

# ***Energy in the Canadian North:***

## ***Recent Advances and Remaining Knowledge Gaps and Research Opportunities***

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### **Abstract and Methodology**

This summary presents energy-related research gains, gaps and opportunities gathered by the Canadian Polar Commission in fulfillment of its mandate to monitor and communicate polar knowledge in Canada and around the world. It is focused on the Canadian North, comprising the Yukon, Northwest Territories, Nunavut, Nunavik, and Nunatsiavut, during the seven-year period beginning with the International Polar Year (IPY) in 2007. The following observations are organized under recent advances and knowledge gaps and research opportunities. They are based on semi-structured interviews with northern housing research experts and practitioners, which have been supplemented and validated with both peer-reviewed and 'grey' literature. Recent advances and knowledge gaps pertaining primarily to larger-scale oil and gas development are covered in the summary on economic development.

## Overview

- *Paths to a Renewable North: A Pan-Territorial Renewable Energy Inventory* provides an overview of electricity generation by source in megawatt hours (MW-h) for 2007 for the territories. In the Yukon, approximately 93% of electricity generation in MW-h is from hydro, 6% from diesel and the remainder from wind and solar; whereas in the NWT, approximately 43% is from diesel, 36% from hydro, 20% from natural gas, and the remainder from wind and solar (A Northern Vision, 2011a). The corresponding website for this renewable energy inventory provides an overview of sources of energy for heat generation in MW-h, which is current as of 2011. In the Yukon, approximately 65% of heat generation in MW-h is from heating oil, 18% from biomass, 13% from propane, and the remainder from electricity or residual heat. In the NWT, approximately 80% is from heating oil, 8% from biomass, 8% from natural gas, and the remainder from residual heat, propane, or electricity (A Northern Vision, 2011b). Nunavut depends on non-renewable fossil fuels for both electricity and heat generation, with an independent electricity generation and distribution system located in each community and no back-up grids (A Northern Vision, 2011a; Qulliq Energy Corporation, 2012). Both Nunavik and Nunatsiavut also rely on non-renewable fossil fuels (Kativik Regional Government & Makivik Corporation, 2010; Goldhar et al., 2012).
- Demand for energy is increasing as a result of increasing population and industrial development (Prowse et al., 2009).
- In many areas of the North, energy infrastructure is aging, and often operating at or beyond its expected life cycle (Yukon Energy Corporation, 2012c; Northwest Territories Power Corporation, 2012; Northern News Service, 2012). Environmental change is also having an impact on energy infrastructure, with instability in some areas as a result of thawing permafrost and increased extreme storm events that can result in high winds and forest fires that threaten grids. Uncertain hydrological conditions may also impact the capacity and operations of hydroelectricity projects (Prowse et al., 2009).
- The cost of imported energy has been increasing in the North (Funston, 2009). This contributes to a high cost of living and doing business. This is especially the case for many smaller and more isolated communities that are not connected to an electrical grid and rely on transported fossil fuels. With the high cost of energy and low population numbers spread across vast geography, energy efficiency and conservation is a key priority (Energy, Mines and Resources – Yukon Government, 2009; A Northern Vision, 2011a). Reliability of energy is also a priority in terms of current energy generation, and when considering potential alternative energy options (Kativik Regional Government & Makivik Corporation, 2010; A Northern Vision, 2011a; Goldhar et al., 2012). With isolated power grids there is no opportunity to sell surplus power or purchase additional power when there is a shortage, and thus self-sufficiency through energy storage and backup is important in terms of the integration of renewable energy (Yukon Energy Corporation, 2011). Southern-based energy models and research are, therefore, not as suited to the northern context. A more northern-based understanding of how to ensure the ongoing long-

term viability of energy security in these communities is needed (Kativik Regional Government & Makivik Corporation, 2010).

### **Recent Advances**

- Northern jurisdictions are examining options for increasing local/regional and renewable energy sources to displace imported oil, with more resources available for the required research and some development related work being undertaken, as well as some assessment of alternative energy options (Government of Nunavut, 2007; Industry, Tourism and Investment & Environment and Natural Resources – Government of the Northwest Territories, 2007; Energy, Mines and Resources – Yukon Government, 2009; Kativik Regional Government & Makivik Corporation, 2010; Qulliq Energy Corporation, 2011; Université Laval, 2012).
- *Paths to a Renewable North: A Pan-Territorial Renewable Energy Inventory* and the National Energy Board's Energy Facts sheet on *Energy Use in Canada's North* provide an overview of the state of renewable energy use in the territories with respect to hydroelectricity, solar electricity, solar heating, wind, biomass, geothermal, residual heat recovery, and ocean current and tidal energy, as well as policies and other initiatives that are underway to enhance use (A Northern Vision, 2011a; National Energy Board, 2011). Each of the territories also has an energy strategy. In the Yukon, the *Energy Strategy for Yukon* is in place (Energy, Mines and Resources – Yukon Government, 2009). As well, Yukon Energy Corporation released a Resource Plan that outlines generation and transmission priorities and options for a 20-year period from 2011 to 2030 (Yukon Energy Corporation, 2011). In Nunavut, *Ikummatiit: Government of Nunavut Energy Strategy* is in place (Government of Nunavut, 2007). In the NWT, *Energy for the Future: An Energy Plan for the Northwest Territories* is currently in place (Industry, Tourism and Investment & Environment and Natural Resources – Government of the Northwest Territories, 2007), along with its *Biomass Energy Strategy 2012-15* and *Solar Energy Strategy 2012-17* (Northwest Territories Climate Change, n.d.). The Northwest Territories Energy Action Plan was recently released, outlining a 3-year plan and long-term vision for energy in the NWT (Government of the Northwest Territories, 2013). The final report from the Energy Charrette that was held in 2012 documents stakeholder input that was provided to inform this upcoming NWT plan (Industry, Tourism and Investment – Government of the Northwest Territories, 2013).
- The Arctic Council's Sustainable Development Working Group's 2009 report *Arctic Energy* highlights previous cooperative energy-related initiatives that have been undertaken by the Arctic Council, as well as a number of emerging energy issues, and areas in which there is an opportunity for future Arctic Council collaboration, such as the development of an Arctic Renewable Energy Assessment to provide a comprehensive circumpolar look at the status of renewable energy and serve as a basis for a research agenda, and enhanced communication of information and ideas on alternative energy technologies in remote communities (Funston, 2009).
- The Final Report and Technical Proceedings for the *Arctic Energy Summit: The Arctic as an Emerging Energy Province* held in 2007 in Anchorage, Alaska highlights some of the progress that has been made with respect to energy related research and

