Electrifying British Columbia

Straight answers to frequently asked questions about the energy transition

June 2023

INTRODUCTION

In a bid to meet climate objectives, all levels of government (including many British Columbia local governments) are considering or introducing policies and programs to incentivize and/or require building and vehicle electrification. As they do, senior managers, elected officials, residents, and key stakeholders are asking legitimate questions about the risks and opportunities associated with this pathway.

Introba and Bright Future Studio worked with BC Hydro, ZEBx, and Community Energy Managers from the Township of Langley, Metro Vancouver and Saanich to develop and provide local-government staff with clear, accessible, and accurate information on electrification in the British Columbia context.[i] The goal of the FAQ is to provide resources to support candid conversations on the benefits, risks, and implications of electrification, including considerations of grid capacity and reliability.

The questions outlined in this document were developed by surveying twelve local governments from around the province on the most common electrification questions that arise through their work. Their responses were used to form the questions in this FAQ, which include:

1. What is electrification?
2. What are we actually talking about when we say "the electrical grid" in BC?
3. What are the different roles of the regulator, the utility, and the provincial government?
4. How are local governments getting involved in utility regulation?
5. Will BC Hydro have enough power to support the widespread electrification of homes, buildings, and industry?
6. How will BC Hydro meet increased electricity demand?
7. How does BC Hydro anticipate future electricity demand?
8. How will BC Hydro address peak demand?
9. How can individuals and communities produce energy to feed into the grid?
10. What is the role and potential of energy storage technologies?
11. What are the climate impacts associated with electricity imports?
12. What are the climate impacts of hydropower?
13. How is BC Hydro addressing costs and timelines associated with electrical service upgrades?
14. How will BC Hydro ensure the reliability of the grid through coming climate impacts?
15. Will homeowners with electric heating stay safe through an extended outage?
16. What are the cost implications of switching from natural gas to electricity?
17. Should the building envelope be retrofitted before electrifying?
18. What are some energy efficiency strategies to reduce electricity bills?

ELECTRICITY 101

1. What is electrification?

Electrification refers to the process of replacing technologies that use fossil fuels (coal, oil, and natural gas) with technologies that use electricity as a source of energy. For example, replacing a conventional heating system with an electric heat pump, or a gas-powered vehicle with an electric vehicle. BC has a very clean electrical grid, with 98% of electricity generated through renewable sources, resulting in significant emissions reduction from electrification.

Electrification of buildings, vehicles, and industry is a critical part of meeting BC's climate targets, including the provincial government's CleanBC Roadmap to 2030, and BC Hydro's Electrification Plan (see sidebar for more information about these plans).

2. What are we actually talking about when we say "the electrical grid" in BC?

An electrical grid can be broken down into three primary functions – **generation** (depicted as #1 and #2 in Figure 1), **transmission** (#3, #4, #5) and **distribution** (#6 and #8).

Figure 1. Electricity generation, transmission, and distribution

1. **Generation:** Electricity is generated by technologies that convert energy into electricity. These can include turbines, solar photovoltaic cells, internal combustion engines (e.g. diesel generators), hydrogen fuel cells, and thermoelectric generators. In BC, hydroelectric turbines generate most of our electricity. Pipes called penstocks direct falling water across a series of blades, spinning a rotor shaft inside a generator. This converts the mechanical energy of the rotor

BC'S ELECTRIFICATION PLANS

Clean BC Roadmap to 2030: outlines a plan for achieving 40% emissions reduction by 2030. Actions include the acceleration of buildings, vehicles and industrial electrification, and the implementation of BC Hydro's Electrification Plan.

BC Hydro Electrification Plan: outlines a plan for investing $260 million to advance electrification in B.C. by focusing on three key segments – homes and buildings, transportation and industry. The plan has set ambitious targets, including encouraging and incentivizing residents and businesses to switch from fossil fuels to clean electricity – adding 3,100 gigawatt hours of load and reducing greenhouse gas emissions.

into electrical energy (see #1 and #2 in Figure 1). BC Hydro operates 30 hydroelectric plants (and will add one more – Site C – in 2025), and partners with independent power producers (IPPs) who generate electricity primarily from run of river hydro, wind, solar, and biomass.

2. **Transmission:** Transmission is the process of transporting electricity from generation facilities to substations, located closer to consumers. Generators usually produce electricity with a low voltage. Before entering the transmission lines, the generator voltage is increased by a large step-up transformer to allow transmission lines to carry the electricity efficiently over long distances. (see #3 in Figure 1). Transmission lines span long distances and are typically at least 30 feet off the ground, and carry multiple wires (see #4 and #5 in Figure 1). BC Hydro has 80,000 km of transmission lines throughout BC (see Figure 2).

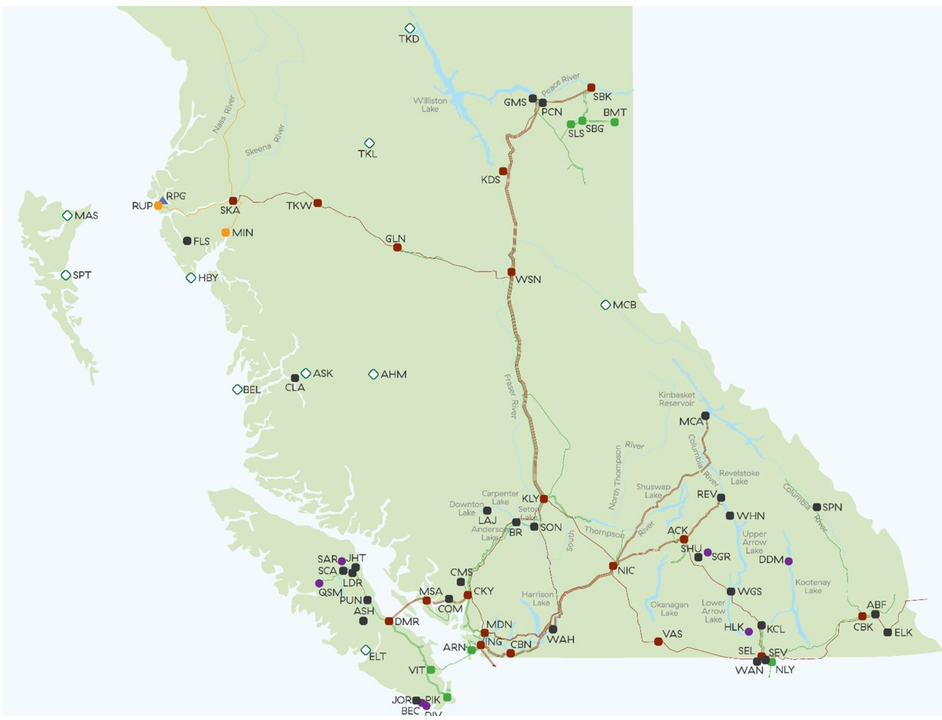


Figure 2. BC Hydro's transmission lines throughout the province

3. **Distribution:** Distribution is the last stage of the delivery process from energy generation to the end-use customer. Before entering the distribution lines, the high-voltage energy from the transmission lines is stepped down through a large transformer. After travelling along the distribution lines, the energy voltage is stepped down once again (through smaller transformers mounted on poles, or on/under the ground) before being safely delivered to homes and businesses. Distribution lines run along streets (or, in some cases, underground) and deliver electricity for space and water heating, EV charging, running appliances, etc. (see #8 and #6 in Figure 1).

