PEMBINA institute

Diesel Reduction Progress in Remote Communities

Research summary

Photo: Green Sun Rising

Remote communities in Canada, the majority of which are Indigenous, are overwhelmingly reliant on diesel fuel for heating and electricity generation. Burning diesel for heat and power creates local health and environmental issues, and diesel must be transported into hard-to-reach communities at high cost. Instead, communities could harness abundant local renewable energy resources such as sun, wind, water and biomass, which would contribute to economic independence while creating local jobs.

This research estimates total energy use in remote communities from 2015 to 2020 for both heat and electricity, and captures the first national collection and quantification of renewable energy systems in remote communities over the past several decades with detailed attention on the past five years. It considers diesel and other fossil fuels, and focuses on four pathways for reducing diesel use: renewable electricity, renewable heat, some specific energy efficiency measures, and connecting remote communities to electricity grids. In this paper, we outline the progress made so far, and the opportunities to advance renewable energy and energy efficiency measures to reduce diesel use in remote communities in Canada.

Key findings

- From 2015-2020, renewable energy projects nearly doubled across remote communities.
- By 2020, remote communities had installed more than 11 times as much solar capacity as they had in place in 2015.
- Over the last five years, through the four pathways addressed (energy efficiency measures, renewable heat and electricity, and grid connections), remote communities saw a total diesel reduction of over 12 million litres per year.
- However, diesel use in 2020 is still a staggering 682 million litres per year; two-thirds for heat and one-third for electricity. Total diesel consumption has increased since 2015, due to population growth, although this has been partly mitigated through the four pathways identified above.
- The transition to community energy systems that replace fossil fuels with renewable energy and zero-emission technologies, and reduce demand through energy efficiency and smart grids, presents significant opportunities for Indigenous communities. Achieving the clean energy transition requires wide collaboration; Indigenous community leaders can leverage economic opportunities on the path to energy security.
- Examining various approaches will be crucial in understanding what will be required to meet the federal government's goal of eliminating diesel-powered electricity generation in remote communities by 2030 (there is currently no interim goal to eliminate diesel for heating) and the country's larger goal of net-zero carbon emissions by 2050.

2015 snapshot – renewable energy and diesel use

Annual diesel-eq* fuel consumed in remote communities: **655** million L/yr

Approximate **number of diesel reduction systems** (not counting residential wood stoves) installed as of 2015: **96**

Avoided annual diesel-eq consumption from renewable energy systems (including wood stoves) installed as of 2015: **170** million L/yr

In 2015, there were a few established small hydroelectric systems, several bioheat systems and a handful of small solar PV and wind projects. Electricity from small hydro dominated the renewable electricity sector in B.C. and Quebec while residential wood stoves dominated the renewable heating sector in Ontario and B.C.

Annual energy production from renewable energy systems

	MWh/yr
Small hydro (Small-scale or run-of-river)	168,908
Residential wood stoves	552,850
Bioheating systems	32,441
Solar photovoltaic (PV)	682
Wind turbines	183

