Vehicle-to-Building/Grid Integration

Ontario Clean Air Alliance submission to the IESO

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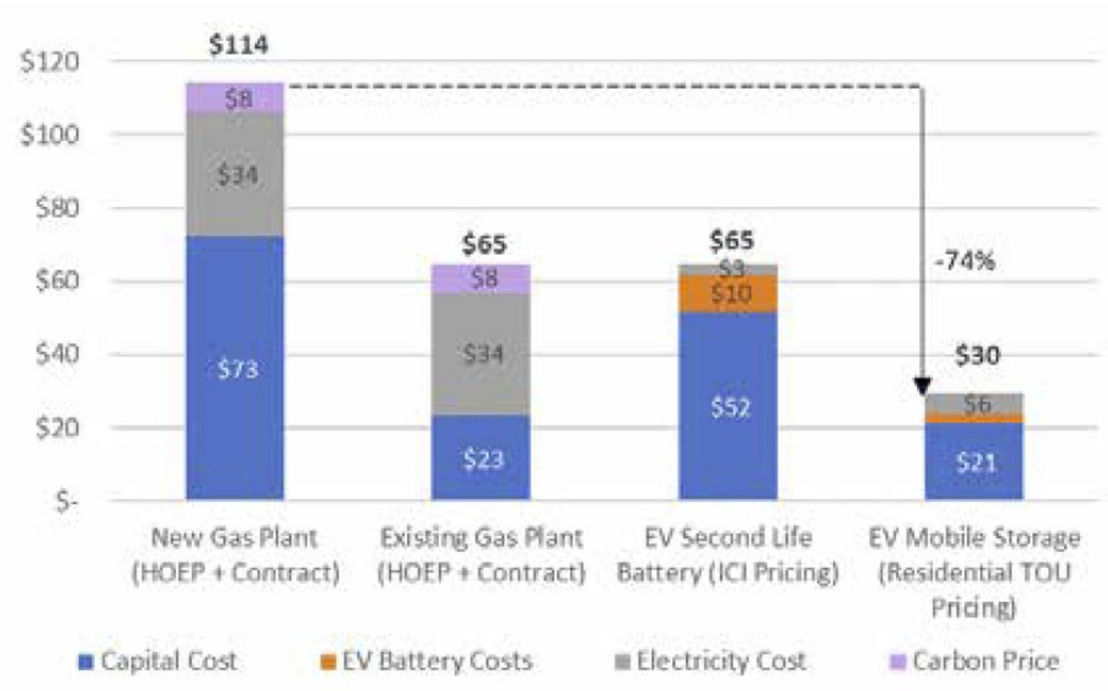
Overview

1. EV batteries with bi-directional chargers are cheaper than gas plants for peak power
2. EVs are an enormous opportunity to lower electricity rates & carbon emissions
3. By 2030, EVs will have more than twice the capacity of Ontario's gas plants
4. When all cars are electric, their gross discharge capacity (GW) will be more than 6 times Ontario's total peak demand
5. Technical barriers to bi-directional charging have largely disappeared (with more bi-directional-capable cars and chargers and million+ mile batteries)
6. This is urgent – it is cheaper to incentivize bi-directional charging now before millions of "dumb" and "one-directional" chargers are purchased