See BC Hydro's [Hydro Electric Generation System page for additional information]

3. What are the different roles of the regulator, the utility, and the provincial government?

Three main entities work together to provide electricity in British Columbia: The Province of British Columbia, BC Hydro, and the BC Utilities Commission (BCUC).

BC Hydro is a provincial Crown corporation, owned by the government and people of British Columbia, Canada. Hydro generates and delivers electricity to 95% of the population of BC, which equals about 5 million customers.

The **Province of British Columbia** sets the strategic direction through policies, plans, and regulations, and grants BC Hydro the authority to generate, manufacture, conserve, supply, acquire and dispose of power through the *Hydro Power Authority Act*.

Meanwhile, the **BCUC** oversees the actions of all energy utilities in the province, this includes Fortis BC, municipally owned electrical utilities and Pacific Northern Gas. Their role is to ensure customers have access to safe and reliable energy at fair rates, and that utilities can earn a fair return on their investment.[ii,iii] Energy utilities require regulatory oversight as they are natural monopolies, meaning they don't operate in a competitive market. The *Utilities Commission Act (UCA)* details the BCUC's regulatory authority and activities, which include:

- **Approving rate applications.** The BCUC reviews and approves public utility rates before a company can lawfully charge them to its customers.[iv]
- **Determining a fair rate of return.** The BCUC reviews proposed utility rates to ensure the allowed earnings (or return on equity) of the utility's shareholders reflect a fair rate of return for their invested capital. The BCUC reviews and determines this rate through the Cost of Capital proceedings, which it hosts every few years.[v]
- **Approving construction and operation of facilities.** Before building, enhancing, or operating a plant, system, or extension, a public utility may need to apply for a Certificate of Public Convenience and Necessity (CPCN). In reviewing these proposals, the BCUC considers whether the project is needed and in the public interest.
- **Accepting energy supply contracts.** Public utilities must seek prior BCUC approval to purchase energy from a third party, such as an independent power producer (IPP).

DEMAND-SIDE MANAGEMENT

Demand-side management (DSM) or Demand-side measures: include rates, measures, actions or programs:

- to conserve energy or promote energy efficiency,
- to reduce the energy demand a public utility must serve, or
- to shift the use of energy to periods of lower demand.

Demand-side measures do not include:

- rates, measures, actions or programs with the main purpose of encouraging a switch from the use of one kind of energy to another that would increase greenhouse gas emissions in British Columbia.

- **Approving Demand-side Management (DSM) Plans:** Utilities are mandated to offer demand-side measures to conserve energy, which are approved by the BCUC based on their adequacy and cost-effectiveness.[vi]
- **Supervising public utility activities.** The BCUC monitors utilities to protect the safety and convenience of the public. It scrutinizes changes to their capital structure, sales and purchases of their properties and/or resources, their infrastructure construction, and any equipment they use. The BCUC also ensures public utilities comply with BCUC orders and directions and legislation or regulations.

The Utilities Commission Act does not yet regulate climate action. However, the provincial government can direct the BCUC to implement its policy priorities—including climate action—through regulations and Orders in Council.[vii] With this direction, BCUC can help ensure any utility proposals intended to help the Province meet its climate targets are cost-effective and transparent, and that the company will hear and fully consider the concerns of those who are impacted.

4. How are local governments getting involved in utility regulation?

Local governments are increasingly getting involved in BCUC proceedings by obtaining intervener status, submitting letters of comment, or subscribing to relevant proceedings. Interveners actively and formally participate in proceedings. They can submit questions, arguments, and evidence on matters that are within the proceeding's scope. Ongoing relevant proceedings at the time of writing include:

FortisBC Energy Inc. (gas) Biomethane Energy Recovery Charge Rate Methodology and Comprehensive Review of a Revised Renewable Gas Program
The District of North Vancouver, District of Saanich, City of Richmond, City of Victoria, City of Vancouver, City of Surrey and Metro Vancouver have sought intervener status in this proceeding.

FortisBC's Energy Inc. 2022 Long-term Gas Resource Plan
The City of Richmond, City of Vancouver, City of Surrey, District of North Vancouver, District of Saanich and Metro Vancouver have sought intervention status in this proceeding.

BC Hydro 2021 Integrated Resource Plan Sign-Post Update

BC Hydro Optional Residential Time-of-Use Rate

HOW TO GET INVOLVED IN BCUC PROCEEDINGS

The easiest way for local governments to get involved in a proceeding is by submitting a Letter of Comment. Letters of Comment provide a relatively low barrier way for individuals, organizations, and groups to share their views, opinions, and insights about an application or matter under review by the BCUC. The BCUC panel reviews Letters of Comment before making its final decisions on any proceeding. For more information or to get involved in a proceeding visit the **Submit a Letter of Comment** page on the BCUC website.

GENERATION AND TRANSMISSION

5. Will BC Hydro have enough power to support the widespread electrification of homes, buildings, and industry?

Yes. BC Hydro is planning for the rapid scale up of building, vehicle and industry electrification, and has developed near- and long-term actions to meet the scale of electrification required for achieving the provincial government's climate targets. The utility continuously updates these plans and projections in response to changing conditions (i.e. government policy and regulation, and market conditions).

6. How will BC Hydro meet increased electricity demand?

BC Hydro employs a range of strategies to conserve and use existing electricity more efficiently, and generate additional sources to meet the growing demand throughout the province. The implementation of the following strategies will vary based on projected demand scenarios outlined in question 7.

1. **Demand-side measures.** BC Hydro has a range of programs and investments to reduce and manage energy demand. These include energy efficiency programs for commercial, industrial, and residential customers. The company has also recently began implementing programs that incentivize customers to shift electricity use into off-peak periods (see below for additional details). *See IRP for further details about demand side measures.*
2. **Upgrades to generation facilities.** BC Hydro can upgrade its existing generation facilities to boost its capacity, but these projects typically have long lead times. BC Hydro is considering and pursuing a number of these projects, including adding additional generating units, making upgrades, decommissioning and refurbishing.
3. **Electricity purchase agreement renewals.** BC Hydro has more than 120 purchase agreements with Independent Power Producers (IPPs) that generate and sell electricity at a utility-scale. About 70 of these agreements are expiring over the next 20 years—primarily small run-of-river facilities, as well as larger run-of-river, storage hydro, biomass, municipal solid waste, wind, solar, waste heat, biogas, and natural gas-fired generation facilities. Most of these contracts will be renewed, apart from the gas-fired generation agreements.
4. **Upgrades to transmission and distribution facilities.** Upgrades to BC Hydro's transmission and distribution systems increase its ability to transfer electricity from where it is generated to where it is needed. These projects often have long lead times. BC Hydro has

CAPACITY VS. ENERGY VS. LOAD

Electricity is measured in both capacity and energy.

Capacity is the maximum output an electricity generator can physically produce under ideal conditions, measured in megawatts (MW) or kilowatts (kW).

Energy is the amount of electricity that is produced and consumed over time. Energy is measured in megawatt-hours (MWh) or kilowatt-hours (kWh). Many generators do not operate at their full capacity all the time. A generator's output may vary according to conditions at the power plant, variability of wind, sun and water, market prices, etc.

