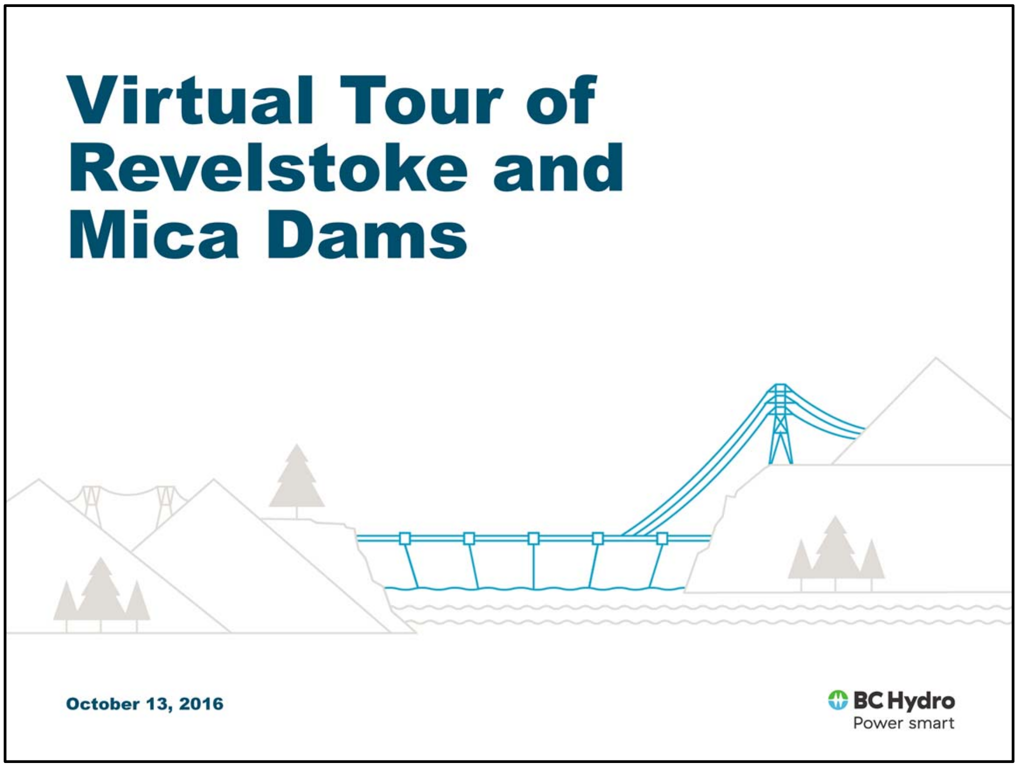


- Overview of hydro-electric dams and how they work
- Provide background on basic principles of hydropower and its history.
- Explain features that all hydro-power dams have and compare the design of Revelstoke and Mica

- Falling water has kinetic energy.
- Amount of kinetic energy depends on the amount of water and the distance it falls.
- Energy = mass x g (acceleration due to gravity) x height
- You can double the amount of energy if you double the height the water falls.
- Humans have been converting the power of water into mechanical energy for thousands of years, Ancient Greeks used water wheels for grinding wheat.
- Water power played a crucial role in the industrial age that started in the early 1800's with the development of water-powered factory equipment for machine and textile industries.

- This water wheel at Holme House textile Mill powered a spinning loom.

- Disadvantages was requirement for mild climate (frozen rivers produced no power and flooding destroyed mills). From mid to late 1800’s watermills were replaced with steam power that allowed factories to be located close to labour sources and markets.

- Not the end of waterpower because a new use was emerging with advances in the understanding of electricity. First electric generator invented in 1831 and the first constant electric light in 1835. By 1880, the first mass-produced incandescent light bulbs became available in 1880.

- Lighting became of the first publicly available applications of electrical power. Public utilities were set up in many cities targeting the growing market for electrical lighting.

