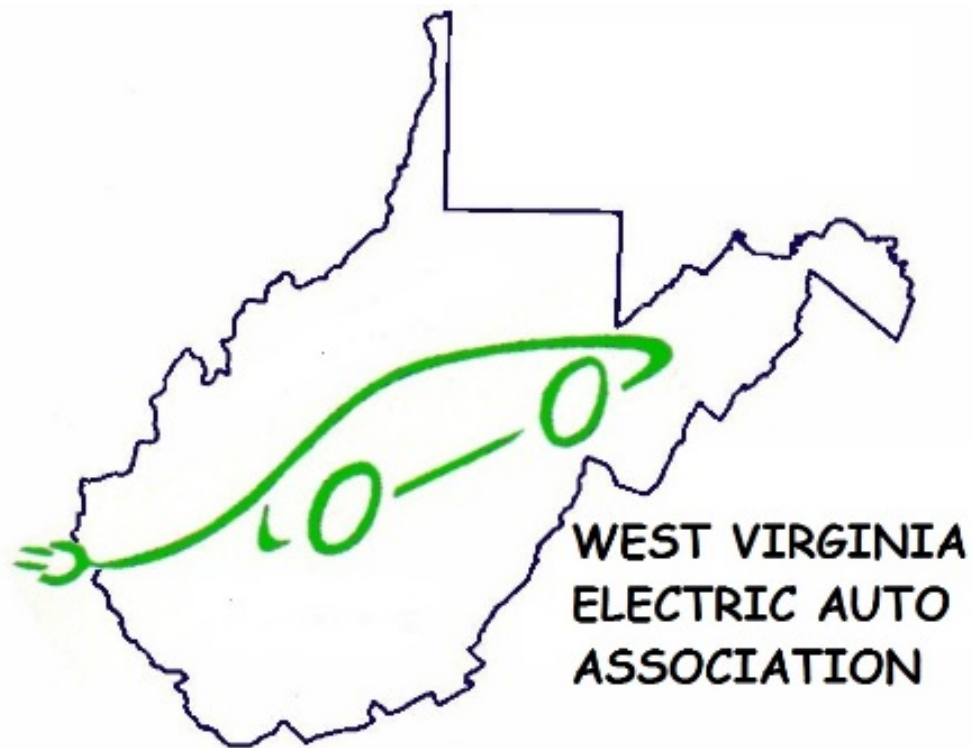
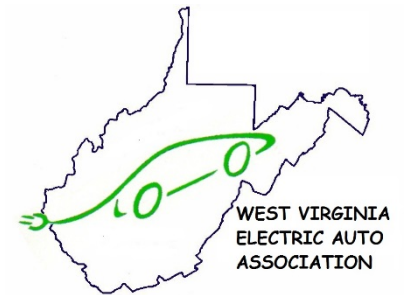


Driving on Sunshine Electric Vehicles And Solar



Electric Autos are not a New Concept

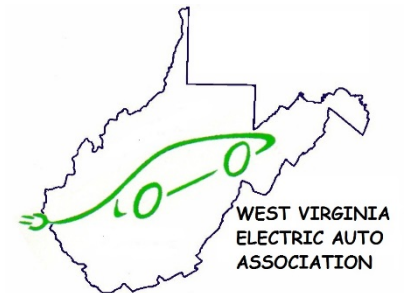


Electric Autos are not a New Concept



1909 Baker Electric

That's over ONE HUNDRED Years Ago



Even in the Modern Era...

GM EV-1



COURTESY: GENERAL MOTORS

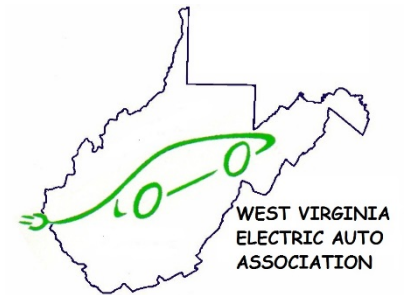
1996-1999

**They've been
around for
OVER TWENTY YEARS**

Toyota RAV4 EV



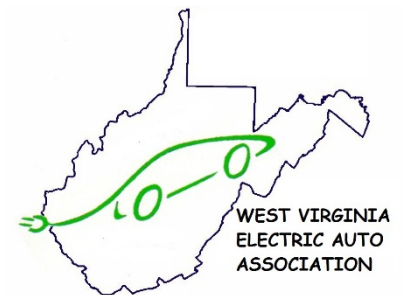
1997-2003



2018 Top Selling Plug-In Vehicle



Tesla Model 3

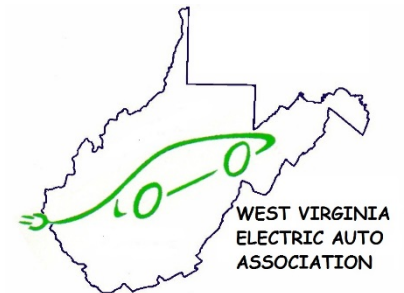


Best Selling Plug-In Vehicles '11-17

Nissan Leaf



Chevy Volt



Europeans coming
in a BIG WAY



BMW i3 - BEV or PHEV



BMW i8 - PHEV



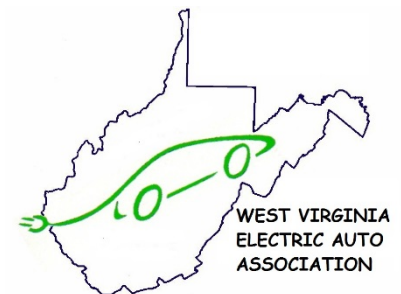
Volvo xc90 - PHEV

2017-2018 Plug-In Hybrids

Chrysler Pacifica Hybrid

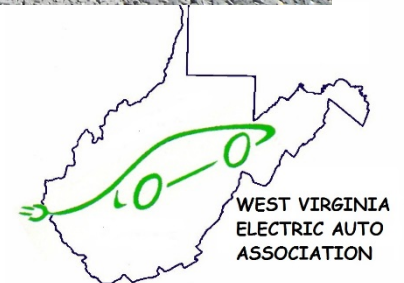


Mitsubishi
Outlander
Hybrid

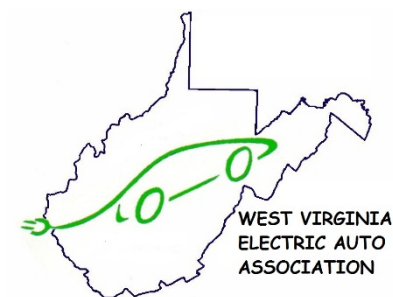


EVs on Solar In West Virginia

Plugged-in,
near Capon
Bridge,
Hampshire
County,
West Virginia

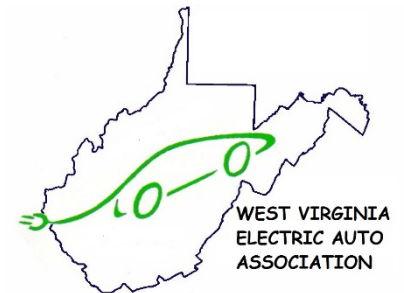


Huntington to Baltimore And Return - 2018



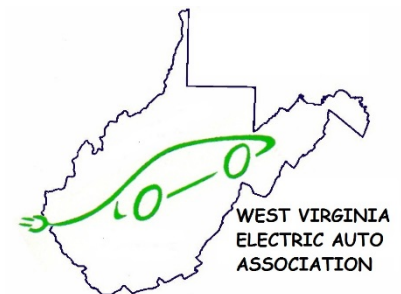
So, Why is Electric Making a Comeback?

- Advances in Electrical Drive Systems and Batteries



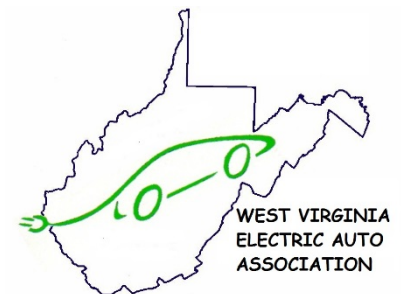
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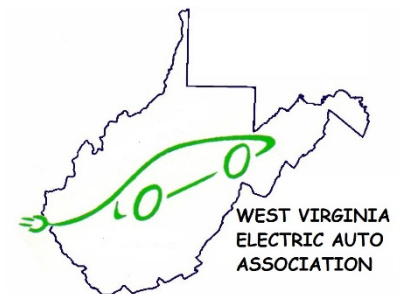
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- **Very Affordable on a Day-to-Day Basis**



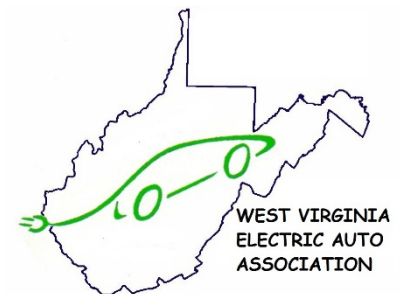
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- **Almost No Drive-Train Maintenance**



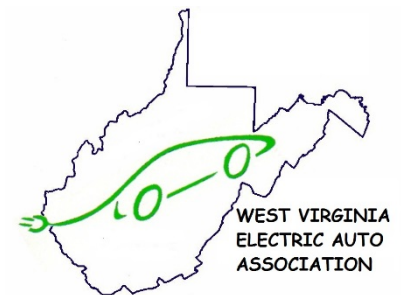
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- **No tailpipe emissions on electric**



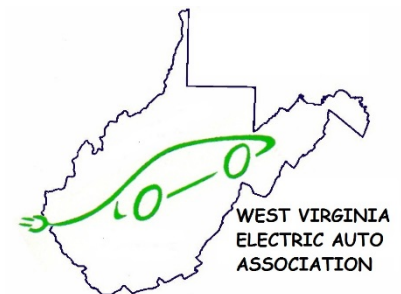
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- Very Affordable on a Day-to-Day Basis
- Almost No Drive-Train Maintenance
- No tailpipe emissions on electric
- Lower total emissions – CO₂, ozone, metals
- **REALLY, REALLY FUN TO DRIVE**

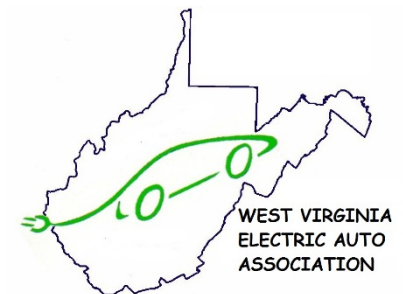


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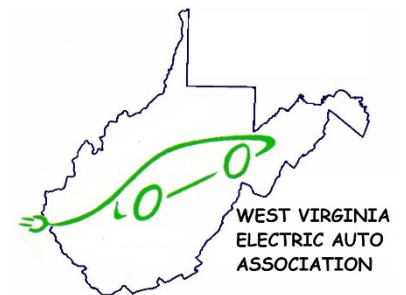
IN SUMMARY

Electric Cars are coming back because of

PERFORMANCE
SUSTAINABILITY

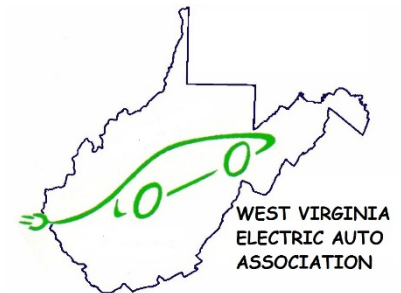


Why should We care about electric cars?