Load is the amount of electricity required by a customer or group of customers (includes capacity and energy).

planned improvements to existing transmission and distribution infrastructure and is exploring options to add additional transmission lines. *See IRP for additional details about transmission upgrades.*

5. **Future resources.** BC Hydro's existing hydroelectric facilities are a natural partner for variable-output renewable energy resources such as wind and solar onto the grid. This is because dams can ramp up or ramp down quickly in response to changing demand; further, dams can act like giant "batteries" by storing energy behind the dam in the form of water. BC Hydro monitors the potential application and cost of resources throughout the province, and has found that, at least in the near term, wind is likely the lowest-cost supply-side energy resource.[viii] The company expects large-scale solar resources to become more competitive over the long term. The utility does not plan to build additional large dams beyond Site C, which will begin feeding power to the grid in 2025.

7. How does BC Hydro anticipate future electricity demand?

BC Hydro determines future electricity supply and demand through its Integrated Resource Plan (IRP), which outlines projected energy needs in the province over the coming 20 years. The utility updates and resubmits its plans to the regulator every three to five years.[ix] The IRP examines future resources with respect to generation, transmission, and distribution, and outlines the actions and investments that will ensure the utility continues providing safe, reliable and affordable electricity.

To address the uncertainty around future electricity demand, BC Hydro creates a base scenario as well as some contingency scenarios. These scenarios aim to forecast supply and delivery under a range of conditions and address factors such as senior government regulations and expectations, the condition and capacity of physical assets such as transmission lines, customer demand, and so on. In the most recent IRP, there are four load scenarios (i.e., three system load scenarios and one regional load scenario):

1. **The Reference or Base Scenario:** this scenario projects moderate growth averaging about 1.4 % per year over the planning horizon. Growth is primarily due to electric vehicle, and oil and gas sector load growth (including LNG) but is partially offset by declines in the forestry sub-sectors.
2. **Stagnation or Low Load Contingency Scenario:** this scenario projects that demand will drop somewhat and then stagnate.
3. **Accelerated Electrification Contingency Scenario:** this scenario projects rapid electrification of buildings, vehicles, and industry at the scale needed to meet BC Hydro's Electrification Plan, and achieve the provincial government's 2025, 2030, and 2040 climate targets.
4. **North Coast Electrification Contingency Scenario:** this scenario projects significant load growth on the North Coast as a result of the electrification of new liquefied natural gas (LNG) and mining operations.

Projected Demand And Near-Term Actions

BC Hydro submitted its most recent IRP to the BCUC in December 2021 with the caveat that periodic "signpost updates" would be needed to match the rapid pace of change in this time of energy transition. In June 2023, this signpost update (or Updated 2021 IRP) was submitted to the BCUC, which accounts for new growth in commercial and large industrial loads. These increased loads can largely be attributed to the provincial government's approval of Cedar LNG and the establishment of a new provincial Energy Action Framework.

In the Updated 2021 IRP, BC Hydro projects increased demand in the *Base Scenario* and the *Stagnation Contingency Scenario* beginning in 2030 (compared to the original modelling in the 2021 IRP). The *Accelerated Electrification* and *North Coast Electrification Contingency Scenarios* remained relatively unchanged or had reduced near-term growth projections. This updated modelling has increased the alignment in growth projections across all scenarios. As a result, BC Hydro has removed the differentiation for near-term actions between each scenario, and proposed the following near-term actions for all four scenarios:

- Accelerating the ramp-up of energy efficiency programs
- Accelerating the ramp-up of demand-response programs and industrial load curtailment
- Extending assumptions regarding electricity purchase agreement renewals past fiscal 2026
- Acquiring new clean or renewable energy resources from greenfield projects as well as from existing facilities
- Accelerating utility-scale battery projects
- Using imported electricity, if needed, to meet any short-term gaps in the electricity supply

This represents BC Hydro's first call for power in 15 years, which will target 3,000 GWh hours from larger, utility-scale projects as early as 2029. Wind and solar are anticipated to be some of the most competitive applications received from IPPs. The call for power process will be designed by BC Hydro and the Province following engagement with First Nations, industry and stakeholders. The engagement will include development of options regarding minimum requirements for Indigenous participation in new projects. *See the BC Government's press release and the Updated 2021 IRP for additional details.*

Figure 8.6-1 Visual timeline of acquisition of new clean clean or renewable from greenfield facilities

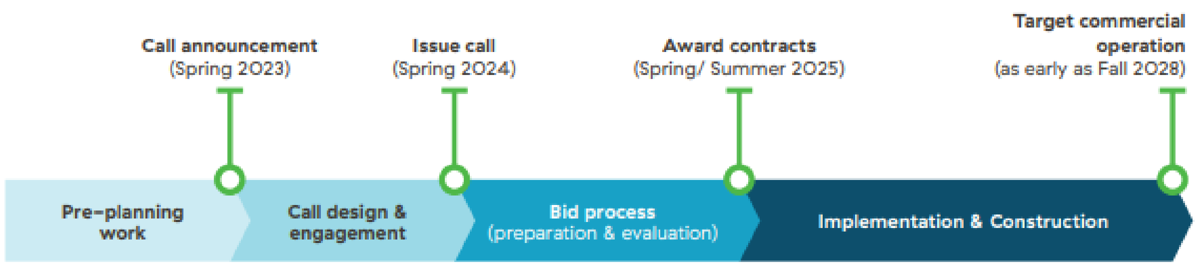


Figure 3. Timelines of acquisitions of new clean or renewable power from greenfield facilities

8. How will BC Hydro address peak demand?

Managing peak demand will be an important strategy for easing strain on the grid with increasing electrification. Peak demand, or peak load, is the highest one-hour load requirement on BC Hydro's grid. This usually occurs on weeknight evenings on the coldest days of the year when most British Columbians are coming home from work and turning on the heat, switching on lights and appliances.

The grid is designed to meet BC's demand for electricity safely and reliably year-round, including peak demand. However, meeting these short-term daily electricity peaks sometimes means relying on imported energy or short-term fossil fuel generation. Helping customers change their energy habits can flatten the peak demand curve, and avoid investing in new generation, transmission and distribution infrastructure. BC Hydro is incorporating *demand response programs* and *time-of-use rates* to incentivize customers to change their energy-use patterns, so they draw less electricity from the grid during peak periods.

