100% “EV Ready” Requirements

Why they exist, how to comply, and design strategies to maximize value

June 2022, Toronto

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EXPERTISE

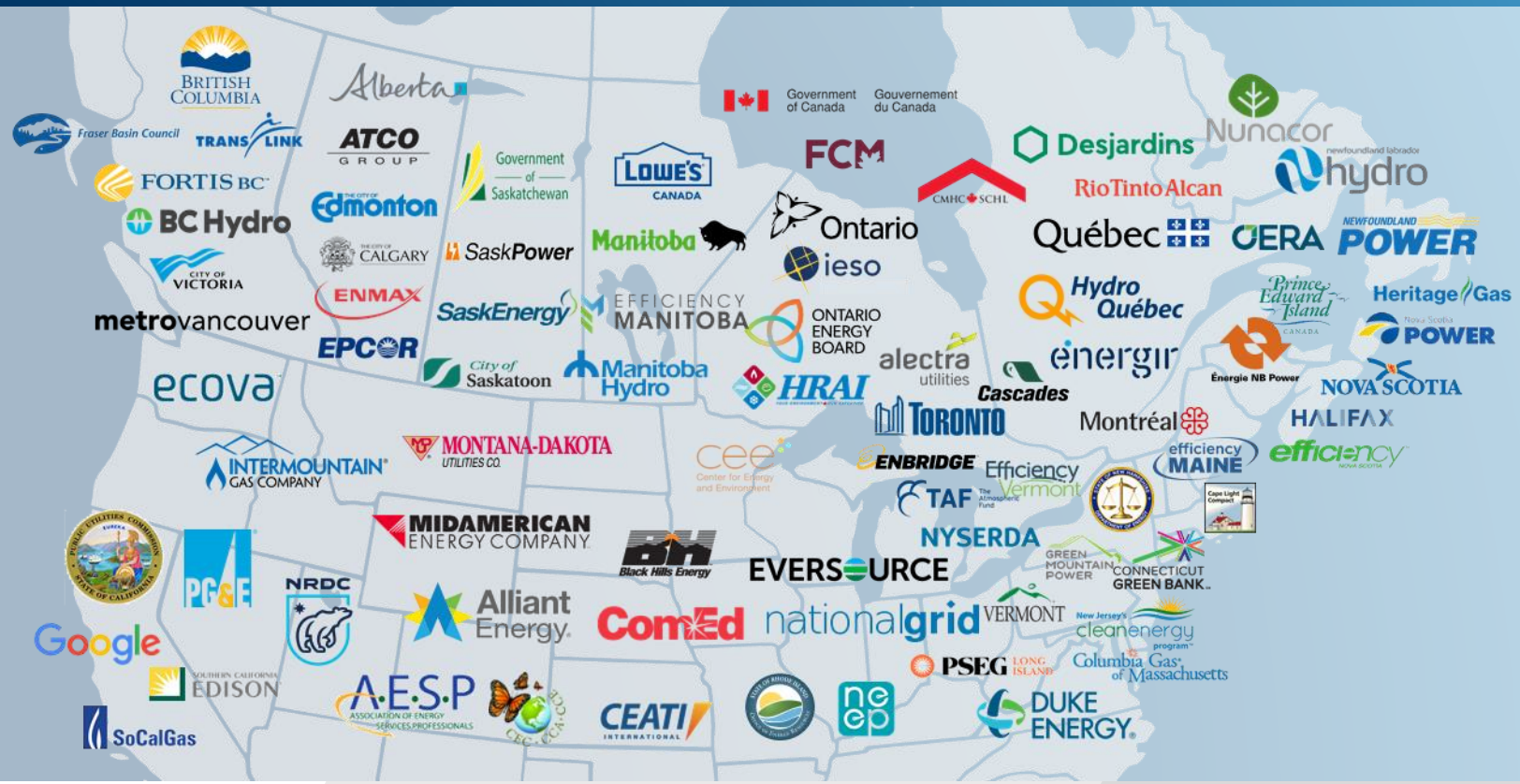
Buildings + Industry — **Energy** — **Mobility**

SERVICES

Quantify Opportunities

Design Strategies

Evaluate Performance



GOVERNMENTS | **UTILITIES** | **CORPORATE + NON-PROFIT**

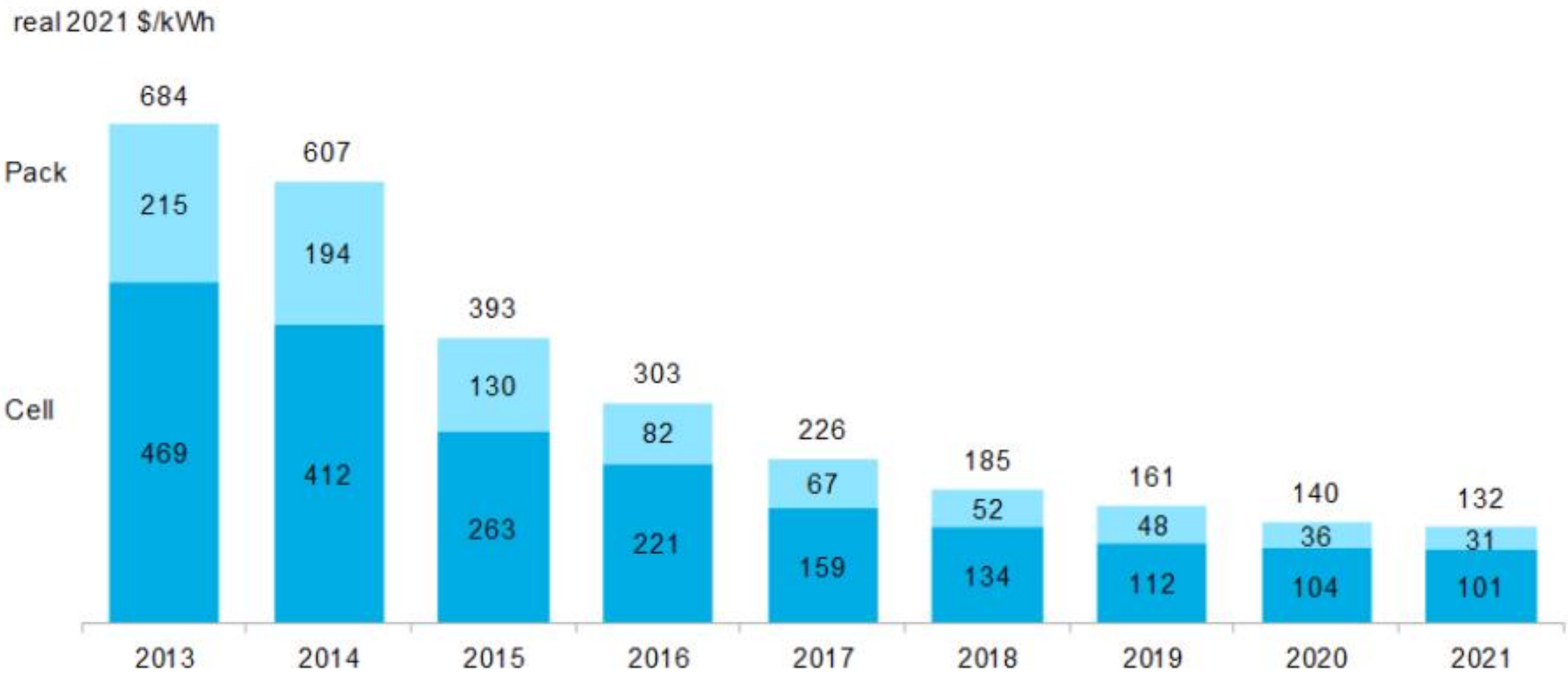
Outline

1. Overview of electric vehicles (EVs)
2. About EV Charging & EV Ready Parking
3. About EV Energy Management Systems & EV Charging Service Providers
4. New Construction EV Ready Requirements & How to Comply
5. Design Strategies to Maximize Value
6. EV Charging Infrastructure in Existing Multifamily Buildings (Time Permitting)

EV Overview

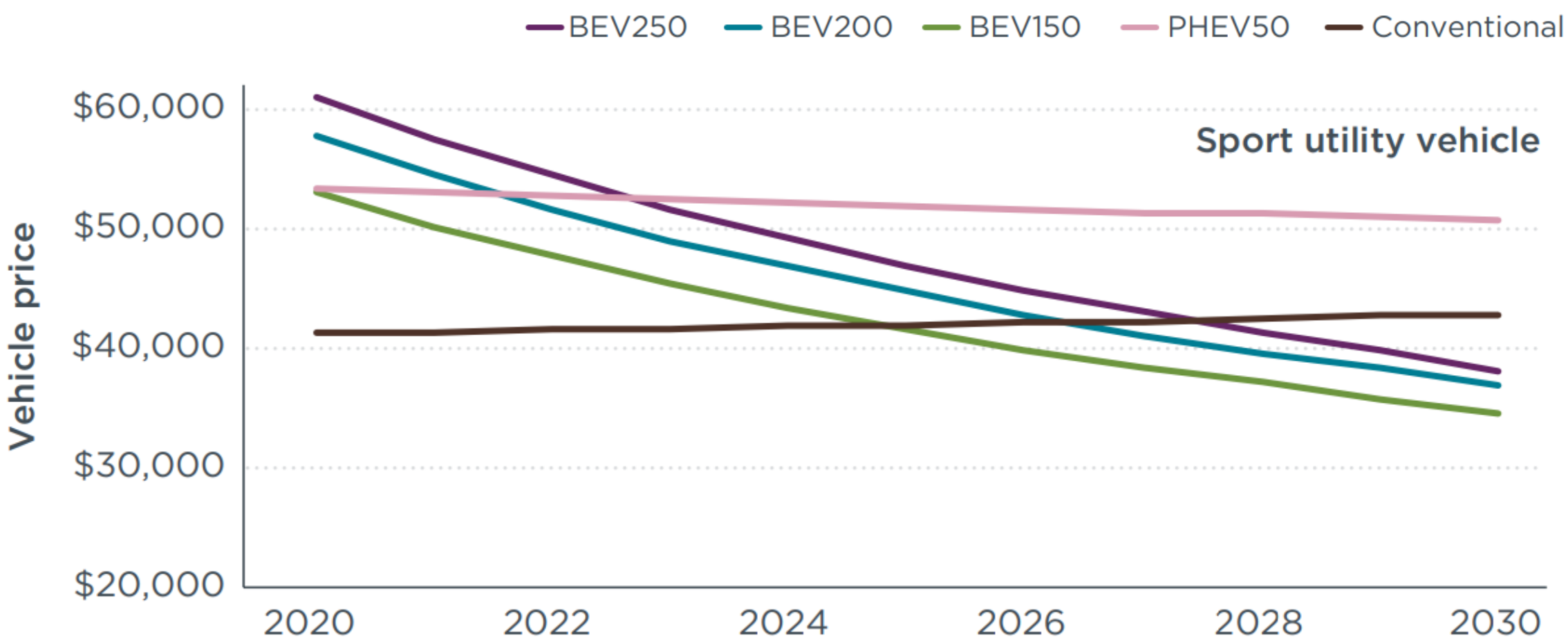
Technology advancements, improving economics & strong policies will drive the transition to EVs in the next decade

