Introduction to BC Hydro’s Integrated Electric System

BC Hydro is a commercial crown corporation owned by the province of British Columbia. BC Hydro’s board of directors is appointed by the provincial government and is accountable to the Minister of Energy and Mines. As a public utility, BC Hydro is subject to regulation by the British Columbia Utilities Commission (BCUC) and is obligated to meet domestic customer demand. Failure to serve is not an acceptable option. Thus, BC Hydro’s first and foremost responsibility is to ensure that it is able to reliably supply electricity in an environmentally and socially acceptable manner as and when demanded by its customers.

As one of the largest electric utilities in Canada, BC Hydro serves more than 1.6 million customers in an area containing over 94 per cent of British Columbia’s population. BC Hydro has a world-class integrated electric system of over 10,000 megawatts of generating capacity, over 87 per cent of which is hydroelectric. British Columbians enjoy amongst the lowest electricity rates in the world.

Electricity is delivered safely and dependably to customers through an interconnected system of over 72,000 kilometres of publicly owned transmission and distribution lines. Both the transmission and distribution assets continue to be owned by BC Hydro. However, the transmission system is planned, operated and managed by the British Columbia Transmission Corporation (BCTC) on behalf of BC Hydro. BCTC is also a commercial Crown Corporation, incorporated in May 2003, owned by the province of British Columbia, and is a public utility regulated by the BCUC. Part of BCTC’s role is to ensure open and non-discriminatory access to the BC transmission system for all electricity producers.

Highlights of BC Hydro’s integrated electric system, including distribution, generation, and transmission are provided below.

Energy/Capacity and Customer Demand

Electricity demand is the term used to describe the amount of electric power required by consumers. Because electricity cannot be stored, electricity power generation must match electric power demand at all times. Some electricity customers, such as large industries need a steady amount of electricity delivered through the day, day after day. Others need a large amount delivered at once. Residential customers, for example, need the most electricity in the early evening when they are home from work preparing dinner, running appliances, and watching TV. They need very small amounts late at night and moderate amounts through the day.

Similarly, the demand for electricity varies throughout the year. In British Columbia, demand is highest in December and January when people use more electricity for heating and lighting than in other months. This seasonal and daily pattern, shown schematically in the following diagrams, influences how BC Hydro plans and operates the electrical system.
To meet customer demand reliably requires BC Hydro to have under its control adequate:

- **Firm energy capability**, the amount of energy the electric system can produce over a given time, usually one year (gigawatt-hours, or GWh),
- **Dependable capacity**, the maximum amount of electrical power that can be produced at any instant (megawatts, or MW), and
- **Generation reserve**, which ensures the ability to provide a reliable supply of electricity even in the face of forecast uncertainties and unscheduled outages.

**Generation of Electricity**

BC Hydro meets most of its customer demand through electricity generated at its own facilities. Since the late 1980’s, BC Hydro has also been purchasing most of its new generation from independent power producers (IPPs). IPPs currently contribute approximately 10 per cent of BC Hydro’s total reliable energy capability. In addition, BC Hydro also imports electricity when it is cost effective. On average in the last five years, BC Hydro has imported approximately 4% of its customers’ energy demand.

**Capacity**

BC Hydro’s existing generating facilities are included in the Heritage Contract. Generation stations that are part of the integrated electrical system include 29 hydroelectric facilities (~10,000 MW), one 913 MW gas-fired steam turbine power plant (Burrard) and one 46 MW gas-fired combustion turbine power plant (Prince Rupert). Of these facilities, about 65 per cent of BC Hydro’s installed generating capacity is at hydroelectric installations in the Peace and Columbia River basins. In contrast to these large facilities in the Interior of the province,

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1 The “Heritage Contract” was created by the BC government in November 2003 through the BC Hydro Public Power Legacy and Heritage Contract Act. The purpose is to preserve the benefits of the existing hydroelectric and thermal resources for BC Hydro’s customers. BC Hydro’s existing resources are included as Heritage Resources.

2 BC Hydro also has a gas-fired combustion turbine in Fort Nelson, which is integrated with the Alberta system but not with the BC Hydro integrated system.
there are 19 hydroelectric generation stations in the Lower Mainland and on Vancouver Island that provide approximately 16% of BC Hydro's installed capacity.