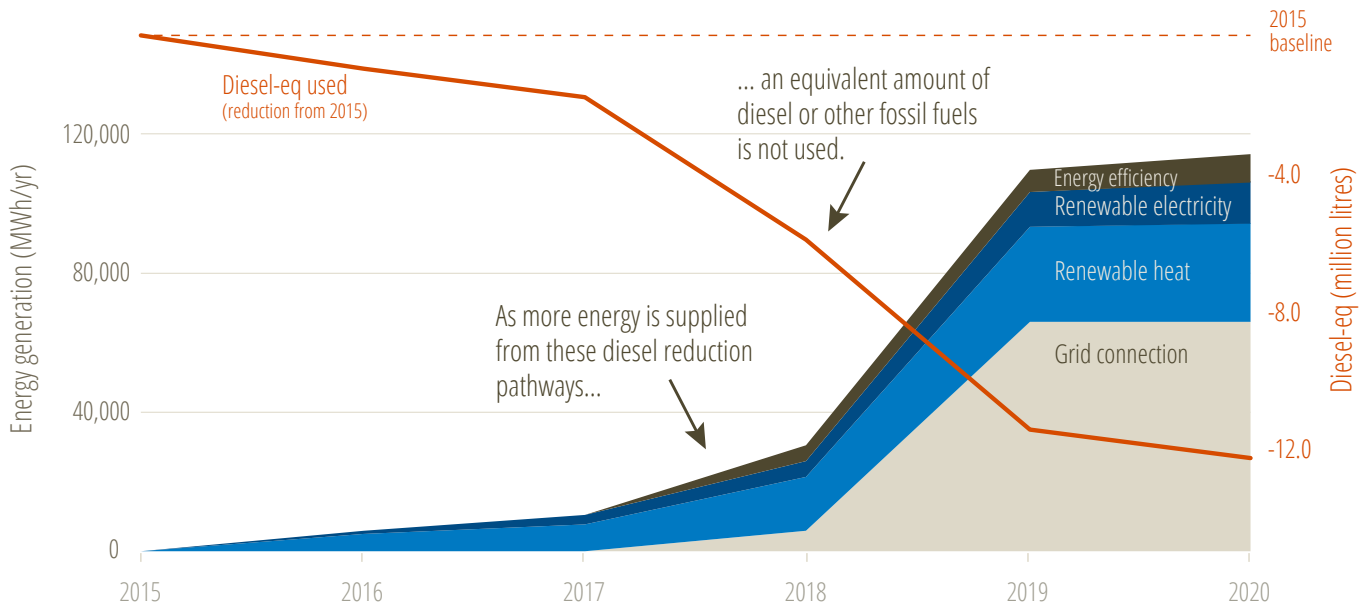
* Diesel is not the only fossil fuel used in remote communities for electricity and heat. Heavy fuel oil, natural gas and propane are also used for energy. For simplicity, all of these fuels are converted into a common energy form that we will refer to as diesel-equivalent, or diesel-eq for short.

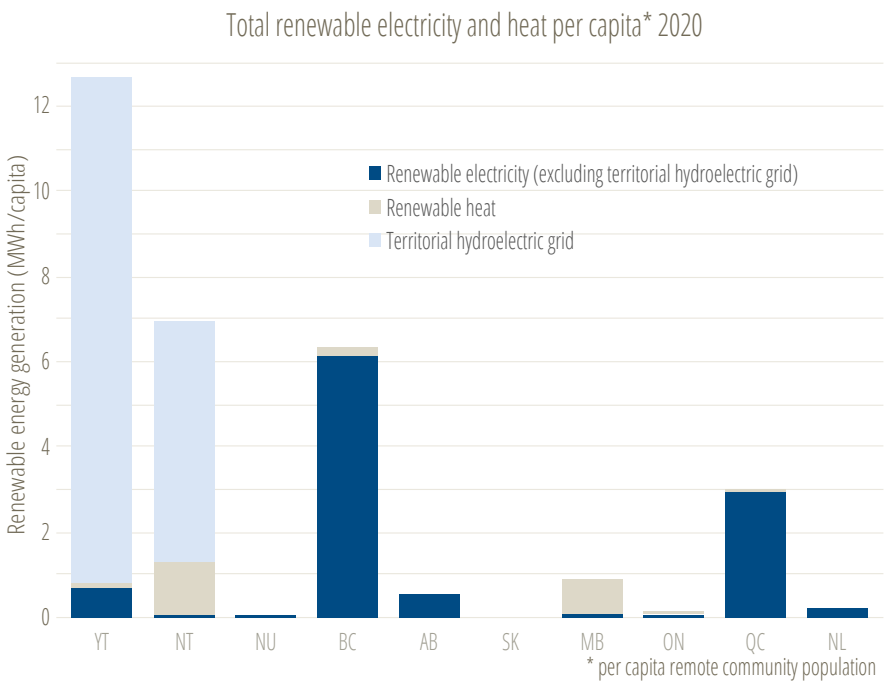
Progress made on renewable energy systems 2015-2020

There has been substantial uptake of solar PV and bioheat projects, especially in the past two years, with larger systems delivering more renewable energy.