Demand response programs
Demand response programs can be used with in-home devices to manage the energy used by specific equipment and appliances, such as electric vehicle chargers or water heaters. They shift electricity use out of peak times and into periods when supply is more available (see Figure 4). For example, BC Hydro has implemented a Peak Saver Incentive Pilot Program for residential customers, and has proposed a smart-charger incentive for EVs and a load curtailment program for commercial and industrial customers.[x]

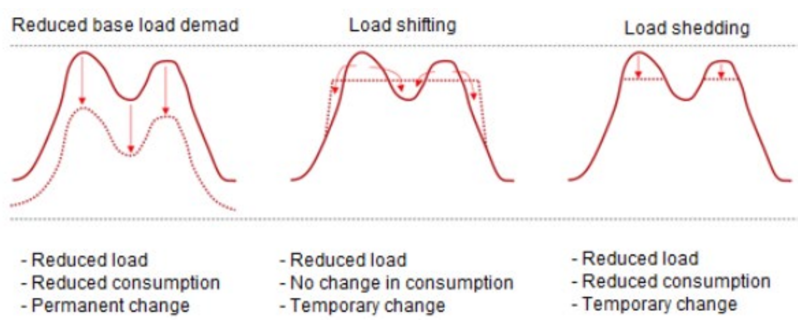


Figure 4. Load shaping options

Time-of-use rates
Time-of-use rates allow customers to save money when they shift their energy-intensive activities—like charging their EV or running their dishwasher or dryer—to off peak hours. Customers with an electric vehicle, for example, could save an average of $40 and up to $250 per year by charging their electric vehicle during overnight hours. Pending review and approval by the BCUC, BC Hydro anticipates this new optional rate could be implemented as early as this year. *For more details, visit BC Hydro's Residential Rate Design Page.*

9. How can individuals and communities produce energy to feed into the grid?

Individuals and communities can produce, store, or manage their electricity through distributed energy resources (DERs). DERs are small-scale electricity supply or demand resources that are interconnected to the electric grid.

PEAK DEMAND IN BC

It is typical for residential electricity use in BC to increase, on average, by 88 percent in the colder, darker, winter months. However, the increase has been even more pronounced in recent years as climate change creates stronger storms and cold snaps that last for days – and sometimes weeks- on end. To put this into perspective, BC Hydro has broken the peak-demand record six times in the past six years.

On December 21, 2022, between 5 and 6 p.m. BC Hydro broke its all-time peak hourly demand at over 10,900 megawatts.

The previous record was set on December 27, 2021, when peak hourly demand reached 10,787 megawatts.

While rooftop solar panels are especially appealing to homeowners and communities, DERs include a wide range of technologies such as:

- Smart thermostats
- Solar PV systems
- Battery storage systems
- Vehicle-to-grid charging stations
- Small-scale wind turbines
- Micro hydro
- Co-generation[xi]

BC Hydro is actively exploring other applications of DERs within the existing grid. The 2021 IRP outlines plans to expand the use of small-scale battery storage and smart charging technologies for electric vehicles, and continues to monitor the cost and applications for residential and community scale energy generation (i.e. solar, wind pumped hydro storage, generation facilities).

10. What is the role and potential of energy storage technologies?

Batteries can store energy that is generated by renewable sources to be used when it's needed (i.e. periods of peak demand, power outages, etc.). Utility-scale batteries in particular have a critical role in meeting future electricity demand with the ramp up of electrification. There are four main types of energy storage, that have distinct for supporting future electricity growth and resilience.

Small scale battery storage

BC Hydro, individual building owners, governments, and public sector organizations are all investigating opportunities for small-scale batteries to help communities stay safe and help businesses reduce costs. The cost of small-scale batteries has decreased in recent years, and certain applications are being actively explored and piloted. For example:

- Using solar and on-site batteries as a replacement for a backup diesel generator for large institutional buildings (e.g., healthcare facilities).
- Using battery storage to reduce demand charges for large businesses or institutional customers. These batteries could also reduce consumption during the hottest and coldest times of the year when demand for electricity is highest.
- Using small scale batteries to reduce the need for infrastructure upgrades caused by short term demand spikes.

Utility-scale battery storage

Utility-scale batteries can store intermittent sources of renewable energy (e.g. solar PV) so it can be used when it's needed. This technology is still relatively expensive and has limited storage capacity, but costs are on the decline and capabilities are expected to increase. Utility-scale batteries are an integral strategy in the IRP's Accelerated Electrification Scenario; BC Hydro is proposing to install 21 megawatts of battery capacity starting in 2029, and within four years ramping it up to 482 megawatts of batteries. Today, BC Hydro is studying, consulting and piloting utility-scale battery resources to understand how this technology can best utilized within the existing grid.

Bi-directional vehicle charging

An electric vehicle can also function as a small-scale—and mobile! —battery. Electric vehicles can provide backup power to buildings or feed their power back into the grid. Sometimes referred to as vehicle-to-grid (V2G), these solutions can complement solar PV arrays and other DER, or supplement diesel generators as backup power.[xii] The following applications of V2G are currently being explored in BC:

- **Backup Power:** Individual customers can currently use V2G as a backup power source for their building during a power outage without the need for BC Hydro approval or oversight.
- **Feeding power into the grid:** BC Hydro has been working with a tour bus company to initiate a trial of V2G with their fleet that sits idle in winter.

There are still technical and regulatory barriers to the widespread application of V2G for peak shaving and load deferral. It will likely become a more viable solution in the coming years as the technology matures, and EV market penetration increases.

Pumped hydro storage

Pumped hydro storage is like conventional large storage hydro in that water stored in an upper reservoir flows through a turbine to generate power. However, pumped hydro storage operators can reverse the flow of water through the turbine, pumping water from a lower reservoir back to the upper reservoir. This cycle is relatively energy intensive (with a 75 percent round trip efficiency); however, the pumping process typically occurs during off-peak periods to make generation available during daily winter peak periods. Pumped hydro storage can take advantage of existing lakes or river systems in an "open loop" configuration, or artificial reservoirs in a "closed loop" configuration.

CLIMATE IMPACTS OF ELECTRICITY GENERATION

11. What are the climate impacts associated with electricity imports?

The BC electrical system is tied to the grids in neighbouring provinces and states. Occasionally, BC needs to import electricity from other jurisdictions or use its thermal generating stations and this impacts the overall carbon intensity of the electricity use in the province.[xiii] While the energy that BC Hydro generates is 98% clean, neighbouring jurisdictions have more carbon intensive forms of electrical generation.

Governments track the quantity of carbon pollution associated with electricity using a standardized methodology called the Electricity Emissions Intensity Factor (EEIF). They publish the factor annually based on energy used in BC, including both generation and imported energy.[xiv]

The EEIF changes year-to-year due to variations in water supply, reservoir levels and consumer demand. While most of the time BC Hydro can provide BC with the electricity needed, periods of low stream flow, low reservoir levels and high or peak demand, can lead to imported electricity being purchased from neighbouring jurisdictions and/or increased generation from BC thermal generation (fossil fuel) facilities. During these periods, the EEIF increases to reflect the increase in GHG emissions associated with imported and fossil-fuel-generated electricity. The EEIF saw a slight increase from 2021 to 2022, from 9.7 to 11.5 tCO2e/GWh.[xv] The EEIF methodology changed in 2021, making year-over-year comparisons challenging (see text box for additional details).

Energy Trading

The EEIF does not capture electricity trading done through, BC Hydro's subsidiary, Powerex. This company buys and sells power to support affordability and reliability throughout the Western Electric Coordinating Council (WECC) region (i.e. the bulk power system). The ability to buy electricity when prices are lower and sell when prices are higher, is an important form of revenue generation, and can often result in BC having positive revenue from the electricity trade –even in years with net electricity imports.

Electricity trading also results in BC selling clean electricity and purchasing higher emissions electricity without it being accounted for in grid emissions or included in climate targets. Currently, there is limited transparency on the generation source of wholesale electricity imports from other regions. In some cases, electricity imports that are identified as being from a clean generating resource are actually being backfilled with fossil-fueled generation.

