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Enhanced Energy Security

The strategic repurposing of orphan wells to diversify energy sources for remote Indigenous communities.

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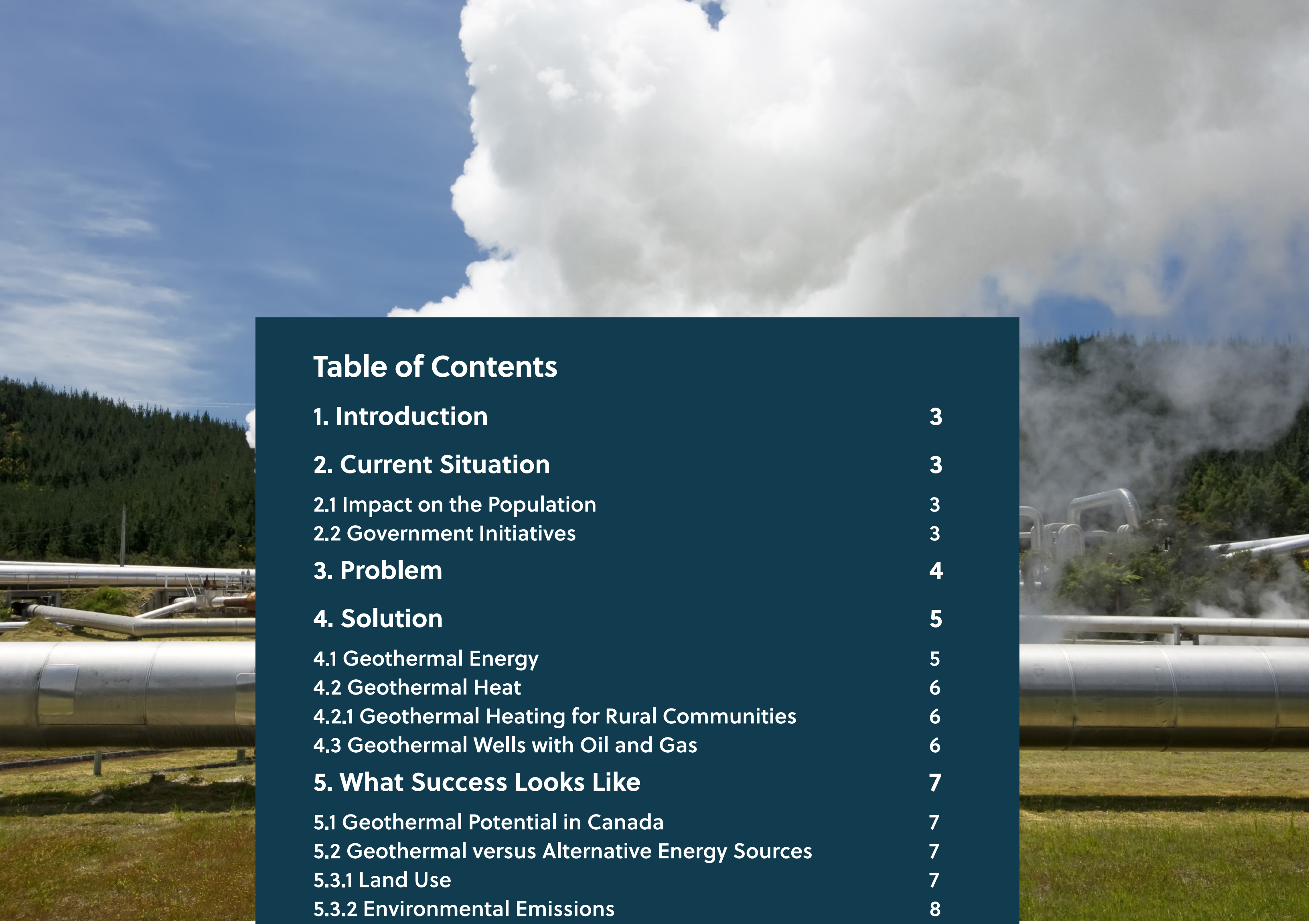

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1. Introduction

More than 185,000 people in remote Indigenous communities across Canada live without access to clean and reliable energy. At least 70 percent of these communities rely on diesel-powered generators. This comes at a high cost and can lead to black outs, health concerns, and environmental contamination. A lack of stable access to electricity is directly correlated to severe poverty and inadequate basic living conditions [1]. An increase in electrification is associated with improved quality of life, as well as improved social, economic, education, and health conditions [2].