These new projects have brought 40,859 new MWh of renewable energy to the energy mix in remote communities, resulting in less noise pollution, less diesel exhaust emissions and increased financial savings and revenue, while creating jobs in communities.

Pathways to diesel reduction in remote communities (2015 to 2020)





	Total number of renewable energy projects (2020)	
	Renewable electricity	Renewable heat (not including wood stoves)
YT	10	6
NT	20	53
NU	12	6
BC	16	6
AB	1	-
SK	-	-
MB	1	2
ON	28	2
QC	8	1
NL	6	-

Progress: 2015 to 2020

Annual avoided diesel-eq fuel consumption in remote communities from diesel reduction pathways: **12.3** million L/yr

Approximate **number of diesel reduction systems** installed since 2015: **82**

Increase in number of diesel reduction systems since 2015: **85%**

Number of remote communities connected to provincial or territorial electricity grids since 2015: **3**

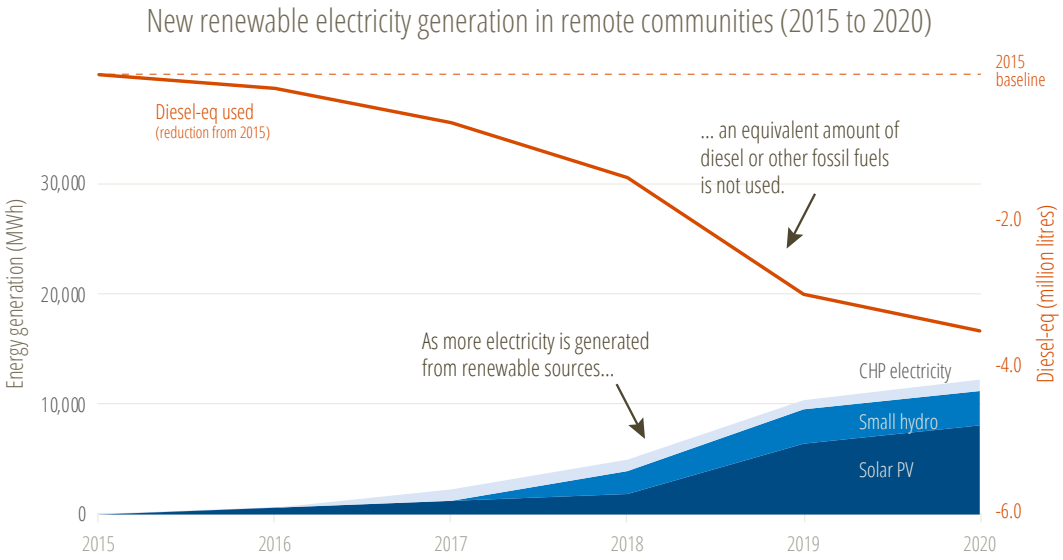
Annual new energy production from new renewable energy systems

	MWh/yr
Renewable electricity	12,148
Renewable heat	28,711
Selected energy efficiency measures (energy saved)	7,908

Important advances since 2015

- **Connecting remote communities to provincial grids** has contributed to additional renewable energy and diesel-eq reduction.
- Most progress over the past two years has been supported by **federal funding programs** combined with **provincial/territorial funding programs**.
- **B.C.** continues to introduce renewable electricity through small hydroelectric projects.
- There was a significant uptake in **larger solar PV projects** (beyond the standard 10–20 kW size), with system size averaging 50 kW by 2018 and increasing to 500 kW for installations in 2019 and 2020 in several jurisdictions.

