

Welcome to this week's presentation and conversation
hosted by the
Canadian Association for the Club of Rome,
a Club dedicated to intelligent debate and action on global issues.

Current EV Market and Impact of Battery Technology Developments.

Our speaker today is Raymond Leury, who is retired from a long career in IT. He attended Al Gore's Climate Reality project leadership course, which reignited his passion for helping others shift to a more sustainable lifestyle. He splits his time between advocating for EVs, talking about climate change, and volunteering for the Red Cross. He bought an EV a decade ago. He is now President of the Electric Vehicle Council of Ottawa (EVCO). He now has a CO₂-free house (except the BBQ), including cars, heating, snow blower, lawn mower, and even the chainsaw. He will provide an update to the current EV situation in Canada and the rest of the world. There have been significant changes on a number of fronts over the last six months. New battery chemistries are being introduced to the market. The heavy duty EVs space is heating up with many in market offerings.

The presentation will be followed by a conversation, questions, and observations from the participants.

CACOR acknowledges that we all benefit from sharing the traditional territories of local Indigenous peoples (First Nations, Métis, and Inuit in Canada) and their descendants.



Website: canadiancor.com
Twitter: [@cacor1968](https://twitter.com/cacor1968)
YouTube: [Canadian Association for the Club of Rome](https://www.youtube.com/channel/UC...)

Agenda

- ▶ EVCO
- ▶ Hydrogen
- ▶ US Regulation Changes and Impact on Canada
- ▶ Canadian Regulation Changes
- ▶ Market Share
- ▶ Battery Technology

EVCO - Electric Vehicle Council of Ottawa

- ▶ The Electric Vehicle Council of Ottawa (EVCO) is dedicated to promoting the use of electric vehicles as a viable transportation alternative that is ecological, economical, practical, and available now.
- ▶ Most of our members driven by **GHG reductions**
- ▶ Non-profit, volunteer based since 1982
 - ▶ Independent fact based
- ▶ Accelerate the electrification of the transportation system
 - ▶ OC Transpo e-buses
- ▶ EVCO.ca





OC Transpo e-Bus Transition

- Currently have 4 e-buses in a “pilot”
- The city plans to acquire 450 electric buses by 2027
- Ottawa will buy 26 in 2022 with the goal of having them in service by the end of 2023.
- www.plugincanada.ca

EV Experience

- ▶ Collaboration with EnviroCentre
- ▶ Answers to your questions
- ▶ Test drive events
- ▶ Corporate events
- ▶ Outreach to dealers
- ▶ (Mentor program)