2. Current Situation

The energy infrastructure currently serving Canadian northern and Indigenous communities is insufficient to meet their energy requirements. They are not connected to an electricity grid and are dependent on diesel generators for power. Diesel is delivered via planes, trains, or trucks at great expense to the community [2]. Remote communities consume more than 90 million litres of diesel fuel per year for electricity generation alone, not including diesel used for heating.

Despite the significant amount of diesel used, these diesel-reliant communities still suffer from blackouts and community standstills due to the inability to obtain fuel on a consistent basis [1]. According to international news organization Reuters and think tank Center International de Formation Européene, diesel power shortages in Indigenous communities can occur as often as once a week [3]. These power outages can last for days, which, in the middle of winter, can be deadly [4].

2.1 Impact on the Population

Energy security with diesel generators is subject to low dependability and high costs. Beyond being an unreliable power source, the supply chain of diesel energy in remote communities also is unpredictable. Transporting diesel to these communities is expensive and has become more challenging due to shorter winters, which causes the ice roads many communities depend on, to melt earlier. Even if there were access to a steady stream of fuel, the generators in Indigenous communities are old, leading to continuous downtimes and constant maintenance [5].

Other challenges faced by the population as a result of diesel usage and power shortages include health concerns, environmental considerations, and social challenges. Using diesel as an energy source can negatively affect air quality, leading to respiratory problems among community residents. Additionally, having an unreliable supply of power for sewage and water treatment facilities leads to other significant health and safety concerns [6]. Diesel fuel also negatively impacts the environment through carbon emissions and fuel spills, which can lead to soil and water contamination [7].

Power shortages have become prevalent in remote communities resulting in school closures, transportation issues, airport closures, and food spoilage [8]. In some communities, up to 20 percent of classroom time is lost due to power outages, delaying graduation for many students. Blackouts and load restrictions also limit housing and business development [9].

2.2 Government Initiatives

As a result of the impact of the COVID-19 pandemic on the energy sector, the Government of Canada has allocated $1.7 billion to support the cleanup of orphan wells in Alberta, Saskatchewan, and British Columbia. The available funding is split by province: up to $1 billion for the government of Alberta to clean up 4,700 orphan wells and 91,000 inactive wells; up to $400 million for the government of Saskatchewan to clean up 600 orphan wells and 36,000 inactive wells, and up to $120 million to the Government of British Columbia to clean up 350 orphan wells and 12,000 inactive wells. Additionally, the Alberta Orphan Wells Association (OWA) can receive up to $200 million to support cleanup efforts in Alberta, which is required to be fully repaid.

Funding will be prioritized to companies in good municipal tax standing, and allocation will be overseen by a federal and provincial committee, ensuring municipal and Indigenous engagement [10]. Eligible activities include remediation and environmental site assessments [11]. As a result of this funding, orphan wells and their negative environmental impact have been brought to the attention of Canadians across the country.

Additional government initiatives exist that promote clean energy and aim to reduce diesel dependence in Canadian indigenous communities include: the Indigenous Off-Diesel Initiative, Clean Energy for Rural and Remote Communities Program (CERRC), the Northern Responsible Energy Approach for Community Heat and Electricity and the Emerging Renewable Power Program (ERPP).

The Indigenous Off-Diesel Initiative is a $20-million Canadian government initiative to help remote Indigenous communities reduce their dependence on diesel [12]. Up to 15 Indigenous communities can be selected to receive up to $1.3 million in funding to develop their energy plan. The leading communities will receive up to $9 million to implement their clean energy project [12].

The CERRC is a $220 million fund created to support projects across Canada over six years to reduce diesel dependence in rural and remote communities. The Northern Responsible Energy Approach for Community Heat and Electricity (Northern REACHE) includes $53.5 million over 10 years for the development and production of renewable energy projects in northern communities to reduce diesel dependence. This fund is specific to Yukon, Northwest Territories, and Nunavut [13].

The Emerging Renewable Power Program (ERPP) provides $200 million to expand the portfolio of commercially viable renewable energy sources available to provinces and territories as they work to reduce greenhouse gas emissions from their electricity sectors. It is designed to address the issue that emerging renewable projects face higher risks, costs, and more regulatory issues than projects using established renewable energy sources. ERPP mitigates the risk of emerging renewable power projects through federal government funding, allowing emerging renewables to play a larger role in Canada's electricity supply mix.

