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Automotive Technology Summit

EVs are in Your Future!

What Will It All Mean?

About me

In Industry since 1979

Dealership Tech, Shop Owner

Educator – Allen Testproducts, General Motors, Brevard Community College

Product Manager – SPX, AutoCare, Delphi, Alldata

Director, Product Management Mitchell1

AutoCare Association Emerging Technologies committee, ETI past-president, AASA Technology Committee Executive Board

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History of EV's

Photo courtesy of Wikimedia Commons.

1832

First Crude Electric Vehicle Is Developed

Around 1832, Robert Anderson develops the first crude electric vehicle, but it isn't until the 1870s or later that electric cars become practical. Pictured here is an electric vehicle built by an English inventor in 1884.

1913 – 1914
Henry Ford & Thomas Edison experimental electric vehicles together

1975 Sebring-Vanguard CitiCar

1996 GM EV1

2000 Toyota Prius – first mass-produced hybrid

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Tesla Proved EV's don't have to be Boring

2022 Tesla Model S $104,990

375mi	155mph	3.1sec
Range (est.)	Top Speed	0-60 mph

2022 Tesla Model 3 $46,990

334mi	145mph	4.2sec
Range (est.)	Top Speed	0-60 mph

2022 Tesla Model X $120,990

330mi	155mph	3.8sec
Range (est.)	Top Speed	0-60 mph

2022 Tesla Model Y $65,990

318mi	135mph	4.8sec
Range (est.)	Top Speed	0-60 mph

Incumbent OE's rise to the challenge

2022 Ford Mustang Mach E
$43,895

2022 Hyundai IONIQ 5 $39,950

2023 VW ID.4 $37,495

2022 Ford F-150 Lightning
$39,947

2023 Nissan Leaf $27,800

2022 Mazda MX-30 EV $33,470

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Along with new nameplates

2022 Lucid Air $87,400

2022 Rivian R1S $72,500

2022 Rivian R1T $67,500

2022 Polestar 2 $48,400

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What's lution?

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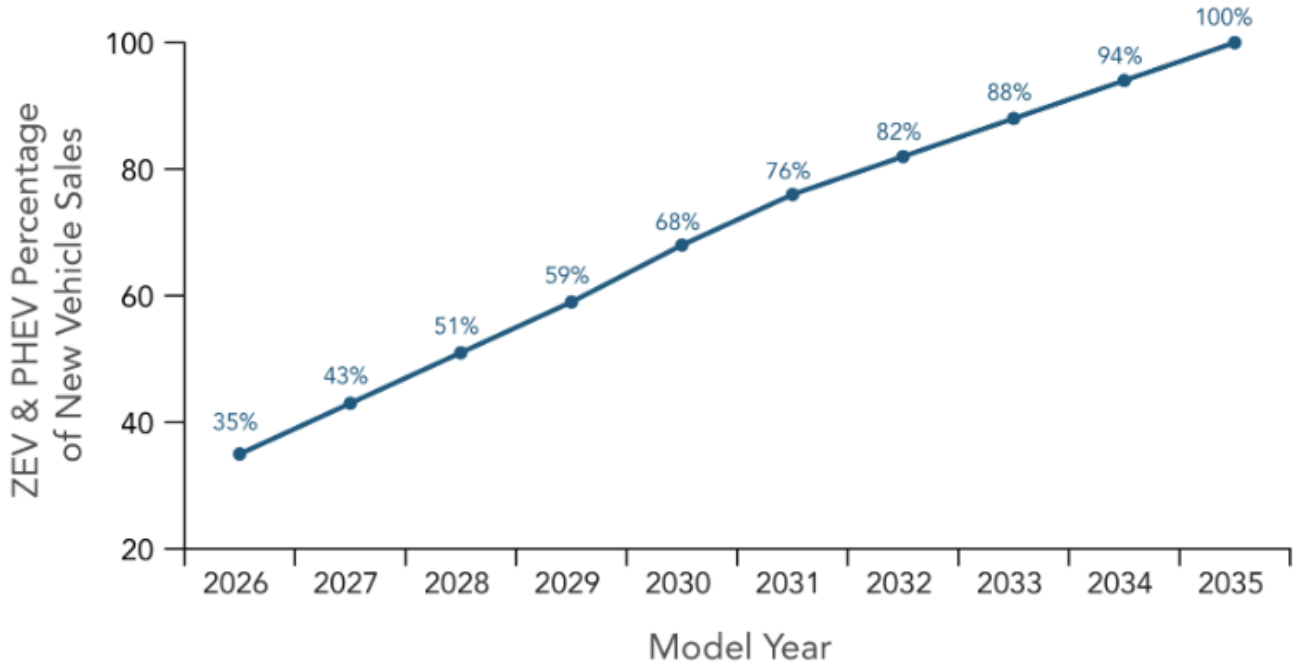
California Zero Emissions Vehicle Mandate

- Under new rules:
  - 35% of new vehicles must be zero emissions by 2026
  - 68% by 2030
  - 100% by 2035



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California Zero Emissions Vehicle Mandate

- Under new rules:
  - 35% of new vehicles must be zero emissions by 2026
  - 68% by 2030
  - 100% by 2035
- Consumers or businesses can still buy internal combustion engine-equipped vehicles in other states
  - Owners of ICE-equipped vehicles can still drive them after 2035
  - It's still legal to buy and sell used ICE-equipped cars and light trucks
  - HD vehicles zero emission mandate by 2045

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California Zero Emissions Vehicle Mandate

- The zero-emission vehicle mandate includes vehicles that are not zero-emission
  - Up to 20% of a carmaker's sales can be plug-in hybrids (PHEV), which have both electric motors and gas engines, and still count as zero-emission vehicles as long as the battery range is 50 miles or more
- Not all automakers are on-board with mandate
- Challenges remain:
  - Costs
  - Charging at multi-family housing
  - Customer acceptance

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Account Ending: 9529
2047 JOHNSTON G

Tomorrow is a Power Saver Rewards Event Day

A Power Saver Rewards event will take place tomorrow from **4:00PM – 8:59PM**. Earn incentives when you conserve energy between **4:00PM and 8:59PM** tomorrow.

