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# British Columbia Electricity Supply Gap Strategy: A Redefinition of Self-sufficiency

*British Columbia faces an electricity supply shortage due to policy constraints, including a legislated mandate for self-sufficiency. In addition to the restrictions imposed by the Clean Energy Act, the province has committed to supporting liquefied natural gas facilities that will further increase electricity demand. By redefining self sufficiency to require export revenue to exceed import costs, that supply gap can be filled while keeping energy costs low.*

*Amy Sopinka and Lawrence Pitt*

The Province of British Columbia faces growing electricity demand and yet is severely constrained by legislation in how it can meet the estimated supply gap. The 2010 *BC Clean Energy Act* requires clean and renewable energy projects for 93 percent of provincial supply. Ambitious greenhouse gas reduction targets are embedded in legislation as is electricity self-sufficiency. Government policy further requires British Columbian electricity rates to be amongst the lowest in North America. At the same time the province is strongly encouraging electricity-intensive resource extraction projects such as mining, oil and gas production, and liquefied natural gas export projects. The means by which British Columbia rectifies its impending supply gap will impact the province's electricity rates; market purchases may be the most cost-effective means of ensuring supply over the next 10 years. This could be achieved by redefining self-sufficiency to reference net

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export revenue rather than electricity volumes.

## I. Introduction

The British Columbia electric grid is dominated by the presence of BC Hydro, the provincial utility that provides generation, transmission and distribution services to 95 percent of the population. The remaining 5 percent is served by FortisBC, a regulated, for-profit entity. BC's electricity system includes nearly 11,000 MW of hydroelectric capacity, 1,100 MW of thermal, and 3,214 MW of independent power projects.[1] The province's significant storage capacity includes the Williston Reservoir, with active storage of 393 million cubic metres ($Mm^3$) and has multiyear storage capabilities.[2] The hydroelectric facilities are the workhorse of the system, providing 49,784 GWh of generation in 2012; independent power projects produced 10,827 GWh, while the thermal units were generally used for ancillary support, generating only 143 GWh.[3]

Provincial energy policy is governed by the *BC Clean Energy Act* which constrains how the province can increase its electricity supply. There is a growing population base in BC and the *BC Jobs Plan* and *BC LNG Strategy* could add 4,935 GWh of industrial load to system requirements as liquefied natural gas (LNG) terminals are added to the system.[4] With the initial LNG load estimates, BC Hydro forecasts that a supply gap will emerge as early as 2017. Compounding the problem is the stipulation in the *BC Clean Energy Act* requiring that the province's electricity rates remain among the most competitive of rates charged by public utilities in North America. In 2012, the provincial government directed the British Columbia Utilities Commission (BCUC) to order the utilities to reduce rate increases by 50 percent over three years.[5] The rate reductions were achieved through provincial government financial contribution and in part due to higher revenues from electricity trading.

*Due to the abundance of low-carbon energy, the Province of BC wishes to remain at the forefront of clean energy policy.*

There are several ways to alleviate the expected electricity shortfall. These include inducing further demand-side reductions, upgrades to existing resources, and the purchasing of energy from facilities built by independent power producers (IPPs). The costs associated with each of these remedies will impact ratepayers differently. For IPP projects, not only is the energy cost a consideration but a complete valuation must also incorporate the cost of the additional transmission infrastructure that is required to move the electricity from its source to the load centers, as well as the limitations that intermittent energy puts on the system's existing firm resources thereby restricting potential trading revenues.

## II. Legislated Constraints

Electricity generation in the province of British Columbia is primarily hydroelectric with a small number of biomass, run-of-river, and wind projects developed by independent power producers. Due to the abundance of low-carbon energy, the Province of BC wishes to remain at the forefront of clean energy policy. To this end, the *BC Clean Energy Act* was created in 2010 and amended in 2012. The Act formally legislates the Province's energy objectives. These include[6]:

(a) electricity self-sufficiency; that is, electric utilities must hold the rights to an amount of electricity that meets the electricity supply obligations from electricity generating facilities within the province.

(b) demand-side measures that conserve energy and reduce the expected increase in demand for electricity by the year 2020 by at least 66 percent;

(c) generating at least 93 percent of the electricity in British Columbia from clean or renewable resources; an

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exemption was made for electricity required to support LNG exports.

(d) ensuring that provincial electricity rates remain among the most competitive charged by public utilities in North America;

(e) reducing BC greenhouse gas emissions by 33 percent below the levels of 2007;

(f) becoming a net exporter of electricity from clean or renewable resources; and

(g) achieving British Columbia's energy objectives without the use of nuclear power.