EEIF METHODOLOGY

BC amended the EEIF methodology in 2021, resulting in a decrease in the emissions intensity of the electricity grid from 40.1 to 9.7 tCO2e/GWh between 2020 and 2021. **This decrease does not reflect significant changes to grid emissions in BC.**

The new methodology more accurately reflects the carbon intensity of the electricity consumed in BC, while also better aligning B.C. with other trading jurisdictions, including California and Washington state.

The primary change made to the methodology was from "gross imports" to "net imports". This change reflects the distinction between imports needed to meet domestic demand and the trading activities intended to maximize the value of B.C. as a provider of energy storage services. This is because in a "net imports" methodology only emissions associated with the portion of imports needed for domestic use are included in the EEIF.

To address this issue, Powerex's recently adopted Clean Energy Trade Standard to help ensure that electricity trading is not resulting in an increase in carbon emissions throughout the WECC region. This framework will provide the transparency that BC is not producing high emissions electricity for the sole purpose of exports. However, other jurisdictions within the WECC region will need to follow suit by adopting similar frameworks to create transparency on emissions from electricity trading.

From a climate perspective, there are benefits and trade-offs for electricity trading, summarized below.

Benefits

- Electricity trading is an important source of revenue for BC Hydro and the Province.
- BC clean electricity exports are displacing high-emissions electricity elsewhere, leading to a net GHG benefit as BC tends to be a net exporter.
- The US has a goal for a net-zero grid by 2035, making imports cleaner over time.

Trade-offs

- BC is not always a net exporter, and if electrification accelerates at the pace needed to meet climate targets, BC will rely more on imports in the coming years to meet the short-term supply gaps.
- BC's imports of fossil-fuel base electricity generation are helping to support the business case for these facilities to continue operating.

See BC Hydro's Importing and Exporting Electricity for more information on energy trading, and Powerex: 100% Clean Energy Standard Discussion Paper for more information on Powerex' role in climate action.

12. What are the climate impacts of hydropower?

Based on an analysis completed by the Intergovernmental Panel on Climate Change, over the lifecycle of the facility, hydropower produces fewer emissions than coal, natural gas, biomass, solar, or geothermal, and slightly more than wind or nuclear (see Figure 5).[xvi]

A lifecycle assessment captures the full range of greenhouse gas emissions from the construction, operation, and eventual decommissioning of the generation facilities associated with a given energy resource. The most significant lifecycle emissions from hydropower are those produced during construction—including concrete and steel, and their transportation to the site—and methane emissions from the reservoir. Plant materials decomposing at the bottom of the reservoir release methane, a potent greenhouse gas. On the Site C project, BC Hydro has cleared about three

WESTERN INTERCONNECTION

Four major electric system networks serve the United States and Canada – with the Eastern Interconnection and the Western Interconnection being the largest.

BC is part of the Western Interconnection, or the Western Electric Coordinating Council (WECC) region which extends from Canada to Mexico and includes the provinces of Alberta and British Columbia, the northern portion of Baja California, Mexico, and all or portions of the 14 Western states between.

The WECC promotes bulk electric system reliability for the entire Western Interconnection system. They are responsible for compliance monitoring and enforcement, and oversee reliability planning and assessments. BCUC works with WECC on the compliance and enforcement of Mandatory Reliability Standards (MRS).

quarters of the vegetation within the reservoir footprint. Some trees will remain in the lower areas and on steep slopes where it's unsafe to work.

Studies undertaken in Quebec have found that the largest share of methane emissions occur during the first 10–15 years following a reservoir's initial creation.[xvii] This is very different from fossil fuel power plants, which release more or less constant operational emissions over their lifetime. As many of BC Hydro's larger facilities are multiple decades old, their reservoirs currently release very small amounts of carbon pollution. The very long life of hydro facilities results in very low emissions per unit of power produced. For example, solar panels or wind turbines will operate for 25 to 30 years, while some hydropower stations in Eastern Canada are still producing power after more than a century.[xviii]

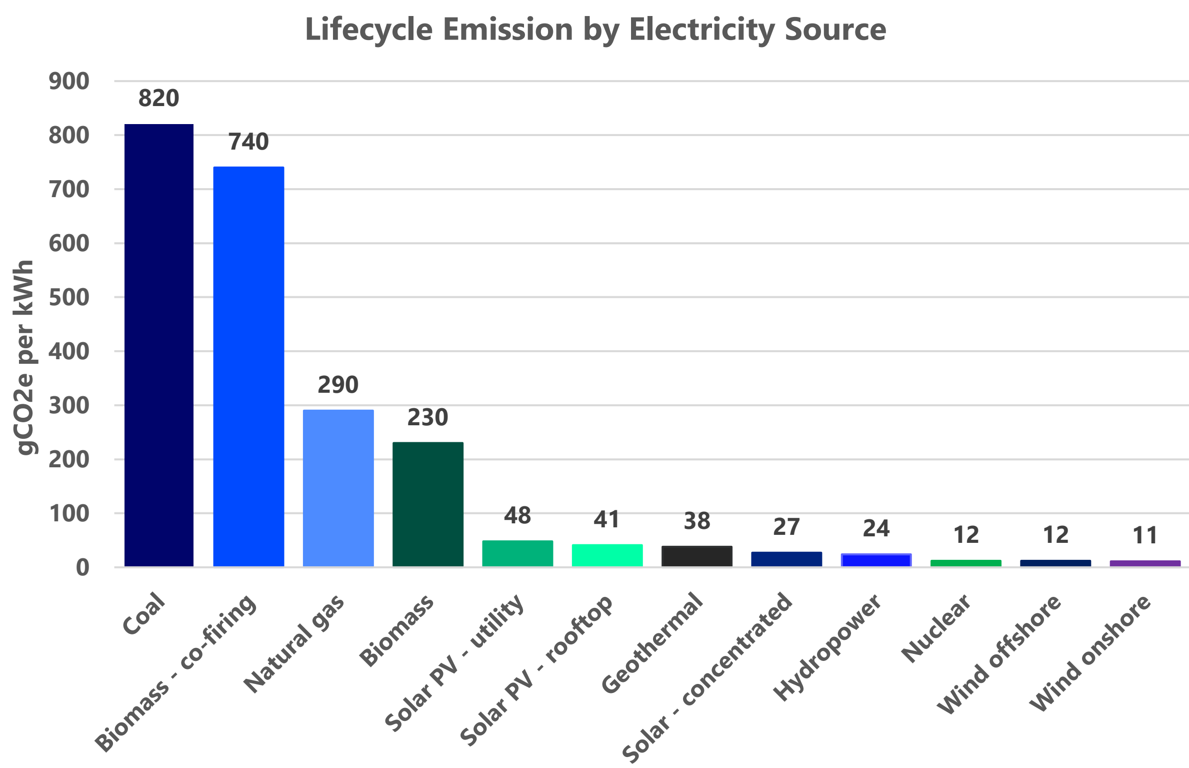


Figure 5. Lifecycle emission by electricity source (data source: IPCC)

CONNECTING TO THE GRID

13. How is BC Hydro addressing costs and timelines associated with electrical service upgrades?

One of the common barriers that residential and commercial customers face in electrifying buildings and vehicles is the need for a distribution system upgrade if they do not have adequate power to meet the additional load on their site.

