CHIEFS OF ONTARIO

FIRST NATIONS ENERGY TOOLKIT

Toolkit 1: Foundational energy knowledge for First Nations in Ontario

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Toolkit 1: Foundational energy knowledge for First Nations in Ontario

Toolkit 1 is designed to equip First Nations in Ontario with the foundational knowledge they need to understand, navigate, and engage with energy systems. Its primary goals are to:

- Empower First Nations communities to make informed decisions about energy policies, systems, and opportunities.
- Build awareness of how energy systems function and their direct and indirect impacts on First Nations and their respective territories.
- Support leaders in planning for energy sovereignty, ensuring affordability, and fostering long-term sustainability.
- Provide a steppingstone for communities embarking on energy planning, serving as a gateway to more advanced tools and actions introduced in subsequent toolkits.

This toolkit honors the importance of First Nations knowledge and cultural practices in shaping sustainable energy futures while supporting communities in asserting greater control over their energy systems and decisions.

This is the first in a three-part series addressing the diverse and evolving energy needs of First Nations communities:

- **Toolkit 2** explores practical energy planning, financing options, and renewable energy development.
- **Toolkit 3** highlights case studies, best practices, and strategies for long-term energy sovereignty and project implementation.

Together, the toolkit series forms a comprehensive guide for First Nations communities as they navigate the energy transition, assert control over their energy futures, and align energy development with their rights to land, self-determination, and sustainability.

We invite First Nations communities to use this toolkit as a foundation for building a sustainable energy vision, engaging with stakeholders, and taking meaningful steps toward energy sovereignty.

How to use this toolkit

Toolkit 1 is designed to be a practical, user-friendly guide for community leaders, citizens, and decision-makers. It provides actionable insights to help First Nations communities begin their journey toward energy sovereignty. To get the most value from this toolkit:

1. **Start with the Basics:** Review foundational concepts in energy systems and policies (Section 2) to gain a solid understanding of how energy systems work and their role in your community.
2. **Understand Your Local Context:** Reflect on your community's unique energy landscape, including current challenges, needs, and opportunities (Section 3).
3. **Learn About Policy and Rights:** Explore federal and provincial energy policies, regulations, and agreements, and learn how they impact your community (Section 4).

4. **Engage Your Community:** Use this toolkit as a conversation starter with community members citizen to discuss energy goals, challenges, and priorities, and gather input on collective energy planning.
5. **Build Toward Future Initiatives:** Treat this toolkit as the foundation for more advanced energy planning.
    - Toolkit 2: *Energy Planning and Clean Energy Practical Applications* focuses on project financing, renewable energy development, and practical implementation.
    - Toolkit 3: *Case Studies, Best Practices, and Long-Term Planning* provides real-world examples, strategies, and guidance for developing and implementing sustainable energy systems.

Each section of this toolkit builds on the last, creating a cohesive learning experience to help communities develop a strong foundation for energy planning. By connecting the lessons learned in Toolkit 1 with the more advanced resources in Toolkit 2 and Toolkit 3, communities will be better prepared to achieve energy sovereignty and sustainability.

1. Understanding energy systems

Developing a comprehensive understanding of energy systems is crucial for First Nations communities in Ontario as they navigate toward energy sovereignty. This section provides foundational knowledge on energy concepts, an overview of Ontario's energy infrastructure, the roles of key agencies, and the significance of energy independence.

1.1 Basics of energy and electricity

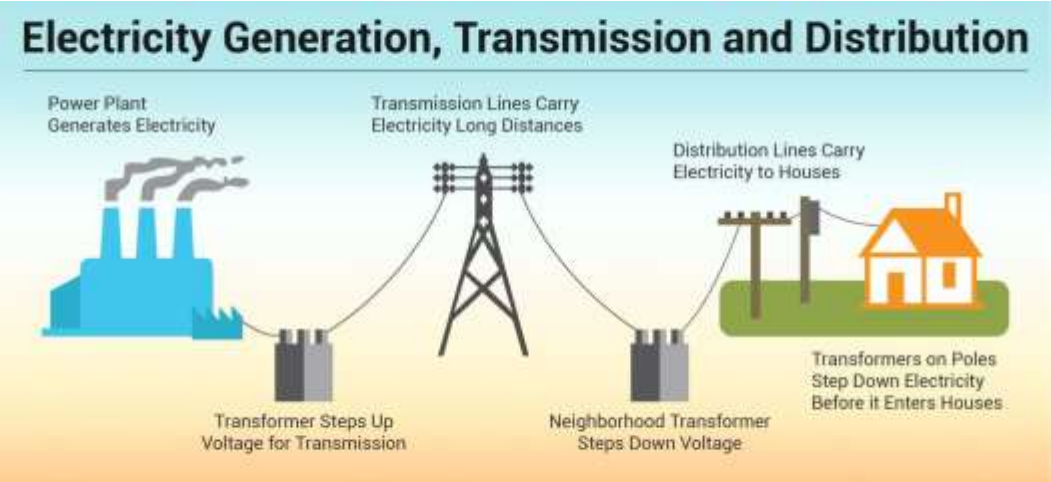
What is Energy? Definitions and key concepts

Energy is the capacity to perform work, enabling activities such as heating, transportation, and powering devices. It manifests in various forms, including thermal (heat), mechanical, chemical, and electrical energy. Understanding these forms is essential for effective energy planning and utilization.

For First Nations communities, energy is deeply connected to the land and customary ways of life. Recognizing the different types of energy and their applications supports informed decisions about energy use and development, aligning with cultural values and promoting sustainability.

Electricity: How It Is produced and delivered

Electricity is a secondary energy source produced by converting primary sources such as natural gas, nuclear, hydro, wind, and solar energy. In Ontario, the electricity generation mix includes a diverse range of sources, enhancing the province's energy reliability[1]. Once generated, electricity is transmitted through high-voltage power lines managed by Hydro One, which operates approximately 98% of Ontario's transmission capacity[2]. This network delivers electricity to local distribution companies (LDCs) that distribute power to consumers via local networks[3].



[1] Independent Electricity System Operator (IESO). (2024). *Supply mix and generation.* Retrieved from https://www.ieso.ca/Learn/Ontario-Electricity-Grid/Supply-Mix-and-Generation
[2] Hydro One. (2024). *Transmission services.* Retrieved from https://www.hydroone.com/about
[3] Burlington Hydro. (2024). *Ontario's electricity system.* Retrieved from https://www.burlingtonhydro.com/works/electricity-landscape/ontario-electricity-system.html

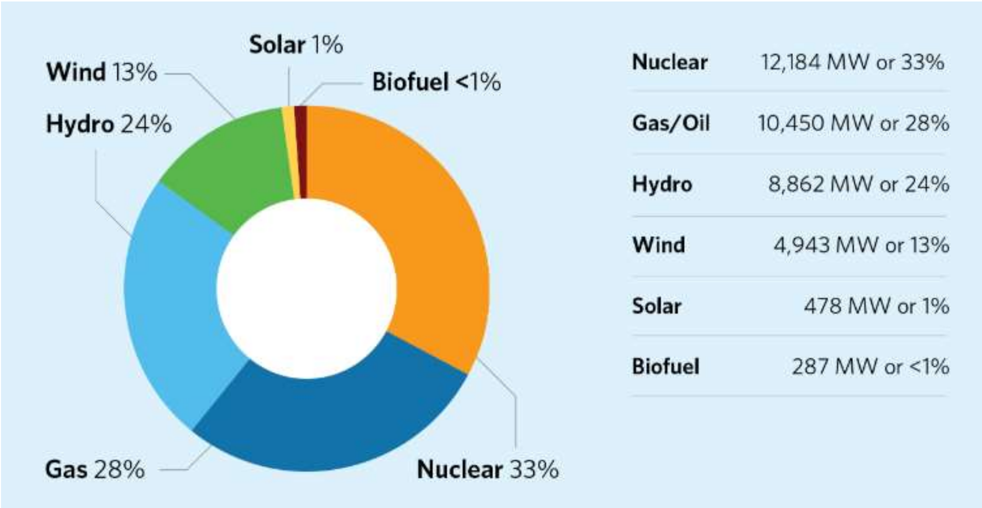
1.2 Overview of Ontario's energy system

Ontario's electricity system operates in three key stages: **generation, transmission, and distribution.** It integrates centralized and decentralized components to balance supply and demand, ensuring reliability, sustainability, and affordability.

i) Generation

Based on the latest data from the Independent Electricity System Operator (IESO), the **Transmission-Connected Capacity as of December 19, 2024**, for Ontario's electricity generation mix is as follows[4]:

- **Nuclear energy:** Approximately 53% of Ontario's electricity was generated from nuclear power plants.
- **Hydroelectric power:** Hydroelectric facilities contributed about 24% to the province's electricity generation.
- **Natural gas:** Natural gas-fired power plants accounted for approximately 13% of the electricity produced.
- **Wind energy:** Wind power contributed around 9% to Ontario's electricity generation.
- **Solar energy:** Solar power made up about 1% of the province's electricity generation.
- **Biofuel:** Biofuel sources contributed less than 1% to the overall electricity generation.



ii) Transmission

Electricity transmission in Ontario involves the high-voltage transportation of electricity from generating stations to local distribution networks. The transmission network ensures the efficient and

[4] Independent Electricity System Operator (IESO). (2024). *Supply Mix and Generation*. Retrieved from https://www.ieso.ca/Learn/Ontario-Electricity-Grid/Supply-Mix-and-Generation

reliable movement of electricity across long distances and is a critical component of the province's energy infrastructure. Key aspects include:

- **Transmission network management:** Hydro One, Ontario's largest electricity transmission provider, owns and operates approximately 97% of the province's transmission infrastructure, covering nearly 30,000 kilometers of high-voltage transmission lines. It plays a pivotal role in delivering electricity to local utilities and industrial customers across the province[5].
- **Grid reliability and operations:** The Independent Electricity System Operator (IESO) oversees the operation of Ontario's electricity grid, balancing supply and demand in real time to maintain system stability and reliability. The IESO coordinates with generators, transmitters, and local distributors to ensure grid resilience[6].
- **Interconnections with other jurisdictions:** Ontario's transmission system is interconnected with neighboring provinces (Quebec and Manitoba) and U.S. states (New York, Michigan, and Minnesota). These interconnections allow for electricity imports and exports, enhancing grid flexibility and stabilizing supply during peak demand periods or generation shortfalls[7].
- **Renewable energy integration:** The transmission network has been adapted to accommodate a growing share of renewable energy sources, such as wind and solar power, through upgrades and investments in smart grid technology and grid-scale storage solutions[8].

iii) Distribution

Electricity distribution is the final stage of delivering power from the high-voltage transmission network to homes, businesses, and industries through local utilities known as **Local Distribution Companies (LDCs).** Key elements of Ontario's electricity distribution system include:

- **Local Distribution Companies (LDCs):** Ontario has over **60 LDCs**, responsible for delivering electricity to end-users in urban, suburban, and rural areas. Some of the largest LDCs include Toronto Hydro, Alectra Utilities, and Hydro One Networks, which collectively serve millions of customers across the province[9].
- **Service to rural and remote areas:** Hydro One Remote Communities Inc. provides electricity to 24 isolated communities that are not connected to Ontario's main grid, using a combination of diesel generation and emerging renewable energy solutions such as microgrids[10].
- **Decentralized energy systems:** Ontario is witnessing a rise in decentralized energy solutions, including solar microgrids and community energy projects. These systems help reduce reliance

[5] Hydro One. (2024). *Transmission System Overview.* Retrieved from https://www.hydroone.com/about/transmission
[6] Independent Electricity System Operator (IESO). (2024). *Ontario's Electricity Grid.* Retrieved from https://www.ieso.ca/Learn/Ontario-Electricity-Grid
[7] Independent Electricity System Operator (IESO). (2024). *Ontario's Electricity Grid.* Retrieved from https://www.ieso.ca/Learn/Ontario-Electricity-Grid
[8] Independent Electricity System Operator (IESO). (2024). *Ontario's Electricity Grid.* Retrieved from https://www.ieso.ca/Learn/Ontario-Electricity-Grid
[9] Ontario Energy Board (OEB). (2024). *Local Distribution Companies in Ontario.* Retrieved from https://www.oeb.ca/ontarios-energy-sector/distributors
[10] Hydro One Remote Communities. (2024). *Remote Community Services.* Retrieved from https://www.hydroneremotes.ca

on centralized generation, lower costs, and enhance local resilience, particularly in off-grid areas[11].

- **Smart grid and modernization efforts:** The distribution sector is undergoing significant modernization efforts, with investments in smart meters, grid automation, and demand response programs aimed at improving energy efficiency and customer engagement[12].

1.3 The Role of governments and key agencies in Ontario's energy sector

Ontario's energy sector is governed by multiple levels of government and regulatory agencies, each with distinct responsibilities. Understanding these roles is crucial for communities seeking to engage with the energy system and advocate for their interests effectively.

Roles of Federal, Provincial, and First Nations Governments

Energy governance in Ontario involves collaboration between the federal and provincial governments, alongside the active participation of First Nations governments.

