Multiplex Electrical Process Guide

Using Power Efficient Design to Optimize Electrical Service Capacity

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Overview

This **Multiplex Electrical Process Guide** describes **power efficient design (PED)** strategies that can reduce electrical loads, as calculated under electrical codes. PED includes a range of strategies to limit the instantaneous power consumption in a building. PED can often be used to limit new multiplexes' electrical utility service capacities. In turn, it can reduce:

- Electrical infrastructure costs.
- Utility extension fees that are charged for a new service.
- Space requirements for electrical infrastructure (for example, ground mount transformers) on the lots where multiplexes are built.

This Guide first provides a brief overview of the electrical regulations that dictate electrical service and equipment sizing, including the Vancouver Electrical By-Law and the Canadian Electrical Code, Part I (CSA 22.1, referred to in this document as the "CE Code"). It then summarizes the process for a multiplex to receive an electrical service from BC Hydro, and types of costs that multiplex developers and builders can incur. The rest of the document describes how to apply PED in multiplexes.

PED strategies reviewed in this document include:

- **Building efficiency and right-sizing equipment**, which encompasses:
  - Low power Level 2 electric vehicle (EV) charging (e.g. 20A 208V/240V outlets, as opposed to 40A+).
  - Building efficiency to reduce peak heat demand.
  - Lower power space heating and cooling equipment.
  - Other lower power equipment, including various electric cooking appliances, heat pump hot water heaters and electric dryers.
- **Energy management systems**, including:
  - Circuit monitoring and switching devices.
  - Various EV energy management systems (EVEMS).
- **Energy storage systems**, including batteries and thermal energy storage.

The latest version of the CE Code enables many, though not all, of these PED strategies to reduce calculated loads. This document focuses particularly on those PED strategies that are enabled in the CE Code, illustrating how they can limit multiplexes' electric demand to stay within relevant service size thresholds (e.g. 200A, 400A, etc.). It also notes strategies that are not currently enabled but that could be considered for a variance by the City of Vancouver Electrical Inspections Branch subject to professional assurance.

This document also includes **sample load calculations for three multiplex archetypes** – A triplex, quadplex, and six-plex. For each archetypal multiplex, the Guide calculates loads for three scenarios:

- A "baseline" all-electric building with limited use of PED strategies.
- An all-electric building using all CE Code compliant PED strategies.
- A building that uses only gas appliances (note that this building is provided for reference only, as it would not Vancouver Building By-Law requirements).

Figure ES-1 provides an example of these load calculations for a **six-plex with three (3) parking spaces**. The "baseline" all-electric and gas equivalent scenarios' calculated loads are within 80% (320A) of the 400A service capacities. Conversely, the all-electric scenario is lower. This lower load calculation increases the likelihood that the multiplexes will be able to be served by a lower cost 400A overhead service from BC Hydro.

Using PED strategies is not a guarantee of lower cost utility services – Necessary utility service works for multiplexes are determined by BC Hydro, and are site specific. Nevertheless, PED is an important strategy to reduce electrical loads and thereby reduce the likelihood of more costly electrical services and related works.

	Electrification (Baseline)	**Electrification** (with all PED)	**Gas equivalent** (no PED)
Service capacity (calculated load)	400A (397A)	**400A (276A)**	400A (348A)
Panel size	3x 125A + 3x 100A	6x 100A	6x 100A
Space heat. & cool.	**1 ton mini-split cold climate ASHP + baseboards**	**1 ton mini-split cold climate ASHP + baseboards**	1 ton mini-split AC + gas heating
Building Envelope	VBBL/Step 3	VBBL/Step 3	VBBL/Step 3
Water heating	60 gal. elect. storage	**HP water heater**	Gas instantaneous
Other Appliances	Elect. range and dryer	Elect. range and **HP dryer**	Gas range and elect. dryer
EVSE	L2 on 40A circuit	L2 on 40A circuit	L2 on 40A circuit
Circuit sharing/EVEMS	None	**EVEMS controlling all EVSEs**	None

ES-1: Example load calculations for a six-plex, with calculations for all-electric building using "baseline" PED strategies, all-electric with PED, and gas appliances.

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Glossary

Dwelling Unit	A single residential unit for the purposes of a electrical load calculation per the CE Code.
Interlock Mechanism	Control feature designed to prevent simultaneous operation of multiple components or systems (such as heating elements or mechanical systems).

List of Acronyms

ASHP	Air Source Heat Pump
BIA	Battery-Integrated Appliances
ccASHP	Cold-Climate Air Source Heat Pump
CE Code	Canadian Electrical Code
EMS	Energy Management Systems
EV	Electric Vehicle
EVEMS	Electric Vehicle Energy Management System
EVSE	Electric Vehicle Supply Equipment
HP	Heat Pump
HPWH	Heat Pump Water Heater
HTAP	Housing Technology Assessment Platform
PED	Power Efficient Design
R1-1	Vancouver's multiplex zone
VBBL	Vancouver Building By-Law

1. Multiplex Development in Vancouver

The City of Vancouver has changed zoning so now over 60% of the buildable land in Vancouver allows residential construction up to Multiplex densities, which is a 3-6 unit (in limited cases 8 unit) single lot development. This new zone is called R1-1. The City's Low Density Housing Options How-to Guide provides a detailed overview of R1-1 development.

This **Multiplex Electrical Process Guide** focuses on considerations relating to multiplexes' electrical utility services. Particularly, it describes **power efficient design (PED)** strategies that can reduce the calculated electrical loads that dictate the capacity of multiplexes' electrical utility services. Reducing electrical service capacity requirements using power efficient design can in turn reduce:

- Utility extension fees.
- Electrical infrastructure costs.
- Space requirements for electrical infrastructure on the lots where multiplexes are built.

1.1 Organization of this Guide

This Guide is organized as follows:

- **Section 2** reviews the Vancouver Electrical By-Law and the methodologies in the Canadian Electrical Code that dictate electrical load calculations.
- **Section 3** summarizes the process for a multiplex to receive an electrical service from BC Hydro.
- **Section 4** reviews various PED strategies that can be used to reduce electrical loads and minimize electrical service sizes.
- **Section 5** illustrates load calculations for all-electric triplex, quadplex and six-plex building archetypes.
- **Section 6** provides a case study of the process for a multiplex to receive a 400A service from BC Hydro.

2. The Vancouver Electrical By-Law and the Canadian Electrical Code, Part I

This section provides a brief overview of the regulations, codes and standards that dictate the **calculation of electrical loads** in new multiplex developments. This background information is intended for people without electrical expertise (e.g. architects, developers, property owners, etc.). Electrical engineers and contractors are expected to understand the relevant regulations, beyond the overview presented below.

2.1 About the Canadian Electric Code & the BC Electrical Safety Regulation

The Canadian Electrical Code, Part 1 (CSA Group Standard 22.1, the "CE Code") is a model code published by CSA Group (formerly the Canadian Standards Association). Canadian provinces and some cities including the City of Vancouver (see below) base their electrical codes on the CE Code, sometimes with amendments. The CE Code applies to all electrical work and electrical equipment in buildings, structures and premises on the consumer's side of a utility's electric service connection. The CE Code's objective is to reduce risks of electric shock, fires, and other electrical hazards.

BC's *Electrical Safety Regulation* under the *Safety Standards Act* adopts the CE Code as the BC Electrical Code. BC and the City of Vancouver will adopt the 26th Edition of the CE Code (CSA C22.1-24) in March 2025. Accordingly, calculations in this *Multiplex Electrical Process Guide* are based on this latest CE Code edition CSA C22.1-24.

Per the *Safety Authority Act*, Technical Safety BC (TSBC) administers the *Safety Standards Act*, including interpreting the BC Electrical Code, establishing licensing requirements for electrical contracts, issuing permits and conducting inspections and risk-based oversight of electrical work. However, eight BC local governments have been delegated authority to regulate electrical work, including the City of Vancouver.

2.2 The Vancouver Electrical By-Law

Under the *Vancouver Charter* and the *Safety Standards Act*, the City of Vancouver has delegated authority from the Province of BC to regulate electrical works in the City. The Vancouver Electrical By-law (No. 5563) adopts the CE Code. Thus, both the BC Electrical Code and the Vancouver Electrical By-law adopt the CE Code, and accordingly electrical safety requirements are very similar across BC.

However, the Vancouver Electrical By-law also includes additional requirements pertaining to a few matters, which prevail over the language in the CE Code. These additions include load calculation methodologies for secondary suites and lock-off units – Load calculations for new buildings in the City of Vancouver must consider these provisions where relevant. Additionally, different electrical safety authorities having jurisdiction (i.e. TSBC, City of Vancouver, and the seven other local governments with delegate authority to administer electrical permitting and inspections under the *Safety Standards Act*) may have different requirements and processes for documenting compliance with the CE Code or pursuing variances.

2.3 Electrical Load Calculations

Section 8 of the CE Code establishes requirements for **load calculations** for buildings' **electrical services, feeders** and **branch circuits**.[1] Installed equipment must have sufficient capacity to accommodate the calculated load. Likewise, the capacity calculated dictates the electrical service capacity that must be requested from utilities. Like other utilities, BC Hydro has processes and standards regarding what type of equipment can be deployed for new electrical services of different sizes, and standard increments for the capacity of electrical services (as noted in Chapter 3 below).

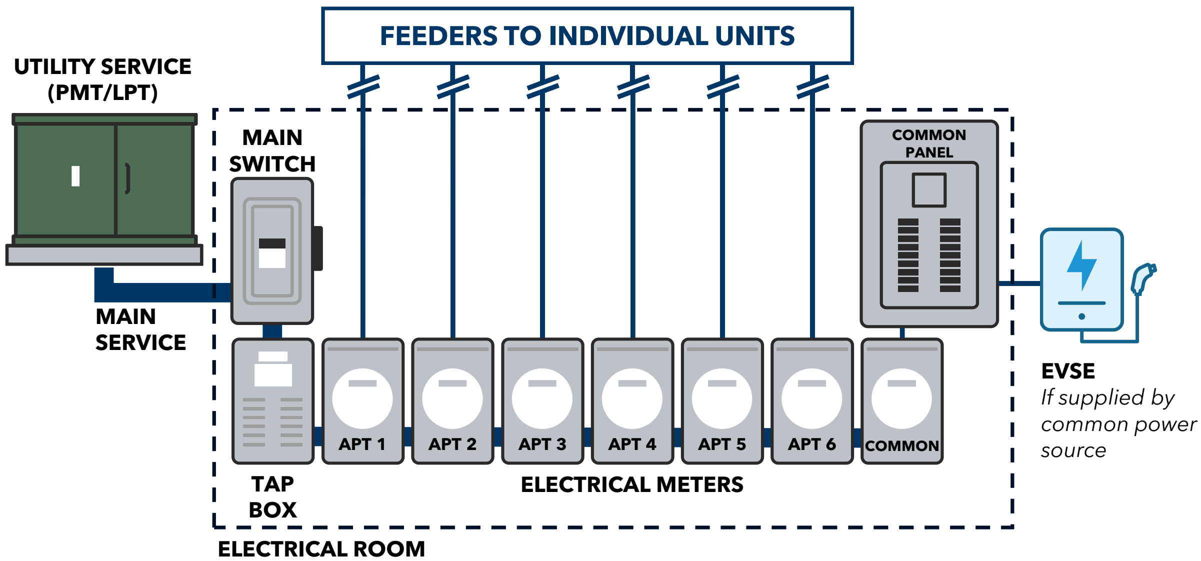

Figure 2: Example schematic of an electrical system in a multiplex.

Rules 8-200 and 8-202 of the CE Code specify load calculation methodologies for single dwellings (i.e. a detached, semi-detached, duplex, triplex, quadraplex, or row-housing unit) and apartments, respectively. Depending on the number of units, load calculations for multiplexes must adhere to the rules described 8-200 or 8-202, though the calculation methodologies are broadly similar. A load calculation must be performed for both individual dwelling units, as well as for a building's utility service and feeders supplying two or more units.