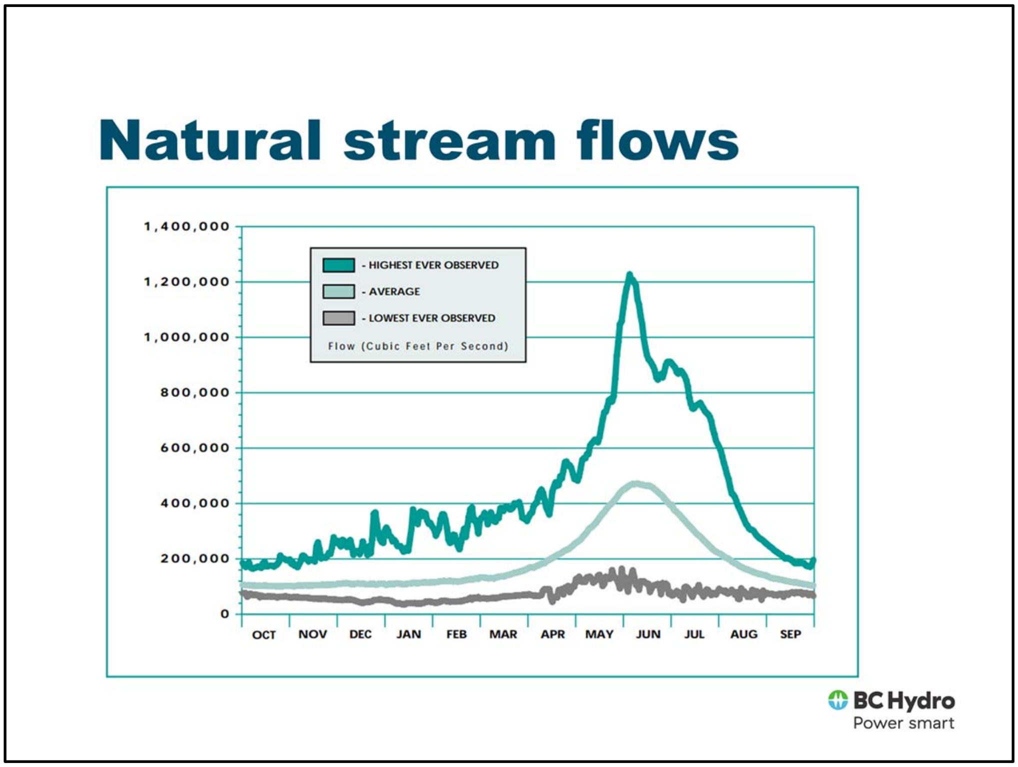
BC Hydro
Power smart

- The first use of water to produce electricity was for a wheel built by the Ottawa Electric light company in 1881.
- First hydropower plant in BC built by Nanaimo Electric Light in 1888

Illecillewaet River Dam:

- Built by the Revelstoke Light & Power Company in 1898 on the Illecillewaet River and bought by the City of Revelstoke in 1902, this dam supplied the City with power for street lights and house lighting.
- The original dam was a run of river dam that diverted water into a 8 foot square wooden flume to a wooden frame powerhouse.
- The turbine was connected to two 120-kW generators.

Challenge for run of river hydropower is variation in stream flows.



- Lots of variability in flows year to year
- Flooding can cause damage
- Timing of peak flows does not match with provincial electricity demand

What a dam is good for

- Storing water
- Generating power when you need it

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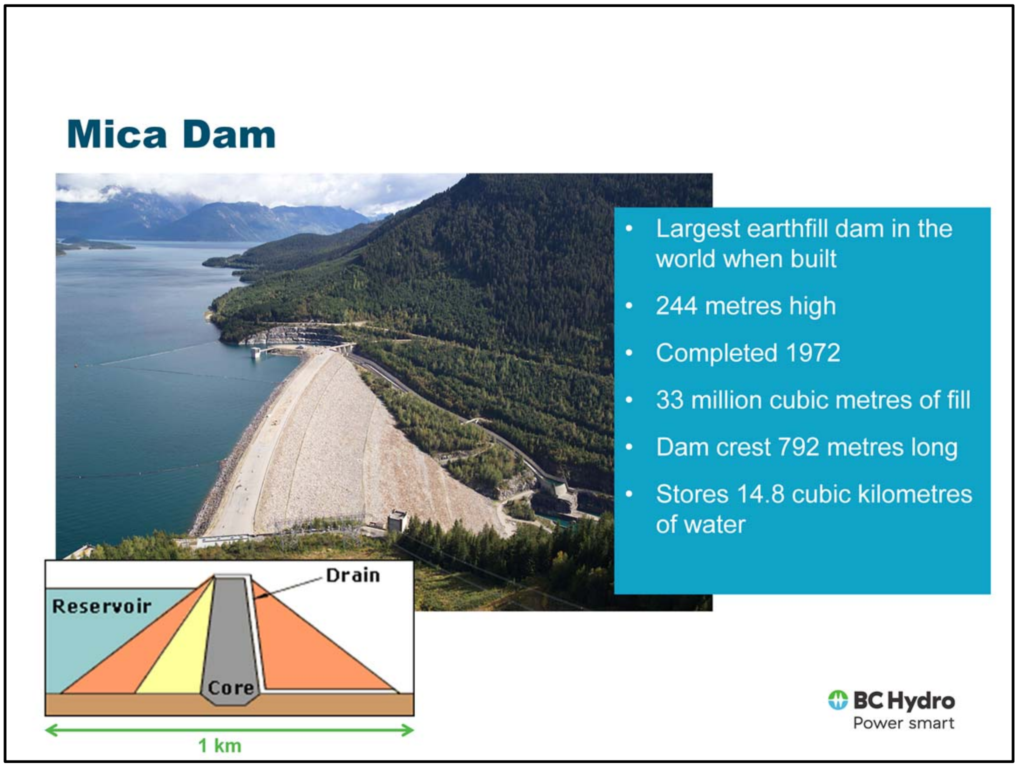
Building a dam allows you to store water and generate power when you need it.

