BESS vs. the hydrogen energy system in the community. These results suggest that renewable energy penetration of > 95% could potentially be achieved by employing a smaller BESS (e.g. 1.600 MWh), a smaller solar array (e.g. 440 kW), the same 1 MW wind turbine, and a larger hydrogen storage system (e.g. 250 kW generation capacity).

Further details would be needed to refine this study, and to manage the various risks and complexities associated with hydrogen storage—however **these efforts may be worthwhile to identify the optimal configuration of components to achieve a Net Zero electrical grid most affordably.** We note that economies of scale can be achieved by building a large hydrogen storage system in one effort, however the Hamlet may choose instead to pursue a smaller pilot-scale facility as an initial step.

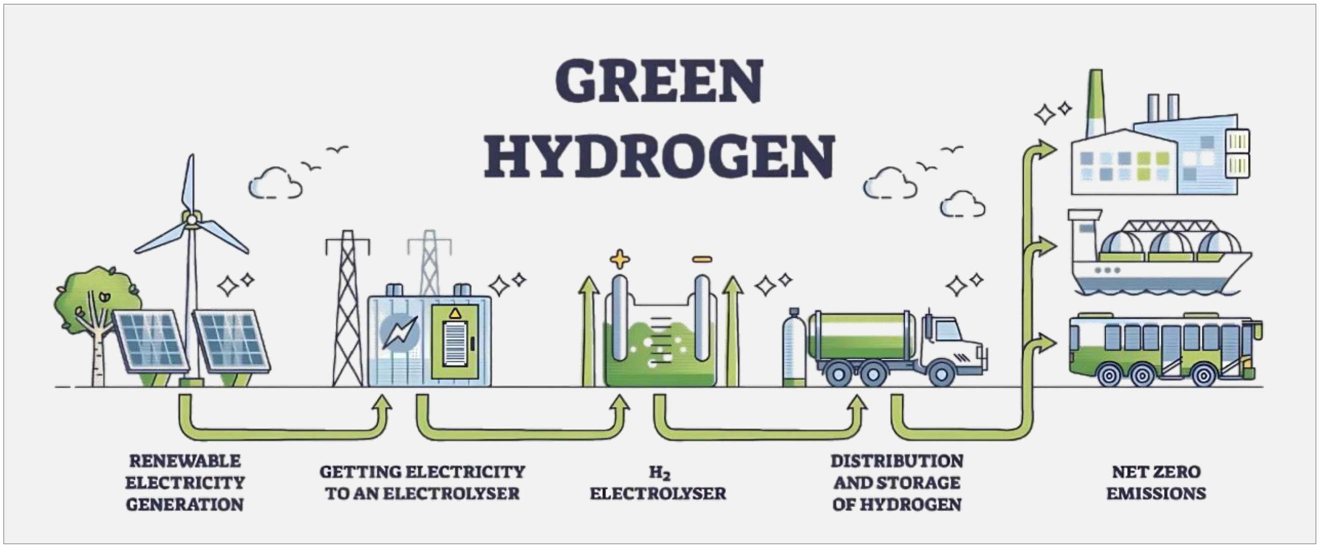


Figure 63: Green Hydrogen Process[68]

[68] https://www.sciencedirect.com/science/article/pii/S0360319924025825.

8.3 JOBS ANALYSIS

Installation of a **2.38-MW(AC) ground-mounted solar PV** system would require a 5-10 construction contractor crews of approximately 4-8 people each. All contractors favour hiring some of these workers locally. During operations, two individuals in Chesterfield Inlet should be trained to conduct regular monitoring and maintenance, with outside services brought in as required.

Installation of a **3.0 MW wind energy facility** would require a construction crew of approximately **35 people**. During construction a portion of the labour can be sourced locally, with other specialized labour and equipment coming from outside of Nunavut. During operations, local people can be trained for regular maintenance and monitoring work, with support for major maintenance activities coming from southern Canada.

Installation of a **5.7 MWh battery storage system** would require a crew of approximately **5-10 people**.

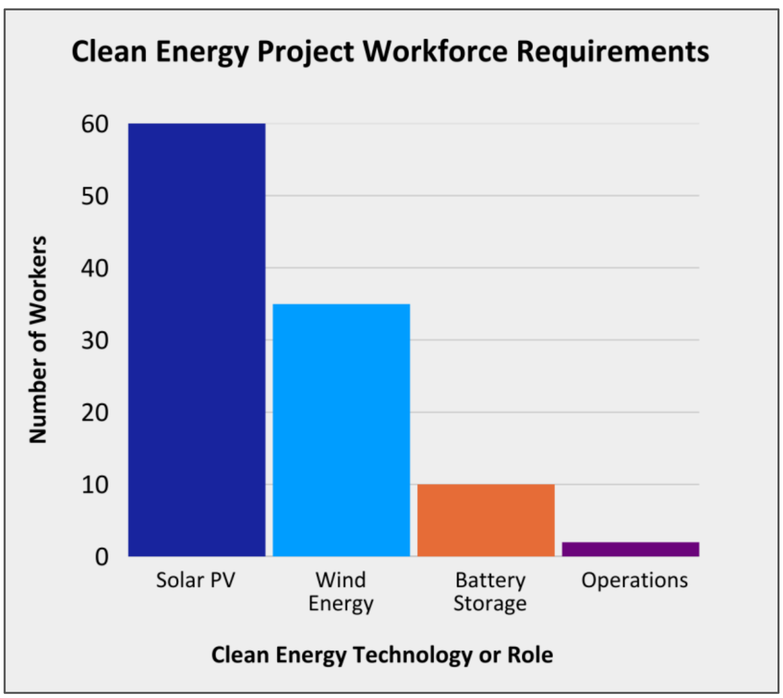


Figure 64: Estimated number of workers required to build and operate a clean energy project in Chesterfield Inlet.