In the subsections below, we describe in general terms the factors considered in load calculations. Chapter 4 includes description of power efficient design strategies that can help reduce calculated loads. Chapter 5 includes load calculations for sample multiplex developments, to illustrate whether and how they can stay within relevant service size limits.

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[1] A feeder is any portion of an electrical circuit between an electrical utility service or other source of supply and the overcurrent devices (e.g. an electrical breaker on an panel) protecting a branch circuit. A branch circuit is the wiring between the final overcurrent device and an outlet that provides power to equipment (e.g. a wall outlet). see Figure 2 for an overview of electrical terms used in this section.

2.3.1 Load calculations for individual dwelling units

Under Rules 8-200 and 8-202, load calculations for individual dwelling units' services or feeders involve:

- A "basic load" for **lighting and receptacle circuits loads**. For example, in a unit considered an apartment in the CE Code, the basic load is calculated as 3500W for the first 45m^2 of living area, 1500W for next 45m^2, and 1000W for each additional 90m^2.
- Electrical loads associated with **space heating and air conditioning equipment**. Section 8-106 specifies that where interlocks prevent simultaneous operation of electric space-heating and air-conditioning loads, the greater load is used in load calculations.
- **Electric range loads** for cooking, calculated as 6000W for a single range plus 40% of any amount by which its rating exceeds 12kW.
- The load for any **electric tankless water heaters** or **electric water heaters** for steamers, swimming pools, hot tubs, or spas.
- The load for **EV chargers**, if supplied off the panel board in the dwelling units.
- **Other loads** (e.g. hot tub, other loads not encompassed in other parts of the load calculation). If the unit includes an electric range, loads greater than 1500W loads are derated to 25% of their electrical capacity (i.e. the load calculation includes only 25% of that electrical load, recognizing it is unlikely to be at full capacity at the same time other loads are at full capacity). If there is no electric range, loads are derated by 25% for loads in excess of 7500W. Thus, 6000W is reserved for an electric range.

These loads are summed together. Services, feeders and panel serving individual dwelling units are based on the larger of these calculated loads or other minimum sizes:

- For buildings subject to Rule 8-200, 24,000W (100A on 120V/240V service) for single dwellings with floor area of 80m^2 or more, or 14,400W (60A on 120V/240V service) for single dwellings with floor area less than 80m^2.
- 60A for an apartment dwelling unit subject to Rule 8-202.

2.3.2 Load calculations for services & feeders supplying two or more units

Load calculations for a building's utility service or feeders supplying two or more units involve summing the following:

- **Unit loads** (as calculated above), excluding EV charging, space heat and air conditioning. The combined unit loads for a whole building is calculated as the sum of 100% of the largest load, 65% of the next two largest unit loads, 40% of the next two largest unit loads, 25% of the next 15 largest unit loads, and 10% of the loads of the remaining units. The CE Code derates the loads from additional units in recognition of the **diversity** of households' electricity use – It is very unlikely that all households will have all these loads on at the same time, allowing for derating of subsequent loads.
- Electric **space heating** and **air conditioning loads** for all units summed with limited derating, recognizing that these loads are often continuous (i.e. operating uninterrupted for long periods of time) and can be synchronous.
- **EV charging loads** again without substantial derating unless controlled by an EV energy management system (EVEMS - see below), in recognition of their continuous nature.
- Lighting, heating and power **loads not located in dwelling units**, for example elevators, parking areas, outdoors, and common stairwells and hallways.

2.3.3 Energy management strategies to reduce calculated loads

As noted in Chapter 4, a variety of power efficient design strategies can be used to reduce buildings' calculated loads. Notably, Rule 8-106 of the CE Code enables certain energy management strategies to reduce calculated loads:

Rule 8-106 (2) enables **circuit switching** strategies, specifying that where two or more loads are installed so that only one can be used at any one time, the one providing the greatest demand shall be used in determining the calculated demand. For example, this can enable an EV charger and an oven range to share the same branch circuit, or sharing between a hot water heater and a clothes dryer.

The CE Code also enables a variety of **EV energy management systems (EVEMS)** to reduce calculated loads:

- Rule 8-106 (10) specifies that where EV charger loads are controlled by an EVEMS, EV charger demand will equal the maximum load allowed by the EVEMS. For example, multiple 40A EV chargers can share a branch circuit, but the calculated load will be limited to the 40A allowed by the EVEMS.
- Rule 8-106 (11) specifies that EV charger loads do not need to be included in load calculations if an EVEMS monitors the capacity of a buildings' service, feeders and branch circuits, and controls EV charger loads so as not to exceed their capacity. With these **service monitoring** technologies, EV charger loads can be ignored entirely in load calculations.

CSA Group has issued CSA SPE-343 *Electric vehicle energy management systems*, to provides guidance for design, manufacture, and testing of electrical equipment that comprises or forms a part of an EVEMS. Likewise, CSA Group is in the process of developing a product standard for EVEMS (CSA 22.2 No. 343). However, the standard has not yet been published. In the absence of such a standard, electrical safety authorities have needed to clarify their approvals processes for use of EVEMS. The City of Vancouver requires electrical engineering drawings for some EVEMS deployments.[2]

[2] See the City's Bulletin 2019-006-BU/EL "Electric Vehicle Charging for Buildings".

2.3.4 Variances for PEDs that are not enabled in the CE Code

As described in Chapter 4, **there are some PED and energy management strategies that are not recognized in the 2024 CE Code as means to reduce calculated loads**. For example, the current version of the CE Code does not recognize the following strategies as means to reduce calculated loads:

- Service/feeder monitoring and control of non-EV charging loads (e.g. turning a hot water heater or a hot tub off as electrical limits are approached).
- Battery integrated appliances (e.g. battery integrated oven ranges) that can use lower power circuits (e.g. oven ranges) while still providing high power output to customers.
- Energy storage to reduce buildings' peak demand.

Variances to the CE Code may be allowed by the City and/or other electrical authorities having jurisdiction. The City of Vancouver is also involved in processes exploring updates to future iterations of the CE Code and/or the Vancouver Electrical By-Law.

Proponents considering such strategies should engage with the City Electrical Inspections Branch regarding whether their design is acceptable under a variance.[3]

2.4 Clearances for BC Hydro Infrastructure

In addition to load calculation provisions, it is important to note that the CE Code includes a wide range of other electrical safety provisions that multiplex developments must comply with. Notably, these include requirements that all new or modified structures must adhere to minimum clearances from existing BC Hydro overhead structures and conductors. further information can be found in BC Hydro's guide to utility clearance requirements.

[3] See the City's Bulletin 2009-004-EL "Special Permission" of the Electrical By-Law No. 5563 Application of Rule 2-030 of the Canadian Electrical Code, Part I "Deviation or Postponement".

3. Process to Receive an Electrical Service from BC Hydro

In Vancouver, all multiplexes will proceed through **BC Hydro's Design Connections application process.**[4] The Design Connections process reflects that most multiplex developments require bespoke design to electrical grid distribution infrastructure to accommodate the project, and coordination with BC Hydro to implement these works.[5] A high-level overview of the Design Connections process is included in Figure 3.

3.1 Overhead or undergrounded electrical service

Electrical services can either be overhead or underground. Overhead systems tap into BC Hydro's pole-mount secondary wires, which are 120V/240V in most R1-1 neighbourhoods, though 120V/208V along some arterial streets.

Underground services feed via a ground mount transformer – e.g. a low-profile transformer (LPT) for single phase service or a pad-mount transformer (PMT) for multi-phase. Because of the need for customers to perform civil works, BC Hydro distribution system upgrade costs, and the potential need to accommodate a ground-mount transformer on the property that requires other useable space, underground services can entail greater costs for customers.

BC Hydro ultimately determines whether an electrical service will be overhead or underground, in accordance with service requirements and local bylaws. Nevertheless, in general, multiplexes with smaller service capacities are more likely to be able to be provided overhead, while larger services are more likely to be needed to be provided underground.

- Most services of **200A** can be overhead.
- **400A** services may be overhead or undergrounded. Factors that influence whether an overhead service is possible include the length of the service span, whether there is a utility pole adjacent to the property, and whether it is possible to avoid aerial trespass across neighboring properties. As a load calculation exceeds approximately 80% of 400A (320A), the likelihood of requiring undergrounded service increases. However, a lesser load calculation is not a guarantee of overhead service, and some multiplexes with load calculations of 320A to 400A could receive overhead service.
- **600A** services or larger will usually be undergrounded.

[4] BC Hydro's information on the Design Connections process is at this website: https://app.bchydro.com/accounts-billing/electrical-connections/connection-requests/design.html

[5] Some builders that previously built predominantly single-family homes or duplexes may be familiar with BC Hydro's Express Connect program. However, all multiplex projects in the City of Vancouver will proceed through BC Hydro's Design Connection process because BC Hydro expects that most services for multiplexes will 1) be 400A or more and/or 2) require BC Hydro assets including transformers, power lines, poles, service boxes or fuses to be upgraded or moved. Early in the application process, if BC Hydro finds that a 200A service requires no infrastructure works and thus is eligible for the Express Connect, BC Hydro will automatically stream applicants to the Express Connect process.

BC Hydro does not provide 120V/240V service above 600A. A larger service is fed from BC Hydro 120V/208V network or customer-owned transformation; in some cases, BC Hydro can only provide 347V/600V service for these larger services, which would require further onsite transformation to be used for residential applications.

SERVICE APPLICATION

Property owners must authorize the service application. Typically coordinated by electrical engineer, electrical contractor, electrician or development project representative. Information should include:

- Amps & volts needed (derived from electrical design and load calculation)
- Service location (address & GPS coordinates)
- BC Hydro ID numbers for assets nearest project, including pad mount transformers or pole
- Applicable drawings – e.g. electrical, architectural

Service requests made through MyHydro or phone 1.877.520.1355

PRE-DESIGN COORDINATION

BC Hydro will:

- Determine preliminary scope of work and potential service connection designs
- Request project documentation, forms, additional drawings, etc.
- Require statutory right of ways when a LPT/PMT needs to be installed on private property

Customer needs to coordinate with other utilities (e.g. Telus) and engage contractor through BC Hydro's registered civil contractor list if civil works necessary (e.g. for a PMT)[1].

Payment: A non-refundable design deposit may be required before project proceeds

DESIGN & PRE-CONSTRUCTION

BC Hydro develops detailed electrical connection design.

Customer must meet electrical installation requirements.

Payment: BC Hydro will invoice costs for the design connection

CUSTOMER CIVIL WORK

Customers must complete civil works before BC Hydro connection, if a ground-mount PMT/LPT is necessary.

The work must be realized by registered civil contractor.

BC HYDRO CONSTRUCTION

BC Hydro constructs distribution system electrical works in preparation for electrical service connection.

ENERGIZATION

Customer documents electrical permit from City of Vancouver and completes the electrical service declaration on MyHydro.

BC Hydro conducts final inspection and energizes the property

[1] Contractors or Engineers not already familiar with BC Hydro Metering requirements may obtain the necessary information in the Revenue Metering Guide for Secondary Voltages published on bchydro.com.

Figure 3: BC Hydro Design Connections process for a multiplex.

3.2 Metering

Rule 6-104 of the CE Code specifies that "the number of consumer's services of the same voltage and characteristics, terminating at any one supply service, run to, on, or in any building, shall not exceed four, unless there is a deviation allowed". Effective January 2025, the City of Vancouver Electrical Inspection Branch will provide this deviation. Per BC Hydro's Distribution Standard ES54 S1-01 R12 "Secondary Single-Phase Services 200A Single and 400A Multiple Self-Contained Meter Installation", BC Hydro will provide up to six meter positions in jurisdictions providing this relaxation, effective January 2025.

3.3 BC Hydro Distribution Extension Policy

BC Hydro applies extension fees for new services. Extension fees are a development's share of the cost to supply and install the infrastructure necessary to receive service from BC Hydro (different sources of costs are noted in Figure 5 below). BC Hydro invoices customers for extension fees that encompass these costs, which must be paid before BC Hydro's construction begins.