technology. It also includes a focus on extractive energy development, rural and renewable power, and environmental, socioeconomic and sustainability impacts of energy projects (Institute of the North, 2010).

- Some energy complement technologies (e.g. wind-diesel) have been tested as a way to incorporate renewable energy by increasing reliability (National Energy Board, 2011).
- Collaborative work has been undertaken between Yukon College, Yukon Energy and smaller Yukon communities with respect to research and development, including the installation of monitoring stations to assess the impacts of climate change on hydrology and the assessment of the potential of using biomass for electricity generation (Yukon College, 2012a & b; Stantec, 2013).

### **Knowledge Gaps and Research Opportunities**

- In addition to providing an overview of the state of renewable energy use in the territories, *Paths to a Renewable North: A Pan-Territorial Renewable Energy Inventory* and the National Energy Board's Energy Facts sheet on *Energy Use in Canada's North* also outline some of the challenges that must be overcome before some of these potential energy solutions can be implemented or further expanded (A Northern Vision, 2011a; National Energy Board, 2011).
- Further innovation, testing, adaptation and marketing of renewable energy systems and technologies including energy complement technologies is needed to overcome impediments, reduce associated costs, and improve efficiency, reliability and viability in cold regions (Energy, Mines & Resources – Yukon Government, 2009; National Energy Board, 2011; Rodon & Schott, 2013).
- The implementation of more waste heat recovery projects has been identified as an opportunity in the NWT (North of 56, 2012).
- Continued adaptation and testing of cost-effective energy storage technologies for northern conditions is needed to overcome challenges with respect to resource availability (e.g. wind, sun) and promote reliance on alternative energy technologies (Rodon & Schott, 2013).
- Further monitoring and baseline data collection is needed to better understand, measure, and predict short and long-term impacts (including environmental, health, and socioeconomic impacts) of renewable energy resource projects (Université Laval, 2012).
- There is an opportunity for feasibility assessments that consider the full costs and benefits (e.g. financial, economic, social, and health), both current and projected, of linking communities and regions to more southern grids.
- Liquefied natural gas (LNG) has been identified as an energy option in both the Yukon and NWT (Yukon Energy Corporation, 2012a; Industry, Tourism and Investment – Government of the Northwest Territories, 2013). A workshop that included governments, industry, and communities was held in the Yukon in 2012 to examine LNG in terms of reliability, affordability and potential environmental and socioeconomic impacts of this resource, to inform Yukon Energy's resource options planning (Yukon Energy Corporation, 2012a), and some LNG power generation

projects have been initiated which are currently in the environmental assessment and permitting stage (Yukon Electrical Company, n.d.; Yukon Energy Corporation, 2013).

- There is a need to continue implementing pilot projects involving the adaptation, testing and marketing of energy efficiency and conservation programs and initiatives to reduce energy demand in areas such as housing, transportation, and government operations (Energy, Mines & Resources – Yukon Government, 2009; A Northern Vision, 2011a; Nunavut Housing Corporation, 2012).
- There is a need for further research regarding energy security in the different regions of the North, including an analysis of renewable energy policies, compared with other circumpolar jurisdictions. There is also an opportunity to examine energy research and development initiatives taking place in rural Alaska for lessons learned with respect to renewable energy technologies.
- There is a need for further community-level energy planning and engagement initiatives to better understand current and projected energy needs on a community level (e.g. types, quantity, and costs of energy used for electricity, heating, and transportation) in order to identify more sustainable energy options and inform long-term resource planning initiatives. For example, a partnership between the Kluane First Nation and the Yukon Research Centre resulted in the development of a Community Energy and Emissions Inventory in which a community-based approach to inventorying energy and greenhouse gas emissions was developed and implemented, community perspectives were explored, and alternative energy options and conservation measures were identified (Yukon Research Centre & Kluane First Nation, n.d.). There is also a potential opportunity to integrate community-level energy planning with land-use planning.
- There is a need for further research to examine the health and socioeconomic impacts of energy insecurity at the household and community level.

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