Date:	9/7/2022
Time:	4:00PM – 8:59PM

Thank you for your continued participation in the Power Saver Rewards program and your efforts to conserve energy. Your collective efforts during this prolonged heatwave have made a difference. Our work is not done yet. The heatwave is expected to continue through much of this week and the California Independent System Operator (CAISO), which manages the state's power grid and directs utilities to initiate rotating outages, has warned that the situation is still critical. We are asking that you keep up the good work. Conservation is essential in helping reduce the possibility of widespread rotating outages and the number of impacted customers.

By conserving electricity and shifting use outside the hours of **4:00PM to 8:59PM**, you can support the California energy grid, and earn $2/kWh for energy use below your typical use, too. The more energy you can save, the more you can earn.

Ways to Save

- Pre-cool your home before **4:00PM** and adjust your thermostat to 78 degrees between **4:00PM and 8:59PM**.
- Shift high energy-consuming chores such as running the dishwasher, laundry or EV charging to before **4:00PM or after 8:59PM**.
- Turn off unnecessary lights.

Looking to see the success of your energy saving efforts after the Power Saver Rewards?

- Check out your bill credit details, after your bill credit is posted in My Account.
- Visit My Account and check out your home's energy usage on the date of the Power Saver Rewards event.

Remember, the more energy you save, the higher your reward can be. If you're looking to learn more about the program or looking for energy savings tips, visit sdge.com/powersaver or you can contact our Power Saver Rewards call center at (866) 291-9516.

2022 TESLA

CALIFORNIA EDITION

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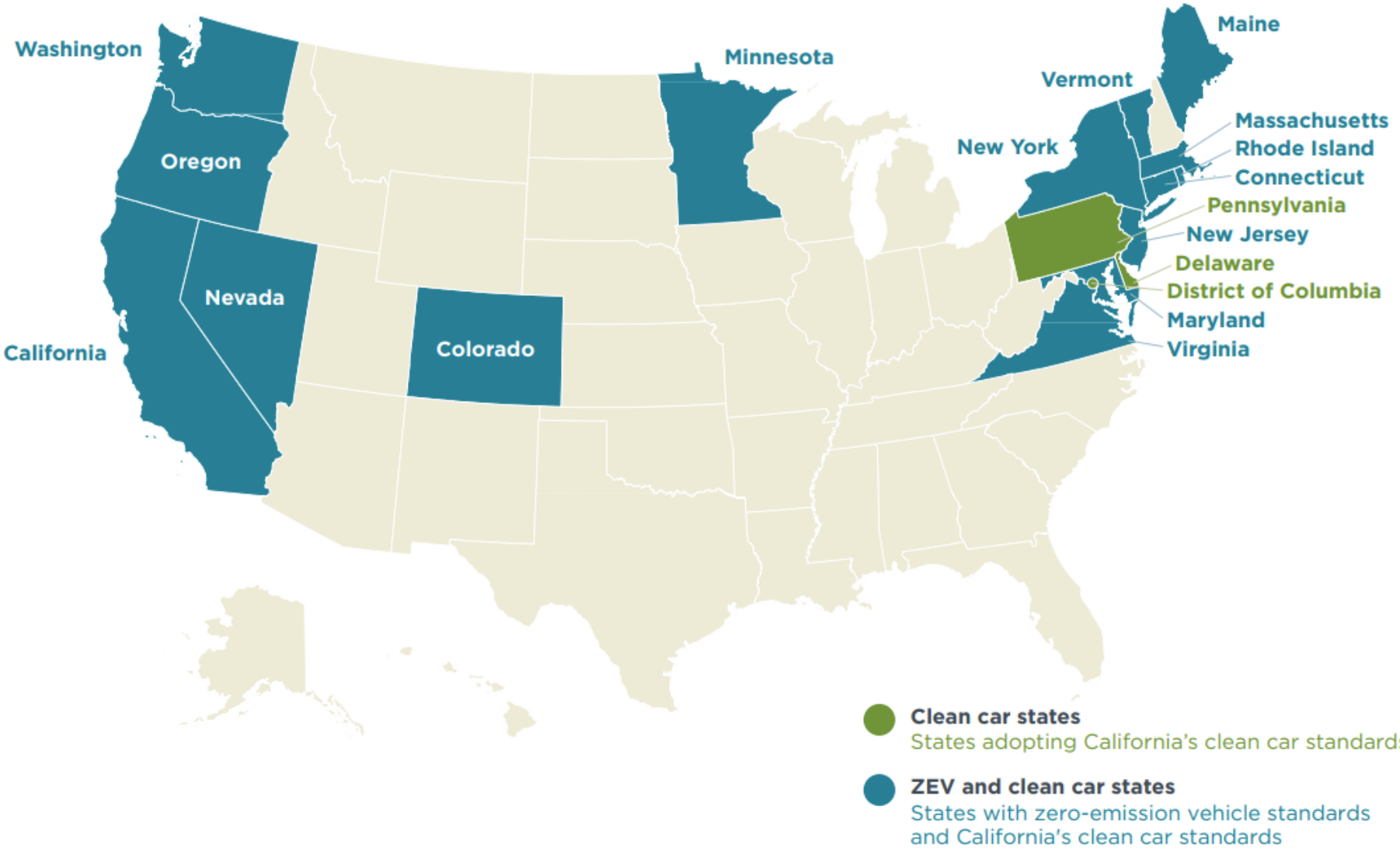
What's Driving the EV Revolution?