Under BC Hydro's current Distribution Extension Policy, BC Hydro will contribute up to $1475 per residential dwelling towards the extension fee. The remaining cost of an extension and service connection must be paid by the development. These extension costs can include the costs of transformers (e.g. an LPT or PMT), poles, cabling, and associated civic works. Multiplexes are *not* be charged additional "System Improvement" costs for upstream utility distribution system works, as multiplexes will generally not exceed the 500kVA maximum demand beyond which such System Improvement charges apply.

In July 2024, BC Hydro proposed changes[6] to the BC Utilities Commission (BCUC) to update its Distribution Extension Policy. Based on BCUC's regulatory timetable, a decision on this matter is expected in early 2025. BC Hydro's proposed new contribution are summarized in the table below.

Rate Class	Proposed maximum contribution in 2025 (adjusted annually to reflect rate increases)	Existing maximum contribution
Residential (per dwelling)	$2,690	$1,475
General Service (per kW of estimated Billing Demand)	$501	$200

[6] https://www.bcuc.com/OurWork/ViewProceeding?applicationid=1250

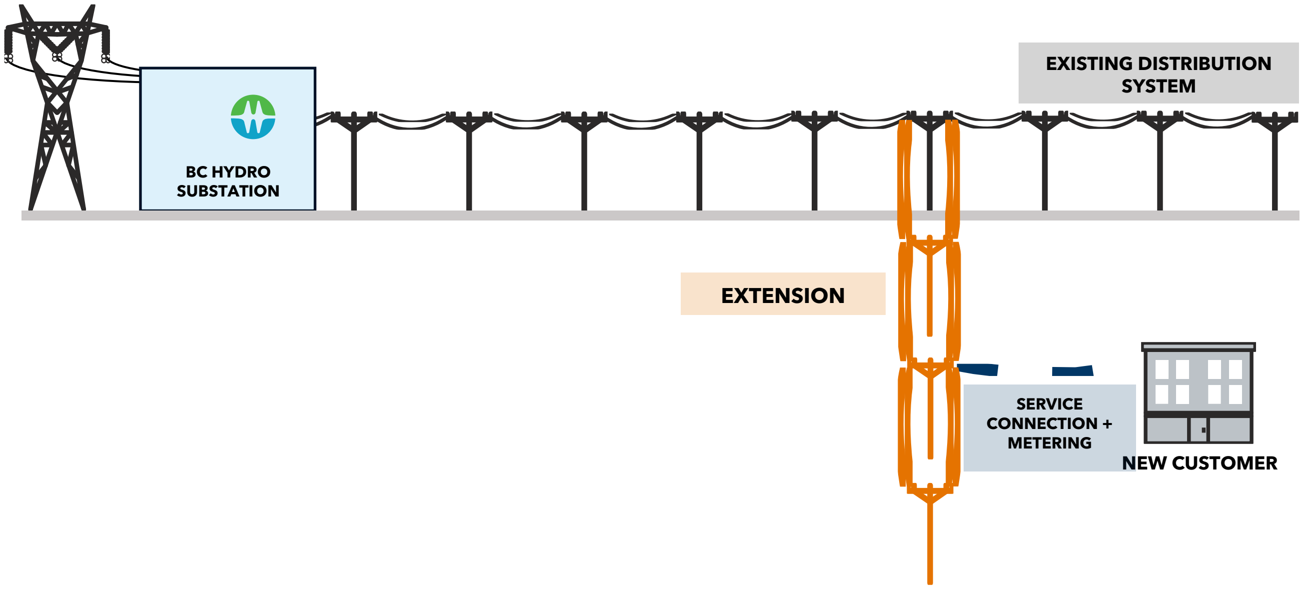


Figure 4 Elements of distribution extension fees.

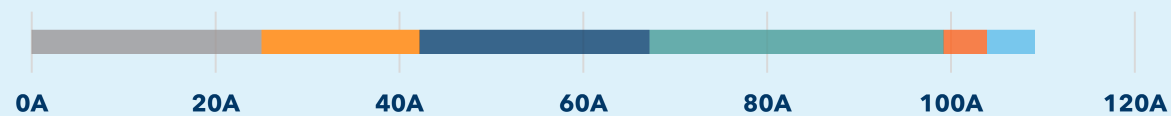
4. Power Efficient Design

Power efficient design (PED) refers to a range of strategies that limit a buildings' instantaneous electrical power demand, and the associated calculated electrical loads that dictate a consumer's service load under the relevant electrical code.

To properly assess the potential impact of the various PED strategies on the electrical load calculation, we must first understand the relative impact of each end use.

What end-uses make up the CE Code electrical load calculation in a fully electrified dwelling, without accounting for PED

The figure below shows the **load breakdown in a fully electric 100 m² (~1,075 ft²) single dwelling** part of a six-plex building.



An initial **baseload** proportional to the size of the living area is first allocated to account for lighting and the various equipment that will use the electrical outlets. While this load is significant at the dwelling level, its impact on the service size in a multiplex is diminished by a load diversity that increases with the number of units. (per 8-202 a) i) to iii) and 8-202 3) a))

Space heating and air-conditioning loads based on the installed equipment capacity. This is a significant load at the dwelling level and the service level as very little diversity can be accounted for (per 8-202 a) iv) and Section 62).

Electric range load based on the range capacity– 6000W at a minimum – with some diversity for anything above (per 8-202 a) v)).

EVSE load installed on the dwelling's electrical panel, considering a 40 A Level 2 charger (per 8-202 a) vii)).

Hot water heating load, 25% of the equipment rating (per 8-202 a) viii)).

Electric dryer load, 25% of the equipment rating (per 8-202 a) viii)).

Three takeaways must be highlighted:

1) A portion of the load – the **baseload**, and in some cases the range load **– cannot be acted upon** in new constructions using PED strategies per the CE Code. In a six-plex, these baseload and range end uses represent 45% of the load at the dwelling level and 40% at the service level.
2) **EVSE and space heating** and cooling loads are the most significant loads that **can be addressed** using PED strategies.
3) While the remaining **hot water heating** and **electric dryer** loads can be reduced with PED strategies, the overall potential is limited. These loads, even when unmitigated, already account for an important diversity factor which lowers their weight in the load calculation. Nevertheless, some PED strategies can be useful in shaving enough power to attain a lower service capacity increment, when the calculated load is close to the threshold for a smaller service size.

There are three broad categories of PED applicable to new multiplex developments.

1. Right sizing equipment's electrical power.
2. Energy management systems.
3. Energy storage.

Several strategies within these categories are currently enabled in the CE Code, Vancouver Electrical By-Law, and BCEC. Others are not, but may be enabled in the future.

This section describes various PED strategies, organized into the three categories above. It focuses especially on those strategies that are currently enabled in the CE Code, while also noting other strategies that could theoretically be pursued on a special permissions basis and/or become available to contractors in the future.

4.1 Right Sizing Equipment

Right sizing an equipment ensures its capacity is matched to its intended purpose. This approach can involve several strategies, such as:

- Selecting an equipment with a smaller capacity that can still meet households' energy service needs (for example, lower power 20A Level 2 EV chargers).
- Opting for a more power-efficient model that meets the same needs (heat pump space heating, water heating and clothes drying), or
- Reducing the load at the source through design improvement (building envelope).

4.1.1 Lower Power Level 2 EV Charging

The City of Vancouver Parking By-Law[7] requires that an energized outlet capable of Level 2 (i.e. 208V/240V) must be provided for parking spaces are provided for dwelling uses. Level 2 EV chargers can deliver between 16 A and 80 A at 240 V.

Under the CE Code, this load must be accounted for without any diversity, unless an EVEMS or circuit branch sharing is used (in which case the load might not need to be accounted for, see section 0).[8] This represents a significant load on the electrical service.

While a higher charger capacity means faster charging, **research shows that urban households usually receive adequate home charging performance from a 20 A Level 2 charger.[9]** In fact, most electric vehicle (EV) owners drive fewer kilometers per day than the battery capacity allows, meaning that even lower-capacity chargers can fully replenish the battery overnight. A 20A 208V/240V outlet for EV charging complies with Vancouver Parking By-Law.

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[7] Parking By-law, article 4.11.1, City of Vancouver (2024)

[8] While the current adopted version of the CE Code adopted in Vancouver (CSA 22.1:21) would allow a 90% diversity factor for most L2 EVSEs in six-plexes, this allowance is not included in the next version to be adopted.

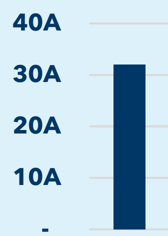
[9] EV Charging Performance Requirements, Clean Air Partnership (2021)

Let's see how the different approaches compare in terms of electrical load.

To do so, we will highlight how the two EVSE capacities compare in terms in the electrical load assessment calculation.

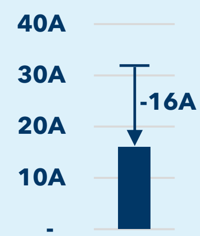
Level 2 EVSE on 40A circuit

A Level 2 EVSE on a 40A circuit can draw a **maximum power of 32A**.



Level 2 EVSE on 20A circuit

A Level 2 EVSE on a 20A circuit can draw a **maximum power of 16A**.



Overall, the lower capacity charger reduces the required electrical capacity by **16 A at the dwelling level**, which, in a six-plex with parking spaces for each dwelling, represents a **96 A reduction**.

Most Level 2 EVSE manufacturers offer products that can operate across a large power range. This means the maximum output capacity will be determined by the wire gauge and circuit breaker. Opting for a lower power Level 2 charging capacity can reduces installation costs, requiring lower gauge wiring and smaller capacity circuit breakers.

4.1.2 Lower Power Space Heating & Cooling Equipment

Under the CE Code, electrical space heating and cooling loads must be accounted for with little to no diversity, both at the panel and service level, with the following exceptions:

- Heating loads above 10 kW can be accounted for at 75% of the rating, given the heating equipment is used in a residential occupancy and each room or heated area has its own thermostatic control (62-118 3)).
- The lowest of the heating or cooling loads can be disregarded provided that an interlock mechanism is installed between both equipment (8-106 3))

As shown at the beginning of the section, the heating load can have a notable impact of the electrical requirement, even in Vancouver's mild climate. But this load can be reduced by using more efficient equipment, like heat pumps. Given Vancouver's climate[10], **cold-climate air-source heat pumps** (ccASHP), which can heat down to -25°C and below, **will be able to cover the full heating load** throughout the year, often negating the need for power-intensive auxiliary electric resistance heating elements. A proper design should also ensure that the heat pump (HP) is not oversized to minimize short cycling operation, which affects efficiency and equipment durability. To do so, there are trade-offs that should be considered when selecting amongst the following HP configurations. Use of ASHPs with limited or no

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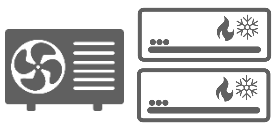
[10] The Vancouver Region design heating temperature varies between -7°C and -10°C (NBC 2020)

electric resistance is a common, though not universal, strategy in Vancouver's multiplex market.

Single-head ductless mini-split air-source heat pump, which consist of one exterior and one interior unit are generally installed in a dwelling's main living area. Most manufacturers offer models ranging from ¾ ton to 2 tons, offering flexibility to closely match the heating and cooling loads, especially in smaller dwellings.

The fact that there is only one indoor unit generally means auxiliary heat will likely be required — baseboards in the bedrooms for instance — to ensure the heating load is met and adequate occupant comfort.



Multi-head ductless mini-split air source heat pumps, as the name suggests are mini-split heat pumps that can accommodate more than one indoor unit. Properly designed, they can cover a dwellings full heating load without the need for auxiliary heat.

While this significantly reduces the space heating electrical load, most manufacturers only offer models ranging from 1.5 ton to 3 tons, a capacity likely higher that what is required in a multiplex dwelling unit. This suggests an opportunity for manufacturers and distributors to offer lower capacity units, which can realize benefits for equipment costs, utility bills, and lower load calculations.

Centrally ducted air source heat pump are generally used in combination with an air or water distribution system. Properly designed, they can cover a single dwelling unit's full heating load without the need for auxiliary heat.

