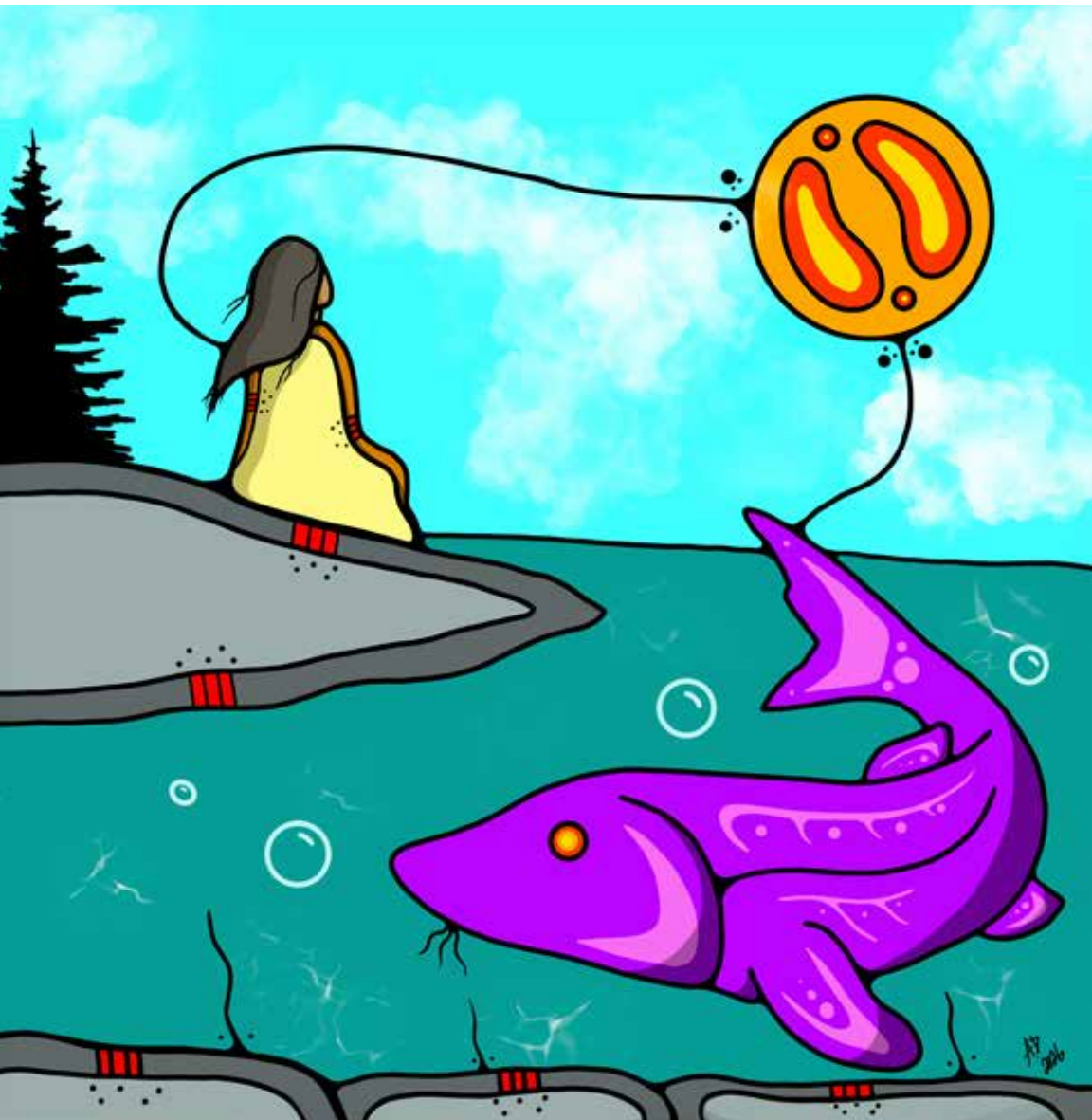


# Indigenous Community Guide to Waterpower Development



# Land Acknowledgement

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By acknowledging the traditional and treaty territories upon which waterpower facilities are located, the OWA and its members respect the relationship Indigenous people have with the land, water and natural environment. The OWA is committed to relationship building and supporting economic reconciliation with Indigenous communities through the responsible development of waterpower in Ontario.

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*Original front cover artwork by Alex Dokis, Dokis First Nation*

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# Introduction

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Ontario's electricity system is undergoing a generational shift to meet decarbonization, electrification and economic development objectives. By some estimates, the province may almost have to double its installed capacity of electricity generation by 2050 – the equivalent of building as much generation and transmission in the next three (3) decades as has been built in the last century. In addition, with the exception of waterpower, assets which last virtually forever, almost all of Ontario's existing generation facilities will need to be rebuilt or replaced within the same timeframe.

Ontario's Indigenous communities are already at the forefront of this transition, as proponents and partners in new transmission and generation projects, including waterpower, and this participation can only be expected to grow in the coming years and decades.

This guide is a high-level overview of the many considerations involved in a waterpower project. It is designed to support Indigenous communities who will be proponents (i.e., the developer), partners or participate otherwise in waterpower projects. It provides an initial introduction to Ontario's electricity system, the determination of waterpower potential, environmental considerations and business development models. It also includes reference sources for communities interested in exploring opportunities in more detail.

Our goal is to provide you, the reader, with relevant information about waterpower in an easy-to-understand format. In creating version 3 of this guide, we hope we have achieved this and welcome all comments and suggestions to enhance future versions. Please provide your comments to [info@owa.ca](mailto:info@owa.ca).



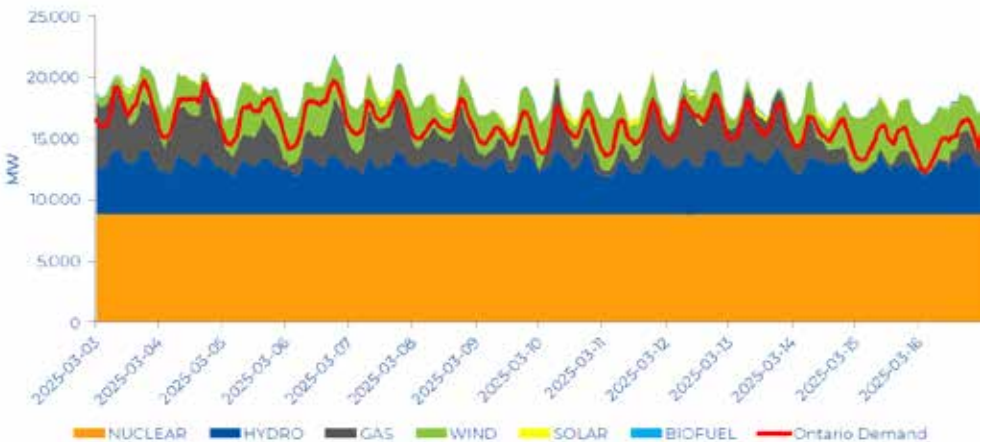
*Figure 1 Construction phase of community waterpower development.*

# 1.0 Ontario's Electricity System

Ontario has a clean electricity grid with a range of diverse resources, including hydro, nuclear, natural gas and renewables. Each resource generates electricity differently and has unique operating characteristics. Because no single resource can meet all of the system's needs at all times, maintaining a diverse supply mix is an effective way to ensure the ongoing reliability of Ontario's electricity system. Waterpower currently accounts for approximately one-quarter of Ontario's installed capacity for electricity generation. In meeting the challenge of emergent and enduring growing demand for electricity, it is widely agreed that an "all of the above" approach will be required.

Today we have a very large transmission system – a web of wires, towers and transformers – that moves and distributes the electricity. This is a very sensitive and complex process that involves precise attention to many interconnected details. The quantities of electricity being generated in different ways and at different locations must be balanced with how much electricity is needed where, and when. In realizing Ontario's untapped waterpower potential to help meet demand growth, new and expanded transmission and distribution facilities will be required, and Indigenous communities will be directly involved in this expansion.

Figure 2



## 1.1 Waterpower’s role in Ontario’s electricity system

Waterpower plays a particular role in the province’s overall energy system mix. It provides base-load and peak-load generation. This means that, depending on the type of facility, waterpower can provide a constant electricity supply and/or generate electricity in response to changes in demand. The flexibility of Ontario’s waterpower fleet (>220 facilities) is illustrated in Figure 2.

