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Harnessing Geothermal for Energy Sovereignty and Food Security in Northern Canada

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ABSTRACT

In Canada, the Acho Dene Koe First Nation is leading a transformative geothermal project at Fort Liard, Northwest Territories, that addresses critical Food-Energy-Water (FEW) interdependencies in a remote community reliant on fossil fuels. Building on a successful first phase of subsurface assessment and community engagement, the project is now advancing toward drill targeting, environmental planning, and capacity-building to enable deep geothermal development. Potential geothermal end uses under evaluation, such as geothermal-heated greenhouses, will support several United Nations Sustainable Development Goals (SDGs), including affordable and clean energy (SDG 7), economic opportunity (SDG 8), and climate action (SDG 13). The integration of geothermal-heated agriculture presents a path to year-round food production, strengthening local food security and aligning with zero hunger (SDG 2). Clean energy alternatives will also reduce emissions and particulate matter from fossil fuel combustion and wood smoke, improving air quality and supporting good health and well-being (SDG 3), particularly for Elders and youth. By reducing reliance on imported fossil fuels, retaining energy revenues locally, and creating jobs in system operation, greenhouse management, and tourism, this Indigenous-led initiative fosters energy sovereignty and economic resilience. The project also strengthens local stewardship of land and water by eliminating risks associated with fuel transport and storage. This initiative demonstrates how community-driven geothermal development can deliver integrated sustainability outcomes that build environmental, economic, and health resilience in remote and Indigenous communities.

1 INTRODUCTION

Fort Liard, located in the Northwest Territories of Canada, is a remote off-grid community with high energy costs and a strong reliance on imported fossil fuels for heating and electricity. These dependencies, coupled with vulnerable transportation routes and extreme winter conditions, create ongoing challenges for energy and food security. In response, the Acho Dene Koe (ADK) First Nation is leading a geothermal development project that aims to reduce fossil fuel reliance, increase local food production, and enhance economic resilience. This paper provides an update on the project's progress, highlighting geothermal resource assessments, community engagement, and the integration of geothermal energy into food and energy systems. The initiative contributes to multiple United Nations Sustainable Development Goals (SDGs), particularly those related to clean energy, food security, health, economic development, and climate action.

2 PROJECT OVERVIEW AND OBJECTIVES

The ADK geothermal project builds on a completed Phase 1 desktop assessment of subsurface temperature and reservoir data, which identified the Mattson Formation as a promising geothermal target. Phase 2, currently underway, includes detailed reservoir modelling, well targeting, environmental and regulatory planning, and end-use feasibility studies. The project's primary goals are to displace fossil fuel use for heating, support the development of geothermal-heated greenhouses, and create new local employment opportunities. Ultimately, the project aims to reach shovel-ready status for deep geothermal drilling.

3 GEOTHERMAL RESOURCE ASSESSMENT AND MODELLING

Fort Liard is located in the north of the Western Canada Sedimentary Basin (WCSB), a large intracratonic basin that hosts extensive sedimentary successions, within an area of elevated regional heat flow. Previous regional geothermal studies have identified parts of the WCSB as having favourable thermal gradients for direct-use geothermal applications (Majorowicz and Grasby, 2021).

Geothermal exploration began in 2023 with the review of oil and gas well data near Fort Liard. Five key wells were selected for detailed analysis: I02, K02, K36, O80, and 2K02. These wells were evaluated using petrophysical

logs (gamma ray, spontaneous potential, resistivity, density, neutron porosity, and sonic), core analysis, DSTs, production data, and bottom-hole temperatures. Particular attention was given to the Mattson Formation sandstone, which showed favourable porosity, permeability, and thermal characteristics.

A total of 22 distinct sand zones (S1 to S22) were identified within the Mattson Formation, interbedded with shale and mixed lithology units. Petrological analysis revealed that the sandstones are generally fine- to medium-grained quartzarenites with intergranular silica cement (Hayes, 2013). Shale units were typically planar-laminated mudstones with minor bioturbation and rare pyrite. Porosity across the sand units averaged 11%, with permeability ranging from less than 1 mD to over 330 mD. The S11 sand unit emerged as the most promising, with high porosity, permeability, and continuous thickness across key wells.