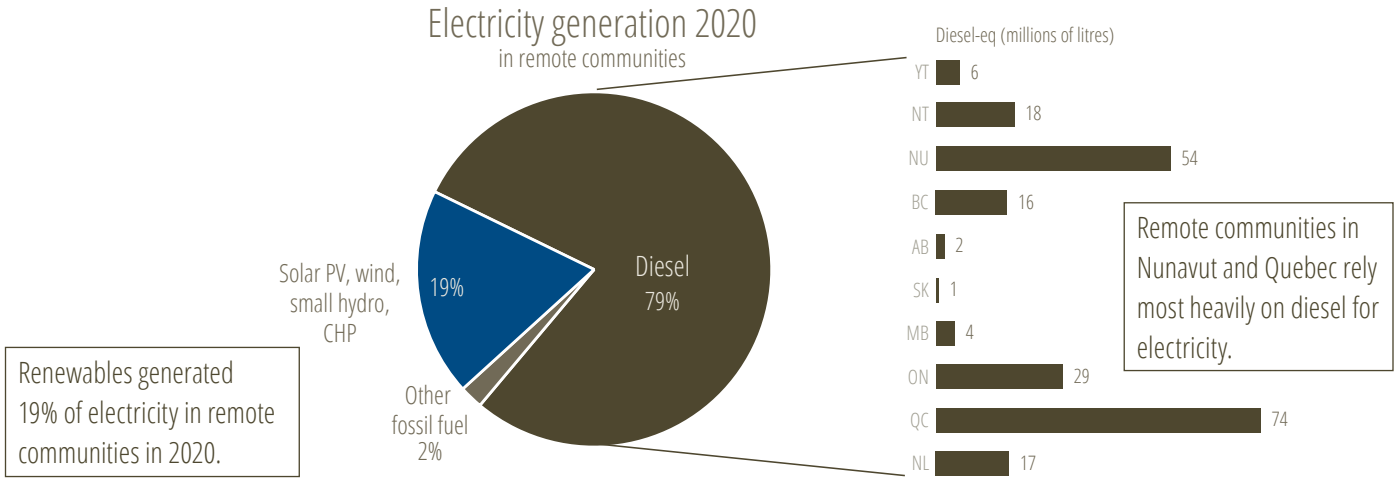
Renewable electricity



Avoided annual diesel-eq consumption from renewable electricity systems installed 2015-2020:

3.5
million L/yr

213 communities were analyzed for diesel use for electricity generation (see map page 7)



Renewables generated 19% of electricity in remote communities in 2020.

Remote communities in Nunavut and Quebec rely most heavily on diesel for electricity.

Renewable electricity technologies

The technologies considered in our research are:

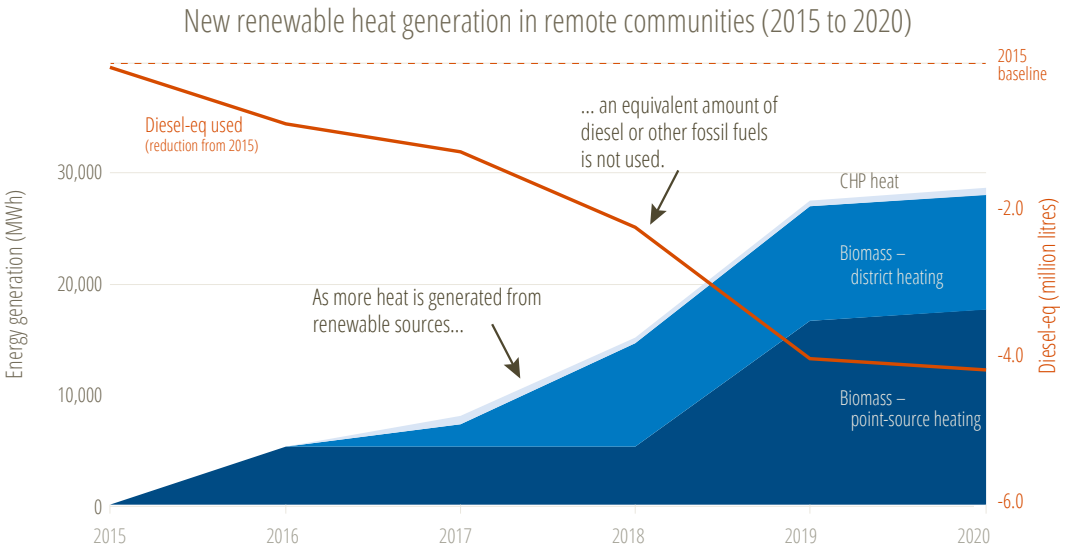
Solar photovoltaic (solar PV): Solar panels convert sunlight directly into electricity.