FEDERAL GOVERNMENT

The federal government oversees national energy policy, environmental regulations, and infrastructure funding[13], including:

- Regulating major energy projects under the Impact Assessment Act (IAA) and environmental standards.
- Supporting Indigenous participation through initiatives like the Indigenous Services Canada's Clean Energy for Rural and Remote Communities Program.
- Enforcing climate commitments such as Canada's net-zero emissions goals and the Clean Electricity Regulations (CER).

PROVINCIAL GOVERNMENT

The Ontario Ministry of Energy develops and implements policies that ensure the province's electricity system remains affordable, reliable, and sustainable[14], including:

- Overseeing energy planning and conservation programs and encouraging clean energy development and Indigenous participation.
- Setting regulatory frameworks in collaboration with agencies like the Ontario Energy Board (OEB) and Independent Electricity System Operator (IESO).

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[11] Independent Electricity System Operator (IESO). (2024). *Ontario's Electricity Grid.* Retrieved from https://www.ieso.ca/Learn/Ontario-Electricity-Grid

[12] Ontario Energy Board (OEB). (2024). *Local Distribution Companies in Ontario.* Retrieved from https://www.oeb.ca/ontarios-energy-sector/distributors

[13] Government of Canada. (2024). *2030 Emissions Reduction Plan – Canada's Next Steps for Clean Air and a Strong Economy.* Retrieved from https://www.canada.ca/en/environment-climate-change/news/2022/03/2030-emissions-reduction-plan--canadas-next-steps-for-clean-air-and-a-strong-economy.html

[14] Ontario Ministry of Energy. (2024). *Ministry of Energy Overview.* Retrieved from https://www.ontario.ca/page/ministry-energy

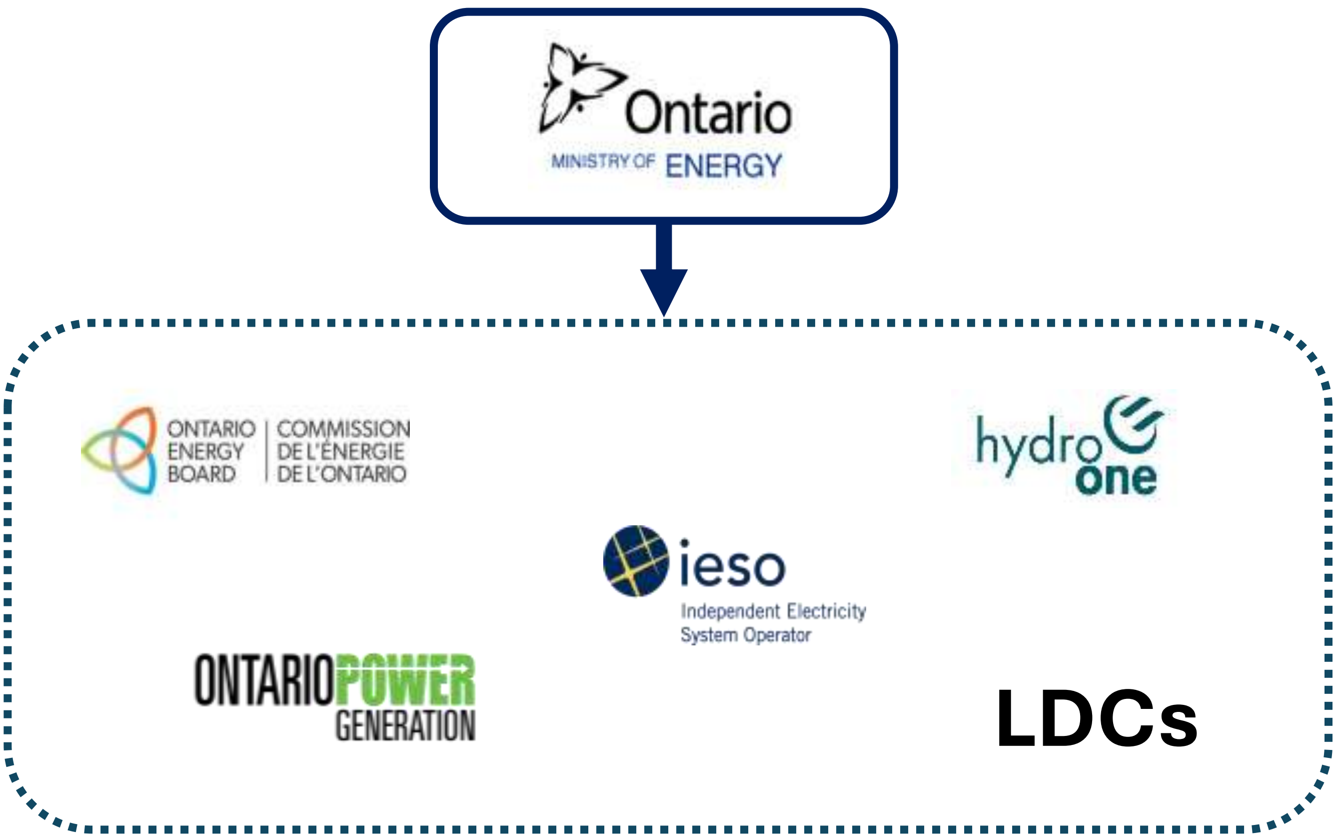
FIRST NATIONS GOVERNMENTS

First Nations governments are increasingly asserting their role in energy planning and development, working toward energy sovereignty[15], including:

- Participating in consultation and negotiations for energy projects under Free, Prior, and Informed Consent (FPIC).
- Leading community-driven renewable energy initiatives.
- Developing and supplying energy independently or through strategic partnerships, ensuring greater control over energy production and distribution.
- Collaborating with federal and provincial programs to secure funding and technical support.

Key regulatory and operational agencies

Once the roles of governments are understood, it is important to explore the key agencies responsible for managing Ontario's energy infrastructure and policies:



[15] Assembly of First Nations. (2024). *Energy Sovereignty and First Nations Participation.* Retrieved from https://www.afn.ca

Ministry of Energy (MENER)

The Ontario Ministry of Energy (MENER) is responsible for setting the province's energy policy, overseeing electricity sector operations, and issuing directives that guide energy generation, transmission, conservation, and Indigenous participation[16].

MENER's Long-Term Energy Plan (LTEP) outlines the government's priorities, including energy conservation, the transition to renewable energy, and strengthening partnerships with Indigenous communities to enhance participation in energy projects. The ministry works closely with agencies like the Independent Electricity System Operator (IESO) and Hydro One to ensure First Nations communities are considered in energy planning and benefit from funding and technical support programs.

Independent Electricity System Operator (IESO)

The Independent Electricity System Operator (IESO) is responsible for ensuring a stable and cost-effective electricity supply across Ontario. The IESO manages the provincial electricity market, procures energy through long-term contracts, and administers programs that support Indigenous engagement in energy initiatives[17]. Key responsibilities include:

- Operating Ontario's electricity grid in real-time to balance supply and demand.
- Administering programs such as the Indigenous Energy Support Program (IESP) to provide funding and capacity-building for First Nations.
- Supporting the transition from diesel to renewable energy sources in remote communities.

Ontario Energy Board (OEB)

The Ontario Energy Board (OEB) is the regulatory authority overseeing the province's electricity and natural gas sectors. The OEB's mandate is to protect consumers by setting fair rates, ensuring service reliability, and overseeing infrastructure planning[18]. The board also ensures that Indigenous communities are consulted in energy planning processes that may affect their lands and resources.

Key functions of the OEB include:

- Licensing electricity retailers, distributors, and generators.
- Setting rates and approving energy projects, including transmission and distribution lines.
- Providing guidelines for Indigenous consultation requirements in energy project approvals.

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[16] Government of Ontario. (2024). *Ministry of Energy.* Retrieved from https://www.ontario.ca/page/ministry-energy
[17] Independent Electricity System Operator (IESO). (2024). *Ontario's Electricity Market.* Retrieved from https://www.ieso.ca
[18] Ontario Energy Board. (2024). *Energy Regulation in Ontario.* Retrieved from https://www.oeb.ca

Ontario Power Generation (OPG)

Ontario Power Generation (OPG) is a Crown corporation that generates approximately 50% of Ontario's electricity[19]. OPG's generation portfolio includes:

- Nuclear power plants, such as Darlington and Pickering, which provide baseload electricity.
- Hydroelectric stations, including partnerships with First Nations, such as the Lower Mattagami River Project.
- Renewable energy projects, including wind, solar, and biomass initiatives to support Ontario's clean energy goals.

OPG collaborates with Indigenous communities to develop sustainable energy solutions that align with cultural values and environmental stewardship.

Hydro One

Hydro One is Ontario's largest electricity transmission and distribution company, owning 98% of the province's high-voltage transmission network and directly serving over 1.4 million customers, including many rural and First Nations communities[20].

Key roles of Hydro One include:

- Operating and maintaining transmission lines that connect power generation to local distribution systems.
- Managing the Hydro One Remote Communities Inc., which provides electricity to 24 remote First Nations communities in Northern Ontario.
- Partnering with Indigenous communities to develop energy infrastructure and transition to cleaner power sources.

Local Distribution Companies (LDCs)

Local Distribution Companies (LDCs) are responsible for delivering electricity from the provincial grid to end-users, including homes and businesses. Ontario has over 60 LDCs, each regulated by the OEB to ensure fair pricing and reliable service.

Some First Nations communities operate their own distribution companies, such as:

- Six Nations Power Corporation, which manages energy services for the Six Nations of the Grand River.
- Five Nations Energy Inc., which delivers power to James Bay coastal communities.

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[19] Ontario Power Generation. (2024). *About OPG.* Retrieved from https://www.opg.com
[20] Hydro One. (2024). *Our Services.* Retrieved from https://www.hydroone.com

Canada Energy Regulator (CER)

The National Energy Board (NEB), now known as the Canada Energy Regulator (CER), oversees interprovincial and international pipelines and transmission infrastructure. The CER ensures environmental and social considerations are included in energy project approvals, with a focus on Indigenous engagement and consultation[21].

Canadian Nuclear Safety Commission (CNSC)

The Canadian Nuclear Safety Commission (CNSC) regulates the use of nuclear energy and materials to protect human health and the environment. It is responsible for licensing nuclear facilities and ensuring compliance with the Nuclear Safety and Control Act[22].

Hydro One Remote Communities Inc.

A subsidiary of Hydro One, Hydro One Remote Communities Inc. provides electricity to 24 off-grid First Nations communities that are not connected to the provincial grid[23]. These communities primarily rely on diesel generation, and efforts are underway to transition to renewable energy alternatives with First Nations leadership.

2. Energy sources for First Nations

Energy is central to the economic development, environmental stewardship, and self-determination of First Nations communities. Renewable energy offers a path to energy sovereignty by providing sustainable, affordable, and locally sourced power solutions.

2.1 Renewable energy sources

Renewable energy sources, including solar, wind, hydroelectric, biomass, and geothermal, are especially well-suited to the needs of First Nations communities. These technologies reduce reliance on external systems, align with environmental values, and offer long-term economic benefits.

2.1.1 Solar, Wind, Hydroelectric, Biomass, Geothermal energy

Solar

How it works: Solar energy harnesses sunlight through photovoltaic (PV) cells, which directly convert sunlight into electricity, or through solar thermal systems, which concentrate sunlight to produce heat for generating steam that drives turbines.

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[21] Canada Energy Regulator. (2024). *Regulatory Framework.* Retrieved from https://www.cer-rec.gc.ca

[22] Canadian Nuclear Safety Commission. (2024). *Nuclear Regulation in Canada.* Retrieved from https://www.cnsc-ccsn.gc.ca

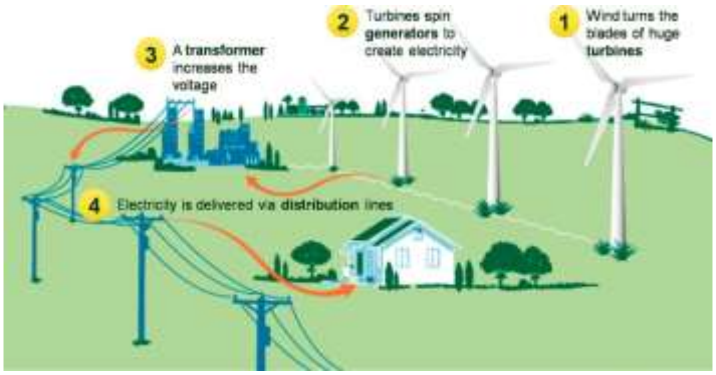
[23] Hydro One Remote Communities Inc. (2024). *Providing safe and reliable electricity to remote communities.* Retrieved from https://www.hydrooneremotes.ca/

Benefits
• Solar power generates clean electricity, eliminating greenhouse gas emissions from traditional diesel systems. • By reducing diesel use, solar energy lowers costs, especially in remote areas where fuel transport is expensive. • It enhances energy autonomy, offering reliable power and minimizing supply chain vulnerabilities. • Solar systems are versatile, scalable, and long-lasting, requiring little maintenance over their 20+ year lifespan. • Operating silently with minimal environmental impact, solar preserves the natural landscapes valued by First Nations[24].
Limitations
• Solar energy is weather-dependent and unavailable at night, requiring energy storage systems for consistent power supply. • Large-scale solar installations require significant land, potentially impacting agricultural use and ecosystems. • Solar technologies rely on materials like silicon and rare elements, which may face supply chain and production challenges. • Although costs have decreased, improving efficiency and scalability remains a critical research focus. • High penetration of solar energy requires advanced grid systems and energy storage to balance supply and demand[25].

