





Safety Moment



The health and safety of our employees and visitors to our facilities is our top priority. Throughout your tour you will be required to wear personal protective equipment (PPE) including safety glasses, hard hats and ear protection unless otherwise directed by your tour leader. Gloves are available upon request.

You should also wear casual clothing including pants (no shorts) and a long sleeve shirt or jacket. Sandals and open toe shoes are not permitted. Your tour will involve heights, stair climbing and walking over grating. If at anytime you're uncomfortable, notify your tour leader.

Remember to stay with your tour guide at all times. Your guide is well trained and familiar with all of the site's safety procedures and is responsible for your well being.



Electricity in Alberta

Currently more than half of Alberta's electricity is produced from coal-fired generation facilities like Capital Power's Genesee Generating Station which provides critical base load¹ electricity for homes, schools, hospitals, industry, businesses and farms throughout the province.

Electricity in Alberta is also produced from natural gas, including cogeneration² plants that produce electricity as a by-product of their normal activities. The remainder comes from renewable energy sources such as hydro, wind and biomass (energy produced from organic sources such as wood waste or garbage).



Jenesee

The Genesee Generating Station

The three units at Genesee are responsible for providing 1,376 MW of base load power for Alberta's electricity grid.



generating Station

Genesee Units 1 and 2

- Genesee Unit 2 (G2) was the first unit to be completed and was commissioned in October 1989. G2's current gross capacity is 430 Megawatts³ (MW).
- Genesee Unit 1 (G1) was commissioned in May 1994. G1 has an identical gross capacity (to G2) of 430 MW.
- Capital Power is the owner and operator of G1 and G2.
- Both subcritical⁴ units consist of a pulverized coal-fired pressure boiler, steam turbine and electrical generator.
- Power from G1 and G2 is sold through a long-term Power Purchase Arrangement (PPA)⁵ with the Balancing Pool of Alberta⁶.
- G1 and G2 each have a typical net annual production of approximately 3,297 gigawatt⁷ hours (GWh).
- Combined G1 and G2 require approximately 3.4 million tonnes of coal annually (2015).



Genesee 3 ESEE



- Genesee Unit 3 (G3) was the first coal-fired unit in Canada to use supercritical⁸ boiler technology.
- G3 has a gross generating capacity of 516 MW.
- Commissioned in March 2005, G3 is an equal joint venture partnership between Capital Power and TransAlta.
- Capital Power operates the plant, and both companies independently dispatch and market their share of the electrical output through the Alberta Power Pool⁹.
- G3's typical net annual production is approximately 3955 (net) gigawatt hours (GWh).
- G3 requires approximately 1.9 million tonnes of coal annually (2015).
- G3 is outfitted with:
 - Fabric filters that stop 99.8% of particulate matter from reaching the atmosphere.
 - A flue gas desulphurization¹⁰ unit that brings sulphur dioxide (SO₂) emissions well below the provincial emission standard, and less than half the emissions produced by older plants.
 - Low nitrogen oxide (NO_x) burners that reduce NO_x emissions by 54%, meeting more stringent CASA NO_x emissions standards in 2016.
 - The installation of a DSI (lime injection system) engineering project in 2015 ensures G3 meets more stringent CASA SO₂ emissions standards.





Coal is the world's most plentiful fossil fuel'¹¹. Alberta's coal reserves represent approximately 70% of Canada's total reserves extending from the Alberta-U.S. border to north of Grande Prairie. There are two basic uses for coal – thermal (to produce electricity) and metallurgical (to make steel).

Coal is formed from the remains of plants that lived and were buried hundreds of millions of years ago at about the same time dinosaurs roamed Alberta. Over millions of years, the plant remains were crushed together into layers under tremendous heat and pressure and the layers slowly turned black and hard forming coal.

The coal at the Genesee Mine is estimated to be approximately 65 million years old. There are up to six coal seams (layers) of coal at Genesee Mine located at varying depths. The coal at Genesee is "sub-bituminous" meaning it is low in sulphur and burns hotter than other varieties of coal which makes it ideal for electricity production.



Genesee Mine

The adjacent Genesee Mine is a joint venture between Capital Power and Westmoreland Coal. It began operating in 1988 and is operated continuously 24 hours a day, 365 days a year by Westmoreland. Westmoreland operates a fleet of loaders, haul trucks, shovels, dozers, graders, scrapers and electric shovels and draglines to mine the coal.

Approximately 14,560 tonnes (equivalent to 130 to 150 rail cars) of coal is mined daily or 5.5 million tonnes annually as fuel for the Genesee Generating Station. The Genesee Mine contains an estimated 330 million tonnes of mineable coal reserves.

There are typically between 3 and 5 mineable coal seams ranging between 4 and 6 metres in combined thickness. The interburden (layer of dirt and sandstone) between the coal seams varies in thickness.

Coal at the Genesee Mine is dug out of the ground using surface mining techniques to recover the coal. This process first involves using draglines to remove overlying soil and rock layers called "overburden" to expose and extract the coal reserves.