While constrained by the above legislated requirements, the Province unveiled the *BC Jobs Plan* and the *BC Liquefied Natural Gas Strategy*, both with the aim of increasing employment through energy-intensive resource extraction. However, with the emerging electricity shortfall, the policy objectives outlined in the *BC Clean Energy Act* cannot be achieved simultaneously.

## III. Supply Shortfall

In 2012, BC Hydro released its draft integrated resource plan, a document outlining the resources required to balance electricity supply and demand over the long term, as well as a 30-year view on transmission requirements. Under the *BC Clean Energy Act*, a final plan was to be submitted to the Province by December 2011. This deadline was subsequently extended, first by a year to December 2012 and then to August 2013. The reason given for the second extension was to give BC Hydro, the provincial government, and LNG proponents the time and flexibility to complete electricity supply agreements. Given the current constraints on the system's expansion, and with two LNG proponents procuring electricity from the BC Hydro system, a firm energy shortfall will occur as early as 2017 (**Fig. 1**).[7]

The magnitude of the supply gap depends on a number of assumptions, including the efficacy of the province's demand-side management (DSM) plans and the electricity requirements of potential industrial customers.[8] In Fig. 1, the thinner dashed line is the electricity demand forecast including demand-side management efforts and includes the demand from LNG terminals. The thicker black line is the demand forecast with DSM but without LNG load.

The province is committed to seeing three liquefied natural gas terminals in operation by 2020. It is assumed that the first two LNG projects will require electricity provided by BC Hydro. With this initial LNG load requirement, the utility forecasts a growing supply gap of 761 GWh by 2017, 4935 GWh by 2021, and 12,478 GWh by 2031.[4] However, if the liquefied natural gas terminals are permitted to self-generate, the

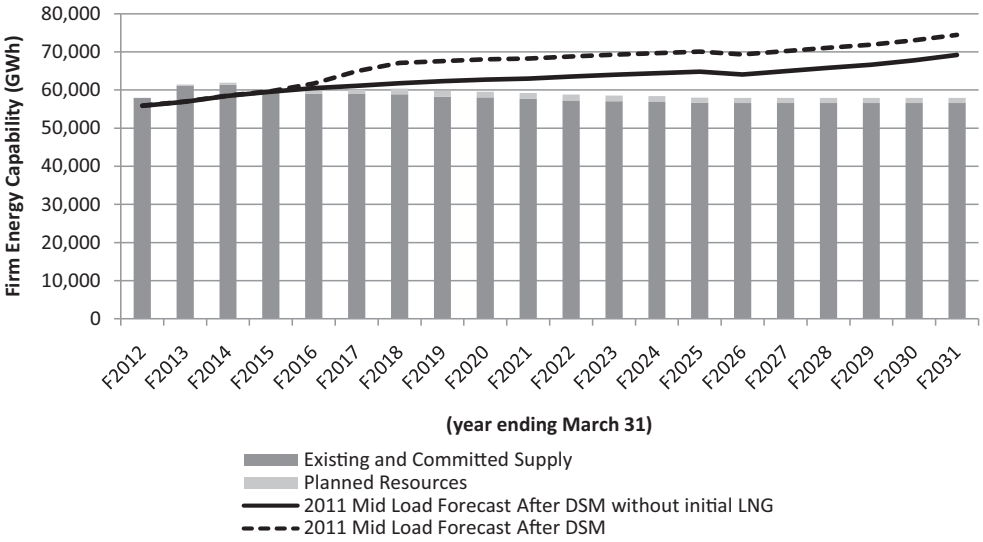


**Fig. 1:** BC's Firm Energy Capability Load Resource Balance.[7]

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supply gap will be delayed until 2023.

## IV. Domestic Resource Options

At present, the province has the following electricity supply resources[9]:

- Power Smart (demand-side management program);
- Heritage Hydro (existing hydroelectric units and the proposed Site C facility);
- Heritage Thermal (existing thermal units);
- Resource Smart (upgrades to existing heritage hydro facilities);
- Downstream Benefits (the Canadian Entitlement from the Columbia River Treaty);
- Non-Firm/Market Imports 2,500 GWh allowance, and
- Electricity Purchase Agreements (EPAs) with IPPs.