- ▶ <http://EVexperience.ca>



envirocentre

Project funders and partners

envirocentre

Canada

OCAF OTTAWA
CLIMATE
ACTION
FUND
By the Ottawa Community Foundation



Communauto

Ottawa

HydroOttawa

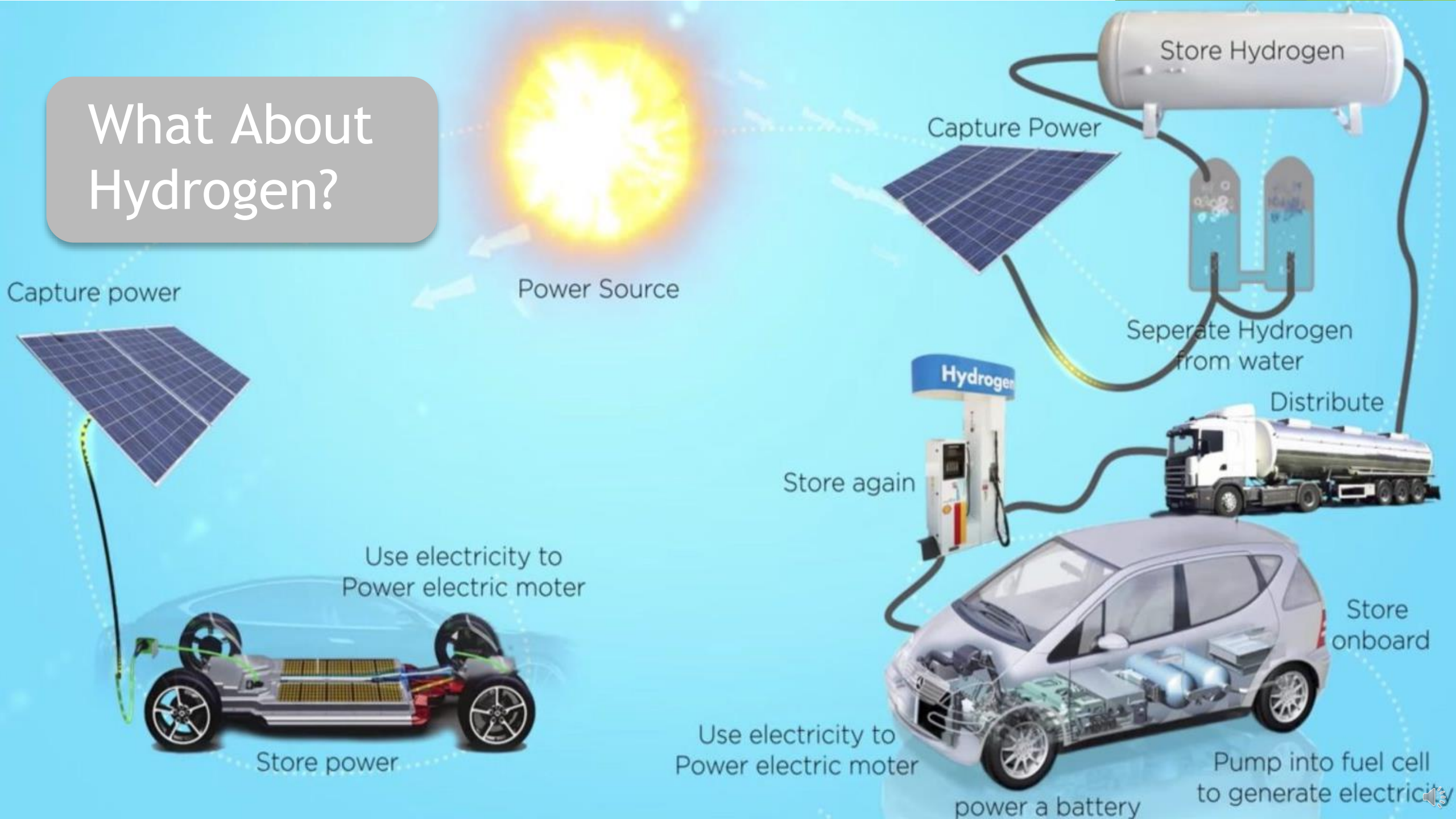
SMARTNet
Alliance.ca

Hydrogen

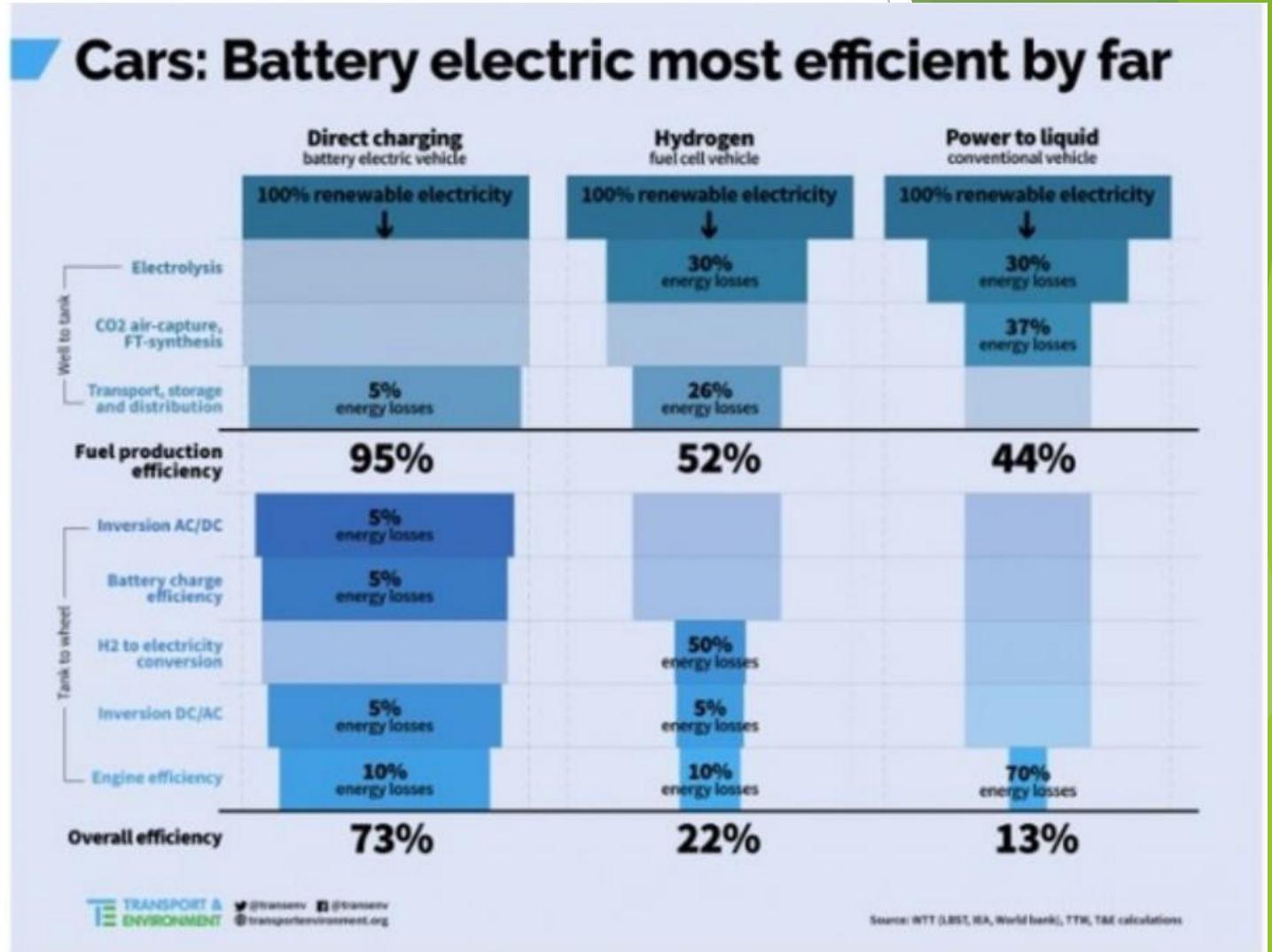
“Don’t ask a barber if you need a haircut.”

Warren Buffett

What About Hydrogen?



Battery electric vs H2



Green Hydrogen

“Current production of **hydrogen**, mainly used in the chemical and petrochemical sectors, is responsible for more than **900 Mt of CO2 emissions**”*

About 40% used in refining petroleum...

We need Green hydrogen to replace existing production of gray hydrogen

...and more for “hard to abate” sectors like steel

- iron ore reduction, high heat processes

Not for energy

For in depth discussion Dr David Cebon <https://www.youtube.com/watch?v=JlOCS95Jvjc>



* <https://www.iea.org/reports/hydrogen>

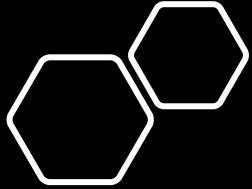
Bloomberg New Energy Finance projects that
“green hydrogen,”
produced with renewable energy,
will be cost-competitive
with fossil-produced hydrogen by 2030.

US Regulatory Changes



US Landscape - Tax Credit

- ▶ Old regime - Up to \$7,500 Federal tax credit - has been in place since 2010
 - ▶ Applies to first 200,000 deliveries in the US per manufacturer
 - ▶ GM and Telsa have reached 200,000 some time ago
 - ▶ “Penalizes” market leaders
- ▶ IRA replaces the current regime
 - ▶ Some changes already in place
 - ▶ Removal of incentives for some vehicles built outside of North America
 - ▶ Other changes to take effect on or after Jan 1st, 2023
 - ▶ Removal of 200,000 vehicle limit
 - ▶ Adding requirement for vehicle built in North America
 - ▶ Battery content requirements TBD
 - ▶ Tax credit likely to be changed for a sales rebate in 2024
- ▶ Many state and local incentives – California \$2,000



IRA Impact in Canada

- ▶ US Rules change on Jan 1st 2023
- ▶ Few vehicles will qualify for tax credit after Jan 1st
 - ▶ Tesla and GM will return
- ▶ US Tesla and GM buyers likely to postpone purchase to 2023
 - ▶ Shorter wait times in Canada
- ▶ Surge in US Tesla sales after Jan 1st
 - ▶ Longer wait times in Canada
- ▶ US “other” vehicle buyers
 - ▶ Buy in 2022
 - ▶ More vehicles will be available in Canada after Jan 1st

Inflation Reduction Act of 2022

Timeline 10 Years <ul style="list-style-type: none">• After December, 31 2022• NOT Retroactive	Credit \$7,500 Credit <ul style="list-style-type: none">• \$3,750 NA Battery Components<ul style="list-style-type: none">• 50% by 2024; +10%/Year• 100% by 2029• \$3,750 FTA Battery Minerals<ul style="list-style-type: none">• 40% in 2023; +10%/Year• 80% by 2027	MSRP Van: \$80k SUV: \$80k Truck: \$80k Others: \$55k
Income Cap \$150k Individuals \$225k Head of House \$300k Joint Filers	Used EV's \$4,000 Credit/30% <ul style="list-style-type: none">• 2 Years old or older• \$25k price tag• From Dealer	Used EV's Limits \$75k Individuals \$150k Joint Filers

Refundable Credit

[BREAKING: EV Tax Credits Signed Into Law - Everything You Need to Know - YouTube](https://www.youtube.com/watch?v=Y5HsB3x2rB8)

<https://www.youtube.com/watch?v=Y5HsB3x2rB8>

Observed Impact

- ▶ Tesla offering credits of 3,750 in US for people to take delivery now

Cars that qualify for IRA

- ▶ Sedans with a retail price of more than \$55,000 aren't eligible, nor are vans, SUVs or trucks over \$80,000.
- ▶ GM CEO Mary said that most of their cars will not qualify for \$7500 tax credits in 2023 but instead for \$3750
- ▶ Cadillac Lyriq
- ▶ Chev Bolt EUV
- ▶ Chev Bolt EV
- ▶ Ford F150 Lightning
- ▶ Ford Mustang Mach e
- ▶ Nissan Leaf
- ▶ Rivian R1T (dual motor Adventure only)
- ▶ Rivian R1S (dual motor Adventure only)
- ▶ Tesla Model 3
- ▶ Tesla Model Y
- ▶ VW ID.4 (made in US only)

California Air Resource Board (CARB)

- ▶ Many US states (12-14) have aligned with California
 - ▶ About half of US population
- ▶ New California announcement
 - ▶ All new passenger cars and trucks zero-emissions by 2035
 - ▶ Specific numbers for 2025 and beyond
 - ▶ All new medium and heavy duty zero-emission by 2045