Battery Prices are Declining



Source: BloombergNEF.

EV Prices are Declining

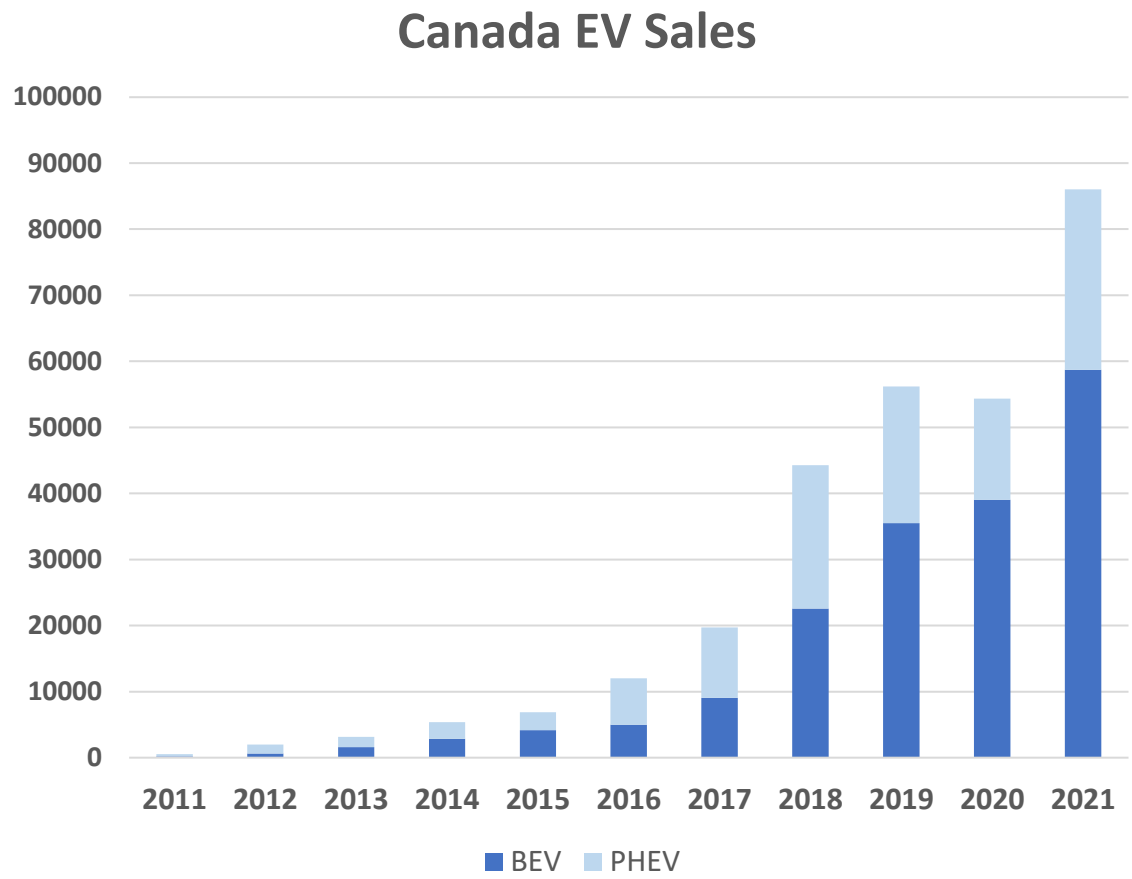


Source: International Council on Clean Transportation. 2019. *Update on electric vehicle costs in the United States through 2030*. https://theicct.org/wp-content/uploads/2021/06/EV_cost_2020_2030_20190401.pdf

Policy is Driving EV Adoption

In June 2021, the Federal Government announced it would adopt zero emissions vehicle sales requirements:

- 20% by 2026
- 50% by 2030
- 100% by 2035



Source: Statistics Canada. 2022. https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x2019028-eng.htm

About EV Charging & EV Ready Parking

About EV Charging

Know your EV Charging Stations

Voltage
120V 1-Phase AC

Amps
12 – 16 Amps

Charging Loads
1.4 to 1.9 kW

Charge time for vehicle
3 – 5 miles of range per hour

Voltage
208V or 240V 1-Phase AC

Amps
12 – 80 Amps (Typ. 32 Amps)

Charging Loads
2.5 to 19.2 kW (Typ. 7kW)

Charge time for vehicle
10 – 20 miles of Range per hour

Voltage
208V or 480V 3-Phase AC

Amps
<125 Amps (Typ. 60 Amps)

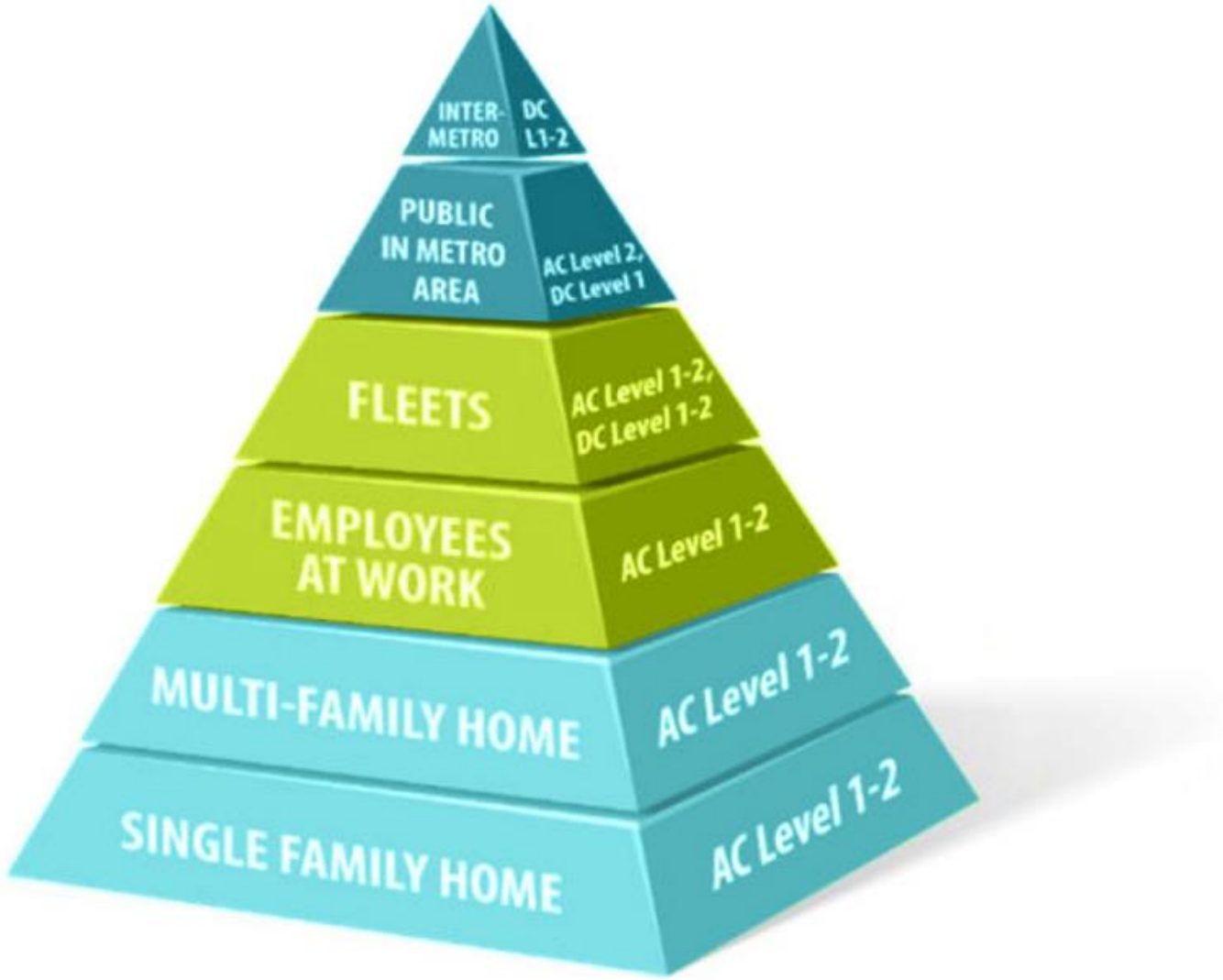
Charging Loads
<90 kW (Typ. 50kW)

Charge time for vehicle
80% Charge in 20 – 30 minutes

Source: Geotab

Where do we charge?