8.4 GHG ANALYSIS

The wind / solar / battery project described above would achieve the following results:

- → **94%** reduction in diesel fuel used for electricity consumption, or
- → **559,000** litres/year of diesel saved
- → **1.54 million** tonnes CO_2e savings each year (approx.)

Addition of hydrogen energy storage could potentially achieve the following results:

- → **>95%** reduction in diesel fuel used for electricity consumption, or
- → **565,000** litres/year of diesel saved
- → **1.56 million** tonnes CO_2e savings each year (approx.)

Figure 65: Comparison of Annual CO_2e savings from a wind/solar/BESS project and with added hydrogen storage

SECTION 09

RECOMMENDATIONS

Considering all of the options investigated in **Section 8** above, the CEP Team provides the following recommendations to Chesterfield Inlet in order to achieve Net Zero electricity as well as diesel fuel reductions across the community.

- **Near-Term Transition to Net Zero Electricity:** Recommendations for projects in the next five years to achieve a Net Zero electrical grid, address consumption of heating oil in buildings, and investigate further diesel reductions related to heating in Chesterfield Inlet.
- **Longer-Term Opportunities:** Recommendations for projects beyond the next five years that transition away from diesel fuel / heating oil as a heat source in Chesterfield Inlet's buildings.
- **Next Steps:** Recommendations to advance a near-term and longer-term transition to Net Zero

9.1 NEAR-TERM TRANSITION TO NET ZERO ELECTRICITY

In the next five years, the CEP Team recommends the following:

To achieve a Net Zero electrical grid, install the following equipment to achieve a reduction in diesel fuel used for electricity of approximately 90-95%:

- **Wind Energy:** e.g. 1 x EWT DW61 wind turbine with 1 MW capacity,
- **Solar Energy:** e.g. 2.38 MW (AC) solar array,
- **Battery Storage:** e.g. BESS with 5.7 MWh storage capacity and instantaneous capacity of at least 500 kW
- Subject to further study, this project could potentially achieve **> 94%** diesel reduction through the addition of hydrogen storage,
- Purchase **annual carbon offsets** to address remaining electricity demand met by diesel
- Seek **grant funds** to cover a portion of project costs.

To address use of heating oil in buildings, with the goal of achieving **20%** reduction in heating fuel:

- A program of building audits to **ASHRAE Level 2** standard across as many buildings (both residential and community scale) as possible.
- Costing research on the above package of building retrofits incorporating bids from contractors.
- Funding applications (or loans) to fund this package of building retrofits.
- Implementation and monitoring to achieve reductions of heating oil fuel.

To investigate further diesel fuel reductions in relation to heating:

- A pilot project incorporating high-efficiency heating technologies (e.g. ground-source heat pumps) to reduce the need for heating oil as the source of heating (space and hot water).
- This technology, if proven, could potentially be pursued across the community (at residential and district scale) over the medium-term.

9.2 LONGER-TERM OPPORTUNITIES

Beyond the next five years, and assuming that the projects listed in **Section 9.1** have been implemented and Net Zero electricity achieved, then the CEP Team recommends consideration of the following:

Transition away from diesel fuel / heating oil as building heat source by pursuing one of two paths:

- **Biomass heating** by importing sustainably harvested wood pellets from southern Canada to burn in high-efficiency heat or heat-and-electricity devices, or
- Electrical heating by installing **high-efficiency heat pumps** (at the building scale or district scale) to replace heating oil, AND
- Substantial **expansion of the clean energy system** (wind, solar, storage) in order to provide the energy needed for the above electrical heating. Based on fuel consumption data in the community, this would likely require the clean energy system to at least double in capacity.

9.3 NEXT STEPS

This CEP is intended to be a **living document**, adaptive to the evolving needs of the community, technological advancements, and policy changes. The recommendations put forward in this CEP are designed to help Chesterfield Inlet achieve its short-term energy goals, while also considering long-term sustainable change.

To advance the transition to Net Zero within the next five years, the following action items should be prioritized:

- Develop detailed implementation plans for the recommended wind, solar, and battery storage projects.
- Conduct a Connection Impact Assessment (CIA) study with QEC to obtain approval for the proposed mix of wind, solar, and battery storage capacity.
- Build local capacity and create employment opportunities related to the energy transition.
- Secure funding for key projects through federal programs and partnerships with organizations like the federal government and the GN.

In the longer term, Chesterfield Inlet should explore opportunities for broader energy transition, including:

- Transitioning away from diesel fuel for heating through biomass heating or further electrification.
- Expanding the clean energy system to support increased electrical heating demands.
- Exploring the potential for electrical interconnection with other communities, which could also bring benefits for the local clean energy generation projects in Chesterfield Inlet.

By taking these steps, Chesterfield Inlet can continue to build on the foundation laid by this CEP, and progress towards a cleaner, more secure, and sustainable energy future.

APPENDIX A: SURVEY RESULTS

APPENDIX B: HOMER STUDY REPORT

KIVALLIQ ALTERNATIVE ENERGY

The Chesterfield Inlet Community Energy Plan was funded with the support of the following organizations:

Canada

Canadian Northern Economic Development Agency

Indigenous Green Economy Initiative

cando Inspiring Success