- Washington
- Oregon
- Maine
- Massachusetts

- Colorado
- Illinois

- Pennsylvania
- Virginia
- Minnesota

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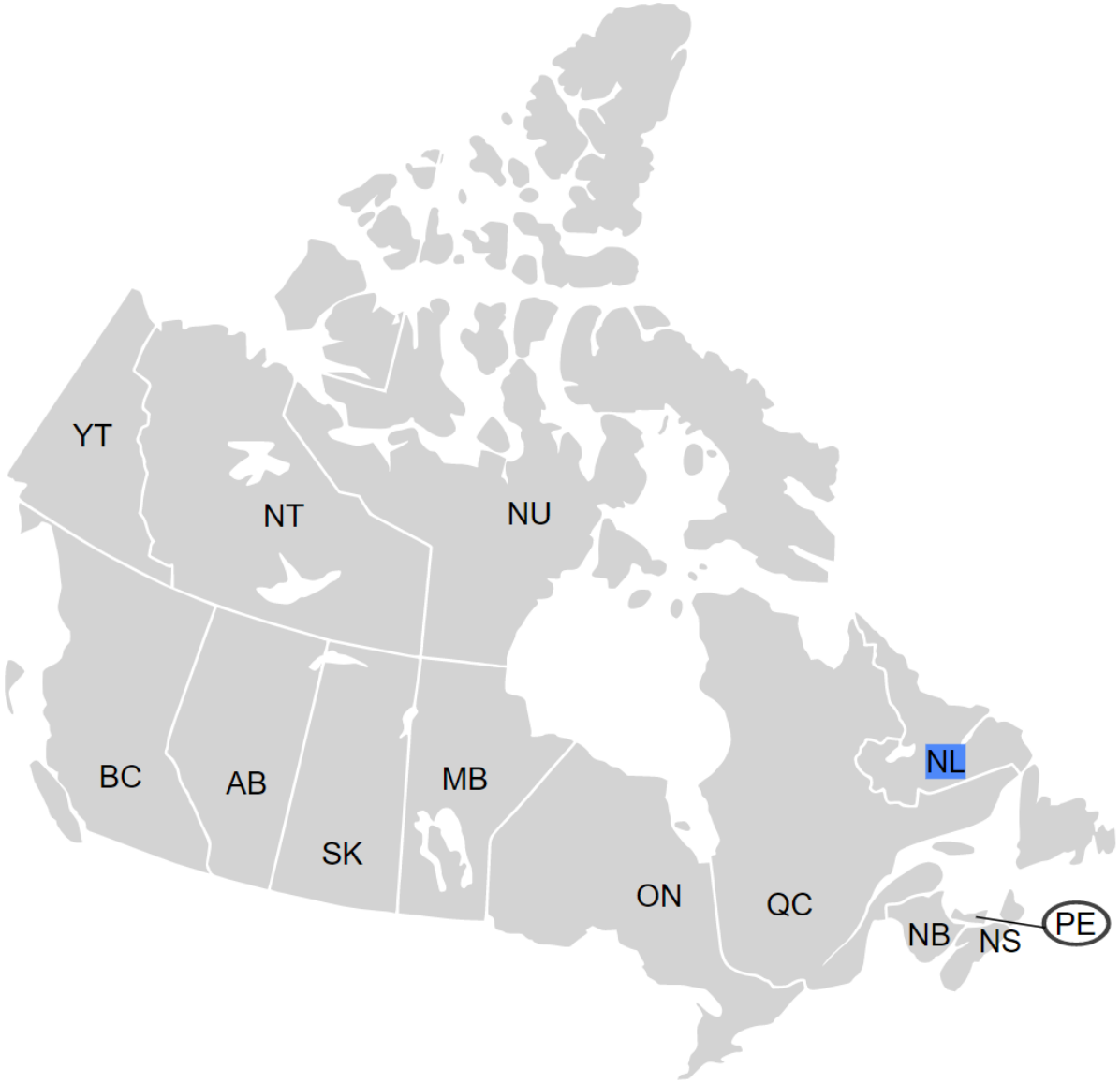
Canada Announces ZEV Mandate by 2035



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Growing Pains

"The world needs more oil and gas now to deal with an energy shortage while pushing to transition to renewable supplies." – Elon Musk, ONS Energy Conference, Norway
(Tesla (TSLA) Elon Musk Says World Needs More Oil and Gas as Bridge to Renewables – Bloomberg)

"The shift to relying on electricity for transport requires more battery materials including iron and lithium…That industry needs to expand massively so enough cells can be made to replace the energy provided by fossil fuels." – Elon Musk, ONS Energy Conference, Norway
(Tesla (TSLA) Elon Musk Says World Needs More Oil and Gas as Bridge to Renewables – Bloomberg)

"staggering amount of work and investment that is needed to scale this industry quickly"; and that "90% to 95% of the battery capacity supply chain the industry will need over the next 10 years has not been built yet" – RJ Scaringe, CERA Week 2022, Houston
(https://ihsmarkit.com/research-analysis/fuel-thought-pace-change-energy-mobility-climate-innovations.html)

""How did the F-150 Lightning fare in this head-to-head challenge? Let's just say it didn't match up well against the gas-powered Sierra. Towing the travel trailer significantly ate into the EV's range, limiting how far the truck could drive before requiring a recharge"
- RV.com (See How Towing a Travel Trailer Impacts the Range of an Electric F-150 Lightning – RV.com)

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Can you imagine 30 min + per vehicle?