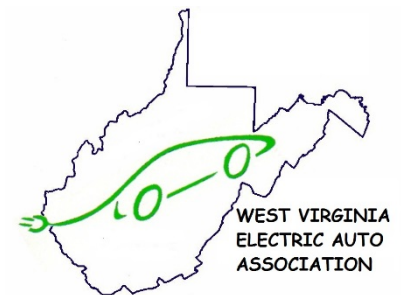
Why should We care about electric cars?

- Positive for US & W.Va. Economics
 - Reduce Imported Oil



Why should We care about electric cars?

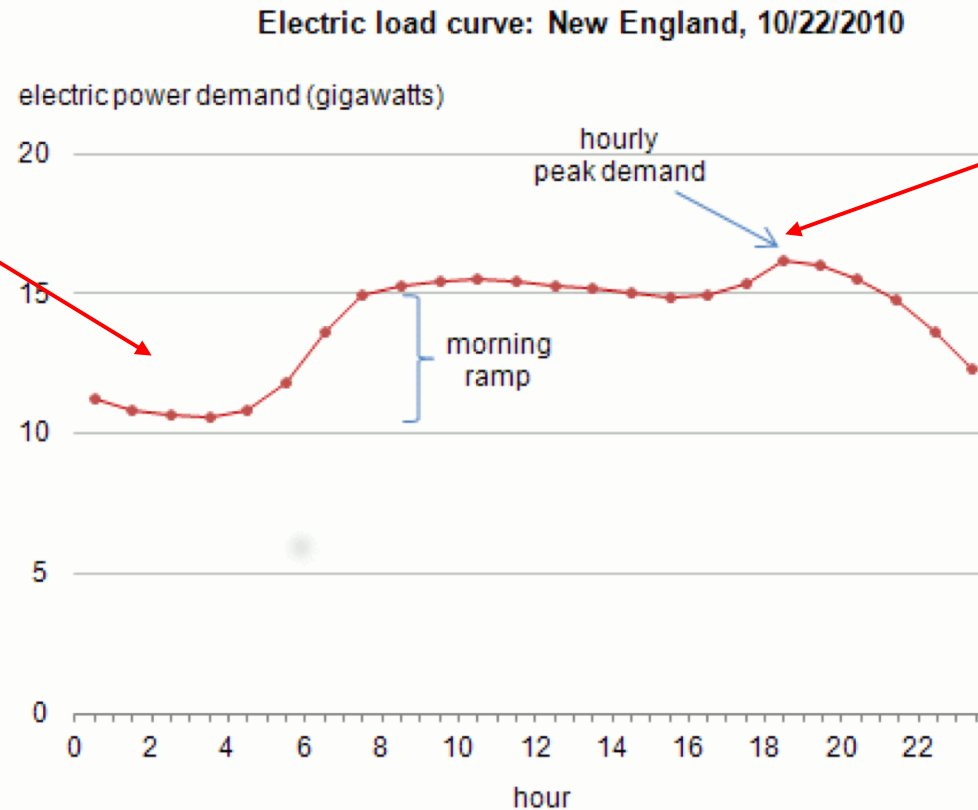
- Positive for US & W.Va. Economics
 - Reduce Imported Oil – Eliminate 500 gals gas per EV/yr
 - Limited effect on the Electrical Grid



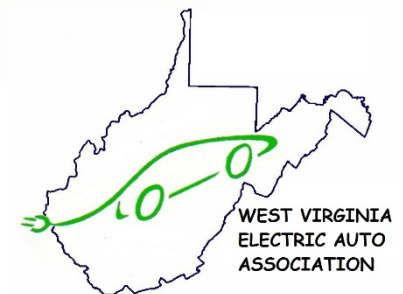
Most EVs are Charged at Home

At NIGHT!

Electric car charging can be programmed to fill this dip

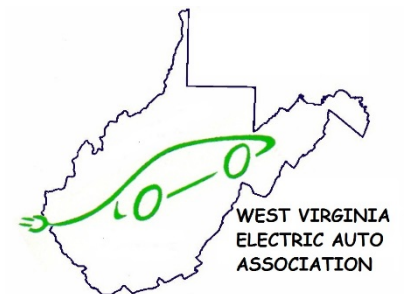


And miss this peak



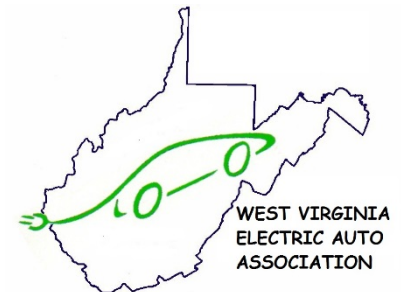
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- Positive for US & W.Va. Economics
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 - Powered by West Virginia energy sources:
 - Coal, Natural Gas, or **SUNSHINE**.



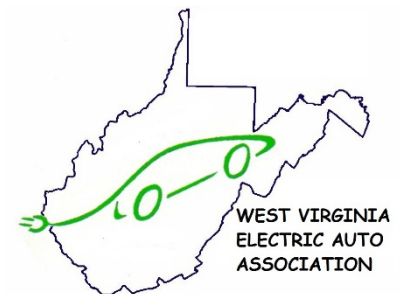
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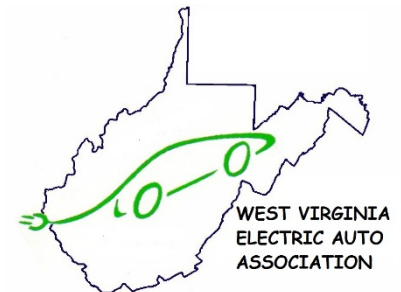
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 - EVs can use power from the grid, or



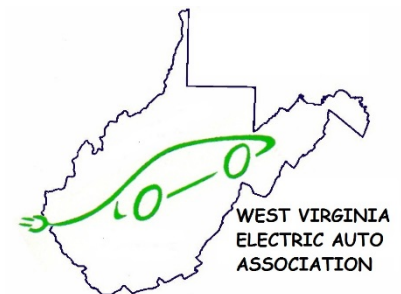
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- **EVs can use power from rooftop solar**



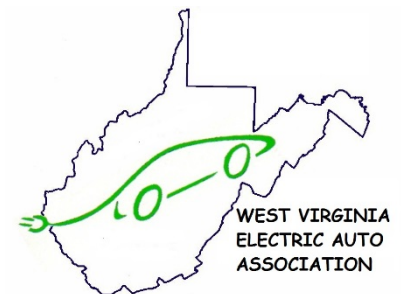
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- **Typical EV needs 11 kW-hr/day (on average)**
- **3,300 watt solar array will allow 100% driving on sunshine (on average)**



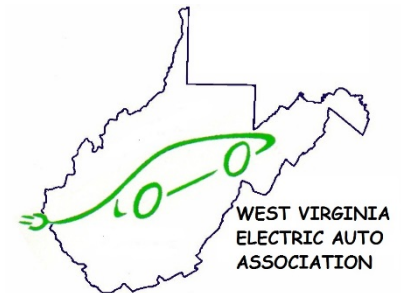
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 - Typical EV needs 11 kW-hr/day (on average)
 - 3,300 watt solar array will allow 100% driving on sunshine (on average)
- **Even driving on power made from coal, an EV is cleaner than a gas or diesel vehicle.**



So, What's It Cost to Operate?

- Running Costs per 1,000 miles
 - Chevy Volt:
 - Power: \$15 - \$30
 - Gasoline: \$10 - \$30
 - Tesla or Nissan Leaf:
 - Power: \$40 - \$50



So, What's It Cost to Operate?

Welcome To Loves#378

Date: 03/18/18
Time: 16:19
Invoice # 89446

Card Sale
#####

Pump	Gallons	Price
7	5.257	\$2.989

Product
Super

TOTAL SALE **\$15.71**

Terminal :
Approved# 01
REF: 21193

Thank You !!!

- Running Costs per 1,000 miles

- Chevy Volt:

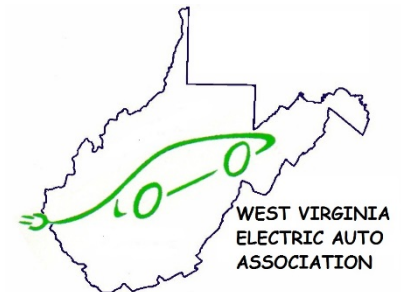
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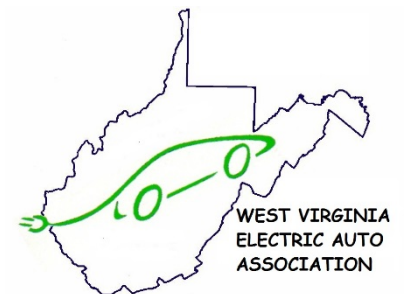
- Tesla, Leaf or Bolt EV:

- Power: \$40 - \$50

- Marty's March Gasoline
 - Bill

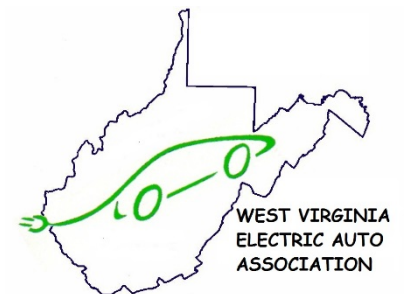


So, What's It Cost to Drive on Sunshine?