BC Hydro is in the process of reviewing the *Distribution Extension Policy* that has been in place since 2008,[xix] which is based on the "cost causation principle." That is, those who initiate an infrastructure upgrade must pay for it.[xx] To reduce this cost, and in recognition of the benefits of extension to BC Hydro, the utility provides a $1,475 incentive per single-family dwelling, and $200 per kilowatt of the estimated billed demand for commercial customers. In both cases, within five years, the first (or "pioneer") customer can apply for contributions from subsequent connections.

However, BC Hydro says its customers have found the process to be time consuming, costly, and unpredictable—to the point that it can make an electrification project financially unviable. This issue will only grow more acute as more natural-gas buildings look to electrify. To help address this issue, BC Hydro is exploring ways to shift cost allocation and shorten timelines.

Cost allocation

BC Hydro is in the process of exploring alternative options for allocating costs associated with system improvements, including:

- Increasing its financial contribution to a needed infrastructure upgrade.
- Increasing its financial contribution and introducing an average system improvement fee
- Increasing its financial contribution and simplifying the cost-recovery process with an average system improvement charge. Such an arrangement would aggregate the costs of all system improvements for a given area over a predefined period and divide the costs between customers served by the upgrade.

Timelines

BC Hydro is also taking steps to reduce timelines for system upgrades, including:

- Increasing internal resourcing and training
- Streamlining the design process for simple projects
- Creating a specialized design team to address more complex requests

BC HYDRO RESIDENTIAL EMS RESEARCH

Demand response technologies, or energy management systems (EMS), can also help home and building owners avoid costly electrical service upgrades. BC Hydro undertook a research project to understand how to better enable EMS as a strategy to avoid electrical service upgrades during electrification projects. The report recommends that BC Hydro can take a three-pronged approach including:

1. Continuing to build an internal understanding of EMS and related approaches.
2. Incentivizing both contractors and customers to apply these technologies.
3. Working with partners such as Technical Safety BC to create regulatory clarity.

- Creating a new customer intake process
- Improving online access to information to help customers get the information they need more easily
- Identifying and proactively upgrading parts of the distribution system in areas with high growth projections

Read more about the updates to the Distribution Extension Policy.

RELIABILITY AND RESILIENCE

14. How will BC Hydro ensure the reliability of the grid through coming climate impacts?

Climate change presents an increasing risk to the BC's infrastructure, homes, and buildings. Over the past ten years, BC Hydro has seen an increase in the frequency and intensity of extreme weather, wildfire, and water-related events, which have resulted in unprecedented customer outages and asset damage.

To prepare for these changes, BC Hydro is taking steps to ensure infrastructure is prepared to withstand the impacts of climate change (see Figure 6).

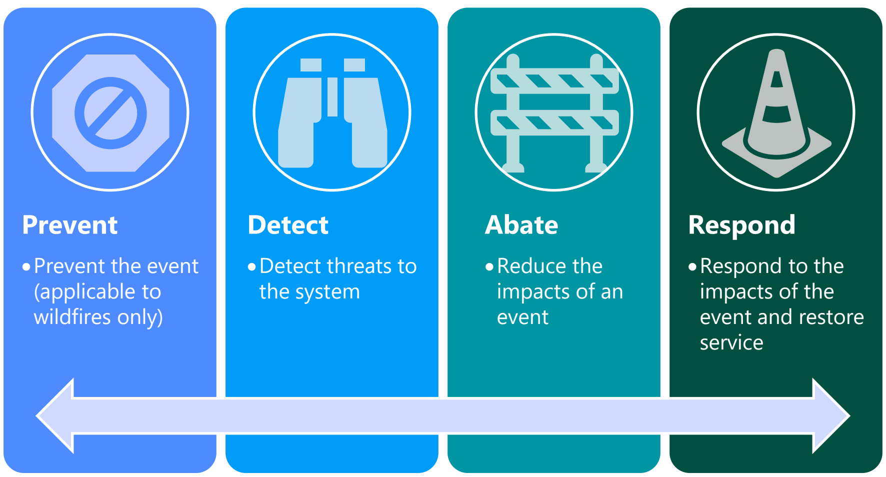


Figure 6. BC Hydro's climate risk management framework

BC Hydro has a detailed strategy outlining specific actions to prevent, detect, abate, and respond to the impacts of climate change. At a high-level, this plan includes:

- Creating a coordinated and cost-effective approach to understanding the impacts of climate change on planning, design, and operations
- Using consistent, quantitative, evidence-based assessments to inform decision-making related to climate change adaptation
- Integrating current climate change science into planning, design, and operations
- Ensuring adaptation and mitigation strategies are complimentary
- Engaging, consulting and transparently communicating efforts and actions with key stakeholders, peers, First Nations communities, and customers
- Improving processes, to reduce response times, speed up the coordination and allocation of company resources, communicate

EXAMPLES OF CLIMATE ADAPTATION

Understanding impacts: BC Hydro has worked with Pacific Climate Impacts Consortium (PCIC) to assess historical changes to B.C.'s climate over the last century and to produce future climate and hydrological scenarios out to the end of the current century. This work also includes the study of climate impacts on the transmission and distribution system.

Incorporating climate adaptation into codes and standards: The Canadian Standards Association is working to incorporate strategies for climate change in existing and new standards and codes. BC Hydro has representatives on some of the codes and standards committees working to identify and implement these changes.

Site management: BC Hydro uses Fire Smart principles in facility site management plans.

better to the crews and to customers, and arrange for external resources in cases where they are needed

15. Will homeowners with electric heating stay safe through an extended outage?

There is a misconception that relying solely on electricity puts customers at greater risk in the case of a power outage than having both natural gas and electricity. In general, gas heating systems will not operate during a power outage as they use components that require electricity to operate, including circuit boards, relays and blower motors and fans. An exception is where homeowners can light a natural gas fireplace or stove with a match; the same is true for some older domestic hot water systems. Some other considerations for keeping residents safe when the power goes out include the following:

- **Efficient homes and buildings are more resilient.** As the efficiency of homes and buildings improves, they are more resilient to power outages. A well-insulated high-performance building will remain warm or cool for longer—meaning occupants will stay safe and comfortable for longer when the power goes out. BC Hydro, the provincial government, and some local governments provide incentives to support improvements to the building envelope in new and existing homes and buildings. *See CleanBC Better Homes or Better Buildings for full list of incentives.*
- **Large buildings and essential services are required to have backup generators.** Large buildings and critical infrastructure are required to have a backup generator (regardless of the building's energy source) to keep occupants safe in the case of power outages.
- **Resiliency in rural and remote locations.** Many occupants in rural and remote locations that are prone to more frequent or longer power outages have wood stoves as a source of backup heating and/or are equipped with temporary or permanent generators or batteries to provide short term power. BC Hydro also proactively works with these communities to increase preparedness when outages occur (see Text Box[xxi]). *Read more about generator options here.*
- **Education and preparedness for residents.** Residents should prepare for an outage by building an emergency kit for the first 72 hours and having a plan in case of an extended outage. *Read more about preparing for an outage here.*

FIELD BATTERY ENERGY STORAGE PROJECT

BC Hydro delivers power to the Town of Field, B.C. via a single distribution line from its Golden Substation. In 2013, BC Hydro installed a one-megawatt battery bank unit close to Field, in Parks Canada's Boulder Compound, to act as a back-up power source to the existing distribution line. The new battery facility provides up to seven hours of backup electricity to customers in Field during power outages.