Access to “Home Charging” is Critical to EV Adoption



It's costly & complicated to implement EV charging in existing multifamily buildings that are not future-proofed

EV Charging in Multifamily Buildings

- **Incremental additions of EV charging cost ~$5-$15k+ per EVSE**
- **Complicated approvals process for condominiums, rental apartments**
- **Electrical capacity is limited**
  - Risk of stranded assets & significant costs as EV charging infrastructure grows, if initial designs are properly future-proofed

Future-proofing parking to support easy implementation of EV charging

“EV Ready” Infrastructure

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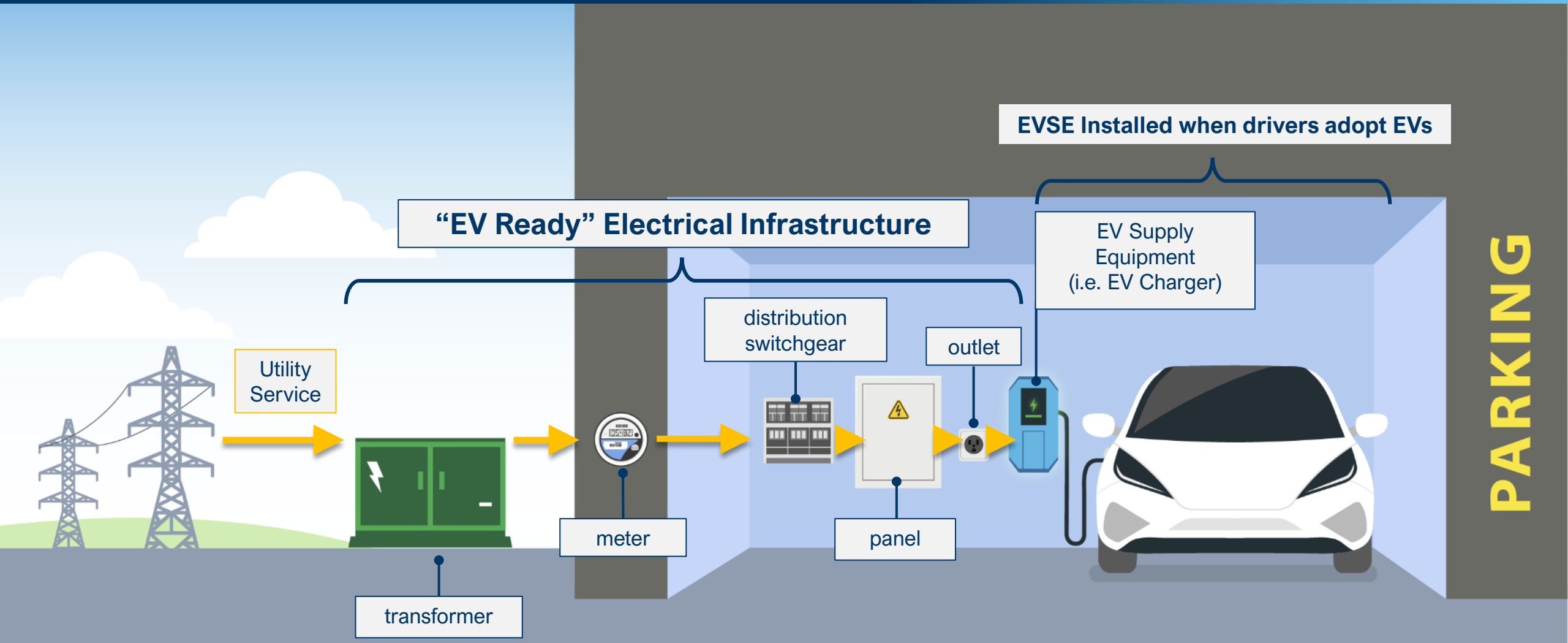


What is an electrical outlet?

Junction Box

Receptacle

About EV Energy Management & EV Charging Service Providers

EV Energy Management Systems

- **EVEMS monitor and control EV loads.**
  - Enabled in Canadian Electrical Code.
- **Advantages include:**
  - Reduction in electrical capacity and associated electrical infrastructure costs to provide EV charging.
  - Managing EV loads to maximize value – e.g. avoid demand charges; respond to dynamic rates; respond to utility demand response events; use variable renewable energy; etc.
- **EVEMS are important to enabling high levels of EV charging in many MURBs, workplaces, and fleet parking applications.**

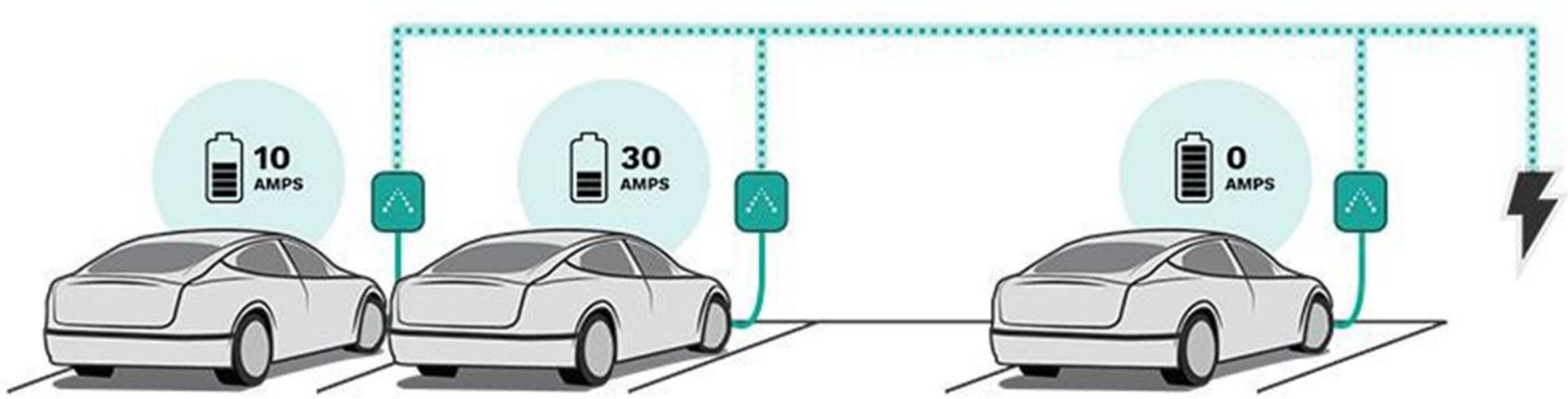
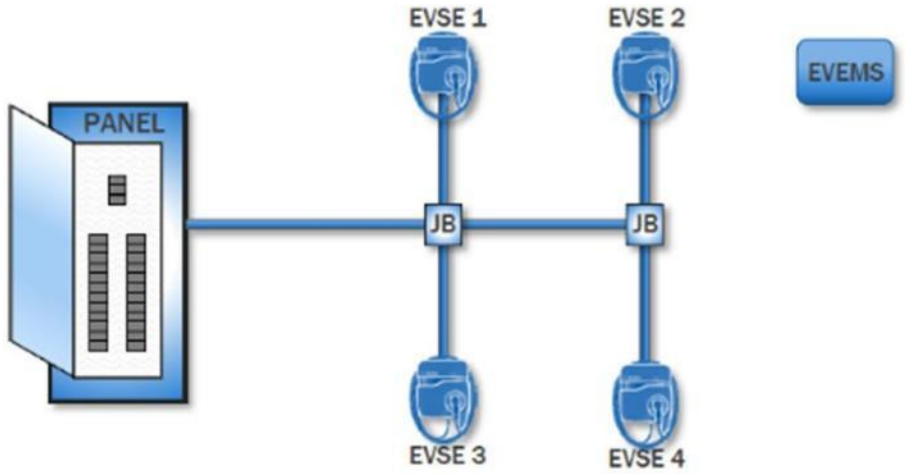


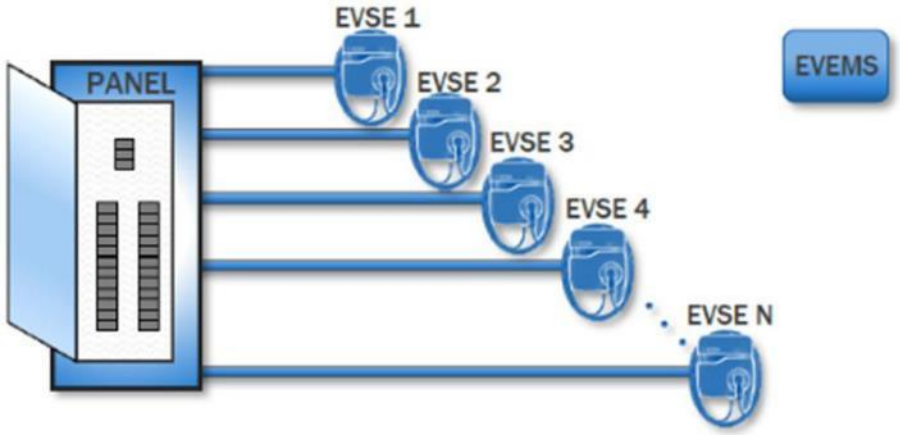
Image Source: Evercharge.