[24] Robertson, B., Bekker, J., & Buckham, B. (2020). Renewable integration for remote communities: Comparative allowable cost analyses for hydro, solar and wave energy. *Applied Energy, 264*, 114677. https://doi.org/10.1016/j.apenergy.2020.114677
[25] Lewis, N. (2016). Research opportunities to advance solar energy utilization. *Science, 351*(6280). https://doi.org/10.1126/science.aad1920

Wind

How it works: Wind turbines capture the kinetic energy of moving air with their rotating blades. The blades drive a rotor connected to a generator, converting mechanical energy into electricity. Modern turbines are designed for efficiency across a wide range of wind speeds, while offshore wind farms utilize stronger, more consistent winds over open water to produce higher energy output.



Benefits
• Wind energy produces no greenhouse gas emissions or air pollution during operation, making it a clean and environmentally friendly energy source. • It is a renewable resource, ensuring long-term sustainability without the risk of depletion[26]. • Wind projects contribute to economic growth by creating jobs in manufacturing, construction, and maintenance[27]. • Turbines can be deployed at various scales, from small installations for localized use to expansive wind farms supplying electricity to larger grids[28].
Limitations
• Wind energy is unpredictable and varies depending on weather, requiring backup systems to ensure consistent electricity supply[29]. • Its effectiveness depends on location, with low wind speeds and unsuitable terrain reducing viability. Remote optimal sites can also increase transmission costs[30]. • Turbines may affect wildlife, generate noise, and alter landscapes, which can lead to resistance from local communities[31]. • High installation costs and reliance on subsidies challenge economic feasibility, and the energy return on investment may be lower compared to other sources[32].

[26] Veers, P., Dykes, K., Lantz, E., Barth, S., Bottasso, C. L., Carlson, O., Clifton, A., Green, J., Green, P., & Wiser, R. et al. (2019). Grand challenges in the science of wind energy. Science, 366(6464), eaau2027. https://doi.org/10.1126/science.aau2027

[27] Mckenna, R., Ostman V.d. Leye, P., & Fichtner, W. (2016). Key challenges and prospects for large wind turbines. Renewable and Sustainable Energy Reviews, 53, 1212-1221. https://doi.org/10.1016/j.rser.2015.09.080

[28] Veers, P., Dykes, K., Lantz, E., Barth, S., Bottasso, C. L., Carlson, O., Clifton, A., Green, J., Green, P., & Wiser, R. et al. (2019). Grand challenges in the science of wind energy. Science, 366(6464), eaau2027. https://doi.org/10.1126/science.aau2027

[29] Rahimi, E., Rabiee, A., Aghaei, J., Muttaqi, K., & Nezhad, A. E. (2013). On the management of wind power intermittency. *Renewable & Sustainable Energy Reviews, 28*, 643-653. https://doi.org/10.1016/J.RSER.2013.08.034

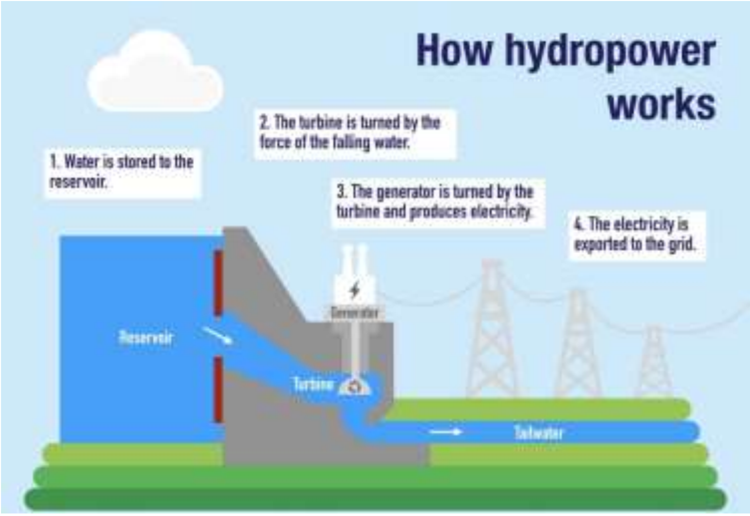
[30] Dupont, E., Koppelaar, R., & Jeanmart, H. (2018). Global available wind energy with physical and energy return on investment constraints. *Applied Energy, 209*, 322-338. https://doi.org/10.1016/J.APENERGY.2017.09.085

[31] Veers, P., Dykes, K., Lantz, E., et al. (2019). Grand challenges in the science of wind energy. *Science, 366*. https://doi.org/10.1126/science.aau2027

[32] Arshad, M., & O'Kelly, B. (2019). Global status of wind power generation: Theory, practice, and challenges. *International Journal of Green Energy, 16*(11), 1073-1090. https://doi.org/10.1080/15435075.2019.1597369

Hydroelectric

How it works: Hydroelectric energy generates electricity by capturing the kinetic energy of flowing or falling water to turn turbines. Common methods include large dams, run-of-river systems, and pumped-storage systems.



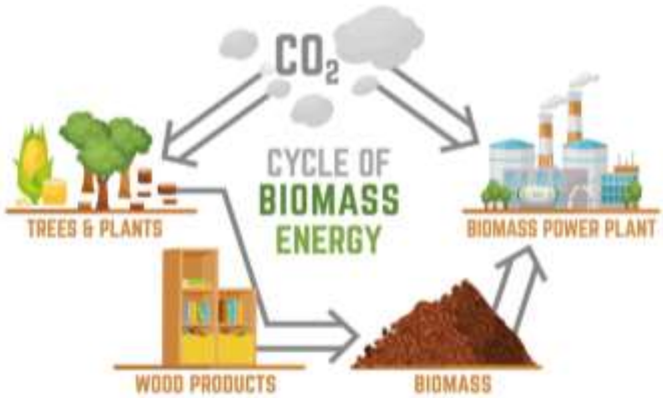
Benefits
• Hydropower provides consistent electricity, ensuring a stable energy supply while complementing other renewable sources like solar and wind[33]. • It produces minimal greenhouse gas emissions during operation, contributing to cleaner energy systems[34]. • Reservoirs built for hydropower can support irrigation, flood management, and water supply for nearby communities[35]. • Hydropower plants are cost-effective in the long term due to their low operational costs and long lifespans[36].
Limitations
• Large dams can harm ecosystems, reduce biodiversity, and disrupt aquatic life, particularly in rivers with sensitive habitats[37]. • The creation of reservoirs often leads to the displacement of communities and significant land use changes[38]. • Depends on consistent water availability, making it less effective in regions prone to drought or water scarcity[39].

[33] Sayed, E., Wilberforce, T., Elsaid, K., et al. (2020). A critical review on environmental impacts of renewable energy systems and mitigation strategies: Wind, hydro, biomass, and geothermal. *Science of the Total Environment, 766*, 144505. https://doi.org/10.1016/j.scitotenv.2020.144505.
[34] Grubert, E. (2020). Conventional hydroelectricity and the future of energy: Linking national inventory of dams and energy information administration data to facilitate analysis of hydroelectricity. *The Electricity Journal, 33*, 106692.
[35] Moran, E., Lopez, M., Moore, N., Müller, N., & Hyndman, D. (2018). Sustainable hydropower in the 21st century. *Proceedings of the National Academy of Sciences of the United States of America, 115*, 11891–11898. https://doi.org/10.1073/pnas.1809426115.
[36] Grubert, E. (2020). Conventional hydroelectricity and the future of energy: Linking national inventory of dams and energy information administration data to facilitate analysis of hydroelectricity. *The Electricity Journal, 33*, 106692.
[37] Moran, E., Lopez, M., Moore, N., Müller, N., & Hyndman, D. (2018). Sustainable hydropower in the 21st century. *Proceedings of the National Academy of Sciences of the United States of America, 115*, 11891–11898. https://doi.org/10.1073/pnas.1809426115.
[38] Grubert, E. (2020). Conventional hydroelectricity and the future of energy: Linking national inventory of dams and energy information administration data to facilitate analysis of hydroelectricity. *The Electricity Journal, 33*, 106692. https://doi.org/10.1016/j.tej.2019.106692
[39] Mitsubishi, S., Okamoto, M., Takahashi, H., & Imai, H. (2009). Potential maximum hydroelectric energy development in Japan. *Hydrological Research Letters, 3*, 14–17. https://doi.org/10.3178/HRL.3.14

- The construction of hydropower facilities requires substantial investment and planning, including environmental assessments and mitigation measures[40].

Biomass

How it works: Biomass energy involves burning organic material, such as agricultural residues, wood, or waste, to generate heat and electricity. Anaerobic digestion processes can also convert organic matter into biogas.



Benefits
• Biomass is derived from organic materials such as agricultural residues, wood, and waste, making it a renewable energy source when managed sustainably[41]. • Biomass energy utilizes agricultural and industrial waste, reducing landfill dependency and contributing to better waste management[42]. • When sourced sustainably, biomass can be carbon-neutral, as the carbon released during combustion is offset by the carbon absorbed during the growth of the biomass. • Supports rural economies by creating jobs in harvesting, processing, and energy production[43].
Limitations
• Biomass production can compete with food crops for arable land, potentially impacting food security. • While often considered carbon-neutral, biomass combustion still releases CO_2, and improper sourcing can lead to deforestation and increased emissions[44]. • Biomass conversion to energy is less efficient compared to other renewables, requiring advancements in technology to improve energy output. • Combustion of biomass can produce particulate matter and other air pollutants, requiring careful management and emission controls[45].

[40] Sayed, E., Wilberforce, T., Elsaid, K., et al. (2020). A critical review on environmental impacts of renewable energy systems and mitigation strategies: Wind, hydro, biomass, and geothermal. *Science of the Total Environment, 766*, 144505. https://doi.org/10.1016/j.scitotenv.2020.144505.

[41] Alper, K., Tekin, K., Karagöz, S., & Ragauskas, A. (2020). Sustainable energy and fuels from biomass: A review focusing on hydrothermal biomass processing. *Sustainable Energy and Fuels, 4*, 4390-4414. https://doi.org/10.1039/d0se00784f.

[42] Deitos, M., Araújo, A., & Silva, R. (2024). Sustainability and innovation in green energy: Biomass as a pathway for a renewable future. *Green Energy Review, 12*, 215-234. https://doi.org/10.24857/rgsa.v18n10-169

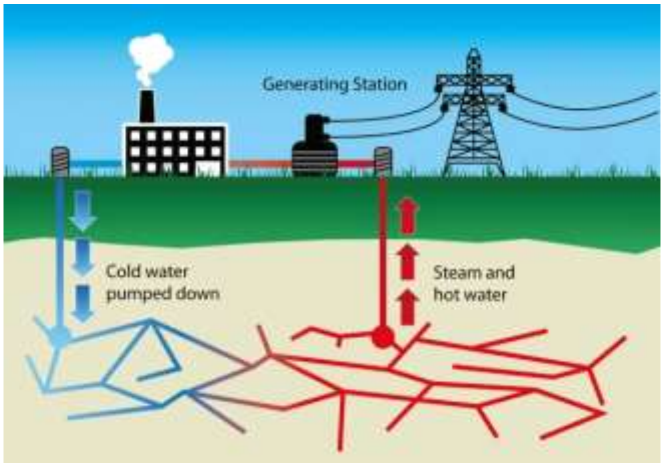
[43] Deitos, M., Araújo, A., & Silva, R. (2024). Sustainability and innovation in green energy: Biomass as a pathway for a renewable future. *Green Energy Review, 12*, 215-234. https://doi.org/10.24857/rgsa.v18n10-169

[44] Alper, K., Tekin, K., Karagöz, S., & Ragauskas, A. (2020). Sustainable energy and fuels from biomass: A review focusing on hydrothermal biomass processing. *Sustainable Energy and Fuels, 4*, 4390-4414. https://doi.org/10.1039/d0se00784f.

[45] Deitos, M., Araújo, A., & Silva, R. (2024). Sustainability and innovation in green energy: Biomass as a pathway for a renewable future. *Green Energy Review, 12*, 215-234. https://doi.org/10.24857/rgsa.v18n10-169

Geothermal

How it works: Geothermal energy uses heat from beneath the Earth's surface to generate electricity or provide direct heating. It typically involves tapping into hot water or steam reservoirs deep underground.