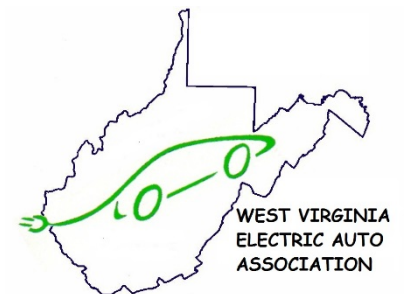
Where is the US Electric Car market?

- There are **785,000** plug-in cars **NOW** in USA
- 43 models across 15 brands – Today
- More than 100 new models in pipeline
 - From GM, Ford, Nissan, BMW, Audi, VW, Volvo, Jaguar, Porsche, Tesla and others



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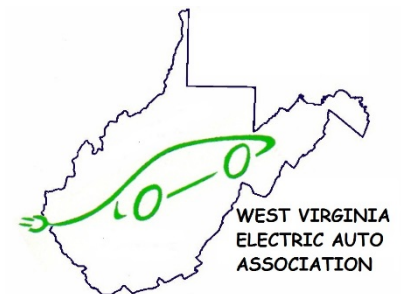
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 - How Many EV's charge on solar today?



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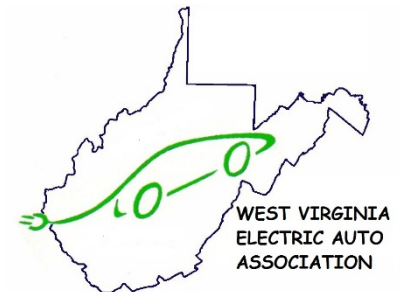
» Probably about 25%



Why should We care about Electric Cars?

Tourism is a Driver in West Virginia

Public Charging Stations are bringing
Drivers to
W.Va.'s Tourism Destinations



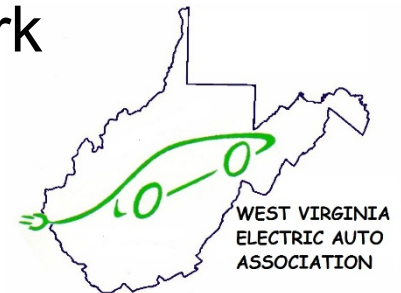
Why should We care about Electric Cars?

Tourism is a Driver in West Virginia



Overnight guests at Pipestem Resort State Park

photo by Dr. Darren Harris

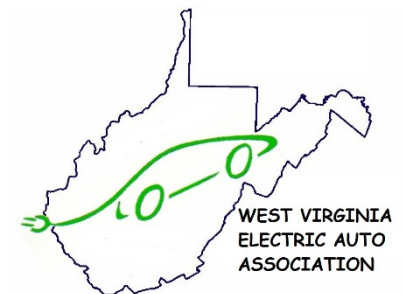


Why should We care about Electric Cars?

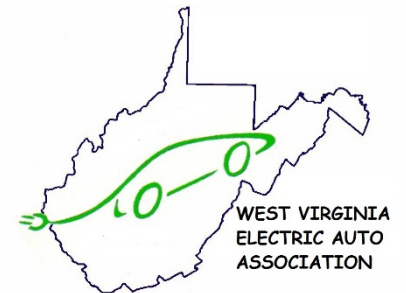
Tourism is a Driver in West Virginia



Charging at Canaan Resort State Park



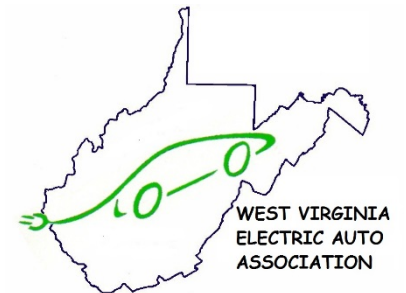
Access Control for Public Charging



Access Control for Public Charging

Or

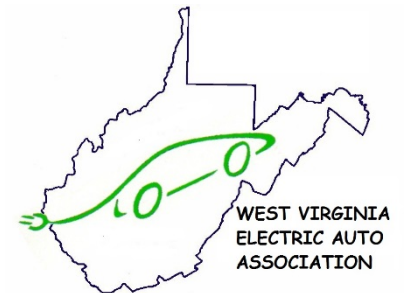
Who Pays?



Access Control for Public Charging

Open Access

Sponsor pays

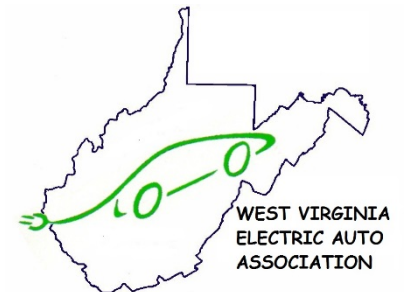


Access Control for Public Charging

Open Access

Sponsor pays

Marketing Effort – attract high income customers



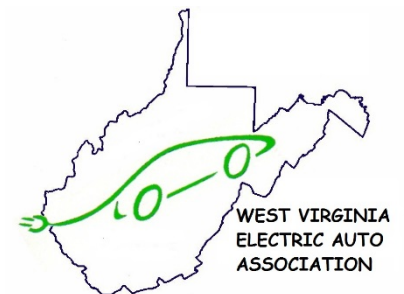
Access Control for Public Charging

Open Access

Sponsor pays

Marketing Effort – attract high income customers

Lowest cost installation



Access Control for Public Charging

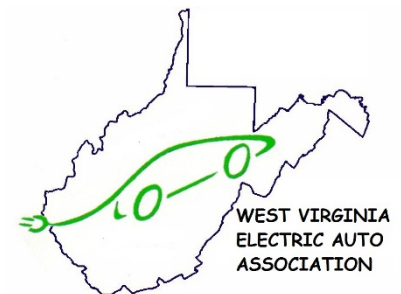
Open Access

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Marketing Effort – attract high income customers

Lowest cost installation

Difficult to control abuse



Access Control for Public Charging

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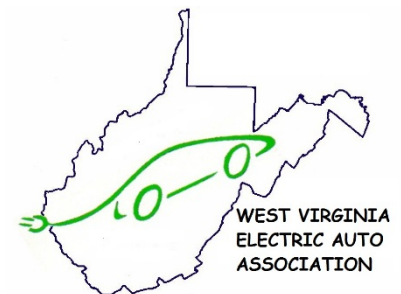
Sponsor pays

Marketing Effort – attract high income customers

Lowest cost installation

Difficult to control abuse

Wide variety of vendors



Access Control for Public Charging

Destination - Open Access

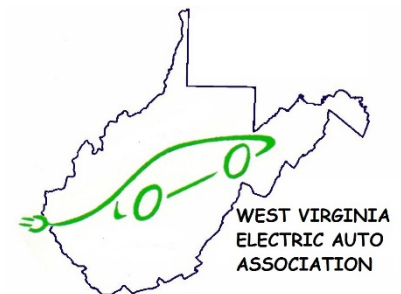


Tesla EVSE



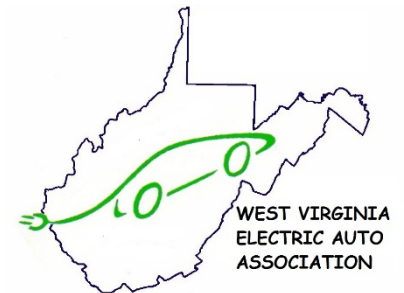
Leviton EVSE

More than 20 brands available today



Access Control for Public Charging

Manual Access

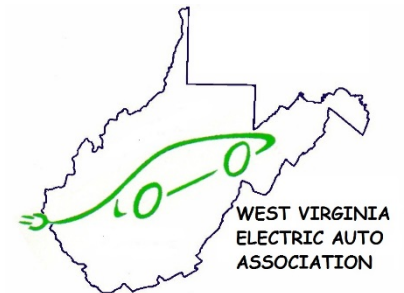


Access Control for Public Charging

Manual Access

- Controlled by Host

Multiple Payment Strategies

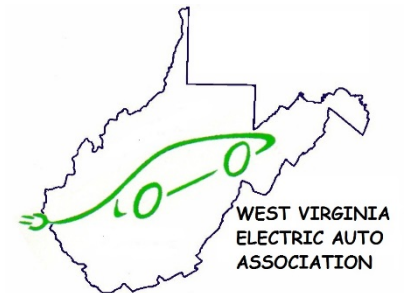


Access Control for Public Charging

Manual Access

- Controlled by Host
- Multiple Payment Strategies

Staff overhead concerns



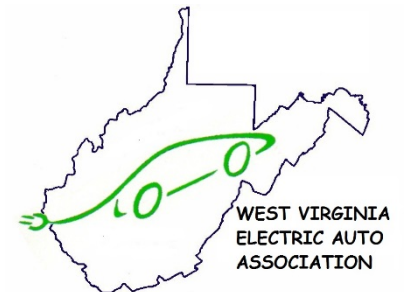
Access Control for Public Charging

Manual Access

Lock and Key



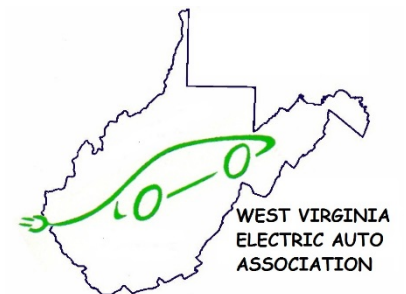
\$10 - \$200 uninstalled
Staff operation



