



## Emerging technology snapshot

# Energy generation and storage in cold climates

Northern and remote communities are heavily reliant on fossil fuels, with between 70-80% of primary energy being generated by diesel. The global push toward decarbonization has led to a flurry of research on clean energy generation and storage. However, extreme cold environments present a unique set of additional technical, social and economic hurdles to overcome to realize a clean energy future.



## Enabling Science and Technology

### Microgrids

Microgrids are self-contained, community-scale electrical grids. In northern North America, microgrids are primarily diesel-powered but are increasingly integrating batteries and renewable energy including wind, solar, geothermal, biomass-based fuel and small-scale hydro. Northern microgrids represent a unique opportunity to field test numerous system components and configurations to identify optimal combinations of clean energies.

### Renewable energy integration

To reduce reliance on diesel generators in the north, the integration of renewable energies into existing microgrids is being pursued in the lab and on the ground. The shift away from diesel requires investment, not

only in clean energy technologies but in energy storage devices in order to mitigate the intermittency of clean energies and provide uninterrupted power flow.

### Sensors

Sensors are used across all areas of energy generation and storage. In the north, they can detect ice buildup on wind turbines, snow coverage on solar panels and the structural health of batteries. Extreme cold environments present a major challenge for the energy storage components of sensors and is an emerging area of research.

### Artificial Intelligence (AI)

AI is an enabling technology, capable of speeding up the transition to clean energy. AI can be used to coordinate the generation, storage, transmission

and use of energy across systems. It can also help to optimize grid operations, forecast the availability of renewable energies and smooth intermittency issues.

**“AI is not a silver bullet, and no technology can replace aggressive political and corporate commitments to reducing emissions.[...] Used well, AI will accelerate the energy transition while expanding access to energy services, encouraging innovation, and ensuring a safe, resilient, and affordable clean energy system.”**

Espen Mehlum, Dominique Hirschier, and Mark Caine, World Economic Forum. [This is how AI will accelerate the energy transition](#), Sept 1, 2021.

## Signals

### Academic



As of 2021, China is the leader in research and development (R&D) on energy generation and storage in cold climates, with almost double the scientific publications of the United States.

### Government



Governments worldwide have committed to reducing dependency on fossil fuel. According to the Intergovernmental Panel on Climate Change's Sixth Assessment Report current efforts will fall short, and immediate action is required if the world is to maintain the goal of 1.5°C temperature rise.

### Collaboration



International collaboration on clean energy R&D for the north is minimal. Within Canada, collaboration networks are mostly regional and often include energy utilities.

### Defence



The US Department of Defense is working on optimizing combinations of infrastructure and energy alternatives to minimize environmental impacts and reduce costs in northern military bases and communities.

### Corporate



Canadian energy utilities are working with universities to connect northern communities to the main electrical grid, integrate renewables, and investigate hybrid systems for off-grid power generation.

**“Modernizing electricity systems will involve expanding energy storage, updating infrastructure and deploying smart-grid technologies to improve the reliability and stability of existing grids and to allow more renewable power to be added.”**

Government of Canada. [Pan-Canadian Framework on Clean Growth and Climate Change](#), 2016.

## Impact



### Social

Indigenous communities are increasingly pursuing clean energy independence as a means of advancing self-governance and self-reliance.



### Policy

New business models and regulatory reform are needed to facilitate the integration of renewables generated by communities and independent power producers.



### Economic

Displacing diesel with cleaner energies can significantly lower the costs of greenhouses in the north while increasing food security.



### Environmental

According to Natural Resources Canada, remote and northern communities in Canada use nearly 100 million litres of diesel fuel annually for electricity generation. Replacing diesel with renewables could significantly lower emissions.



### Defence

Climate change is opening up access to the far north bringing safety and security challenges as Arctic and non-Arctic states express increasing interest in the region. The inevitable increase in military installations and surveillance technologies means novel cold tolerant energy generation and storage systems are more urgently needed.

**“There is tangible momentum across remote Indigenous communities in Canada shifting away from diesel reliance and toward clean and sustainable sources of energy, with dozens of projects in operation or development.”**

Connie Vitello, ReNew Canada. [The future of energy in remote communities](#), July 24, 2020.

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### Please provide feedback

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