Of these seven mechanisms, only three (Power Smart, Resource Smart, and EPAs) are able to increase energy supply in the future given the policy constraints that currently exist within the province. The amount of energy from the heritage hydro units fluctuates based on water inflows but on average produce 48,000 GWh per year. Under a special direction from the Province, the 950 MW Burrard thermal unit is constrained to provide only emergency capacity and ancillary services.[10]

The downstream benefits from the Columbia River Treaty represent the additional power that is generated in the United States emanating from the water management provided by Canadian storage reservoirs. The size of the entitlement varies over years but provides an average of 4,400 GWh of energy to the system. Under the terms of the Treaty, there is no termination date however either the U.S. or Canada can end the arrangement as early as September 2024 given 10 years' notice. The market import allowance and market reliance options will be eliminated by 2016 under the electricity self-sufficiency requirement of the *BC Clean Energy Act*.

In addition to the mechanisms outlined above, the BC Hydro is currently in the process of developing Site C, a 1,098 MW storage hydroelectric unit on the Peace River. The project is already through three of five stages of the provincial review process and is expected to be in service sometime after 2020. Once online, the facility will generate approximately 5,100 GWh of electricity per year.[11]

### A. Power Smart

The *BC Clean Energy Act* requires that the province undertake demand-side management (DSM) measures to reduce its expected increase in demand for electricity by the year 2020 by at least 66 percent. Without entering the debate as to how true DSM conservation can be measured, the current Power Smart program is not inexpensive. The annual BC Hydro Demand Side Management Activities report for fiscal 2012 stated that ''BC Hydro's DSM expenditures in F2012 totalled $175.3 million while incremental DSM electricity savings totalled 1,123 GWh/year''.[12] The current cost of the Power Smart DSM program is $15.55/MWh, given a 15-year amortization period and a discount rate of 5.5 percent. This is shown in **Fig. 3**.

### B. Resource Smart

The Resource Smart program upgrades and/or modifies existing heritage hydroelectric units to provide additional firm capacity to the BC system. These include replacement, power house upgrades, and additional turbine units. The projects are expected to increase provincial generating capacity by 793 MW.[13] Further upgrades to existing powerhouses may occur, however there is a significant lag time associated with capital spending programs due to regulatory and consultative processes.

### C. EPAs from independent power projects

Although both the Power and Resource Smart programs will reduce the supply shortfall, the bulk of the supply gap is expected to be filled with electricity purchase agreements (EPAs) with potential independent power producers. Due to the clean and renewable policy



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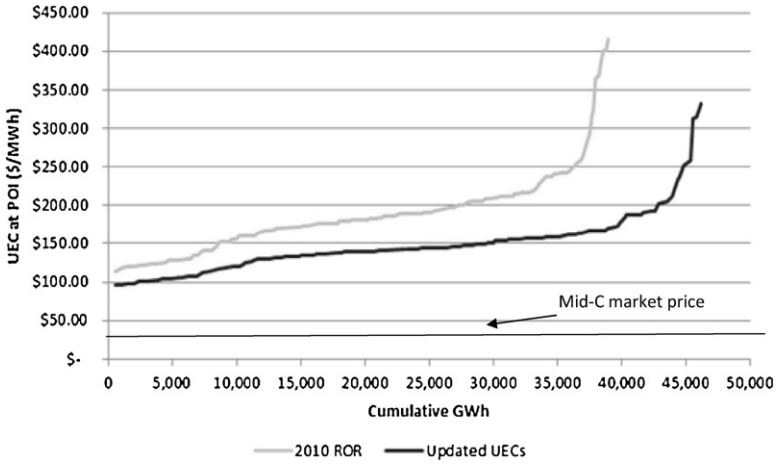


**Fig. 2:** Comparison of Onshore Wind 2010 Resource Options Report and Onshore Wind Supply Curve Based on Updated Turbine Efficiency and Cost Information (in $F2013).[15]

requirements, the majority of these independent projects are small, intermittent, and remote from the province's main load centers.

BC Hydro asserts that the long-run marginal cost associated with wind projects that fall into the clean and renewable energy category will be approximately $124.30/MWh when delivered to the Lower Mainland, the province's main load area.[14] This value includes adjustment costs to account for wind integration, network upgrades, and firm transmission reinforcements. **Fig. 2** shows both the 2010 and the 2013 unit energy costs (UEC) for on-shore wind projects; the UEC represents the annualized cost of the energy generated over the life of a project. The lower UECs for on-shore wind energy are related to higher wind turbine efficiencies and lower turbine costs.[15,16]

Other resource options include wood-based biomass, biogas, municipal solid waste, offshore wind, geothermal, and run-or-river. BC Hydro has determined that solar, tidal, and wave technologies are currently economically infeasible options while coal carbon capture and storage is technically infeasible at this time. The price range of differing projects is shown in Fig. 3. In addition, we calculated the energy-weighted average cost of each technology; that value is shown by the triangle marker. Note that the upper range of the wood-based biomass and offshore wind costs were truncated at $600/MWh but in fact go as high as $984/MWh and $734/MWh respectively. The Mid-C market price is the average historical price of purchasing electricity at the closest U.S. market hub.