EV batteries: very cheap peak power

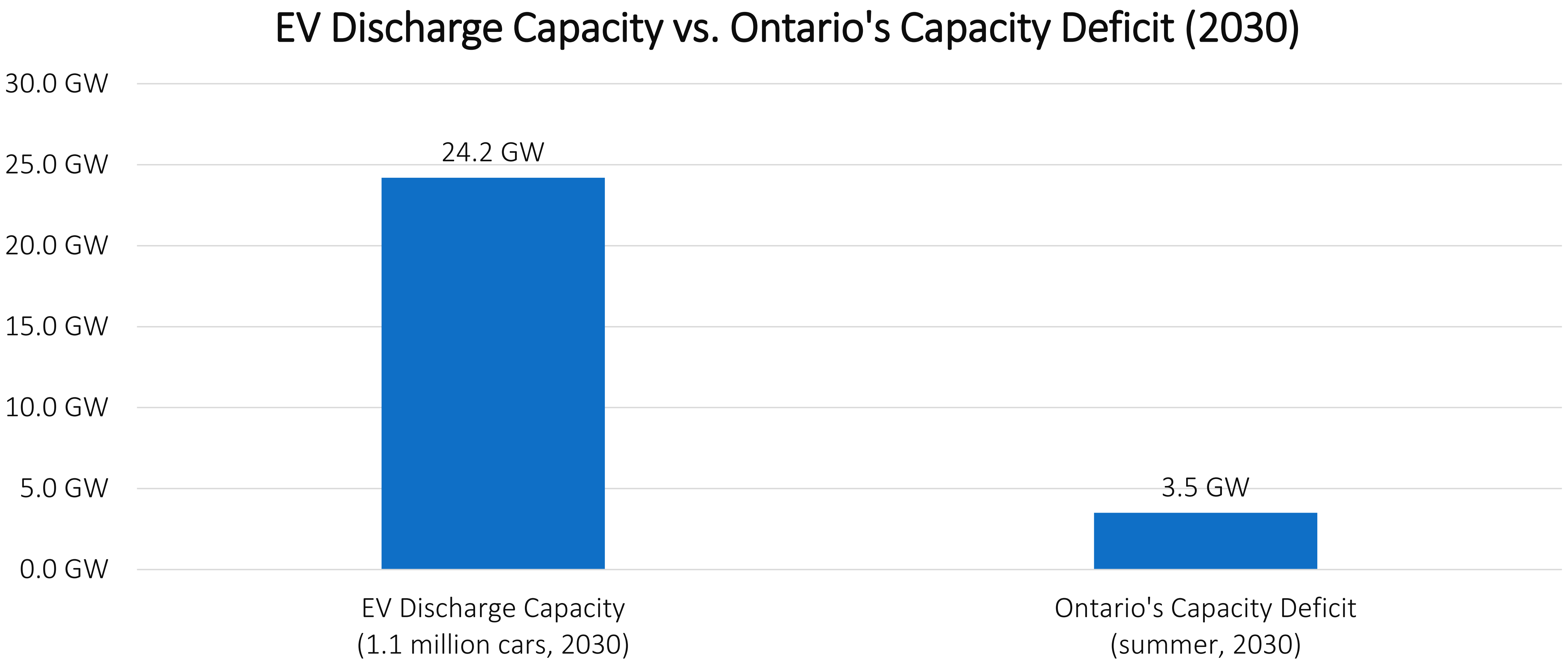
- Bi-directional chargers allow EVs to offset building loads or export to the grid
- This can provide very cheap peak power
- It is much cheaper than gas plants (see right)

Figure 18: Cost Comparison of EV Storage Options with Natural Gas
($/MWh)