Waterpower is also critical to system reliability. As illustrated in Figure 3 below, among technologies, waterpower is the only resource that provides all essential system reliability services.

| Resource Type   | ESSENTIAL RELIABILITY SERVICES            |                 |            |                         |                | FLEXIBILITY |   |  | OTHER               |
|-----------------|---|-----------------|------------|-------------------------|----------------|-------------|---|--|---------------------|
|                 | Frequency Response<br>(Inertia & Primary) | Voltage Control | Ramp       |                         |                | Cycle       | Short Min. Run Time<br>(<2 hrs) / Multiple Starts Per Day | Startup/Notification<br>Time <30 Minutes | Black Start Capable |
|                 |   |                 | Regulation | Contingency<br>Response | Load Following |             |   |  |                     |
| Waterpower      | ●   | ●               | ●          | ●                       | ●              | ●           | ●   | ●  | ●                   |
| Gas             | ●   | ●               | ◐          | ●                       | ◐              | ●           | ●   | ●  | ●                   |
| Nuclear         | ◐   | ●               | ○          | ○                       | ◐              | ○           | ○   | ○  | ○                   |
| Battery Storage | ◐   | ◐               | ●          | ●                       | ○              | ●           | ●   | ●  | ◐                   |
| Demand Response | ○   | ○               | ◐          | ◐                       | ◐              | ●           | ●   | ◐  | ○                   |
| Solar           | ◐   | ◐               | ○          | ○                       | ◐              | ●           | ●   | ●  | ○                   |
| Wind            | ◐   | ◐               | ○          | ○                       | ◐              | ●           | ●   | ●  | ○                   |

Figure 3 Reliability Services. Adapted from various sources and Waterpower Canada’s “Hydropower’s Value to Net-Zero Electricity Grid” report

## 1.2 Key Agencies and Ministries

The Independent Electricity System Operator (IESO) works at the heart of Ontario’s power system. The IESO delivers key services across the electricity sector including: managing the power system in real-time, planning for the province’s future energy needs, enabling conservation and designing a more efficient electricity marketplace to support sector evolution.

## The IESO:

- coordinates and integrates Ontario's electricity system. System operators monitor the energy needs of the province in real time – 24 hours a day, 7 days a week – balancing supply and demand and directing the flow of electricity across Ontario's transmission lines;
- oversees and evolves Ontario's electricity markets, driving competition to maintain affordability.
  - Reviews and accepts offers from electricity suppliers, starting with the lowest-cost options, until Ontario's energy needs are met
  - Sets and enforces rules that govern participation in Ontario's electricity markets
  - Fosters an open, dynamic and sustainable marketplace that encourages new opportunities for emerging resources
- uses forecasts to inform future infrastructure planning and supply procurement. These forecasts consider many variables, including:
  - The impact that weather could have on demand
  - The sector's ability to make - and deliver - enough power to Ontario's communities
  - Future electricity demand drivers, such as the opening of new manufacturing plants, electric vehicle uptake and economic sector growth
- works closely with municipalities, Indigenous communities and other sector partners to understand local electricity requirements and priorities, and to determine the best options to meet growing needs.

The **Ontario Energy Board (OEB)** is an independent regulator of the electricity and natural gas sectors. The Board protects consumers and makes decisions that serve the public interest. Its goal is to promote a sustainable and efficient energy sector, for today and tomorrow. It is an independent entity with a Board of Directors, a Chief Executive Officer, Chief Corporate Services Officer & General Counsel, Chief Operating Officer and Commissioners led by a Chief Commissioner. The OEB:

- Sets the delivery rates energy utilities can charge
- Approves major new electricity transmission lines and natural gas pipelines

- Approves corporate changes by energy utilities
- Establishes and enforces the rules for energy companies operating in Ontario
- Monitors the wholesale electricity market and the financial and operational performance of utilities
- Develops new energy policies and provide unbiased advice to government
- Licenses energy companies in the electricity sector and natural gas marketers
- Provides information and tools to help consumers understand the rules that protect them and their responsibilities

The **Ministry of Energy and Mines (MEM)** is responsible for setting government policy to ensure a safe, reliable and affordable energy supply across Ontario.

The **Ministry of Natural Resources (MNR)** makes Ontario's Crown land resources available for transmission and generation opportunities. MNR policies and procedures guide the orderly release of potential waterpower sites.

### **1.3 Power System Planning**

A long-term view of Ontario's electricity system, the IESO's Annual Planning Outlook (APO) forecasts electricity demand, assesses the reliability of the electricity system, identifies capacity and energy needs, and explores the province's ability to meet them. In providing comprehensive information and insights about future electricity needs, and other considerations, including system performance, the outlook helps inform the decisions that will lay the foundation for a reliable and affordable electricity future.

The APO provides a long-term view of Ontario's electricity system, forecasting system needs and exploring the province's ability to meet them. Looking forward using current, confirmed information, it gives the sector the most predictive signals possible to serve as a guide for near-term investment decisions and activity.

### **1.4 Electricity procurement**

One of the ways the IESO helps meet Ontario's energy needs is through securing new supply through competitive procurements. The IESO

works with large grid-connected generators, small-scale distribution-connected producers, communities, small businesses and individuals to address future supply challenges in a timely and cost-effective manner.

The IESO's Resource Adequacy Framework sets out a competitive strategy for securing new generation resources in the short, medium and long term, the majority of which feature some form of contract with a supplier. This framework aligns acquisitions with evolving needs, balances ratepayer and supplier risk and recognizes the unique characteristics of different resource types.

The IESO publishes Resource Adequacy updates that provide a status report on how competitive procurements are helping to meet Ontario's future energy needs. Many of these procurements for new generation provide a competitive advantage to projects with local Indigenous equity participation.

Every Indigenous community is unique. Indigenous peoples and communities are expected to have a range of views towards a proposed waterpower project. Some communities are interested in the economic

opportunities that a waterpower development can offer. Others may have concerns with the potential impact of a project on established or asserted Aboriginal and Treaty rights. Many communities will have both of these considerations to bring to the table. It is important that the rights, aspirations and concerns of Indigenous peoples are identified and acknowledged early during the planning of waterpower projects.



*Figure 4 Construction phase of community waterpower development.*

# 2.0 Community Involvement

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## **2.1 Potential benefits to communities**

Waterpower offers potential community economic development opportunities for self-reliance through:

- full, majority or partial ownership of projects;
- capacity building;
- training and job creation; and/or
- a business relationship with a proponent.

Revenue generated from waterpower development can be reinvested in the project to increase the level of ownership, used for other community needs such as housing and infrastructure development, or invested in other economic development projects.

Properly constructed facilities with regular maintenance and refurbishing can last over 50 years, with many still generating electricity after 75 to 100 years of operation.

Waterpower development offers a clean and renewable way to strengthen local electricity supplies. For example, waterpower can reduce dependence on diesel generated electricity in remote communities.

## **2.2 Potential considerations for communities**

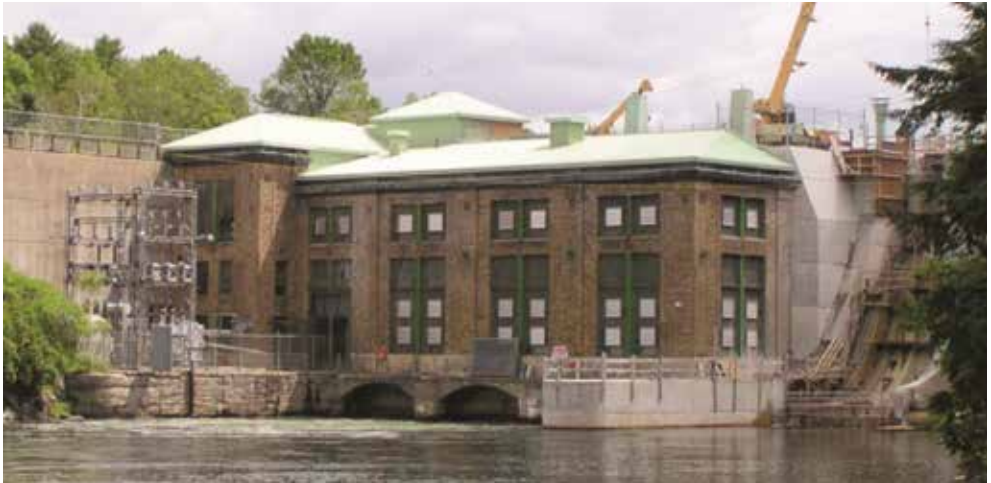
When participating in development projects, communities need to be aware of some of the challenges associated with pursuing these opportunities. Challenges may include finding skilled advisors and raising sufficient funds to cover the feasibility studies of a potential project during the pre-development stage. These studies are crucial to determine the financial viability of the project from the beginning and to identify potential construction issues and environmental considerations.

When communities engage in waterpower projects they need to become familiar with the approvals that take place before any development can occur. The acquisition of permits and approvals for building along rivers can take several months to years. Another significant issue is the potential for competing community priorities.

### **2.3 Community Energy Plans**

To carefully assess the costs and benefits of waterpower projects, and energy projects more generally, many Indigenous communities have developed Community Energy Plans. These plans look at:

- how much energy a community is using now and in the future;
- ways to increase energy conservation; and
- opportunities to become involved in commercial electricity generation and/or transmission.