Combined-heat-and-power electricity (CHP electricity): Combined-heat-and-power systems produce both electricity and heat. Feedstocks (predominantly wood fibre) are combusted in a gasifier to produce a bio-gas which is then used to generate electricity.

Small hydroelectricity (less than 50 MW)**:** The production of electricity by using moving water to turn an electrical turbine. In remote community installations, water can either be stored in a small reservoir and released (small-scale hydroelectricity) or diverted directly through a penstock (run-of-river hydroelectricity).

Wind: Wind turns the blades of a large turbine to produce electricity.

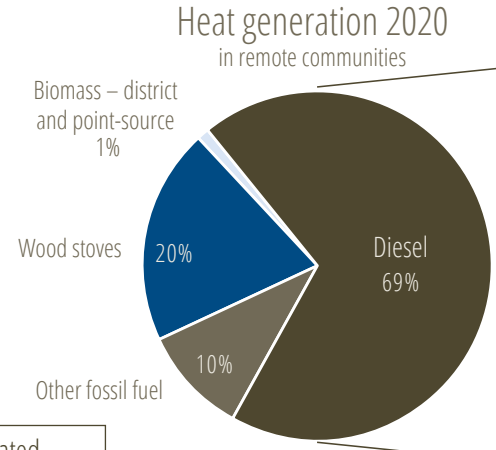
Renewable heat



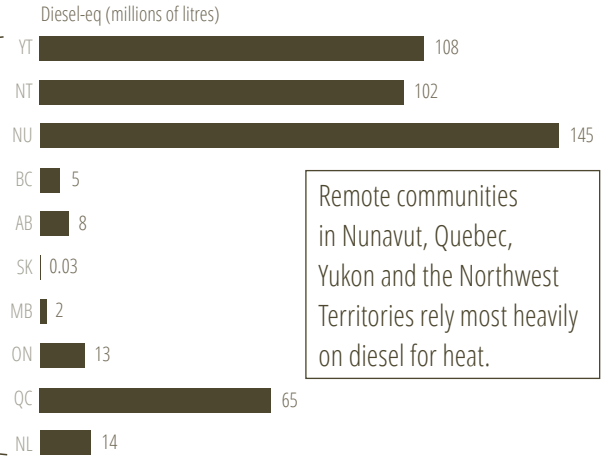
Avoided annual diesel-eq consumption from renewable heat systems installed 2015-2020:

4.1
million L/yr

238 communities were analyzed for diesel use for heating (see map page 7)



Renewables generated 21% of heat in remote communities in 2020.



Remote communities in Nunavut, Quebec, Yukon and the Northwest Territories rely most heavily on diesel for heat.

Renewable heat technologies

All renewable heat technologies considered in this research are **bioheat systems**. The typical feedstocks for these systems are cordwood (large pieces of wood — typically from trees); wood chips (smaller but still intact pieces); or wood pellets (compressed wood remnants typically from forest by-products or waste from the forest industry). The technologies considered in our research are:

Biomass boilers: Boilers combust feedstock to heat water or air, which is distributed throughout the building for space heat. Older conventional biomass boiler systems used water to produce steam to distribute. Newer systems now just heat water to a lower temperature and distribute. Biomass boilers can deliver bioheat to a single building (biomass – point-source heating) or to a group of buildings (biomass – district heating).

Wood stoves: Stoves using mostly cordwood or wood pellets are used for space heating.