Access Control for Public Charging

Manual Access

Parking Control

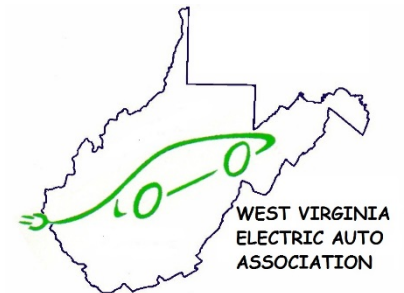


Access Control for Public Charging

Destination - Clock and Pin



\$2650 per EVSE uninstalled
\$9 / month pin fee
Non-Networked

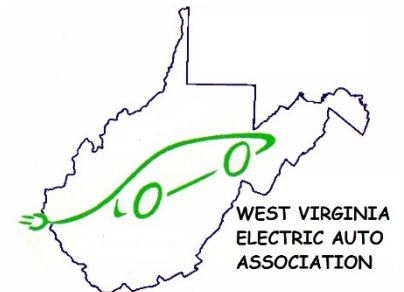


Access Control for Public Charging

Destination Charging - Networked



~\$3700+ per EVSE uninstalled
\$21 / month network fee
Requires field network for billing

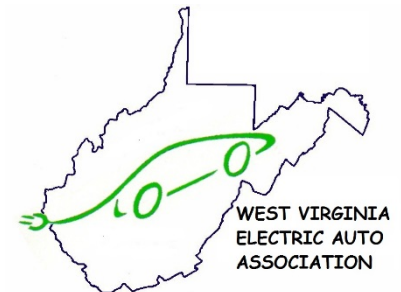


Access Control for Public Charging

480v Fast Charge - Networked



~\$40,000+ per EVSE
Plus network fee
Requires field network for billing



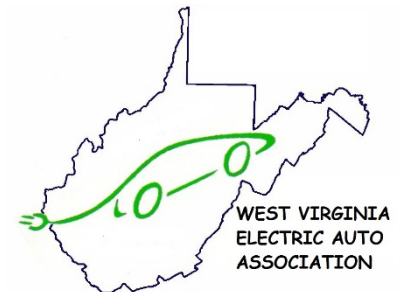
IN SUMMARY

EVs are Here & More are On the Way

- Advances in Electrical Drive Systems and Batteries
- Electric is very Convenient – especially for Job Commuting
- Very Affordable on a Day-to-Day Basis
- Much Reduced Vehicle Maintenance
- REALLY, REALLY FUN to DRIVE!

West Virginia stands to benefit:

- Sustainable Travel
- Reduced Oil Imports
- Grid Friendly Electrical Consumption
- Market Boosts Available for Tourism and Retail Sales



IN CLOSING

**The West Virginia Electric Auto
Association is a ready resource for
Information and Policy Development**

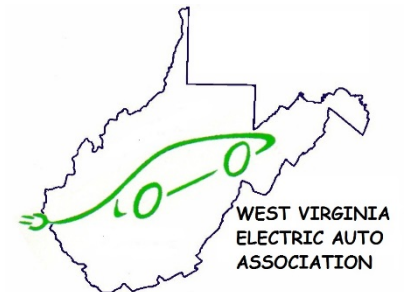
Contact us via the Internet at

www.WVEAA.org

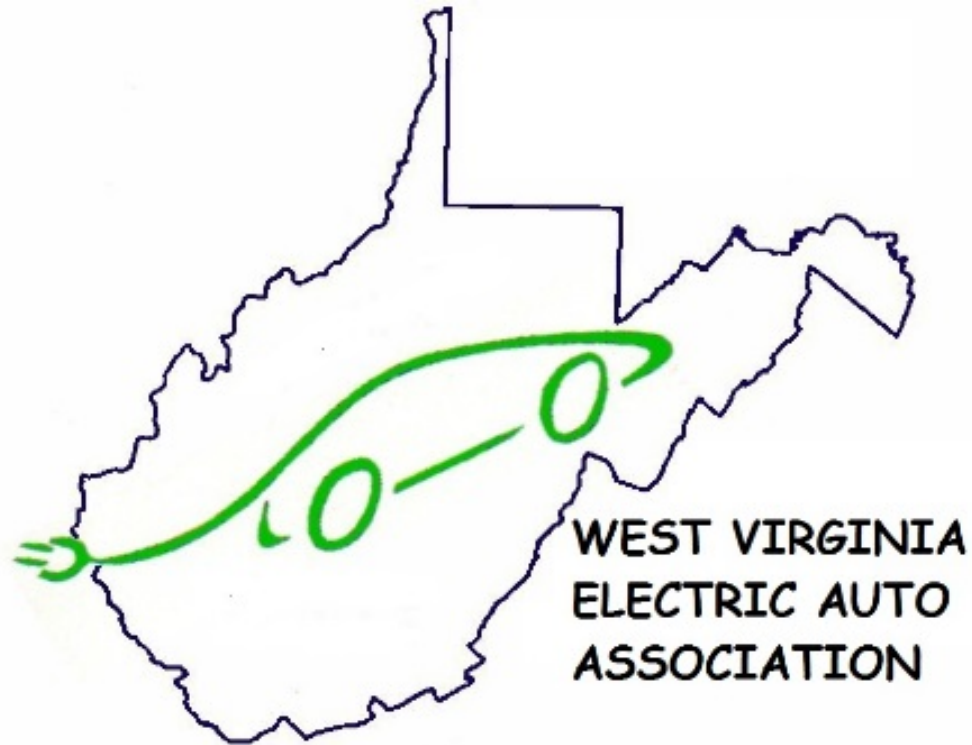
or directly at

Marty Weirick: Marty.Weirick@gmail.com

Larry Harris: lharris1@comcast.net



Electric Autos and West Virginia Energy





ELECTRIC VEHICLES

ELECTRIFICATION IS THE FUTURE! (AGAIN.)

THE EV WAS AHEAD OF ITS TIME...



1830-1860

- 1832: Robert Anderson invents the first crude electric carriage powered by non-rechargeable primary cells.
- 1835: Thomas Davenport is credited with building the first practical electric vehicle - a small locomotive.
- 1859: French physicist Gaston Planté invents the rechargeable lead-acid storage battery. In 1881, his countryman Camille Faure will improve the storage battery's ability to supply current and invent the basic lead-acid battery used in automobiles.



1860-1898

- 1891: William Morrison of Des Moines, Iowa builds the first successful electric automobile in the United States.
- 1897: The first electric taxis hit the streets of New York City early in the year. The Pope Manufacturing Company of Connecticut becomes the first large-scale American electric automobile manufacturer.



1899

- Believing that electricity will run autos in the future, Thomas Alva Edison begins his mission to create a long-lasting, powerful battery for commercial automobiles. Though his research yields some improvements to the alkaline battery, he ultimately abandons his quest a decade later.



1900-1910

- 1900: The electric automobile is in its heyday. Of the 4,192 cars produced in the United States 28 percent are powered by electricity, and electric autos represent about one-third of all cars found on the roads of New York City, Boston, and Chicago.
- 1908: Ford Model T Henry Ford introduces the mass-produced and gasoline-powered Model T, which will have a profound effect on the U.S. automobile market.



1910-1920

- 1912: Charles Kettering invents the first practical electric automobile starter. Kettering's invention makes gasoline-powered autos more alluring to consumers by eliminating the unwieldy hand crank starter and ultimately helps pave the way for the electric car's demise.
- 1920: During the 1920s the electric car ceases to be a viable commercial product. The electric car's downfall is attributable to a number of factors, including the desire for longer distance vehicles, their lack of horsepower, and the ready availability of gasoline.

THE ELECTRIC PRESENT

Why buy an EV today?

- If you have solar, EV and solar are like chocolate and peanut butter – they go better together! Control your fuel source and fuel costs, eliminate emissions!
- If you don't have solar, EV is still a great choice! No local emissions and it only gets cleaner as the grid gets cleaner, which is a lot more than you can say about a gas powered vehicle.
- Efficient
- Quiet
- Convenience of home charging
- Powerful
- Low operational and maintenance costs

THE ELECTRIC PRESENT

EV Purchase Considerations

- As with any vehicle, make sure it's the right vehicle for your needs. Frequently carrying bulky cargo and trying to fit it into most sedans isn't going to work well, electric or not.
- Be honest with yourself about your driving needs and what a BEV can deliver. Consider a PHEV if necessary to fit your driving needs. Or, in a multi-car household, use a BEV and an efficient ICE.
- Keep an eye on federal tax credits as they will expire for some manufacturers this year unless extended. Consider whether you owe enough in federal taxes to benefit from the credit.
- If you travel long distances regularly, consider the charging infrastructure available along your routes.
- If you don't keep a vehicle for many years, remember that EV technology is evolving, so some vehicles may take a greater hit on depreciation as new technology arrives.

HOW MANY KWHs DO I NEED?

- The US Department of Energy provides fuel efficiency ratings for all vehicles.
- For Electric Vehicles (EVs), DOE uses the Miles Per Gallon Equivalent (MPGe) rating.
- To convert MPGe into something a little more useful, just divide the MPGe rating by 33.7 to get miles per kWh (1 gallon gas = 33.7 kWh).
- With this number you can easily determine how many kWhs you will need to generate to cover a given distance annually.

www.fueleconomy.gov
the official U.S. government source for fuel economy information


Find a Car | Save Money & Fuel | Benefits | My MPG | Advanced


You are here: [Find a Car Home](#) > Compare Side-by-Side

Compare Side-by-Side

Fuel Economy | Energy and Environment | Safety | Specs


2018 Tesla Model 3 Long Range X

 **Electric Vehicle**




Automatic (A1)
MSRP: \$35,000

Electricity

 **130** MPGe
combined city highway
city/highway
26 kWh/100 mi

EPA Fuel Economy
1 gallon of gasoline=33.7 kWh
[Show electric charging stations near me](#)

Electricity 
310 miles
Total Range

Personalize

Diagram illustrating the conversion of EPA Fuel Economy to Electricity consumption and Total Range for an electric vehicle.