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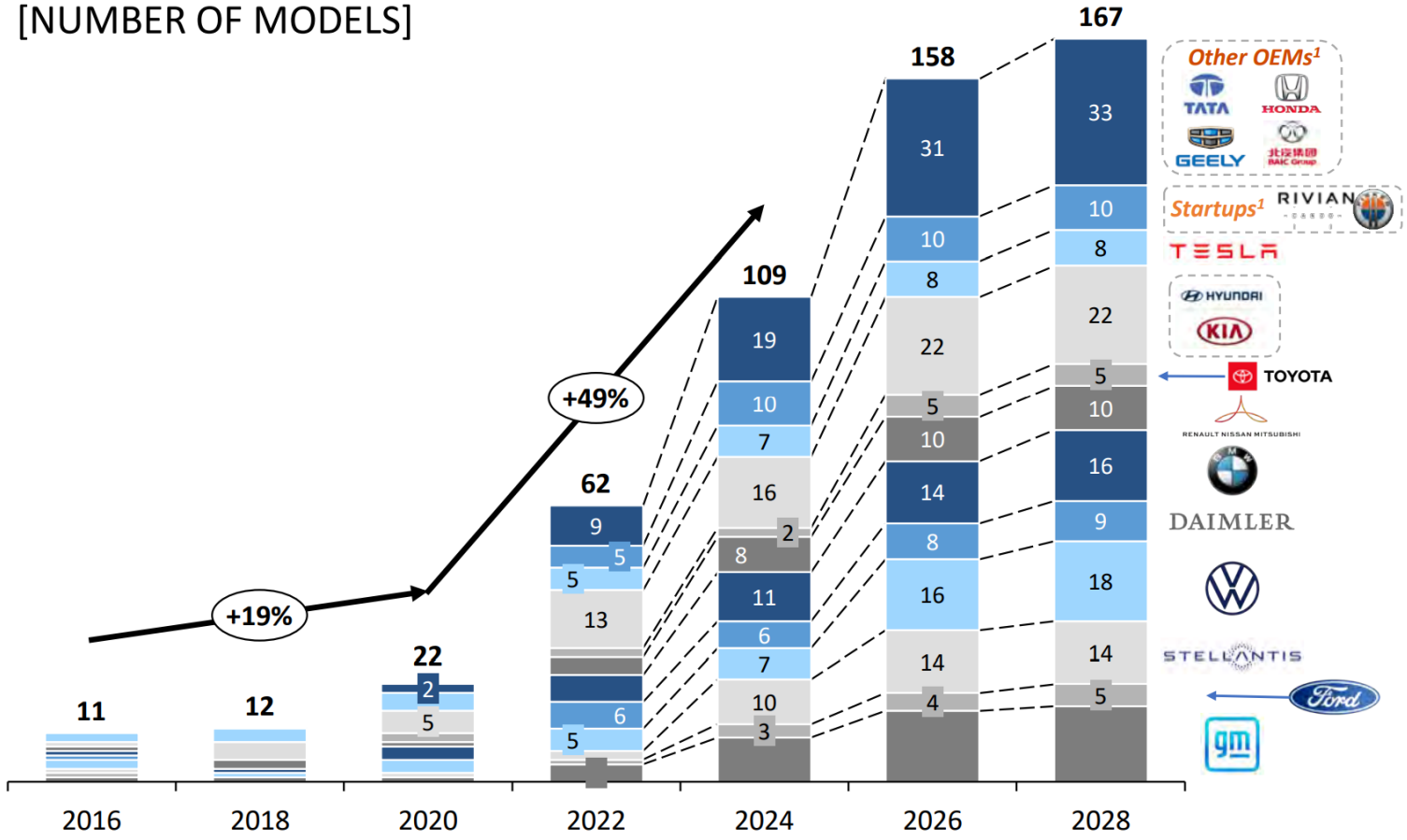
EV Launches Accelerating – Driven by incumbent OEMs

2016-2028F EV MODELS PRODUCED IN NORTH AMERICA
[NUMBER OF MODELS]