A 3D geologic model of the Mattson Formation was constructed using Leapfrog Geo and imported into CMG STARS for dynamic reservoir simulation. Various well configurations and injection temperatures (15°C and 25°C) were simulated over 30+ year timeframes. Horizontal production wells targeting the S11 unit demonstrated the best performance, sustaining flow rates up to 3600 m^3/day and producing up to 3.98 MW_{th} of energy without the need for pumping. Vertical and hybrid configurations also yielded viable results for district heating and greenhouse integration.

4 INTEGRATION WITH COMMUNITY ENERGY AND FOOD SYSTEMS

Fort Liard's energy consumption is dominated by heating, transportation fuels, and diesel-generated electricity. Heating oil is the single largest energy source, accounting for 34% of total annual energy use, followed by gasoline (23%) and diesel for vehicles (10%). Electricity generation using diesel contributes approximately 25% of total energy use. Electricity is produced by a diesel generator that consumes around 564,000 litres of diesel per year at a cost of $1.6 million, producing approximately 21,700 GJ of electricity and emitting 1,500 tonnes of CO_2e (Arctic Energy Alliance, 2020). Due to generator inefficiencies, only 33% of the fuel's energy content is converted into electricity, while the remaining 66% becomes waste heat. Waste heat recovery contributes less than 1% of total energy use (Arctic Energy Alliance, 2020).

Homes account for 21% of community energy consumption, including 44% of all heating oil and 46% of all electricity, with firewood providing additional heat for many households. Institutional and commercial buildings consume another 20% of energy, including 56% of heating oil and 54% of electricity. Annual energy expenditures total roughly $3.65 million, or $6,700 per person, with none of the energy produced locally.

Food security is similarly constrained. Nearly all food is trucked in along a single highway, which is vulnerable to seasonal disruptions from wildfires, extreme cold, and flooding (Figure 1). High transportation costs result in elevated food prices, especially for perishable goods like fresh produce and eggs. For example, Fort Liard experiences a cost of food ~1.45 times greater than that of Yellowknife (Table 1), which is itself already ~1.28 times the national average (Statistics Canada, 2025). Additionally, community members report frequent winter stock-outs and limited dietary diversity.

Geothermal development directly addresses these vulnerabilities. District heating infrastructure can reduce household fuel demand and improve indoor air quality, while geothermal-heated greenhouses enable year-round food production. These systems offer greater supply stability, better nutrition, and economic savings over time.