Orange arrows indicate the flow of information:

- From EPA Fuel Economy (1 gallon of gasoline=33.7 kWh) to Electricity consumption (130 MPGe, 26 kWh/100 mi).
- From Electricity consumption (130 MPGe, 26 kWh/100 mi) to Total Range (310 miles).

HOW MANY KWHs DO I NEED?

- Using the Tesla Model 3 as an example, it's 130 MPGe rating equates to 3.86 miles/kWh.
- If you planned to drive this vehicle 12,000 miles per year and charge exclusively at home, then you would need to generate 3,108 kWh of electricity for the car ($12,000 / 3.86 = 3,108$).
- Add about 10% more for charging losses and you arrive at 3,418 kWh annually.
- As a solar homeowner, now you know how much energy you need to generate on an annual basis to offset the energy used by this EV or how much grid energy you will use and the cost.

www.fueleconomy.gov
the official U.S. government source for fuel economy information

Find a Car | Save Money & Fuel | Benefits | My MPG | Advanced

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Personalize

2018 Tesla Model 3 Long Range

Electric Vehicle



Automatic (A1)
MSRP: \$35,000

EPA Fuel Economy
1 gallon of gasoline=33.7 kWh

[Show electric charging stations near me](#)

Electricity

130 MPGe
combined city highway
city/highway
26 kWh/100 mi

Electricity

310 miles
Total Range

FACTORS THAT AFFECT EV EFFICIENCY

- Similar to an ICE vehicle, EV efficiency and therefore its range is affected by many factors. Some of these are in your control, others are not.
- The largest factors that affect EV efficiency include:
 - Temperature (batteries are like Goldilocks...)
 - Driving speed (speed kills your driving range roughly because 2x speed requires 4x energy)
 - Driving conditions (city vs highway driving is the opposite of what you're familiar with)
 - Driving style (aggressive driving is always less efficient in any vehicle)
 - Accessory usage (heating, cooling)
 - Battery age, degradation

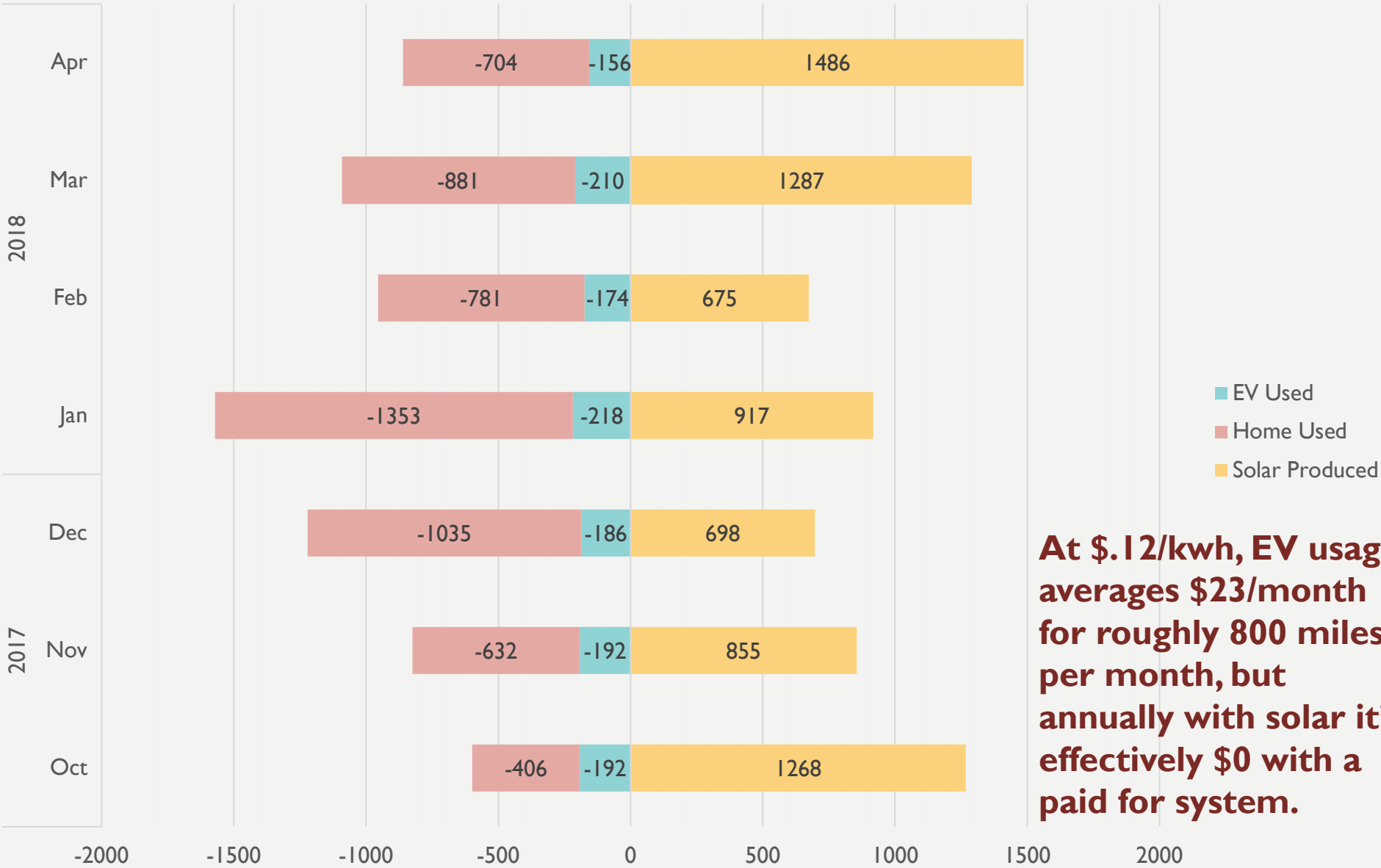


CLOSE TO HOME

Frequently Asked Questions

- Do you have to charge during the day? No, but it's nice when you can!
- How much does an EVSE (charger) cost? Depends, but \$300-\$600.
- Can you charge the car and run the dryer, electric range, etc.? Yes.
- What do you enjoy most? "Free" fuel and charging at home. Did I mention free fuel?
- How much energy does the EV use compared to the home?

Actual Solar Production vs Home & BEV Usage (kWh)



At \$.12/kwh, EV usage averages \$23/month for roughly 800 miles per month, but annually with solar it's effectively \$0 with a paid for system.

THE ELECTRIC PRESENT – OTHER TRANSPORT



“...contract to build seven battery-powered ferries for Fjord, Norwegian transport conglomerate. The news comes after the operators of the first all-electric ferry in Norway, the *Ampere*, reported impressive statistics after operating the ship for over 2 years. **They claim that the all-electric ferry cuts emissions by 95% and costs by 80%.**”

“No Need To Wait: Electric Buses Are Cost-Competitive Transit Buses Today!”

**Proterra
Catalyst E2**



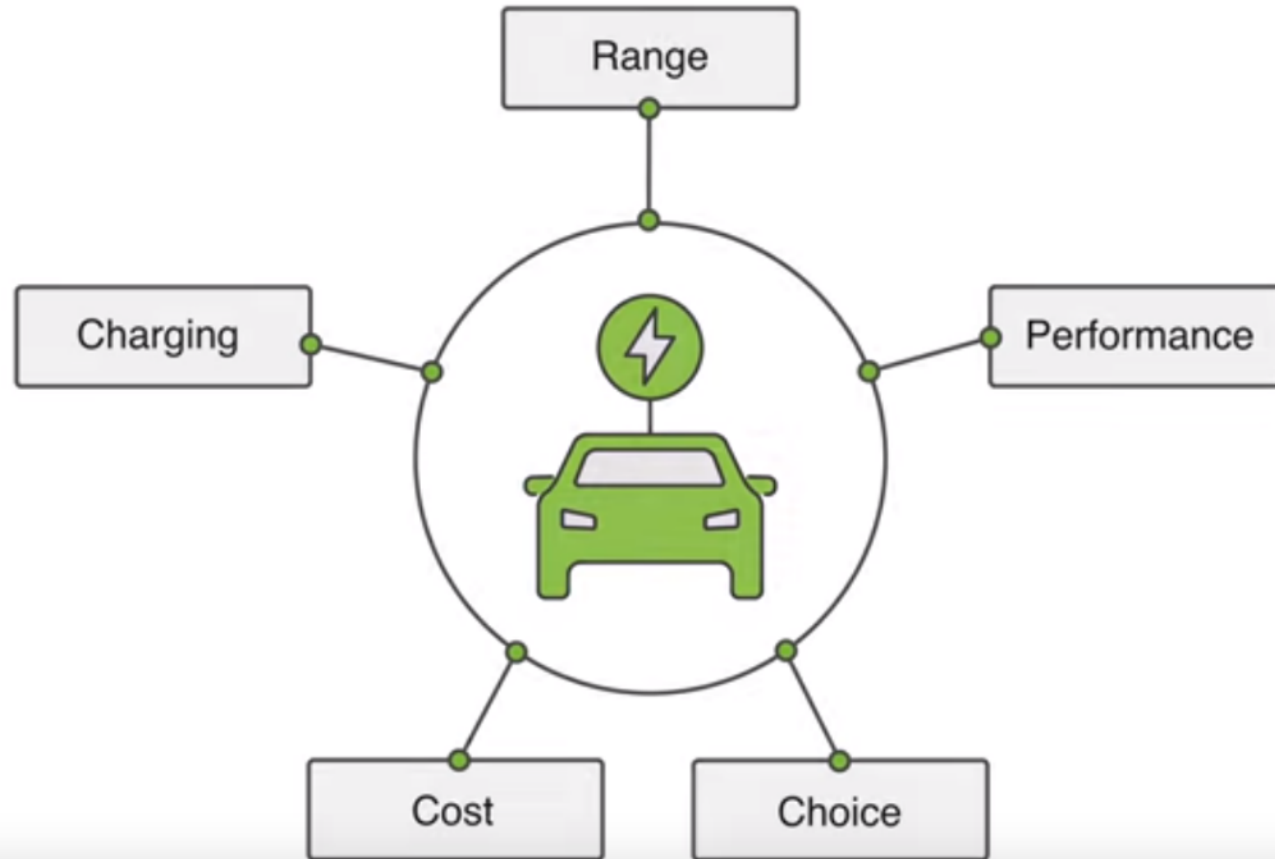
Pipistrel Alpha Electro
Serial production Battery Electric Aircraft

WHERE WE'RE GOING, WE DON'T NEED GAS!