The program will establish new industries in Canada by supporting renewable power technologies that are already established at the commercial level abroad but not yet in Canada, or demonstrated in Canada but not yet deployed at utility scale. The ERPP has already supported several geothermal projects, including $25.6 million in support to the DEEP Geothermal Project in Saskatchewan and $25.4 million for the Terrapin Geothermal Project in Alberta.

Indigenous communities are also eligible for the Capital Facilities and Maintenance (CFM) program within Aboriginal Affairs and Northern Development Canada (AANDC) is the main pillar of the government of Canada's effort to support community infrastructure for First Nations on reserve. More than $1 billion per year can be used to help in the electrification of communities.

The CFM program's funding is managed through regional five-year capital plans, which list specific projects the region plans to undertake, subject to the availability of funding. It is made up of projects identified by First Nations communities. INAC's National Capital Management Board and Regional Investment Management Boards oversee CFM program investments. Spending is prioritized to get the money where it is needed most to ensure health and safety concerns are addressed within available funding levels [15].

3. Problem

The majority of remote Indigenous communities are located away from a power grid, or have low population density, decreasing the feasibility of transmission projects connecting them to the grid [6]. Reducing reliance on diesel fuel by advancing clean energy is one way to address these and other issues facing remote communities. Despite several solutions being proposed over the past few years, the majority of remote communities still live on inefficient, unsustainable and unreliable diesel generators to fulfill all their power needs [1]. The proposed solutions from the government initiatives mentioned in the previous section include solar, hydro, and tidal energy sources.

However, there are several communities that do not have access to sufficient solar, hydro, or tidal resources. Many of these communities are located near orphaned oil wells with suitable characteristics for geothermal energy. By directing investment funds towards repurposing these oil wells, the environmental costs associated with an orphaned oil well would be reduced and electrification rates would increase, thereby improving the quality of life for citizens in these remote communities.

4. Solution

Canada's oil and gas industry is facing a crisis regarding the management and use of more than 155,000 orphaned or inactive oil wells [16]. The Alberta Energy Regulator estimates the total financial liability of cleanup measures for these orphaned wells is more than $260 billion [17].

A strategic initiative to reduce environmental impact, cleanup fees and lost investment associated with orphaned oil wells is to repurpose them into geothermal energy sources. Several orphaned oil wells in Canada have suitable characteristics for geothermal technologies. Most oil wells have a 5,000-meter-deep drilled hole; for geothermal wells, a depth of only 4,000 meters is required. The highest costs associated with geothermal energy are minimized by repurposing orphaned oil wells, including surveying, purchasing land and drilling costs. Additionally, pre-existing survey data can be leveraged to identify wells located in favorable geothermal hot spots in Canada. Repurposing these wells can create a renewable energy source for upwards of 30 years.

As many orphaned oil wells are in remote locations, there is an opportunity to use geothermal energy output to heat remote communities currently dependent on imported and unreliable energy sources.

4.1 Geothermal Energy

Geothermal energy uses heat from the earth to produce energy. This energy can be used to meet energy demands for large and complex power stations or even small and relatively simple pumping systems. Geothermal energy is used across the globe as a sustainable alternative to conventional energy sources to help minimize the reliance on fossil fuels [18]. In Alberta alone, there are an estimated 500 wells suitable for geothermal-electrical power generation [19].

In 2018, the global geothermal power generation capacity reached 14.6 gigawatts (GW). This is the equivalent of powering roughly 9.8 million mid-sized U.S. homes. Global geothermal power capacity is expected to reach 17 GW by the end of 2023 [18]. To date, the U.S. leads the world, with more than 3,800 megawatts (MW) of installed capacity.

Currently, the Canadian energy market has no commercial geothermal power capacity. Canada remains the only major country in the Pacific Rim not producing electricity from its geothermal resources on a large scale [21]. Colder temperatures enable geothermal plants to operate more efficiently and produce more power due to the large difference between the internal temperature and ambient air temperature. In June 2018, the BC Oil and Gas Commission issued a permit authorizing the construction of a geothermal energy project within the province, the first permit of its kind in the province and in Canada [22].

Since then, significant policies and contracts have been awarded opening the potential to create a new market for geothermal power plants in Canada.