*Figure 5 Orillia Power’s Swift Rapids Generating Station*

# 3.0 An Introduction to Waterpower

Waterpower generation harnesses the energy of moving water. When water flows downhill the force of gravity changes the potential energy to kinetic energy. The higher the hill, or drop, the more kinetic energy is created. The first step in changing the kinetic energy into electricity is to divert the water from the main water body (e.g., the river), direct it through an intake pipe into the penstock, and then into a powerhouse containing a turbine(s), a generator, and controls. The momentum (kinetic energy) of the flowing water forces the blades of a turbine to move. The turning of the blades causes a shaft to spin and this, in turn, spins the rotor of a generator. When the rotor in the generator is spun, an electromagnetic field and electricity is generated.

## 3.1 How does waterpower work?

The following sketch illustrates a typical waterpower development and the key elements of a project.

Definitions of these key features are as follows:

- 1. Headpond:** Area of the waterbody immediately upstream of the intake. The elevation of the headpond is used to calculate the head available for the project, and in turn, the amount of energy the project can produce.
- 2. Hydroelectric Dam:** A structure constructed to create a reservoir, maintain a headpond at a certain level, and direct water into the power plant intake.
- 3. Spillway/Sluiceway:** An opening in the dam that allows water to pass without going through the plant. This is done to maintain

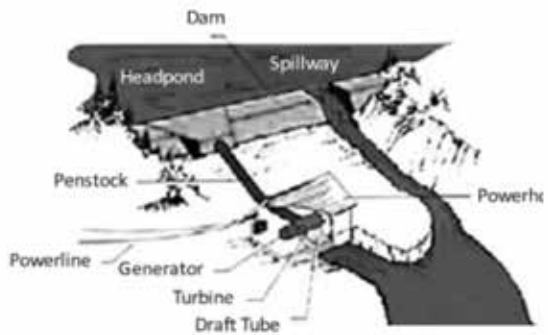


Figure 6 Components of a Hydro System

environmental flows important to the ecology of that section of the river. It also helps to manage higher flows during the spring or during very heavy rainfall events.

4. **Intake:** A structure, generally made of concrete, that is the opening through which the water leaves the headpond and goes into the power plant trashrack to keep debris from entering the plant.
5. **Penstock or Tunnel:** A penstock is a pipe or tunnel that carries the water from the intake to the powerhouse.
6. **Powerhouse:** A building containing the generating equipment, control room, electrical switches etc.
7. **Turbine:** The part of the generating equipment that water flows through to rotate the blades and spin the generator shaft.
8. **Generator:** The part that converts the mechanical energy from the spinning shaft into electrical energy using magnetic fields.
9. **Draft Tube:** A pipe that discharges the water from the turbine to the tailrace.
10. **Tailrace:** An open canal that returns all the water originally diverted from the river back to the original river course.
11. **Switchyard:** A fenced in area containing the transformer that converts the electricity from the generation voltage to the transmission voltage. It is from here that the electricity is connected to the transmission line, which then takes the electricity to homes and businesses.



*Figure 7 View inside a powerhouse*

### **3.2 What are the different types of waterpower facilities?**

Different types of waterpower structures suit different locations for reasons including: terrain, amount of water available, environmental impacts, construction and operating costs, local demand, and economic viability.

Waterpower facilities can be characterized by the degree to which they involve water storage. The four main types are:

- Run-of-river
- Run-of-river with modified peaking
- Reservoir storage and cascade systems
- Pumped storage

#### **Run-of-River**

A run-of-river facility uses only the natural flows in the river, as they are available, for generation. Therefore, the flow in the river is either passed through the plant, or partially released around the plant if the flow exceeds the capacity of the plant to use all of it.

#### **Run-of-River with modified peaking**

Many run-of river plants allow for limited storage of water over the course of the day or days. This allows the plant to produce more electricity during periods of high demand i.e., during the day/work week, and save water during periods of low demand i.e., at night/weekends. This type of plant can provide electricity service to the system, but with limitations imposed by the amount of storage and flexibility available (generally through a headpond).

#### **Reservoir storage and cascade systems (peaking)**

These are waterpower projects that use reservoirs to store water from periods of high flow, such as during the spring. The stored water is then used to generate electricity during low flow periods such as during the winter or summer. Reservoirs may be managed specifically for waterpower production at the site and may also serve a series (or cascade) of facilities downstream. Note that this type of management regime is also used for purposes other than electricity generation (e.g., flood control). Big Eddy, High Falls and Nairn on the Spanish River are a good example of a cascading system.

## Pumped storage

Pumped storage facilities pump water from a lower reservoir to a higher reservoir during off-peak periods. This water is then released from the upper reservoir through the plant to generate electricity during peak periods e.g., Sir Adam Beck's pumped storage facility at Niagara Falls. The key to the success of this type of plant is to spend less money pumping the water up to the higher reservoir than you make when you release it to generate electricity. In ideal conditions, pumped storage is the perfect partner for wind energy: wind energy can help to pump the water to the higher reservoir when the wind is available and allow the water-power to supply power to the grid during the peak or high load times.



*Figure 8 Run-of-River facility on the Bonnechere River*

# 4.0 How to Assess Waterpower Site Viability

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Assessing the viability of a site will tell us if it is worth developing. There are three major factors to consider:

- how much electricity the site is physically capable of generating;
- what the social and environmental values of the river are; and
- where and what type of grid connections are available.

To determine how much electricity a waterpower site can generate consider:

- the head, or the height of the vertical drop the water will fall;
- the quantity or flow of water; and
- electricity generation.

## 4.1 Head and site viability

The head is an important factor in the electricity generation equation. In general, for a plant to be economically feasible, the height that the water will fall (head) usually needs to be greater than 3 metres. The higher and steeper the drop, the less water you need to create the same amount of electricity. Conversely, the lower the head, the more water you will need.

## 4.2 Water flows and site viability

The flow of water available to run through the turbines is equally important. More water = more electricity. Flow is a physical measurement of the amount or volume of water in the river over time. It is measured in cubic metres per second (m<sup>3</sup>/s) The amount of water available for the turbine needs to be determined through a multiuse approach that balances the actual physical amount of water in the river with all the demands (wildlife, businesses, social) on the same resource.

Figure 9 illustrates one year of the daily flows on Batchawana River, an unregulated river in Ontario.

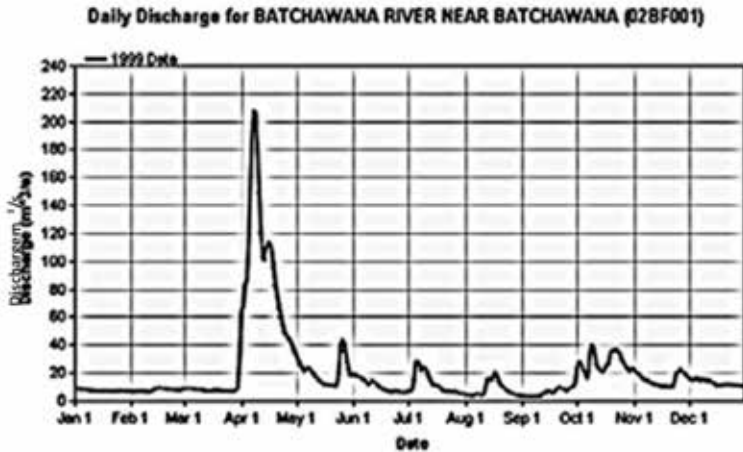


Figure 9 Daily Discharge for Batchawana River near Batchawana (02BF001)

Figure 9 shows that during one year the river experienced low flows from January through April. In mid-April the flows dramatically increase, reflecting the spring melt water runoff. By mid-May, the flows are again low for the summer season. Several spikes from June through December indicate rainy periods.

By analyzing this flow data over time, a **Flow Duration Curve [FDC]** can be made to provide a good summary of the changes in river flow.



Figure 10 Flow Duration Curve

This flow duration curve shows the percentage of time (x-axis) that the flow in the river in m<sup>3</sup>/s (cubic metres per second – y-axis) has reached or exceeds a given flow rate.

For this example the flow in the river is greater than 75 m<sup>3</sup>/s approximately 5% of the time (point A).

For most run-of-river projects, it is generally advisable to pick a plant flow in the order of 50 to 65% exceedance. Therefore, if we were to pick the 50% exceedance flow, we would get approximately 10 m<sup>3</sup>/s (point B).

If the facility is going to produce electricity all year long it needs a steady flow all year long. In Ontario this usually means that an upstream lake or reservoir is required.

### 4.3 Annual energy generation potential (site capacity MW)

To estimate annual energy generation potential, first determine the MW capacity of the site using a simple equation:  $P = H * Q * g * e$  where:

- P = Power or capacity of the plant in kW
- H = Head in meters i.e., the distance the water falls or the difference between the headpond elevation and the tailwater elevation.
- Q = Plant flow in m<sup>3</sup>/s as determined above (for above example Q(50%) = 10 m<sup>3</sup>/s)
- g = Gravitational constant = 9.8
- e = Efficiency of the generating equipment. As a first guess a value of 85% or 0.85 can be used until additional information is obtained from an engineering consultant or equipment supplier.