The logo for the movie "Back to the Future" is displayed on a black rectangular background. The word "BACK" is in a large, bold, italicized font with a red-to-yellow gradient and a blue outline. The word "TO" is smaller and positioned to the left of "FUTURE". The word "FUTURE" is in the same large, bold, italicized font as "BACK", also with a red-to-yellow gradient and a blue outline. A small trademark symbol (TM) is located at the end of "FUTURE".

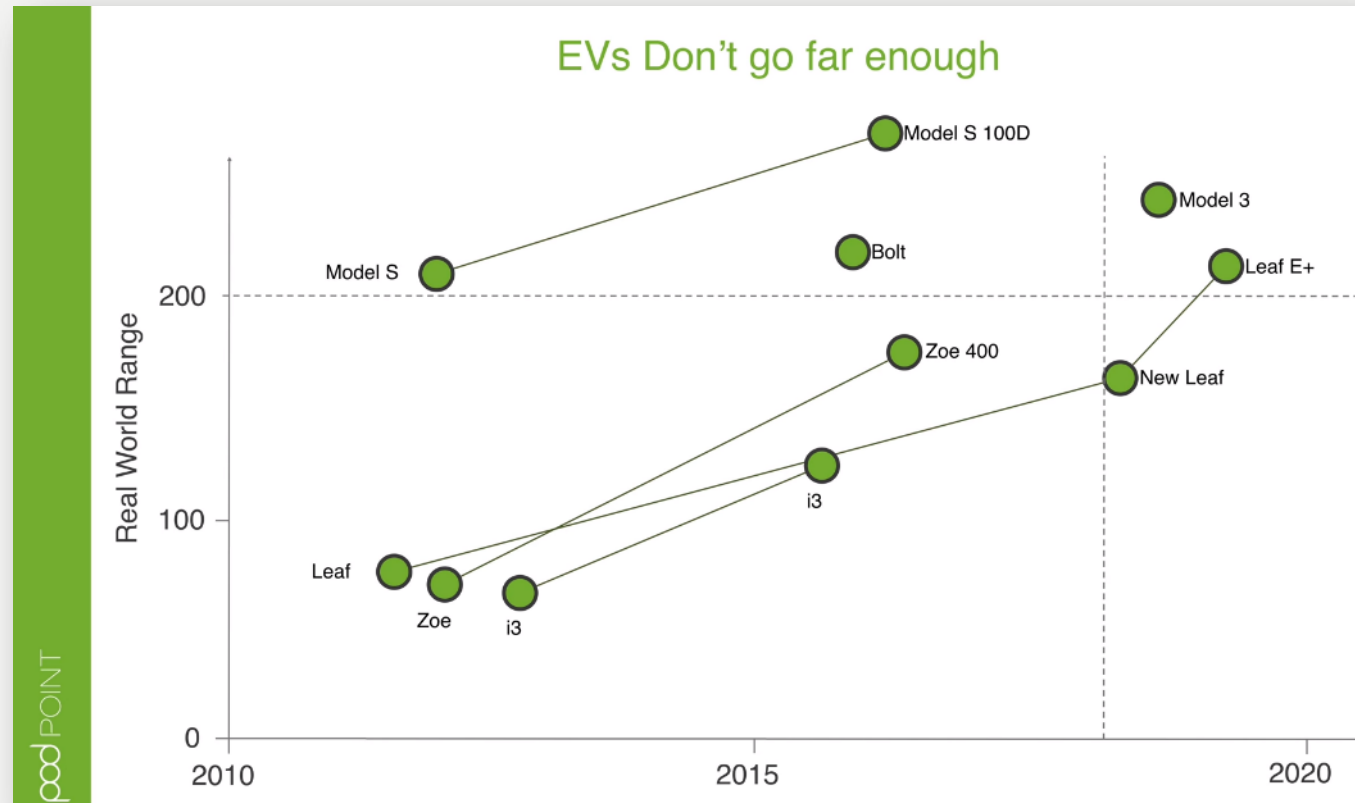
**BACK
TO
THE FUTURE™**

BARRIERS TO BEV ADOPTION



BEV RANGE

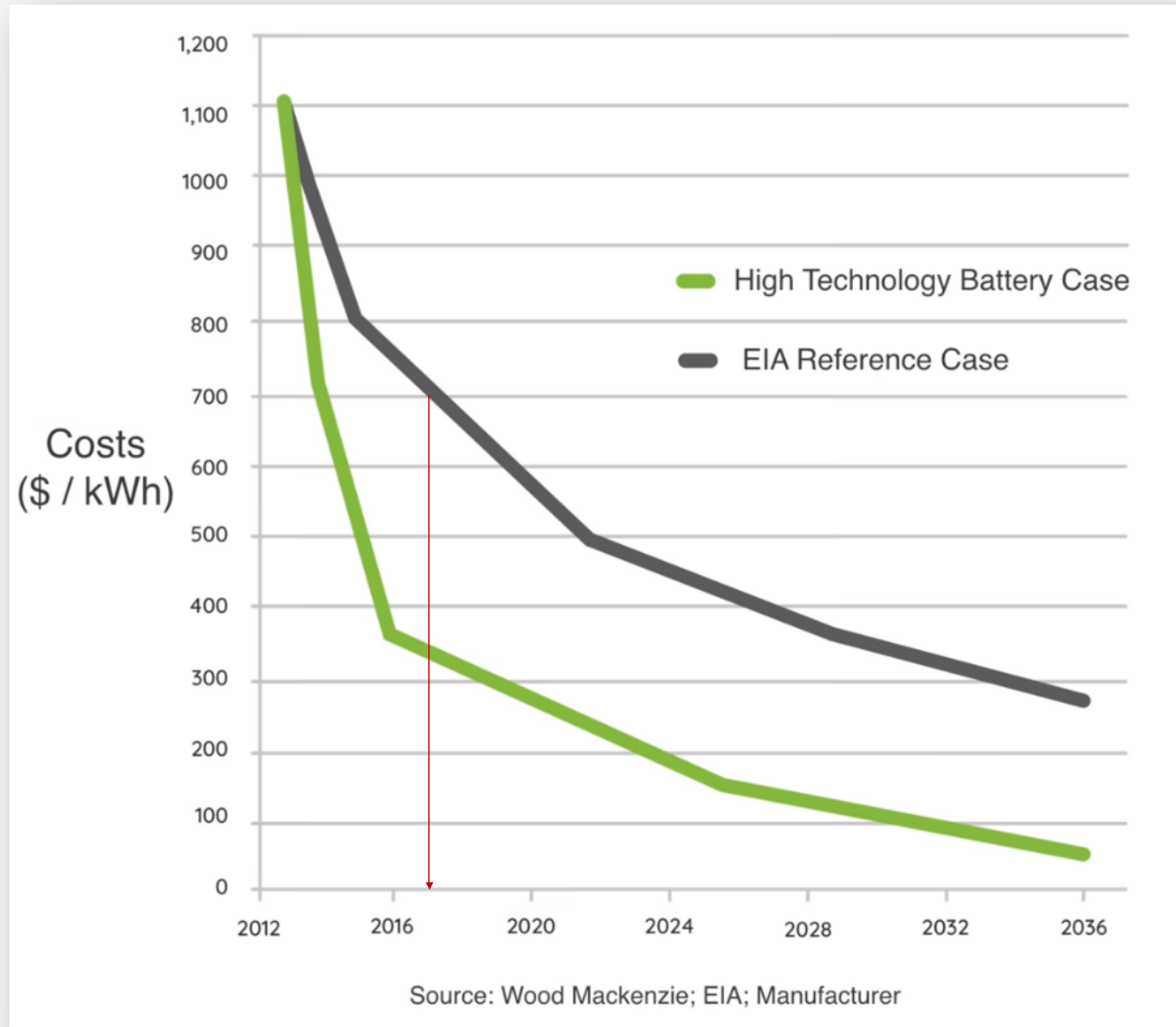
- One of the greatest historic barriers to adoption is being solved fairly rapidly.
- Multiple models with more than 200 miles of range, some greater than 300, are either in production or will be soon.
- This includes all Tesla models, Chevrolet Bolt, 2019 Nissan Leaf, Jaguar i-PACE, etc.



BEV COST

- Unlike ICE vehicles with thousands of moving parts, the BEV is comparatively simple and therefore less expensive to produce.
- You don't realize this in the sticker price because of the battery, which is currently the single most expensive component of a BEV.
- However, as scale production of lithium ion batteries comes online worldwide, the price of battery packs is set to keep dropping. New technologies may also emerge.
- When that happens, the cost of BEV ownership will drop below dramatically compared with ICE vehicles.
- At some point in the not too distant future, the shoe will be on the other foot. You'll have to have a reason to justify purchasing an ICE vehicle because it will be more expensive to purchase and maintain.