California - CARB Targets

Effective Nov 30, 2022

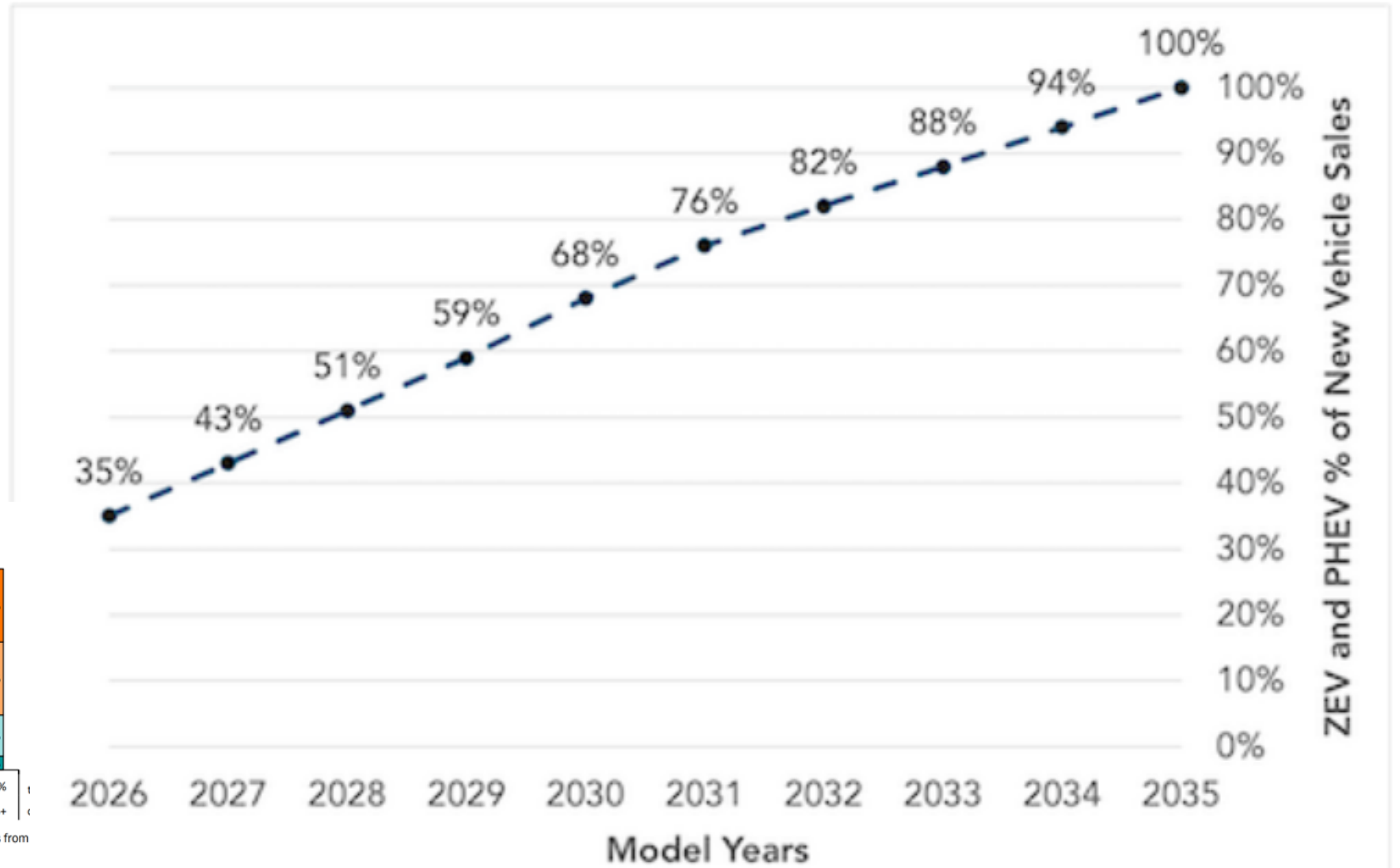


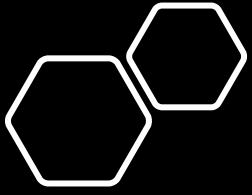
Figure 2: California LVM compliance requirements



* All credits include credits generated by ZEV, BEVx, TZEV, NEV, and discounted exceed credits from iterations of the policy; credits that can be met by all four categories for MY 2018 is 0.6%.

Canadian Regulatory Changes





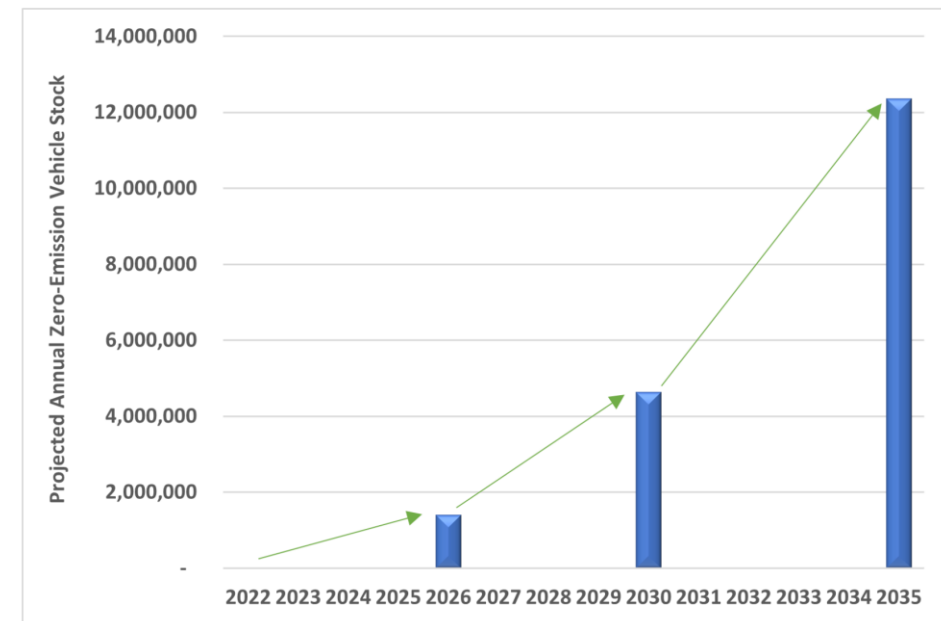
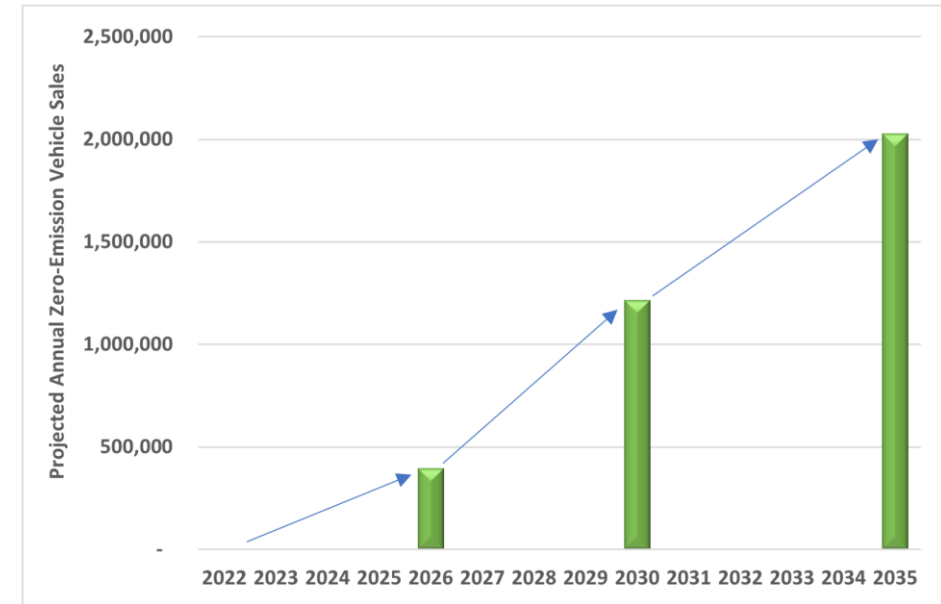
Transport Canada's Projected Annual New Zero-Emission Vehicles Sales/Stock

► Sales

- "At least" 20% by 2026 (CARB 35%)
- "At least" 60% by 2030 (CARB 68%)
- 100% ZEV sales by 2035
- Q3 2022 – already at 9.4%...

► Fleet

- 5% of total light-duty on the road by 2026
- 16% by 2030
- 40% by 2035



Canadian - Incentives

- ▶ Federal iZEV program
 - ▶ Up to \$5,000 rebate at purchase
 - ▶ Passenger price limit is \$55,000 for base model
 - ▶ Station wagon, pickup truck, SUV, etc. up to \$60,000 for base model
 - ▶ [Zero-emission vehicles \(canada.ca\)](http://canada.ca)
- ▶ Provinces
 - ▶ Québec - up to \$7,000
 - ▶ B.C. - up to \$3,000
 - ▶ Nova Scotia - up to \$3,000
 - ▶ New Brunswick - up to \$5,000
 - ▶ NL - \$2,500
 - ▶ PEI - \$5,000
 - ▶ Yukon - up to \$5,000
 - ▶ NWT - up to \$5,000
 - ▶ Ontario...\$0

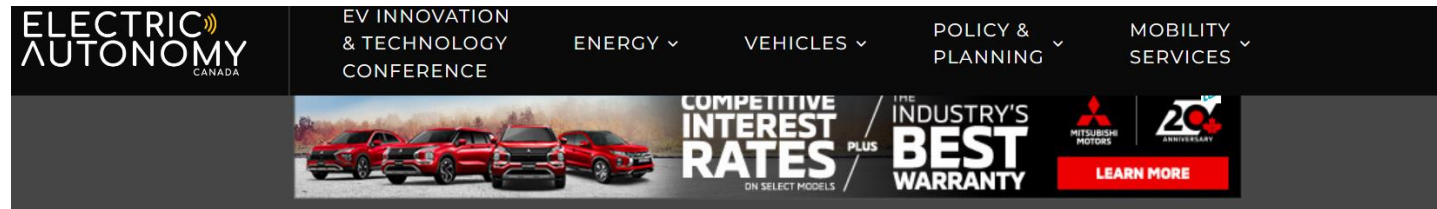
Charging - The Math for EVs in Ontario

- ▶ Naïve users will plug their car in when they get home from work
 - ▶ Why should they do anything else...
- ▶ Assuming charging at 30A 240v which is 7.2kW
- ▶ Assuming one million EVs charging during the evening peak
 - > 7,200MW
 - 50% higher evening peak!
 - > we need smart charging!
 - > we need incentives to charge at night
- ▶ 10M light duty vehicles in Ontario (2040)
 - ▶ 72,000MW if all charge at the same time
 - ▶ Without considering heavy duty
- ▶ Alternatively...