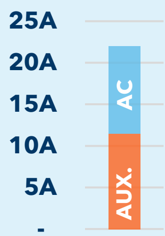
Like multi-head ductless mini splits, most manufacturers only offer models ranging from 1.5-2 ton to 5 tons, which is typically more capacity than required for a multiplex dwelling unit.

Given the trade offs highlighted above, let's see how the different approaches compare in terms of electrical load.

To do so, we will compare three (3) design approaches to heating and cooling a **100 m²(~1,075 ft²) single dwelling** in a six-plex building, which has a design heating load of this unit is **2 750 W**.

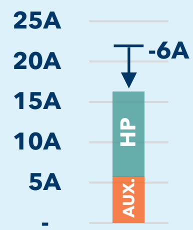
Baseboards

In this design, a **1 ton mini-split AC** in combination with electric resistance baseboards – covering the full heating load – are installed.



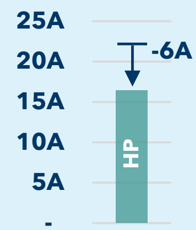
Single head mini-split

In this design, a **1 ton single-head mini-split ccASHP** in combination with electric resistance baseboards – covering 50% of the heating load – are installed.



Multi head mini-split

In this design, a **1.5 ton multi-head mini-split ccASHP** with no auxiliary heat is installed.



Overall, the lower capacity charger reduces the required electrical capacity by **6 A at the dwelling level**, which, in a six-plex represents a **27 A reduction**. Interestingly, calculations reveal that **in this case**, selecting a heat pump sized to cover the full heating load does not significantly change the outcome as even the smallest capacity multi-head mini split is oversized compared to the load. Ultimately, it provides no advantage in terms of electrical load optimization and might lead to inefficient operation (i.e. short cycling).

While **this conclusion may vary with different dwelling sizes** and layouts, it underscores the importance of accurately assessing the load and selecting the appropriate equipment for optimal performance. Likewise, it demonstrates the opportunity for lower capacity heat pumps to fill a market niche for multiplex units, apartments and other smaller buildings.

Another possible way to reduce the heating load is through envelope improvements. On top of reducing annual energy use, this allows for the use of smaller capacity heating equipment. Performance targets that address the heating and cooling load specifically – such as Passive House – will likely have the biggest impact in optimizing the electrical service size.

Research indicates that achieving a high-performance building envelope can be accomplished with minimal total cost increases.[11]. When considering long-term energy savings and durability, the investment often proves cost-effective. This conclusion is further strengthened when this improvement reduces the size of the electrical service.

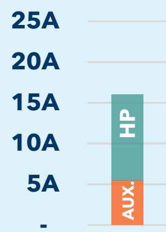
[11] Addressing the Cost of Efficiency (2021), Scaling Up Passive House Multifamily: The Massachusetts Story (2022)

Let's compare the impact of building to Vancouver Building By-Law (VBBL) or Passive House

To do so, we will compare the two (2) design approaches to heating and cooling in a **100 m² (~1,075 ft²) single dwelling** in a six-plex building, which has a design heating load of this unit is **2 750 W**.

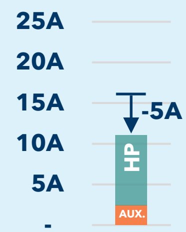
VBBL envelope

In this design, a **1 ton single-head mini-split ccASHP** in combination with electric resistance baseboards – covering 50% of the heating load – are installed to cover the heating load.



Passive House envelope

In this design, the same overall design is used, but the lower heating and cooling loads allows for a smaller **¾ ton single-head mini-split heat pump** with a smaller auxiliary.



Overall, this reduces the required electrical capacity by **5 A at the dwelling level**, which, in a six-plex, represents a **24 A reduction**.

4.1.3 Other Lower Power Equipment

According to the CE Code, any loads exceeding 1,500 W that are not explicitly covered elsewhere in the calculation must be included in load calculations.

In residential buildings, these typically include appliances like **water heaters and clothes dryers**. Since the code already incorporates diversity factors – allowing only 25% of the equipment's rated capacity to be included in the calculation – installing power efficient appliances may not drastically lower the calculated load.

However, choosing high-efficiency models can still help optimize the service size and potentially fit the building in a lower service capacity, if the building is close to a threshold for a smaller service size.

4.1.3.1 Hot Water Heaters

When designing the electrical service for a small multiplex, selecting the right water heating system will play a role in optimizing power draw. This section focuses on typical water heaters installed on a per-unit basis, excluding central systems, which, although they offer potential reductions in total system size, complicate design and tenant billing. Understanding the power requirements of each system ensures an efficient electrical service design.

Traditional electric resistance storage water heaters use two electric resistance elements to heat water. In a typical unit, the heating elements require 4500 W each, but the overall nameplate rating is also 4500 W as they cannot operate simultaneously. This system is the most power-intensive, leading to higher electrical service requirements.

Power efficient electric resistance storage water heaters reduce power requirements by distributing the heating load **across three smaller elements**. This design lowers the instantaneous power draw, typically to 3800 W, helping to optimize electrical service sizing. The system delivers comparable water heating capacity but with better demand management.

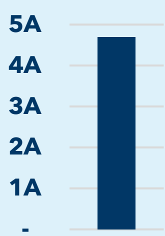
Hybrid heat pump water heaters (HPWH) are highly efficient, consuming about one-third of the power of traditional electric resistance water heaters. While a typical hybrid-HPWH may require only 1 to 2 kW of power to operate, hot water recovery times are generally longer. While larger storage tanks are a solution to meet peak hot water demands, "off the shelf" products typically come with an auxiliary heating element to ensure occupant satisfaction.

Let's see how the different approaches compare in terms of electrical load.

To do so, we will compare the three (3) design approaches to water heating in a **100 m² (~1,075 ft²) single dwelling** in a six-plex building.

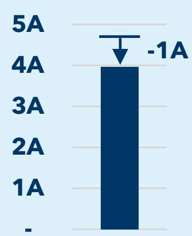
Electric resistance water heater

Giant 172STE 60 gal. tank
4,500 W nameplate rating



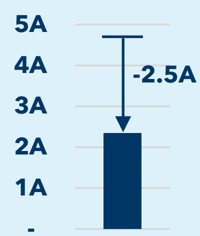
Power efficient electric resistance water heater

Giant 172EPS 60 gal. tank
3,800 W nameplate rating



Hybrid heat pump water heater

Rheem XE65T10H22U1 65 gal. tank
2250 W nameplate rating



Overall, this reduces the required electrical capacity by **2.5 A at the dwelling level**, which, in a six-plex, represents approximately an **8.4A reduction** (following derating). The impact is limited because only 25% of the water heater's nameplate rating is used in the load calculation, which reduces the potential savings from power-efficient models.

! Smaller 30 or 40 gal. electric resistance water heater also have smaller **3,000 W** nameplate ratings. Thus, ensuring the right equipment size is selected will also have repercussions on the electrical load calculation.

4.1.3.2 Clothes dryer

In fully electrified buildings, the choice of dryer type can impact the overall electrical load. This section compares regular electric dryers, condensing dryers, and heat pump dryers, focusing on their operation and power consumption.

Traditional electric dryers use a heating element to generate hot air, which is circulated through the drum to dry clothes. These dryers operate on 240V circuits and have power draw between 4,000 and 6,000 W. While they provide quick drying times, power draw is the highest amongst the available technologies.

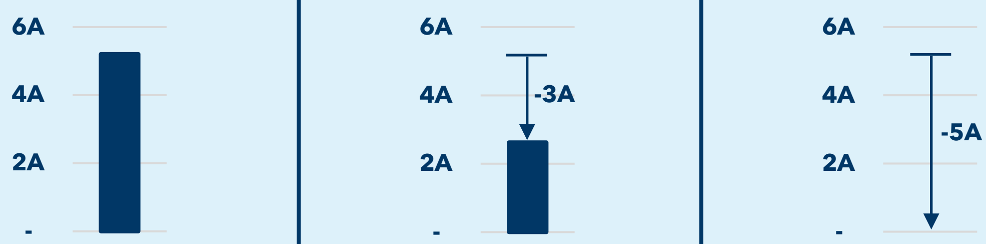
Condensing dryers work without the need for external ventilation. Instead, they condense the moisture from the air inside the drum into water, which is then collected in a reservoir or drained away. These dryers generally use slightly less power than traditional electric dryers but still have a significant power draw, around 2,500 to 4,000 W.

Heat pump dryers are the most power efficient option, using a heat pump to dry the laundry. Although they take longer to dry clothes, this method reduces power draw substantially, with most models operating between 1,000 and 2,500 W. This effectively means that some models do not need to be included in load calculations as they are less than 1,500 W.

Let's see how the different approaches compare in terms of electrical load.

To do so, we will compare the three (3) dryer types in a **100 m² (~1,075 ft²) single dwelling** in a six-plex building.

Traditional electric dryer	Condensing dryer	Heat pump dryer
Regular appliance with a **5,000 W** nameplate rating.	Bosch WTG86403UC with a **2,520 W** nameplate rating	Bosch WQB245AXUC with a **900 W** nameplate rating



Overall, the condensing dryer reduces the required electrical capacity by **3 A at the dwelling level**, which, in a six-plex, represents approximately a **10 A reduction**. The impact is limited because only 25% of the water heater's nameplate rating is used in the load calculation, which reduces the potential savings from power-efficient models.

Crucially, **since the HP dryer has a nameplate rating under 1,500W, it does not have to be included** in the electrical load calculation which reduces the required electrical capacity by **5 A at the dwelling level**, which, in a six-plex, represents a **16.8 A reduction.**

4.1.3.3 Battery Integrated Appliances (BIAs)

Battery-integrated appliances (BIAs) function similarly to conventional appliances but **incorporate an internal battery system to power the device** during operation. This built-in battery is recharged during periods of inactivity.

While the total energy consumption of the appliance remains the same, the integrated battery system reduces instantaneous demand and distributes the load over a longer period. Instead of drawing high power all at once, the appliance relies on stored energy to supply demand. BIAs allow power-intensive appliances (e.g. electric range) to use a smaller 120V circuit, rather than a typical 240V circuit. They also offer resilience during power outages.

Currently, two BIA cooking ranges are available in the USA. Both cooking ranges are designed as a replacement in dwellings with gas ranges where converting to an electric range would require a new circuit. To the best of our knowledge, none are certified for use in Canada at the time of this writing.

	Traditional electric range	Battery integrated electric range
Voltage	240V 1-Phase AC	120V 1-Phase AC
Amps (min. breaker size)	Typically 40 A (Typically 50 A)	12 A (15 A)
Examples of Manufacturers and Models	Multiple.	COPPER Copper Induction Range impulse Impulse Cooktop

BIAs are **not recognized in the CE Code load calculation methodologies**. As a result, they would not permit a reduction in electrical service size. Currently, when an electric range is installed, it adds a minimum load of 6,000W to the load calculation [per 8-202 1) a) v)] . Even when a gas range is installed, a provision for this 6,000W load must still be included in the calculations [per 8-202 1) a) viii) B)]. To enable implementation of BIAs for the purpose of service capacity optimization would require CE Code be updated, or a variance to enable their use to provide credit for reduced load calculations. They are noted here for completeness sake, and to flag a technology that could be useful for PED in future years.

4.2 Energy Management Strategies

Energy management systems (EMS) monitor and control electrical loads so as not to exceed the capacity of service, feeder and/or branch circuits. Some EMS can also control loads for other purposes, such as responding to time-varying electricity rates (for example, BC Hydro's new Time of Use rates) and utility demand response programs.

EV Energy Management Systems (EVEMS) represent the greatest PED opportunity. EV loads are inherently flexible – While the speed of charging slows when load management is occurring, using reasonable amounts of load management is perfectly appropriate in situations where vehicles are parked for longer periods of time, such as overnight in residential parking. And as EV charging loads are often large (40A+) and must be calculated at 100% demand factor unless an EVEMS is used, reducing these loads is particularly valuable. The CE Code enables several EVEMS configurations.