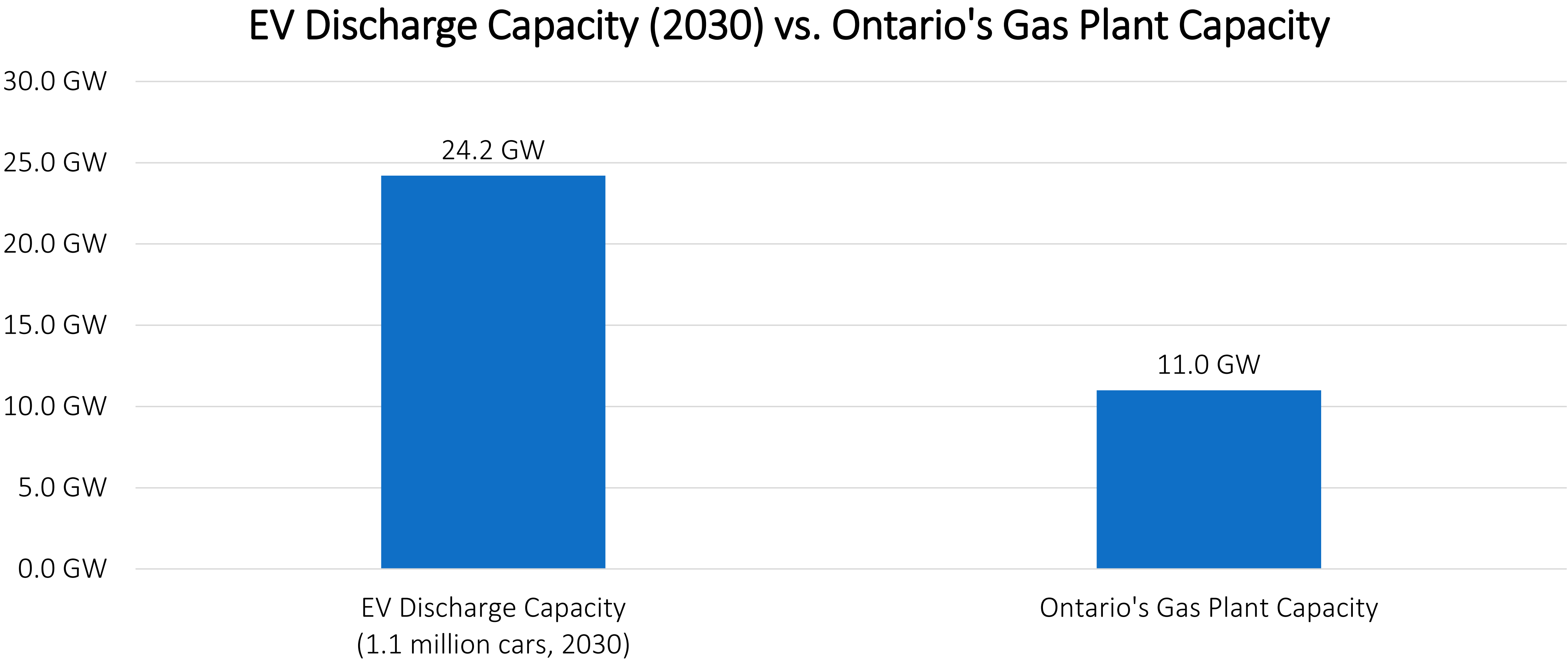
Strategic Policy Economics, *EV Batteries Value Proposition for Ontario's Electricity Grid and EV Owners A Preliminary Cost and Benefit Assessment*, July 2020 (link).

Enormous opportunity



This is an order of magnitude illustration of technical potential, not an achievable potential forecast. See slide 7 for sources and calculations.

Enormous opportunity



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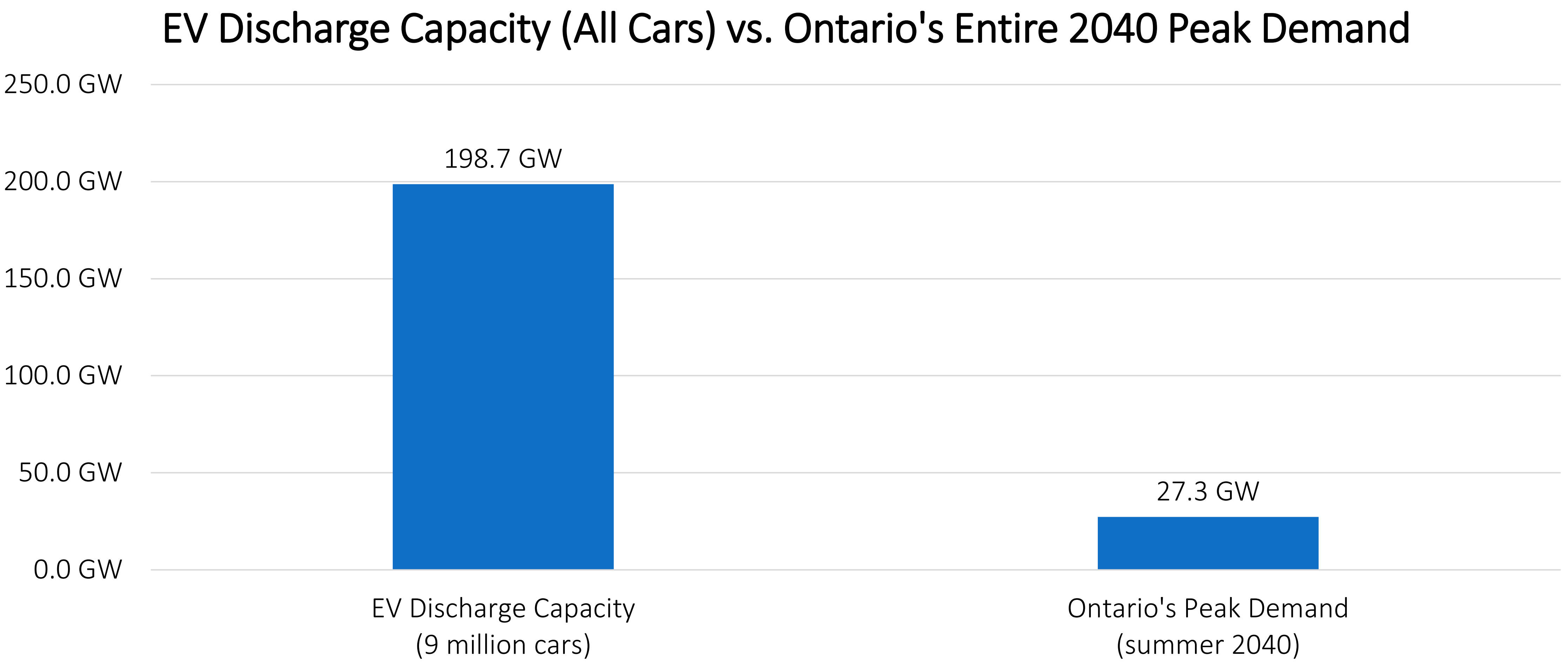
Enormous opportunity