Ultra Low Overnight Rate Adopted in Ontario

- ▶ Lower rate between 11PM and 7AM - 2.5 cents per kWh
 - ▶ Currently 8.2 cent per kWh for Hydro Ottawa
- ▶ Important to encourage people to charge overnight
- ▶ LDC's need to follow through



EV Charging, Policy

Ultra-low overnight electricity rates could save Ontario EV drivers up to \$90 a year: Ontario Energy Board report



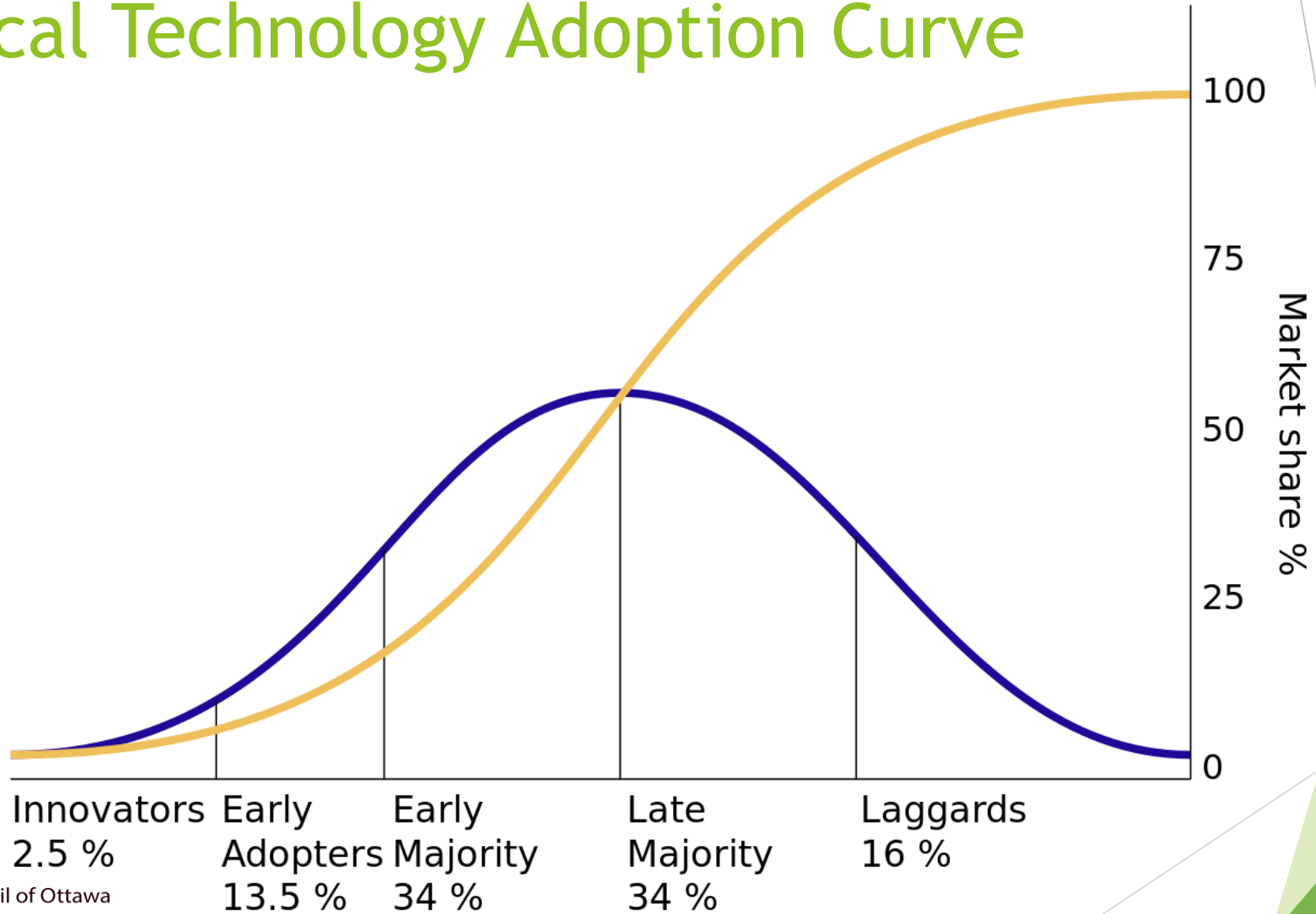
Proposed Implementation of an Ultra-Low Overnight Electricity Price Plan for Regulated Price Plan Consumers

PRO number	019-5849
Notice type	Regulation
Act	Ontario Energy Board Act, 1998
Posted by	Ministry of Energy
Notice stage	Decision
Decision posted	October 31, 2022
Comment period	August 10, 2022 - September 24, 2022 (45 days) Closed
Last updated	October 31, 2022