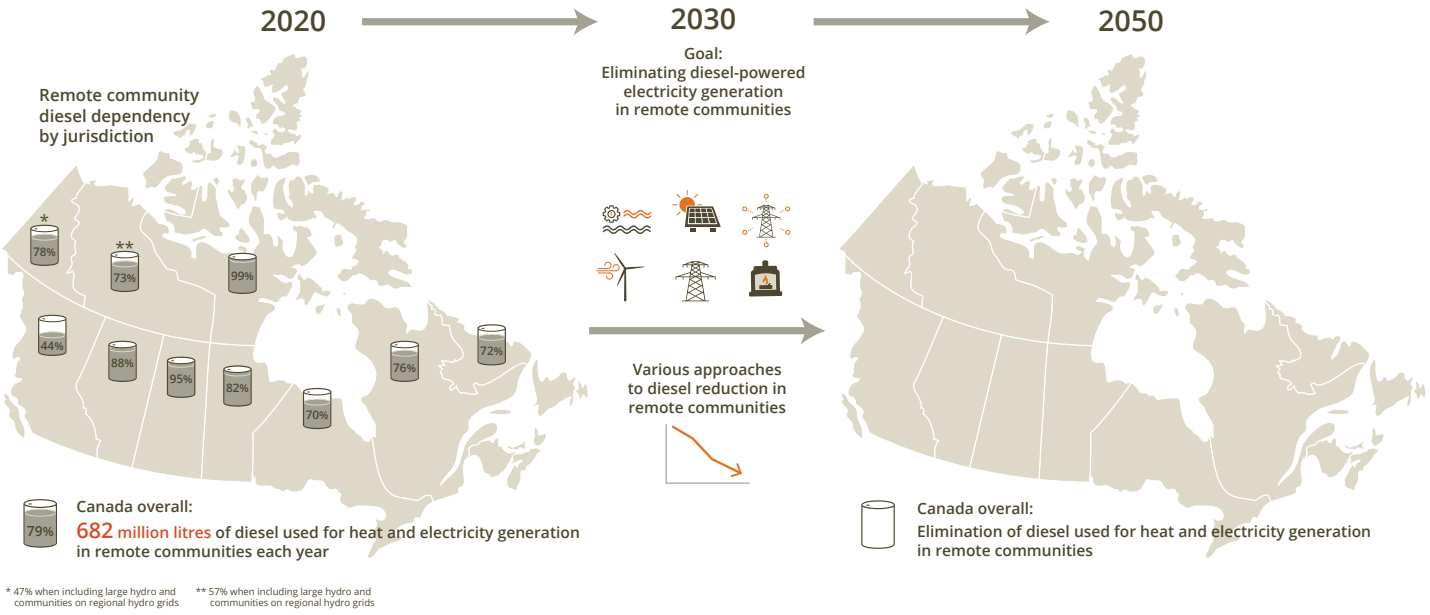
Combined-heat-and-power heat (CHP heat): Combined-heat-and-power systems produce both electricity and heat. Feedstocks (predominantly wood fibre) are combusted in a gasifier to produce a bio-gas which is then used to generate electricity; residual heat from combustion is used to heat buildings.

Conclusions and next steps

Eliminating diesel dependency: What does this mean and how do we get there?

Considerable effort is still required to put an end to diesel dependency and to transition to clean energy in remote communities, but this also presents a great opportunity for remote communities. Achieving the clean energy transition requires wide collaboration; Indigenous community leaders can leverage economic opportunities on the path to energy security.

This transition will only be possible through: continued work to **build capacity** in remote communities; continued **investment** in infrastructure and business opportunities for Indigenous communities and businesses; **progressive targets**; **effective climate and energy policy**; **support for Indigenous self-determination** for their energy future; and a **full accounting** of the environmental, health, community and social benefits of this transition to improve the economic case for these projects.



Initiatives in development

There are many initiatives still in development that will further reduce diesel use in remote communities. Some of these include:

Further project deployment funding — At least 11 more renewable energy systems being funded by NRCan's Clean Energy for Rural and Remote Communities (CERRC) program are planned to be operational after 2020 and will provide a further annual diesel reduction of 4 million litres per year.

