Electric Vehicles (EVs) How Green are They?

A presentation
for the
Danforth Jewish Circle Climate Action Team

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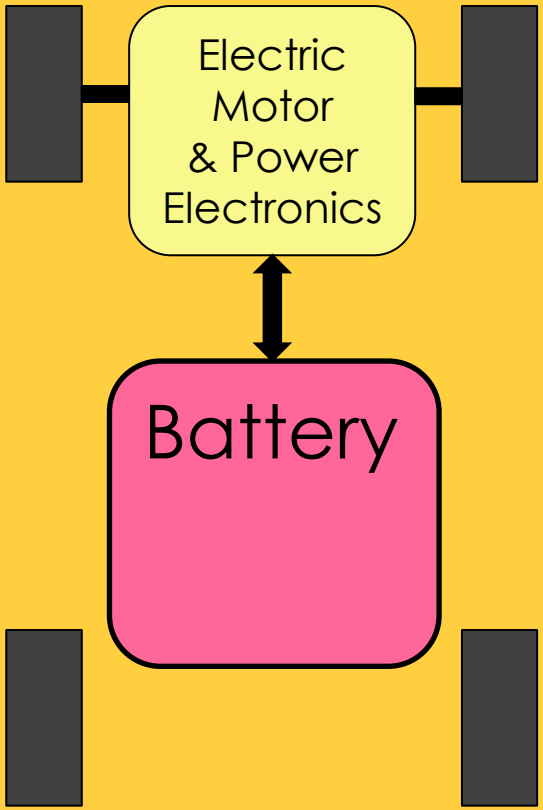
Carbontakedown.com

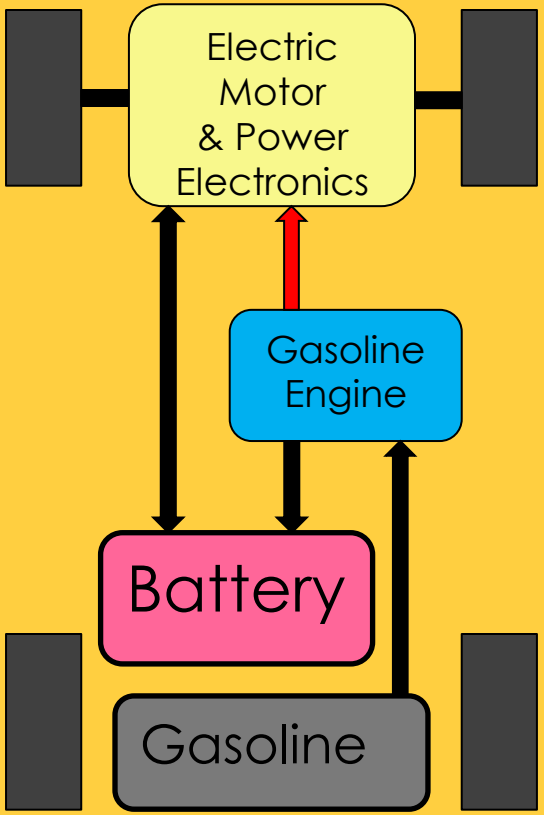

50 km

40 Minutes

- You and EVs
  - Greenhouse Gas Emissions and EVs
  - Available Vehicles
  - Range
  - Charging
  - Economics
- EVs and the World
  - The Electricity Grid
  - Manufacturing Impacts
- Your Questions