Some Electrical Infrastructure Configurations

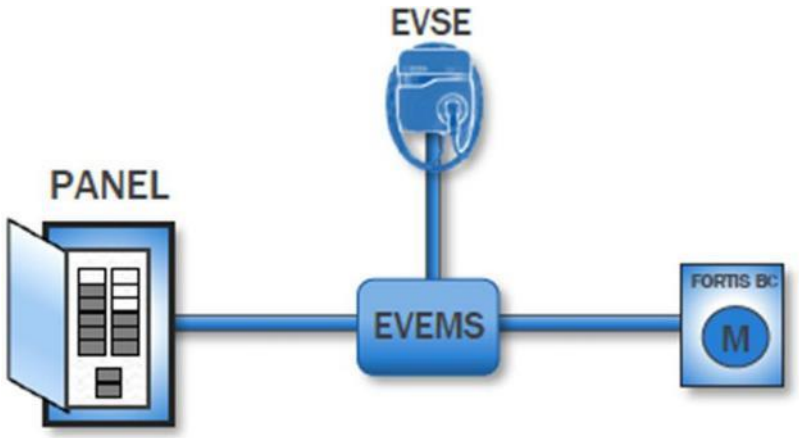
Source: AES Engineering. 2019.



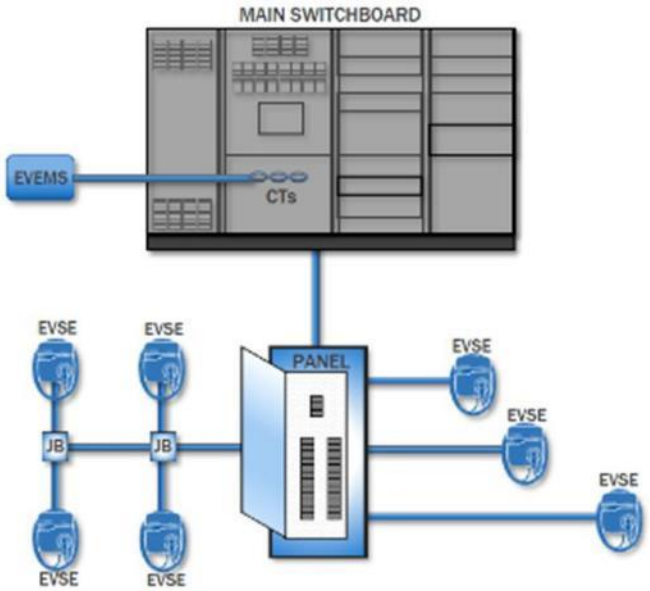
Circuit sharing: Multiple EVSE on a circuit, with control to ensure capacity is not exceeded.



Panel sharing: EVSE loads in excess of panel, with control to ensure capacity is not exceeded.

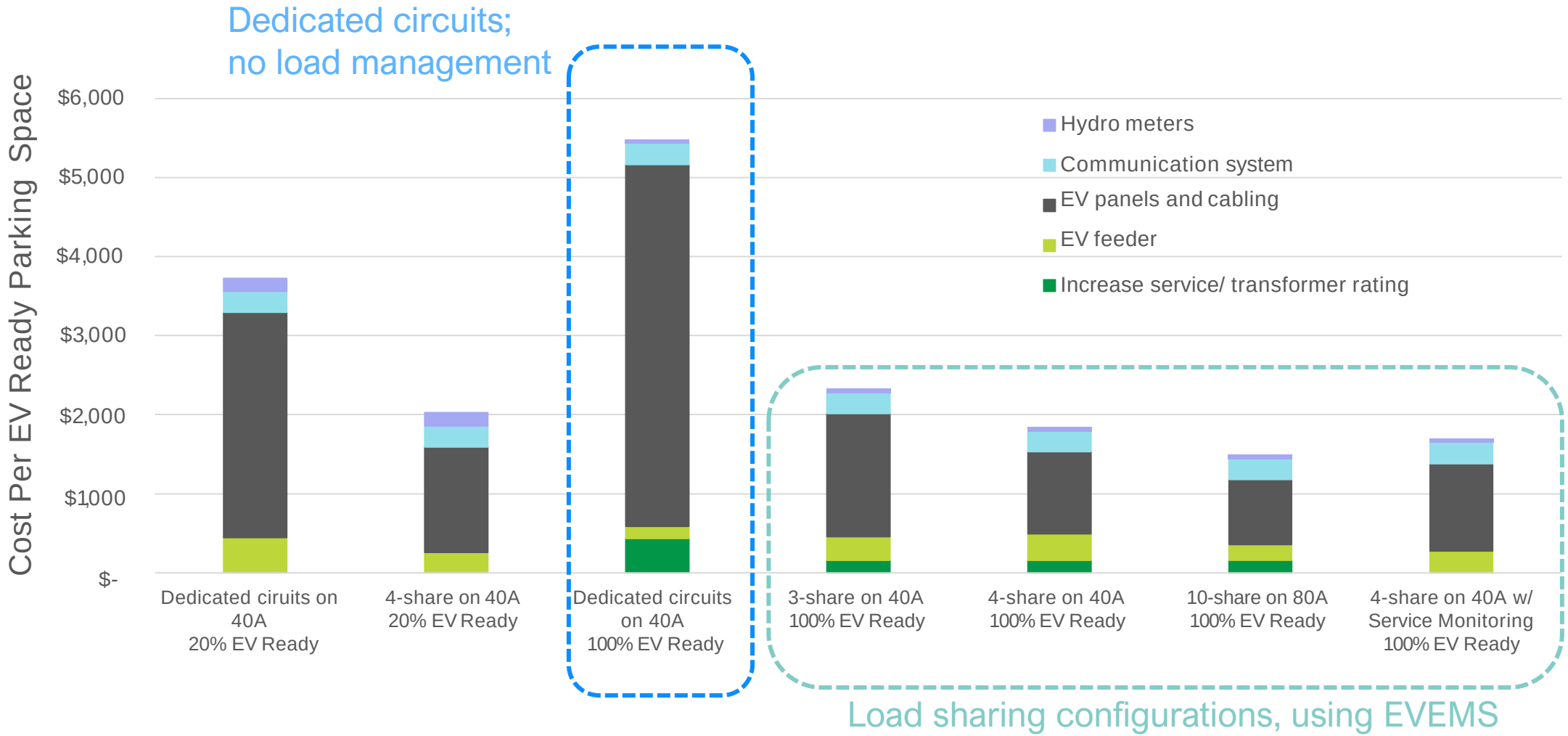


Feeder sharing: on/off control of EVSE based on available capacity on the supply to an electrical panel.



Service monitoring: Monitoring of spare capacity on building's main electrical board; and control of EV loads accordingly.

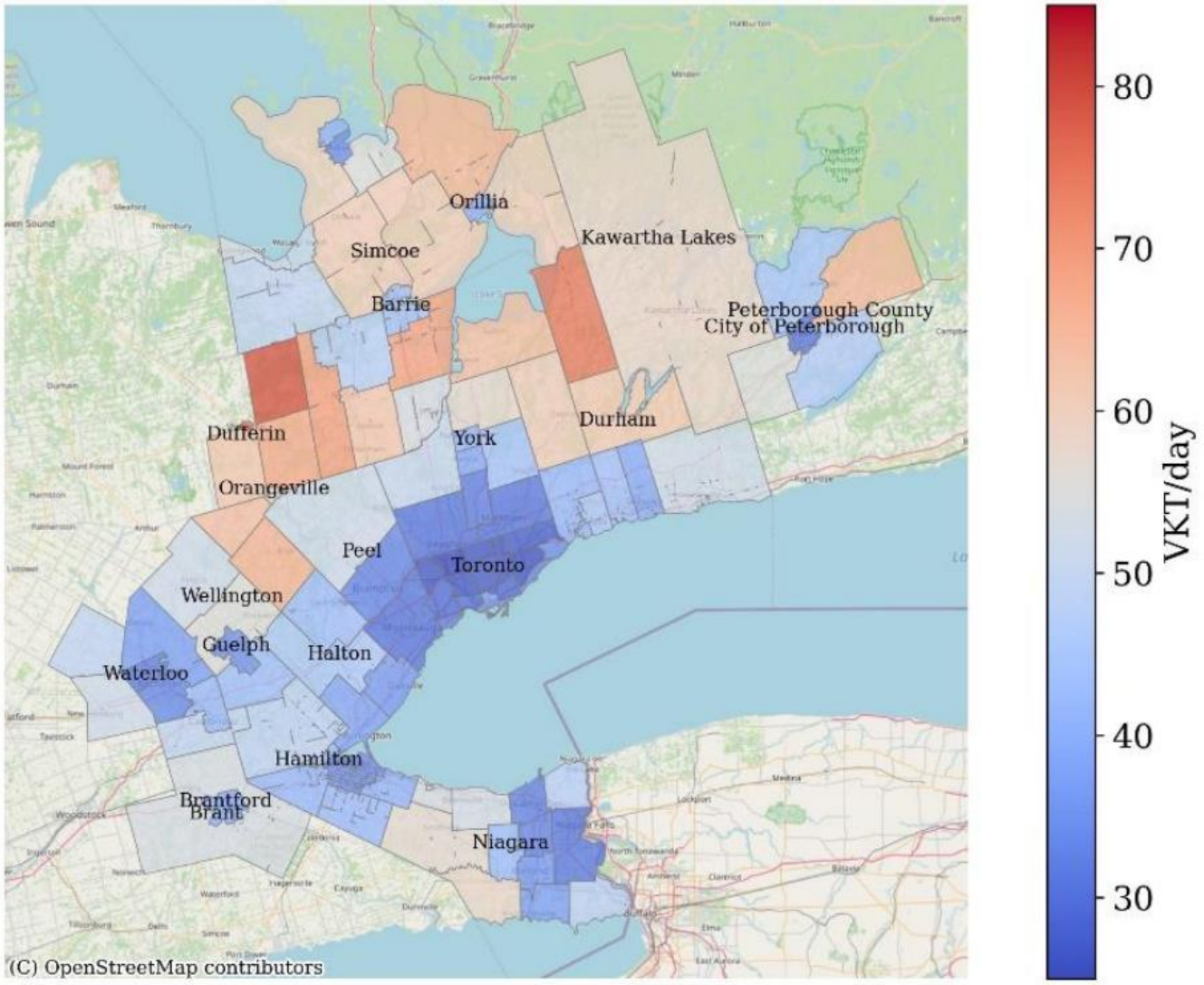
Designing for load sharing using EVEMS reduces costs