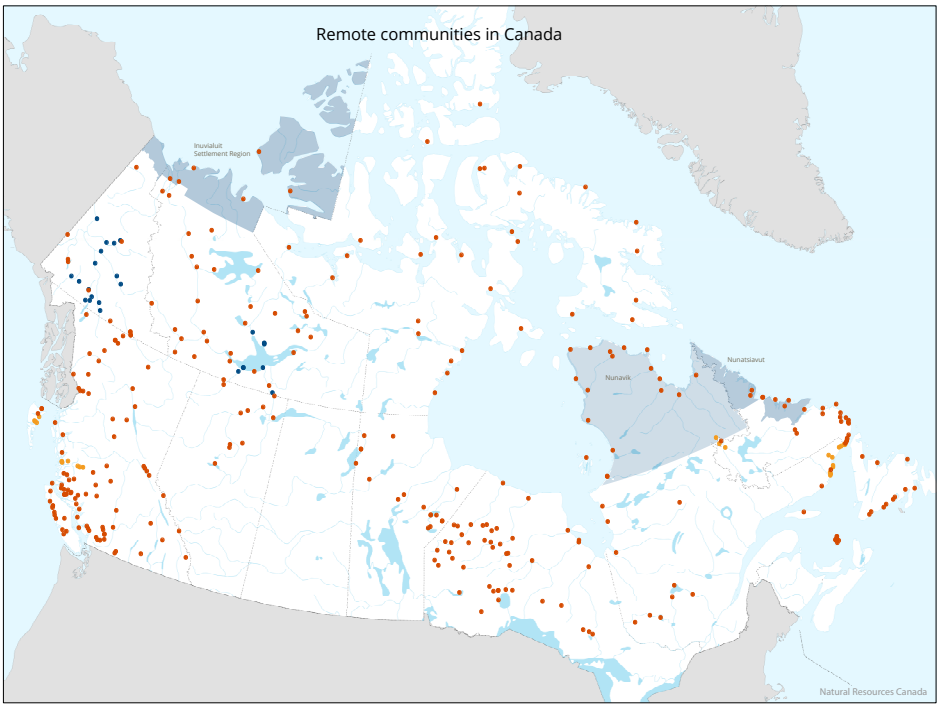
Grid connections — The Watay Power transmission project continues and will connect more than a dozen remote communities in northern Ontario, reducing diesel-power dependency and creating opportunities for electrification (heat and transportation). Projects in other jurisdictions including the NWT (the potential Taltson hydroelectric expansion), Nunavut (the potential Kivalliq hydro-fibre link) and Quebec (connecting the Magdalen Islands to the Quebec grid by 2025) would further reduce diesel reliance for both electricity and heat.

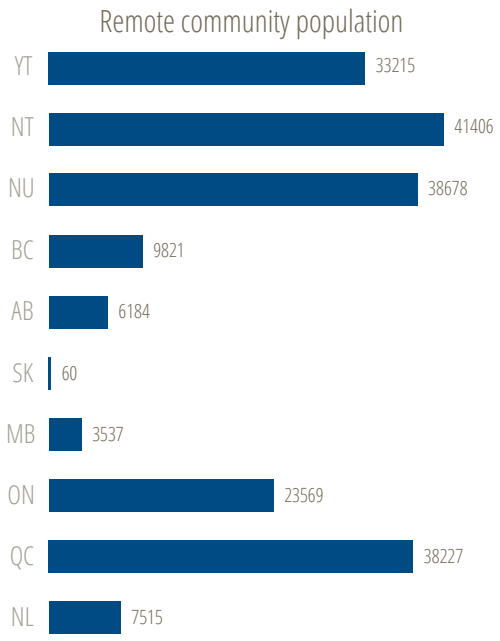
More systems being developed — Other small hydro-electric systems are under development in B.C. and the Nunavik region of northern Quebec, and Canada's first wind systems in remote communities are being planned in Yukon, Nunavut and the Nunatsiavut region of Labrador.

Territorial infrastructure funding — The Arctic Energy Fund is supporting increased diesel generator efficiency and integration of renewable energy systems in the three territories.

More energy efficiency gains — Major energy efficiency systems, deep retrofits and housing renewal programs are making significant improvements in reducing energy demand in buildings.