Conversely, the CE Code does not define "energy management systems" that control other end use loads. For equipment other than EV chargers, the CE Code only enables **circuit switching devices** to reduce load calculations. Use of other EMS strategies to reduce calculated loads – for example, monitoring a service and controlling loads such as hot tubs, hot water tanks or electric dryers – are not enabled in the CE Code, and thus would require a variance. While not generally as important as EVEMS, such EMS strategies can be useful in certain circumstances, such as when a development is close to a threshold for a smaller service. Accordingly, such strategies are noted in this section for completeness.

The sub-sections below provide further backgrounder on EVEMS and EMS technologies and design strategies.

4.2.1 EV Energy Management Systems

Without an EVEMS, load calculations for EV charging require using a 100% demand factor (see e.g. CE Code Rule 8-202 1) a) vii). However, Rule 8-500 allows the use of EVEMS, and Rules 8-106 (10) and (11) specify that a wide range of EVEMS can reduce EV loads:

- Rule 8-106 (10) specifies that where EV charger loads are controlled by an EVEMS, EV charger demand will equal the maximum load allowed by the EVEMS. For example, multiple 40A EV chargers can share a branch circuit, but the calculated load will be limited to the 40A allowed by the EVEMS.
- Rule 8-106 (11) specifies that EV charger loads do not need to be included in load calculations if an EVEMS monitors the capacity of a buildings' service, feeders and branch circuits, and controls EV charger loads so as not to exceed their capacity. With these **service monitoring** technologies, EV charger loads can be omitted entirely in load calculations.

The CE Code requires that installed electrical equipment be certified to a product standard for its specific purpose. CSA Group is in the latter stages of developing an EVEMS standard (CSA C22.2 No. 343), but it must be published before any devices can be certified as EVEMS. Until this issue is resolved, the approval of the products listed in this report as an EVEMS are subject to approvals processes established by electrical safety authorities having jurisdiction.

Accordingly, **the City of Vancouver requires electrical engineering drawings for some EVEMS deployments**.[12]

In the sub-sections below, we review two electrical configurations that can be useful in reducing EV loads in multiplexes: 1) Branch circuit and panel sharing "dynamic" EVEMS, and 2) Service and feeder monitoring EVEMS.

4.2.1.1 Branch Circuit and Panel Sharing Using Dynamic EVEMS

"Dynamic" EVEMS involve using EV chargers (i.e. EV supply equipment, EVSE) that can communicate via an EVEMS and incrementally adjust power consumption up and down to stay within the electrical capacity of a circuit, as opposed to simply switching circuits on/off. An example of such dynamic load sharing is when four "smart" 50A EV chargers are installed on the same 50A branch circuit – If only one EV is plugged in and charging, it can be allocated the full capacity of the circuit; however, if another EV is plugged in while the first is still charging, then the EMS communicates to reallocate capacity between the chargers, ensuring the limit of the circuit is not exceeded. Figure 5 illustrates branch circuit sharing and panel sharing electrical configurations with dynamic EVEMS controls.

Using such dynamic control schemes requires "networked" (i.e. "smart") EVSE capable of wireless (e.g., Wi-Fi, cellular) or wired (e.g., ethernet cable) communications to receive and/or send messages and control power consumption. Typically, an owner/developer, condominium or rental building owner will select a single EV charging service provider (EVCSP) for a building. The EVCSP is responsible for ensuring that compatible EVSE are installed that can communicate via the EVEMS. EVCSPs also often provide other customer services, such as billing drivers for common electricity costs, authenticating users, coordinating utility demand response programs, valorizing any low carbon fuel requirement credits generated through EV charging, etc.

In multifamily buildings, branch circuit or panel sharing configurations will often have the EVSEs fed from a common (i.e. "house") electrical panel and meter. The condominium or rental manager may then charge user fees for the power consumed by residents' EVs. Often, these fees are based on the actual power consumed; some condominiums have instead opted to charge drivers a flat fee, or some other arrangement, to simplify billing.

Branch circuit sharing configurations using networked EVSE are common in larger multifamily buildings. In the context of small residential buildings like multiplexes, use of dynamic sharing on common electrical meters can entail some billing challenges – Systems that instead supply power from residents' metered panel/feeder can be administratively simpler, and avoid ongoing network service fees that are often charged by EVCSPs. However, for multiplexes with common onsite parking areas, for example a shared parking pad in the lane, designing for load sharing using networked EVSE on branch circuit off a common panel can be cost-effective for new construction, and is usually not too administratively complex for residents.

[12] See the City's Bulletin 2019-006-BU/EL "Electric Vehicle Charging for Buildings".

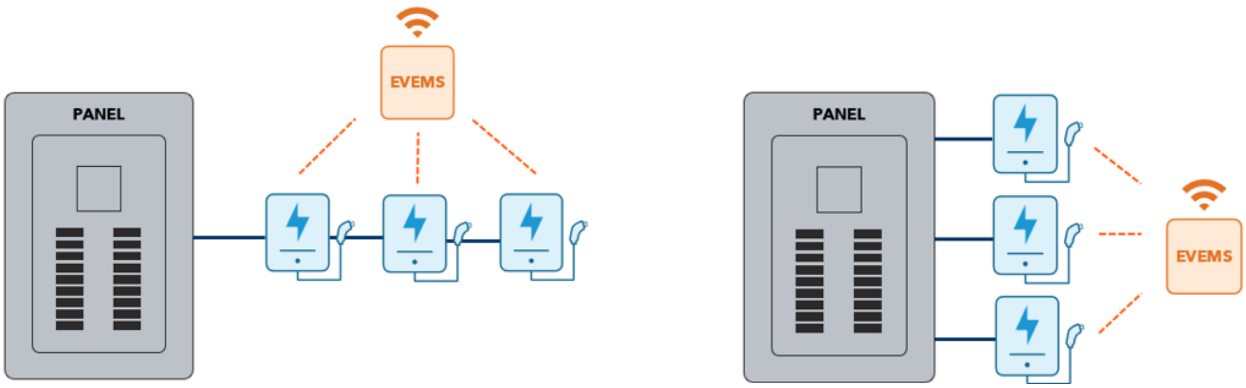


Figure 5: Branch circuit sharing (left) and panel sharging (right) using "dynamic" EVEMS controls.

4.2.1.2 Service and Feeder Monitoring

Service and/or monitoring EVEMS monitor the real-time electrical load on a service and/or feeders, and control EVSE loads so as not to exceed the electrical capacity limits of these monitored circuits. Per Rule 8-106 (11) of the CE Code, using monitoring allows exclusion of the controlled EV loads from load calculations for the monitored service and/or feeder.

Some EVEMS switch off the circuit to the charger when the feeder is at or approaching its capacity (see Figure 7) – This allows a "dumb" non-networked EVSE to be used, which often come with a new EV. Other EVEMS are predicated on "smart" networked EVSE that can control the EV charger load dynamically.

Per Rule 8-106 (11) of the CE Code, using such multi-tier service and feeder monitoring allows exclusion of all EV loads from the load calculation. Service monitoring enables a larger proportion of the real-time available charging in a building to be provided to vehicles, which can be perceived by residents as improved charging service (see Figure 6).

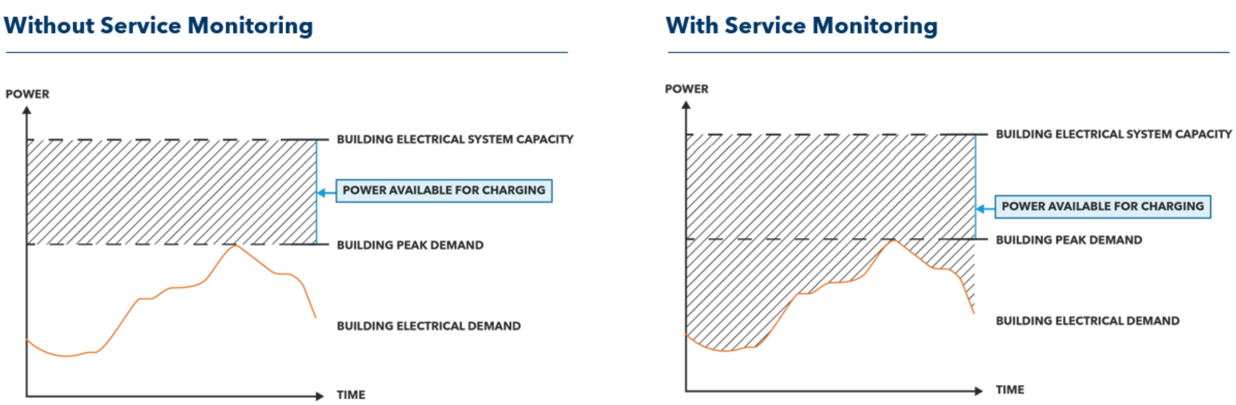


Figure 6: Service monitoring enables greater capacity for EV charging.

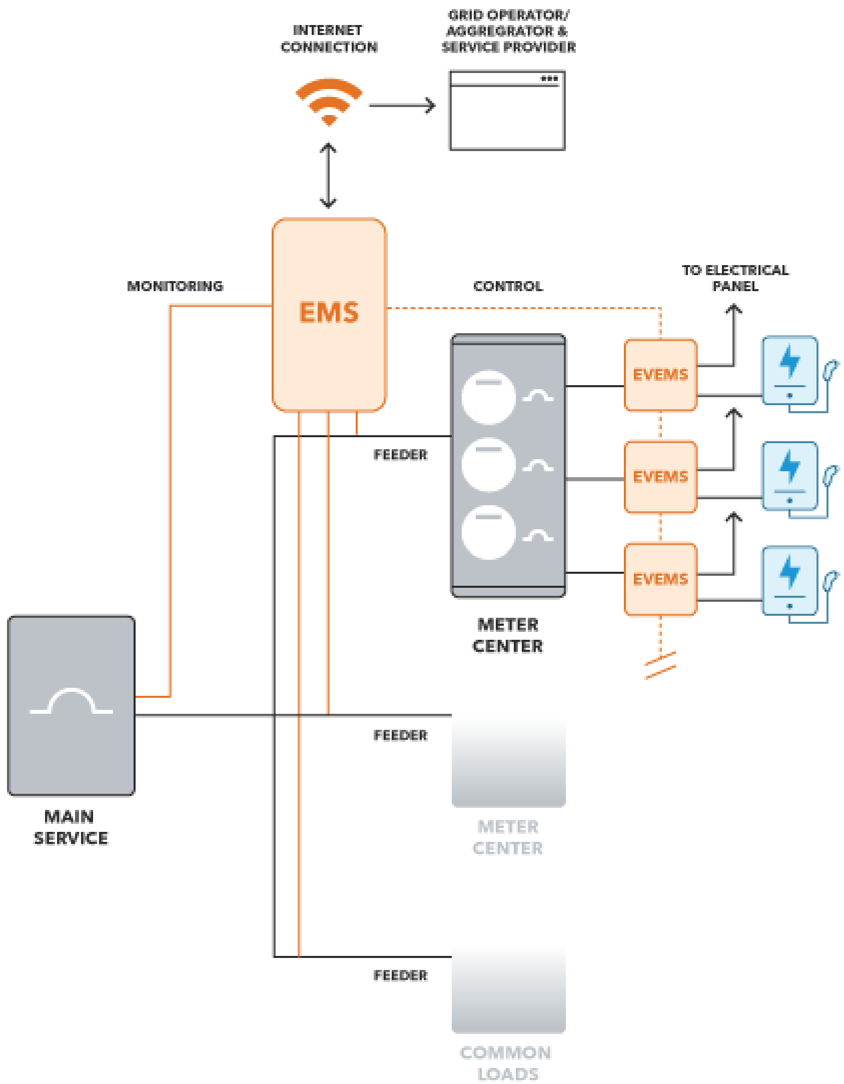


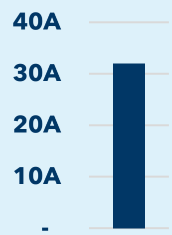
Figure 7: Example of an EMS monitoring the main service, feeder to the residential meter center, and feeders to individual units. If capacity limits of monitored circuits are exceeded, circuits to EVSE are automatically switched off. EV circuits are switched on again when there is sufficient capacity.