Many dams were built starting in the 1880’s to meet growing need for electricity in communities. By 1920, 97% of electricity in Canada was produced by hydropower.

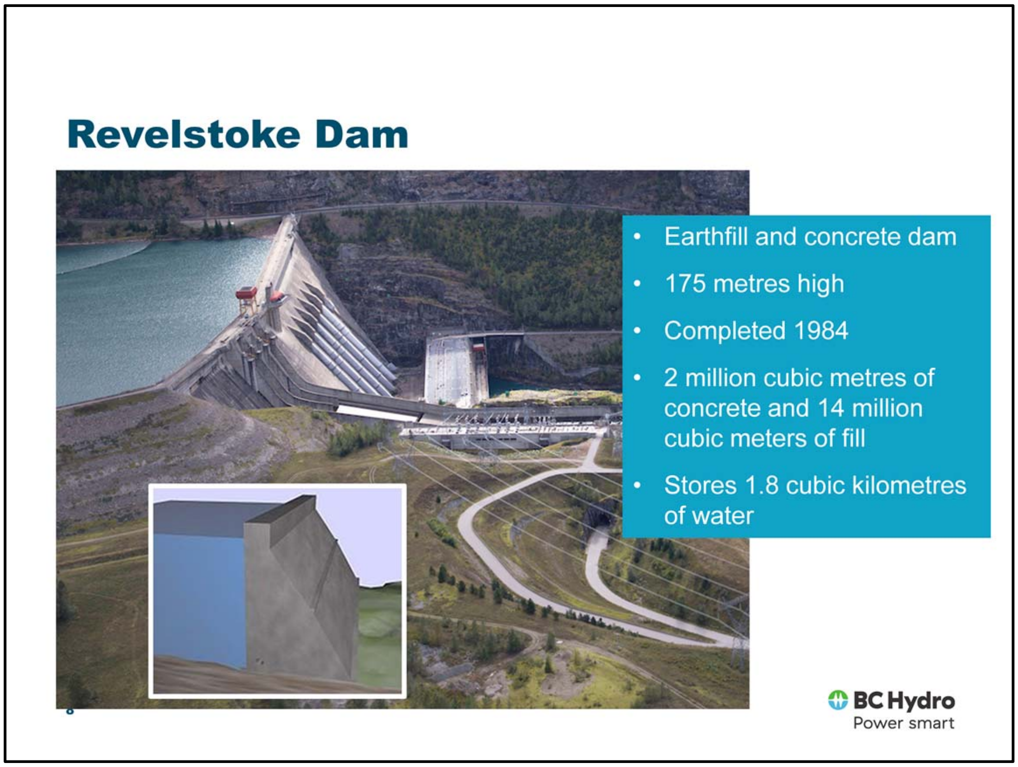


Located about 150 km north of Revelstoke

Largest earthfill dam in the world when built at 244 metres high. Still tallest dam in BC. Creates Kinbasket Reservoir – about 216 kilometers long, 42,500 hectares