4.2 Geothermal Heat

Geothermal energy is generated far below Earth's crust, in the layer of hot and molten rock called the mantle. Heat is continually produced in this layer from the decay of naturally radioactive materials within the mantle. There is a steady supply of milder heat, useful for direct heating purposes, at depths of anywhere from 10 metres to a few hundred meters below the surface in virtually any location on Earth. The ground below us has enough heat to control the climate of homes, warehouses and any other buildings in the community. In addition, there is a vast amount of heat energy available from dry rock formations deep below the surface (4-10 km). In Alberta alone, it is estimated there are more than 11,500 wells suitable for repurposing orphaned oil wells into a geothermal heat source [19].

4.2.1 Geothermal Heating for Rural Communities

In regions with temperature extremes, such as northern Canada, ground-source heat pumps are the most energy-efficient and environmentally clean heating and cooling systems available. Far more efficient than electric heating and cooling, these systems can circulate as much as three to five times the energy they use in the process. A heat pump can save a typical home hundreds of dollars in energy costs each year, with the system typically paying for itself in eight to 12 years [23].

In rural areas without access to natural gas pipelines, homes must use propane or electricity for heating and cooling. Heat pumps are less expensive to operate than these conventional systems, and since buildings are generally widely spread out, installing underground loops is often not an issue. Underground loops can be easily installed during construction of new buildings, resulting in savings for the life of the building.

4.3 Geothermal Wells with Oil and Gas

Low temperature geothermal energy is derived from geothermal fluid found in the ground at temperatures of 150ºC or less. These resources are typically utilized in direct-use applications, such as heating buildings, but can also be used to produce electricity through binary cycle geothermal processes. Oil and gas fields already under production represent a large potential source of this type of geothermal energy. In many existing oil and gas reservoirs, a significant amount of high-temperature water or suitable high-pressure conditions are present, which could allow for the co-production of geothermal electricity along with the extraction of oil and gas resources. In some cases, exploiting these geothermal resources could even enhance the extraction of the oil and gas.

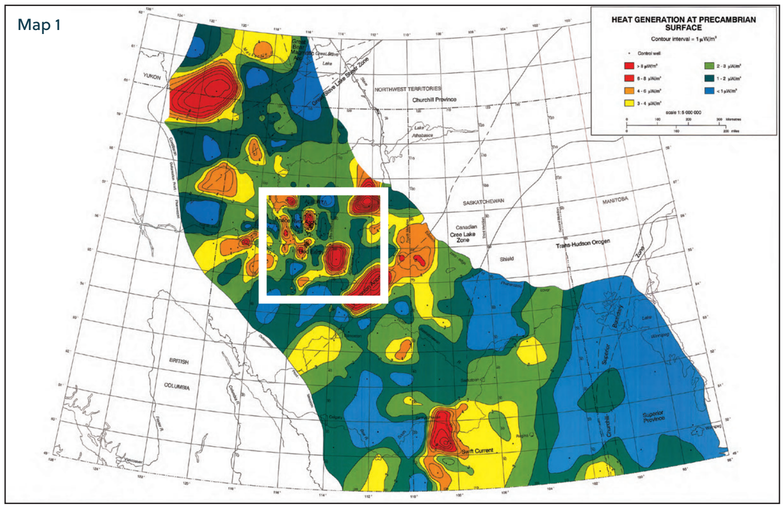
According to the United States Department of Energy, oil and gas wells in the U.S. produce an average of 25 billion barrels of hot water each year. This water, which has historically been viewed as an inconvenience to well operators, could be harnessed to produce up to three giga watts (GW) of clean, reliable baseload energy [24]. This energy could not only reduce greenhouse gas emissions, it could also increase profitability and extend the economic life of existing oil and gas field infrastructure. On August 1, 2019, a Calgary-based oil and gas company announced the development of a 21-megawatt (MW) hybrid geothermal and natural gas-fired power station, the first of its kind in Canada, proving it can be accomplished here.