EV



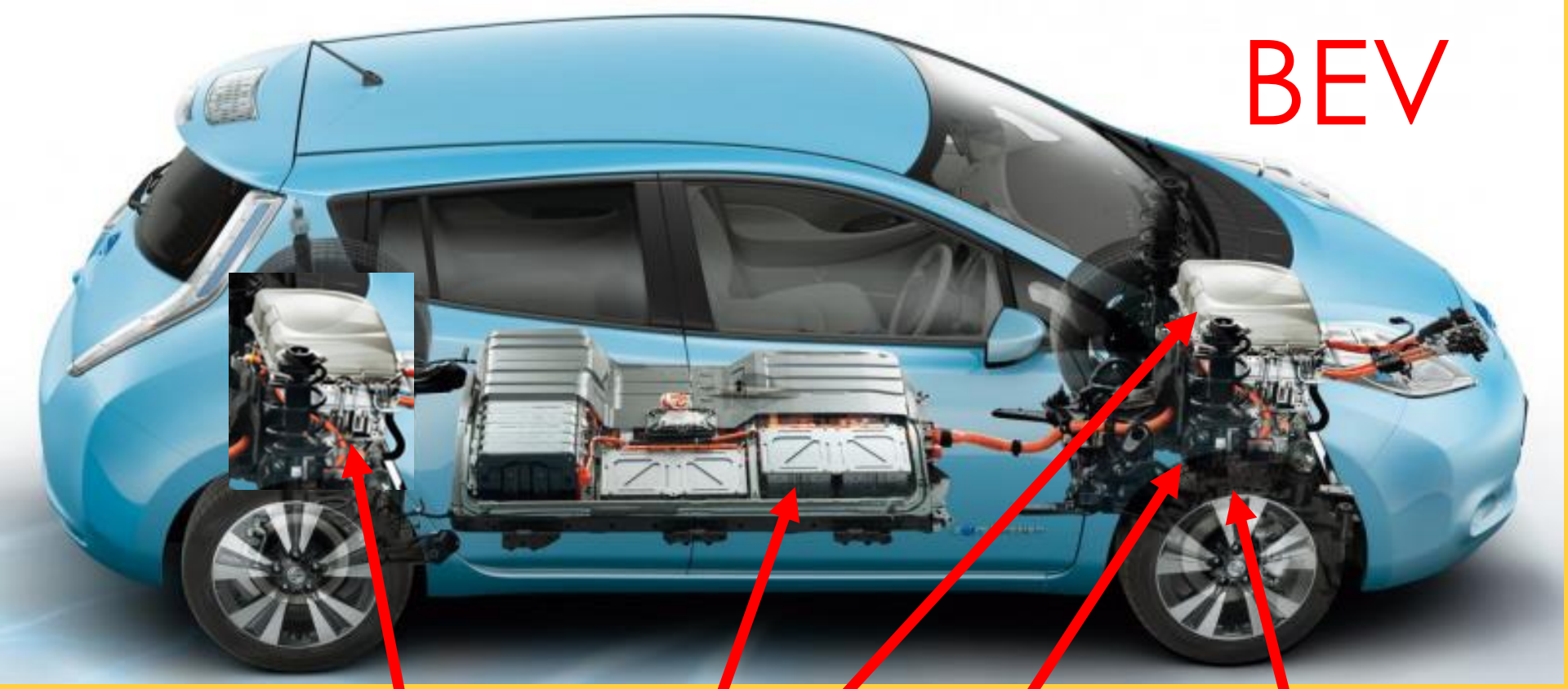
BEV

Battery Electric Vehicle

PHEV

Plug-In Hybrid Electric Vehicle

BEV



Battery

Inverter

Electric Motor

Reducing gears and differential

4 Wheel Drive – add a motor

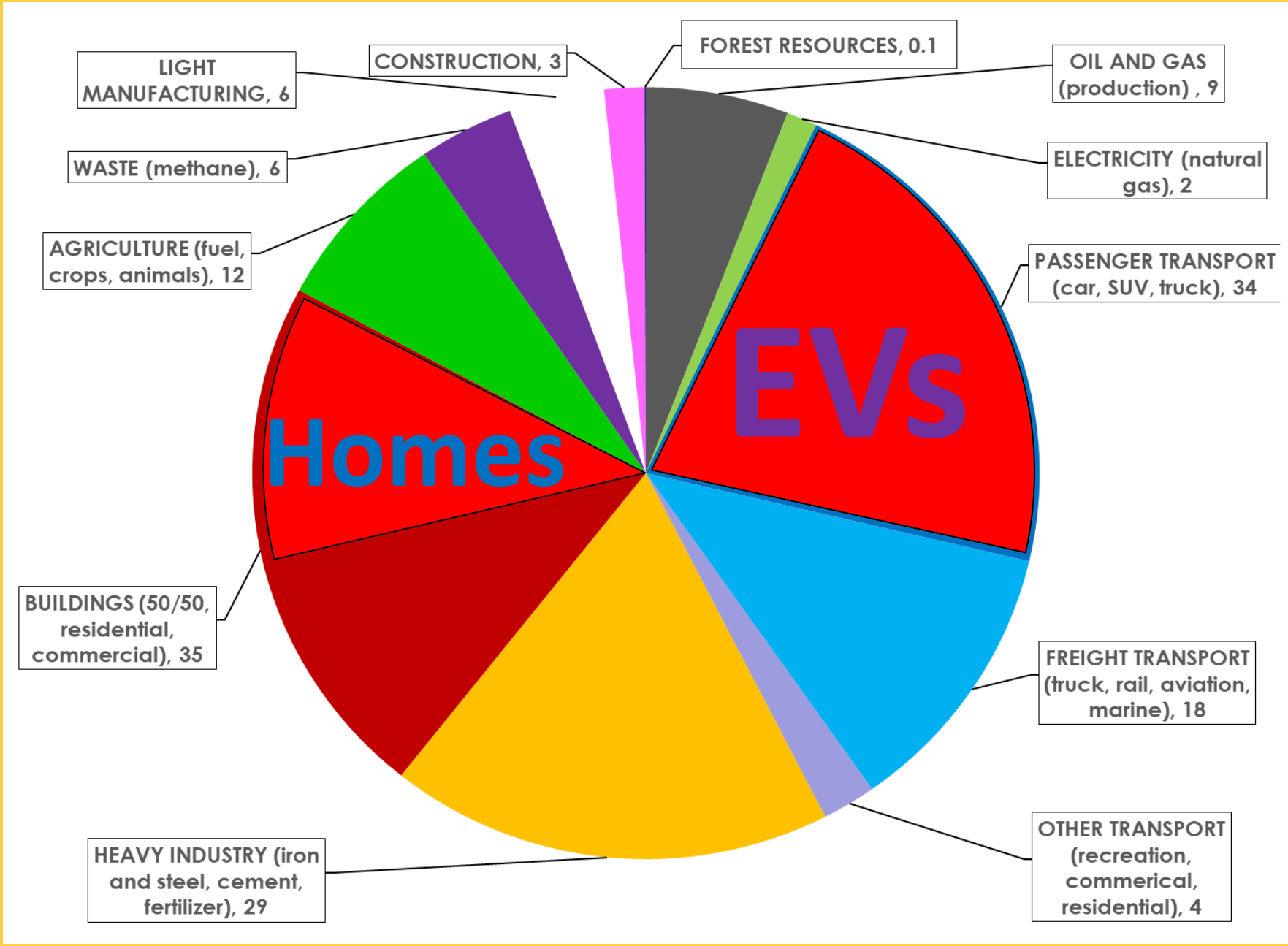
Gasoline Vehicles

- upstream emissions
- mining, extraction
- CO_2
- CO
- nitrogen oxides
- ozone
- hydrocarbons (unburned fuels)
- brake dust

EVs

- no tailpipe emissions
- what electricity source?
- less brake dust

+



Ontario 2017 159 Mt GHG/year

From 2017 NIR

Ontario's generation mix of hydro, nuclear, wind, solar and natural gas allows an EV in Ontario to have a very, very low GHG impact