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Enormous opportunity

Discharge Capacity of EV Batteries (GW)		
	All Cars (2019)	EVs by 2030
Number of Cars	9,031,832[1]	1,100,000[2]
GW Capacity (@ 22 kW) [3]	198.7 GW	24.2 GW

[1] Statistics Canada (link).
[2] Strategic Policy Economics, *EV Batteries Value Proposition for Ontario's Electricity Grid and EV Owners A Preliminary Cost and Benefit Assessment*, July 2020 (link).
[3] Calculation: cars * 22 kW (see slide 6 re example discharge rates). The average discharge rate could be higher or lower than the 22 kW used. In-home discharging will typically be less than 22 kW whereas commercial discharging can be much higher – see slide 6.

Ontario Capacity Needs[1]		
Capacity Deficit (2030)	Peak Demand (2030)	Peak Demand (2040)
3.5 GW	25.5 GW	27.3 GW

[1] IESO, 2020 Annual Planning Outlook (link)

Factors impacting available capacity

- Cars are parked 95% of the time on average
  [Donald Shoup, *The High Cost of Free Parking* (link); Professor Paul Barter, *"Cars are parked 95% of the time"*, (link)]

- The large majority of cars are parked even at rush hour
  [Avg. car commute is 26.3 minutes in Ontario (per Statistics Canada); Most cars are not used for commuting (per Statistics Canada)]

- The number of EVs is increasing

- The number & discharge capacity (kW) of bidirectional EV chargers is increasing
  - Some examples: The new Ford F150 will have a ~10 kW discharge capacity; there are some intermediate DC options with 22 kW including one from Volkswagen and some others; commercial grade chargers can reach higher rates, such as 30 kW, 51 kW, 60kW and 125 kW.