5. What Success Looks Like

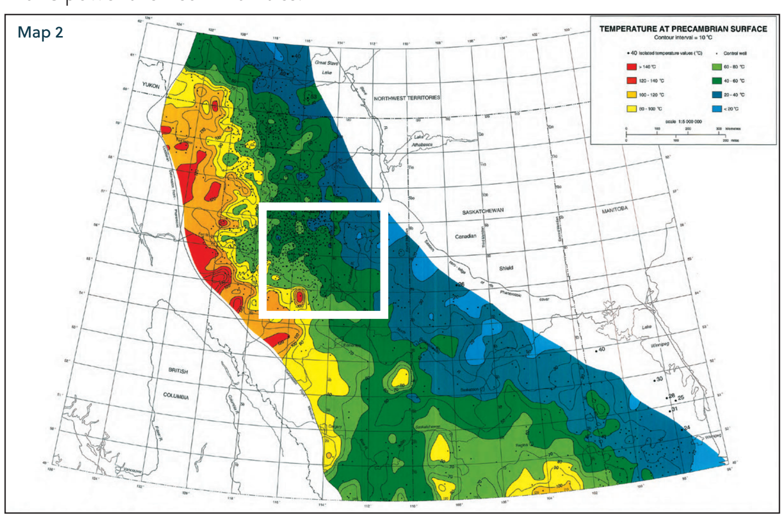
To successfully use geothermal energy to power or heat remote Indigenous communities, the main criteria to consider includes the geothermal potential and feasibility relative to alternative energy sources.

5.1 Geothermal Potential in Canada

The feasibility and success of geothermal energy production is dependent on location. The primary geothermal potential spots in Canada are in Alberta, Saskatchewan, and B.C. The figure below outlines the Heat Generation capacity at Precambrian Surface depths (~3.5km) along with orphan wells (black dots) located to these temperature gradients. The heat generation at these depths are demonstrated using a color scale below with red, orange, and yellow being the highest degree of heat generation.



The figure below illustrates the actual temperature reading at Precambrian surface. This map demonstrates that there is a plethora of wells in the area that have extensive geological data collected on them. Leveraging this data would allow nearby indigenous communities to begin exploring alternatives to diesel to heat and power their communities.



To further analyze the possibility of implementing this solution, Peace River was selected. It has high geothermal potential and there are multiple Indigenous communities that reside there, including Blueberry River First Nations, Doig River First Nation, Halfway River First Nation, Kwadacha Naiton, Saulteau First Nations, Tsay Keh Dene Band, and West Moberly First Nations. It was also identified that in the Peace River Arch Area, there is sufficient heating at less than 200m to supply space heating (~20 C) to buildings and sufficient temperatures at 3km to begin exploring the potential of a baseload energy plant (~120°C) [30].ecosystems.

Map 1 and Map 2:
S. Bachu, R.A. Burwash (1994): Geological history of the Peace River Arch; in Geological Atlas of the Western Canada Sedimentary Basin, Chapter 30 - Geothermal Regime in the Western Canada Sedimentarty Basin, URL https://ags.aer.ca/document/Atlas/chapter_30.pdf, [August 12, 2020].

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5.2 Geothermal versus Alternative Energy Sources

To compare geothermal energy with alternative energy sources, an evaluation matrix of diesel, natural gas, hydro, wind, solar and geothermal was used. To select the ideal energy source for a remote community, consistency and variation in energy production is required. Power must be supplied by constant and reliable sources of electricity. Geothermal energy is a consistent, renewable source of energy that is not dependent on external weather conditions to be produced. With the combination of both the size of the resource base and its consistency, geothermal can play an indispensable role in a cleaner, more sustainable power system.

5.3.1 Land Use

In terms of land use, the top three energy sources with the largest negative impact are coal, solar and hydro. Coal extraction causes significant contamination to the soil and requires a large surface area. For solar power, an increase in production requires an increased surface area. Hydropower can negatively impact rivers and downstream

5.3.2 Environmental Emissions

As outlined in the 2016 Paris Agreement on climate change, Canada pledged to reduce greenhouse gas emissions by 30 percent relative to 2005 levels. Prime Minister Justin Trudeau has stated Canada will achieve net zero carbon emissions by 2050 [26]. To achieve these goals and increase power production, it is crucial to consider the carbon emissions for each energy source. The table below outlines how much CO2 is produced for every kilowatt hour (kWH) of energy generated. Geothermal energy has one of the lowest levels of CO2 production per kWh out of the options analyzed.