The area's remote location presents challenges to electricity reliability and field crew response times. The battery improves reliability for Field by providing a critical source of back-up power during prolonged outages. In addition to improving reliability, the battery facility helps reduce the costs and environmental impacts of supplemental supply (such as diesel generators) that are used during prolonged power outages.

COST TO CUSTOMERS

16. What are the cost implications of switching from natural gas to electricity?

Heating electrification involves two distinct costs: The capital costs associated with the purchase and installation of new equipment, and the operating costs associated with utility bills.

Capital Costs

Typically, electric heat pumps systems cost one to five times more than replacing an existing natural-gas heating system. For **single family homes,** electrification projects are typically at the lower end of this range, as these projects are generally less complex and are easier to implement. For **larger commercial buildings and multi unit residential buildings** (MURBs), the capital costs for a fuel switch project will be dependent on several project specific factors including the existing equipment and system design, the new all-electric design, the backup and peaking requirements, the existing system temperature regime (e.g. high-temperature vs low-temperature), the type of terminal units[xxii], the local climate, and the building type and operation.

There are several other factors that can influence the cost of installing a heat pump system:

- **Cooling:** If you're replacing (or adding) both heating and cooling systems in a home and building, heat pumps – which provide both heating and cooling – are more cost effective than having to purchase two separate pieces of equipment to heat and cool a home.
- **Incentives:** There are significant incentives available from BC Hydro, the provincial government and some local governments to help offset the additional capital cost of electrification. *See CleanBC Better Homes or Better Buildings for full list of incentives.*
- **Electrical service upgrade:** It's important to consider if the existing electrical infrastructure will require an upgrade to support the new electrical load, and the potential cost impacts. These upgrades can range from individual building panel upgrades to more substantial projects involving upgrades to the incoming electrical supply and transformers. *See above for further discussion of electrical service upgrades.*

Utility bills

All-electric heat pump systems are more efficient than natural gas heating systems (typically 2-3 times more efficient) and, therefore, result in energy savings. Whether the energy savings translate to energy cost savings is dependent on several factors, including the price of electricity, the price of

HEAT PUMP REBATES FOR HOMEOWNERS

BC Hydro offers up to $3,000 in rebates for switching from a fossil fuel-based system, which can be combined with provincial and federal rebates for a total savings of up to $11,000 on cost and installation with some municipalities adding additional rebates on top of that.

natural gas, the efficiency of the existing natural gas system and the efficiency of the heat pump system (which varies with outdoor air temperature and therefore climate/location).

Historically, electricity rates have been higher than natural gas rates (per unit of energy delivered). In general, for fuel switching to be cost effective, the efficiency of the new system and energy savings must be high enough to offset the higher utility rates. However, with the increasing cost of natural gas, this is becoming less and less significant.

Energy cost savings will also vary depending on whether the customer opts for an all-electric system (i.e. no gas connection, all other gas loads are converted to electric appliances), or a hybrid gas/electric system (i.e. maintaining a gas connection for cooking and/or peaking requirements). In residential households, an all electric system can result in savings from avoiding the fixed charges associated with a natural gas connection.[xxiii, xxiv, xxv, xxvi]

In commercial buildings, the peak electrical demand charges associated with electrification can impede the business case for electrification.

17. Should the building envelope be retrofitted before electrifying?

In general, building envelope upgrades help improve efficiency and comfort, and reduce the heating capacity that is needed for a home or building. However, whether this is required for electrification will depend on several factors, including the existing building envelope performance, the existing system design (i.e. low temperature vs, high temperature system), the building operations, the local climate and the proposed all-electric system design.

The building owner should contract a mechanical consultant to calculate the thermal heating demand of the building and determine whether an envelope upgrade is required to support the electrification project.

If the existing building envelope has poor performance, some envelope upgrades will likely be required as part of the electrification project. This will help reduce impacts on utility bills, but can also significantly increase the cost of the retrofit project, depending on envelope measures that are pursued.

18. What are some energy efficiency strategies to reduce electricity bills?

Energy efficiency measures (EEMs) reduce energy costs and associated greenhouse gas emissions. There are several EEMs that can be implemented to reduce electrical consumption, some examples are listed below:

HOME ENERGY SAVINGS FROM ELECTRIFICATION

BC Hydro Bringing the Heat: For the average household in B.C., it is less expensive to heat with an electric heat pump than a natural gas furnace. A natural gas furnace costs around $731/year to operate, compared to $642/year for an electric heat pump.

Make the Switch: 66% of participating homes, the switch from a natural gas furnace or boiler to a heat pump yielded similar, or lower energy costs. On average participants reduced their energy bills on by 10%. Homes that saw an increase in their energy bills were, on average, older than the overall sample, and very few of these homeowners' pursued insulation or air-sealing upgrades. This reaffirms that upgrades to a building envelope will improve a heat pump's performance, particularly in older homes.

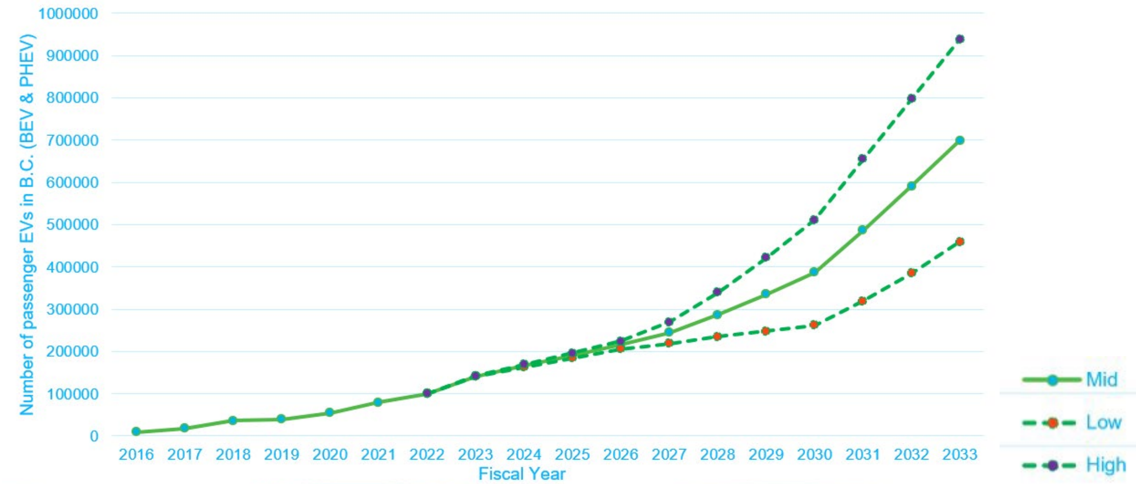
- **Metering and benchmarking** is the process of tracking the energy performance of a building and comparing this performance to other buildings of the same size and archetype. This process allows building operations staff to identify underperforming assets, establish a baseline to measure efficiency improvements against and prioritize energy efficiency investments within a portfolio. BC Hydro offers energy management assessments for commercial customers.
- **Recommissioning** EEMs are low-cost measures that focus on optimizing the control settings and/or installing low-cost sensors and additional controls to reduce energy consumption and improve building performance. These measures typically have a short pay back period. Recommissioning can be completed in regular intervals (BC Hydro recommends every 5 years) or whenever a building has undergone a substantial change in usage.
- **Upgrading lighting systems** to high-efficiency light-emitting-diode (LED) lamps, combined with advanced lighting controls, is a low-cost EEM resulting in reduced electrical consumption.
- **Incorporating Heat Recovery Ventilation** via Energy Recovery Ventilators (ERVs) to recover heat from exhaust air. This EEM will reduce the heating energy associated with the ventilation heating load.
- **Envelope upgrades,** include improvements to walls, roofs and windows. These upgrades include insulation and air-sealing to improve the building envelope and therefore reduce thermal heat losses and, thus, the energy required to heat the building.