Westmoreland Coal operates two electric walking draglines (51 cubic metre (m³) and 81 m³ buckets) and electric shovels to expose the coal out of the ground. Front end loaders load the coal into enormous haul trucks which transport the coal to Genesee's coal handling facility where it is first crushed then stored before being burned to produce electricity.



The bucket of this behemoth 8750 electric walking dragline is the same size as a two car garage and the 420 foot boom is almost as long as a Canadian Football League field.





- Soil removal Earth moving machines remove the topsoil and subsoil (the earth beneath the topsoil) and set it aside where it will be used again in the reclamation process.
- Removal of overburden Two mammoth electric walking draglines scoop away the rock and soil (overburden) that lie above the coal seams. Two electric shovels and a fleet of haul trucks are also used to remove overburden.
- Mining the coal Front end loaders dig out the coal and load it into haul trucks where it's transported to the power station. Shovels, front end loaders and enormous trucks also remove the interburden which separates the coal seams.
- **Transport to the plant** It takes about five minutes to load a single coal hauler which carries up to 136 tonnes of coal to the plant. The coal hauler dumps its load into an underground hopper where it is processed.







Once coal is transported to the plant it is ready to be used in he production of electricity.	the way to Fort McMurray) wl called "boiler feed water", M	hich circulates treated, purified water /ater from the nearby Genesee Coolino
Crushing the coal – From the hopper, the coal is carried on a	Pond is purified at the plant' reduce corrosion in the boild	's water treatment facility in order to er tubes.
conveyor to where it is first crushed to five inch pieces before secondary crushing further reduces it to about two inches in size, smaller than a tennis ball. The coal is then conveyed outside to a live storage pile.	 Intense heat from the burning boiler tubes into steam, just I 	g coal turns the purified water inside the ike water in a kettle. I ocated west of the plant, the
Moving the coal into the plant – The crushed coal is processed and delivered by another conveyor to the generating plant and stored in 16 five storey high bunkers each with a six hour storage capacity. (There are five bunkers for each of Genesee Units 1 and 2 and six bunkers for Unit 3).		Genesee Cooling Pond, is an artificial water body covering 735 hectares and contains approximately 34 million cubic metres (m³) of water. The water level in the cooling pond
Pulverizing of the coal – From the bunkers the coal is fed into mills which pulverize or crush the coal to a fine powder about the same consistency as flour, where it is mixed with hot air and blown into the boiler (furnace) of the generating plant.		Renational cut of puriphing watch nour the nearby North Saskatchewan River where it is eventually returned. Surface water and some ground water is also diverted from the Genesee Mine to the cooling pond.
Blowing the coal into the furnace – Hot air from nearby fans blow the powder like coal into a gigantic 66 metre high furnace or boiler (the size of a 22 storey building). Inside the boiler, burners instantly ignite the coal and air mixture to achieve combustion and create the maximum amount of heat possible. Temperatures inside the boiler may reach 1,300° C.		Water is essential to cool and condense the steam discharged from the plant's three turbines. The steam that passes through the turbine flows to condensers where it is cooleo and condensed back into water, and circulated back to the boiler as feeo

 The boiler contains a web of about 440 kilometres of high pressure steel boiler tubes (if laid out the tubes could stretch from Edmonton all

Turbine Generator

- The high-pressure steam from the boiler passes through pipes into the turbine (a massive drum with hundreds of shiny propeller-like blades). When the steam hits the turbine blades, it causes the turbine to spin rapidly, at approximately 3,600 rpm.
- A single shaft connects the turbine to an electrical generator.
 The rotating shaft turns electromagnets within a series of wire coils, creating electric current producing electricity.

http://www.ehow.com/how_6734818_make-electromagnet-kids.html Construct a simple electromagnet demonstrating how power is created. You can find instructions online at:







Ash Handling

Valuable by-products are created as a result of burning coal. Naturally occurring impurities in coal result in leftover ash similar to burning wood in a camp fire. Coal from the Genesee Mine generally contains between 13-20% ash. Approximately 99.5% of the ash is recovered and put into permanent storage or sold for industrial uses. By using this ash in cement (instead of kilning limestone), coal-fired power plants reduce the greenhouse gas emissions of the combined industries by using the ash waste as their feedstock.

Bottom Ash

Coarse sand-like fragments called bottom ash fall to the bottom of the boiler and have to be continuously removed. This by-product of burning coal is often sold as a substitute for gravel as a sub-base for road construction. Bottom ash from Genesee was used in the construction of the ring road, Anthony Henday Drive, and under the turf base of Commonwealth Stadium. A portion of the bottom ash is transported and stored in licenced ash landfills within the Genesee Mine.

In 2015, independent testing of Stack Particulate Emissions determined G3 and G1/2 are operating at 28.3% and 27.8% of their respective license limits for particulate emissions, reflecting Capital Power's commitment to operational excellence.