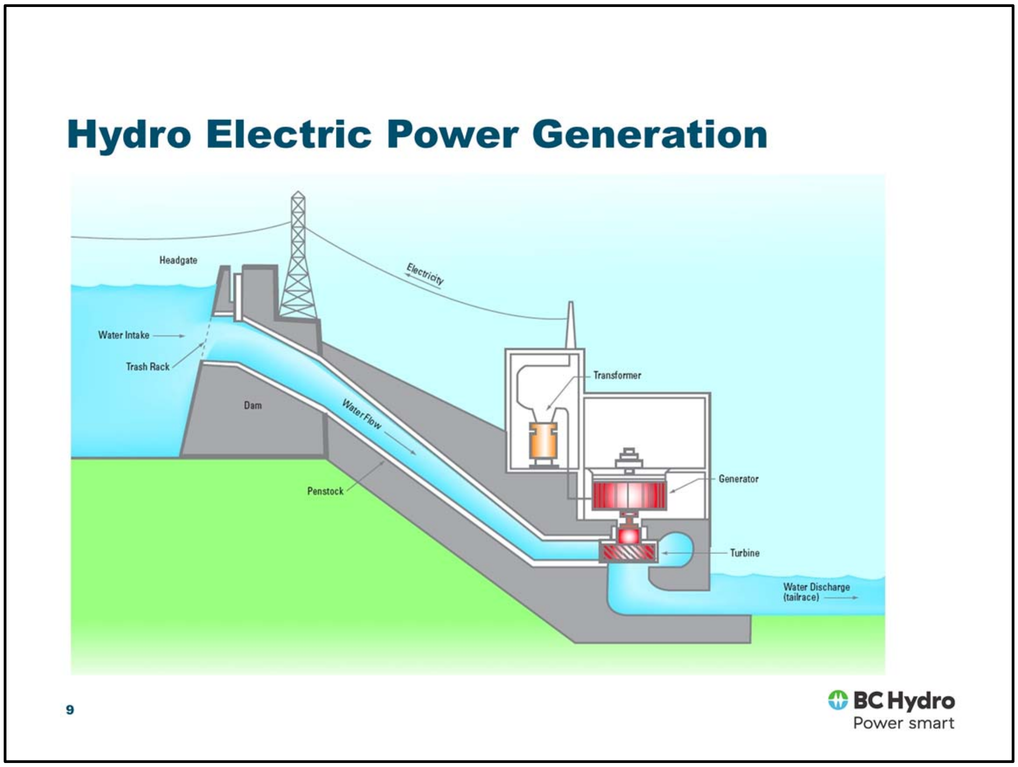
Earthfill dams are built with several layers of different types of materials

- An impervious core is built directly on bedrock
- Layers of other materials are placed overtop along with provision for filtration, drainage, etc
- Both sides are covered with rock rip rap for protection
- Very large structure
- At the base, Mica dam is nearly 1 kilometre thick (deep).



Revelstoke dam located just upstream of the City

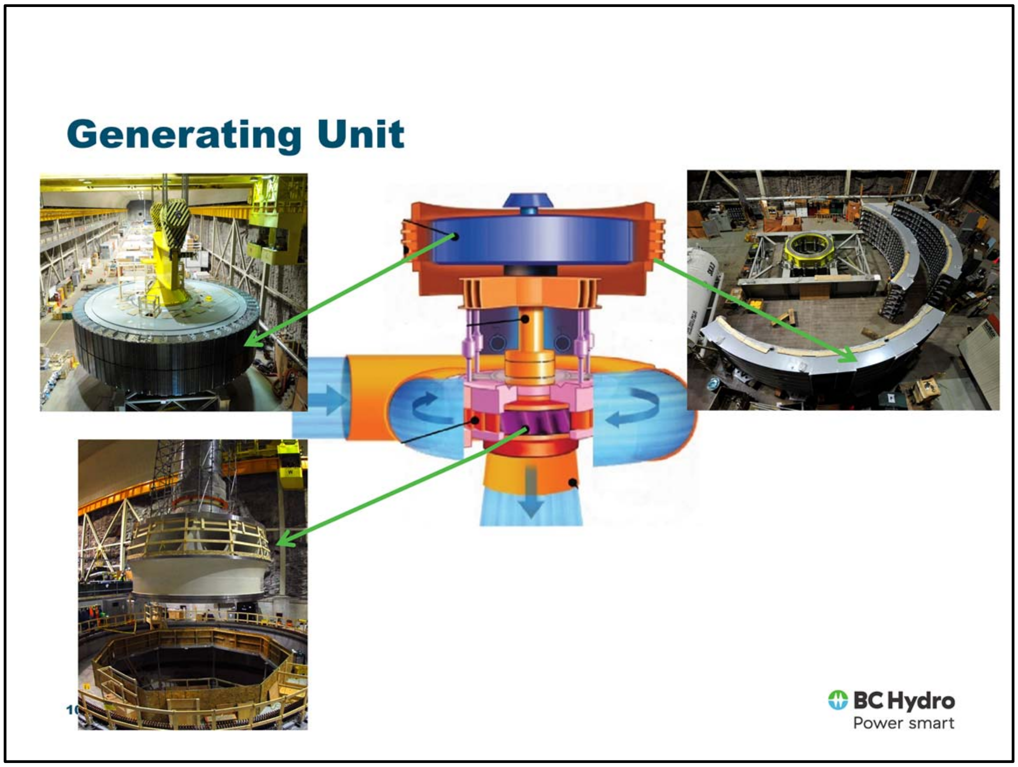
- Concrete dam relies on its massive weight and resultant friction to hold back the reservoir
- Concrete Dam: 470 metres long, 126 metres thick at base, 9 metres thick at the crest
- Stores 1.8 cubic kilometers of water in Revelstoke Reservoir
- Reservoir 130 km long and max width 1.2 km