Example – for a site with a head of 15 metres then:

$$P = H * Q * g * e$$

$$P = 15 \text{ m} \times 10 \text{ m}^3/\text{s} \times 9.8 \times 0.85$$

$$P = 1,250 \text{ kW so } P = 1.25 \text{ MW}$$

Therefore, the plant potential capacity would be approximately 1.25 MW.

Once you know the approximate size of the plant, calculate the amount of energy generation (E) that can be expected per year:

$$E = P \times \text{time} \times \% \text{ of time the plant will run at capacity}$$

$$P = \text{Power or capacity in MW. Use } P = 1.25 \text{ MW from example above.}$$

Time = number of hours in a year = 24 hours/day x 365 days/year = 8,760 hours/year

A consultant will have to give you an estimate of the percentage of time the plant will run at capacity based on your site. However, for a very rough estimate, 55% may be assumed. This will account for repair times and low flow periods when the plant cannot run at full capacity. Therefore, from our earlier example:

$$E = P \times \text{time} \times 55\%$$

$$E = 1.25 \text{ MW} \times 8,760 \text{ hours/year} \times 0.55$$

$$E = 6,022 \text{ MW hours}$$

**Note:** This example is based on a run-of-river type of project. Projects that involve any type of water storage/reservoir will need to determine and factor in the other uses or values of the stored water.

# 5.0 Waterpower and the Environment

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When considering the potential impacts of waterpower development, the term “environment” is used in a broad sense to include the natural environment as well as social and cultural values. From a natural environment perspective, a key benefit of producing energy through waterpower is that this energy is emissions-free (i.e., compared to CO<sub>2</sub> emitting forms of energy production). While this is a significant benefit, it is important to understand that there can also be local environmental impacts associated with waterpower development and operations.

## 5.1 Key considerations

Aspects of the environment that may be affected by waterpower include:

- **Fish and Fish Habitat** – The vast majority of new waterpower projects are anticipated to involve potential effects related to fish and fish habitat (as defined in the federal Fisheries Act).
- **Aquatic Ecology** – changes in water levels, temperature, etc. can affect nutrient enrichment, access to aquatic species habitats, and connections between the river channel and the floodplain e.g.,
  - Downstream Ecosystems (erosion, low flows)
  - Upstream Ecosystems/Reservoirs (flooding, sedimentation)
- **Water-Resource Users** – navigation, resource-based tourism, water intakes. These potentially interested parties are important to consider for early involvement in a proposed waterpower project.
- **Water-Related Natural Resource Use** – e.g., recreational fishing, fur harvesting, baitfish harvesting and wild rice harvesting.
- **Riparian owners** – a riparian owner is a person who owns land that goes to the water’s edge. The rights of riparian owners must be respected and accommodated and the interests of other affected land-owners must be considered in the development of waterpower.



*Figure 11 Run-of-river facility under construction at Umbata Falls*

## **5.2 The importance of flow regime**

***Flow regime*** is a concept that covers many parts of a river's behaviour including: magnitude, frequency, duration, timing, and rate of change. Flow regime is a defining characteristic of river systems, and is important to its environmental health and integrity, as well as to the interests of other users of the resource.

***Flow magnitude*** refers to the volume of water moving past a fixed point over a period of time. Waterpower facilities and dams modify flow magnitude in rivers by holding water back in reservoirs and controlling the discharge of water below the dam.

***Flow frequency*** refers to how often a flow of a certain magnitude takes place over a specific period of time. Waterpower operations and other control structures can change the recurring pattern of flows on long and short-term scales.

***Flow duration*** is the interval of time, or how long or short a flow occurs. This can be affected by waterpower facilities with storage reservoirs, which manage water discharge to maintain flows for longer or shorter periods than what would naturally occur in the river.

The ***timing of flows*** relates to the release of water through waterpower turbines, to generate electricity during certain seasonal periods or times throughout the day. The timing of flow events created by waterpower operations often differs from that of an undeveloped river.

Finally, the *rate of change of flow (or ramping rate)* refers to how quickly flow rates can change in a specific period.

River flow plays a very central role in the life of a river. Here we have outlined the connections between potential environmental impacts and the many types of alteration to flows, and Section 4 laid out how a waterpower site's viability is dependent on flow. This is the fundamental challenge and opportunity of the power of water – to achieve a balanced sharing, a sustainable use, of this resource through understanding, respect, compromise, and cooperation.

### **5.3 Class Environmental Assessment for Waterpower Projects**

The Ministry of the Environment, Conservation and Parks (MECP) describes environmental assessment (EA) as a planning process that allows proponents to assess the potential for effects on the environment using the best information available in order to make an informed decision about how or whether a project should proceed.

In October of 2008, the Ontario Waterpower Association's Class EA for Waterpower Projects was approved by the Ministry of the Environment and is now the source document for understanding the rules governing the development of waterpower facilities. The Class EA has been continuously updated and improved since its initial approval and, as of 2024, was in its tenth edition. The Class EA ensures clear requirements for considering environmental impacts and working with communities to design projects. As illustrated in Figure 12, a key objective of the Class EA is the coordination and integration of the multiplicity of provincial and federal requirements into a single process for the project.

As outlined in Section 7 of the OWA Class EA Indigenous communities are expected to have a range of views to offer and contribute. Some communities are interested in the economic opportunities that a waterpower project, as a form of renewable energy, can offer. Others may have concerns with the potential impact of project on their traditional uses of land, water and resources. Engagement may take on different forms in each community, depending on both the scope of the project and the interests of the community. The common thread with respect to Indigenous interests and waterpower development is the need for openness and inclusiveness. It is important to be aware of the potential impacts that environmental change can have on Indigenous communities. In many cases, activities that affect the environment will also affect the ability of communities to exercise their Indigenous and Treaty

rights to use the land and its resources, and may also have far-reaching economic, social and cultural effects. Thus, it is important that the rights and concerns of Indigenous communities are acknowledged during the planning of waterpower projects.

Further, any project that interferes with or infringes on the exercise of these rights or potential rights may result in a duty to consult on the part of the Crown. Nothing in the Class EA is intended to alter or detract from any obligation the Crown may have to consult with Indigenous communities in light of the protection provided for the existing Aboriginal and treaty rights of the Indigenous peoples of Canada as recognized and affirmed in Section 35 of the Constitution Act, 1982.

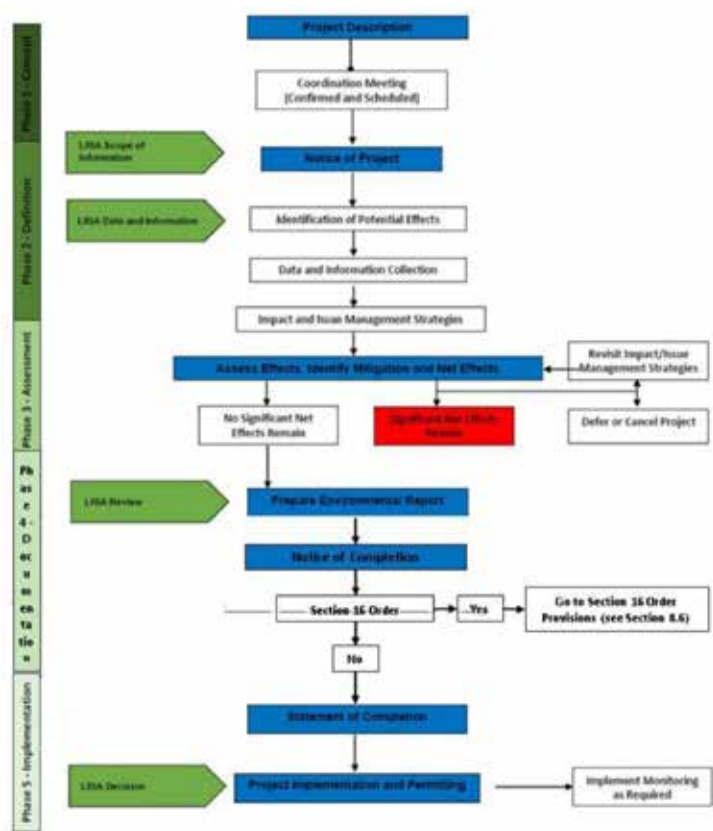


Figure 12 Class EA for Waterpower Projects

The outcome of the Class EA process is used to inform the more detailed project permitting and construction phases of a project. EA is neither the beginning nor the end of the project cycle.

# 6.0 Getting the Power to Market

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Ontario has a very diverse energy supply from nuclear, gas, wind, solar, energy storage and water. A complex grid system – a web – of wires, towers and transformers moves the electricity from where it is made to where it is used.