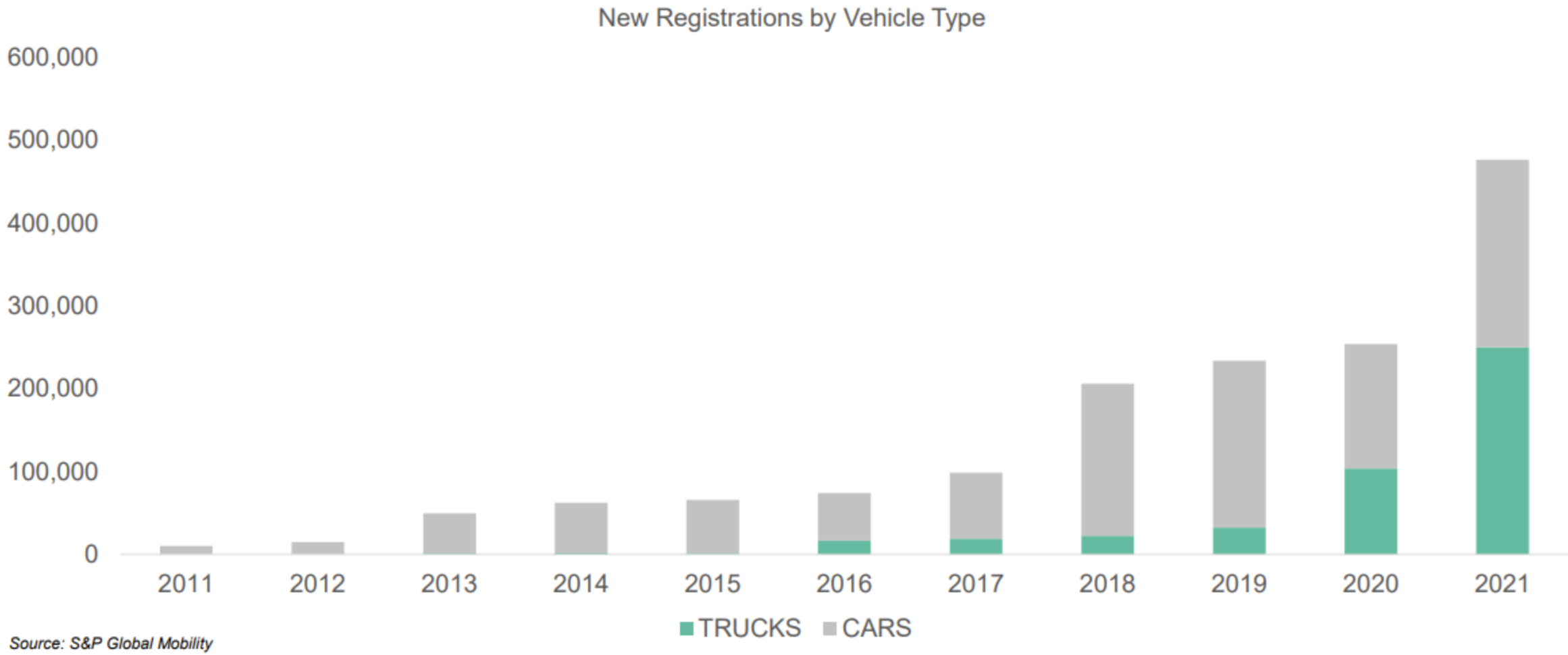


Discussion

- Nearly **90 new EV models** are expected between 2020 and 2024
- **Various EV startups** intend to release **10 new models** between 2020 and 2024
- **Major OEMs** such as GM, Stellantis, and VW intend to introduce the **bulk of their EV models in 2024+**
- Other OEMs intend to introduce BEV models later in the decade

Source: IHS Markit June 2021 Forecast Release, Strategy& Analysis
Note: Available models assessed as models produced and/or sold in a specific region. Various PV and LCVs excluded based on available information and intended market. Variations of models / nameplates consolidated to a single model or nameplate when deemed appropriate. Excludes models with planned regional sales <1000 units ; (1) Non-exhaustive

Truck body style EVs boosting registrations



Source: S&P Global Mobility

S&P Global Mobility

The Battery Electric Vehicle (BEV) Landscape is Changing

US BEV Market

	2021	2030
Tesla Share of US EV Sales	71%	10%
California Share of US EV Sales	35%	12%
Top 90% **Brands** of US EV volume		
Models # of EV Models	26	250+
Charging Infrastructure Private, Public, Semi-Public Stations	0.94M	15.3M

Source: S&P Global; 2021 based on Total New Registrations

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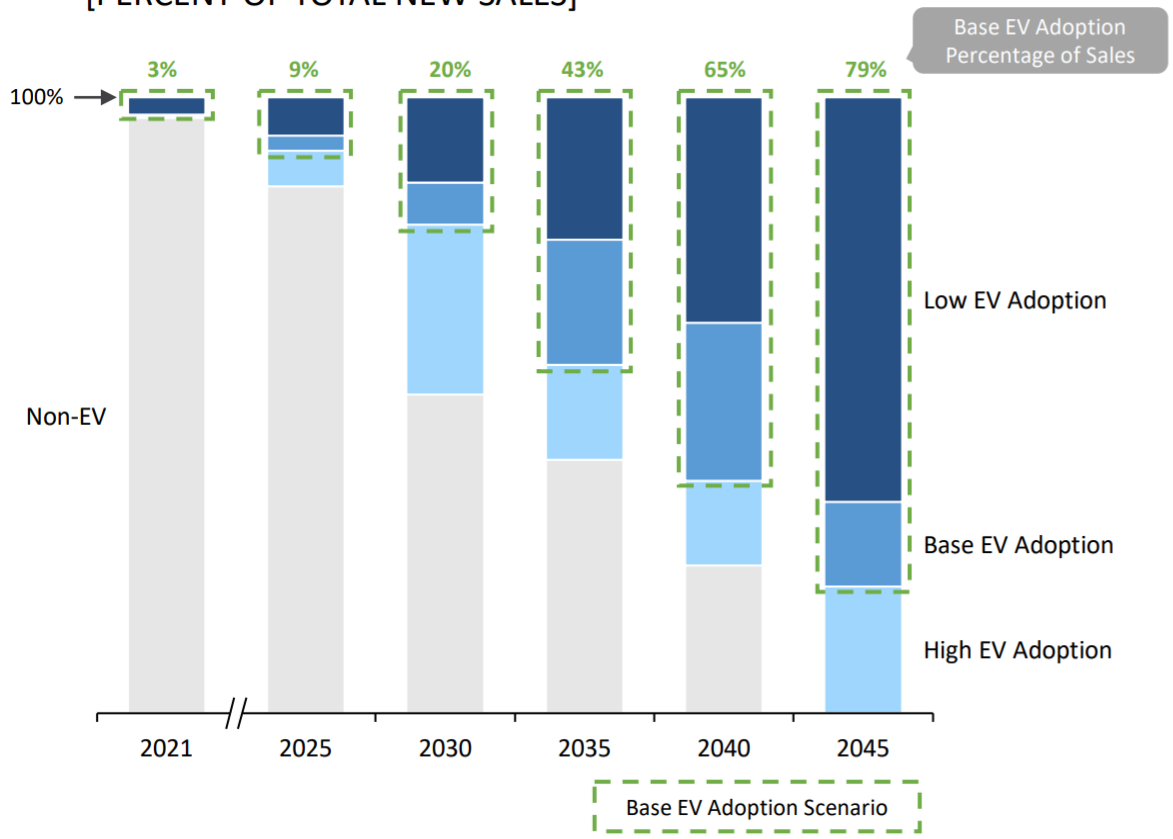
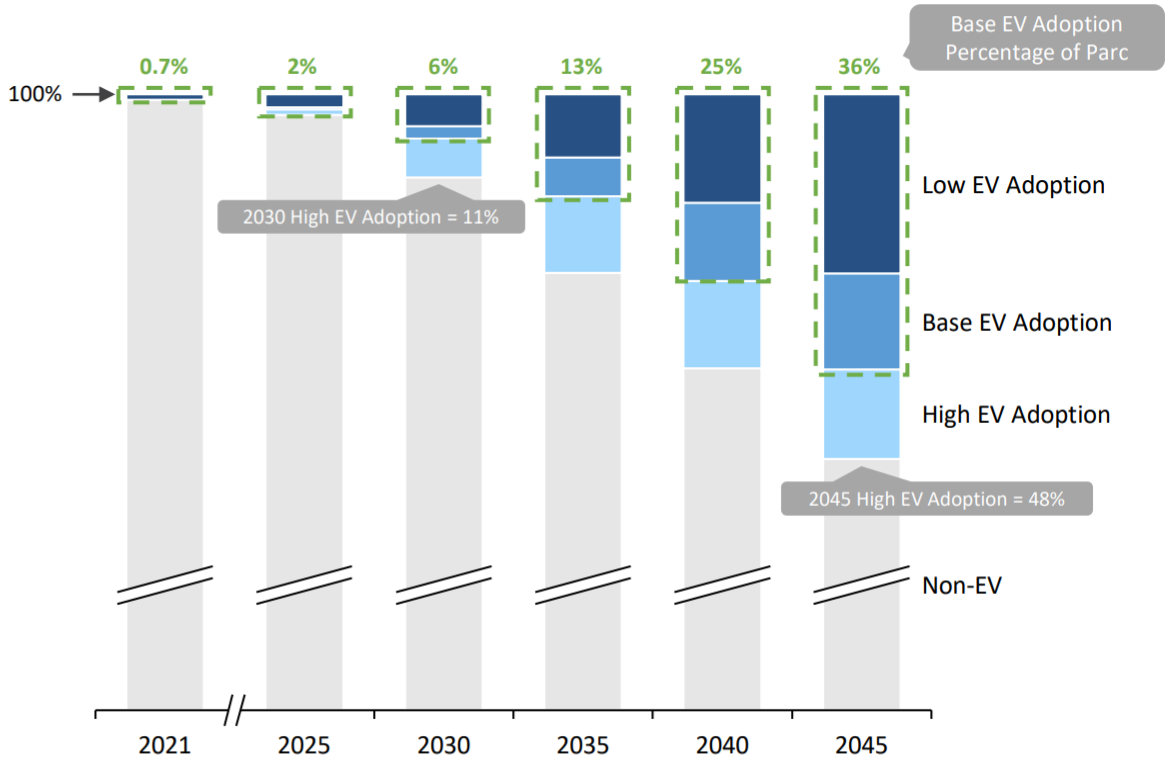
EV Mix begins ramping up after 2030