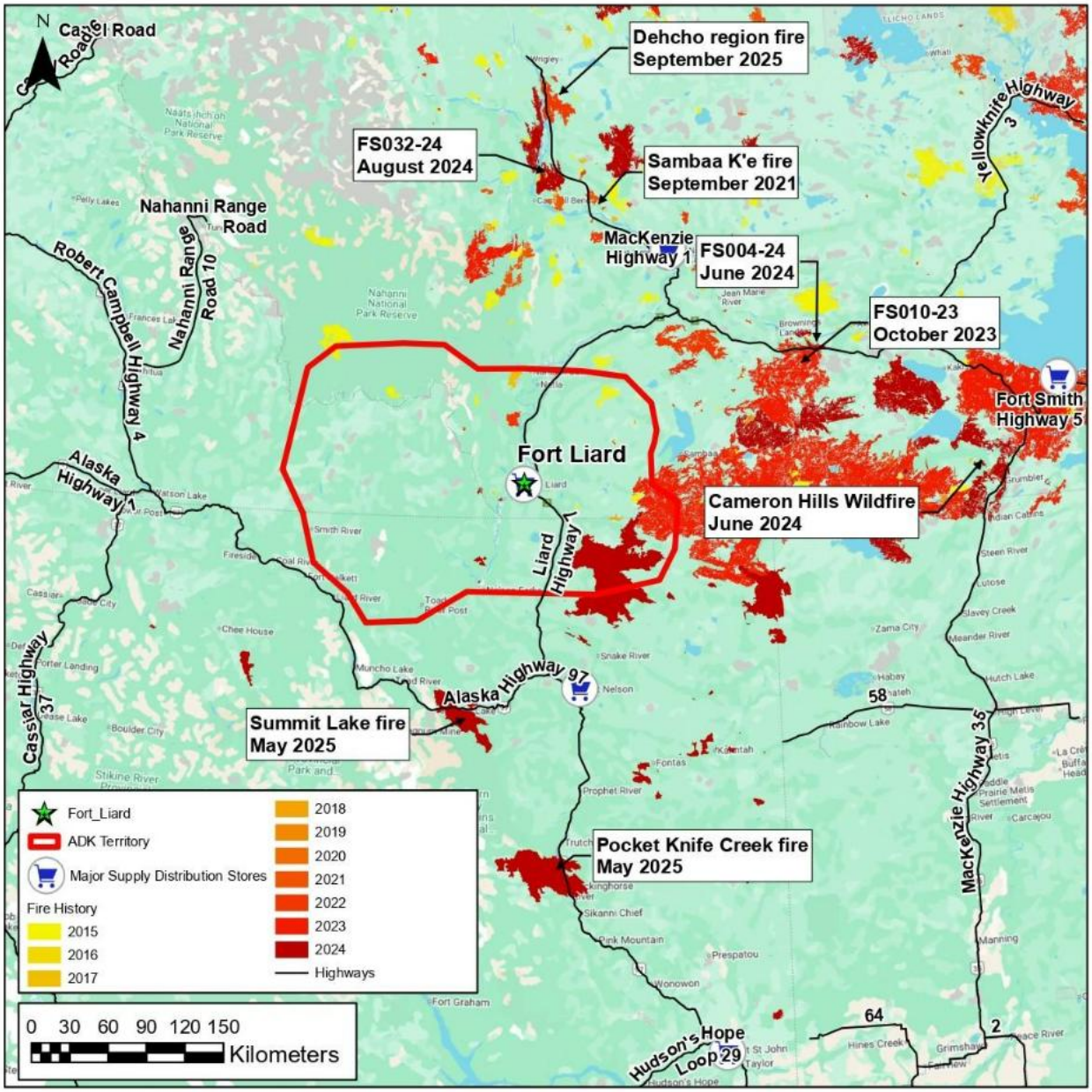


Figure 1. Map showing the location of Fort Liard relative to major food supply distribution centres, transportation routes, and historical wildfire activity (2015–2025). The figure highlights the vulnerability of supply chains into Fort Liard due to frequent wildfire disruptions along key access corridors.

Table 1. Northwest Territories Food Price Index by community in 2019, with Yellowknife set to 100. (NWT Bureau of Statistics, 2019).

Northwest Territories Food Price Index, by Community
2019 (Yellowknife = 100)

	2019		2019
Beaufort Delta			
Aklavik	162	Fort Simpson	148
Fort McPherson	163	Hay River Reserve	121
Inuvik	159	Nahanni Butte	169
Paulatuk	187	Sambaa K'e	170
Sachs Harbour	197		
Tsiigehtchic	182		
Tuktoyaktuk	158	South Slave	
Ulukhaktok	180	Fort Resolution	146
		Fort Smith	119
Sahtu		Hay River	126
Colville Lake	184	Lutselk'e	169
Deline	171		
Fort Good Hope	183	Tlicho	
Norman Wells	170	Behchoko	144
Tulita	174	Gameti	146
		Wekweeti	140
Dehcho		Whati	145
Fort Liard	145		
Fort Providence	130		

5 COMMUNITY ENGAGEMENT AND SOCIAL PRIORITIES

Community engagement has been central to the project. Engagement activities were co-developed with Acho Dene Koe First Nation to ensure two-way knowledge exchange and culturally grounded input. Activities included community roundtables, elders' lunches, youth-focused sessions at Echo Dene School, and household energy and end-use surveys (Figure 2). These efforts created space for residents to share concerns, ask questions, and influence project design.

In total, two structured surveys were conducted: the 2024 Community Energy Survey and the 2025 Geothermal End-Use Survey. The Community Energy Survey found that 93% of participants expressed interest in renewable energy projects, and energy affordability was the most frequently cited concern. Respondents reported high heating costs, cold drafts, aging furnaces, and dependence on firewood. When asked about alternative options, participants overwhelmingly supported geothermal development, seeking more reliable and affordable heating systems.

In the 2025 End-Use Survey, all respondents supported geothermal development, with 86% preferring community-wide district heating and 57% supporting greenhouse integration (Figure 3). Some participants also expressed interest in using geothermal heat for poultry operations or other agricultural uses. A small number of respondents raised general questions about long-term environmental impacts, indicating curiosity but no direct opposition.

Engagement events also served to build enthusiasm, with many residents asking when drilling would begin and how geothermal could support local jobs. This feedback has informed project design, technical priorities, and communication plans. The ADK Holdings entity ensures local ownership and long-term benefit retention, while capacity-building and training opportunities are being explored to prepare the community for geothermal operations.



Figure 2. Community engagement held in Fort Liard, August 2025.