Market Share



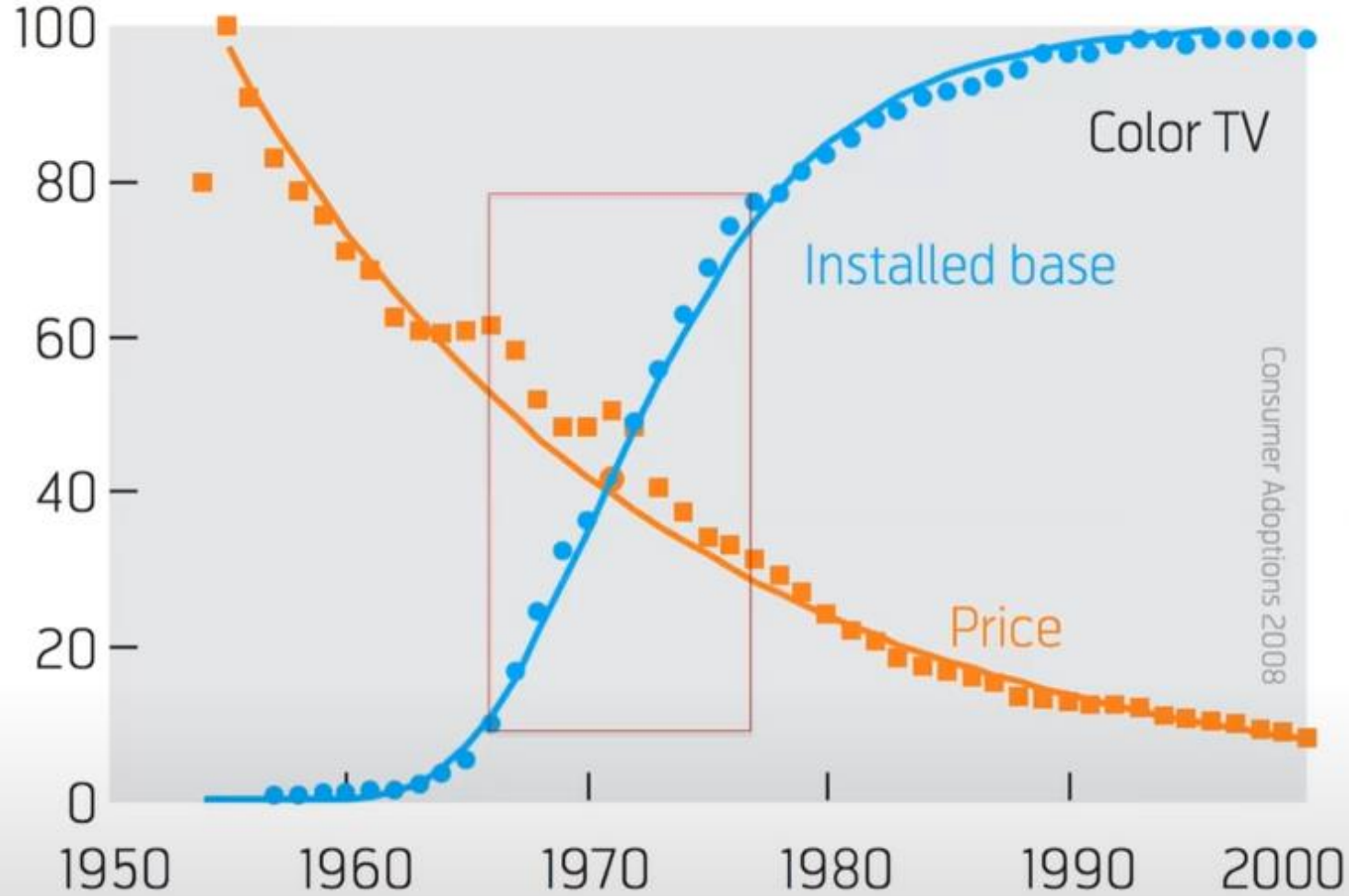
Typical Technology Adoption Curve



Electric Vehicle Council of Ottawa

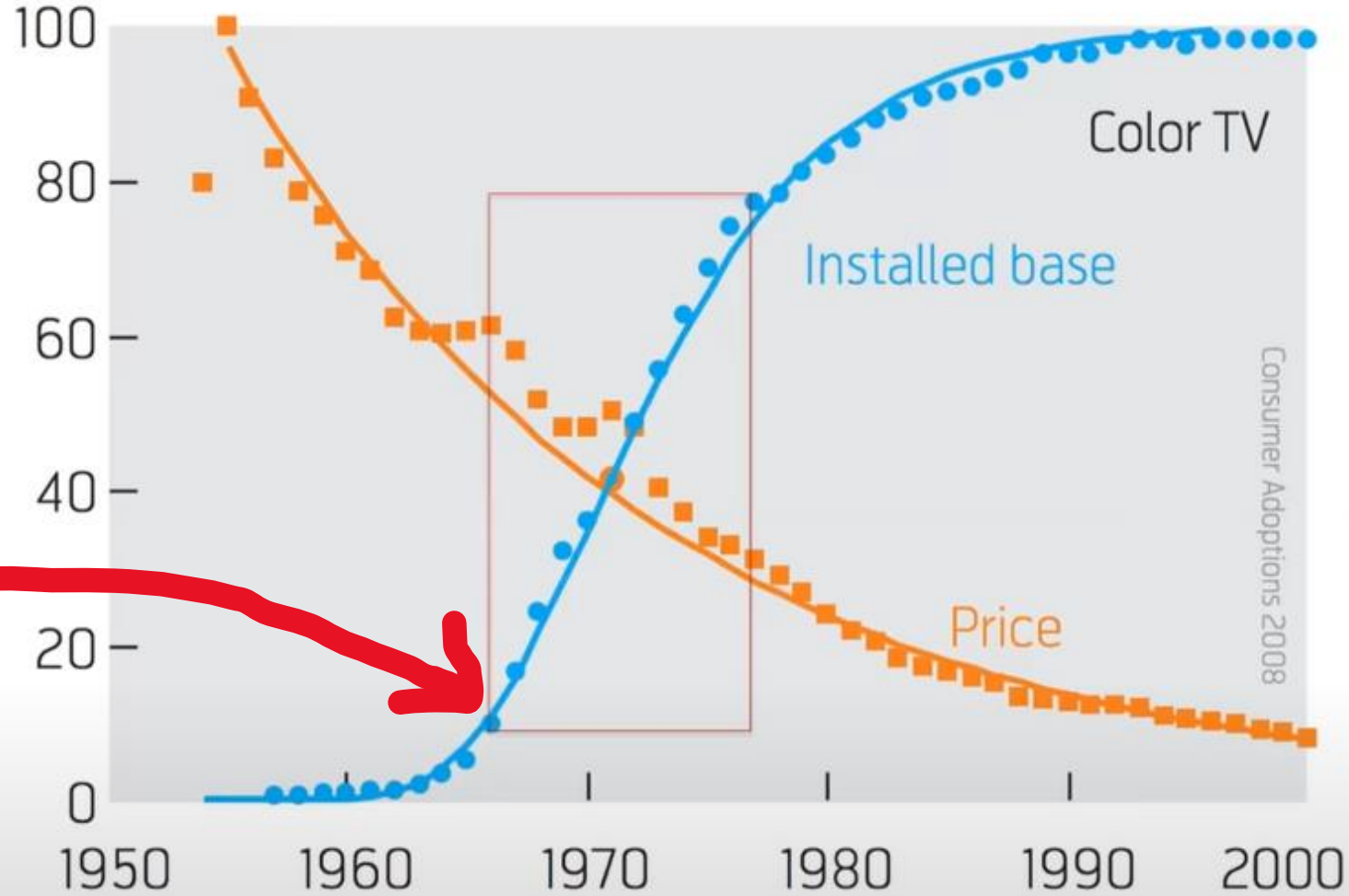


Technology Adoption S-Curve (Color TV % US)