Let’s see how this approach impacts the of electrical load calculation.

To do so, we will highlight how using an EVEMS or not compare in terms in the electrical load assessment calculation.

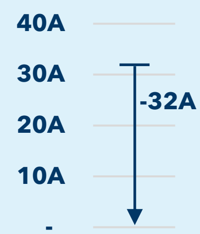
Level 2 EVSE on 40A circuit

A Level 2 EVSE on a 40A circuit represents a **32A load**.



Level 2 EVSE on 40A circuit with service and feeder monitoring

A Level 2 EVSE on a 40A circuit with an EVEMS using service and feeder monitoring does not have to be accounted in the load calculation.

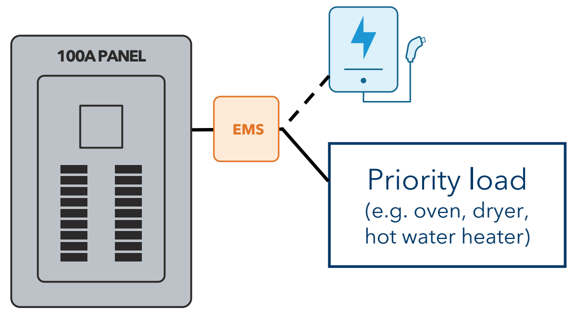


Overall, the EVEMS reduces the required electrical capacity by **32 A at the dwelling level**, which, in a six-plex with parking spaces for each dwelling, represents a **192 A reduction**.

	Dynamic EVEMS & Networked EV Chargers (Some with Service Monitoring)	Service & Feeder Monitoring EVEMS with On/Off Control of Circuits
Example manufacturers and service providers	CHARGELAB Hypercharge chargepoint flo SWTCH variablegrid	rve SMP

4.2.2 Circuit switching technologies

A **branch circuit switching** control scheme deactivates one device on a branch circuit to stay within the power constraints of the circuit (determined by the circuit breaker protecting the branch circuit). This approach typically uses a contactor(s) on the circuit(s) to switch ON or OFF based on the control logic of the EMS, field wiring, or user-input.



When these devices are used, only the highest load is considered in calculating the demand, per CE Code Rule 8-106 (2). This can effectively reduce both a single dwelling's panel and a multiplex's service size. There are two typical configurations for this system:

- **Hard-wired devices** require installation by an electrician but offer a more seamless integration. They are appropriate for new construction.
- **Plug-in devices** connect directly to an existing power outlet (typically for appliances like an oven or dryer), eliminating the need for an electrician. This makes them suitable for existing buildings.

Most devices in this category allow the secondary load (e.g., an EVSE) to operate only when the power drawn by the priority load falls below a specified threshold (e.g., 250 W). The **priority load typically remains powered** to preserve user-controlled features, such as clocks and custom settings, ensuring they are not disrupted.

Branch circuit switching could theoretically interact with multiple different devices. However, it is important to note that **many devices might not be appropriate/do not respond well to being switched off regularly** (i.e. be the secondary load) and product warranties may be void if a branch circuit switching device is used.

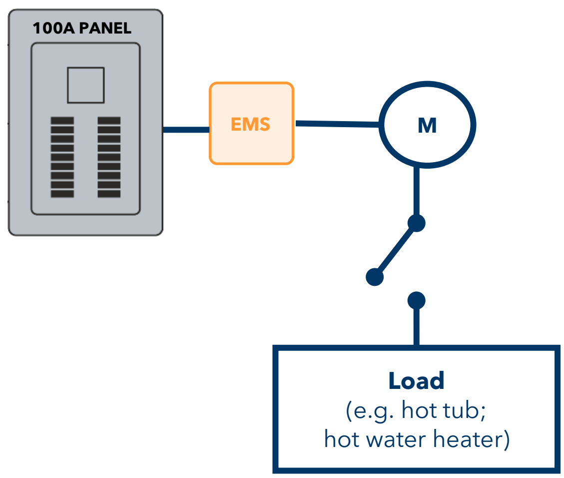
Most commonly, EVSE serve as the secondary (interruptible) load, sharing the circuit with a range/oven. A few homebuilders have reportedly used switching between a clothes dryer (primary load) and a hot water tank (secondary load). However, careful consideration of *legionella* risk from switching off hot water heating elements is necessary if considering this strategy.

	Hard-wired devices	Plug-in devices
Voltage	240V 1-Phase AC	240V 1-Phase AC
Max circuit amps	Up to 60 A	Up to 50 A
Examples of Manufacturers and Models	DANDY — LOADMISER simpleSwitch CANADA — simpleSwitch LOADSHARE TECHNOLOGIES — DIVVEE rve — DCC	NeoCharge — Smart Splitter BSA — Electric Range Buddy SPLITVOLT — Splitter Switches

4.2.3 Service and Feeder Monitoring for non-EV Loads

Service and feeder monitoring (such as described in section 4.2.1.2) could also theoretically be used to control a secondary load other than an EVSE. For example, a hot tub, dryer, or hot water heating loads could be controlled on/off based on monitoring of the real-time capacity on services or feeders. The same service and feeder monitoring systems that control breakers on/off for EV charging could instead be used for other end uses.

This strategy is not recognized by CE Code load calculation methodologies. Thus, a variance is required to deploy it. While loads from non-EV equipment tend to be small, it could comprise a valuable strategy in buildings that are close to an electrical service threshold.



4.3 Energy Storage Strategies

Energy storage strategies typically involve storing energy in the form of electricity (e.g. batteries) or heat (e.g. water, heated rocks, bricks or other materials that can store heat for the purposes of later water or space heating). Electrical storage primarily employed for improving grid resiliency and peak shaving[13, 14], often as part of utility demand response programs or under favorable rate structures.

Theoretically, buildings could be designed to use electrical or heat storage to meet peak loads while staying within electrical service limits – The electrical or heat storage would be filled while demand is low, then would serve certain loads (e.g. space heating and/or hot water in the case of thermal storage) during periods of high demand.

The CE Code currently does not enable the use of energy storage systems to reduce calculated loads and service sizes. While this could be a potential option under special permissions or in future iterations of the Code, it is very uncommon at present. Further exploration of the practical applicability of such designs is required. It is noted here for completeness only.

The following products are examples of energy storage strategies.

	Battery storage	Thermal storage
Examples of Manufacturers and Models	TESLA: Powerwall GENERAC: PWRcell 2	STEFFES: Serenity (forced air), Comfort Plus (hydronic) Wilsons Mechanical: Room units and forced air furnaces

[13] Vermont's biggest utility dramatically expands home battery subsidies, Canary Media (2023)
[14] Hydro-Québec subsidizes thermal storage system to reduce winter peaks

5. Load Calculations for Multiplex Archetypes

In this section, we present the high-level results of detailed electrical load calculations for combinations of three multiplex archetypes – triplex, quadplex and six-plex – with parking space ranging from none to one per dwelling unit.

In each case, we will compare the impact of three (3) building design approaches – outlined below – on the required service capacity. Overall, we found that building electrification is achievable across all archetypes within a 400A service – or 200A for a triplex – when implementing PED strategies. **All-electric buildings using PED have lower load calculations than gas-heated buildings.** This means an efficient design can allow for electrification without increasing service capacity **and** eliminate the need for a gas hookup.

Electrification following current market trends (baseline)

This approach fully electrifies the building **without optimizing the electrical service size**. Water heating, as well as clothes drying and cooking, rely on electric resistance. For space heating and cooling, a single head heat pump is installed with electric resistance baseboards for supplementary heating, as is a relatively common practice in Vancouver's market. When EVSE equipment is needed, a Level 2 charger connected to a 40A circuit is used.

Electrification using all PED strategies

This approach uses all PED strategies outlined in the previous section. In real world implementations, not all PED strategies may be necessary to achieve a given service size and a high likelihood of lower cost (e.g. overhead) type. The goal of this scenario is to show the combined potential.

Gas equivalent building

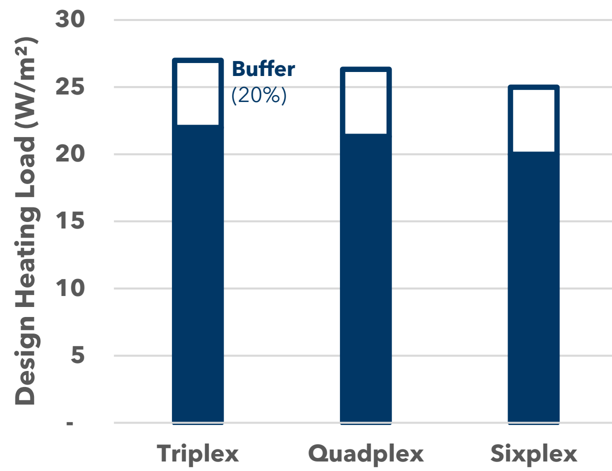
This approach uses **natural gas** for space heating, water heating, and cooking. For practicality, the clothes dryer remains electric. For space cooling, a mini split AC is installed. When EVSE equipment is required, a Level 2 charger connected to a 40A circuit is used, unless otherwise specified.

Detailed and itemized electrical load calculation for the specific cases presented in this section are available in Appendix A.

Finally, it is important to reiterate that just because a multiplex's consumer's service is below some threshold for service sizes (e.g. 200A, 400A) does not mean that low-cost (e.g. overhead) service is necessarily possible for particular site. Furthermore, it is important to note that as a multiplex increases from approximately 80% to 100% of the value of a service threshold, there is increasing likelihood of BC Hydro requiring underground service (or other onsite works) and/or a larger utility service. This is due to a variety of utility infrastructure design considerations and engineering standards for BC Hydro works, relating to factors such as the length of service cabling, placement of utility polls and other factors (as noted in Section 3.1 above). Thus, minimizing calculated loads can be valuable.

5.1 Key Assumptions

Space heating load is a key factor in the load calculation in electrically heated buildings. The heating loads for the archetypes noted below were derived from recent analysis of multiplexes anticipated energy use prepared for the City of Vancouver[15] as well NRCan's HTAP tool[16]. All archetypes are deemed VBBL compliant, with a designed heating as presented on the right, with an addition 20% buffer added to reflect the possibility that some multiplexes will have a higher design heat load.



All archetypes include **heat pumps for space heating and cooling** as they are considered standard in the Vancouver new construction market. For active cooling specifically, recent provisions in the BC Building Code[17] require that new developments protect occupants from overheating.

All parking space feature an adjacent **"EV Ready" outlet capable of "Level 2" charging (208V/240V)**, in accordance with the requirements for EV charging infrastructure futureproofing adopted in the Vancouver Parking By-Law in 2018.[18] In the baseline electrification scenario, it as assumed that dedicated 40A branch circuits serve each parking space. PED strategies include right-sizing to lower power branch circuits (for example, 20A) and different types of EVEMS.

Common loads, including common area lighting and other miscellaneous loads, range from 4A (triplex) to 8A (six-plex), in line with common construction practices.

Power efficient design strategies used in each archetype are noted below and described further in Chapter 4 above.

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[15] Analysis of Net-Zero Multiplexes for Electrical Considerations – Baseline Results, RDH Science (2023)
[16] Housing Technology Assessment Platform
[17] Information Bulletin No. B24-08, BC Building and Safety Standards Branch (2024)
[18] Parking By-law, article 4.11.1, City of Vancouver (2024)

5.2 Triplex

The triplex archetype has a gross floor area of **250 m²** (approximately 2700 square feet), with **three (3) identical units** of 84 m² each. The table below shows the required consumer's service size depending on the building design approach and number of parking spaces.