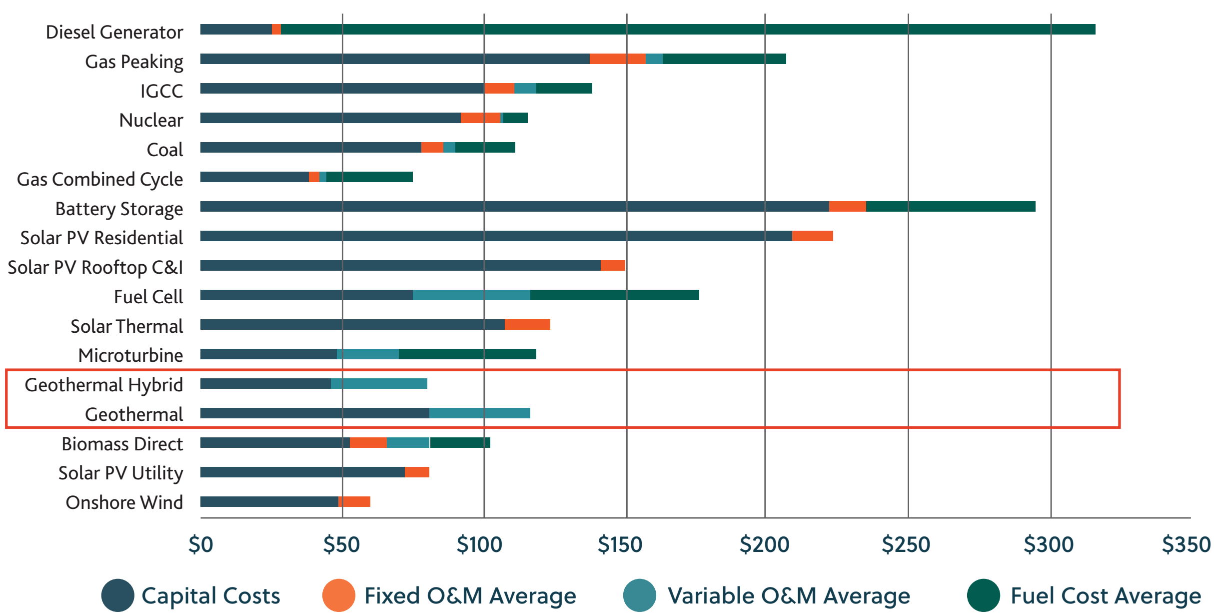
Analysis on how many tonnes of CO2 are produced per kWh [27]

Technology	Minimum CO2	Median CO2	Max CO2
Coal	740	820	910
Gas Combined Cycle	410	490	650
Biomass	130	230	420
Solar PV	18	48	180
Geothermal	6.0	38	79
Hydro	1.0	24	220
Wind	8.0	12	35

5.3.3 Costs

Geothermal projects are capital intensive and dependent on the location, but the operating costs are low and predictable. After the initial investment in the technology, associated costs for geothermal energy projects decrease [14].

The installed costs for geothermal plants include exploratory drilling, drilling of production and injection wells, geothermal fluid collection and disposal systems, as well as field infrastructure [28]. The levelized cost of energy (LCOE) for geothermal energy projects compared to other energy sources can be seen in the figure below.



From the figure above, geothermal and geothermal hybrid systems have a competitive LCOE when compared to other energy sources. In addition, these systems also are able to provide 24-hour consistent baseload energy with no carbon emissions. When comparing geothermal hybrid to geothermal, leveraging pre-drilled holes, surveyed land, transportation routes developed to reach the wells and locations significantly reduces the LCOE of traditional geothermal wells by approximately 40 percent. This is achieved by using the pre-existing survey data and infrastructure to reduce the overall capital costs of building a geothermal system.

The three lowest levelized costs of energy are:

1) Onshore Wind: approximately $60/MWh

2) Gas Combined Cycle: approximately $75/MWh

3) Hybrid Geothermal: $80/MWh

The savings are further bolstered due to federal grants and subsidies to produce green energy alternatives and to provide reconciliation funding for indigenous communities.

6.0 Next Steps

The need to derive alternate energy solutions for remote Indigenous communities in Canada is evident. Currently, Indigenous communities are facing high costs, environmentally destructive fuel, and inconsistent energy sources. If these issues are not addressed, Indigenous communities will continue to suffer from health problems due to environmental pollution, as well as energy blackouts that prevent business and schools from functioning. These communities could face a state of economic stagnation.

Diversifying the energy supply in these communities provides the opportunity to set them on a new direction. Leveraging a geothermal energy source could provide a source of heat, create jobs, develop sustainable energy sources, and improve the environmental impact for the surrounding communities. Repurposing existing oil and gas wells to be a geothermal energy source would also reduce the associated costs for cleaning and maintaining inactive or orphaned oil and gas wells.

6.1 How MNP Can Help

MNP can act as an industry expert and mediator between Indigenous communities, the federal government and the oil and gas industry. MNP has deep connections in each of these given groups, with multiple industry experts, partners, specialists and employees focused on working with them.