0.013 to 0.044 kg GHG/kWh*

*Toronto Atmospheric Fund 2019

Gasoline Vehicle*: 2-6 t GHG/year

House: N.G.: 4-10 t GHG/year

Flying: YYZ/Paris: 2 t GHG/person

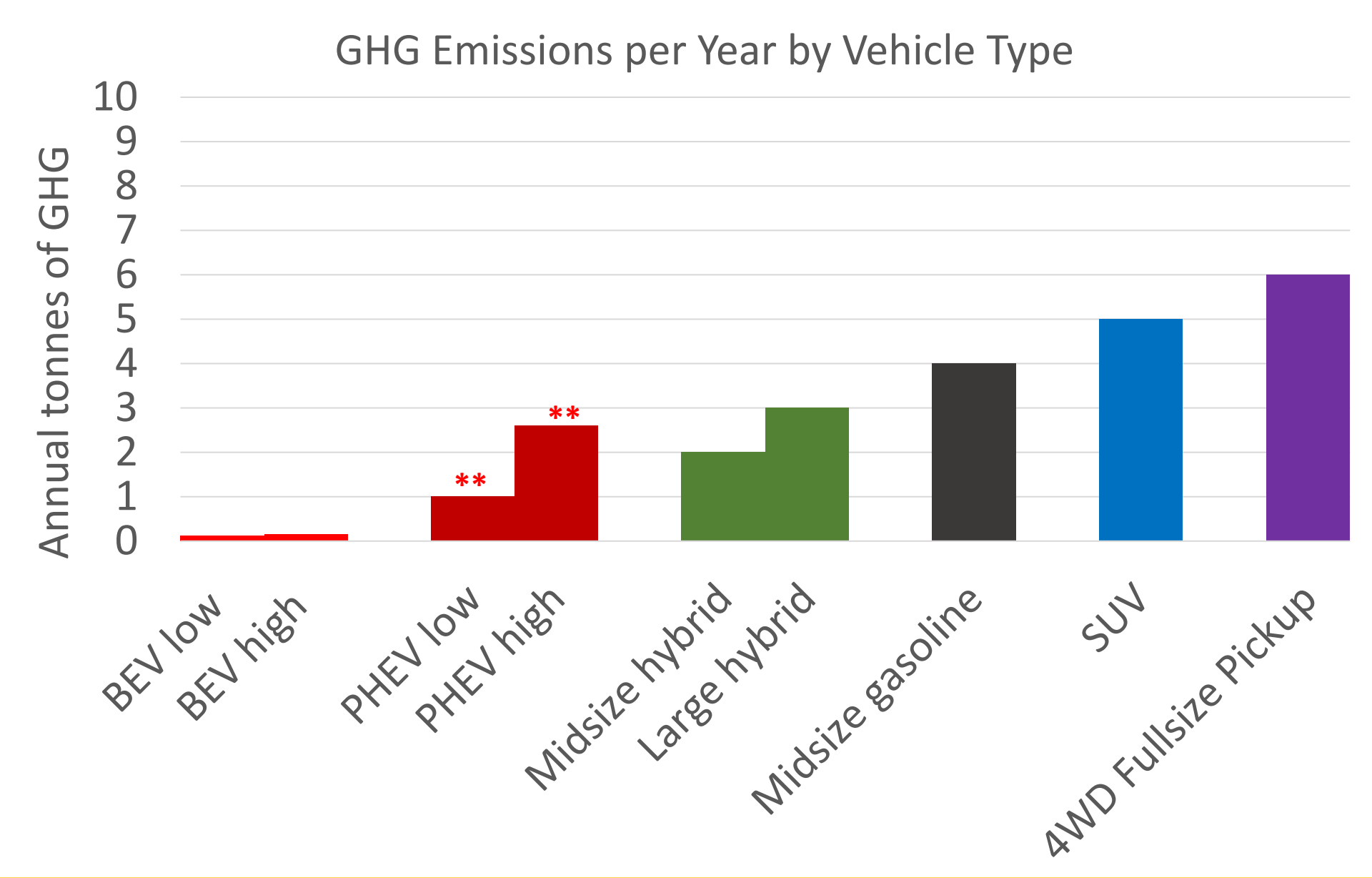
Total 8-18 t GHG/year

(Ontario 11.3 t GHG/person/year)**

EV: 0.07 t GHG/year

**Ontario data 2017

*20,000 km/year



20,000 km per year

* 0.04 kg CO_2e Ontario grid emissions

** depends on ratio of EV to gas operation

EV History


1970's
weird EVs


April 2014 – 3 models
320,000 Sold

Forces Driving the EV Market

- Enabling technologies of high performance batteries and electronics
- Public and political forces with worldwide goal of zero GHG by 2050
- Regulations in many countries to reduce GHG from:
  - transportation
  - electricity generation
  - industrial processes

Common reasons to not buy an EV

- Cost
- Concerns surrounding range and charging
- You want 4WD/crossover – 2022!
- Concerns around batteries
- Inaccuracies about the energy required to make an EV

9 Models
2018

2,100,000 Sold

















2021 BEV
40+ models

6,000,000 Projected

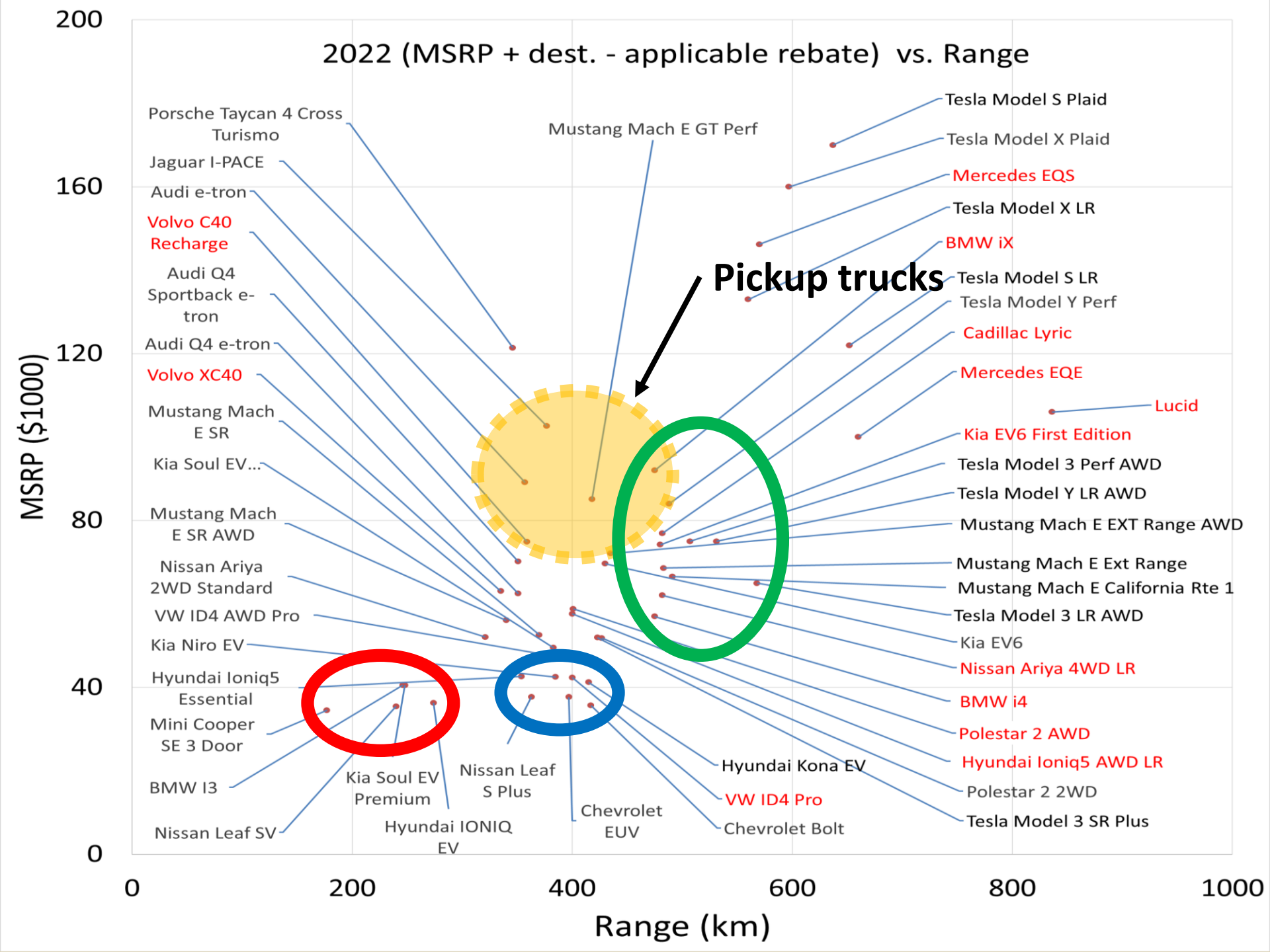
70,000 Plug In Vehicles in Ontario

(IEA estimates 250 M Worldwide by 2030)