2021-2045F U.S. PERCENT OF NEW CAR SALES BY PROPULSION TYPE
[PERCENT OF TOTAL NEW SALES]



2021-2045F EV PARC PENETRATION IN THE U.S.
[PERCENT OF TOTAL CAR PARC]

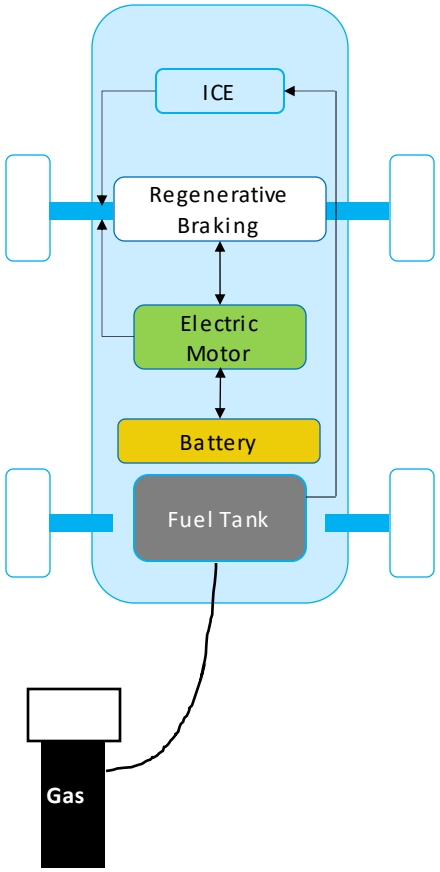


Note(s):
1) "EV" includes BEV and PHEV propulsion types. "Non-EV" includes ICE and Hybrids (micro, mild, and full-hybrid)
Sources: IHS Markit. DOT. Strategy& research.