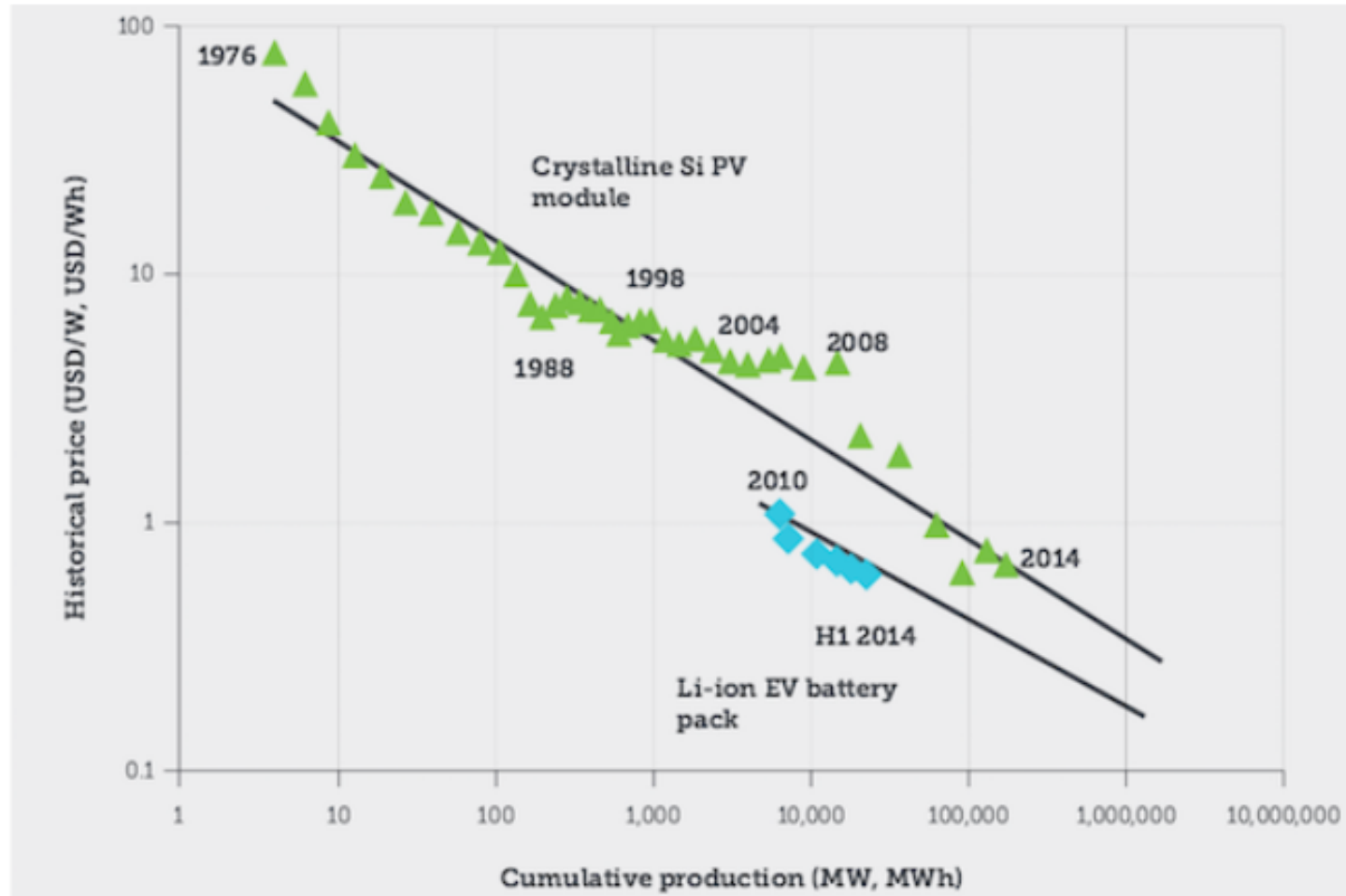
BATTERY COST PROJECTIONS



ANOTHER LOOK AT BATTERY COSTS



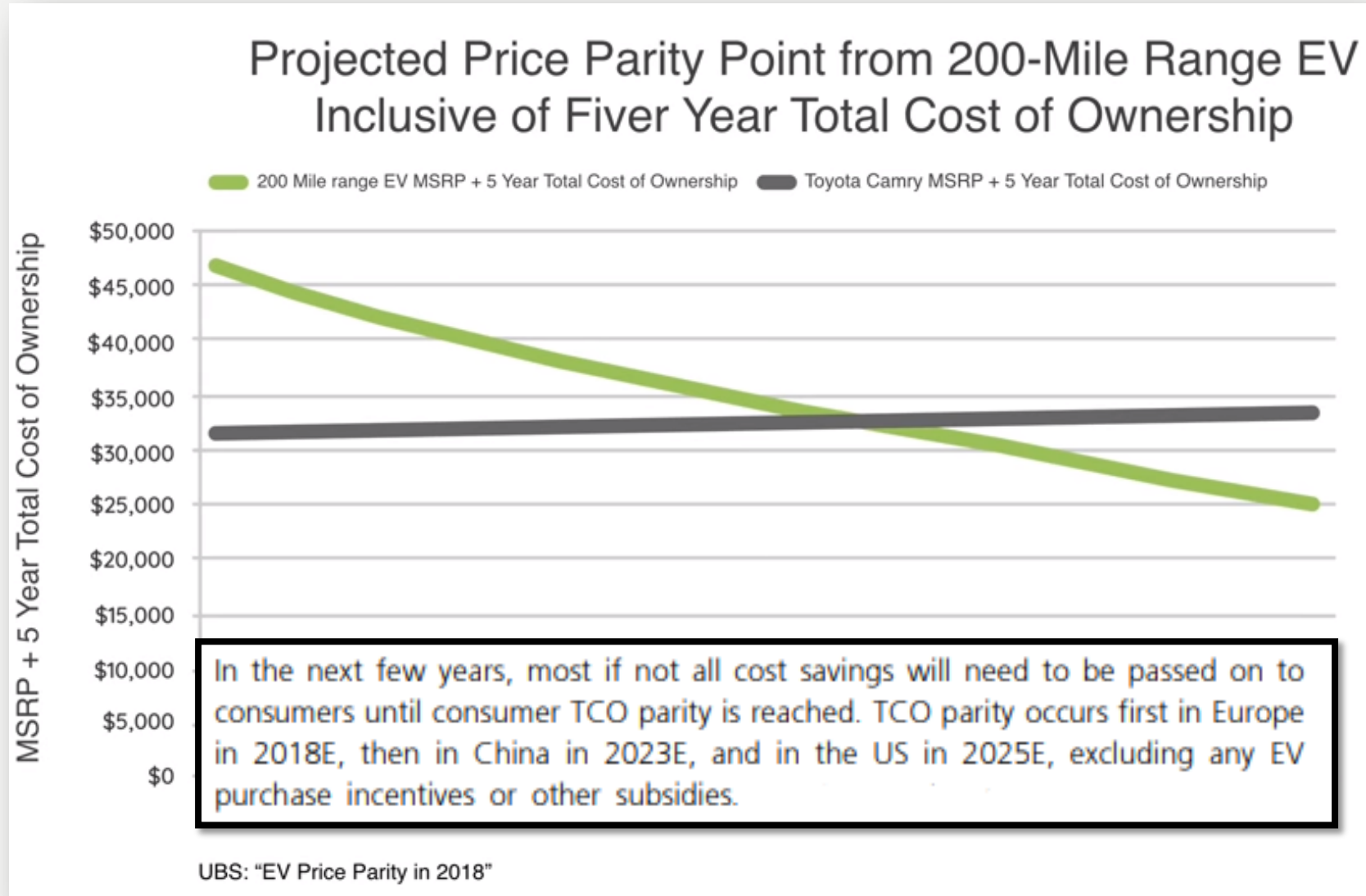
THIS LOOKS FAMILIAR...