Benefits
• Geothermal energy provides stable baseload electricity, unaffected by weather or seasonal changes, ensuring a consistent energy supply[46]. • Geothermal systems emit significantly fewer greenhouse gases compared to fossil fuels, making them an environmentally friendly energy source[47]. • Geothermal plants require less land, preserving natural landscapes[48]. • In addition to electricity generation, geothermal energy can be used directly for heating homes, greenhouses, and industrial processes[49].
Limitations
• Geographically limited, requiring access to suitable underground heat reservoirs, which may not be available in all regions[50]. • Exploration, drilling, and infrastructure development for geothermal plants involve substantial upfront investments[51]. • Geothermal activities can lead to subsurface water contamination and induced seismicity if not carefully managed[52]. • Expanding geothermal capacity is challenging due to the dependency on specific geological conditions and the need for detailed exploration[53].

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[46] Moya, D., Aldas, C., & Kaparaju, P. (2018). Geothermal energy: Power plant technology and direct heat applications. *Renewable and Sustainable Energy Reviews*. https://doi.org/10.1016/J.RSER.2018.06.047.

[47] Sayed, E., Wilberforce, T., Elsaid, K., et al. (2020). A critical review on environmental impacts of renewable energy systems and mitigation strategies: Wind, hydro, biomass, and geothermal. *Science of the Total Environment, 766*, 144505. https://doi.org/10.1016/j.scitotenv.2020.144505.

[48] Anderson, A., & Rezaie, B. (2019). Geothermal technology: Trends and potential role in a sustainable future. *Applied Energy*. https://doi.org/10.1016/J.APENERGY.2019.04.102

[49] Moya, D., Aldas, C., & Kaparaju, P. (2018). Geothermal energy: Power plant technology and direct heat applications. *Renewable and Sustainable Energy Reviews*. https://doi.org/10.1016/J.RSER.2018.06.047.

[50] Anderson, A., & Rezaie, B. (2019). Geothermal technology: Trends and potential role in a sustainable future. *Applied Energy*. https://doi.org/10.1016/J.APENERGY.2019.04.102.

[51] Moya, D., Aldas, C., & Kaparaju, P. (2018). Geothermal energy: Power plant technology and direct heat applications. *Renewable and Sustainable Energy Reviews*. https://doi.org/10.1016/J.RSER.2018.06.047.

[52] Sayed, E., Wilberforce, T., Elsaid, K., et al. (2020). A critical review on environmental impacts of renewable energy systems and mitigation strategies: Wind, hydro, biomass, and geothermal. *Science of the Total Environment, 766*, 144505. https://doi.org/10.1016/j.scitotenv.2020.144505.

[53] Anderson, A., & Rezaie, B. (2019). Geothermal technology: Trends and potential role in a sustainable future. *Applied Energy*. https://doi.org/10.1016/J.APENERGY.2019.04.102.

2.2 Non-Renewable Energy Sources

Non-renewable energy sources include fossil fuels (diesel, natural gas, coal) and nuclear energy. These sources have historically been integral to global energy systems but pose challenges such as environmental degradation, resource dependency, and long-term sustainability.

2.2.1 Diesel, Natural Gas, Coal, and Nuclear

Diesel

How it works: Diesel energy is generated by burning diesel fuel in internal combustion engines, which produce mechanical energy converted into electricity. Diesel generators are commonly used in remote First Nations communities due to their portability and reliability[54].

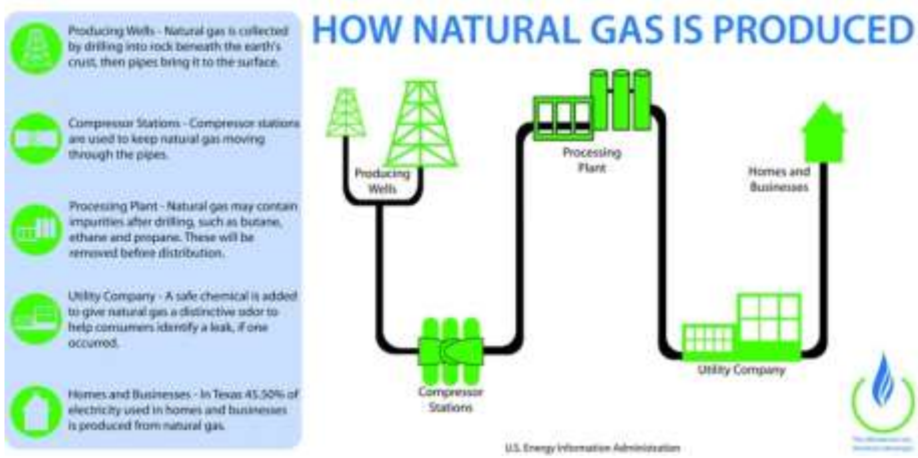
Benefits
• Diesel generators are a well-established technology, providing reliable electricity generation in remote areas. This reliability is crucial for communities that are not connected to the main power grid, ensuring a consistent power supply[55]. • Diesel generation contributes to local employment and community resilience. It is a familiar technology that communities have adapted to over time, providing a sense of security and stability in energy supply[56]. • Many remote communities already have the infrastructure in place for diesel power, which can be a cost-effective solution compared to the initial investment required for renewable energy systems[57].
Limitations
• Diesel power generation is associated with significant greenhouse gas emissions, oil spills, and black carbon, contributing to environmental degradation and climate change[58]. • The high cost of diesel fuel, coupled with transportation and operational expenses, poses an economic burden on remote communities. These costs are often subsidized by the government, which is not a sustainable long-term solution[59][60].

[54] Smith, C., & Kumar, S. (2021). The economics of diesel power generation in off-grid communities. *Energy Policy, 146*, 111-120. https://doi.org/10.1016/j.enpol.2021.111120
[55] Mercer, N., Parker, P., Hudson, A., & Martin, D. (2020). Off-grid energy sustainability in Nunatukavut, Labrador: Centering Inuit voices on heat insecurity in diesel-powered communities. Energy research and social science, 62, 101382. https://doi.org/10.1016/j.erss.2019.101382
[56] Mercer, N., Parker, P., Hudson, A., & Martin, D. (2020). Off-grid energy sustainability in Nunatukavut, Labrador: Centering Inuit voices on heat insecurity in diesel-powered communities. Energy research and social science, 62, 101382. https://doi.org/10.1016/j.erss.2019.101382
[57] Elsaraf, H., Jamil, M., & Pandey, B. (2021). Techno-Economic Design of a Combined Heat and Power Microgrid for a Remote Community in Newfoundland Canada. IEEE Access, 9, 91548-91563. https://doi.org/10.1109/ACCESS.2021.3091738
[58] Karanasios, K., & Parker, P. (2018). Tracking the transition to renewable electricity in remote indigenous communities in Canada. Energy Policy. https://doi.org/10.1016/J.ENPOL.2018.03.032
[59] Arriaga, M., Cañizares, C., & Kazerani, M. (2013). Renewable Energy Alternatives for Remote Communities in Northern Ontario, Canada. IEEE Transactions on Sustainable Energy, 4, 661-670. https://doi.org/10.1109/TSTE.2012.2234154
[60] Das, I., & Cañizares, C. (2019). Renewable Energy Integration in Diesel-Based Microgrids at the Canadian Arctic. Proceedings of the IEEE, 107, 1838-1856. https://doi.org/10.1109/JPROC.2019.2932743

- Dependence on diesel can lead to energy insecurity due to external control and the need for fuel imports. This reliance can be problematic, especially in harsh weather conditions that can disrupt supply chains[61] (Mercer et al., 2020).
- Diesel combustion can lead to air pollution, which poses health risks to community citizens.

Natural Gas

How it works: Natural gas is extracted from underground reservoirs and burned in turbines or power plants to generate electricity. Advanced combined-cycle plants improve efficiency by using waste heat to generate additional power[62].



Benefits
• Natural gas emits less CO_2 compared to coal and oil, making it a cleaner fossil fuel option for electricity generation and other uses[63]. • It provides essential load balancing services, supporting the integration of renewable energy sources by using existing infrastructure[64]. • Natural gas is abundant and domestically available in many regions, offering economic benefits and energy security[65].

[61] Mercer, N., Parker, P., Hudson, A., & Martin, D. (2020). Off-grid energy sustainability in Nunatukavut, Labrador: Centering Inuit voices on heat insecurity in diesel-powered communities. Energy research and social science, 62, 101382. https://doi.org/10.1016/j.erss.2019.101382

[62] McJeon, H., Edmonds, J., & Clarke, L. (2019). Natural gas and the energy transition. *Nature Climate Change, 9*(1), 34-38. https://doi.org/10.1038/s41558-019-0430-4

[63] Hausfather, Z. (2015). Bounding the climate viability of natural gas as a bridge fuel to displace coal. Energy Policy, 86, 286-294. https://doi.org/10.1016/J.ENPOL.2015.07.012

[64] Kinnon, M., Brouwer, J., & Samuelsen, S. (2018). The role of natural gas and its infrastructure in mitigating greenhouse gas emissions, improving regional air quality, and renewable resource integration. Progress in Energy and Combustion Science, 64, 62-92. https://doi.org/10.1016/J.PECS.2017.10.002

[65] Chong, Z., Yang, S., Babu, P., Linga, P., & Li, X. (2016). Review of natural gas hydrates as an energy resource: Prospects and challenges. Applied Energy, 162, 1633-1652. https://doi.org/10.1016/J.APENERGY.2014.12.061

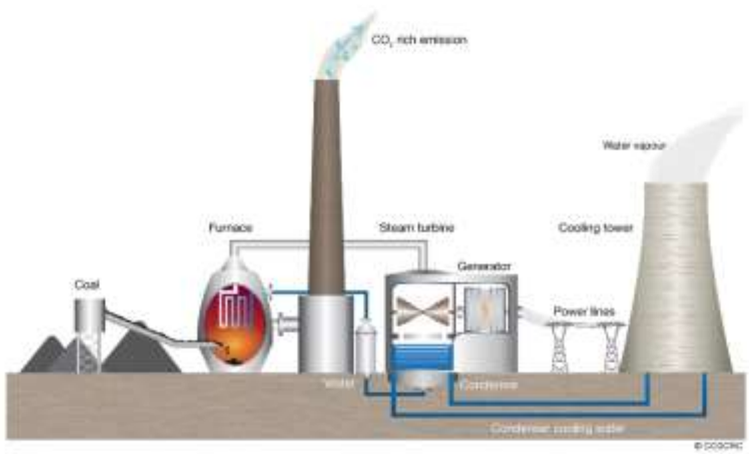
- Switching from coal to natural gas can significantly reduce emissions of harmful pollutants like SO2 and NOx, leading to substantial health benefits[66].

Limitations

- Methane, a potent greenhouse gas, can leak during production and distribution, potentially offsetting the climate benefits of using natural gas over coal[67].
- The long-lived nature of natural gas infrastructure can delay the transition to near-zero carbon technologies, potentially locking in emissions levels above long-term targets[68].
- While natural gas can reduce emissions in the short term, its role in achieving ambitious climate stabilization goals is limited without carbon capture and sequestration technologies[69].
- Although cleaner than coal, natural gas still emits more GHGs and pollutants compared to renewable energy sources[70].

<u>Coal</u>

How it works: Coal-fired power plants burn coal to produce heat, which converts water into steam. The steam drives turbines connected to generators, producing electricity. Although Ontario has phased out coal, it remains widely used globally for electricity generation[71].



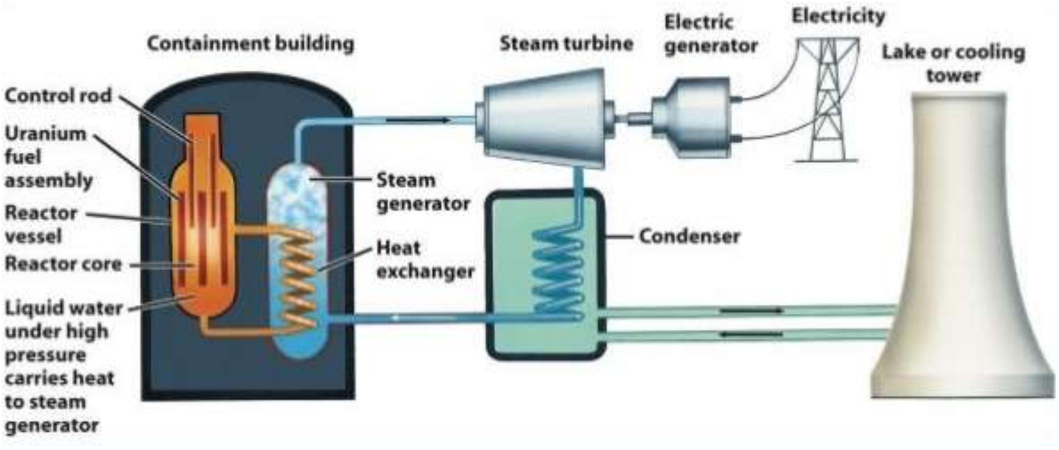
[66] Lueken, R., Klima, K., & Griffin, M. (2014). The climate and health effects of a USA switch from coal to gas electricity generation. Energy, 109, 1160-1166. https://doi.org/10.1016/J.ENERGY.2016.03.078
[67] Hausfather, Z. (2015). Bounding the climate viability of natural gas as a bridge fuel to displace coal. Energy Policy, 86, 286-294. https://doi.org/10.1016/J.ENPOL.2015.07.012
[68] Zhang, X., Myhrvold, N., Hausfather, Z., & Caldeira, K. (2016). Climate benefits of natural gas as a bridge fuel and potential delay of near-zero energy systems. Applied Energy, 167, 317-322. https://doi.org/10.1016/J.APENERGY.2015.10.016
[69] Levi, M. (2013). Climate consequences of natural gas as a bridge fuel. Climatic Change, 118, 609-623. https://doi.org/10.1007/s10584-012-0658-3
[70] Kinnon, M., Brouwer, J., & Samuelsen, S. (2018). The role of natural gas and its infrastructure in mitigating greenhouse gas emissions, improving regional air quality, and renewable resource integration. Progress in Energy and Combustion Science, 64, 62-92. https://doi.org/10.1016/J.PECS.2017.10.002
[71] Shindell, D., Faluvegi, G., Seltzer, K., & Shindell, C. (2020). Coal and air pollution in rural energy systems. *Journal of Cleaner Production, 277*, 124-137. https://doi.org/10.1016/j.jclepro.2020.124137

Benefits
• Provides a stable source of baseload electricity, ensuring consistent power supply. • Coal reserves are abundant globally, ensuring long-term supply security. • Historically, coal has been a cost-effective energy source for large-scale power generation.