Range and Price

2022 BEV (100% Electric) 49 +/- Models

100% Battery Electric Vehicles	Range (km)	Price in $1000's inc. del.	MSRP (plugndrive) 1000s includes del.
Lucid	836	106.0	$106,000
Mercedes EQE	660	100.0	$100,000
Tesla Model S LR	652	122.0	$121,990
Tesla Model S Plaid	637	170.0	$169,990
Tesla Model X Plaid	597	160.0	$159,990
Mercedes EQS	570	146.2	$146,200
Tesla Model 3 LR AWD	568	65.0	$64,990
Tesla Model X LR	560	133.0	$132,990
Tesla Model Y LR AWD	531	75.0	$74,990
Tesla Model 3 Perf AWD	507	75.0	$74,990
Mustang Mach E California Rte 1	491	66.6	$66,590
Tesla Model Y Perf	488	84.0	$83,990
Mustang Mach E Ext Range	483	68.6	$68,590
Nissan Ariya 4WD LR	482	62.1	$62,050
Cadillac Lyric	482	77.0	$76,950
Kia EV6 First Edition	480	74.2	$74,200
BMW i4	475	57.0	$56,990
BMW iX	475	92.0	$91,990
Mustang Mach E EXT Range AWD	435	72.1	$72,090
Kia EV6	430	69.7	$69,654
Polestar 2 2WD	427	51.8	$51,800
Tesla Model 3 SR Plus	423	52.0	$56,380
Mustang Mach E GT Perf	418	85.1	$85,090
Chevrolet Bolt	417	35.7	$40,098
Hyundai Kona EV	415	41.2	$45,651
Polestar 2 AWD	401	58.8	$58,800
Hyundai Ioniq5 AWD LR	400	57.6	$62,049
VW ID4 Pro	400	42.4	$46,780
Chevrolet EUV	397	37.7	$42,098
VW ID4 AWD Pro	386	47.4	$51,780
Kia Niro EV	385	42.5	$46,929
Kia Soul EV Limited	383	49.5	$53,929
Jaguar I-PACE (CO)	377	102.6	$102,626
Mustang Mach E SR	370	52.6	$52,590
Nissan Leaf S Plus	363	37.7	$42,174
Volvo C40 Recharge	359	74.9	$74,900
Audi e-tron	357	89.2	$89,150
Hyundai Ioniq5 Essential	354	42.6	$47,049
Audi Q4 e-tron	351	62.5	$62,500
Audi Q4 Sportback e-tron	351	70.2	$70,150
Porsche Taycan 4 Cross Turismo	346	121.4	$121,400
Mustang Mach E SR AWD	340	56.1	$56,090
Volvo XC40	335	63.1	$63,070
Porsche Taycan S Cross Turismo	325	219.5	$219,500
Nissan Ariya 2WD Standard	321	52.1	$52,050
Hyundai IONIQ EV	274	36.3	$40,726
Kia Soul EV Premium	248	40.5	$44,929
BMW I3	246	40.5	$44,950
Nissan Leaf SV	240	35.4	$39,874
Mini Cooper SE 3 Door	177	34.5	$38,956


2022 (MSRP + dest. - applicable rebate) vs. Range
MSRP ($1000)
Range (km)
0
40
80
120
160
200
0
200
400
600
800
1000
Pickup trucks
Porsche Taycan 4 Cross Turismo
Jaguar I-PACE
Audi e-tron
Volvo C40 Recharge
Audi Q4 Sportback e-tron
Audi Q4 e-tron
Volvo XC40
Mustang Mach E SR
Kia Soul EV...
Mustang Mach E SR AWD
Nissan Ariya 2WD Standard
VW ID4 AWD Pro
Kia Niro EV
Hyundai Ioniq5 Essential
Mini Cooper SE 3 Door
BMW I3
Nissan Leaf SV
Kia Soul EV Premium
Hyundai IONIQ EV
Nissan Leaf S Plus
Chevrolet EUV
Mustang Mach E GT Perf
Hyundai Kona EV
VW ID4 Pro
Chevrolet Bolt
Tesla Model S Plaid
Tesla Model X Plaid
Mercedes EQS
Tesla Model X LR
BMW iX
Tesla Model S LR
Tesla Model Y Perf
Cadillac Lyric
Mercedes EQE
Lucid
Kia EV6 First Edition
Tesla Model 3 Perf AWD
Tesla Model Y LR AWD
Mustang Mach E EXT Range AWD
Mustang Mach E Ext Range
Mustang Mach E California Rte 1
Tesla Model 3 LR AWD
Kia EV6
Nissan Ariya 4WD LR
BMW i4
Polestar 2 AWD
Hyundai Ioniq5 AWD LR
Polestar 2 2WD
Tesla Model 3 SR Plus

2022 PHEV

40 +/- Models

Plug In Hybrids (PHEV) 2021/2022	100% EV Range (NRCAN)
BMW i3 Rex	203
Polestar 1	84
Honda Clarity PHEV	77
Toyota Rav4 Prime	68
Lexus NX 450h+ PHEV	61
Ford Escape PHEV	60
Fiat Chrysler Pacifica PHEV	51
BMW X5 xDrive45e	50
Hyundi Santa Fe PHEV	50
Hyundai IONIQ PHEV	47
Lincoln Corsair Grand Touring	45
Kia Optima PHEV	45
Kia Niro PHEV	42
Audi A7 Sportback 55 TFSI e	42
Toyota Prius Prime	40
Mitsibushi Outlander PHEV	39
Audi Q5 55 TFSIe	37
BMW 330e	37
Volvo S60 T8 AWD Recharge	35
Jeep Wrangler 4xe	35

Plug In Hybrids (PHEV) 2021/2022	100% EV Range (NRCAN)
Lincoln Aviator Grand Touring	34
Volvo S90 T8 AWD Recharge	34
BMW 530e	34
Land Rover RR PHEV	31
Volvo SV60 T8 AWD Recharge	31
Volvo XC60 T8 AWD	31
BMW 530e xDrive	31
Porsche Panamera 4E-Hybrid	31
Bently Bentaga	29
Audi A8 L 60 TFSie	29
BMW X3 xDrive 30e	29
Mini Cooper SE Countryman All4	29
Volvo XC 90 T8 AWD Recharge	29
BMW X3 xDrive30e	29
Subaru Crosstrek Hybrid AWD	27
Subaru Crosstek PHEV	27
BMW 745Le xDrive	27
Porsche Cayenne E-Hybrid	27
Porsche Panemara Turbo SE-Hybrid	27
Porsche Cayenne Turbo SE-Hybrid	24
Mercedes GLC350e	21

Range Change

- On mild spring and fall days range may be better than NRCAN on non-highway trips, “400” km may be 450 km
- kWh consumption increases with speed^2
- BEV worst day (-25°C, snow) range at 110 kph could be 40 - 50% reduced.
- PHEV range ½ in winter, engine for heat
- A few percent a year range decrease due to battery aging
- Older model EVs, good value, less range

Charging

LEVEL 3
(Petro Canada)


ivy
Charging
Network

Level 3 High Power “CCS”