Note: Prices are in real (2014) USD

Source: Adapted from Liebreich 2015

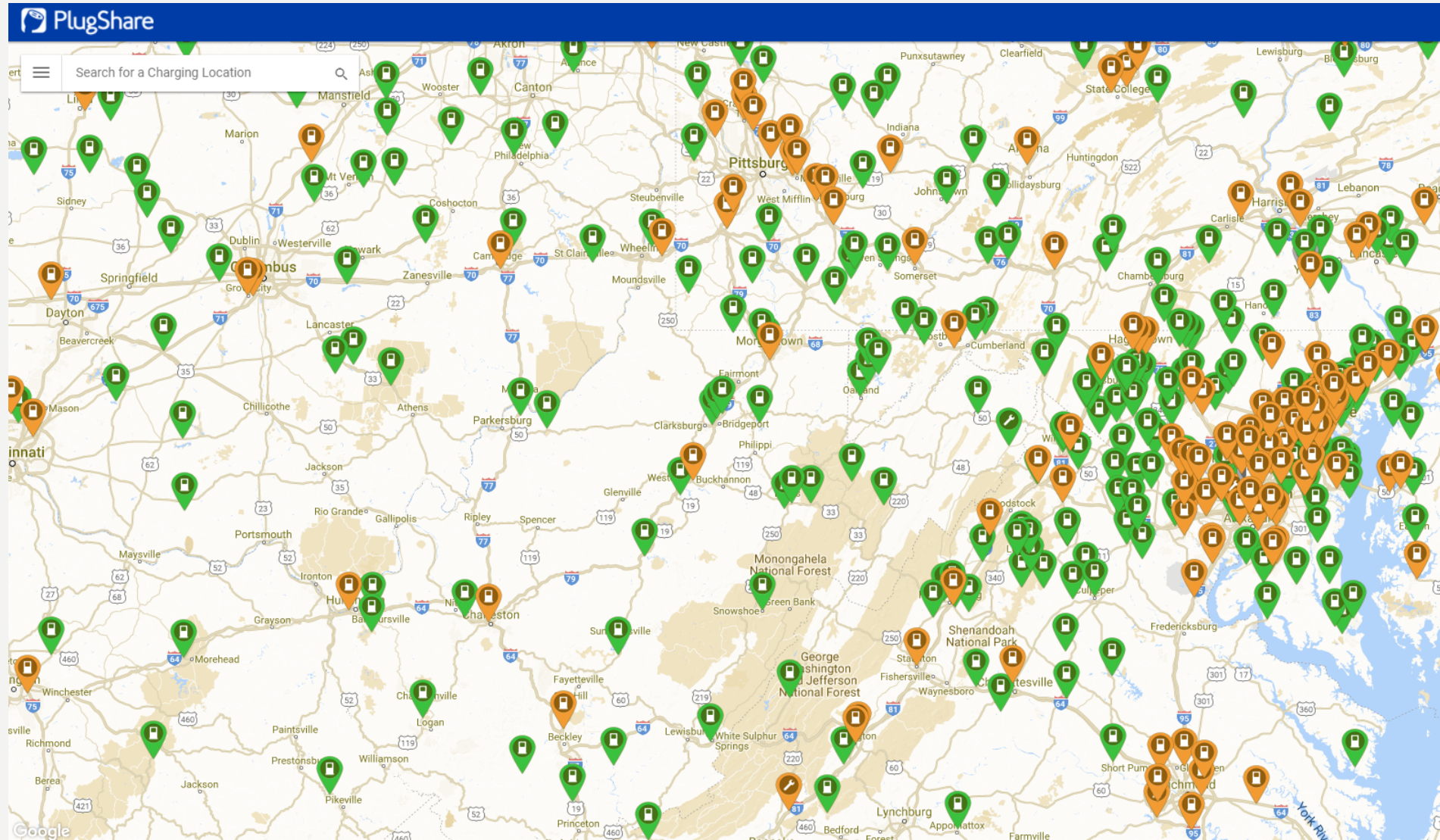
PROJECTED EV vs ICE PRICE PARITY



CHARGING

- Practical long distance travel with a non-Tesla BEV is still a challenge. It may be better than ever before, but it's still not great. Rural areas can be challenging for any BEV, including Tesla.
- Competing high-speed charging (L3) standards are part of the issue. CCS vs CHAdeMO vs SuperCharger and different support among manufacturers doesn't help. Beta vs VHS...
- Even with L3, not all high speed charging is equal nor is the support between vehicles. Plugging into an 80 kW DC fast charger won't mean much if your car only supports 40kW fast charging.
- Until fast charging options are plentiful and standardized, PHEVs still offer value for long distance or rural travel.
- With increasing interest in fast charging, however, I do see this issue being resolved in the near future. As BEVs become cheaper, demand for charging will increase and the market will respond. It's not a matter of if, but when.

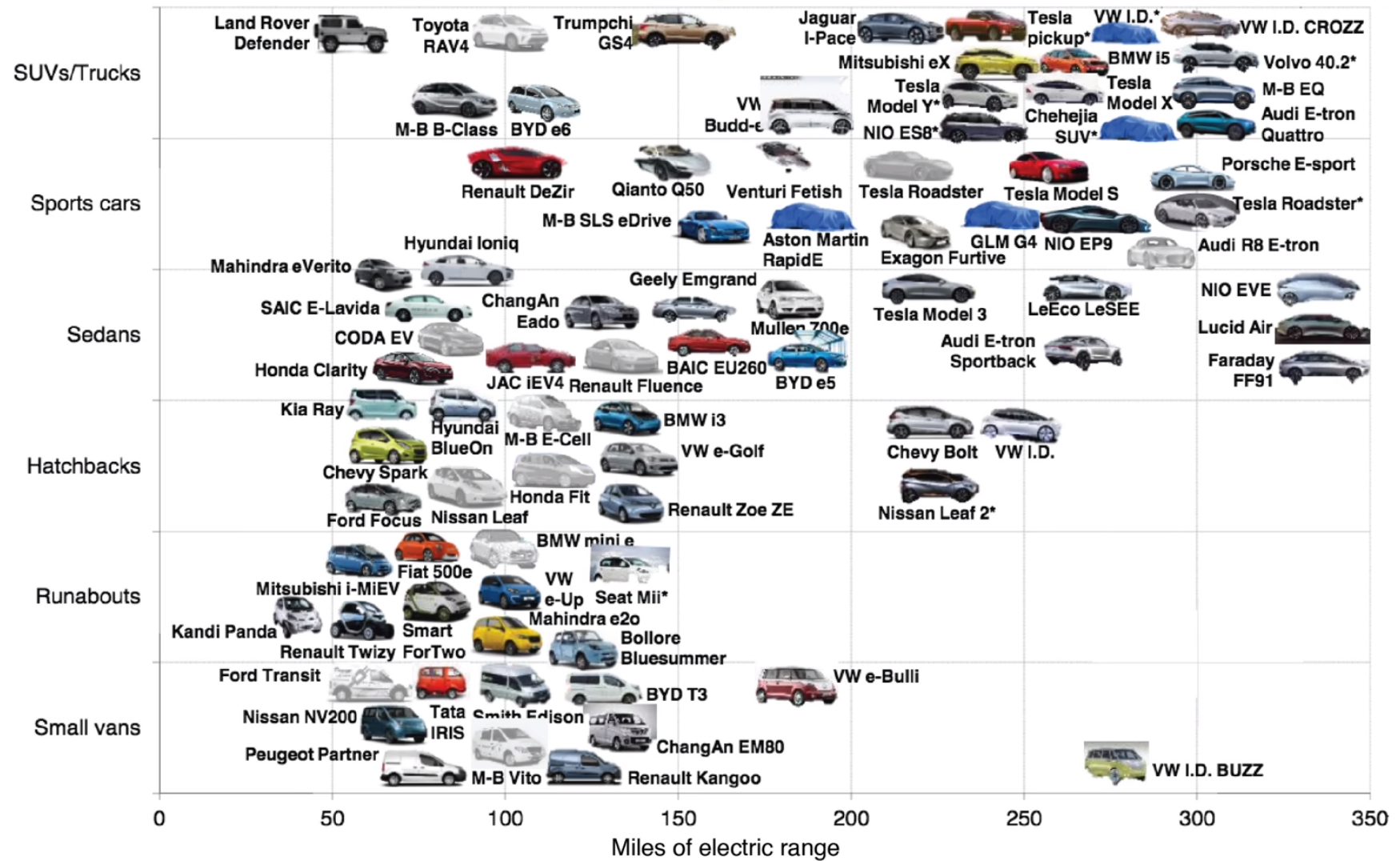
CHARGING



CHARGING



CHOICE



CHOICE: TRUCKS AND VANS



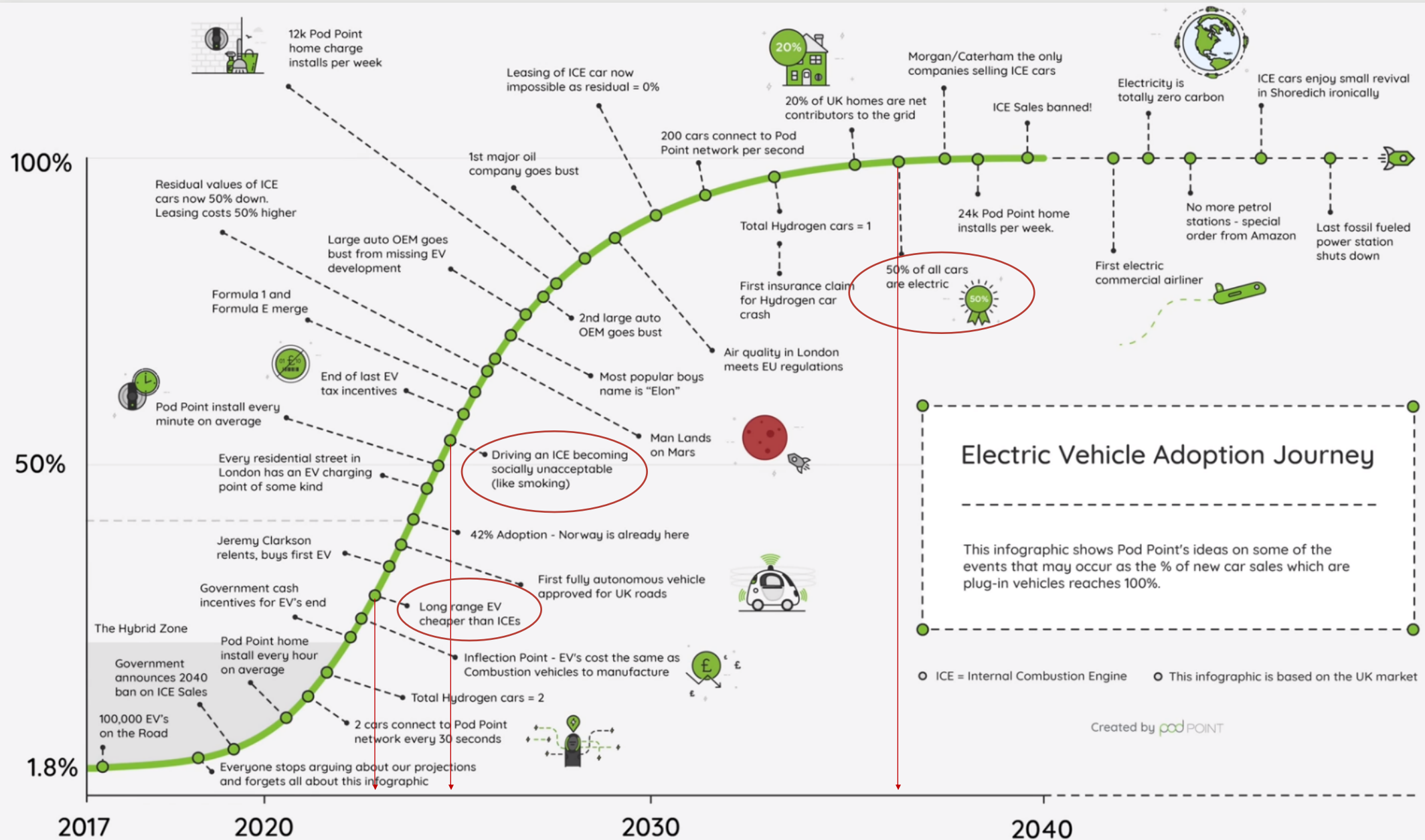
Workhorse
Delivery Vans and
Work Trucks

Bollinger B1
Heavy Duty SUV



PERFORMANCE





OTHER FUTURE EV TECH

- New battery technologies: solid state batteries are the ultimate energy storage solution, but there are many barriers to large scale production. Battery chemistries and other improvements will continue to drive down battery cost and increase energy density.
- EV to Grid: Two way power transfer to/from EVs with larger battery packs could help balance the load on the grid and provide emergency power for your home.
- Wireless charging: Top up anywhere, no cable needed.

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<https://electrek.co/2018/03/05/all-electric-ferries-battery-packs/>