Connecting a waterpower project to the existing grid is typically negotiated between the developer and the applicable local distribution company or transmitter.

Connections are made to the grid system at the location that can manage the level of power (voltage) generated by the project. The closer a proposed site is to an interconnection point the better because of the costs of:

- Building the transmission corridor; and
- Transmitting the electricity produced.

There are three important factors to consider in assessing power transmission for a project: design, cost, and timing.

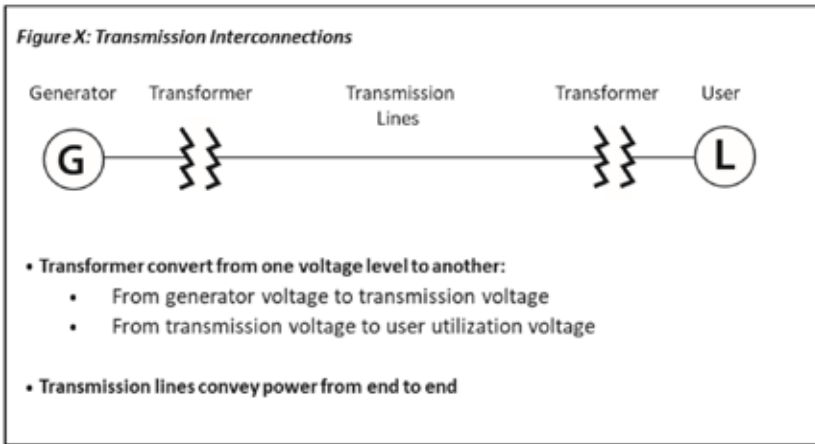
## 6.1 Design considerations

The provincial power grid is made up of transmission systems and distribution systems:

- **Transmission systems** are the high voltage lines (44,000 Volts to 500,000 Volts) and associated transformer stations – that you see across the province, the tall steel towers carrying many wires.
- **Distribution systems** deliver electricity locally using community facilities, such as customer connections and substations and sub-transmission circuit at lower voltages (12,500 Volts to 44,000 Volts) – the wires on wooden poles along the road that bring the electricity to your home.

There are usually 3 parts involved in generator interconnection; the transformer/ substation, the transmission line, and the switching substation. These are shown in Figure 13.

The **transformer/substation** is where the electricity generated at the site is increased to a suitable voltage level to travel the distance to the grid.



*Figure 13 Transmission Interconnections*

The **transmission or distribution line** carries the power from the site's transformer to the switching substation at the grid.

The **switching substation** is where the power line is connected to the power grid transmission or distribution lines. It can be an existing substation site or one that is built specifically for the project.

**It takes energy to send energy.** Generally, the higher the power distribution voltage, the farther it will travel. The table below shows how much power can be transmitted at different voltage levels, over defined distances.



*Figure 14 Transmission Corridor*

| Voltage Level (kV) | Power Transfer Capability (MW) at Given Distance |      |       |       |
|--------------------|--|------|-------|-------|
|                    | 10km   | 50km | 100km | 200km |
| 12.5               | 11   | 1.6  |       |       |
| 25                 | 23   | 6.3  |       |       |
| 27.6               | 25   | 7.6  |       |       |
| 34.5               | 31   | 12   |       |       |
| 44                 | 40   | 19   |       |       |
| 69                 | 62   | 48   |       |       |
| 115                | 181  | 132  | 15    |       |
| 230                | 417  | 417  | 37    |       |
|                    |  |      | 102   | 63    |
|                    |  |      | 410   | 251   |

Figure 15 Power Transfer Capability (MW) at Given Distance. Source SNC Lavalin

According to Figure 15, the maximum amount of power that could be transmitted a distance of 50 km using a 12.5 kV line is 1.6 MW. A project bigger than this or further away would have to use a higher voltage line.

### 6.2 Cost considerations

The cost of connection to a power network increases with the voltage level of the network. It is usually best to connect to the closest transmission or distribution grid that can absorb the power. The table below shows typical pricing for transmission and distribution lines and power substation facilities, needed to connect a generation project to the grid.



In addition to these first costs for design, procurement, and construction of interconnection facilities and lines, there will be ongoing costs for operation and maintenance of the facilities. These costs are typically low at the beginning and increase over time as equipment and infrastructure ages.

Figure 16 Switchyard at Sir Adam Beck I

| Element  | Description          | Details   | Units                                     | Typical Cost<br>(Cdn \$) |
|--|----------------------|---|---|--------------------------|
| Line   | 12.5 kV ac single    | Wood pole   | Km  | 39,000                   |
|  | 25/27.6 kV ac single | Wood pole   | Km  | 52,000                   |
|  | 44 kV ac single      | Wood pole   | Km  | 65,000                   |
|  | 69 kV ac single      | Wood pole   | Km  | 97,500                   |
|  | 115 kV ac single     | Wood pole   | Km  | 156,000                  |
|  | 230 kV ac single     | Wood pole   | Km  | 325,000                  |
|  | 230 kV ac double     | Lattice tower   | Km  | 560,000                  |
|  | Substation           | Stepup Substation<br>13.8 kV to 25 or 27.6 kV or 44 kV                    | 5 MVA transformer,<br>LV and HV switching | Ea                       |
| Switching Substation at 25<br>kV or 27.6 kV or 44 kV |                      | Switching and protection at<br>utility connection point                   | Ea  | 250,000                  |
| Stepup Substation<br>13.8 kV to 115 kV               |                      | 10 MVA transformer,<br>LV and HV switching                                | Ea  | 3,000,000                |
| New Line Bay at Existing 115<br>kV Substation        |                      | Line entry for one 115 kV circuit   | Ea  | 1,250,000                |
| Switching Substation at 115<br>kV                    |                      | Tapoff switching station, plus<br>control and protection<br>modifications | Ea  | 4,000,000                |
| Stepup Substation<br>13.8 kV to 230 kV               |                      | 25 MVA transformer,<br>LV and HV switching                                | Ea  | 5,000,000                |
| New Line Bay at Existing 230<br>kV Substation        |                      | Line entry for one 230 kV circuit   | Ea  | 3,000,000                |
| Switching Substation at 230<br>kV                    |                      | Tapoff switching station, plus<br>control and protection<br>modifications | Ea  | 5,000,000                |

Note: These are 2008 price estimates and will vary based on soil conditions, site access and other factors.  
MVA - megavolt-amperes      LV - low voltage      HV - high voltage

*Figure 17 Transmission Interconnections.*

### 6.3 Timing considerations

The schedule for typical transmission or distribution interconnection is determined by the following sequence of activities:

- impact study with local electricity distribution company;
- regulatory approvals;
- construction permitting;
- project engineering;
- equipment procurement; and
- construction and facility start-up.



*Figure 18 Construction phase at Umbata Falls, Wawa*

# 7.0 The Business of Waterpower Development

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A feasible waterpower site is the foundation of a successful project. A strong business plan will make the project happen. Three things can determine the long-term success of the project:

- Identifying appropriate project team members;
- Finding appropriate business partners and adopting the right business model; and
- Choosing the best financial options.

## 7.1 Project team members

The project team is a group of people who work together to make the project a success. Every project is unique and, depending on the role of the community(ies), the project team will differ. If a community is a partner in the project they will bring knowledge of the site and surrounding area. If they have developed projects in the past they may bring technical expertise. The project team must include a mixture of technical and business team members, such as:

- **Developer:** The developer (proponent) is typically the one that takes the most risk on the project and as an equity (ownership) partner generally puts in the most money. The developer(s) will often be responsible for securing financing and permits/approvals, and will sometimes act as the engineer and/or constructor. The developer, in many cases, will also be the operator, at least for an initial period.
- **Engineer:** The engineer is the first technical expert required. The engineer will help determine the technical feasibility of building and operating the project, and will estimate the costs of construction and operation, revenues, and the Return on Investment (ROI) to determine profitability. Often the engineer will help to manage the entire design and construction process.
- **Environmental Consultant:** The environmental consultant will assist with assessing the potential environmental impacts of a project

and will suggest strategies to eliminate or minimize these impacts. They may also lead or review the environmental assessment process.

- **Lawyer:** The lawyer will help to review risks associated with the project, such as insurance, tax, land access, labour and financing. The lawyer will also help to create business and partnership models and, together with the engineer, will determine permit, approvals and licensing requirements and assist with obtaining them.
- **Banker:** A banker is often required to provide the debt portion of project financing i.e., the loan. This is the money required for the project that has not been contributed by the project developer.
- **Constructor:** In some cases the project partners, either the developer or the engineer, will take responsibility for construction. In other cases, the constructor will be contracted by the project team. Typically, construction is undertaken for a fixed price, and will involve qualified skilled labour and businesses.
- **Suppliers and Sub-contractors:** The constructor or developer will typically act as the general contractor responsible for obtaining all the skilled labour, equipment and materials required to build the project. A broad number of qualified suppliers and sub-contractors will be involved.
- **Operator:** The operator has the day-to-day responsibility for managing the facility in compliance with any applicable legislation, regulation and policy.