Level 1 and 2 at home or away “J1772”

Other Connectors

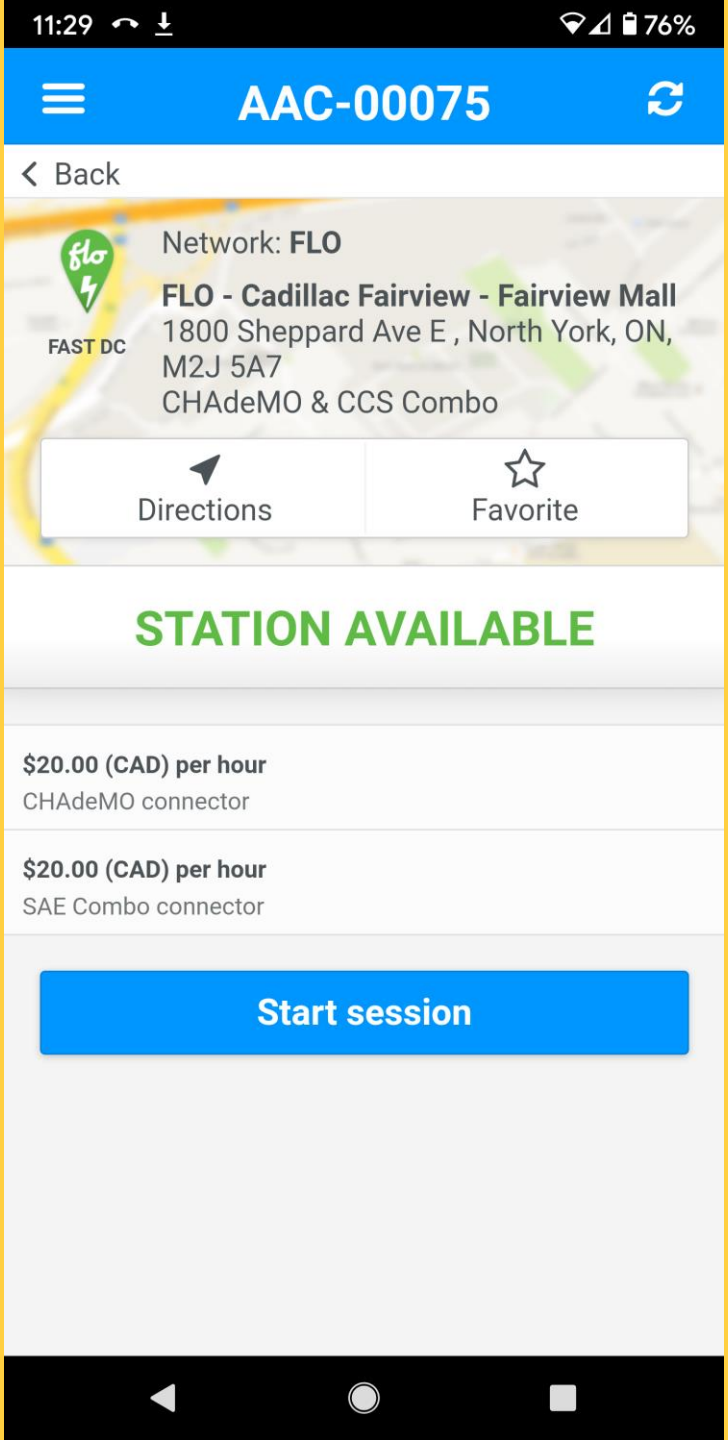
Tesla

CHAdeMO
Level 3
Leaf, Soul

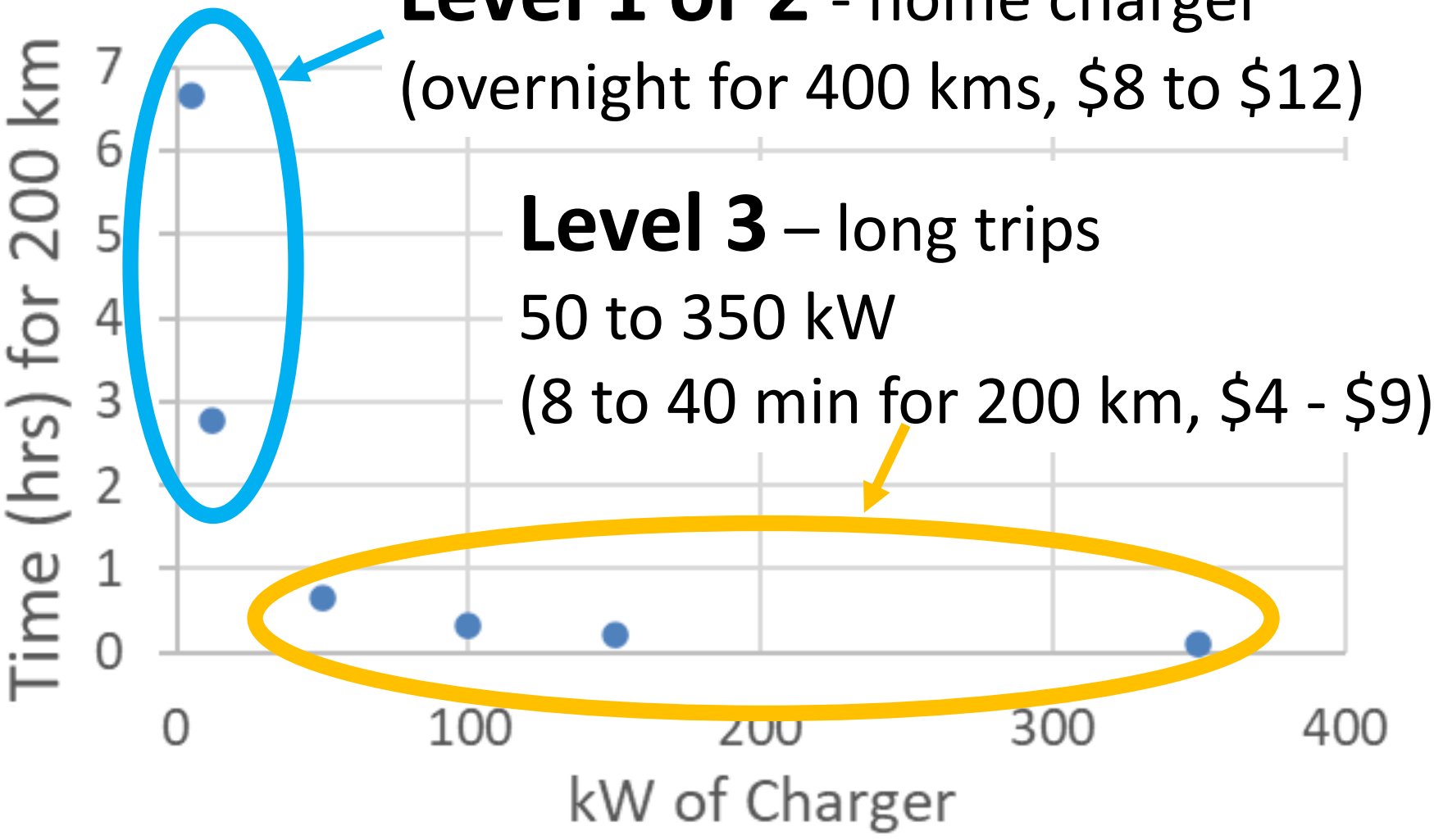
SAE J1772
Level 2

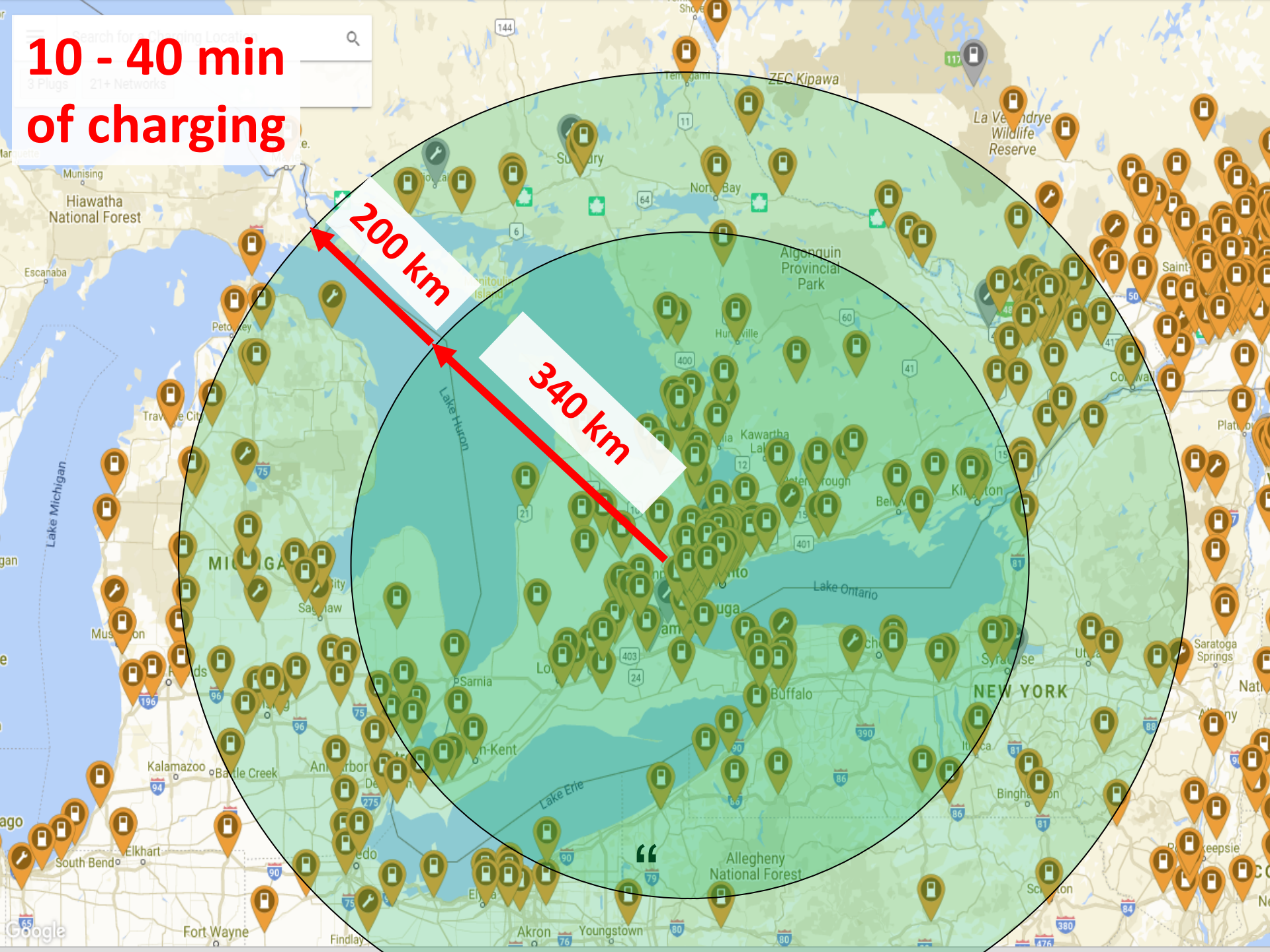
Charging

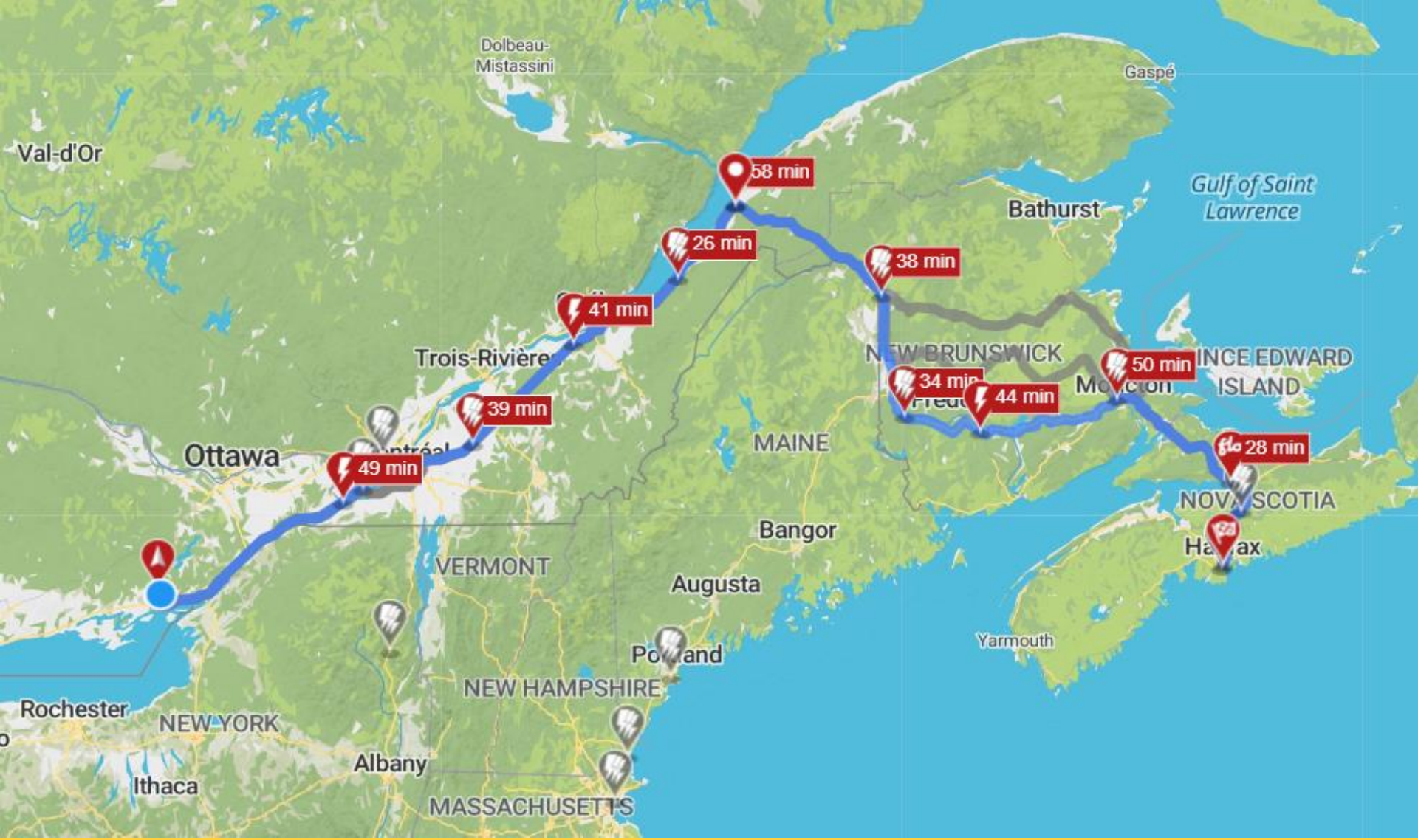
- The vast majority of charging will be done at night at your residence, inside or outside (condos?)
- On trips of more than 300 - 400 km you'll use Level 3 for fee chargers
- On the longer trips you will need some apps to access all chargers (over 15 companies), but some take credit card taps
- PHEVs only have Level 2 charging