## V. Market Purchases: Redefining Self-sufficiency

British Columbia trades electricity with Alberta and the U.S. The BC-Alberta intertie, known as Path 1, potentially allows the transfer of up to 1,000 MW east-to-west and 1,200 MW west-to-east, although the available transfer capacity is significantly reduced by transmission constraints mostly on the Alberta side. British Columbia can trade electricity with the U.S. via Path 3, two 500 kV lines from Ingledow to Custer, one 230 kV transmission line from Nelway to Boundary and one 230 kV line from Waneta to Boundary. Trade with the U.S. is lucrative. In 2011, provincial net export revenue amounted to $128.2 million. British Columbia import and export revenues by

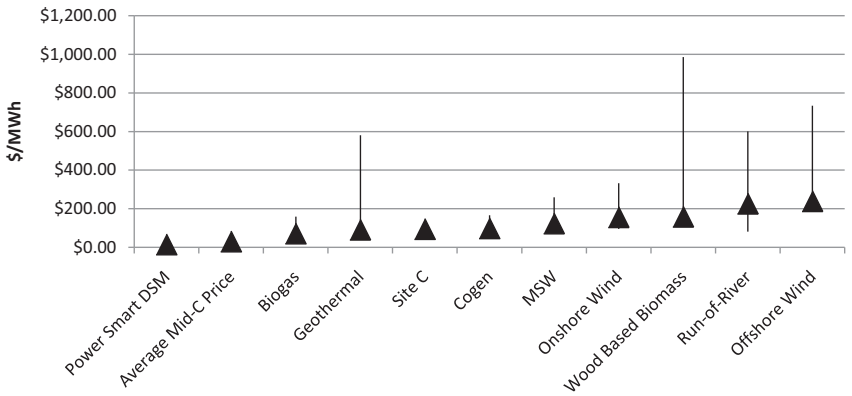


**Fig. 3:** BC Hydro Range of Costs and Energy-Weighted Average Cost for Differing Technologies.[15]

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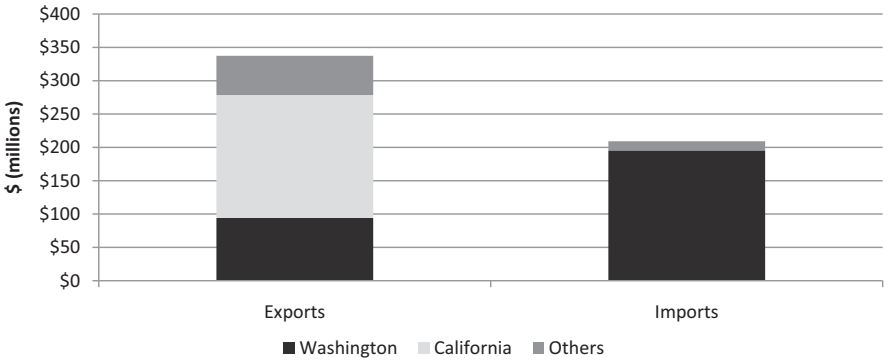


**Fig. 4:** BC Exports and Imports in 2011.[17]

destination in 2011 are shown in Fig. 4.[17]

In the first nine months of 2012, the province's gross trade revenue was $460 million, a decrease of $136 million compared to the same period in 2011. BC Hydro attributes a portion of the revenue decline to lower Pacific Northwest electricity prices resulting from higher hydro and wind generation in the region.[18] Historical statistics relating to key pricing hubs in the Western Electricity Coordinating Council (WECC) are shown in Table 1.[19]

Electricity prices within WECC are likely to remain low as renewable and underutilized natural gas capacity is predicted to increase until at least 2020.[19] As electricity demand growth within the region is expected to remain low,[20] electricity prices within the region are also likely to remain low.[21] Given the expectation of continued low prices in the region, BC could manage to meet its electricity needs, at least over the near and medium term through market purchases. Although this option violates the electricity self-sufficiency requirements, the independence requirement as it relates to energy could be redefined as *revenue* self-sufficiency, demanding that the revenue from exports exceeds the cost of imports.