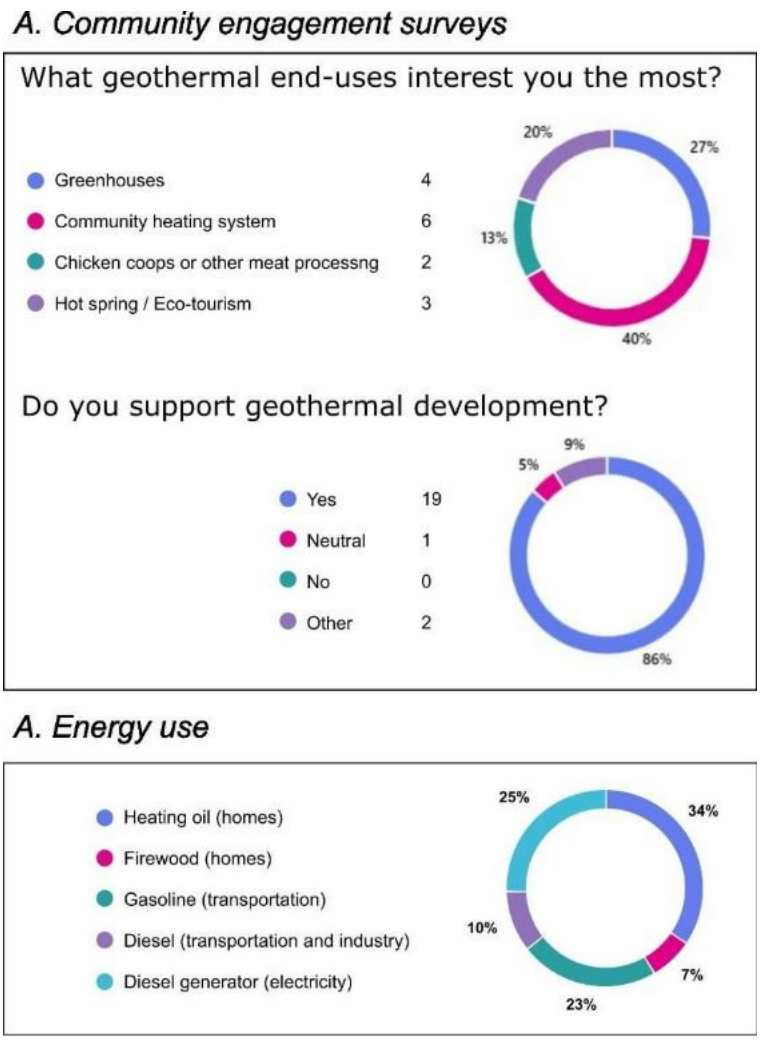


Figure 3. Energy sources used in Fort Liard in 2018, expressed as a percentage of total community energy consumption (Arctic Energy Alliance, 2020).

6 SUSTAINABLE DEVELOPMENT IMPACT

The project aligns with five key UN Sustainable Development Goals (Figure 4):

- **SDG 2 (Zero Hunger):** Local food production reduces reliance on imported goods.
- **SDG 3 (Good Health and Well-Being):** Improved air quality and nutrition.
- **SDG 7 (Affordable and Clean Energy):** Renewable heat displaces fossil fuels.
- **SDG 8 (Decent Work and Economic Growth):** New employment in energy and agriculture.
- **SDG 13 (Climate Action):** Emissions reductions and resilience to climate-driven disruptions.

By integrating geothermal energy into the food-energy-water nexus, the project strengthens environmental, economic, and health resilience in Fort Liard and provides a model for other remote Indigenous communities.



Figure 4. United Nations Sustainable Development Goals that are addressed with the ADK geothermal project (modified from United Nations, 2025).

7 NEXT STEPS AND IMPLEMENTATION TIMELINE

The project team is finalizing well design and preparing for permitting and funding submissions to support deep geothermal drilling. Key milestones for the next 12 months include:

- Completion of environmental and regulatory assessments
- Final well configuration and drilling schedule
- Feasibility and costing of district heating and greenhouse systems
- Community capacity-building and training sessions

The project is on track to enter a shovel-ready phase in 2026.

8 CONCLUSION

The Acho Dene Koe geothermal project demonstrates the technical and community-driven potential of geothermal energy to address multiple development challenges in remote northern Canada. With strong local leadership, clear technical feasibility, and broad community support, the initiative is positioned to deliver long-term benefits in energy sovereignty, food security, and climate resilience.

Acknowledgments

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