- BUT: Appropriate price signals and procurement is needed

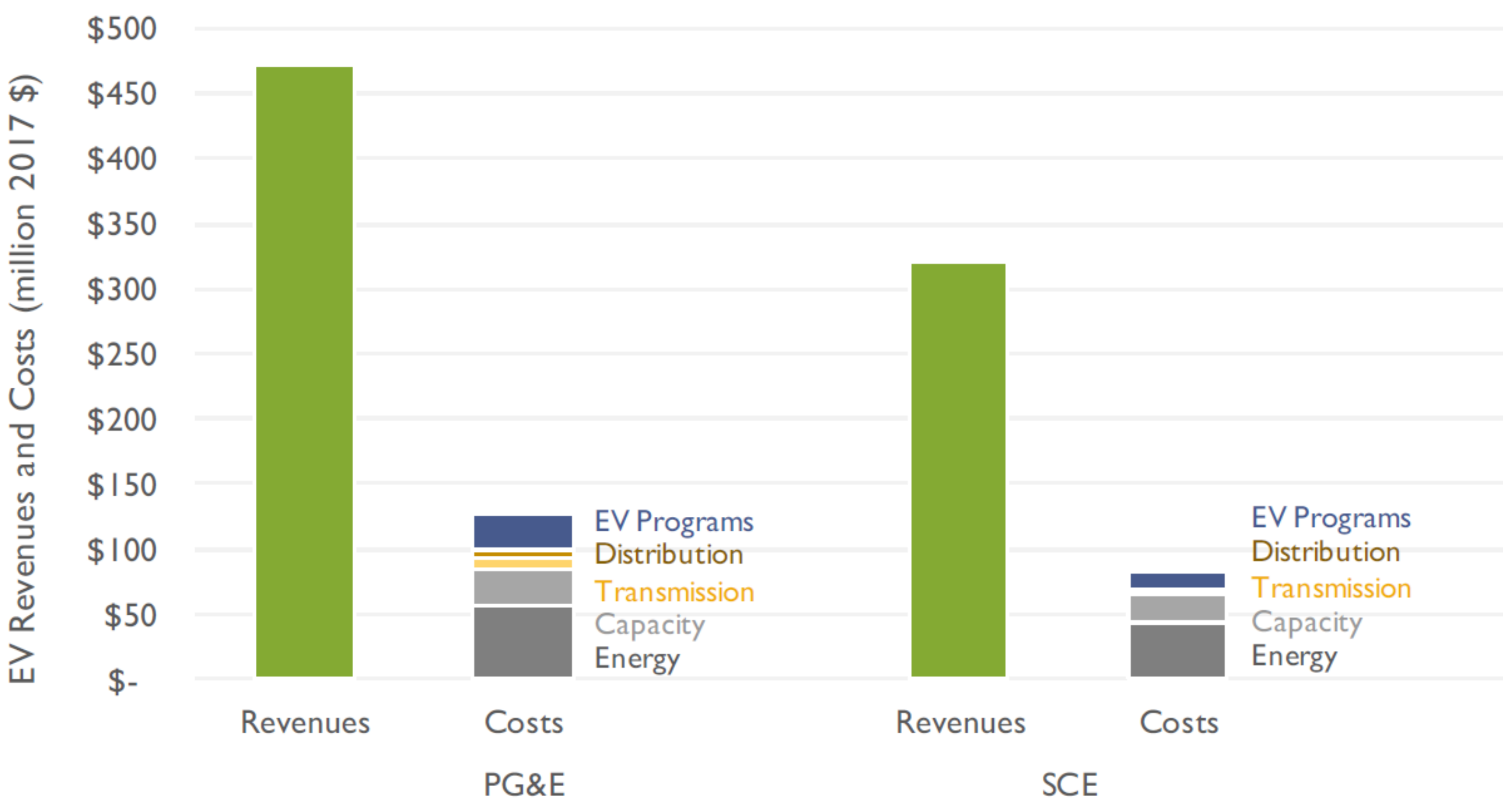
Types and terms

- **One-way smart charging** (V1X), which shifts EV load to off-peak times
- **Bi-directional charging** (V2X), which offsets other loads
  - **Vehicle-to-building** (V2B): Discharging battery to offset other building loads at the peak (often includes vehicle-to-home, which is the residential version of vehicle-to-building)
  - **Vehicle-to-grid** (V2G): Discharging battery to export into the grid to offset other grid loads

Smart charging (V1X) & EV/TOU rates

- Major system benefits opportunity
- EV's saved distribution customers **$584 million** in California (Synapse Energy Study)
- Results transferable to Ontario (Plug'n Drive study)
- Off-peak loads lower electricity costs ($/kW and $/kWh)

Figure 4. PG&E and SCE Revenues and Costs of EV Charging, 2012-2018



Barriers to V2G/B disappearing

- More EVs available with bi-directional capabilities
  [Including Volkswagen Group EVs starting in 2022 (incl. VW, Audi, etc.), Tesla vehicles (date TBD), the Ford F150 Lightning, and the 2022 Hyundai Ioniq 5. Previously only the Nissan Leaf and Mitsubishi Outlander had official bidirectional capabilities in Canada (for other vehicles there was a risk of voiding the warranty).]
- More chargers available with bi-directional capabilities [See slide 8 for a few examples.]
- "Million mile+" batteries will reduce concerns about reduced battery life
  [Bloomberg, *A Million-Mile Battery From China Could Power Your Electric Car*, June 7, 2020 (link); RMI, *A Million-Mile Battery: For More Than Just Electric Vehicles*, June 24, 2020 (link).]
- V2B is becoming a selling point: Ford is advertising that its new F150 can power your home for up to 10 days
- EVs are expanding faster: The federal government is mandating that 100% of new cars be EVs by 2035