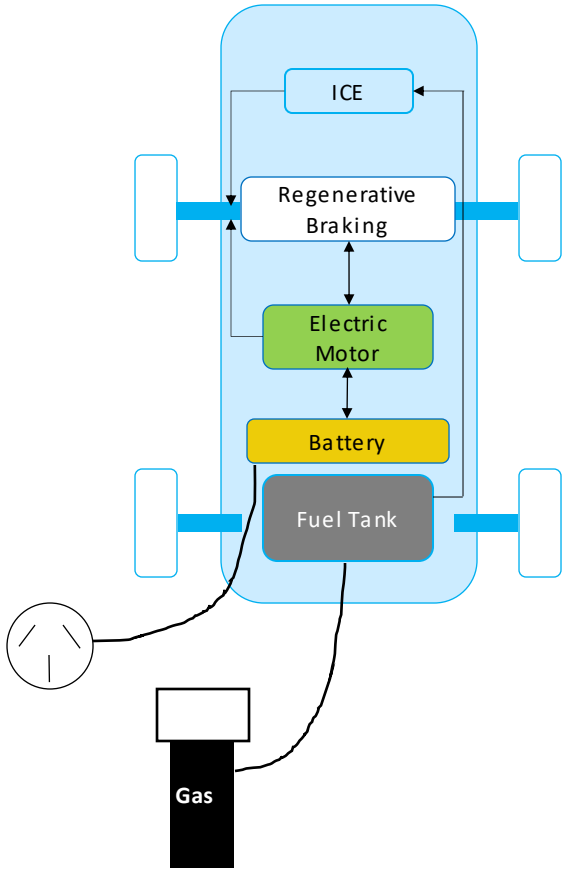
Types of Electric Vehicles

PEV
Plug-in Electric Vehicle

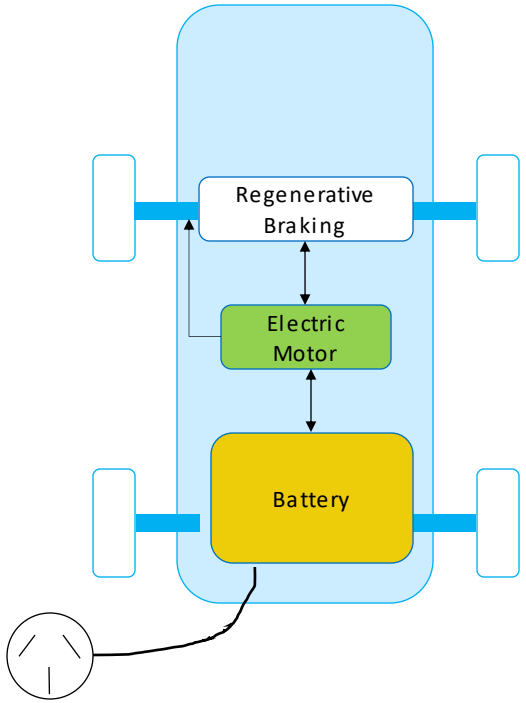
HEV
Hybrid Electric Vehicle



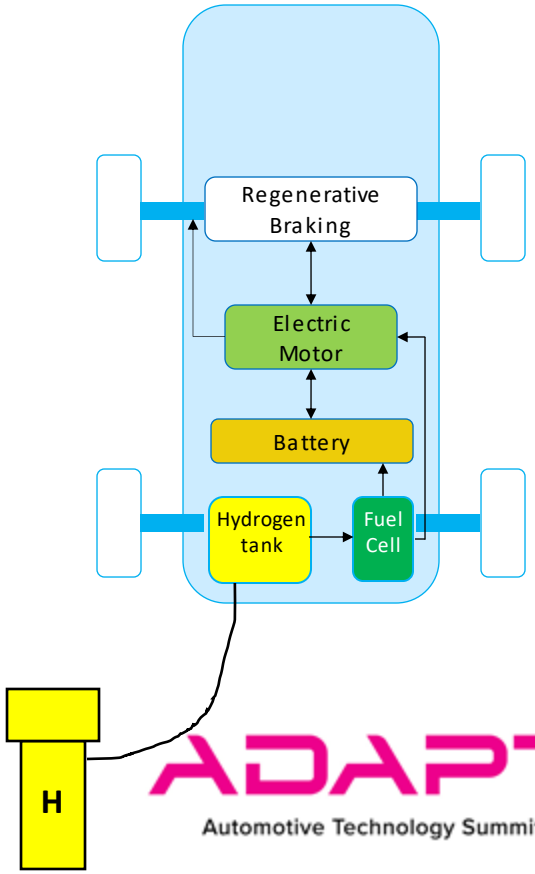
PHEV
Plug-in Hybrid Electric Vehicle



BEV
Battery Electric Vehicle



FCEV
Fuel Cell Electric Vehicle



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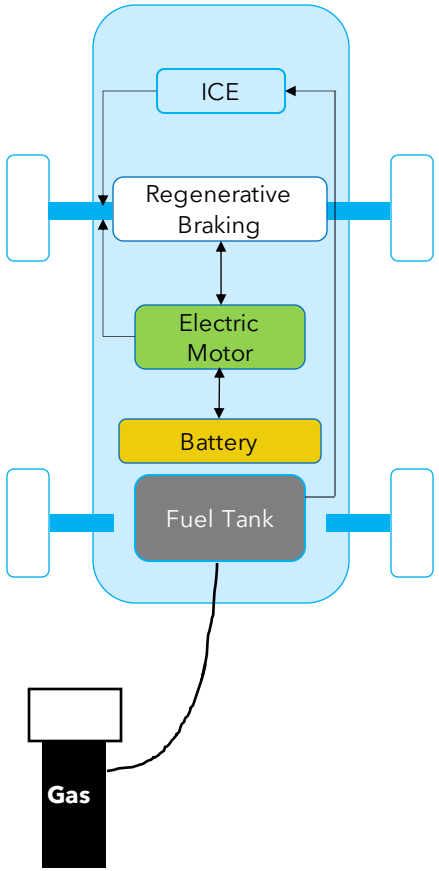
Types of Electric Vehicles - HEV

HEV
Hybrid Electric Vehicle



- Most popular electric vehicle on the road
- ICE + Electric Motor
- Can switch from full electric to electric assist to ICE only
- High Voltage (144-380v typical)
- Voltage converter can more than double that voltage for the HV motor to use
- Electric or Electric/Belt AC compressors
- ICE used for propulsion and to charge the battery packs (12v + HV)