Fly Ash

Fly ash is a dust-like by-product formed from coal combustion with a consistency similar to talcum powder. Fly ash from Genesee Unit 1 and Unit 2 is separated from the flue gas using an electrostatic precipitator (ESP). The ESP, which is about the same size as a large apartment building, uses static electricity to capture fly ash which is then vibrated off and collected in large hoppers or bins.

Fly ash is sold to the cement industry for use as an additive in the manufacturing of Portland cement. Fly ash from Genesee Unit 1 and 2 has been used in concrete for construction of airport runways, roads and building construction. Unsold ash is transported and stored in licenced landfills within the Genesee Mine.

Genesee Unit 3 does not use an ESP. It uses a different technology called a bag house. With more than 11,000 filter bags, the bag house is essentially like a vacuum cleaner used to collect fly ash. Approximately 98% of the particulate is captured in the bag house.

In 2015, third party tests of Capital Power's Stack Particulate Emissions determined that G3 and G1/2 are operating at 28.3% and 27.8% of their respective license limits, reflecting our commitment to operational excellence.



How Does the Power get From the Plant to Your House?



Once the electricity leaves the generator it passes though a step-up transformer where its voltage is increased to 500 kilovolts (kV) (500,000 volts) so it can be transmitted long distances through the transmission network. There are three 225 tonne transformers for each of the facility's three units located at Genesee.

 Towers measuring 28 to 30 metres in height carry high-voltage transmission wires which carry electricity to substations located near large population centres.

While this sounds like a long trip it happens in less than a blink of an eye.

 Equipment in substations reduce the electricity's voltage so it can be distributed safely to retail customers including homes, offices, factories and farms throughout the province.



Reclamation

Since 1989, Capital Power and Westmoreland Coal have been actively working to ensure that mined land is returned back to levels of productivity as good or better than what existed prior to mining through a process called "reclamation".



Reclamation involves filling in areas where coal was mined and recreating landscapes and revegetating the areas with trees and/or grasses as well as re-establishing surface water resources. Sometimes instead of turning the land back for agricultural purposes it's simply returned as wildlife habitat.

At the end of 2015 Capital Power and Westmoreland Coal have completely reclaimed 2,333 acres or (944 ha) into crop land. Current reclamation activities include reforestation, reestablishment of agricultural lands and the creation of wetland areas.

Following reclamation, the land is managed to support other land use initiatives including land leasing, cattle grazing, research and environmental monitoring.

Capital Power and Sherritt Coal (previous mine owner) received the 2009 Alberta Chamber of Resources Major Reclamation Award. The award recognized both companies' commitment to conducting reclamation activities in the Genesee Mine. The companies were nominated by Alberta Environment.

End Notes

¹ **Base load** – The minimum amount of electric power delivered or required over a given period of time at a steady rate.

² **Cogeneration** – An energy efficient, environmentally-friendly, method of producing electricity, steam and/ or hot water at the same time, in one process, with one fuel.

³ **Megawatt** – The productive capacity of electrical generation are measured in megawatts (MW). A MW is a unit of power equal to 1,000 kilowatts equal to one million watts.

⁴ **Subcritical** – The conventional technology for coal-fired electricity production.

⁵ Power Purchase Arrangement – A legal contract between an electricity generator and a power purchaser. The power purchaser purchases energy, and sometimes capacity and/or ancillary services, from the electrical generator.

⁶ Balancing Pool of Alberta – Manages the Power Purchase Arrangements of several major power plants. The Balancing Pool was established in 1999 by the Government of Alberta to help manage certain assets, revenues and expenses arising from the transition to competition in Alberta's electric industry.

⁷ **Gigawatt hour (GWh)** – Unit of electrical energy representing one billion watt hours and is equivalent to one million kilowatt hours or one thousand megawatt hours. ⁸ **Supercritical** – In a supercritical boiler, less fuel is used to produce the same amount of power. The higher steam temperatures and pressures, together with a high-efficiency steam turbine, means less coal is used per megawatt-hour. Because less fuel is used to produce the same amount of power, CO₂ emissions per MW are lower than a conventional coal plant.

⁹ **Power Pool of Alberta** – All electric energy bought and sold in Alberta must be exchanged through the Power Pool of Alberta. The Power Pool does not buy or sell electric energy. It is an independent, central, open-access pool that functions as a spot market, matching demand with the lowest supply to establish an hourly pool price.

¹⁰ *Flue gas desulfurization* – A technology used to remove SO₂ from the exhaust flue gases of fossil fuel power plants.

¹¹ **Fossil fuels** – Formed from the remains of dead plants and animals millions of years ago. This includes hydrocarbons, primarily coal, fuel oil or natural gas.

¹² **Flue gas** – Burning coal produces carbon dioxide, sulphur dioxide and nitrogen oxide. These gasses are collectively called "flue gas" and are vented from the boiler. The flue gas passes through Genesee Unit 1 and 2's ESP or Unit 3's Baghouse which captures the fly ash particles before the flue gas exits to the atmosphere through the plant's stacks.

¹³ **Particulate** – Tiny particles of fly ash and dust remaining at the end of the coal combustion process.









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