11:29
76%
AAC-00075
Back
Network: FLO
FAST DC
FLO - Cadillac Fairview - Fairview Mall
1800 Sheppard Ave E , North York, ON, M2J 5A7
CHAdeMO & CCS Combo
Directions
Favorite
STATION AVAILABLE
$20.00 (CAD) per hour
CHAdeMO connector
$20.00 (CAD) per hour
SAE Combo connector
Start session

Charging time/km/$




10 - 40 min
of charging
200 km
340 km
Lake Huron
Lake Michigan
Lake Ontario
Lake Erie
Algonquin
Provincial
Park
Hiawatha
National Forest
Allegheny
National Forest
NEW YORK
Buffalo
Sarnia
Kalamazoo
Battle Creek
Fort Wayne
Akron
Youngstown
Elkhart
South Bend
Munising
Escanaba
Saratoga
Springs
ZEC Kipawa
Google

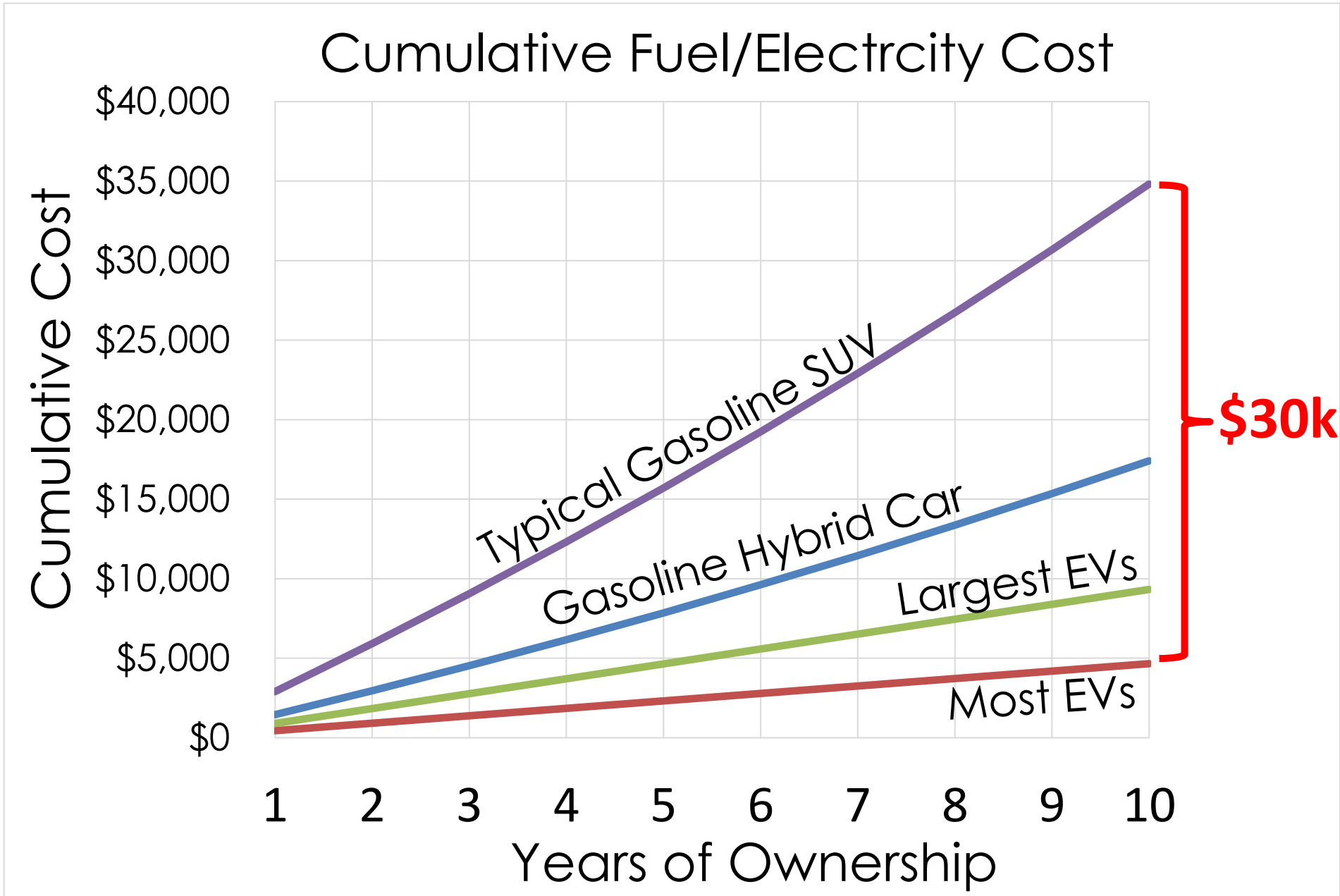


Trip Planning Software
(“A Better Routeplanner”)

Costs

=

3,000 to 4,000 kWh/year



($1.45/litre, $0.15/kWh, 20,000 km/year, 4% infl.)