The current configuration of the BC's intertie connection with the Pacific Northwest potentially allows for a maximum of 3,150 MW per hour export and 2,000 MW per hour of import capacity.[22] This translates to maximum potential annual export and import energy values of 27,600 and 17,500 GWh respectively, although constraints can reduce actual transmission capacity. However, given that the largest forecasted supply gap is 12,300 GWh in 2031, the existing transmission infrastructure should be adequate to meet import requirements. Although the interties can be constrained during peak hours, BC's storage capacity is flexible allowing the utility to import electricity and store water during off-peak hours.

In addition to the increased cost associated with purchasing energy from IPPs, there are other reasons not to add these generators to BC's electricity supply. Most of the IPP projects provide non-firm, non-dispatchable energy to the system. The addition of this intermittent energy requires BC Hydro to restrict potential trading volumes, holding back its firm energy to backstop any variation in these intermittent resources. This firming need reduces the system's supply flexibility.

With 34,000 MW of renewable capacity expected in the WECC by 2020,[20] supply flexibility is a valuable commodity in areas lacking it. Regions that have already integrated high levels of intermittent resources, including Alberta, Bonneville Power Administration (BPA), and California Independent System Operator (CAISO), require short-term, fast-ramping energy to backstop the variability of supply. British Columbia's hydroelectric system can ramp its output by

**Table 1:** Summary Statistics from Selected Pricing Points Within WECC from April 2009 to November 2012.[19]

| | ($/MWh) | | | |
|---|---|---|---|---|
| | Mid Columbia | NP15 | SP15 | Palo Verde |
| Min | $0.49 | $21.00 | $21.50 | $19.55 |
| Max | $108.81 | $81.23 | $72.67 | $71.73 |
| Average | $30.72 | $37.34 | $37.50 | $35.18 |

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200 MW/minute. This capability is highly valued. In Alberta, on average in 2011, active spinning reserve was paid $55/MW and over 26 percent of Alberta's spinning reserve was provided by the AB–BC tie line.[23]

Revenue from electricity trading is one of the chief reasons that BC Hydro was able to keep rates low in the past. Restricting the province's ability to trade will reduce profits and require rate increases. The BC Hydro Review, completed in 2011, found that the ''BC Hydro system has significant flexibility to import power at times of the day or year when market prices are low. As a result, BC requires additional flexibility in its energy policy. Additional flexibility for BC Hydro, including increased access to low-cost energy from the market, could reduce costs significantly for ratepayers''.[24]

One consideration related to imported energy is the carbon content of the purchased electricity. British Columbia imports mostly low-carbon energy from Washington state as the fuel mix is almost 80 percent low carbon (wind, hydroelectric, and nuclear).[25] The carbon content may be lower than 20 percent, as British Columbia would purchase low-priced electricity which results from coincident high-water and high-wind conditions.

British Columbia would be diminishing a valuable resource in adding energy-only resources to the system as it would have to use the flexibility of the Heritage hydro assets to manage its own variability rather than being paid to provide this service to other electric grids.

## VI. Conclusions

The magnitude and timing of the provincial electricity shortfall depends on whether BC Hydro

supplies most of the potential LNG loads. LNG proponents may not want to purchase electricity from the utility particularly as they have the input fuel at hand, With the July 24, 2012, Clean Energy Act Regulation 572 exempts exporting LNG facilities from the 93 percent renewables requirement, it is expected that some LNG proponents will self-supply electricity with behind-the-fence generating units.[26]

Even if some (or all) of the LNG plants decide to generate their own electricity, BC Hydro's electricity system will become supply-constrained in the next decade. Although growth in industrial electricity demand would exacerbate shortfalls, the many legislated constraints limit how any supply shortfall will be alleviated. Electricity purchase agreements with independent power producers are one possible solution, although this course of action would likely violate the rate requirements as it is by far the most expensive option. Redefining self sufficiency to require export revenue to exceed import costs would allow the supply gap to be filled at the same time keeping energy costs low. Surplus supply conditions in Washington state resulting from high wind and water conditions can even lead to zero or negative prices at Mid-C. British Columbia has storage capacity and flexibility to buy low-cost electricity and store water in its reservoirs for future use or to sell into the market when prices are high. Electricity self-sufficiency restricts electricity trade, which means that those foregone revenues cannot be used to reduce electricity rates.■

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