Basic principles of hydro-power plants
Generate power and deliver this power to transmission system

Generation

- water rushes through the penstock and into the scrollcase.
- It turns the turbine blades and is then drawn to the turbine axis to exit through the underneath draft tube.
- The mechanical energy produced by the tremendous force that rushing water exerts on the turbine is transmitted to the generator, which then converts it into electrical energy.
- Remember head and flow determines amount of electricity that can be produced.

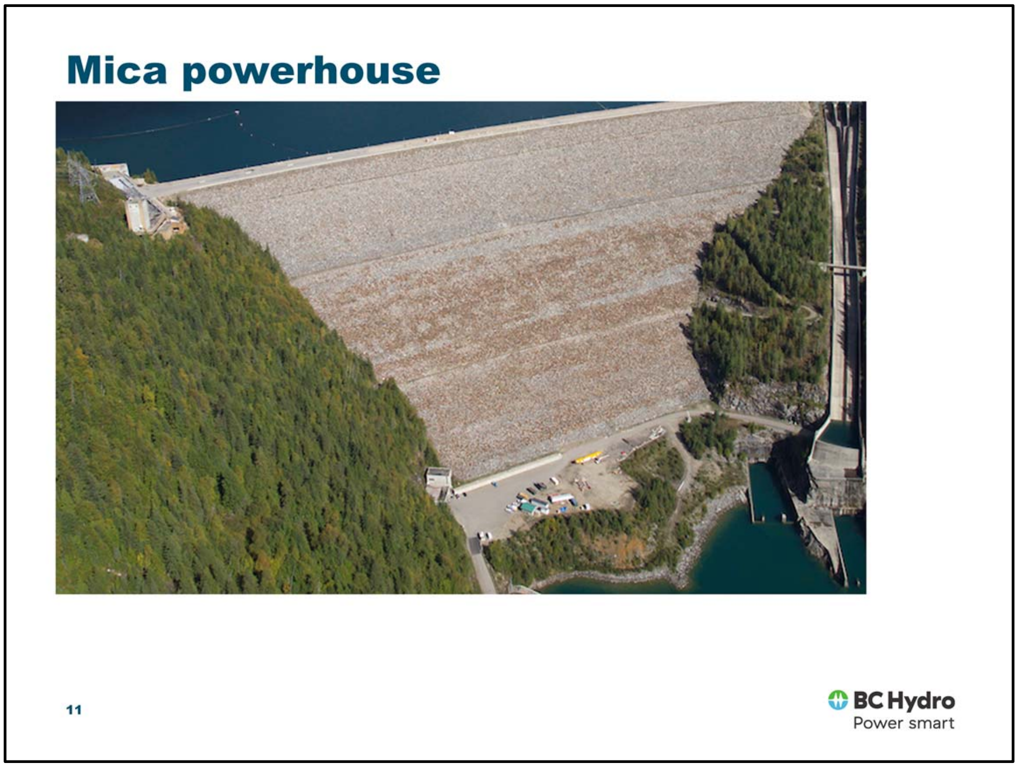


The turbine powers the generating unit that has a moving part–the rotor–and a fixed part–the stator.
The rotor's outer surface is covered with magnetized steel plates.
The stator's inner surface, or cylinder wall, is made up of copper windings.
When the rotor turns inside the stator, the electrons in the copper windings "vibrate." Their movement generates an electric current