## **7.2 Business partners**

It is the project developer, with advice from other members of the project team, particularly the legal and financial advisers, who must decide on the approach to partnership in the project.

A partner needs to have the skills, interest and ability to contribute to the project. Potential business partners could include, businesses, Indigenous communities, municipalities or individuals. No matter who the potential business partner may be, these questions need to be answered:

- What level of financial risk is the potential business partner prepared to take?
- What financial capital, or other resources, does the potential business partner have available for initial investment?

- What is the potential business partner’s ability to raise equity (investment capital) and/or debt financing from other sources?

In some cases, the developer may be the Indigenous community(ies). In others, the Indigenous community may be a business partner along with one or more other developers.

### 7.3 Business models

The role of the Indigenous Community as a business partner will depend on:

- the willingness and capacity of the community to assume business risk (the higher the degree of ownership, the higher the risk);
- the ability of the community to provide capital (financial or otherwise) for initial investment; and
- the level of interest and capacity on the part of the community in taking on significant business responsibilities, such as a participation on a corporate Board with responsibility for overseeing the investment.

Below is a table of the three most common business partnership models. These may not be mutually exclusive and may be designed to change over the lifespan of the asset.

| Type                                  | Description   | Comment   |
|---------------------------------------|---|---|
| <b>Impact Benefit Agreement (IBA)</b> | Negotiated: win-win. Focus on offsetting (e.g., jobs, money) for any negative impacts. Indigenous Community involvement passive. Owner released from further obligation.                                      | Involves the least investment and least business risk to the Indigenous community.  |
| <b>Joint Venture Agreement (JVA)</b>  | Shared assets. Partners agree on percent ownership and responsibilities. Agreement defines governance structure and process, monetary flow, and conditions under which agreement can be altered or cancelled. | Involves Indigenous community investment in projects and assumption of business risks.  |
| <b>Limited Partnership (LP)</b>       | Shared assets. Partners have authority to decide what will be done. Provides more legal separation between the partners than a JVA.   | The dominant partner (which could be an Indigenous community) with greatest investment retains greater authority and liability. |

*Figure 19 Characteristics of Business Partnership Models*

Indigenous communities may or may not have the financial resources to contribute significantly to initial equity but may have a desire to increase their degree of ownership over time. One model that has been successful involves the Indigenous communities “purchasing” increased ownership over time by investing their share of project revenues and profits into the purchase of shares from other owners in the partnership, while other projects have begun with a majority ownership by Indigenous community(ies).

## **7.4 Community Support Programs**

### **IESO Indigenous Energy Support Program (IESP)**

The IESO’s Indigenous Energy Support Program (IESP) promotes broad equitable participation in Ontario’s energy sector for First Nation and Métis communities and organizations by supporting community capacity building, including energy planning and energy infrastructure development, as well as the building of energy knowledge and awareness, and skills related to energy projects.

The Program provides funding through three Areas of Funding (AOF):

- Capacity Building
- Economic Development
- Energy Resiliency & Monitoring

### **Building Ontario Fund’s Indigenous Opportunities Financing Program (IOFP)**

The \$3 billion loan guarantee program supports Indigenous participation in electricity infrastructure projects, including renewable energy infrastructure in Ontario (e.g., wind, solar and hydroelectric generation projects) and transmission projects.

The program provides a Provincial guarantee for a loan to an Indigenous entity to finance a portion of its equity investment (typically about 75 per cent) in an eligible project.

The program is available to entities that are wholly-owned by Indigenous communities. By participating in eligible renewable energy projects, First Nation and Métis communities could benefit from jobs and training as projects are developed and from potential dividends once projects come into service.

## Natural Resources Canada RETScreen International Software

NRCAN has developed and made publicly available The RETScreen Small Hydro Project Model, providing a means to assess the available energy at a potential small hydro site that could be provided to a central-grid or, for isolated loads, the portion of this available energy that could be harnessed by a local electric utility (or used by the load in an off-grid system).

### **7.5 Financing options**

There are two ways of finding the money for a project:

- Equity – where a company, individual or community invests their own money
- Debt – where money is borrowed from outside third parties such as banks

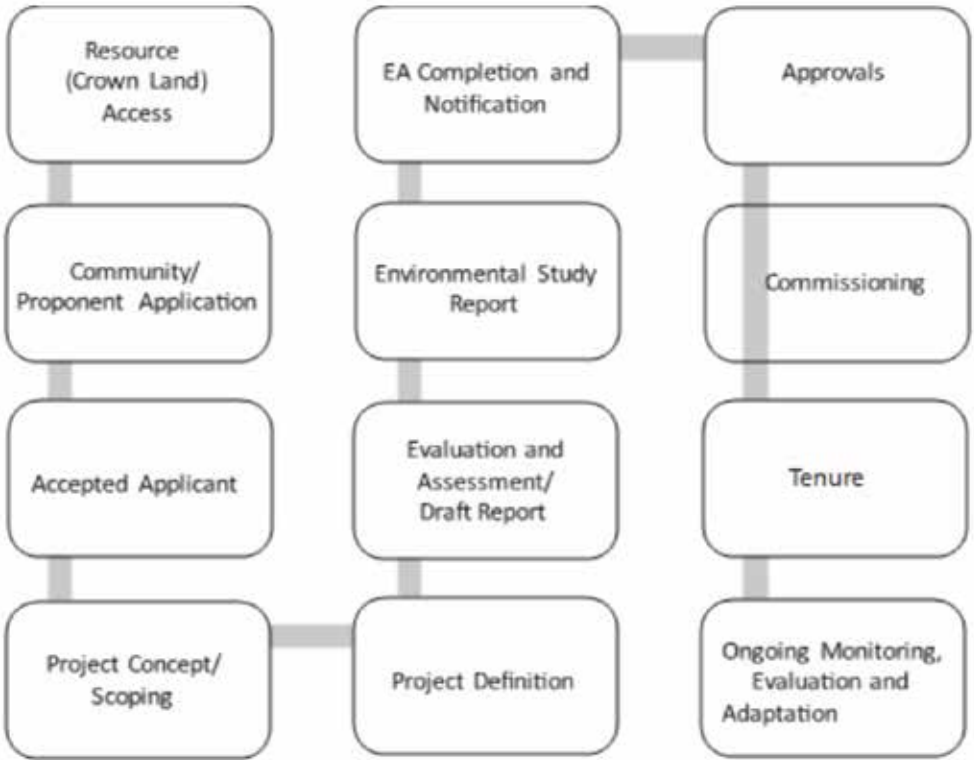
Most projects are a blend of both equity and debt. Choosing the best financial arrangement depends on:

- Project Return on Investment (ROI) – as a general rule, the more profitable the project, the more financing options will be available
- Ownership structure and equity investment – the form of partnership and the degree of owner capital (equity) in the project is an important factor in determining options for financing the balance of the project costs.
- Risk – There are a number of risks which will affect project financing such as strength of the partnership;
- Source of revenues and extent to which the revenue stream can be guaranteed over the life of the project (i.e., strength of the Power Purchase Agreement);
- Percentage of initial equity investment;
- Source of skilled labour;
- Strength of operator experience; taxes and insurance, etc.

### **7.6 Waterpower project stages, tasks and timelines**

Figure 20 provides a basic illustration of the various phases involved in the development of a typical waterpower project.

Waterpower projects, and their costs, can be broken down into stages: Pre-feasibility, pre-development and planning, permitting and construction, and operation and maintenance.



*Figure 20 Phases in the Development of a Waterpower Project*

## 7.7 Waterpower project revenue

To calculate the expected average annual revenue of a project, multiply the plant capacity times the design capacity factor, times the number of hours in a year (8,760), times the selling price of electricity (see Section 8 for further detail on pricing).

For the 5 MW example, if we assume in this case a 55% capacity factor, and a 20-25 cent/Kwh contract price the expected average yearly revenue would be:

- 5,000 kW x 55% x 8,760 hours x 20-25 cents/kW hour or approximately \$4,800,000-\$6,000,000 annually.