6.1.1 MNP and the Oil and Gas Sector

The MNP Oil and Gas team is a leading supplier of financial, consulting and management services to the oilfields services industry and has regional offices in all major production areas of Western Canadian Sedimentary Basin. With a leading team of professionals in your area, we offer hands-on oilfield management and operational expertise, along with knowledge of where the oilfields services industry has been and where it is going.

Committed to this industry, we service a broad base of clients operating in highly specialized sectors. MNP has divided the oilfield services industry into the following main segments in order to help support companies:

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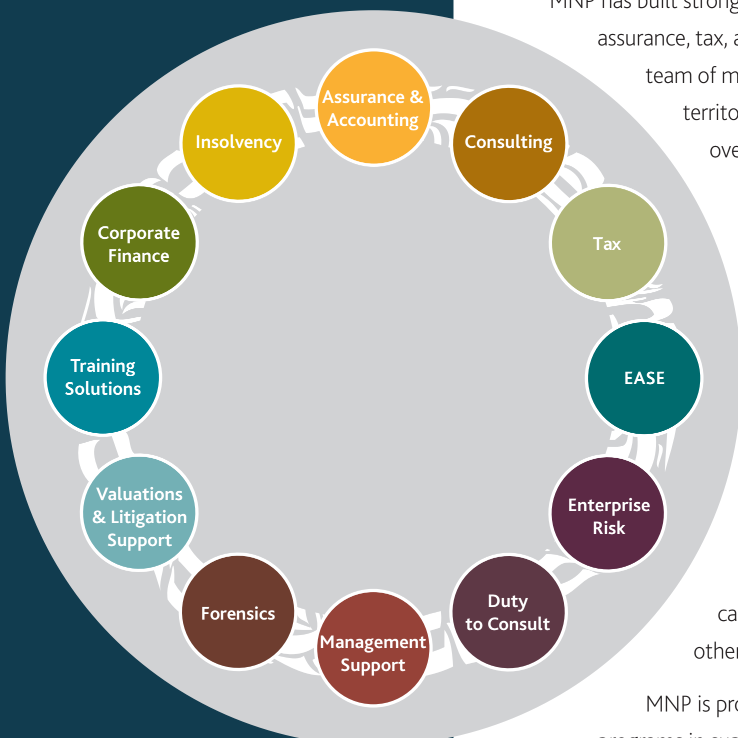
Beyond MNP's extensive experience in tax, assurance and accounting, we offer oilfield consulting services. The oilfield services industry is constantly in flux and is currently under significant pressure to become more environmentally friendly while maintaining international competitiveness. MNP offers services to optimize oil and gas industries operations, organizational structure and finances to achieve sustainable performance. This is why we suggest leveraging pre-existing data to provide heating and energy from abandoned oil and gas wells. It will help the industry meet its required goal, as set out by the federal government, to be carbon neutral by 2030.

6.1.2 MNP and Indigenous Communities

MNP has a strong commitment to Indigenous Nations in Canada. Working in partnership with Indigenous communities, organizations, businesses and individuals, MNP has built strong relationships and has become Canada's leader in providing assurance, tax, accounting and advisory services to them. We have a dedicated team of more than 80 people working with Nations in every province and territory, representing more than 250 Indigenous communities and over 800 clients.



For more than 30 years, MNP has been providing services to Indigenous communities, developing a diverse suite of services designed to help preserve our clients' traditions and position them for success. We understand what will work – and what will not – in Indigenous communities because we have the depth of experience operating at the grassroots. We're familiar with the reporting requirements as mandated by various regulatory environments and we have significant hands-on knowledge working with circumstances unique to you. These include economic development entities, taxation, assurance, trusts, settlements and claims, resource development, capacity building, capital projects, procurement, and a host of other components essential to Indigenous communities.

MNP is proud to be involved with a range of organizations, events and programs in support of this dynamic sector. Some of the initiatives we are involved with include:

- Aboriginal Financial Officers Association (AFOA)
- Assembly of First Nations
- Council for Advancement of Native Development Officers (CANDO)
- Canadian Aboriginal Mining Association
- Canadian Council for Aboriginal Business (CCAB)
- First Nations Health Managers Association
- National Aboriginal Achievement Foundation (NAAF)
- National Aboriginal Capital Corporation Association (NACCA)
- National Aboriginal Trust Officers Association (NATAO)

With these connections and commitment, MNP can readily advise and support Indigenous communities.