**Energy**

The hydroelectric facilities on the Peace and Columbia Rivers also provide a significant portion of the energy capability of BC Hydro's Heritage resources. The GM Shrum and Peace Canyon generating stations on the Peace River produce 29 per cent of BC Hydro's Heritage energy, while Mica and Revelstoke hydroelectric plants on the Columbia River together produce 25 per cent. Both of the hydroelectric systems on the Columbia and the Peace River have large reservoirs that provide multi-year storage. Williston Reservoir on the Peace River is 1773 km$^2$ while the Kinbasket Reservoir behind Mica Dam on the Columbia is 425 km$^2$.

The generation system must be operated in a way that protects consumers from a shortage of electricity in periods of low inflows and makes the best use of the water available when inflows are at average or higher levels. In general, BC Hydro's storage reservoirs are drawn down in the winter months and are at their lowest point in the spring before the freshet. The large water volume from snowmelt in the spring and summer then refills the reservoirs. The large storage reservoirs on the Peace and Columbia Rivers allow water from wet years (above average snow and rain) to be stored and used in subsequent drier years. Operation of reservoirs on the Columbia River is partly constrained by the Columbia River Treaty, which is a treaty between Canada and the U.S. signed in 1961 when the hydroelectric development of the Columbia basin was initiated.

The energy capability of resources under BC Hydro's control is directly dependent on the volume of water received by the reservoirs, availability of gas to operate thermal plants, and purchases from independent power producers. BC Hydro operates the generation system to optimise the use of the water and storage in the reservoirs. High reservoir levels provide more energy from the same amount of water, a more secure future supply of electricity and a higher risk of spilling (wasting) water. Low reservoir levels result in less energy from the same amount of water, a less secure future supply of electricity and a lower risk of spilling water. There are times when it is the ratepayers' interest to displace dispatchable resources in BC with purchases of lower cost energy from markets in the U.S. and Alberta.

**Delivering Electricity**

The Lower Mainland and Vancouver Island regions account for approximately 70% of BC Hydro's total load, while most of the generation is produced at the two major remote sources of generation, on the Peace and Columbia Rivers. As a result, the electricity produced at these remote facilities travels a long way before it reaches BC Hydro’s customers. Electricity is transmitted across the province via the high voltage (500kV or 230kV) bulk transmission network. Electricity from the Peace River generation system is connected to the heavily populated southwest BC through the Kelly Lake Substation, and from the Columbia River system through Nicola Substation. These two substations are major hubs of the transmission network.

Figure 1 (attached file Figure 1 for Information Sheet #4 – see transmission.pdf handout at meeting), shows the bulk transmission network including the main transmission corridors that connect the Lower Mainland to the Interior. The figure also shows the submarine cables that connect Vancouver Island to the Lower Mainland as well as the interties that connect the BC transmission network with the U.S. and Alberta. These interconnections bring mutual benefits as well as obligations to the interconnected parties. Some of the key benefits to BC include
enhanced supply reliability and access to external electricity markets in the U.S. and Alberta. The interconnection to Alberta consists of one 500 kV line (Cranbrook to Calgary) and two 138 kV lines (Natal area to southern Alberta). The interconnection to the U.S. consists of two 500 kV lines (Lower Mainland to Bellingham) and two 230 kV lines (near Trail).

So far, the discussion has concentrated on the bulk transmission system that is the backbone of the system. From the major substations, the voltage is reduced using transformers to lower voltage levels for delivery to the regional transmission systems, which moves the power from the major substations to substations supplying the local distribution system. Some of the larger industrial customers are also supplied directly from the regional transmission systems. From the regional transmission system, BC Hydro’s 56,400 kilometres worth of distribution lines (25 kV and less) carry the electricity to our customers to power homes, businesses and industries.

Some of BC Hydro’s customers live in areas too remote to be served by transmission lines. These non-integrated areas are served with electricity generated by local diesel engines and gas turbines or small hydroelectric stations. These generation plants are primarily BC Hydro-owned, although some electricity supply is provided under contract with independent power producers (IPPs).

Powerex

BC Hydro’s wholly owned power marketing subsidiary, Powerex, trades energy outside the province. This includes selling any domestic surplus and, if cost-effective, purchasing power for domestic use. BC Hydro also uses its flexible hydroelectric storage reservoir system to buy energy when prices are low and to sell energy when prices are high. Powerex has become a leading marketer of wholesale energy products and services in western Canada and the western United States, and is a growing player in other markets in North America.