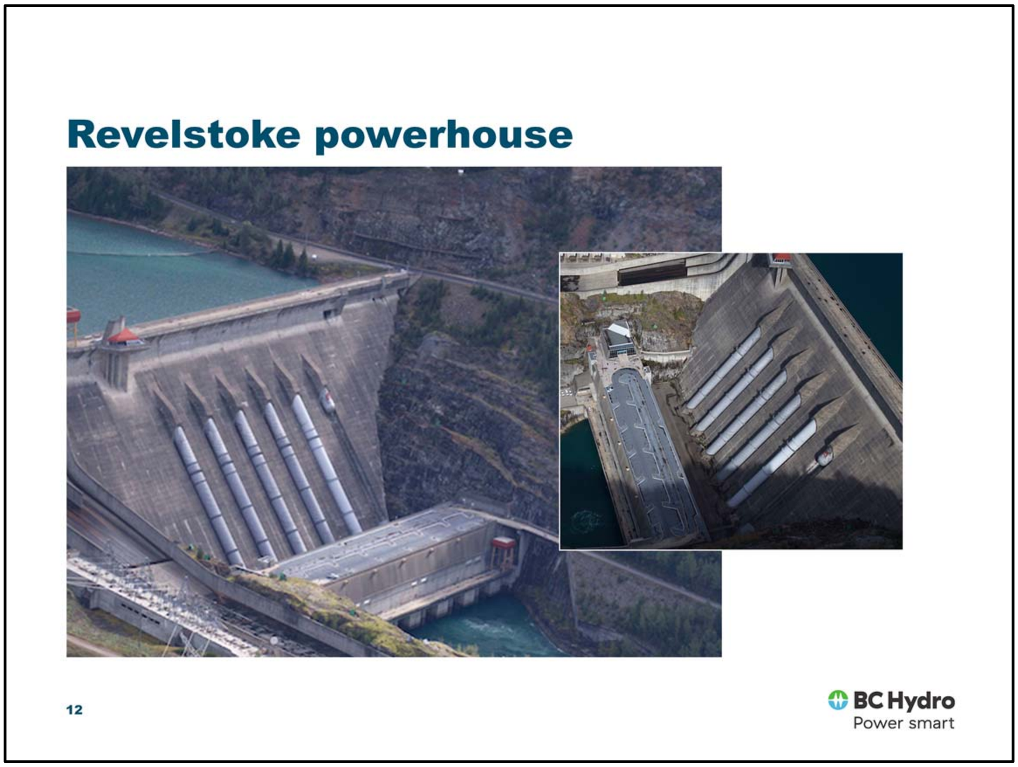
Turbines have a constant rotation speed
All the generating units in a power system must be synchronized I.E. it is essential that they maintain an exact rotation speed. Equipment that runs on electricity is designed to use alternating current of a specific frequency (standing alternating current cycle of 60 per second (60 Hz) in North America). This frequency depends on the generating unit's rotation speed. Mica and Rev rotors spin at 112.5 revolutions per minute.

REV AND MICA very large generating units:

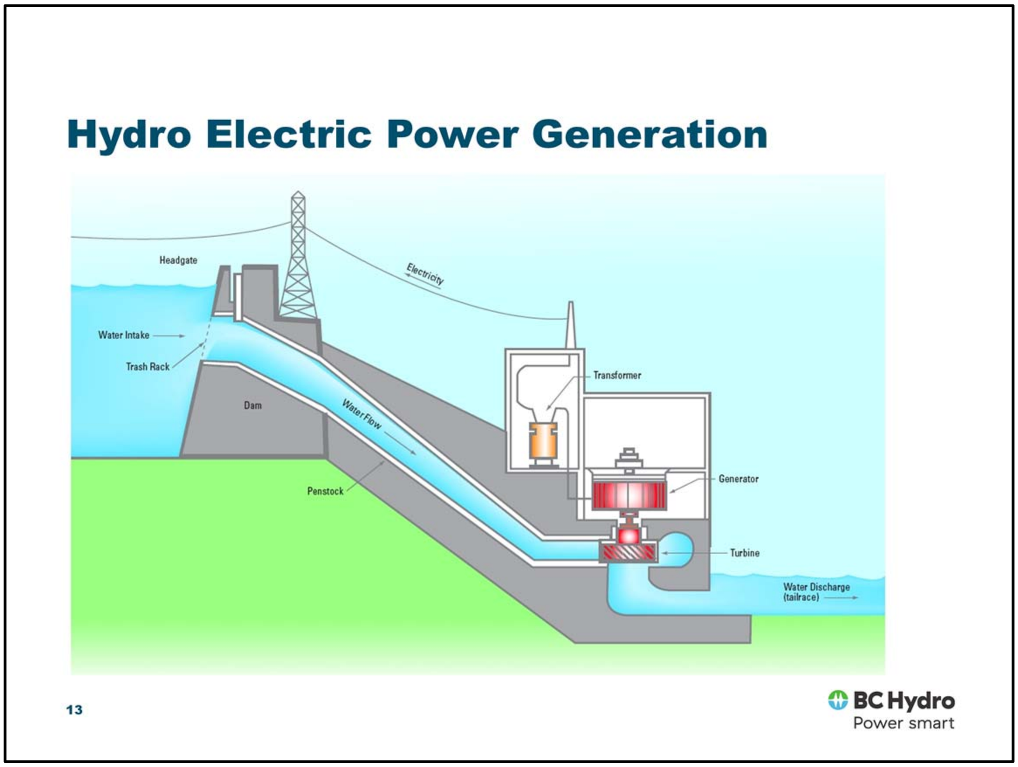
- Mica turbine measures 6.45 metres in diameter and weighs 137.5 tonnes, equivalent weight of just over 1,800 people.
- Magnetic rotor. The outer ring of the rotors is made by stacking 6,210 steel plates into a precise sequence. Each steel plate weighed 90 kg, making the rotor the heaviest part of the turbine at 1,000 tonnes that took two overhead cranes to lower into place.
- Each stator frame contains nearly 250 kilometres of copper wire.



- Underground powerhouse excavated in left bank
- Volume of underground powerhouse 27,000 cubic metres, more than 12 times the volume of BC Place (2.6 million cubic metres.
- Intake gates, penstocks, 6 generating units, access road, draft tubes



- Penstocks 8 metres (26 feet) diameter
- Powerhouse 213 metres long, 50 metres wide, 60 metres high

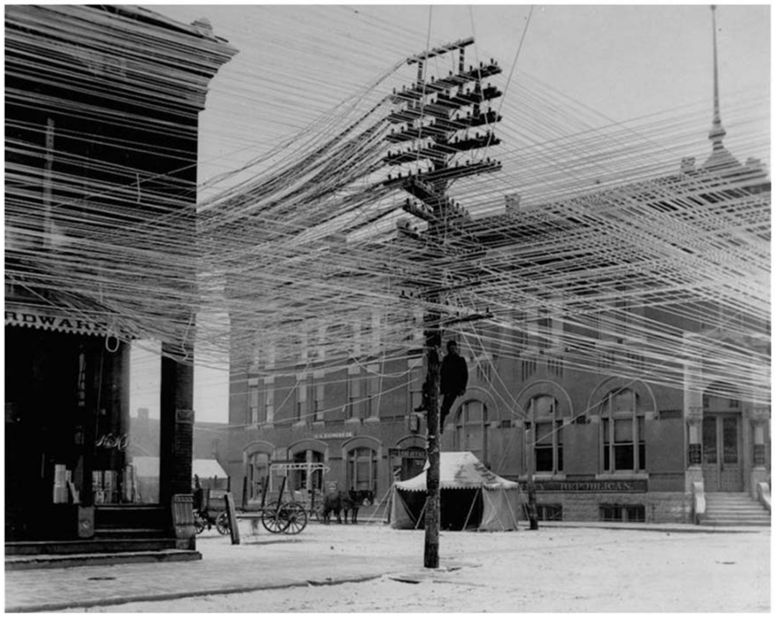


How power plants deliver the power to the transmission system

Hydro plant must take power generated by the units and convert it to an appropriate voltage to deliver it to the transmission system.