The energy actually produced by a waterpower facility over the years – and therefore the actual amount of revenue – will be affected by the amount of snowfall/rainfall in the watershed, by downtime needed for repairs and by environmental and social needs. For example, environmental and social uses of the river can reduce flow and/or restrict

| Stage  | Tasks   | Cost   | To keep in mind  |
|--|---|--|--|
| Pre-feasibility: General information gathering focused on basic technical and financial needs, and potential barriers. | <ul style="list-style-type: none"> <li>• identify the opportunity</li> <li>• determine the energy potential</li> <li>• identify potentially affected Aboriginal communities</li> <li>• determine type of MNR application (e.g., Competitive, or Direct)</li> </ul>  | <p>A relatively inexpensive exercise that will cost \$10,000 to \$50,000 to complete</p>   | <p>Common to analyze several likely sites before choosing the best</p> <p>Building early relationships can expedite subsequent process steps</p>   |
| Pre-development and planning: the period of time when a project is being studied and planned.                          | <ul style="list-style-type: none"> <li>• identify and pursue project team requirements</li> <li>• initiate and develop business model and relationships</li> <li>• financing – loans and negotiating sale of power</li> <li>• regulatory approvals</li> <li>• transmission connection study</li> </ul>  | <p>Can take 1 to 2 years.</p> <p>Will range in cost from tens of thousands for a small and relatively simple project, to millions of dollars for more complex projects</p> <p>Financing for predevelopment work is generally more expensive because there is no guarantee of success at this stage</p> <p>(i.e., risk is higher)</p> | <p>It is important for proponents to look for and deal with issues that could stop the project early.</p> <p>There is no way of knowing whether/ how the project will go ahead until all of the technical, environmental, cost and permitting issues have been addressed and understood.</p>     |
| Permitting and Construction stage  | <ul style="list-style-type: none"> <li>• detailed engineering and cost estimating</li> <li>• obtaining permits and approvals</li> <li>• implement project development elements: <ul style="list-style-type: none"> <li>• access roads</li> <li>• dams and water intake structures</li> <li>• canals and penstock pipelines</li> </ul> </li> <li>• powerhouse buildings, generating equipment and controls, and</li> <li>• transmission lines to the grid connection point.</li> </ul> | <p>Costs can range from \$7,500 to \$15,000 per kW, or \$7.5 million to \$15 million per megawatt. e.g., a project with a plant capacity of 5MW could cost between \$37.5 and \$75 million.</p> <p>Subject to changing costs of building material i.e., steel, concrete.</p> <p>Higher cost in remote locations</p>                  | <p>Construction takes from 1 to 3 years depending on the size and complexity of the project. Winter weather, spring floods, and wildlife needs all impact the timing of construction. The lead time required to order equipment (turbines, generators and controls) can be 1 year or longer.</p> |
| Operation and maintenance  | <ul style="list-style-type: none"> <li>• construction loan principal and interest payments</li> <li>• insurance</li> <li>• repairs and maintenance</li> <li>• operations personnel</li> <li>• environmental monitoring</li> <li>• administration</li> </ul>   | <p>Regular maintenance costs will generally be related to the original investment – estimated as a percentage of capital costs</p>   | <p>Owners will have to consider and account for costs and uncertainty beyond regular maintenance and normal operations and hydrologic variances year over year.</p> <p>Significant infrastructure re-investment can be expected during the first 20-40 years of operation.</p>                   |

Figure 21 Tasks and Costs for each stage in Waterpower Development

timing of flow. These instances will reduce plant capacity and in turn, reduce total revenue.

A facility with storage (head pond or reservoir) has much more flexibility in terms of production as the water can be managed to produce energy as needed or on demand. It is critical to understand the intended function of the project when preparing the initial estimate of costs and revenues.

## **7.8 Waterpower project basic financial analysis**

Financial analysis compares the revenue from the sale of electricity with all of the costs (pre-feasibility, planning, pre-development, construction, operation and financing costs) over the course of the years (or “life cycle”) of a project’s operating life.

The revenue should be used to repay money borrowed to build the project, and to pay the on-going operating costs. Money left over after these payments have been made is the project owner’s profit.

Waterpower projects will usually have an expected life cycle of 50 or more years, but it is normal to analyze the expected costs and revenues for the first 25 to 40 years to determine whether a project is viable or financially worthwhile. Generally project proponents want to see a return on their investment within 15 years. This means startup money is repaid within 15 years.

Two ways to measure the financial viability of projects i.e., how the banks will evaluate the project, are Simple Payback and Return on Investment.

Simple Payback is all the costs, divided by expected yearly operating profit. Yearly operating profit in this calculation is the revenue from electricity generation, minus the annual operating costs excluding loan principal and interest payments. The result is expressed in years.

### **Example using a 5 MW project**

Investment of \$50 Million (\$10M-\$12/MW)

Annual revenue \$4.8 Million

Annual operations \$625,000

Simple Payback = \$50 million - \$60 million/ (\$4,800,000 - \$625,000)

This is between 12.5 and 15 years.

It is not unusual for viable waterpower projects to have Simple Payback results of 10 to 15 years. The shorter the time indicated by the Simple Payback calculation, the more viable the project.

Return on Investment (ROI) is a calculation that takes into account the concept of the time-value-of-money, comparing projects with different distributed cash flows over time. It helps answer the question “What else could an investor invest in to get a better return.”

The higher the rate-of-return indicated by the ROI calculation, the more viable the project. Most private sector waterpower project investors will require the ROI to be above 15% in order to seriously consider investing; some investors have even higher criteria. In general, community-owned projects can be acceptable at somewhat lower returns.

## **7.9 Waterpower Taxation and “Water Rentals”**

Hydro-electric generating station owners and waterpower leaseholders need to register with the Ministry of Finance to pay taxes and charges on their gross revenue. The taxes and charges owed are known as the Gross Revenue Charge (GRC). Gross revenue is calculated by multiplying the station’s annual generation for the year by a price of \$40,000 per gigawatt hour.

The gross revenue charge is broken into three parts:

- property taxes payable to the Minister of Finance
- property taxes payable to the Ontario Electricity Financial Corporation
- water rental charges payable to the Minister of Finance

### **Property tax rates**

The amount of property tax owed depends on how much electricity the station generates each year.

Property tax revenue is split between the Minister of Finance and the

| <b>Total Annual Generation</b>               | <b>GRC Rate</b> |
|--|-----------------|
| Up to and including 50 gigawatt hours (gWh)  | 2.5%            |
| Greater than 50 up to and including 400 gWh  | 4.5%            |
| Greater than 400 up to and including 700 gWh | 6.0%            |
| Greater than 700 gWh                         | 26.5%           |

Ontario Electricity Financial Corporation.

### Water rental charge rate

A fixed rate of 9.5% on the station's annual gross revenue is charged for water rental, regardless of how much water the station uses.

### Deduction for Eligible Capacity Available for 120 Months (GRC Deduction)

In order to encourage investment in the generation of electricity from waterpower, the Electricity Act provides that the gross revenue from the generation of electricity from eligible capacity may be deducted from gross revenue for the purposes of calculating the GRC amounts payable. The deduction for eligible capacity (also known as the GRC Holiday) is available for the first 120 months after the eligible capacity is put into service, as determined by the Minister of Natural Resources.

## **7.10 Corporate Structure and Consideration of Federal Investment Tax Credit(s)**

An important consideration when structuring the business entity is the potential treatment of a project investment from a federal Investment Tax Credit perspective. An Investment Tax Credit (ITC) is a tax incentive that allows businesses or individuals to deduct a percentage of the cost of specific capital investments directly from their tax liability. Often used to encourage investments in clean technology, manufacturing, and research, these credits can be refundable, meaning you may receive money back even if you owe no tax.

At present, there are two (2) ITC measures of potential relevance to new waterpower projects:

The Clean Electricity Investment Tax Credit (CE ITC) is a 15% refundable tax credit available to Indigenous-owned corporations and communities for investments in clean electricity generation, storage, and inter-provincial transmission. Eligible projects must not have begun construction before March 28, 2023, and must be available for use between April 16, 2024, and 2034.

### **Key Details and Eligibility**

#### **Eligible Entities:**

- Taxable Canadian Corporations: Including those in partnerships
- Provincial & Territorial Crown Corporations: Designated corporations
- Corporations Owned by Municipalities/Indigenous Communities:

Entities at least 90% owned by these bodies

- **Wholly-Owned Subsidiaries:** Companies wholly owned by eligible corporations, Indigenous communities, or municipalities
- **Pension Investment Corporations:** Certain trusts and corporations

**Eligible Investments:** Projects that generate, store, or transmit clean electricity (including solar, wind, water and other low-emitting sources).

**Refundable Nature:** As a refundable credit, it is accessible to organizations that do not pay corporate taxes, allowing them to receive the 15% incentive, helping to reduce high upfront costs.

**Timeline:** The credit applies to property acquired and available for use on or after April 16, 2024, until 2034.

**The Clean Technology Investment Tax Credit(CT ITC)** is a 30% refundable tax credit for capital investments in new, qualifying clean energy property (solar, wind, water, energy storage, heat pumps, and non-road zero-emission vehicles) acquired between March 28, 2023, and December 31, 2033. The rate drops to 15% in 2034 and disappears after 2034.

### **Key Details and Eligibility**

**Eligible Entities:** Includes corporations, partnerships of taxable corporations, and certain trusts

**Eligible Property:** Includes equipment for electricity generation (including waterpower), stationary storage, active solar heating, air-source heat pumps, geothermal energy, and non-road zero-emission vehicles.