BC Hydro offers several rebates to support individuals and organizations with energy saving and electrification projects. Visit CleanBC Better Homes and Better Buildings to explore residential and commercial rebates.

APPENDIX A - ADDITIONAL INFORMATION ON ELECTRIC VEHICLES

Zero-emission vehicles represented 18.1% of new light-duty passenger vehicles sold in BC in 2022, the highest percentage for any province or territory, and well ahead of CleanBC targets. The number of registered light-duty electric vehicles rose from 5,000 in 2016 to more than 100,000 today – a 1,900% increase in the past six years.

Historical and Forecast EV Stock in BC



BC Hydro: 2023 - 2025 Expansion Plans for EV Charging

- Grow to 325 DC chargers across 145 sites (about 450 DC ports)
- Geographic coverage – Haida Gwaii, Northern BC & reach Yukon border
- Urban densification – fill in gaps to meet the needs of EV drivers
- 300 L2 ports in 2023-2024 – Community Charging Pilot with NRCan/other partners – utility-grade equipment, MC grade metrology, hydro-pole mount trial
- Technology platform improvements – Support $/kWh rates, user experience improvements, operational improvements, additional payment options
- Site improvements – accessibility, lighting, pull-through charging, hub sites
- Increasing power levels – F2024 will be predominately 100kW and 180kW units
- Increasing number of DC ports per site – from 2-4 ports to up to 12 ports per site depending on location

Resources

- BC Hydro – Electric Vehicles - YouTube
- BC Hydro – EV incentives in BC
- Plug in BC – Electric Vehicles 101
- Emotive – Electric Vehicle FAQ
- Plug in BC - Incentives

APPENDIX B: ADDITIONAL INFORMATION ON HEAT PUMPS

There are approximately 200,000 heat pumps installed in BC Hydro residential customer homes. This is equivalent to about 10% of homes.

General

- BC Hydro - Heat Pumps 101
- BC Hydro - Heat Pumps - YouTube

Rebates

- Clean BC – Better Homes: BC Energy Rebates & Resources
- Clean BC – Better Buildings: BC Energy Rebates & Resources

Cost

- Saanich – Make the Switch
- BC Hydro – Bringing the Heat
- Government of Canada- Cold-climate air source heat pumps: Assessing cost-effectiveness, energy savings and greenhouse gas emissions reductions in Canadian homes
- BC Hydro - Report: Cost correction - It is now both cheaper and greener to heat with electricity

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[i] Note: This information is for intended for local governments within BC Hydro's service area. Other electric utilities in the province, including ATCO Electric Yukon, Corix Multi-Utility Services (Sun Rivers and Sonoma Pines), Fortis BC (southern interior), Hemlock Utility Services (Hemlock Valley), Kyuoquot Power Ltd (Kyuoquot Sound), Nelson Hydro, New Westminster Electrical Utility, and Silversmith Power & Light Corporation (Sandon).
[ii] British Columbia Utilities Commission. Our Role.
[iii] Note: The BCUC also regulates Insurance Corporation of BC (ICBC) basic automobile insurance, common carrier pipelines, Natural Gas Customer Choice Program, and Mandatory Reliability Standards).
[iv] More information about the BCUC's role can be found in Setting Utility Rates fact sheet.
[v] To learn more about this, see the How Utilities Make Money fact sheet.
[vi] British Columbia. Energy Utility Demand-side Management (DSM).
[vii] British Columbia Utilities Commission. Our Role in BC's Energy Transition.

[viii] The current costs of these resources were assessed based on input from technical stakeholders and previous BC Hydro studies. Future costs of these resources were assessed based on the National Renewable Energy Laboratory's 2019 Annual Technology Baseline report, which accounts for future cost reductions associated with evolving technologies.
[ix] BC Hydro. 2021 Integrated Resource Plan.
[x] In March 2023, BC Hydro released an RFI to support the deployment of a commercial demand response program. Source: BC Hydro. 2023. Got demand response expertise? We're going to need you.
[xixi] Co-generation, also known as combined heat and power (CHP), the term cogeneration describes the simultaneous generation of electrical energy and usable heat from a single primary energy source, often natural gas or biofuels.
[xii] U.S. Department of Energy. Bidirectional Charging and Electric Vehicles for Mobile Storage
[xiii] BC Hydro. Thermal Generation.
[xiv] Government of British Columbia. Frequency Asked Questions: Electricity Emission Intensity Factors for Grid Connected Entities.

[xv] Government of British Columbia. Electricity emission intensity factors for grid-connected communities.
[xvi] IPCC. 2018. Technology-specific Cost and Performance Parameters.
[xvii] A. Levasseur et al. "Improving the accuracy of electricity carbon footprint: Estimation of hydroelectric reservoir greenhouse gas emissions." Renewable and Sustainable Energy Reviews. Volume 136, 2021, 110433, ISSN 1364-0321. https://doi.org/10.1016/j.rser.2020.110433.
[xviii] For example, the 167 MW DeCew Falls 1 station, in St. Catharines, Ontario, has produced electricity for Southern Ontario customers for 125 years, and the 446 MW Sir Adam Beck hydropower station began producing electricity at Niagara Falls in 1921.
[xix] These principles apply for new connections and system upgrades, but here we will mainly focus on system improvement costs.
[xx] BC Hydro. 2023. Improving Customer Connections for a Cleaner Future.
[xxi] BC Hydro. 2015. Project Outreach Report: Energy Storage and Demand Response for Improved Reliability in an Outage Prone Community.
[xxii] In an HVAC system, the terminal unit is the point at which conditioned air is delivered to the space. The objective of the terminal unit is (1) mix the correct proportion of hot and cold water to provide the desired supply of air temperature, (2) to deliver the air at a constant volume.
[xxiii] BC Hydro. 2022. Report: Cost correction - It is now both cheaper and greener to heat with electricity
[xxiv] BC Hydro. 2022. Bringing the heat: British Columbians concerned over energy costs, unaware that going all in on gas does not make dollars or sense.
[xxv] Natural Resources Canada. 2022. Cold Climate Air Source Heat Pumps: Assessing Cost-Effectiveness, Energy savings and Greenhouse Gas Emission Reductions in Canadian Homes.[xxvi] District of Saanich. 2023. Make the Switch.