A QUICK ASIDE:

- Rapid developments in transmission voltages made it economically feasible to locate large scale generation facilities far away from load centres.
- Much of the early electricity was direct current (DC) which could not be easily increased or decreased in voltage. Companies simply ran different lines for the different classes of load so separate lines for 10 kV city lighting, 110 volt household lights, 500 volts for streetcars, etc. As a result, transmitting DC power over long distances was inefficient and expensive and generating facilities needed to be located close to the load centres.
- In 1886, George Westinghouse's Electric Company began building an alternating current system that used a transformer to step up voltage for long distance transmission and then stepped it back down for indoor lighting, more efficient and less expensive system.
- War of the Current: battle reached its height in 1888. ended in 1892 as AC electric companies became more profitable than DC and the lower cost of AC power distribution prevailed.



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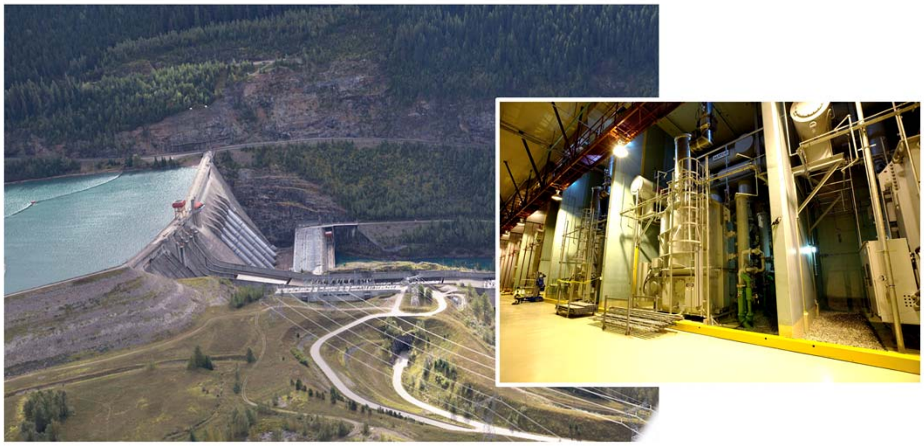
BC Hydro
Power smart

View of lineman working on power or telephone lines at an intersection in Pratt Kansas, 1911.

- Generating units produce high amp, low voltage power (16,000 volts, 17,000 amps)
- Transmisson lines require high voltage, low amps to maximize efficiency and minimize line losses (500,000 volts, 2,500 amps)
- Three transformers per generator take power from the generators at 16 kV and step it up to 500 kV. At Mica transformer gallery is located underground.
- Electricity delivered to overhead transmission lines through underground powerhouse with gas-insulated switchgear equipment. SF6 gas effective insulator, reducing safe limit of approach from 25 feet to six inches.
- The switchgear equipment runs from the underground generating units through long leadshafts (800 metres to 1.3 km) to the above-ground switchgear building.

Revelstoke Transmission



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- Revelstoke transformer gallery above ground

What else a dam needs to do

- release excess water
- monitor its well-being

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- The Mica dam spillway, built when the dam was constructed in 1973, is 585 metres long with a vertical drop over 150 metres, the highest vertical drop of any BC Hydro dam spillway

- Revelstoke spillway is 309 metres long, between 37 metres and 46 metres wide.

Revelstoke Spill

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BC Hydro
Power smart

- Revelstoke – average inflows 6.3 cubic kilometres. In the high water year of 2012, inflows were 7.7 cubic kilometres

- 2012 high water – released 681 cubic metres per second (24,000 cubic feet per second) over the spillway on Sunday June 12.

- BC Hydro tested the Mica Dam spillway on July 26 and 27, 2012 in anticipation of releases that may have been needed to pass record high reservoir inflows that year.
- Kinbasket – average inflows 15.5 cubic kilometres, 2012 was 19.6 cubic kilometres
- During the test, the flow of water released over the spillway reached a maximum of 1,133 cubic meters per second (m^3/s) (40,000 cubic feet per second) at 1 p.m., July 26, 2012.

Monitoring

Extensive instrumentation continuously measures:

- movement
- water levels in slopes, dams and foundations
- water flows, reservoir levels, climate

Mica Instruments:

- 100 survey points
- 100 piezometers (ie electric, hydraulic, pneumatic, multiport and standpipe piezometers)
- 750 temperature measurement nodes
- 25 Earth pressure cells
- 5 strain gauge lines
- Weirs
- 3 strong motion accelerographs

BC Hydro
Power smart

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