Source: AES Engineering. 2021. *Electric Vehicle Charging Infrastructure Costing Study*. Prepared for the Clean Air Partnership. https://cleanairpartnership.org/cac/wp-content/uploads/2021/10/2-21-050-GTHA-EV-Ready-Costing-Study-2021.10.14.pdf

How much load sharing using EVEMS is appropriate? It depends on how far vehicles drive…

VKT by Planning District in the GTHA



Source: AES Engineering. 2021. *EV Charging Performance Requirements*. Prepared for the Clean Air Partnership. https://cleanairpartnership.org/cac/wp-content/uploads/2021/11/2-21-050-EV-Charging-Performance-Requirements-in-GTHA.pdf

EV Charging Performance Requirements

- Developed appropriate performance requirements for GTHA
  - Considered:
    - VKT data
    - Average vehicle mix & efficiency
    - Average temperatures
    - Arrival & departure times (conservative)
  - Goal: Ensure enough electricity for next days driving >99% of time, and full charge >90% of time, assuming all vehicles are EVs (& assuming exclusive use of home charging)

Compare results to *Toronto Green Standard Version 3's* performance requirement:

> *"The system must be capable of supplying a minimum performance level of 16kWh average per EVSE, over an 8-hour period, assuming that all parking spaces are in use by a charging EV"*
> *– e.g. 3-share on 40A circuit*

Circuit Breaker Size	Maximum number of EVs By mean daily weekday VKT
	45km or less (e.g. Toronto)
20A	1
30A	2
40A	4
50A	5
60A	6
70A	8
80A	10
100A	12
125A	15

Source: AES Engineering. 2021. *EV Charging Performance Requirements*. Prepared for the Clean Air Partnership. https://cleanairpartnership.org/cac/wp-content/uploads/2021/11/2-21-050-EV-Charging-Performance-Requirements-in-GTHA.pdf

About EV Charging Service Providers

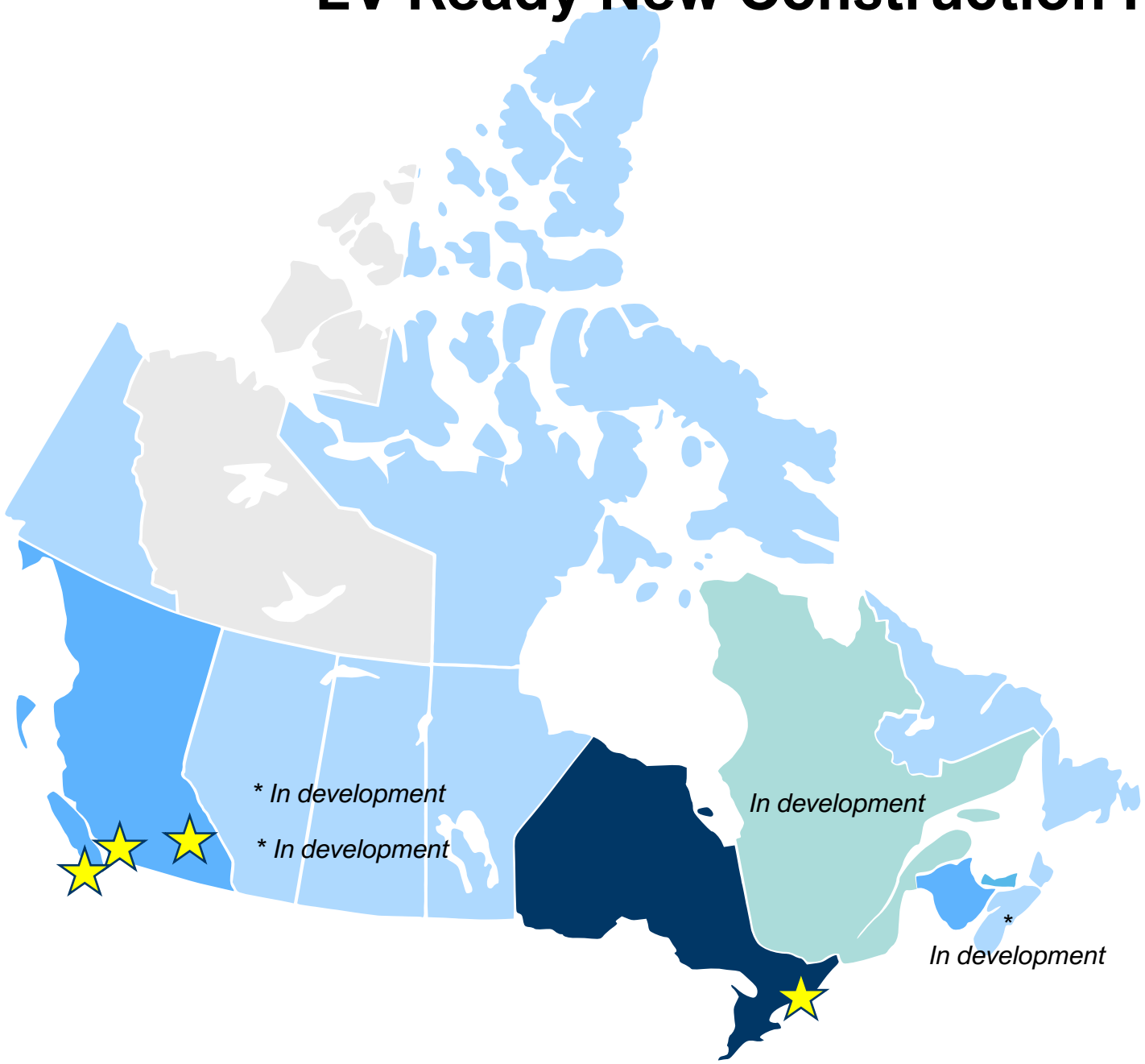
Services provided for "site hosts" (e.g. multifamily buildings)

- Provide EVSE
- Access control
- User apps
- Reconcile electricity costs - Apply user fees, bill EV drivers, repay condo / owner
- Data & Dashboards
- EV energy management
- Utility demand response
- Clean Fuel Standard revenue
- Etc.

Other charging service providers…

EV Ready New Construction Requirements

EV Ready New Construction Requirements



Jurisdiction	Residential	Commercial
City of Toronto, ON	**100% EV Ready**	**25% EV Ready**
City of Vancouver, BC	100% EV Ready	45% EV Ready
City of Richmond, BC	100% EV Ready	TBD
City of P. Coquitlam, BC	1 EV Cap. / dwelling	TBD
City of Burnaby, BC	100% EV Ready	TBD
City of Coquitlam, BC	1 EV Ready / dwelling	TBD
City of New West., BC	100% EV Ready	TBD
City of N. Vancouver, BC	100% EV Ready	45% EV Ready
City of P. Moody, BC	100% EV Ready	TBD
District of Squamish, BC	100% EV Ready	TBD
City of Surrey, BC	100% EV Ready	20% EV Ready
Township of Langley, BC	1 EV Ready / dwelling	TBD
District of Saanich, BC	100% EV Ready	Varies
City of Nelson, BC	1 EV Ready / dwelling	10% EV Ready
District of West Van., BC	100% EV Ready	TBD
City of Victoria, BC	100% EV Ready	5% EV Ready
Ville de Laval, QC	50% EV Ready	
Previous Ontario Building Code (rescinded)	20% EVSE	20% EVSE

In December 2021 Toronto City Council adopted amendments to its Zoning Bylaw

Toronto's EV Ready Requirements

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Zoning By-law 569-2013

200.5.1.14 - Electric Vehicle Infrastructure

Parking spaces must be equipped with an energized outlet, which is clearly marked and identified for electric vehicle charging, in accordance with the following:

(A) all residential parking spaces provided for dwelling units located in an apartment building, mixed use building, "multiple dwelling unit building", detached house, semi-detached house, townhouse, duplex, triplex, fourplex, or for a secondary suite or laneway suite, excluding visitor parking spaces, must include an energized outlet capable of providing Level 2 charging or higher to the parking space; and

(B) in cases other than those set out in (A) above, 25 percent of the residential and non-residential parking spaces in a building must include an energized outlet capable of providing Level 2 charging or higher.

Toronto Green Standard V4:
Charging Performance Requirements

Circuit Breaker Size	Maximum number of EVs
20A	1
30A	2
40A	4
50A	5
60A	6
70A	8
80A	10
100A	12
125A	15