About this research





Diesel use in remote communities

- communities that use diesel fuel for both heating and electricity generation
- communities that use diesel fuel for heating but are connected to regional grids in the NWT and Yukon
- communities that use diesel fuel for heating but are connected to local small hydroelectric facilities

Data sources and modelling assumptions

This research captures the first national collection and quantification of renewable energy systems in remote communities over the past several decades with detailed attention on the past five years, and an initial start on quantifying energy efficiency initiatives. Total energy demand and diesel consumption for heat have also received closer modelling attention and estimates. For a full review of the scope, modelling approach and assumptions, please refer to the modelling report.

2015 starting point

The best available collection of research, data analysis and information on already-developed renewable energy projects was for 2015, making that year the starting point for this report.

The 2015 data is based on the following sources of information on diesel-dependent remote communities in Canada:

- Natural Resources Canada Remote Community Energy Database: Provides details on population, diesel generation capacity, fuel consumed.
- Waterloo Global Science Initiative, "Energy Access – The Canadian Context," *OpenAccess Energy Blueprint,* March 2017: Quantifies diesel and renewable energy demand and generation.

Other data contributors to this work:

- University of British Columbia Master of Engineering Leadership capstone project students, in particular Devin Vranckaert
- Mariano Arriaga, who contributed to previous academic research and modelling in this area

Definitions and scope

Number of remote communities in this study: Twenty-five remote communities in the Yukon and NWT are connected to territorial electricity grids that rely on large hydroelectricity (with some diesel backup) and hence were not included in the electricity analysis but were included in the heat analysis because of their complete dependency on fossil fuels for heat. Thus, 213 communities were considered for electricity and 238 communities for heat.

Residential wood stoves: Residential wood stoves are an essential source of heat in many remote communities – predominantly in B.C., Ontario, Quebec, Yukon and NWT. However, data is very poor on the number of residential wood stoves installed across Canada. For these reasons, this modelling does not count residential wood stoves in tallying the *number* of renewable energy systems, but it includes residential wood stoves when looking at the *amount* of renewable energy contribution from these systems.

Energy efficiency technologies: Energy efficiency includes a variety of technologies. As a starting point, this research includes waste heat recovery (from diesel generators) and heat pumps, as some project data was available. Quantifying further diesel reduction from demand side management and deep retrofit projects will require further work and will be a great opportunity to explore the positive impact energy retrofits are having on diesel reduction.

Modelling approach

Listed communities: Starting with the community list from the NRCan Remote Community Energy Database, the modelling then excluded communities that are abandoned, have population less than five persons, had no data or are only industrial sites. Four isolated communities in Alberta not listed in the NRCan RCED database were added.

Population estimates: From Canadian census data; 2015 population was linearly interpreted from data and 2020 population was forecasted.

Electricity: Using data from the NRCan RCED, electricity was modified to estimate 2020 use and incorporate renewable energy projects implemented between 2015 and 2020.

Heating: Using data from six remote communities with detailed heat breakdowns between residential and home heating, average heat load profiles were estimated accounting for temperatures in the community and type of energy mix (the Energy Access approach). Community and commercial building heat loads were estimated to be 45% higher than residential heating.

Further modelling opportunities

This work provides a robust national model of energy demand, diesel and renewable energy supply and diesel fuel consumption in remote communities and changes over the past five years. There are exciting opportunities to further this research by incorporating the initiatives in development (listed on page 6), but also by exploring approaches that will result in further reductions in diesel fuel, including high-penetration renewable energy projects being considered in remote communities and demonstration renewable energy technologies that are nearing commercialization. Examining various approaches will be crucial in understanding what will be required to meet stated 2030 and 2050 reduction goals. It will also be important to differentiate between government- or utility-led and community-driven projects and what provinces and territories are supporting Indigenous-led and owned projects. The modelling of environmental, social, economic and health impacts as energy decarbonization continues will become an important factor in decision-making.

The Pembina Institute thanks these funders for their financial support for this research:

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