Table 1: Triplex electrical consumer's service sizes

<table>
<tr><th>Number of parking spaces</th><th>Electrification
(Baseline)</th><th>Electrification
(with all PED)</th><th>Gas equivalent
(no PED)</th></tr>
<tr><td>3</td><td rowspan="3">400A</td><td rowspan="4">200A</td><td rowspan="2">400A</td></tr>
<tr><td>2</td></tr>
<tr><td>1</td><td rowspan="2">200A</td></tr>
<tr><td>0</td><td>200A</td></tr>
</table>

In the baseline scenario, the number of parking spaces – and thus EV Ready parking spaces – drives the need for an upgrade from 200A to 400A service. An all-electric building would need 400A if any parking is included, while a gas triplex requires 400A if more than one onsite parking space is included.

However, PED strategies can lower the required service capacity to 200A for any number of parking spaces. Up to one EV Ready parking space can be offset by using heat pump dryers. Two or more parking spaces can be accommodated on 200A by using some form EVEMS or 20A branch circuits. Heating and cooking energy do not significantly change the outcome.

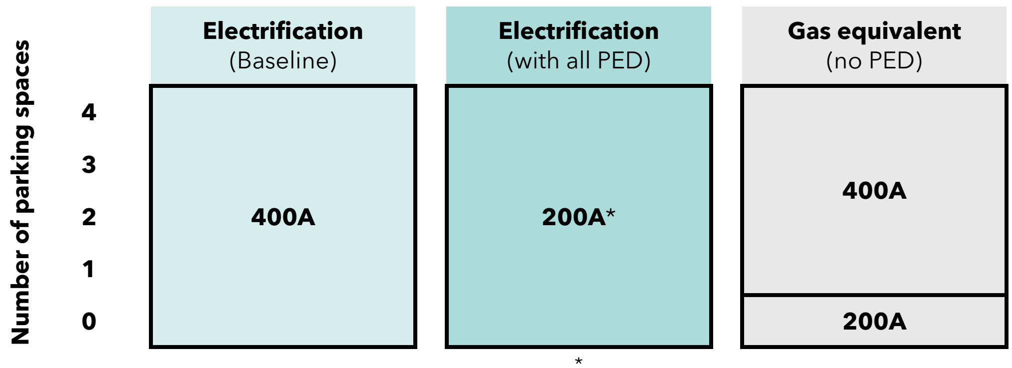
The table below shows the equipment used depending on the design approach for a **triplex with two (2) parking spaces** (detailed calculation in Appendix A). This is an interesting case where both a full electric building and a gas equivalent require a 400A service. Here, the proposed PED strategies effectively reduce the required service to 200A.

	Electrification (Baseline)	**Electrification** (with all PED)	**Gas equivalent** (no PED)
Service capacity (actual capacity)	400 A (238 A)	**200 A (167 A)**	400 A (217 A)
Panel size	2x 125 A + 1x 100 A	**3x 100 A**	3x 100 A
Space heat. & cool.	**1 ton mini-split cold climate ASHP + baseboards**	**1 ton mini-split cold climate ASHP + baseboards**	1 ton mini-split AC + gas heating
Building Envelope	VBBL/Step 3	VBBL/Step 3	VBBL/Step 3
Water heating	40 gal. elect. storage	**HP water heater**	Gas instantaneous
Other Appliances	Elect. range and dryer	Elect. range and **HP dryer**	Gas range and elect. dryer
EVSE	L2 on 40A circuit	L2 on 40A circuit	L2 on 40A circuit
Circuit sharing/EVEMS	None**	**EVEMS on all EVSEs**	None**

5.3 Fourplex

This building has a gross floor area of **400 m²**, with **four (4) identical units** of 100 m² each. The table below shows the required service size depending on the building design approach and number of parking spaces.

Table 2: Fourplex consumer's service sizes



This archetype can be fully electrified using a 400A service **without relying on PED strategies**. To reduce the service to 200A the whole portfolio of PED strategies is required, including reducing the gross heating load through envelope improvements (BCBC Step 5 or Passive House). For gas-powered buildings, a 400A service becomes necessary as soon as parking spaces are introduced. This can be mitigated by employing low-power EVSEs or implementing an EVEMS to manage the load efficiently.

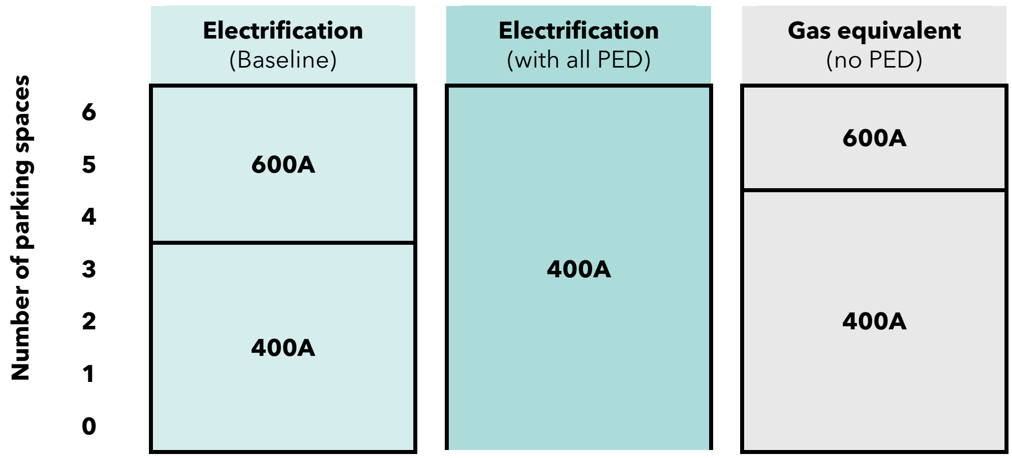
The table below shows the equipment used depending on the design approach for a **fourplex with three (3) parking spaces** (detailed calculation in Appendix A). This shows a situation electrification is possible using a 400A service, but where PED strategies are not sufficient to lower the service to 200A. This also highlights the fact that a passive approach where the envelope performance is improved can ultimately bridge the gap to a smaller electrical service.

	Electrification (Baseline)	**Electrification** (with all PED)	**Gas equivalent** (no PED)
Service capacity (actual load)	400A (327A)	**200A (190A)**	400A (291A)
Panel size	3x 125A + 1x 100A	**4x 100A**	4x 100A
Space heat. & cool.	**1 ton mini-split cold climate ASHP + baseboards**	**1 ton mini-split cold climate ASHP + baseboards**	1 ton mini-split AC + gas heating
Building Envelope	VBBL/Step 3	**Passive House/Step 5**	VBBL/Step 3
Water heating	60 gal. elect. storage	**HP water heater**	Gas instantaneous
Other Appliances	Elect. range and dryer	Elect. range and **HP dryer**	Gas range and elect. dryer
EVSE	L2 on 40A circuit	L2 on 40A circuit	L2 on 40A circuit
Circuit sharing/EVEMS	None	**EVEMS on all EVSEs**	None

5.4 Six-plex

This building has a gross floor area of **585 m²**, with **six (6) identical units** of 98 m² each. The table below shows the required service size depending on the building design approach and number of parking spaces.

Table 3: Six-plex consumer's service size



This archetype can achieve "baseline" electrification with a 400A service, without PED strategies, for up to three parking spaces. Beyond that, a 600A service becomes necessary. However, implementing PED strategies can maintain the 400A service. When four or more parking spaces are introduced, addressing the EVSE load becomes essential. This can be managed by implementing an EVEMS.

Gas-heated buildings face comparable challenges, with EVSE requirements driving the need for a 600A service. In fact, a gas building will ultimately require the same service capacity as an optimized electric building, as heating and cooking loads do not significantly affect the service size.

As seen with the triplex, electrification is not only feasible without the need for a larger service, but it also eliminates the need for a gas hookup, saving both installation costs and reducing the number of trades required during construction.

The table below shows the equipment used depending on the design approach for **a six-plex with three (3) parking spaces** (detailed calculation in Appendix A). This case shows how in some cases, optimizing non-EV loads can mitigate the overall demand.

Here, replacing the mini-split air conditioning system with a cold-climate air source heat pump (which won't require an auxiliary), opting for a three-element water heater and opting for low-amperage EVSE is an effective way to reduce the service requirement to 400A.

	Electrification (Baseline)	**Electrification** (with all PED)	**Gas equivalent** (no PED)
Service capacity actual load)	400A (397A)	**400A (276A)**	400A (348A)
Panel size	3x 125A + 3x 100A	6x 100A	6x 100A
Space heat. & cool.	**1 ton mini-split cold climate ASHP + baseboards**	**1 ton mini-split cold climate ASHP + baseboards**	1 ton mini-split AC + gas heating
Building Envelope	VBBL/Step 3	VBBL/Step 3	VBBL/Step 3
Water heating	60 gal. elect. storage	**HP water heater**	Gas instantaneous
Other Appliances	Elect. range and dryer	Elect. range and **HP dryer**	Gas range and elect. dryer
EVSE	L2 on 40A circuit	L2 on 40A circuit	L2 on 40A circuit
Circuit sharing/EVEMS	None	**EVEMS on all EVSEs**	None

6. 400A Electrical Connection Process Example

This section includes a brief example of a fictitious 6-unit multiplex applying for a 400A electrical service connection from BC Hydro in the City of Vancouver. The diagram below outlines the process.

INTEGRATED DESIGN FOR PED

- As part of an integrated design process (IDP), the consultant team determine early in the conceptual design of the project that a 400A service for the 6-unit multiplex will be feasible when using PED strategies, including a service and feeder monitoring EVEMS, highly efficient envelop, and cold-climate heat pumps.
- The team includes space for a ground mount transformer on site, in case it is necessary. The design includes additional outdoor amenity space, if an overhead service proves possible.

COORDINATION WITH BC HYDRO

- The property owner authorized a load request from **BC Hydro Design Connections** through MyHydro.
- The projects' electrical engineer leads the submission. The initial application included:
    - Project contacts, service information, and other declarations and permissions (See BC Hydo website for full list of forms).
    - Preliminary architectural plans.
    - Preliminary electrical site and profile plans, electrical room plan, single line diagram, and load calculation.
    - The BC Hydro ID numbers for the BC Hydro utility pole nearest the project.
- BC Hydro coordinates with project contacts for other needed design information.
- Customer pays a $5,000 design deposit.

Timeline: Apprx. 2 months.

DESIGN & PRE-CONSTRUCTION

CUSTOMER CIVIL WORK

- BC Hydro provides a detailed electrical connection design and associated quote for the BC Hydro's extension fee. While approximately 60% of multiplexes requiring a 400A service in the City of Vancouver have been served via overhead connection, this project requires an onsite ground-mount transformer (LPT). BC Hydro itemizes civil works required by customer, including concrete pad and trenching. Depending on site conditions, the cost of BC Hydro's works could range from $30,000 to $150,000+, less $16,000 in extension fee contribution ($14,000 - $134,000+ total).
- The electrical engineer revises electrical drawings and shares updated designs with other utilities.
- Customer engages a BC Hydro registered civil contractor for civil works (apprx. $10,000 - $40,000+).
- Customer registers statutory right of way to BC Hydro at land title office.

BC HYDRO CONSTRUCTION

- Customer hosts pre-job conference with civil contractor, design team, and BC Hydro.
- Customer pays extension fee to BC Hydro.
- Customer coordinates with BC Hydro to pick up civil materials supplied by BC Hydro.
- Civil contractor completes civil works.
- BC Hydro completes civil works and electrical connection.

Timeline: Apprx. 4 months.

ENERGIZATION

- Customer documents electrical permit from City of Vancouver and completes the electrical service declaration on MyHydro.
- BC Hydro conducts final inspection and energizes the property.

Timeline: Apprx. 2 months.