✓ Tech adoption is not linear but follows an exponential **S-Curve**

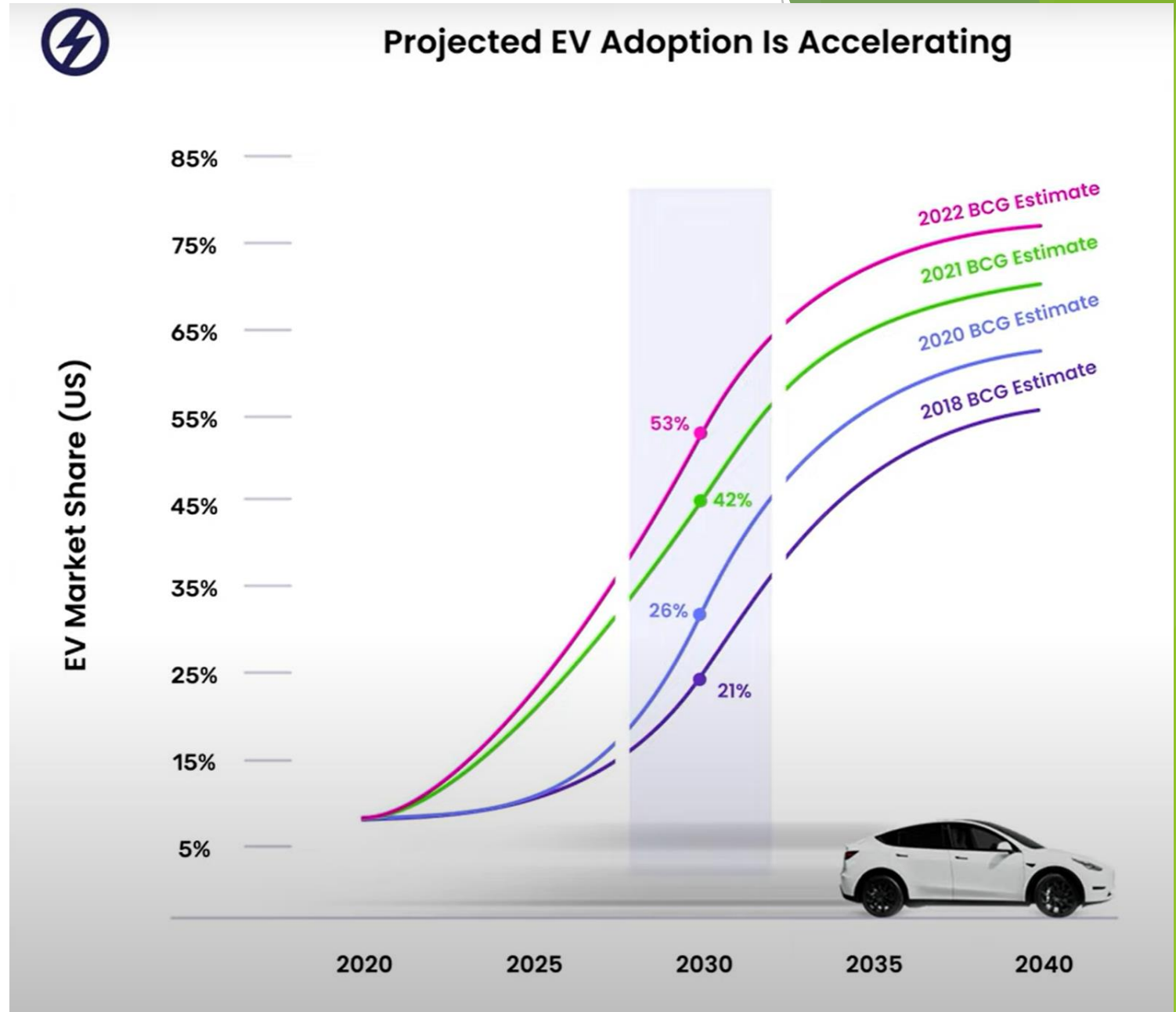
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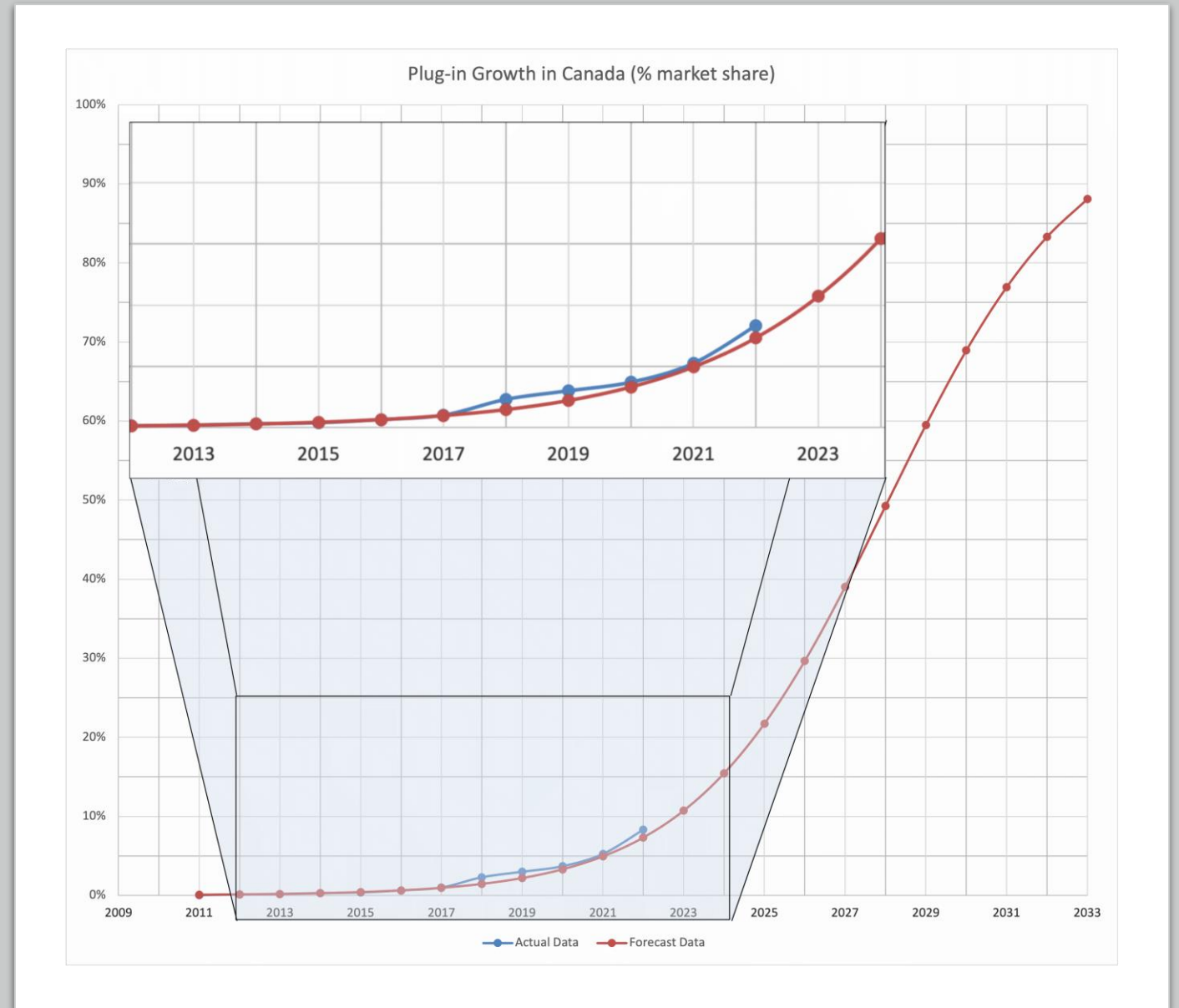
International Energy Agency

- Consistently underestimate growth of solar
- Projections linear when they should be exponential
- Forecasting the future is hard!
- 2014 forecast for 2030 reached by 2018



Q3 2022 EV Sales in Canada

- Q3 market share reached 9.4%
- 1 in 5 cars sold in BC were electric
- 13% of vehicles sold in QC had a plug.
- Ontario market share reached 7.6%.
- If these trends hold into Q4 plug-in sales will once again outperform the 2017 EVCO market predictions.



European EV Sales Hit 20% Market Share

- While the overall auto market in Europe has been declining, EV registrations have increased 38% year-over-year.
- Plug-in registrations have been rising fast in recent months and coupled with a shrinking car market have resulted in an even more rapidly increasing market share figure.
- Tesla Model 3 and Y led sales by a wide margin which is only expected to increase now that Giga Berlin has come online.
- Hyundai-Kia also saw significant year over year growth (+25%) as the company has managed to avoid the chip-shortage issues suffered by its competitors.

Europe Plugin Vehicle Sales (February 2022)

Top 20 plug-in electric vehicles across most of Europe, with data aggregated by Jose Pontes of EV Volumes for CleanTechnica.com. (Bold = fully electric.)