6.1.3 Working Together

Through our deep relationships in the oil and gas industry and with Indigenous communities, we can help efficiently facilitate the implementation of geothermal power into abandoned oil and gas wells. With years of experience helping the oil and gas industry locate, identify, analyze, execute and sustain profitable and operationally efficient oil plants we can use these experiences into geothermal energy projects. Our longstanding relationships with the Indigenous communities can help us facilitate the operational development of oil and gas wells into geothermal energy plants between the indigenous community and the oil and gas sector. Our experience in tax compliance, grant application and subsidies can be leveraged to help both groups obtain government funding to finance developing more sustainable energy sources.

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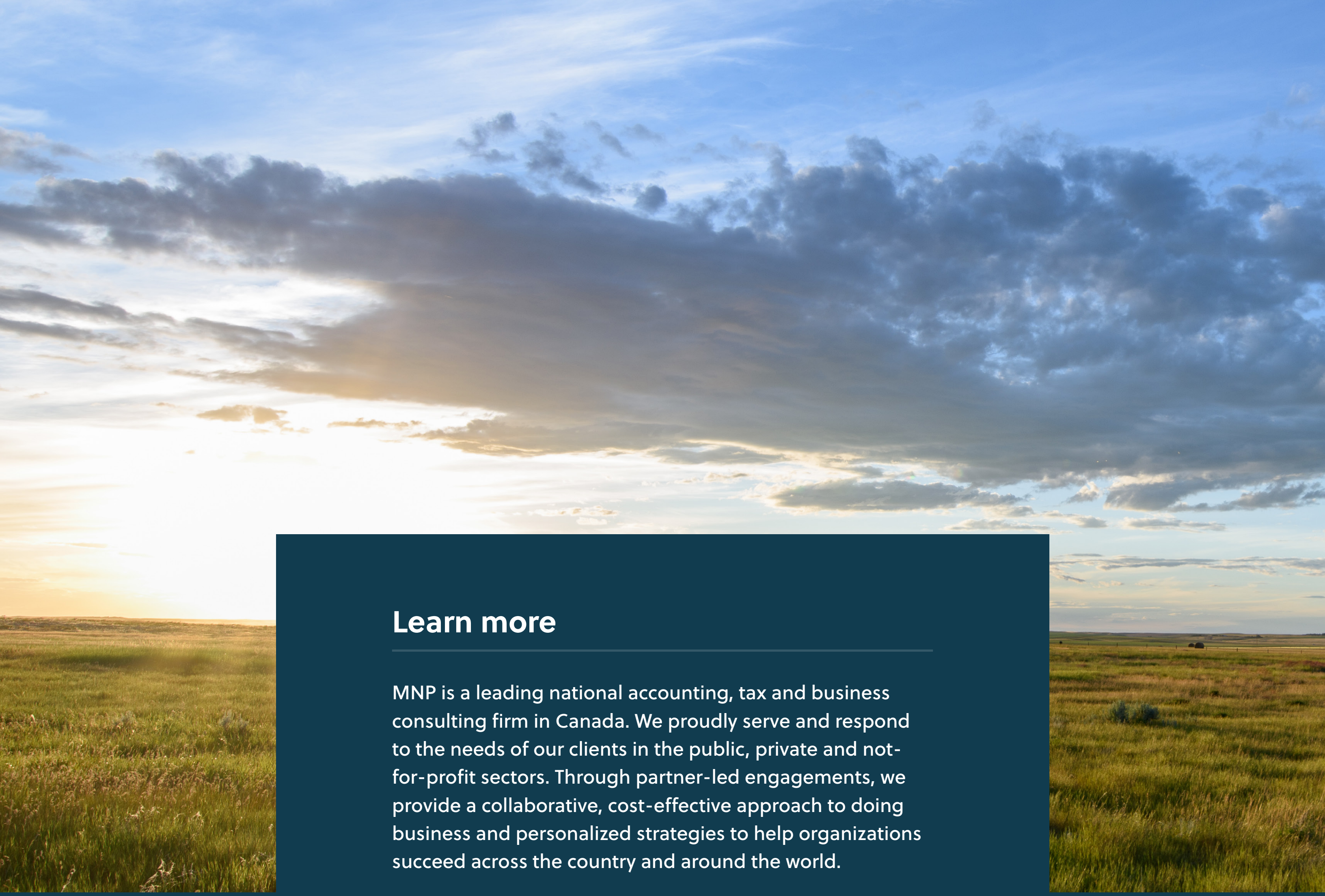

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