APPENDIX

Appendix A: Detailed Electrical Load Calculations

Triplex with two (2) parking spaces

Panel size calculation

		Electrification (Baseline)		Electrification (with all PED)		Gas equivalent (no PED)	
		Unit w/o EVSE	**Unit** w/EVSE	**Unit** w/o EVSE	**Unit** w/EVSE	**Unit** w/o EVSE	**Unit** w/EVSE
8-202 1) The calculated load for the service or feeder from a main service supplying loads in dwelling units shall be greater of:							
i) to iii) a basic load of 3500W for the first 45m² of living area; plus an additional 1500W for the second 45m² or portion thereof; plus an additional 1000W for each additional 90m² or portion thereof in excess of the initial 90m²		5,000 W	5,000 W	5,000 W	5,000 W	5,000 W	5,000 W
iv) any electric space-heating loads provided for with demand factors as permitted in Section 62 plus any air conditioning loads with a demand factor of 100%m subject to Rule 8-106 3)	AC/HP	2,530 W	2,530 W	2,530 W	2,530 W	2,530 W	2,530 W
	Auxiliary	1,125 W	2,250 W	1,125 W	1,125 W	0 W	0 W
v) any electric range load provided as follows: 6000W for a single range plus 40% of any amount by which the rating of the range exceeds 12kW		6,000 W	6,000 W	6,000 W	6,000 W	0 W	0 W
vii) any electrical vehicule supply equipment loads, if they are supplied from a panelboard installed in a dwelling unit, with a demand factor of 100%		0 W	7,680 W	0 W	0 W	0 W	7,680 W
viii) any loads provided for, in addition to those outlines in Items i) to vi) at A) 25% of the rating of each load with a rating in excess of 1500W, if an electric range has been provided for; or b) 25% of the rating of each load with a rating in excess of 1500W plus 6000W, if an electric range has not been provided for.		2,000 W	2,000 W	1,193 W	1,193 W	7,250 W	7,250 W
Peak Load		16,655 W	24,335 W	15,848 W	15,848 W	14,780 W	22,460 W
Peak amperage (at 240V)		**69 A**	**101 A**	**66 A**	**66 A**	**62 A**	**94 A**
Required panel size		**100 A**	**125 A**	**100 A**	**100 A**	**100 A**	**100 A**

Service size calculation

	Electrification (Baseline)	**Electrification** (with all PED)	**Gas equivalent** (no PED)
8-202 3) The calculated load for the consumer's service of feeder supplying two or more dwelling units shall be based on the calculated load obtained from Subrule 1) a) and the following.			
a) i) 100% of the calculated load in the unit having the heaviest load; plus	13,000 W	12,193 W	12,250 W
a) ii) 65% of the sum of the calculated loads in the next 2 units having the same or next smaller loads to those specified in Item i); plus	16,900 W	15,850 W	15,925 W
a) iii) 40% of the sum of the calculated loads in the next 2 units having the same or next smaller loads to those specified in Item ii); plus	0 W	0 W	0 W
a) iv) 25% of the sum of the calculated loads in the next 2 units having the same or next smaller loads to those specified in Item iii); plus	0 W	0 W	0 W
a) v) 10% of the sum of the calculated loads in the remaining units.	0 W	0 W	0 W
b) if electric space heating is used, the sum of all the space-heating loads as determined in accordance with the requirements of Section 62 shall be added to the load determined in accordance with Item a), subject to rule 8-106 3) **c)** if air conditioning is used, the sum of all the air-conditioning loads shall be added, with a demand factor of 100%, to the load determined in accordance with Items a) and b), subject to Rule 8-106 3).	10,965 W	10,965 W	7,590 W
d) except as permitted by Rule 8-106 10) or Rule 8-106 11), any electric vehicule supply equipment loads not supplied from a panelboard installed in a dwelling unit in accordance with Rule 8-202 1) a) vii), shall be added with a demand of 100%, and (+include load from 8-202 1) a) vii))	15,360 W	0 W	15,360 W
e) in addition, any lighting, heating, and power loads not located in dwelling units shall be added with a demand factor of 75%	1,000 W	1,000 W	1,000 W
Peak Load	57,225 W	40,008 W	52,125 W
Peak amperage (at 240V)	**238 A**	**167 A**	**217 A**
Required service size	**400 A**	**200 A**	**400 A**

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Fourplex with three (3) parking spaces

Panel size calculation

		Electrification (Baseline)		Electrification (with all PED)		Gas equivalent (no PED)	
		Unit w/o EVSE	**Unit** w/EVSE	**Unit** w/o EVSE	**Unit** w/EVSE	**Unit** w/o EVSE	**Unit** w/EVSE
8-202 1) The calculated load for the service or feeder from a main service supplying loads in dwelling units shall be greater of:							
i) to iii) a basic load of 3500W for the first 45m² of living area; plus an additional 1500W for the second 45m² or portion thereof; plus an additional 1000W for each additional 90m² or portion thereof in excess of the initial 90m²		6,000 W	6,000 W	6,000 W	6,000 W	6,000 W	6,000 W
iv) any electric space-heating loads provided for with demand factors as permitted in Section 62 plus any air conditioning loads with a demand factor of 100%m subject to Rule 8-106 3)	AC/HP	2,530 W	2,530 W	2,070 W	2,070 W	2,530 W	2,530 W
	Auxiliary	1,350 W	1,350 W	1,350 W	1,350 W	0 W	0 W
v) any electric range load provided as follows: 6000W for a single range plus 40% of any amount by which the rating of the range exceeds 12kW		6,000 W	6,000 W	6,000 W	6,000 W	0 W	0 W
vii) any electrical vehicule supply equipment loads, if they are supplied from a panelboard installed in a dwelling unit, with a demand factor of 100%		0 W	7,680 W	0 W	0 W	0 W	7,680 W
viii) any loads provided for, in addition to those outlines in Items i) to vi) at A) 25% of the rating of each load with a rating in excess of 1500W, if an electric range has been provided for; or b) 25% of the rating of each load with a rating in excess of 1500W plus 6000W, if an electric range has not been provided for.		2,375 W	2,375 W	563 W	563 W	7,250 W	7,250 W
Peak Load		18,255 W	25,935 W	15,983 W	15,983 W	15,780 W	23,460 W
Peak amperage (at 240V)		**76 A**	**108 A**	**67 A**	**67 A**	**66 A**	**98 A**
Required panel size		**100 A**	**125 A**	**100 A**	**100 A**	**100 A**	**100 A**

Service size calculation

	Electrification (Baseline)	Electrification (with all PED)	Gas equivalent (no PED)
8-202 3) The calculated load for the consumer's service of feeder supplying two or more dwelling units shall be based on the calculated load obtained from Subrule 1) a) and the following.			
a) i) 100% of the calculated load in the unit having the heaviest load; plus	14,375 W	12,563 W	13,250 W
a) ii) 65% of the sum of the calculated loads in the next 2 units having the same or next smaller loads to those specified in Item i); plus	18,688 W	16,331 W	17,225 W
a) iii) 40% of the sum of the calculated loads in the next 2 units having the same or next smaller loads to those specified in Item ii); plus	5,750 W	5,025 W	5,300 W
a) iv) 25% of the sum of the calculated loads in the next 2 units having the same or next smaller loads to those specified in Item iii); plus	0 W	0 W	0 W
a) v) 10% of the sum of the calculated loads in the remaining units.	0 W	0 W	0 W
b) if electric space heating is used, the sum of all the space-heating loads as determined in accordance with the requirements of Section 62 shall be added to the load determined in accordance with Item a), subject to rule 8-106 3) **c)** if air conditioning is used, the sum of all the air-conditioning loads shall be added, with a demand factor of 100%, to the load determined in accordance with Items a) and b), subject to Rule 8-106 3).	15,520 W	10,680 W	10,120 W
d) except as permitted by Rule 8-106 10) or Rule 8-106 11), any electric vehicule supply equipment loads not supplied from a panelboard installed in a dwelling unit in accordance with Rule 8-202 1) a) vii), shall be added with a demand of 100%, and (+include load from 8-202 1) a) vii))	23,040 W	0 W	23,040 W
e) in addition, any lighting, heating, and power loads not located in dwelling units shall be added with a demand factor of 75%	1,000 W	1,000 W	1,000 W
Peak Load	78,373 W	45,599 W	69,935 W
Peak amperage (at 240V)	**327 A**	**190 A**	**291 A**
Required service size	**400 A**	**200 A**	**400 A**

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Six-plex with three (3) parking spaces

Panel size calculation

		Electrification (Baseline)		Electrification (with all PED)		Gas equivalent (no PED)	
		Unit w/o EVSE	**Unit** w/EVSE	**Unit** w/o EVSE	**Unit** w/EVSE	**Unit** w/o EVSE	**Unit** w/EVSE
8-202 1) The calculated load for the service or feeder from a main service supplying loads in dwelling units shall be greater of:							
i) to iii) a basic load of 3500W for the first 45m² of living area; plus an additional 1500W for the second 45m² or portion thereof; plus an additional 1000W for each additional 90m² or portion thereof in excess of the initial 90m²		6,000 W	6,000 W	6,000 W	6,000 W	6,000 W	6,000 W
iv) any electric space-heating loads provided for with demand factors as permitted in Section 62 plus any air conditioning loads with a demand factor of 100%m subject to Rule 8-106 3)	AC/HP	2,530 W	2,530 W	2,530 W	2,530 W	2,530 W	2,530 W
	Auxiliary	1,316 W	1,316 W	1,316 W	1,316 W	0 W	0 W
v) any electric range load provided as follows: 6000W for a single range plus 40% of any amount by which the rating of the range exceeds 12kW		6,000 W	6,000 W	6,000 W	6,000 W	0 W	0 W
vii) any electrical vehicule supply equipment loads, if they are supplied from a panelboard installed in a dwelling unit, with a demand factor of 100%		0 W	7,680 W	0 W	0 W	0 W	7,680 W
viii) any loads provided for, in addition to those outlines in Items i) to vi) at A) 25% of the rating of each load with a rating in excess of 1500W, if an electric range has been provided for; or b) 25% of the rating of each load with a rating in excess of 1500W plus 6000W, if an electric range has not been provided for.		2,375 W	2,375 W	563 W	563 W	7,250 W	7,250 W
Peak Load		19,538 W	25,901 W	16,409 W	16,409 W	15,780 W	23,460 W
Peak amperage (at 240V)		**76 A**	**108 A**	**68 A**	**68 A**	**66 A**	**98 A**
Required panel size		**100 A**	**125 A**	**100 A**	**100 A**	**100 A**	**100 A**

Service size calculation

	Electrification (Baseline)	Electrification (with all PED)	Gas equivalent (no PED)
8-202 3) The calculated load for the consumer's service of feeder supplying two or more dwelling units shall be based on the calculated load obtained from Subrule 1) a) and the following.			
a) i) 100% of the calculated load in the unit having the heaviest load; plus	14,375 W	12,563 W	13,250 W
a) ii) 65% of the sum of the calculated loads in the next 2 units having the same or next smaller loads to those specified in Item i); plus	18,688 W	16,331 W	17,225 W
a) iii) 40% of the sum of the calculated loads in the next 2 units having the same or next smaller loads to those specified in Item ii); plus	11,500 W	10,050 W	10,600 W
a) iv) 25% of the sum of the calculated loads in the next 2 units having the same or next smaller loads to those specified in Item iii); plus	3,594 W	3,141 W	3,313 W
a) v) 10% of the sum of the calculated loads in the remaining units.	0 W	0 W	0 W
b) if electric space heating is used, the sum of all the space-heating loads as determined in accordance with the requirements of Section 62 shall be added to the load determined in accordance with Item a), subject to rule 8-106 3) **c)** if air conditioning is used, the sum of all the air-conditioning loads shall be added, with a demand factor of 100%, to the load determined in accordance with Items a) and b), subject to Rule 8-106 3).	23,078 W	23,078 W	15,180 W
d) except as permitted by Rule 8-106 10) or Rule 8-106 11), any electric vehicule supply equipment loads not supplied from a panelboard installed in a dwelling unit in accordance with Rule 8-202 1) a) vii), shall be added with a demand of 100%, and (+include load from 8-202 1) a) vii))	23,040 W	0 W	23,040 W
e) in addition, any lighting, heating, and power loads not located in dwelling units shall be added with a demand factor of 75%	1,000 W	1,000 W	1,000 W
Peak Load	95,274 W	66,162 W	83,608 W
Peak amperage (at 240V)	**397 A**	**276 A**	**348 A**
Required service size	**400 A**	**400 A**	**400 A**

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