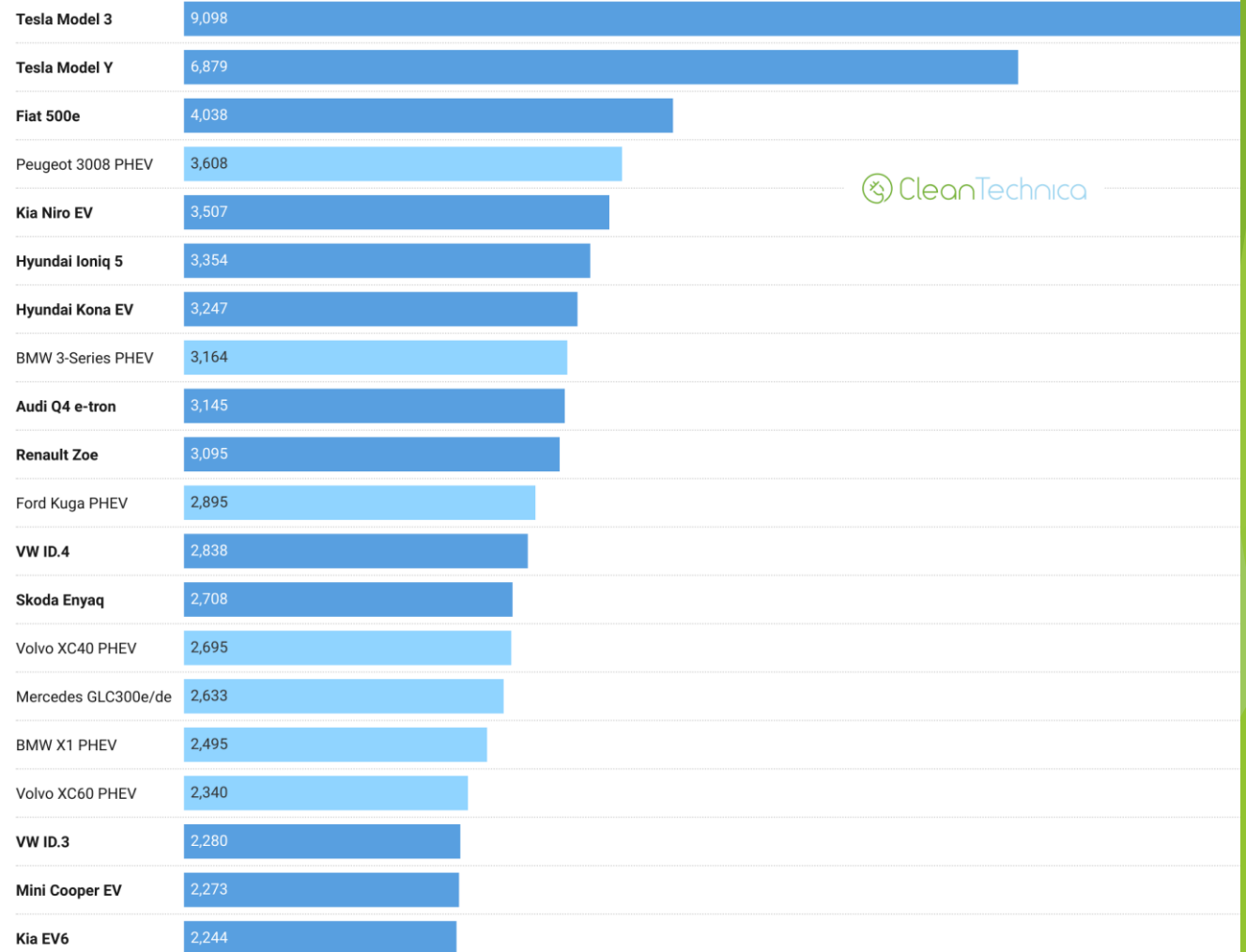


Chart: CleanTechnica • Source: EV Volumes • Created with Datawrapper

Other Developments



Visit to Europe

- ▶ Most cars are diesel...and stink!
- ▶ Portugal is poor and lags Europe in EV adoption
- ▶ Spain is a bit more prosperous
- ▶ Morocco - poorer still - no EVs, but are eliminating old used cars



GM & Volvo Say EVs Will Reach Price Parity With ICE Vehicles by 2025

- Despite recent supply chain issues, both GM and Volvo now predict their EVs will cost the same or less than comparable fossil vehicles.
- Volvo Cars CEO Jim Rowan said in an interview he expects to see price parity around 2025 while GM CEO Marry Barra told CNBC that GM expects profits to match ICE vehicles by 2025.
- The US IRA appears to be a major factor in these predictions as it is expected to boost profit margins for GM.

Tesla Semi



Tesla Semi Completes First 800 km Trip With Full Load.

- With deliveries to Pepsi to start on Thursday, Dec 1st, Musk confirmed in a tweet that a Semi has completed its first “500 mile” trip with a full load.
- An all-electric Class 8 truck, the Semi can carry 80,000 lbs and travel between 480 km and 800 km depending on the model.
- Several other companies now also offer all-electric Class 8 trucks including Volvo, Freightliner and Nikola.
- 800 km is seen as the sweet spot for trucks as it equates to around 8 hours of driving at which point a break is mandated anyway.

Batteries

Battery characteristics

- Energy density by weight and volume
 - Very important for EVs, less so for static applications
- Cost
- Charging speed
- Charging cycles - determines longevity
- Safety

Extensive R&D spending is bearing fruit

Beware of hype...

- Assuming 50kWh battery
 - Requires 1000kW (1MW) charger
 - Likely would melt...
 - May not be realistic
- For comparison
 - Tesla Semi supports 1MW charger
 - 750-1000kWh battery
 - 15-20 times as many cells
 - Charging limit is per cell
 - Special cable to handle cooling
- Hot markets attract all sorts of players

'Game-changing' new battery for electric cars charges in 3 minutes and lasts for 20 YEARS - more than twice as long as current EV batteries

- Researchers at Harvard have created a battery that's inspired by a BLT sandwich
- They say the lithium-metal battery can be charged and discharged 10,000 times
- Startup in Massachusetts has been given a licence to build the battery at scale

By [JONATHAN CHADWICK FOR MAILONLINE](#) 

PUBLISHED: 07:29 EST, 15 September 2022 | **UPDATED:** 07:45 EST, 15 September 2022



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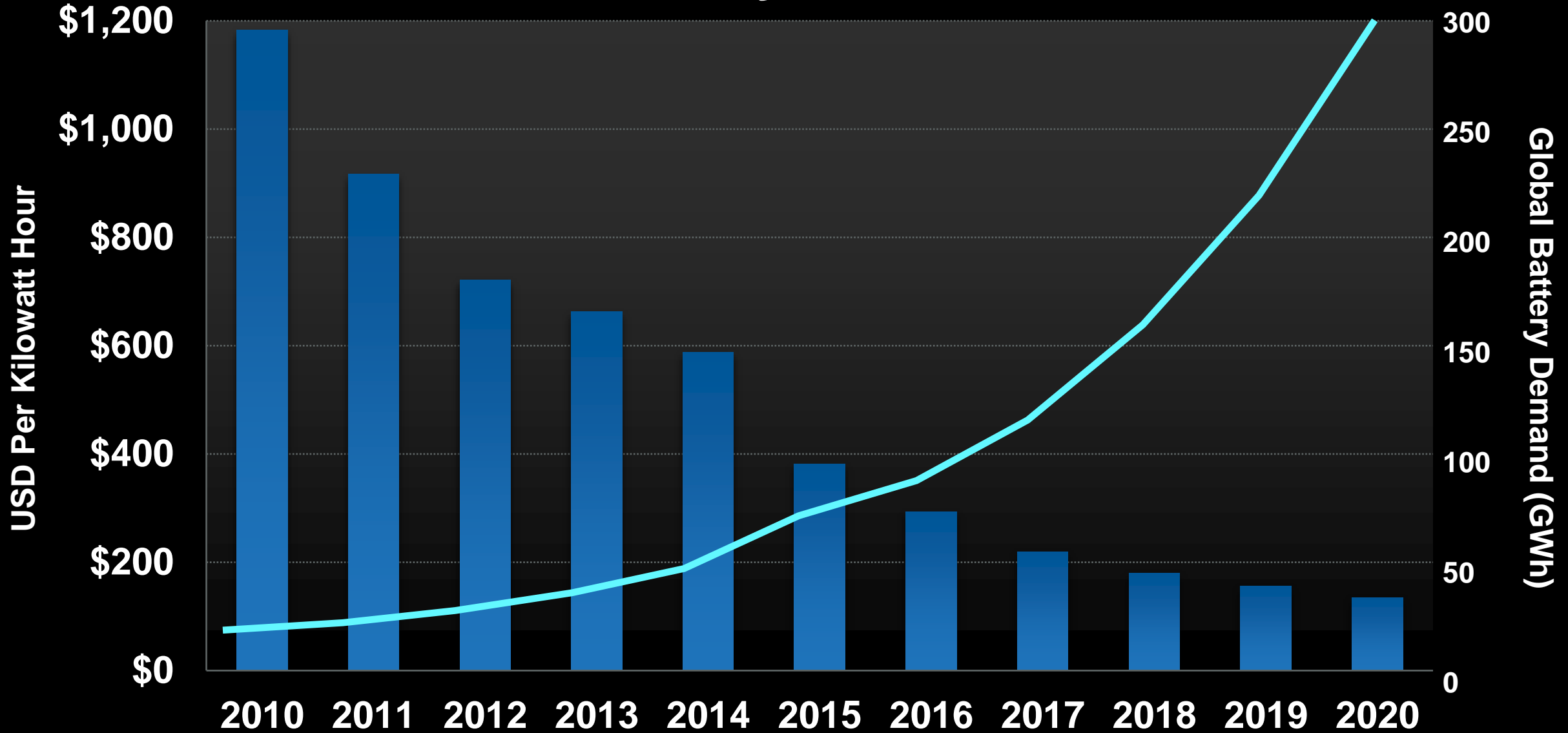
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A 'game-changing' new battery for electric vehicles (EVs) that charges in three minutes and lasts for 20 years could soon be coming to new cars.

Adden Energy, a start-up based in Waltham, **Massachusetts**, has been granted a licence and \$5.15 million in funding to build the battery design at scale to fit in EVs.