Limitations
• Coal combustion is one of the largest sources of greenhouse gas emissions, significantly contributing to climate change. • Pollutants such as sulfur dioxide (SO_2) and nitrogen oxides (NOx) from coal burning cause serious respiratory and cardiovascular health problems. • Coal mining disrupts landscapes and First Nations land use, causing environmental and cultural harm.

Nuclear

How it works: Nuclear power plants generate electricity by using the heat released during the process of atom splitting to produce steam, which drives a turbine. The fission process itself emits no greenhouse gases, and the overall emissions throughout the nuclear lifecycle are minimal. As a result, nuclear energy is considered environmentally friendly and does not contribute to air pollution. In 2018, nuclear power accounted for 10.5% of global electricity production[72].



Benefits
• Produces very low greenhouse gas emissions, making it an effective solution for reducing carbon footprints[73].

[72] World Nuclear Association. (2024). *Where does our electricity come from?* Retrieved from https://world-nuclear.org/nuclear-essentials/where-does-our-electricity-come-from

[73] World Nuclear Association. (2024). *Where does our electricity come from?* Retrieved from https://world-nuclear.org/nuclear-essentials/where-does-our-electricity-come-from

- A small amount of uranium can generate a large amount of energy due to its high energy density.
- Nuclear power provides consistent baseload electricity, ensuring reliability for long-term energy needs.

Limitations

- Building and decommissioning nuclear plants require high initial costs and lengthy timelines.
- Managing radioactive waste poses long-term storage and safety challenges[74].
- Public concerns over safety, driven by accidents like Fukushima and Chernobyl, create social and political barriers to nuclear energy adoption.

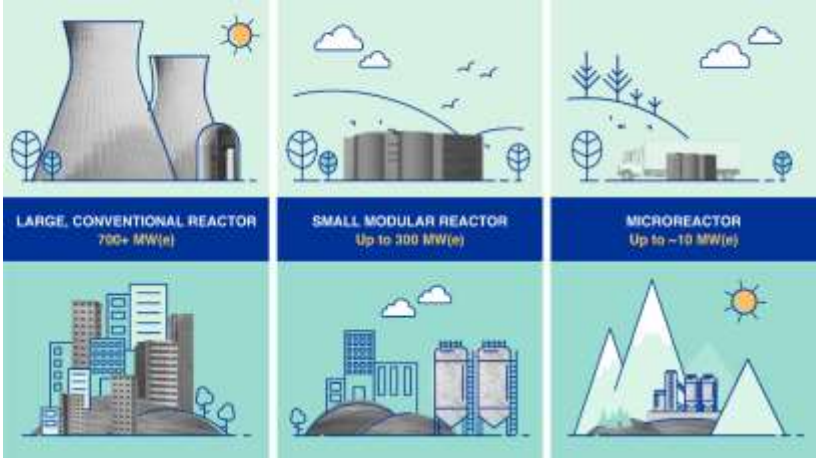
2.3 Emerging energy technologies

Emerging technologies like **Small Modular Reactors (SMRs)** and **Hydrogen Energy** offer innovative solutions that complement traditional renewable and non-renewable energy sources.

2.3.1 Small Modular Reactors (SMRs) and Hydrogen energy

Small Modular Reactors (SMRs)

How it works: SMRs are advanced nuclear reactors with a capacity of less than 300 megawatts (MW). They are designed for modular deployment, meaning they can be factory-assembled and transported to sites for quick installation. SMRs use pressurized water or other coolants to maintain safety and ensure efficient energy generation.



Considerations for First Nations:

While SMRs are being explored by industry and government as a potential energy source, particularly for mining operations in Northern Ontario and the Ring of Fire region, it is essential to critically assess their long-term impacts, costs, and alignment with First Nations values and rights. The Ontario Power Generation (OPG) report suggests that SMRs could provide power for remote mining projects and communities in Northern

[74] Froese, S., Kunz, N. C., & Ramana, M. V. (2020). Too small to be viable? The potential market for small modular reactors in mining and remote communities in Canada. Energy Policy, 144, 111587. https://doi.org/10.1016/j.enpol.2020.111587

Ontario[75], but concerns remain regarding nuclear waste management, environmental risks, and the need for Free, Prior, and Informed Consent (FPIC).

Benefits
• SMRs provide consistent and low-carbon electricity, supporting Ontario's emissions reduction goals[76]. • Their modular design allows flexible and incremental deployment, making them suitable for remote and off-grid communities, including those in Northern Ontario[77]. • SMRs can lower upfront capital costs compared to traditional nuclear plants and create jobs in construction and operation[78]. • They reduce reliance on diesel generators in remote communities, cutting costs and environmental harm[79].
Limitations
• SMRs face higher per-unit costs compared to larger reactors, which can challenge their economic competitiveness[80]. • Managing nuclear waste from SMRs is more complex due to its volume and reactivity, requiring advanced disposal strategies[81]. • Licensing and public acceptance present challenges, as concerns about safety and proliferation risks persist[82]. • Limited operational experience increases uncertainty about long-term performance and costs[83].

[75] Ontario Power Generation. (2024). Made-in-Ontario northern hydroelectric opportunities: Securing a clean energy future through hydropower. Ontario Power Generation. https://www.opg.com/projects-services/projects/hydroelectric-development/new-hydro/

[76] Colterjohn, C., Nagasaki, S., & Fujii, Y. (2023). Optimizing the Implementation of Small Modular Reactors into Ontario's Future Energy Mix. Nuclear Technology, 210, 23 - 45. https://doi.org/10.1080/00295450.2023.2217390.

[77]Ghimire, L., & Waller, E. (2023). Small Modular Reactors: Opportunities and Challenges as Emerging Nuclear Technologies for Power Production. Journal of Nuclear Engineering and Radiation Science. https://doi.org/10.1115/1.4062644.

[78]Colterjohn, C., Nagasaki, S., & Fujii, Y. (2023). Optimizing the Implementation of Small Modular Reactors into Ontario's Future Energy Mix. Nuclear Technology, 210, 23 - 45. https://doi.org/10.1080/00295450.2023.2217390.

[79] Wieser, E. (2023). The economics of small modular reactors at coal sites: A program-level analysis. *University of Texas at Austin*. http://dx.doi.org/10.2139/ssrn.4984434

[80] Ghimire, L., & Waller, E. (2023). Small modular reactors: Opportunities and challenges as emerging nuclear technologies for power production. *Journal of Nuclear Engineering and Radiation Science*. https://doi.org/10.1115/1.4062644

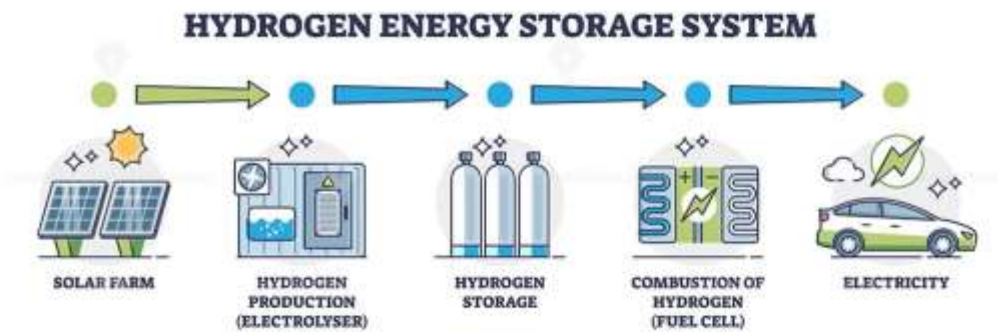
[81] Krall, L., Macfarlane, A., & Ewing, R. (2022). Nuclear waste from small modular reactors. *Proceedings of the National Academy of Sciences of the United States of America, 119*. https://doi.org/10.1073/pnas.2111833119

[82] Crețulescu, A. (2024). Small modular reactors in Romania's energy future: Capital costs and public perception. *Proceedings of the International Conference on Business Excellence, 18*, 1765–1775. https://doi.org/10.2478/picbe-2024-0148

[83] Momin, R. T. (2023). Physics-driven cost optimization and advanced R&D strategies for small modular reactors. Retrieved from: https://arxiv.org/pdf/2307.12989

Hydrogen Energy

How it works: Hydrogen is primarily produced via electrolysis, where electricity from renewable sources like solar, wind, or nuclear energy splits water into hydrogen and oxygen. Another method is steam methane reforming (SMR), which extracts hydrogen from natural gas, though this method generates carbon emissions. Green hydrogen, produced entirely using renewable energy, is emerging as a key focus for decarbonization efforts[84].



Benefits
• Hydrogen generates no greenhouse gas emissions during use, making it a clean energy solution for transportation, industry, and power generation[85]. • It can store surplus energy from renewables, helping to stabilize power grids and address variability in solar and wind generation[86]. • Hydrogen is versatile and can be used across multiple sectors, including heating, industrial processes, and as fuel for vehicles[87]. • It supports a transition to a low-carbon economy when produced using renewable electricity via water electrolysis[88].
Limitations
• Hydrogen production, storage, and transportation remain expensive, particularly for renewable-based production methods[89]. • Significant infrastructure investment is required to develop production facilities, pipelines, and refueling stations[90].

[84] Marouani, I., Guesmi, T., Alshammari, B., Alqunun, K., Alzamil, A., Alturki, M., & Abdallah, H. (2023). Integration of Renewable-Energy-Based Green Hydrogen into the Energy Future. Processes. https://doi.org/10.3390/pr11092685.
[85] Marouani, I., Guesmi, T., Alshammari, B., et al. (2023). Integration of renewable-energy-based green hydrogen into the energy future. *Processes*. https://doi.org/10.3390/pr11092685.
[86] Wang, D., Muratori, M., Eichman, J., et al. (2018). Quantifying the flexibility of hydrogen production systems to support large-scale renewable energy integration. *Journal of Power Sources*. https://doi.org/10.1016/j.jpowsour.2018.07.101
[87] Ball, M., and Weeda, M. (2015). The hydrogen economy – Vision or reality? *International Journal of Hydrogen Energy, 40*, 7903–7919. https://doi.org/10.1016/J.IJHYDENE.2015.04.032
[88] Kovač, A., Paranos, M., and Marciuš, D. (2021). Hydrogen in energy transition: A review. *International Journal of Hydrogen Energy, 46*, 10016–10035. https://doi.org/10.1016/J.IJHYDENE.2020.11.256
[89] Marouani, I., Guesmi, T., Alshammari, B., et al. (2023). Integration of renewable-energy-based green hydrogen into the energy future. *Processes*. https://doi.org/10.3390/pr11092685.
[90] Ball, M., and Weeda, M. (2015). The hydrogen economy – Vision or reality? *International Journal of Hydrogen Energy, 40*, 7903–7919. https://doi.org/10.1016/J.IJHYDENE.2015.04.032

- The process of producing, compressing, and converting hydrogen into energy can result in low overall efficiency, with substantial energy losses[91].
- Hydrogen's flammability poses safety concerns, requiring rigorous handling and storage protocols[92].

3. First Nations energy landscape

Understanding the energy landscape of First Nations in Ontario requires an exploration of historical practices, current challenges, and emerging opportunities in clean and renewable energy.

3.1 Historical context: Energy and First Nations in Ontario

Pre-colonial energy practices

Before European contact, First Nations Peoples practiced sustainable energy use rooted in ecological knowledge. They relied on renewable resources such as wood for heating, water for mechanical power, and solar energy for drying food and materials. Controlled burning techniques were also employed to maintain healthy forests, enhance soil fertility, and manage resources sustainably[93][94].