**Labour Requirements:** To receive the full 30% rate, taxpayers must meet specific prevailing wage and apprenticeship requirements. If requirements are not met, the credit is reduced by 10 percentage points.

# 8.0 Resources

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Indigenous Opportunities Financing Program (IOFP), Building Ontario Fund,  
<https://buildingonfund.ca/iofp/>

Annual Planning Outlook, IESO,  
<https://ieso.ca/Sector-Participants/Planning-and-Forecasting/Annual-Planning-Outlook>

Canada Indigenous Loan Guarantee Program, Department of Finance,  
<https://cilgc-cgpac.ca/en>

Class Environmental Assessment for Waterpower Projects, Ontario Waterpower Association,  
<https://owa.ca/class-ea-notices/>

Evaluation and Assessment of Ontario's Waterpower Potential, OWA,  
<https://owa.ca/wp-content/uploads/2023/10/Evaluation-and-Assessment-of-Ontarios-Waterpower-Potential-Final-Report-.pdf>

First Nations Major Projects Coalition Tools and Resources,  
<https://fnmpc.ca/tools-resources/>

Footprints to Follow, Ontario Aboriginal Waterpower Case Studies, OWA  
<https://owa.ca/wp-content/uploads/2023/10/Footprints-to-Follow.pdf>

Indigenous Energy Support Program, IESO,  
<https://ieso.ca/Get-Involved/Indigenous-Relations/Indigenous-Energy-Support-Program/IESP-Overview>

Real-Time Hydrometric Data, Water Survey of Canada,  
[https://wateroffice.ec.gc.ca/search/real\\_time\\_e.html](https://wateroffice.ec.gc.ca/search/real_time_e.html)

Renewable energy on Crown land policy, MNR,  
<https://ontario.ca/page/renewable-energy-crown-land-policy>

Resource Adequacy Framework- Short, Medium, and Long-Term Procurements, IESO,  
<https://ieso.ca/Sector-Participants/Planning-and-Forecasting/Resource-Adequacy-Framework>

RETScreen® International SMALL HYDRO PROJECT ANALYSIS , NRCan  
[https://publications.gc.ca/collections/collection\\_2007/nrcan-mcan/M39-98-2003E.pdf](https://publications.gc.ca/collections/collection_2007/nrcan-mcan/M39-98-2003E.pdf)



*Figure 22 Matagami River Generating Station*



*Figure 23 Generator room of a community waterpower facility under construction*

# Glossary of Terms

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|                                |  |
|--------------------------------|--|
| Access Road                    | A road built to a site or facility for the purpose of construction, operation and/or maintenance.  |
| Auxiliary Structure            | Any structural device, other than the powerhouse, which affects the operation of the generating station (e.g. dams, weirs, etc.).  |
| Capacity                       | The numerical measure to indicate “size,” and for hydroelectric generating stations the unit of measurement is in Megawatts (MW) or kilowatts (kW)   |
| Class Environmental Assessment | An environmental assessment approved under Part II.1 of the EAA for a class or group of undertakings.  |
| Dam                            | A barrier or obstruction that confines a flow of water.  |
| Decommission                   | To retire, abandon, dismantle, or remove from active service, working order, or operation.   |
| Disposition                    | The granting, by the MNR of certain or all rights to Crown resources through such means as permits, licenses, approvals, permissions, consents, leases, licenses of occupation, or sale.   |
| Electric                       | In the electrical industry a distinction is often made between electric and electrical. Electric means containing, producing, arising from, actuated by, or carrying electricity, or designed to carry electricity and capable of doing so. Examples: energy, motor, stove, vehicle, wave. |
| Electrical                     | Means related to, pertaining to, or associated with, electricity, but not having its properties or characteristics. Example: Electrical equipment and appliances, engineer, handbook, insulator, rating, school, unit.   |

|                                    |   |
|------------------------------------|---|
| Environment                        | <p>Under the Environmental Assessment Act, environment means:</p> <ol style="list-style-type: none"> <li>1. air, land or water;</li> <li>2. land and animal life, including man;</li> <li>3. the social, economic and cultural conditions that influence the life of man or a community;</li> <li>4. any buildings, structure, machine or other device or thing made by man;</li> <li>5. any solid, liquid, gas, odour, heat, sound, vibration or radiation resulting directly or indirectly from the activities of man; or</li> <li>6. any part or combination of the foregoing and the interrelationships between any two or more of them, in or of Ontario.</li> </ol> |
| Flow Duration Curve                | <p>A flow duration curve (FDC) is a graphical representation of streamflow variability, showing the percentage of time a specific discharge value is equaled or exceeded over a period of record. It's a valuable tool in hydrology for understanding streamflow characteristics and applications like water resource management and environmental assessments.</p>   |
| Forebay                            | <p>A reservoir immediately upstream of the generating station intake. Also referred to as headpond.</p>   |
| Generating Station (Hydroelectric) | <p>A facility in which the force of falling water spins turbines to drive generators for electricity production. It is a general term, which includes a powerhouse, dam, headpond and a means of carrying water from the headpond to the powerhouse.</p>  |
| Head                               | <p>The difference in elevation between the water surface at the intake and the tailrace level of the hydroelectric facility.</p>  |
| Headrace                           | <p>A channel through which water passes to reach the hydro plant intake, if the intake is not integral with the main dam.</p>   |
| Hydroelectric                      | <p>Generation of electricity from falling water.</p>  |

|                          |   |
|--------------------------|---|
| Intake                   | A structure that forms the transition from the headpond or channel to a water-conveying conduit. The intake or headworks commonly incorporates trashracks to preclude debris, and gates to stop flow to the conduit and generating unit(s) beyond.  |
| Kilovolt (kV)            | One thousand volts (see volt). Used to describe “high voltage” electrical conductors, as in 115 kV.   |
| Load                     | The power requirement (usually measured in kilowatts) of a system or a piece of equipment at a given instant, or the average rate of energy consumption during a designated period of time.   |
| Maintenance              | The regular, routine actions, taken to retard the natural deterioration of a resource (or fixture and/or equipment). These actions are intended to keep the resource from premature loss due to failure, decline, wear or change attributable to normal use or the effect of the natural environment.   |
| Mechanical               | Those components of a hydroelectric facility that operate by way of machinery or a mechanism. This includes machinery such as cranes, pumps, compressors, turbines and systems such as compressed air, cooling water, sewage and domestic water.  |
| Megawatt                 | One thousand kilowatts or one million watts, abbreviated as MW. (A gigawatt is one million kilowatts; a terawatt equals one billion kilowatts.)   |
| Mitigation               | The elimination, reduction or control of the adverse environmental effects of a project, including restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means. The means, by which, projects can be modified to minimize or eliminate potential negative effects. |
| Net Environmental Effect | The change to the environment that would occur, following the application of proposed mitigation or enhancement measures.   |

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| Operation                | Includes operation, maintenance and repair, rehabilitation, as well as upgrading and replacement, provided that the function or capacity of the facility remains similar.  |
| Proponent                | A person who carries out or proposes to carry out a project; or is the owner or person having charge, management or control of a project.  |
| Riparian                 | Refers to the area adjacent to the shoreline.  |
| Runner                   | An enclosed waterwheel that transforms the static and kinetic energy of the water into useful work.  |
| Sluice                   | An opening or channel in a dam with a gate, valve or stop log at its head to regulate flow; and water flows under the gate.  |
| Storage Dam              | A dam structure, normally with some water passing capability, the purpose of which is to store or impound a quantity of water further upstream from the hydroelectric generating station in order that outflow may be regulated in a manner suitable for power production. |
| Spillway                 | A passageway or channel located near or at the top of a dam, to remove surplus water from a reservoir; and water flows over the gate or control structure.   |
| Surge Tank/Surge Chamber | A structure connected to the penstock(s), designed to avoid damages to water conveying facilities that might otherwise occur due to pressure surges (water hammer).  |
| Tailrace                 | A channel through which the water flows away from a hydro plant following its discharge from the turbine(s).   |
| Transformer              | An electromagnetic device for changing alternating current electricity to either higher or lower voltage. Transformers make transmission of power over long distances possible.  |

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| Transmission Line | The conductors and their supporting towers, used to convey electric energy from a generating station to a distant point.   |
| Tunnel            | A conduit, usually constructed through solid rock, and sometimes lined with concrete, which is used to convey water.   |
| Turbine           | The mechanical machinery, of which the runner is a part, which transforms the kinetic and potential energy of water into mechanical energy that is used to drive the generator. The generator subsequently converts this mechanical energy into electrical energy. |
| Volt (V)          | A measure of electrical “potential difference” between two points in an electrical field. A volt is a unit of electrical pressure, which causes an electric current to flow through a wire.  |
| Watt (W)          | A standard unit used to measure amounts of electrical power. One horsepower is equivalent to approximately 746 watts.  |
| Weir              | Water control structure that either diverts water or holds water back.   |



Ontario Waterpower

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