5 Year Net Vehicle Cost

	Kona Gas	Prius	Kona EV	Chevy Bolt EV
MSRP+Dest.	$ 26,154	$ 31,071	$ 45,651	$ 40,098
Tax	$ 3,400	$ 4,039	$ 5,935	$ 5,213
Federal rebate	$ -	$ -	$ 5,000	$ 5,000
Energy (Gasoline or Electricity)				
1st Year	$ 2,212	$ 1,260	$ 513	$ 513
2nd "	$ 2,300	$ 1,310	$ 533	$ 533
3rd "	$ 2,392	$ 1,363	$ 555	$ 555
4th "	$ 2,488	$ 1,417	$ 577	$ 577
5th "	$ 2,588	$ 1,474	$ 600	$ 600
5 year insurance	$ 4,000	$ 4,000	$ 5,000	$ 5,000
5 year maintenance	$ 5,000	$ 5,000	$ 2,500	$ 2,500
Trade in Value	$ 13,299	$ 15,800	$ 21,374	$ 16,251
Net Expense	$37,236	$35,135	$36,402	$30,140
5 Year GHG tonnes Emitted	18.2	10.4	0.68	0.68

Plus $1000 to $1500 one time $ for a charger at home

EV Incentives in Ontario

New BEV

- Federal BEV $5000
- Federal PHEV $2500

(ZEV federal rebate on cars with an MSRP of below $45k, $55k optioned maximum)

Used BEV (PlugnDrive, Brigham Found.)

$1000 rebate on used EV

$1000 for scrap gas car

$2000 Total

The Bigger Picture

Impact of EVs on the Ontario Electricity Grid

1,000,000 EVs each going 20,000 km/year would create a

2.5%

increase in Ontario's total 137 TWh of electricity generation

The vast majority of charging can be programmed to be in off peak nighttime periods

Batteries
Manufacturing
Recycling

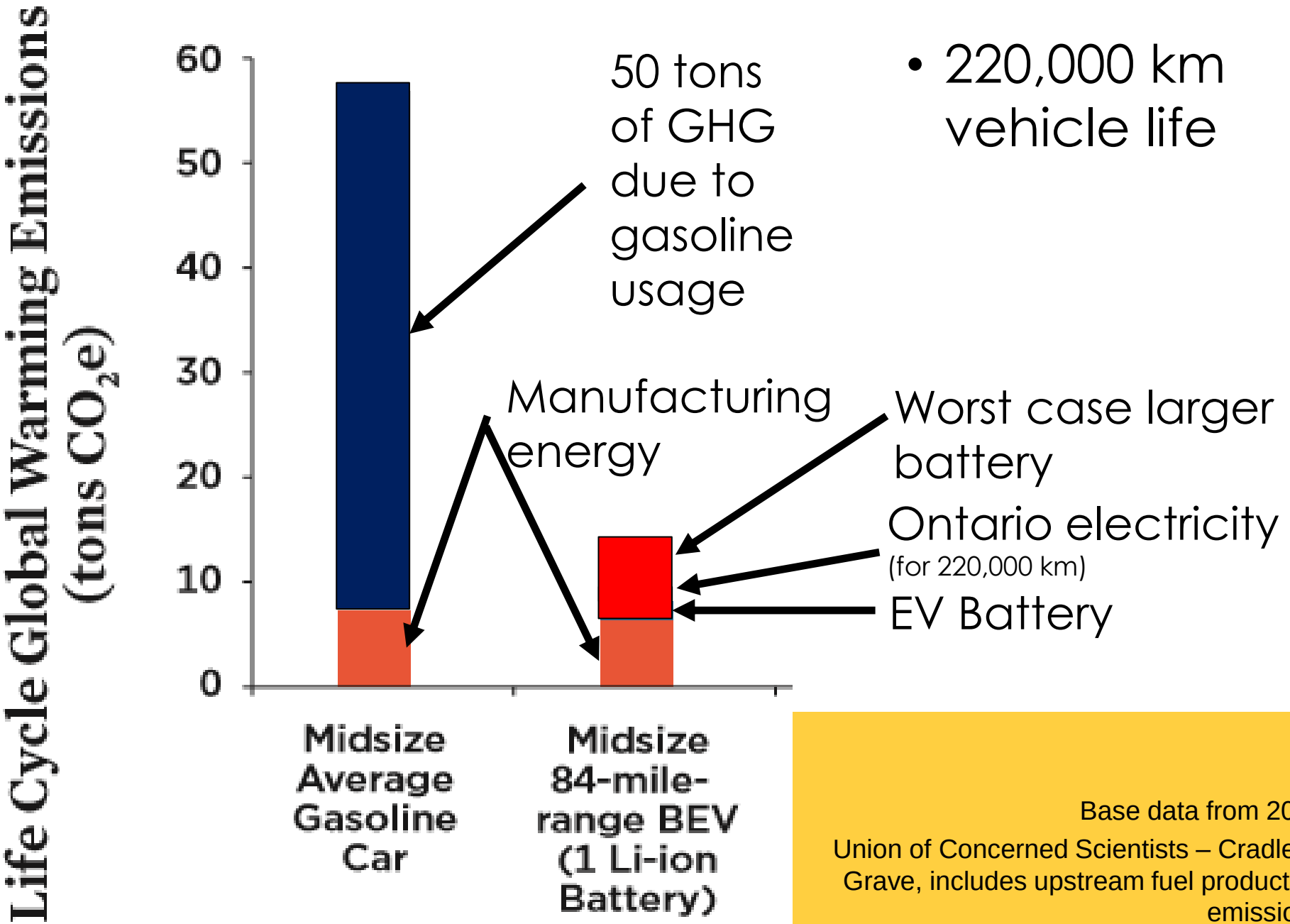
Battery Materials

- 10 kg Lithium per EV = 5.3 billion batteries (1.3 B pass. vehicles world)*
- Other battery chemistries are in use, some require no conflict (Cobalt) minerals

Human Rights / Environmental Impact

- Fossil fuel extraction/use has climate change plus large scale human rights and environmental impacts
- Mining of battery minerals has negative impacts and they can be addressed with policy, laws and through activist pressure and corporate action – all happening
- Virtually every EV maker has ethical supply chain policies
- Recycling being developed in many places

*U.S. Geological Survey, Mineral Commodity Summaries, January 2018



- 220,000 km vehicle life

Base data from 2015

Union of Concerned Scientists – Cradle to Grave, includes upstream fuel production emissions

Wrap-up

EVs and the World

- We humans must virtually eliminate the burning of fossil fuels, that is job one……..EVs address the existential nature of global warming and local pollution
- Global deployment of EVs using low carbon electricity will eliminate 1000's of millions of tonnes of GHG
- Automakers are working to source conflict free minerals and commercialize new battery chemistries, Cobalt already eliminated in some batteries.
- EVs, like all consumer purchases, have impacts, they do not solve every problem

EVs and you

- An EV in Ontario offers a dramatically reduced personal vehicle GHG footprint
- Basic EVs have similar ownership cost to equivalent fossil fuel cars
- Use your gas or electric car as little as possible, walk, bike, public transport
- Make it last as long as possible = less resource extraction
- Long distance travel entirely feasible, requires app use and time to charge

Thank you for your attention.

Questions?

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