These practices prioritized environmental stewardship and resource renewal, ensuring long-term sustainability while fostering harmony with nature[95]. Conservation remains a fundamental tenet of First Nations' relationship with the environment, underscoring the importance of integrating Indigenous knowledge into contemporary environmental and energy planning efforts[96].

Impact of colonial energy policies

Colonial expansion disrupted First Nations energy systems, leading to displacement and loss of resource control. Government policies marginalized Indigenous communities from decision-making processes, leading to the dispossession of land and control over natural resources[97]. Large-scale

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[91] Rolo, I., Costa, V. A. F., and Brito, F. P. (2023). Hydrogen-based energy systems: Current technology development status, opportunities and challenges. *Energies*. https://doi.org/10.3390/en17010180

[92] Ahad, M. T., Bhuiyan, M. M. H., Sakib, A., et al. (2023). An overview of challenges for the future of hydrogen. *Materials, 16*. https://doi.org/10.3390/ma16206680

[93] First Nations Development Institute. (2018) "Leveraging Native Lands, Sovereignty and Traditions: Models and Resources for Tribal Ecological Stewardship." Longmont, CO: First Nations Development Institute. Retrieved from https://www.firstnations.org/publications/leveraging-native-lands-sovereignty-and-traditions-models-and-resources-for-tribal-ecological-stewardship/

[94] Vox. (2024). *How Indigenous controlled burns can prevent megafires*. Retrieved from https://www.vox.com/climate/366765/megafires-climate-indigenous-controlled-burns

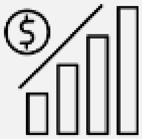
[95] Stefanelli, R., Castleden, H., Harper, S., Martin, D., & Cunsolo, A. (2019). "Experiencing the social determinants of health in Indigenous communities: A systematic review of qualitative literature." *Social Science & Medicine, 230*, 143-157. https://doi.org/10.1016/j.socscimed.2019.02.009

[96] Assembly of First Nations. (2024). *Environmental protection and climate action*. Retrieved from https://afn.ca/environment/environmental-protection-climate-action/

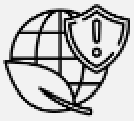
[97] Taylor, J. L. (2021). *Indigenous peoples and government policy in Canada*. The Canadian Encyclopedia. Retrieved from https://www.thecanadianencyclopedia.ca/en/article/aboriginal-people-government-policy

hydroelectric projects and fossil fuel-based infrastructures marginalized Indigenous participation and forced reliance on high-emission energy sources, such as diesel generators[98].

The imposition of centralized, externally controlled energy infrastructures replaced self-reliant energy systems with those dependent on fossil fuels, particularly diesel generators. This shift has created a long-standing reliance on high-emission energy sources, especially in remote First Nations communities that remain off-grid[99]. Many of these communities continue to face significant challenges resulting from this transition:



High costs: Transporting diesel fuel to remote areas, often by ice roads or air freight, drives up energy costs, creating significant financial burdens for communities. For example, some remote communities pay two to three times more for energy than urban areas, severely limiting economic opportunities and household budgets[100].



Environmental risks: Diesel fuel poses significant ecological threats, including the risk of spills that contaminate land and water. These spills compromise traditional hunting and fishing practices and disrupt local ecosystems that are vital to Indigenous cultural and economic sustainability[101]. Additionally, diesel emissions contribute to greenhouse gas emissions and local air pollution.

Energy insecurity: Dependence on external supply chains makes communities vulnerable to disruptions caused by fuel shortages, extreme weather, or logistical issues. The increasing unpredictability of winter road seasons due to climate change further exacerbates these vulnerabilities, leaving communities without reliable access to fuel when it is most needed[102].

[98] Jacob, M., Gonzales, K., Belcher, D., Ruef, J., & Johnson, S. (2020). Indigenous cultural values counter the damages of white settler colonialism. Environmental Sociology, 7, 134 - 146. https://doi.org/10.1080/23251042.2020.1841370.
[99] He, E. (2021). *Reducing emissions from diesel generators in remote communities*. Pembina Institute. Retrieved from https://www.pembina.org/pub/reducing-emissions-diesel-generators-remote-communities
[100] Pembina Institute. (2023). *Reducing energy poverty in remote Indigenous communities*. Retrieved from https://www.pembina.org/pub/energy-poverty-indigenous-communities
[101] Cook, K. (2019). The impacts of diesel on Indigenous communities: Environmental risks and traditional practices. *Journal of Environmental Policy and Indigenous Rights, 45*(2), 87-102. Retrieved from https://doi.org/10.20381/ruor-25247
[102] Pembina Institute. (2023). *Reducing energy poverty in remote Indigenous communities*. Retrieved from https://www.pembina.org/pub/energy-poverty-indigenous-communities

3.2 Current challenges

First Nations communities in Ontario face long-standing energy challenges, largely shaped by historical marginalization and limited access to sustainable solutions. These challenges include:

- **High Energy Costs:** Reliance on diesel generators leads to significantly higher energy prices compared to urban areas.
- **Infrastructure Gaps:** Aging and inadequate power systems contribute to unreliable energy access and hinder economic development.
- **Energy Insecurity:** Dependence on external fuel supplies leaves communities vulnerable to disruptions caused by logistical challenges and climate change.

Further exploration of these challenges, their impacts, and potential solutions are discussed in **Section 5: Challenges and Opportunities.**

3.3 Opportunities for clean and renewable energy

Transitioning to clean energy presents a pathway for First Nations to achieve greater energy sovereignty and sustainability. Renewable resources such as solar, wind, and hydroelectric power offer opportunities to:

- **Enhance Energy Independence:** Reducing reliance on diesel fosters economic resilience and self-sufficiency.
- **Support Environmental Stewardship:** Aligning energy projects with First Nations ecological knowledgehelps preserve natural resources for future generations.
- **Foster Economic Growth:** Clean energy projects create job opportunities and build local capacity.

Detailed pathways and actionable recommendations for maximizing these opportunities are discussed in **Section 5: Challenges and Opportunities.**

4. Policy and regulatory frameworks

Understanding the intersection of energy policies, First Nations' rights, and energy agreements is crucial for fostering equitable and sustainable energy development. Federal and provincial policies must align with Canada's climate commitments, Indigenous rights, and First Nations' aspirations for energy sovereignty.

4.1 Federal and provincial energy policies affecting First Nations

Energy policies at both federal and provincial levels significantly influence First Nations' participation in energy projects and their path to energy sovereignty. While these policies support decarbonization, renewable energy initiatives, and Indigenous engagement, implementation gaps remain.

Federal energy policies

At the federal level, Canada's energy policy framework prioritizes reconciliation, environmental sustainability, and the transition to a low-carbon economy. Key elements include:

- **UNDRIP Implementation (Bill C-15):** Adopted into federal law in 2021 through Bill C-15, this legislation aligns Canadian laws with UNDRIP principles, emphasizing Free, Prior, and Informed Consent (FPIC) and ensuring deeper collaboration with First Nations[103].
- **Clean Electricity Regulations (CER):** Aiming for a net-zero electricity grid by 2035, these regulations encourage Indigenous participation and phase out high-emission fuels like coal and diesel[104].
- **Indigenous Climate Leadership Agenda (ICLA):** This program supports First Nations-led renewable energy projects with funding and technical assistance, promoting culturally aligned energy solutions[105].
- **Canadian Green New Deal:** This initiative prioritizes Indigenous leadership in energy transitions, with investments in clean energy that align with reconciliation efforts[106].

Provincial energy policies in Ontario

Ontario's energy policies include a range of initiatives aimed at improving energy affordability, sustainability, and Indigenous participation. These policies are intended to support First Nations communities in addressing energy challenges; however, their effectiveness in meeting community-specific needs depends on accessible funding, culturally appropriate implementation, and meaningful collaboration.

1. Legislative Frameworks

Affordable Energy Act, 2024
This legislation focuses on improving energy affordability for remote and underserved communities, including First Nations, by promoting equitable energy access and supporting efforts to transition away from diesel dependency. It includes funding mechanisms for renewable energy projects and efficiency upgrades[107].

Ontario Aboriginal Loan Guarantee Program (ALGP)
The ALGP provides loan guarantees for up to 75% of an Indigenous entity's equity investment in

[103] Adkins, S., Jamieson, L., Oleniuk, T., & Spencer, S. (2020). UNDRIP as a Framework for Reconciliation in Canada: Challenges and Opportunities for Major Energy and Natural Resources Projects. Alberta Law Review. https://doi.org/10.29173/alr2621
[104] Canada.ca. (2024). Clean electricity regulations and Canada's net-zero target. Retrieved from https://www.canada.ca/en/environment-climate-change/news/2024/12/powering-canadas-futurecanadas-final-clean-electricity-regulations.html
[105] Reed, G., Brunet, N., Mcgregor, D., Scurr, C., Sadik, T., Lavigne, J., & Longboat, S. (2022). *Toward Indigenous visions of nature-based solutions: an exploration into Canadian federal climate policy.* Climate Policy. https://doi.org/10.1080/14693062.2022.2047585
[106] MacArthur, J., Hoicka, C., Castleden, H., Das, R., & Lieu, J. (2020). *Canada's Green New Deal: Forging the socio-political foundations of climate resilient infrastructure?* Energy Research & Social Science. https://doi.org/10.1016/j.erss.2020.101442
[107] Government of Ontario. (2024). *Affordable Energy Act.* Retrieved from https://www.ontario.ca/page/manage-energy-costs-your-home

renewable energy and transmission projects, helping to lower financial barriers and encourage Indigenous ownership in clean energy initiatives[108].

2. Indigenous Energy Programs

Administered by the **Independent Electricity System Operator (IESO),** these programs aim to support Indigenous energy initiatives with financial and technical assistance[109]. The programs include:

Indigenous Energy Support Program (IESP):
Provides funding for energy audits, feasibility studies, and renewable energy planning for First Nations.

Legacy IESO Programs:

- **Community Energy Champion (CEC):** Supports hiring energy champions within communities to lead energy planning efforts.
- **Education and Capacity Building (ECB):** Provides funding for training programs to enhance Indigenous knowledge of energy systems.
- **Indigenous Community Energy Plan (ICEP):** Assists in the development of community-driven energy plans tailored to local needs and priorities.
- **Indigenous Energy Projects (IEP):** Provides financial support for implementing renewable energy projects such as solar, wind, and hydro.

3. Energy efficiency initiatives

Save on Energy for Indigenous Communities:
This initiative offers incentives for energy efficiency upgrades such as LED lighting, insulation, and heating systems, aimed at reducing energy costs and improving sustainability in First Nations communities[110].

4.2 First Nations rights and energy development

First Nations in Ontario have constitutionally protected rights to land and resources that play a critical role in energy development. These rights are enshrined in Section 35 of the Constitution Act, 1982 and strengthened by international frameworks such as the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). Energy projects on First Nations lands must respect these rights, ensuring alignment with community values and promoting energy sovereignty. However, challenges remain in fully realizing these rights, highlighting the need for stronger consultation processes, enforcement of Free, Prior, and Informed Consent (FPIC), and enhanced community capacity.

[108] Ontario Financing Authority. (2024). *Aboriginal Loan Guarantee Program.* Retrieved from https://www.ofina.on.ca/algp
[109] IESO. (2024). *Indigenous Energy Support Programs.* Retrieved from https://www.ieso.ca/Get-Involved/Indigenous-Relations/Indigenous-Energy-Support-Program/Support-Programs-in-Action
[110] Save on Energy. (2024). *Programs for Indigenous Communities.* Retrieved from https://saveonenergy.ca/First-Nations-Energy-Programs

Legal foundations of First Nations rights

First Nations' rights, which may include energy development, are protected under Section 35 of the *Constitution Act, 1982,* which recognizes and affirms Aboriginal and Treaty rights. These legal protections provide the common law foundation for First Nations' participation in resource and energy projects across Canada. The adoption of the *United Nations Declaration on the Rights of Indigenous Peoples Act* (Bill C-15) in 2021 further reinforces these rights by emphasizing the principle of Free, Prior, and Informed Consent (FPIC), requiring First Nations' consent to proposed government decisions or actions, which may include impacts to their lands and resources[111]. Further, First Nations' own inherent jurisdiction and sovereignty, and traditional laws and customary practices may inform and govern their expectations when it comes to energy development.

FPIC marks a shift from Crown consultation to consent-based processes, promoting Indigenous sovereignty over energy decisions. However, challenges persist, including unclear definitions of FPIC in Canadian law, differing jurisdictional application of UNDRIP, inconsistent adherence by developers, and limited capacity for meaningful engagement. These barriers highlight the need for stronger enforcement and clearer guidelines to ensure effective participation in energy development.

Duty to consult and accommodate

The duty to consult and accommodate is a cornerstone of Canadian law, ensuring Indigenous peoples are involved in decisions that may affect their rights. Landmark Supreme Court rulings, such as *Haida Nation v. British Columbia* (2004) and *Taku River Tlingit First Nation v. British Columbia* (2004), established that consultation must be meaningful and conducted in good faith before projects proceed [112][113].