Strategies to Maximize Value

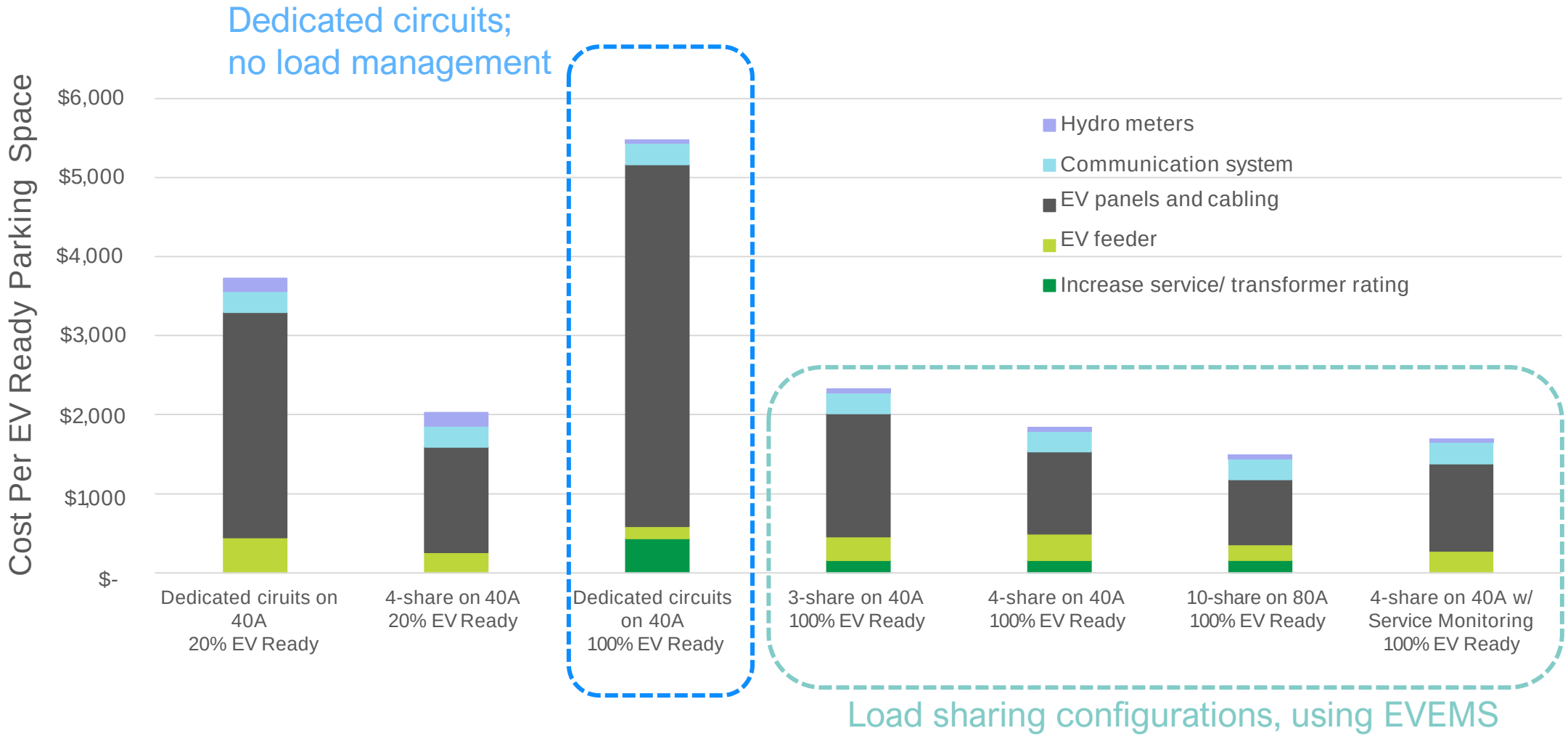
For multifamily apartments/condos & ground-oriented housing with private garages.

Caveat: *I am not an electrical engineer*. New developments are complicated, and every building is different. We are not liable for your design or management decisions. Nothing supplants the value (& responsibility) of the design professionals & developers associated with a project.

Common Multifamily Parking (e.g. underground parkade)

- **Unmanaged dedicated circuits are allowed, but…**
- **Design strategies will usually be predicated on the use of load sharing using EVEMS**
  - Reduces the size of electrical systems, and associated costs of construction
  - Load sharing using EVEMS will reduce energy costs for buildings / EV drivers
  - May increase costs of EVSE for buildings / EV drivers
    - Design & any associated EV services should ensure EV drivers do not need to prematurely replace EVSE!

Designing for load sharing using EVEMS reduces costs



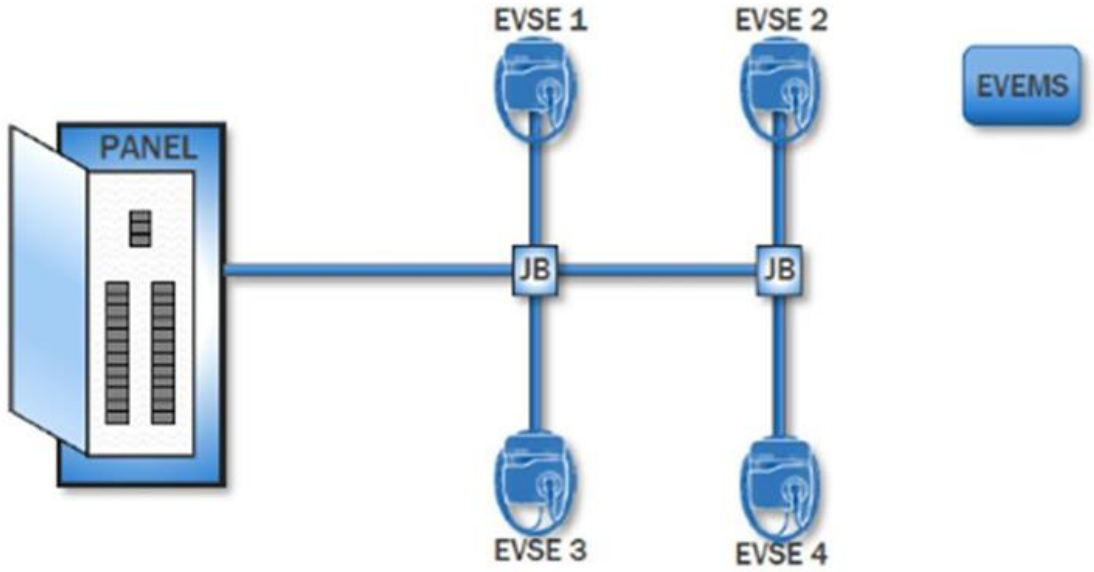
Source: AES Engineering. 2021. *Electric Vehicle Charging Infrastructure Costing Study*. Prepared for the Clean Air Partnership. https://cleanairpartnership.org/cac/wp-content/uploads/2021/10/2-21-050-GTHA-EV-Ready-Costing-Study-2021.10.14.pdf

Common Multifamily Parking (e.g. underground parkade)

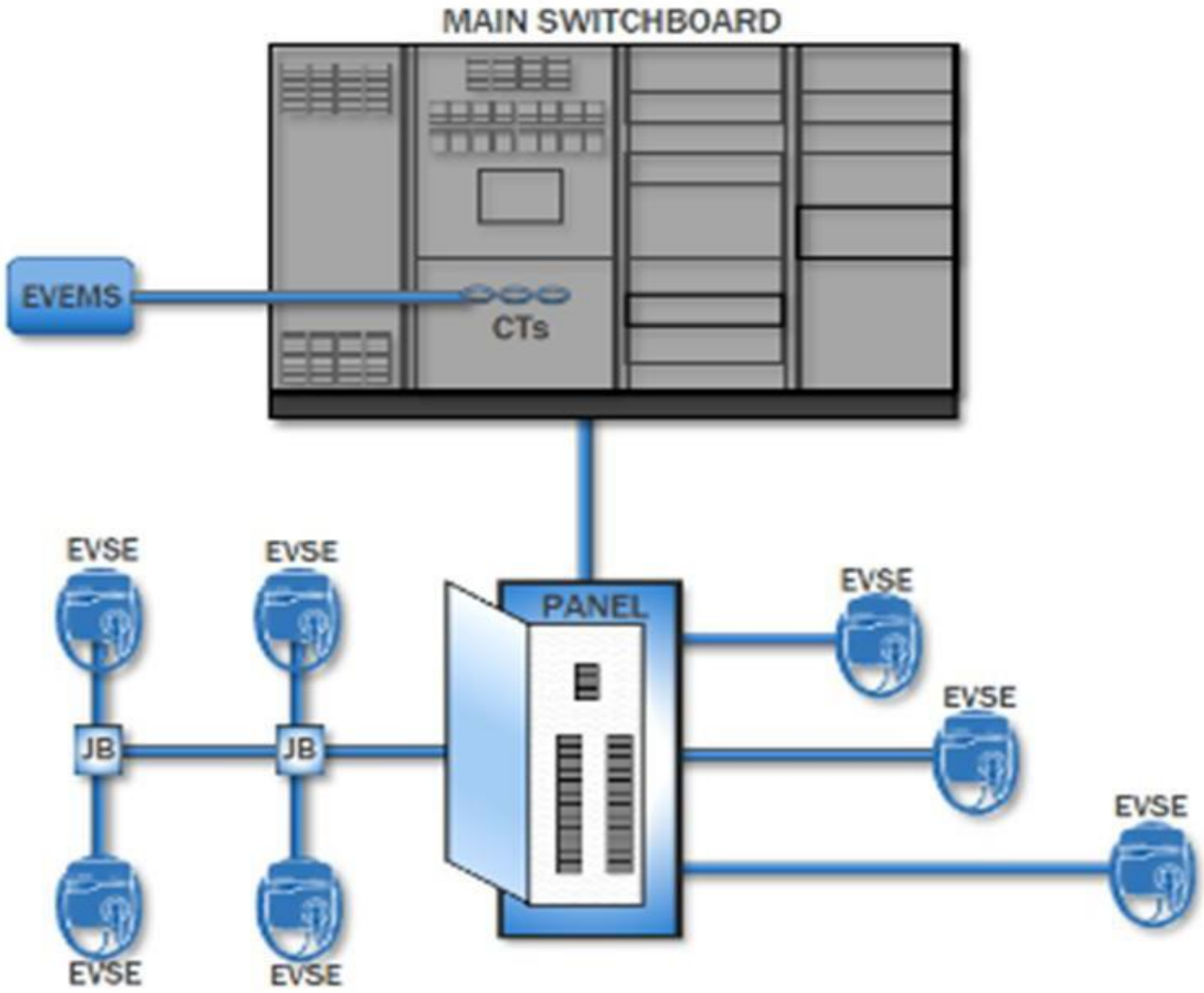
Branch Circuit Configurations

- **4-share on 40A is "bread and butter"**
  - Compatible with many EVSE & associated EV charging services targeted at multifamily buildings
  - Meets Toronto's Performance Requirements
    - Note that other cities/provinces may mandate e.g. 3-share on 40A in future requirements
- **Other design strategies (e.g. 10-share on 80A) are less common**
  - Currently face barriers (e.g. CE Code)
  - Fewer compatible, tested products
  - Could provide value in the future (e.g. reduced cost; reduce loads; etc.)