The technology is available now

- UK Power Networks has contracted for 248 MW of capacity from using EV batteries, mainly through Octopus Energy

UK Power Networks
Delivering your electricity

Some programs / pilots

- Nova Scotia Power:
  - $2.2 million; 200 smart chargers; 20 bi-directional chargers of 4 different types
  - Bi-directional Coritech (30kW); Quebec-based Ossiaco, residential units planned
  - David Landrigan, vice-president of commercial for Nova Scotia Power: **“I think we can call it a game-changing resource”**
- Utilities in the United States are piloting vehicle-to-grid, including:
  - San Diego Gas & Electric in California (10 V2G busses, 25 kW/bus, 250 kW)
  - Con Edison in New York (5 V2G busses, 10 kW/bus, 50 kW)
  - EDF Energy in the UK (Customer-facing V2G program based on ABB equipment)
  - National Grid in Rhode Island (Fermata V2G bidirectional pilot, 15-20 kW)
  - Roanoke Electric Cooperative in N. Carolina (Fermata V2G system, 15-20 kW)
  - Green Mountain Power in Vermont (Fermata V2G bidirectional pilot, 15-20 kW)
  - Austin Energy in Texas (V2G/V2B pilot)
  - Snohomish County Public Utility District in Washington State (V2G pilot)
- Building owners are installing and piloting vehicle-to-building systems
- Many, many more – see the list at the V2G hub

Capacity, NWAs and EV mitigation

- Important as:
  A. Cheap peak demand reduction / capacity that is zero-carbon
  B. A non-wires-alternative (NWA) to traditional capital infrastructure
  C. A tool to manage the impacts of EV expansion on the reserve requirement and on the transmission and distribution grids

Urgent priority

- It is cheaper to incentivize bi-directional charging sooner, before millions of "dumb" and "one-directional" chargers are purchased
- About 1 million customers will start charging EVs at home between now and 2030; many commercial EV chargers will be purchased over that time
- The opportunity to upgrade to bi-directional chargers is greatest before the initial purchase (i.e. the *incremental* cost is lowest)
- The lead time for a vehicle-to-building/grid program is likely long (needs OEB policy changes, LDC program development, program approval by OEB, etc.)

Residential Program Example

- Key design elements:
  - Consumers offered a $X discount on a bi-directional charger
  - Participants must opt-into an EV rate structure
    - The strong TOU price signal increases the incentive to charge off-peak and to discharge to offset household demand on-peak
    - Alternatively (or in addition), the device could communicate with IESO servers to respond to more dynamic and targeted price signals
  - Equipment is pre-set with optimal settings (e.g. discharge threshold levels, timing for charging/discharging, etc.)
  - Consumer has full control over equipment settings and when to charge/discharge
  - Charger is vehicle-to-building (i.e. not exporting to the grid)

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Residential Program Example cont.

- Consumer take-up driven by:
  - Desire for back-up power
  - Desire for high-speed charger (at a discount)
  - Reduced household electricity charges from load shifting and load offsetting
  - Upfront incentive payment (i.e. discount on bidirectional charger)
  - Marketing and technical advice
  - Ability to retain full control over vehicle charging/discharging times
- Utility considerations:
  - Very low cost
  - No need for expensive or complicated communication equipment, grid connection, active control, or ongoing contractual arrangements/payments
  - Demand reductions must be modelled similar to CDM impacts because the resource is not dispatchable (e.g down-rating)

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Commercial Program Examples

- School busses
  - School bus companies paid to install V2G bi-directional chargers
  - Busses have big batteries
  - Commercial DC chargers are very fast (e.g. 125 kW – see right)
  - School buses usually plugged in at peak times
  - Can help pay for fleet electrification
  - 20,000+ school buses in Ontario
- Office buildings:
  - Office buildings incentivized to install bi-directional chargers (V2G or V2B)
  - E.g. see [this July 2020 Plug'n Drive Study]

On-Street / City Parking Example

- Incentivize municipalities to use grid-connected bi-directional chargers when electrifying on-street parking and city lots
  - Low incremental cost because a new grid connection is likely required regardless
  - Grid connection and protection simplified b/c the connection is not shared with other loads
  - Can leverage existing connections between LDCs and municipalities
  - Can be piloted and then implemented at scale
  - Can help to support electrification of on-street parking and city lots