In Ontario, meaningful consultation is required throughout all energy project phases, from initial planning to long-term operation. Effective engagement involves recognizing Indigenous knowledge, addressing community concerns, and fostering collaboration to align projects with Indigenous cultural values, environmental stewardship, and economic goals. Provincial and federal regulatory frameworks, such as Ontario's *Environmental Assessment Act* and the federal *Impact Assessment Act*, provide guidelines to uphold Indigenous rights and promote sustainable development[114][115].

The Crown's duty to consult cannot be delegated to third parties.[116] Only specific procedural process can be delegated to municipalities and/or project proponents.[117] Where procedural aspects of the duty are delegated to a third-party, the Crown must monitor and supervise the delegated process to ensure that the First Nation's concerns are fully addressed.

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[111] Government of Canada. (2021). *United Nations Declaration on the Rights of Indigenous Peoples Act*. Retrieved from https://www.parl.ca/DocumentViewer/en/43-2/bill/C-15/royal-assent
[112] Supreme Court of Canada. (2004a). *Haida Nation v. British Columbia (Minister of Forests), 2004 SCC 73.* Retrieved from https://scc-csc.lexum.com/scc-csc/scc-csc/en/item/2189/index.do
[113] Supreme Court of Canada. (2004b). *Taku River Tlingit First Nation v. British Columbia (Project Assessment Director), 2004 SCC 74.* Retrieved from https://scc-csc.lexum.com/scc-csc/scc-csc/en/item/2190/index.do
[114] Government of Canada. (2019). *Impact Assessment Act.* Retrieved from https://laws-lois.justice.gc.ca/eng/acts/I-2.75/
[115] Government of Ontario. (2024). *Environmental Assessment Act.* Retrieved from https://www.ontario.ca/laws/statute/90e18
[116] Haida Nation at para 53.
[117] Ibid.

Free, Prior, and Informed Consent (FPIC)

Free, Prior, and Informed Consent (FPIC) is a fundamental principle enshrined in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) and recognized in Canadian law through the United Nations Declaration on the Rights of Indigenous Peoples Act (Bill C-15). FPIC ensures that First Nations have the right to:

- Be informed about proposed projects in their territories.
- Provide or withhold consent based on a full understanding of the project's potential impacts.
- Influence project development to align with their cultural, environmental, and social values[118][119].

Despite its legal recognition, FPIC's implementation in Canada faces several challenges, including:

1. **Inconsistent interpretation:** The application of FPIC varies across projects and jurisdictions. While internationally recognized, its domestic implementation remains inconsistent, leading to varying degrees of consultation and consent[120].
2. **Capacity gaps:** Many First Nations communities experience barriers such as limited financial and technical resources, hindering their ability to fully engage in FPIC processes. The Assembly of First Nations has called for increased capacity-building to support Indigenous participation in energy governance[121].
3. **Consent disputes:** Large-scale projects, including the Coastal GasLink and Trans Mountain pipelines, have demonstrated tensions between economic development and Indigenous consent. The United Nations Committee on the Elimination of Racial Discrimination has urged Canada to halt projects lacking proper consent from affected First Nations[122].

To address these challenges, there is a need for clearer guidelines, stronger enforcement, and enhanced support mechanisms to ensure FPIC is effectively implemented in energy projects involving First Nations communities.

4.3 Understanding energy contracts and agreements

Energy contracts and agreements play a crucial role in ensuring that First Nations' interests, rights, and economic aspirations are respected and integrated into energy project development. These agreements serve as frameworks for financial participation, benefit-sharing, and long-term sustainability, aligning with Indigenous values and community priorities.

[118] United Nations. (2007). *United Nations Declaration on the Rights of Indigenous Peoples.* Retrieved from https://www.un.org/development/desa/indigenouspeoples/declaration-on-the-rights-of-indigenous-peoples.html
[119] Government of Canada. (2021). *United Nations Declaration on the Rights of Indigenous Peoples Act.* Retrieved from https://www.parl.ca/DocumentViewer/en/43-2/bill/C-15/royal-assent
[120] Papillon, M., & Rodon, T. (2016). Proponent-Indigenous agreements and the implementation of the right to free, prior, and informed consent in Canada. Environmental Impact Assessment Review, 62, 216-224. https://doi.org/10.1016/j.eiar.2016.06.009
[121] Assembly of First Nations. (2024). *First Nations' Right to Free, Prior and Informed Consent.* Retrieved from https://www.afn.ca/wp-content/uploads/2018/09/2018-06-03-FPIC-factsheet.pdf
[122] United Nations Committee on the Elimination of Racial Discrimination (CERD). (2020). *Concerns on Canada's energy projects.* Retrieved from https://www.ohchr.org/en/treaty-bodies/cerd

1. Impact Benefit Agreements (IBAs)

Impact Benefit Agreements (IBAs) are confidential contracts negotiated between Indigenous communities and project developers, such as mining or energy companies. These agreements aim to formalize the relationship between the parties, mitigate anticipated project impacts, and secure economic benefits for the affected communities[123].

Key components of IBAs include:

- **Employment and training:** Providing job opportunities and skill development programs for community members to enhance local employment prospects.
- **Economic development opportunities:** Ensuring that Indigenous-owned businesses have access to procurement and contracting opportunities related to the project.
- **Environmental management:** Involving communities in environmental monitoring and stewardship to protect traditional lands and resources.
- **Financial compensation:** Offering monetary benefits, such as royalties or profit-sharing, to support community development initiatives[124].

Negotiating IBAs can be complex and resource intensive. To assist communities, organizations like the First Nations of Quebec and Labrador Sustainable Development Institute (FNQLSDI) have established the Centre of Expertise on Impact and Benefit Agreements (CEIBA)[125]. CEIBA provides multidisciplinary support to communities in the negotiation and implementation of IBAs, particularly in the mining, forestry, and energy sectors.

2. Equity Ownership Agreements

Equity ownership agreements allow First Nations to hold ownership stakes in energy projects, providing them with governance rights and a share of the profits. This model promotes economic reconciliation and enables communities to have a direct role in project decision-making. For example, the Waasigan Transmission Line project offers participating First Nations the opportunity to invest in a 50% equity stake, fostering economic growth and capacity building in northwest Ontario[126].

3. Joint Venture Agreements

Joint ventures involve partnerships between First Nations and energy companies, where both parties collaborate on project development and share in the risks and rewards. These agreements can provide communities with access to technical expertise and financial resources, while ensuring that projects align with their cultural and environmental values.

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[123] National Aboriginal Economic Development Board. (2019). *Impact Benefit Agreements: A tool for Indigenous engagement and community development.* Retrieved from https://www.edo.ca/downloads/impact-benefit-agreements-2.pdf

[124] Government of Canada. (2022). *Impact Benefit Agreements (IBA): Support for Indigenous Communities.* Indigenous Services Canada. Retrieved from https://sac-isc.gc.ca/eng/1645561183367/1645561204248

[125] First Nations of Quebec and Labrador Sustainable Development Institute (FNQLSDI). (2021). *Centre of Expertise on Impact and Benefit Agreements (CEIBA).* Retrieved from https://www.fnqlsdi.ca/en/centre-of-expertise-on-impact-and-benefit-agreements/

[126] Electricity Canada. (2023). *First Nations Equity Partnership Model Project.* Retrieved from https://www.electricity.ca/programs/centre-of-excellence/first-nations-equity-partnership-model-project/

An example is the partnership between Suncor and the Fort McKay and Mikisew Cree First Nations, where the communities acquired a 49% interest in the East Tank Farm development, representing a significant investment in energy infrastructure[127].

In Ontario, a key example is Coral Rapids Power, a wholly owned subsidiary of Taykwa Tagamou Nation (TTN). Coral Rapids Power partnered with Ontario Power Generation (OPG) to develop the 28-megawatt Peter Sutherland Sr. Generating Station, ensuring First Nations participation in hydroelectric development while upholding environmental and cultural priorities[128].

4. Power Purchase Agreements (PPAs)

Power Purchase Agreements (PPAs) are long-term contracts between energy producers and purchasers that define the terms under which energy is sold and purchased over a set period. For First Nations developing renewable energy projects, PPAs can provide a stable revenue stream and facilitate financing by guaranteeing a market for the energy produced[129][130].

While there are limited examples of First Nations in Ontario engaging in PPAs, successful projects in other provinces demonstrate their potential in fostering energy sovereignty and economic growth. Notable examples include:

- **Awasis Solar Project (Saskatchewan):**
  Cowessess First Nation spearheaded this 10 MW solar initiative and signed a PPA with SaskPower in October 2020. The agreement supports economic development by providing a reliable income stream and increasing the community's capacity in the renewable energy sector[131].

These cases provide valuable insights into how PPAs can benefit First Nations in Ontario by offering financial stability and facilitating investment in clean energy projects. With growing interest in renewable energy and evolving regulatory frameworks, Ontario First Nations can explore similar opportunities to enhance their energy sovereignty.

Key Considerations

When entering into these agreements, First Nations should consider:

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[127] Bourque, J., & Exner-Pirot, H. (2023). *Completing Transactions, Building Relationships: Lessons from Indigenous Equity Deals in the Oil and Gas Sector.* Macdonald-Laurier Institute. Retrieved from https://macdonaldlaurier.ca/completing-transactions-building-relationships-lessons-from-indigenous-equity-deals-in-the-oil-and-gas-sector-justin-bourque-and-heather-exner-pirot/

[128] Coral Rapids Power. (2024). Peter Sutherland Sr. Generating Station. Retrieved from https://coralrapidspower.com/index.php/new-post-creek/peter-sutherland-sr-generating-station

[129] Pembina Institute. (2024). *Power Purchase Agreements — Part I: An Introductory Guide.* Retrieved from https://www.pembina.org/sites/default/files/2024-10/PPA_guide_for_Indigenous_proponents_pt_1_0.pdf

[130] Pembina Institute. (2024). *Power Purchase Agreements — Part II: An Overview of Contract Terms and Conditions.* Retrieved from https://www.pembina.org/sites/default/files/2024-10/PPA_guide_for_Indigenous_proponents_pt_2.pdf

[131] First Nations Power Authority. (2021). *FNPA Renewable Energy Projects.* Retrieved from https://fnpa.ca/2021/12/09/fnpa-renewable-energy-projects/

- **Legal rights:** Ensuring that agreements respect Indigenous rights and are aligned with legal frameworks, such as the duty to consult and accommodate[132].
- **Capacity building:** Developing the necessary skills and knowledge to effectively participate in negotiations and project implementation. Organizations like CEIBA provide support in this area[133].
- **Long-term benefits:** Assessing how agreements will provide sustainable economic, social, and environmental benefits for the community.

5. Analysis of challenges and opportunities in achieving energy sovereignty for First Nations

Energy sovereignty is crucial for First Nations communities, offering pathways to self-determination, economic development, and environmental stewardship. This section analyzes the current challenges and opportunities in transitioning to clean energy, building upon the 2016 electricity report and incorporating recent developments up to 2025.

Progress since 2016

Since the publication of the 2016 Chiefs of Ontario Electricity report, several initiatives have been undertaken to address these challenges. Key developments include:

GRID EXPANSION PROJECTS

The completion of the **Wataynikaneyap Power Project**, which connected multiple remote First Nations communities to the provincial grid, reducing diesel reliance and enhancing energy security.

RENEWABLE ENERGY INITIATIVES

Programs such as the **Indigenous Energy Support Program (IESP)** and the **Ontario Aboriginal Loan Guarantee Program (ALGP)** have provided financial and technical assistance to support community-led renewable energy projects.

POLICY AND REGULATORY IMPROVEMENTS

The adoption of **Bill C-15**, incorporating the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) into Canadian law, has strengthened Indigenous rights in energy project decision-making.

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[132] National Aboriginal Lands Managers Association. (2017). *Impact Benefit Agreements - NALMA.* Retrieved from https://nalma.ca/wp-content/uploads/2016/01/ImpactBenefitAgreements_AdamMunnings.pdf
[133] Crown-Indigenous Relations and Northern Affairs Canada. (2022). *Centre of Expertise on Impact and Benefit Agreements: An Important Ally.* Retrieved from https://sac-isc.gc.ca/eng/1645561183367/1645561204248

BUILDING AND TRAINING PROGRAMS

Capacity-building initiatives have empowered communities with the skills and knowledge needed to participate effectively in energy development.

5.1 Challenges

First Nations communities in Ontario continue to face significant energy challenges despite progress in recent years. These challenges stem from historical marginalization, limited access to clean energy solutions, and systemic barriers within policy frameworks.

5.1.1 High energy costs and limited access

First Nations communities in remote areas of Ontario face significant challenges due to their reliance on diesel generators for energy. Transporting diesel fuel via unreliable ice roads or expensive air freight results in energy costs that are two to three times higher than in urban areas, placing a heavy financial burden on communities and limiting economic development[134][135]. Climate change further exacerbates these challenges by making ice roads less dependable, increasing logistical costs and uncertainties.

In addition to high costs, inadequate energy infrastructure contributes to frequent power outages and service disruptions. Many First Nations communities experience unreliable energy access due to aging diesel generators and a lack of modern grid infrastructure[136]. These challenges strain local economies and hinder access to essential services such as healthcare, education, and clean water supply, further deepening socio-economic disparities[137].