A 4-share on 40A circuit configuration



Consider service monitoring if otherwise facing expensive electrical service upgrades



A configuration using service monitoring

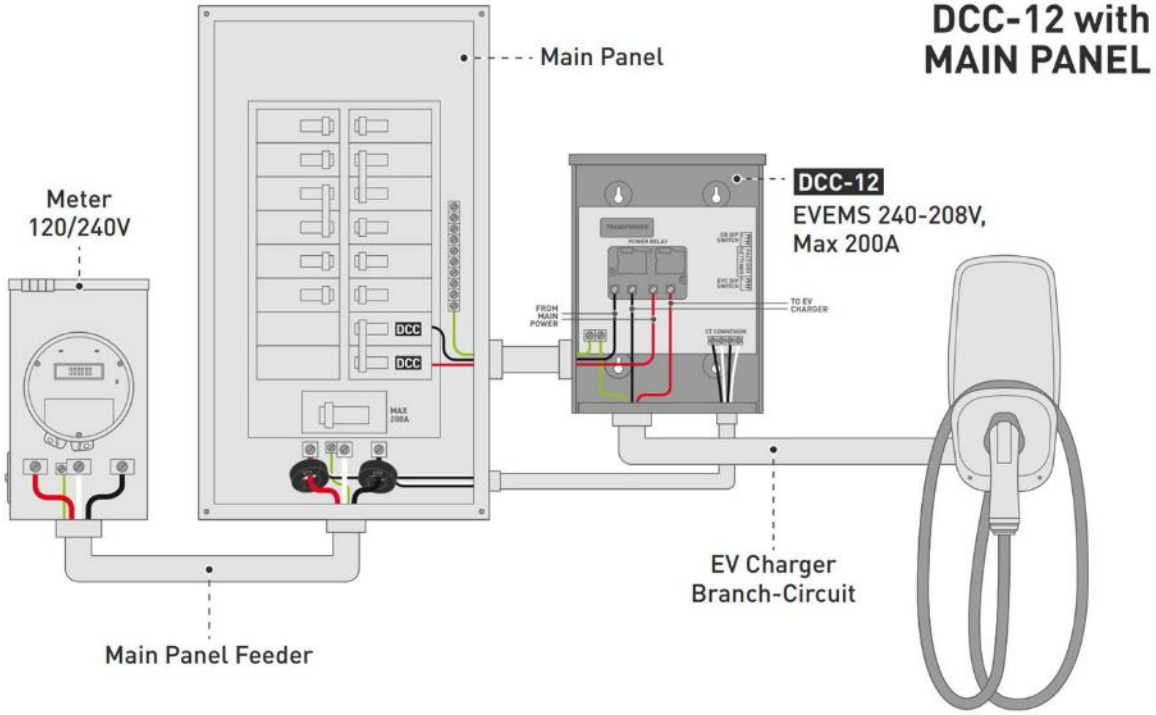
CE Code determines load calculations

> **"8-106 (10)** Where EVSE loads are controlled by an EVEMS, the demand load for the EVSE shall be equal to the maximum load allowed by the EVEMS.
>
> **8-106 (11)** … where an EVEMS as described in Subrule 10) monitors the consumer's service and feeders and controls … the demand load for the EVSE shall not be required to be considered in the determination of the calculated load."

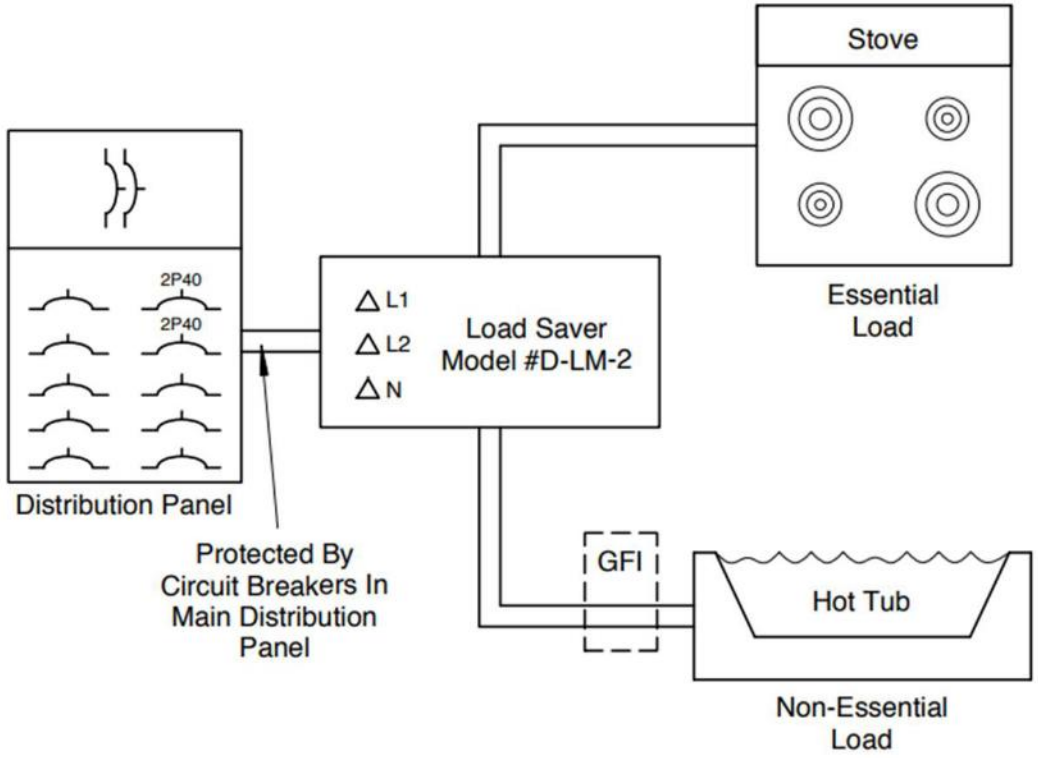
Private Parking (e.g. Townhomes; Single Family Homes)

- **Consider 40A dedicated circuits to parking**
- **Explore impacts of utility service costs early on in a developments' design. If service upgrades required:**
  - Consider cost implications of larger service
  - Consider impact of 20A or 30A circuits – Will service upgrades still be required?
  - Consider impacts of load switching, circuit sharing and/or feeder monitoring EVEMS – Will service upgrades still be required?
  - Consider designing for service monitoring EVEMS
    - See CE Code 8-106 (10), 8-106 (11), & 8-500

EVEMS Solutions Applicable to Townhomes & SFHs



An Example of Feeder Sharing.
Source: RVE.



An Example of Circuit Switching.
Source: AC Dandy.

EV Charging Service Providers

- **Many designs (but not all - e.g. dedicated circuits) require the use of one EV charging service provider for the building**
  - EVSE compatible with the EVEMS
  - Services compatible with building
- **Developers should associate new buildings with a system compatible with the buildings' EV Ready design**
- **Key Considerations When Selecting EV Charging Service Providers**
  - Price (EVSE & ongoing fees)
  - Quality of chargers
  - Warranties
  - Staying power (e.g. market position; reputation)
  - Proprietary systems vs. open protocols (e.g. OCPP)
  - Local service
  - Etc.

EV Charging Infrastructure in Existing Multifamily Buildings

Two broad strategies to provide EV charging infrastructure in existing buildings

EV Charging Infrastructure in Existing Multifamily Condos

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	1. Comprehensive EV Ready Retrofits	2. Incremental Additions of EVSE
Process	One large electrical renovation to make all residential parking spaces “EV Ready”	Series of electrical renovations over time, adding a few EVSE at a time
Cost	• Lower life-cycle cost • Larger one-time upfront cost	• Higher life-cycle cost • Series of smaller projects
Location of EV chargers	In drivers’ assigned parking space	Often, initially in commonly accessible parking (e.g. visitors parking); sometimes in assigned parking
Process for Drivers to Install EV Chargers	Simple (after initial comprehensive renovation)	Typically lengthy, complicated & uncertain
Convenience	• Highly convenient • EV charging in regular assigned parking space	• Depends on location of chargers. • Less convenient if located in common parking (e.g. visitors parking)
Futureproofing	Typically, ensures all drivers will have access to adequate EV charging.	• Potential for stranded assets. • Typically not designed for future expansion. • Potential to exhaust limited electrical capacity, if design for EVEMS not considered.

Source: Brendan McEwen for Electric Mobility Canada. 2022. *Making Parking “EV Ready”. https://emc-mec.ca/wp-content/uploads/EMC-Position-Paper-EV-Ready-Parking-2022.02.24-Formatted-EMC-Format.pdf*

Challenges to Comprehensive EV Ready Retrofits

To date, comprehensive EV Ready Retrofits are rare

Barriers / challenges

- Most programs for multifamily EV charging focus on providing a few EVSE at a time
- Significant upfront cost
  - Condos often do not have sufficient contingency reserves
  - Competing investments & hurdle rates
- Information barriers
  - Most condos & rental apartment managers do not know about this approach
  - Not everyone is convinced of EV adoption
- Complicated condo decision-making processes
- Lack of data on impacts on property value
- Poorly developed market – few electrical engineers nor contractors offer this service

Best Practice Program

The CleanBC EV Ready Rebate Program

Available for multifamily condos & rental apartments

- **EV Ready Plan (i.e. Feasibility Study)**: 75% (up to $3k) of the cost of an EV Ready Plan – a professional strategy to make at least one parking space per residential unit EV Ready.
- **EV Ready infrastructure rebate:** 50% (up to $600 per parking space) of costs to install the electrical infrastructure required to make parking EV Ready for Level 2 charging. Project maximum of $80k.
- **EV charger rebate:** Up to $1,400 for Level 2 EVSE.