Lithium-ion Battery Prices and Demand



Volume-weighted averages
Data: Bloomberg New Energy Finance

Batteries – lithium ion NMC (Nickel Manganese Cobalt)

- Cost has dropped 90% between 2010 and 2020
- Further cost reductions possible
- Raw materials cost are a limiting factor
- Need to look for alternative materials

Nickel Prices for the Last 10 Years



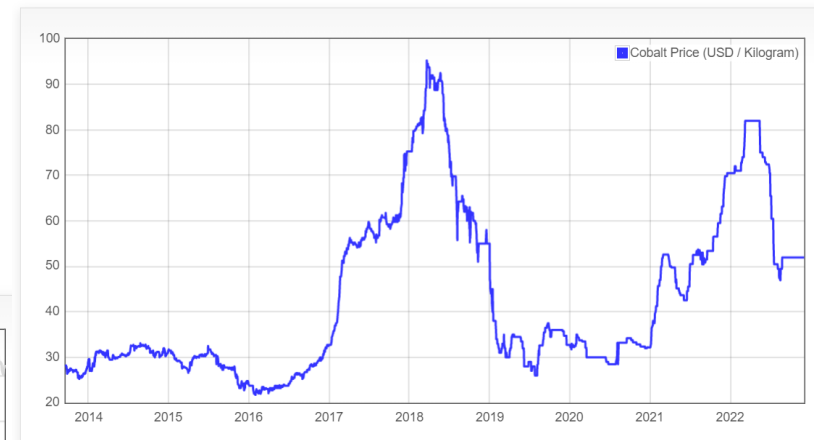
Link directly to this result here: <http://www.dailymetalprice.com/metalpricecharts.php?c=ni&u=kg&d=2400>

Lithium Prices for the Last 10 Years



Link directly to this result here: <http://www.dailymetalprice.com/metalpricecharts.php?c=li&u=kg&d=2400>

Cobalt Prices for the Last 10 Years

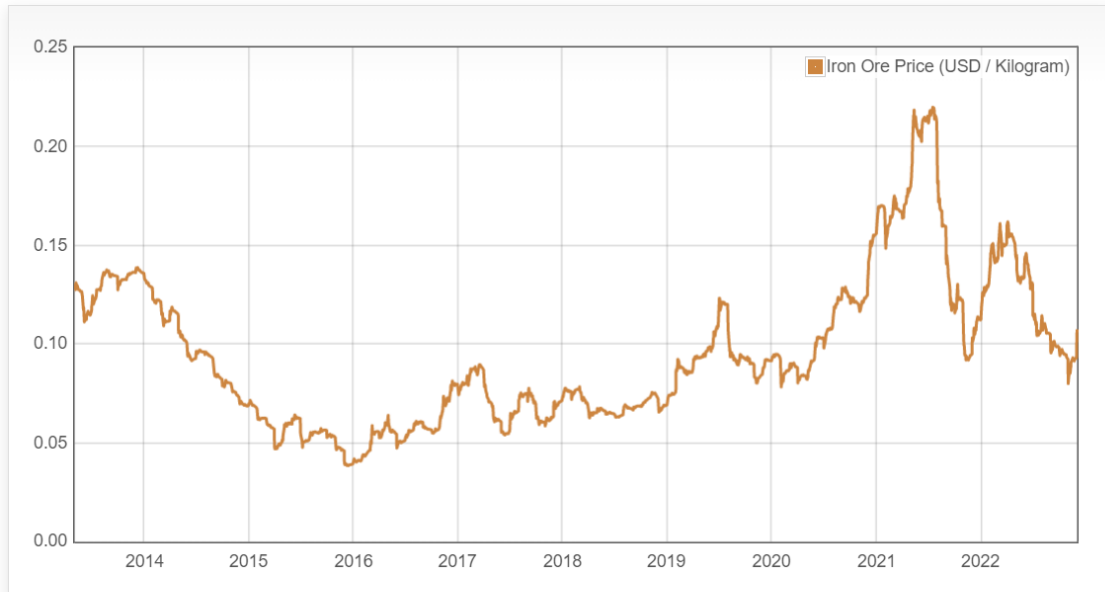


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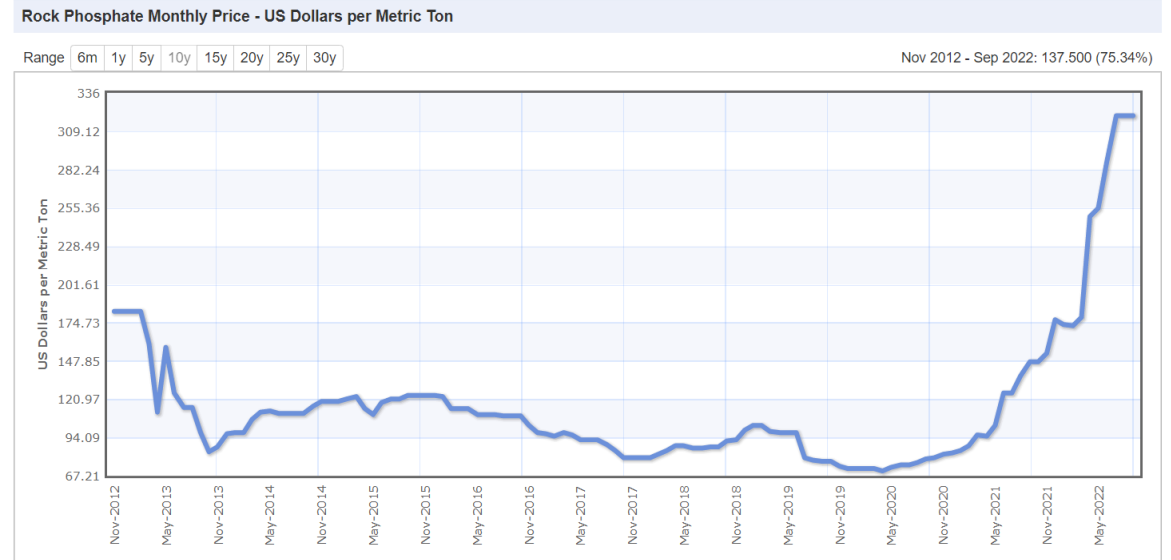
Batteries – lithium ion LFP (Lithium Iron Phosphate)

- Iron much less expensive than Nickel
- Phosphate much less expensive than Cobalt
- Lithium...
- Much less costly than NMC, but lower energy density

Iron Ore Prices for the Last 10 Years



Link directly to this result here: <http://www.dailymetalprice.com/metalpricecharts.php?c=fe&u=kg&d=2400>











What about lithium?

- Is there enough lithium to go around?
- How expensive will it get?

- CATL and BYD have announced sodium-based as well as hybrid sodium/lithium batteries
- Sodium is much more abundant and less expensive than lithium
- CATL first generation sodium batteries 160Wh/kg
 - Will start producing at scale in 2023 for EVs
- Can be produced with the same equipment as NMC
- **Expected to further reduce cost and help address lithium supply issues**

Available vehicles

 Electric Vehicle Council of Ottawa		2022 EVCO EV Buyer's Guide										Visit u Last
	Make and Model	Base MSRP*	Net Price (+ HST, shipping etc, - Federal rebate)	Range* (km)	Battery Capacity* (kWh)	Power* (kW)	0-100 km/hr (60 mph)*	Seating / # of Rows	Towing Capacity* (kg)	Fast Charge Max Rate	Drivetrain Options	Estimated Time For Delivery**
	Chevy Equinox EV 1LT	\$35,000	Pre-orders to open late 2022	400	60	216	6.0	5 in 2 rows	680	150 kW	FWD	Spring 2024
	Chevy Bolt EV	\$38,169	\$40,279	417	65	149	7.2	5 in 2 rows	N/A	55 kW	FWD	8-12 weeks
	Chevy Bolt EUV	\$40,198	\$42,572	397	65	150	7.0	5 in 2 rows	N/A	55 kW	FWD	8-12 weeks
	Imperium SEV Comfort	\$37,995	\$42,934	410	55	-	-	-	-	-	-	> 10 months
	Mini Cooper SE 3 Door	\$40,990	\$44,020	183	32.6	135	7.3	5 in 2 rows	N/A	49 kW	FWD	8-12 weeks
	Hyundai Kona EV	\$43,699	\$44,523	415	64	150	7.6	5 in 2 rows	N/A	77 kW	FWD	8-12 weeks
	Nissan LEAF SV	\$37,498	\$44,719	243	40	110	7.9	5 in 2 rows	N/A	46 kW	FWD	8-12 weeks

□ <https://evco.ca/evs-available-in-ontario/>

GM EVs

- Chevrolet Bolt EV and EUV
- BrightDrop Zevo 600
- GMC Hummer EV Pickup
- GMC Hummer EV SUV
- Cadillac Lyriq - deliveries started
- Chevrolet Blazer EV - spring 2023
- Chevrolet Silverado EV - fall 2023
- Chevrolet Equinox EV - fall 2023
- GMC Sierra EV - spring 2024



Electric Vehicle Council of Ottawa