5.1.2 Policy and regulatory barriers

Despite Canada's commitments to Indigenous energy sovereignty, several policy and regulatory hurdles persist. Indigenous utility providers face regulatory frameworks that reinforce settler sovereignty, limiting their self-determination in energy projects. However, inquiries such as the British Columbia Utilities Commission's Indigenous Utilities Regulation Inquiry provide opportunities to

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[134] Hosszu, M. (2017). The economic feasibility of replacing diesel with renewable energy resources in remote First Nation communities in Northern Ontario. Retrieved from https://thesis.lakeheadu.ca/bitstream/handle/2453/4205/HosszuM2017m-1b.pdf

[135] Karanasios, K., & Parker, P. (2018). Tracking the transition to renewable electricity in remote indigenous communities in Canada. Energy Policy. https://doi.org/10.1016/J.ENPOL.2018.03.032.

[136] Rakshit, R., Shahi, C., Smith, M., & Cornwell, A. (2019). Energy transition complexities in rural and remote Indigenous communities: A case study of Poplar Hill First Nation in Northern Ontario. *Local Environment, 24*(8), 809-824. https://doi.org/10.1080/13549839.2019.1648400

[137] [137] Hosszu, M. (2017). The economic feasibility of replacing diesel with renewable energy resources in remote First Nation communities in Northern Ontario. Retrieved from https://thesis.lakeheadu.ca/bitstream/handle/2453/4205/HosszuM2017m-1b.pdf

challenge these barriers and push for greater autonomy[138]. While many Indigenous communities engage in renewable energy projects to achieve autonomy and economic benefits, concerns remain about whether these initiatives genuinely support reconciliation without overlooking potential shortcomings[139]. Successful energy partnerships require meaningful community engagement, financial capital, and equitable benefit-sharing, yet policy disconnects often hinder Indigenous ownership and control[140]. Environmental risks, such as pipeline spills, further threaten Indigenous lands and livelihoods, highlighting the need for Indigenous-led monitoring and response programs[141]. In addition, bioenergy development faces challenges such as high initial costs and logistical barriers, which require community-based solutions and traditional knowledge for successful implementation[142].

5.1.3 Infrastructure and technological gaps

Aging and inadequate energy infrastructure in many First Nations communities pose significant challenges to the integration of renewable energy technologies. These challenges include transmission and storage issues that hinder the deployment of solar and wind energy projects. Despite efforts such as the Wataynikaneyap Power Project, many remote areas remain underserved, facing persistent barriers related to historical, geographic, and technological limitations in transitioning from off-grid to grid-connected systems[143]. A key issue is the lack of Indigenous ownership and control in renewable energy projects, limiting the economic and social benefits that communities can derive from such initiatives[144]. Furthermore, many Indigenous communities express a strong desire to achieve energy autonomy and reduce dependence on colonial energy structures, yet this transition requires significant planning, resources, and external support[145].

5.1.4 Capacity and funding constraints

First Nations communities in Ontario and across Canada encounter significant challenges in initiating and sustaining clean energy projects due to capacity and funding constraints. Despite the availability of government funding initiatives, such as the Indigenous Leadership Fund, which provides up to

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[138] Midzain-Gobin, L., & McEvoy, J. (2024). Contesting colonial beachheads: Settler colonial (in)security professionals and Indigenous peoples' energy infrastructure. *Security Dialogue.* https://doi.org/10.1177/09670106241229889

[139] Stefanelli, R., Walker, C., Kornelsen, D., Lewis, D., Martin, D., Masuda, J., Richmond, C., Root, E., Neufeld, H., & Castleden, H. (2019). Renewable energy and energy autonomy: how Indigenous peoples in Canada are shaping an energy future. *Environmental Reviews.* https://doi.org/10.1139/ER-2018-0024

[140] Yalamala, R., Zurba, M., Bullock, R., & Diduck, A. (2023). A review of large-scale renewable energy partnerships with Indigenous communities and organizations in Canada. *Environmental Reviews.* https://doi.org/10.1139/er-2022-0011

[141] Datta, R., & Hurlbert, M. (2019). Pipeline spills and Indigenous energy justice. *Sustainability, 12*, 47. https://doi.org/10.3390/su12010047

[142] Buss, J., Mansuy, N., & Madrali, S. (2021). De-risking wood-based bioenergy development in remote and Indigenous communities in Canada. *Energies, 14*, 2603. https://doi.org/10.3390/EN14092603

[143] Rakshit, R., Shahi, C., Smith, M., & Cornwell, A. (2019). Energy transition complexities in rural and remote Indigenous communities: A case study of Poplar Hill First Nation in northern Ontario. *Local Environment, 24*(8), 809-824. https://doi.org/10.1080/13549839.2019.1648400

[144] Hoicka, C., Savić, K., & Campney, A. (2021). Reconciliation through renewable energy? A survey of Indigenous communities, involvement, and peoples in Canada. *Energy Research and Social Science, 74*, 101897. https://doi.org/10.1016/J.ERSS.2020.101897

[145] Agu, O., Tabil, L., & Mupondwa, E. (2023). Actualization and adoption of renewable energy usage in remote communities in Canada by 2050: A review. *Energies.* https://doi.org/10.3390/en16083601

$180 million to support Indigenous-owned and led renewable energy projects[146], and the $300 million investment over five years aimed at reducing diesel reliance in rural, remote, and Indigenous communities[147], the administrative burden of securing and managing these funds remains a major obstacle. Additionally, limited technical capacity and access to training and workforce development programs hinder progress. Addressing these challenges requires tailored financial mechanisms and capacity-building efforts to support sustainable energy development in Indigenous communities.

5.2 Opportunities

Despite the challenges, First Nations communities in Ontario are increasingly leveraging renewable energy to achieve economic and environmental benefits.

5.2.1 Indigenous ownership and leadership

First Nations in Ontario are increasingly leading clean energy projects, fostering economic self-sufficiency and sustainability. The Wataynikaneyap Power Project, the largest Indigenous-led energy initiative, connects 17 remote communities to the provincial grid, reducing diesel dependence[148]. The Henvey Inlet Wind Project, a 300 MW wind farm co-owned by Henvey Inlet First Nation, demonstrates Indigenous leadership in large-scale renewable energy[149]. Other notable projects include the Gull Bay First Nation Diesel Offset Microgrid and the Aroland First Nation Solar Project, showcasing Indigenous commitment to clean energy and economic empowerment[150].

5.2.2 Government support and funding

Federal and provincial programs provide crucial financial and technical support for First Nations' clean energy initiatives in Ontario, fostering sustainable development and energy independence. Various funding programs and initiatives have been established to support Indigenous participation in the clean energy transition, including:

- Indigenous Energy Support Program (IESP)
- Aboriginal Loan Guarantee Program (ALGP)
- Indigenous Leadership Fund
- Smart Renewables and Electrification Pathways Program (SREPs)
- First Nations Clean Energy Business Fund (FNCEBF)
- Remote Electrification Readiness Program (RERP)
- Ontario Indigenous Economic Development Fund (IEDF)

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[146] Government of Canada. (2023, November 14). *Government of Canada launches the Indigenous Leadership Fund to support First Nations, Inuit, and Métis climate action*. https://www.canada.ca/en/environment-climate-change/news/2023/11/government-of-canada-launches-the-indigenous-leadership-fund-to-support-first-nations-inuit-and-metis-climate-action.html

[147] Government of Canada. (2022, April 25). *Government of Canada investing $300 million in clean energy projects in Indigenous, rural, and remote communities*. https://www.canada.ca/en/natural-resources-canada/news/2022/04/government-of-canada-investing-300-million-in-clean-energy-projects-in-indigenous-rural-and-remote-communities.html

[148] Government of Ontario. (2024). *Wataynikaneyap Power Project.* Retrieved from https://news.ontario.ca/en/release/1005040/ontario-supporting-the-largest-indigenous-led-energy-project-in-provinces-history

[149] Henvey Inlet First Nation. (2024). *Henvey Inlet Wind Project.* Retrieved from https://www.hifn.ca.

[150] Lim, A. B., Poelzer, G., & Noble, B. (2024). *Social value of renewable energy in remote northern Indigenous communities.* Journal of Aboriginal Economic Development. Retrieved from https://www.erudit.org/en/journals/jaed/2024-v14-n1-jaed09454/1112519ar/abstract/.

- Community Energy Champion (CEC) Program
- Green Infrastructure Stream of the Investing in Canada Plan

These programs collectively contribute to the advancement of Indigenous clean energy projects in Ontario, driving environmental sustainability, job creation, and community empowerment.

5.2.3 Economic development benefits

Indigenous clean and renewable energy projects in Ontario have created significant job opportunities and economic benefits for First Nations communities. The Henvey Inlet Wind Project, Ontario's largest First Nations wind energy project, generated over 1,000 jobs during its construction and continues to provide operational employment. The Wataynikaneyap Power Project, which aims to connect remote Indigenous communities to the provincial power grid through renewable sources, has provided employment for over 750 Indigenous workers**,** with ongoing opportunities in infrastructure maintenance. Additionally, geothermal and solar initiatives in the Niagara region have resulted in around 200 permanent jobs, while solar installations within the Whitefish River First Nation have created between 50–100 jobs. These projects, supported by government initiatives such as the Indigenous Clean Energy Initiative (ICEI), foster skills development and long-term employment opportunities in sustainable energy[151].

5.2.4 Capacity building and collaboration

Capacity-building programs focused on community engagement, education, and workforce training empower First Nations to shape their energy future. The Indigenous Workforce Development Program, with $1.9 million in funding, creates employment opportunities in the energy sector[152]. The 20/20 Catalysts Program**,** by Indigenous Clean Energy Inc., provides hands-on training and mentorship to advance renewable projects and leadership capacity[153]. Additionally, the Save on Energy First Nations Community Building Retrofit Program offers funding and technical support to improve energy efficiency in band-owned facilities, fostering local expertise[154].

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[151] Bauche, M. (2024). *Clean Energy Funding in Saskatchewan*. Policy Commons. Retrieved from https://policycommons.net/artifacts/12368113/clean-energy-funding-in-saskatchewan-contents/13264576/.

[152] Government of Canada. (2024). *Indigenous Leadership Fund.* Retrieved from https://www.canada.ca/en/environment-climate-change/services/climate-change/low-carbon-economy-fund/indigenous-leadership.html

[153] Indigenous Clean Energy. (2024). *20/20 Catalysts Program.* Retrieved from https://indigenouscleanenergy.com/2020-catalysts-program/

[154] Independent Electricity System Operator (IESO). (2024). *First Nations Community Building Retrofit Program.* Retrieved from https://saveonenergy.ca/en/First-Nations-Energy-Programs/First-Nations-Community-Building-Retrofit-Program

5.3 Recommendations

To address these challenges and maximize opportunities, the following strategic recommendations are proposed:

5.3.1 Policy reform and regulatory improvements

To facilitate greater Indigenous participation in energy development, it is crucial to streamline regulatory processes and remove bureaucratic barriers that hinder First Nations' involvement. Strengthening the enforcement of Free, Prior, and Informed Consent (FPIC) is essential to ensure that Indigenous communities have a meaningful voice in energy projects that affect their lands and resources. Additionally, policies must be introduced to provide long-term, flexible funding arrangements that support not only project development but also ongoing maintenance and operational sustainability. This will help address the financial uncertainty that often undermines long-term planning efforts.

5.3.2 Strengthening financial and technical capacity

Expanding access to funding programs tailored to the specific needs of First Nations communities is vital to empower them in the clean energy transition. Many communities face financial constraints that limit their ability to develop and sustain energy projects. In addition to funding, dedicated technical assistance programs should be developed to support communities throughout the project lifecycle; from planning and implementation to long-term management. Establishing partnerships with industry stakeholders and government agencies can further enhance capacity-building efforts by providing mentorship opportunities and fostering knowledge exchange, ultimately enabling First Nations to lead their energy initiatives with confidence.

5.3.3 Infrastructure investment and modernization

Investing in modern energy infrastructure is critical to ensuring reliable and sustainable energy solutions for First Nations communities. Prioritizing the deployment of technologies such as microgrids and smart grid systems can enhance energy efficiency and reliability, particularly in remote areas. Equitable distribution of resources is necessary to ensure that all communities, regardless of their geographic location, have access to clean and affordable energy. Furthermore, promoting energy storage solutions, such as battery storage systems, can help address the intermittency challenges associated with renewable energy sources, improving energy security and resilience in off-grid and underserved areas.

5.4 Conclusion

Achieving energy sovereignty for First Nations communities in Ontario is a multifaceted endeavor requiring a coordinated effort among Indigenous leadership, government, and industry partners. Addressing key challenges such as policy barriers, infrastructure limitations, and funding constraints will pave the way for meaningful participation in the clean energy transition. By leveraging available opportunities, such as Indigenous ownership models, government support, and capacity-building initiatives, First Nations can achieve long-term sustainability and self-determination in energy development.