Case Study

An EV Ready Retrofit in a West Vancouver Condo

About the Property

- 46 parking spaces
- Underground parking

Overview

- Project Team
  - **Electrical Engineer:** AES Engineering
  - **Electrical Contractor:** Power Pros Electrical
  - **EVSE Provider:** ChargePoint
  - **EV Charging Service Provider:** ChargePoint
- 4-share on 40A branch circuits
- No electrical upgrade
- Costs
  - Electrical engineering feasibility assessment: $6,000.
  - Detailed electrical design: $8,000.
  - Materials & labour (excluding EVSE): $57,200.
  - BC Hydro and other misc. costs: $2,600.
  - Materials and labor to install 10 EVSE: $23,000 (paid by individual unit owners).

Image credit: AES Engineering.

Thanks!

Contact

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Additional Slides

EV Charging Infrastructure Requirement Options

Infrastructure Option	Minimize upfront costs	Minimize retrofit costs	Simple for condo assn. / owner	Equitable for residents	Simple to enforce	Future-proof
Percentage-based EV Ready or EVSE (e.g. 20%)						
Conduit						
EV Capable (all stalls)						
EV Ready (all stalls)						
EVSE Installed (all stalls)						

Legend	
Least Impacts	
Some Challenges	
Major Challenges	

Source: Derived from AES Engineering, Fraser Basin Council, C2MP. 2018. *Residential Electric Vehicle Charging: A Guide for Local Governments.* Prepared for City of Richmond and BC Hydro.

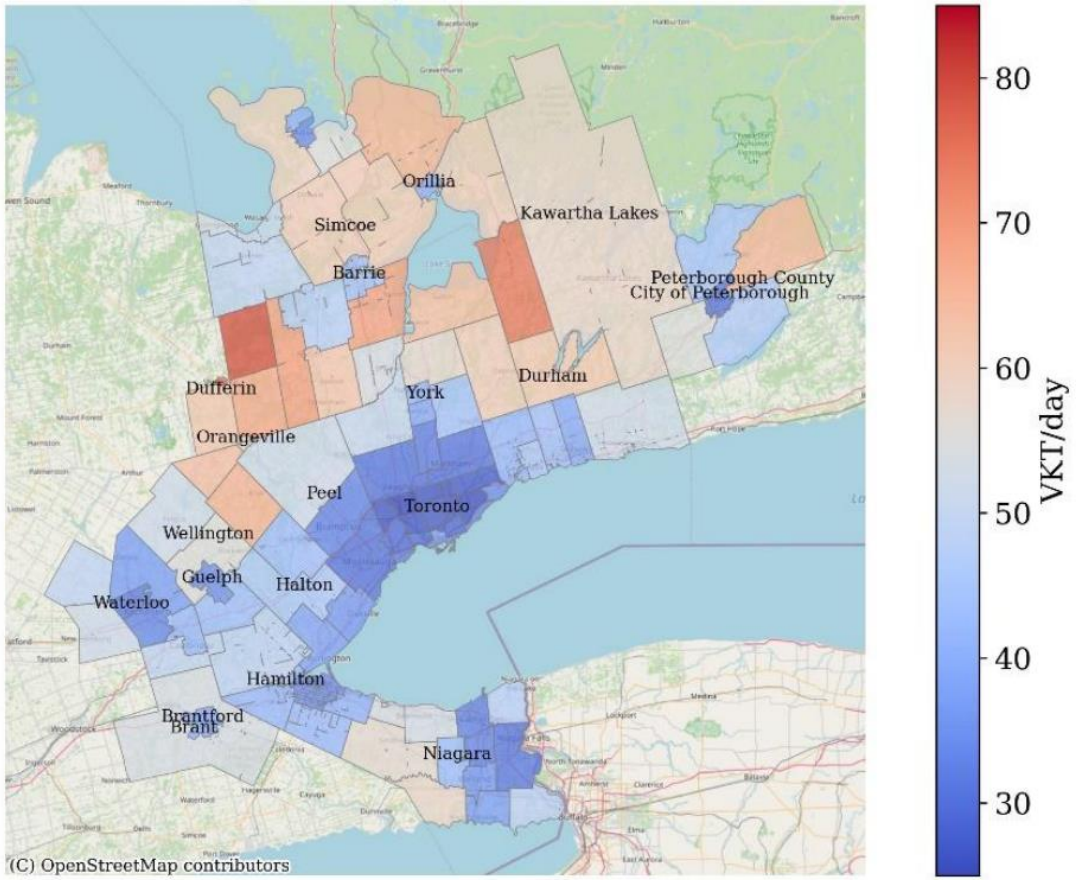
How much load sharing is appropriate depends on how far vehicles drive

EV Charging Performance Requirements

Maximum number of EVs that can share an electrical branch circuit, if all vehicles receive sufficient charge for next day's driving >99% of time (assuming only home charging is used)

	Maximum number of EVs (by Mean VKT)					
Circuit Breaker Size	45km or less	50km	55km	60km	65km	70km
20A	1					
30A	2	2	1	1	1	1
40A	4	3	3	2	2	2
50A	5	4	4	3	3	2
60A	6	5	5	4	4	3
70A	8	7	6	5	5	4
80A	9	8	7	6	6	5
100A	12	10	9	8	7	7
125A	15	14	12	11	10	9

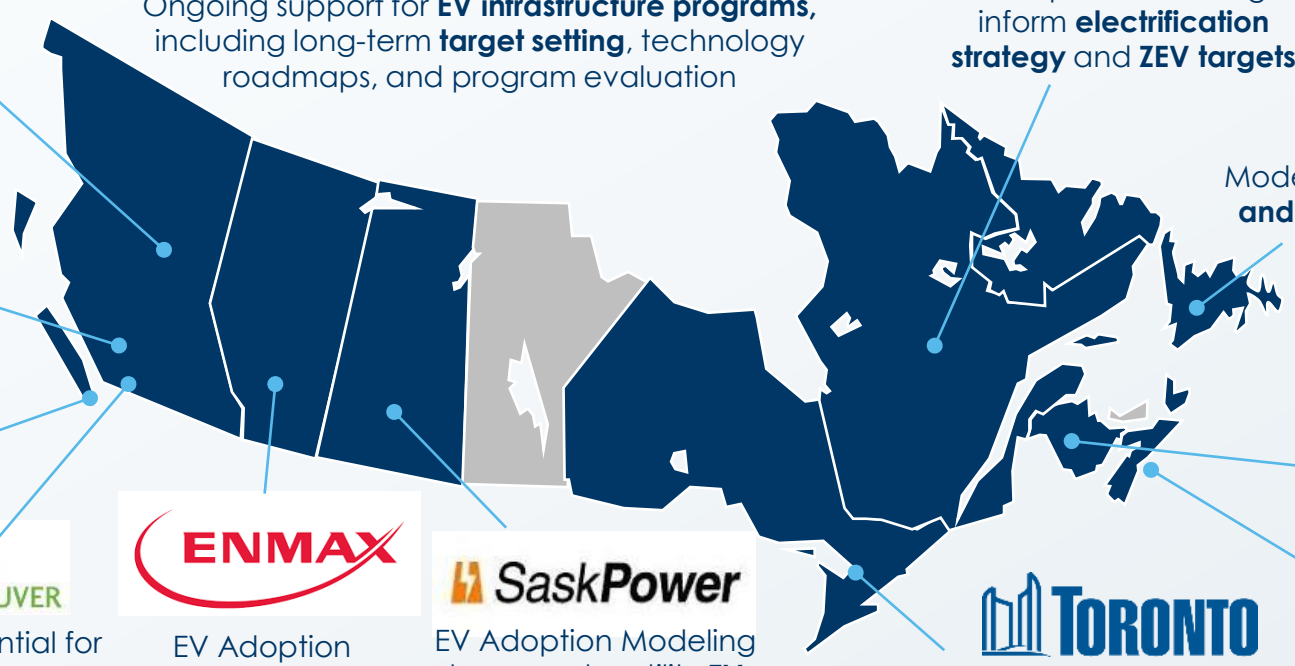
VKT by Planning District in the GTHA



Source: AES Engineering. 2021. *EV Charging Performance R*. Prepared for the Clean Air Partnership. https://cleanairpartnership.org/cac/wp-content/uploads/2021/10/2-21-050-GTHA-EV-Ready-Costing-Study-2021.10.14.pdf

Sample of recent EV projects in Canada

Among more than **70 recent EV projects**



Analysis of regional needs for **charging infrastructure** by 2040

Strategic and analytical support on **Smart-Charging** and **V2G**

EV adoption **modeling** and **strategy development**

Assessing potential for **private investment** in charging infrastructure

EV Adoption Modeling to inform **utility EV strategy**

EV Adoption Modeling to support a utility **EV business plan**

Ongoing support for **EV infrastructure programs,** including long-term **target setting**, technology roadmaps, and program evaluation

EV Adoption modeling to inform **electrification strategy** and **ZEV targets**

Municipal EV strategy development

Modeling adoption of **light, medium and heavy-duty EVs** under several investment scenarios

Modeling adoption of **light, medium and heavy-duty EVs** and developing a **beneficial electrification strategy**

Strategic and analytical support on **Smart-Charging** and **V2G.**

Dunsky's Electric Vehicle Adoption Model

- **Forecasts EV adoption** for personal and commercial vehicles and fleets, in client-defined regions
- **Supports strategy development** by projecting impact of policy, program and infrastructure options
- **Assesses sensitivity** to key global and local parameters
- **Assesses and optimizes** energy, peak demand, cost and revenue impacts

EV Ready Parking

“EV Ready” Electrical Infrastructure

EVSE Installed when drivers adopt EVs