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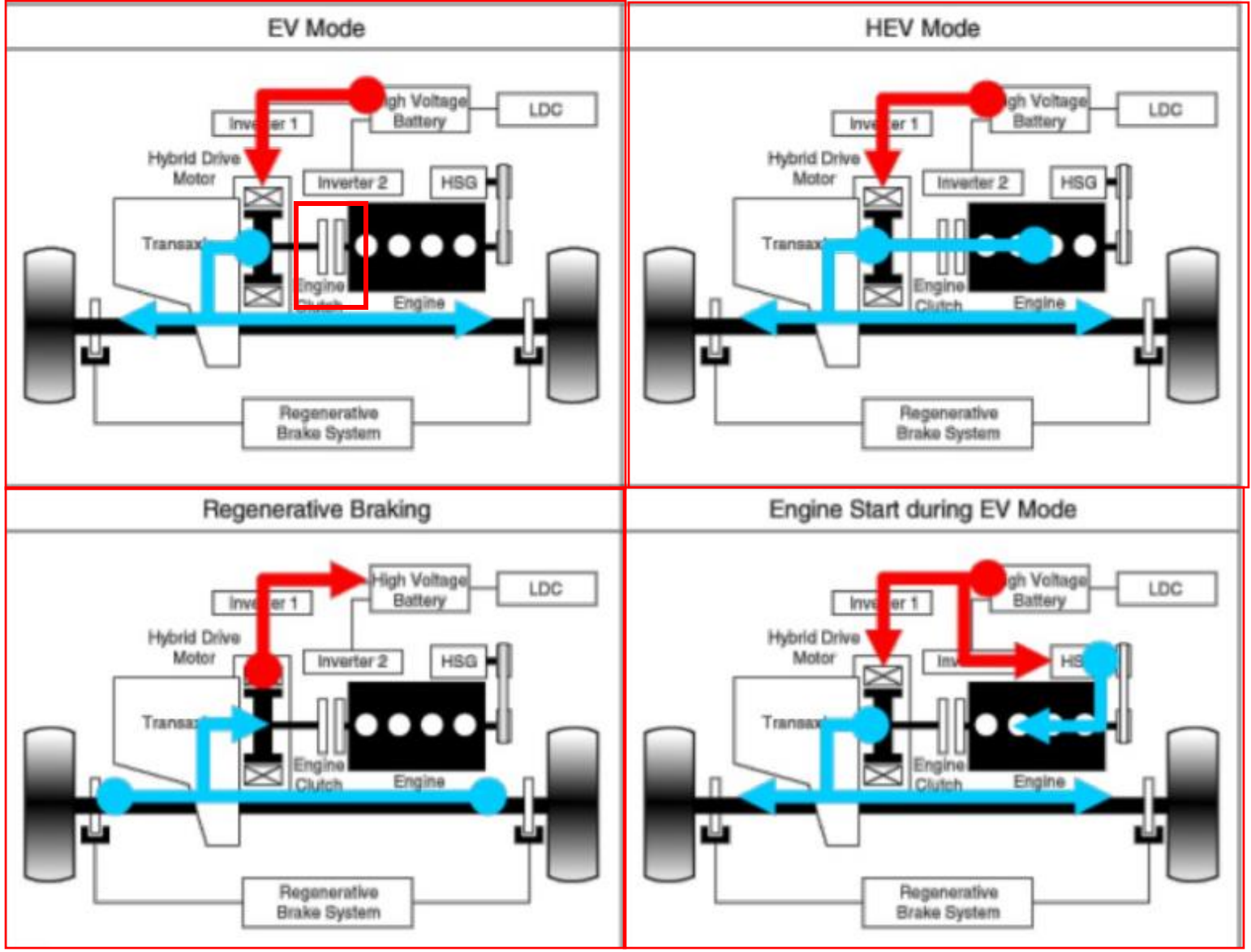
2022 Hyundai Tucson PHEV

- 52 MPG combined/420 mile range
- 90 hp electric motor/261HP combined
- 13.8kWh battery/33 mile all-electric range
- 6 speed transmission
- $36,695 MSRP (SEL)



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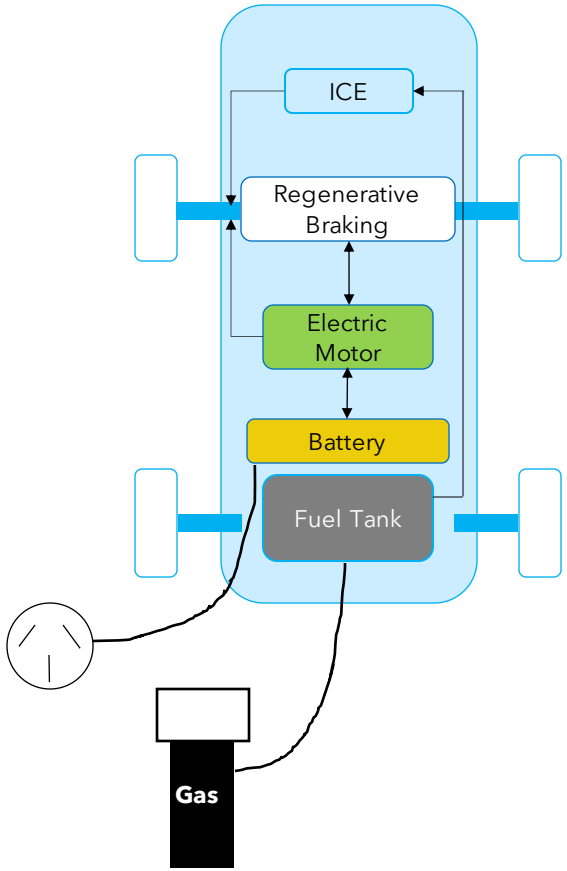
Types of Electric Vehicles - PHEV

PHEV
Plug-in Hybrid Electric Vehicle



- 47 Models in U.S. today (including Ferrari's 986 HP SF90 Stradale)
- Adds Plug-In Charging
- Some powertrains switch from "charge" to "contribute" modes
- 20-40 miles typical "electric only" before ICE kicks in
- Adds complexity to typical ICE systems
  - EVAP
  - Fuel Life issues
  - Fuel Tank Pressure issues
  - Engine designs refined for "partial use" scenarios

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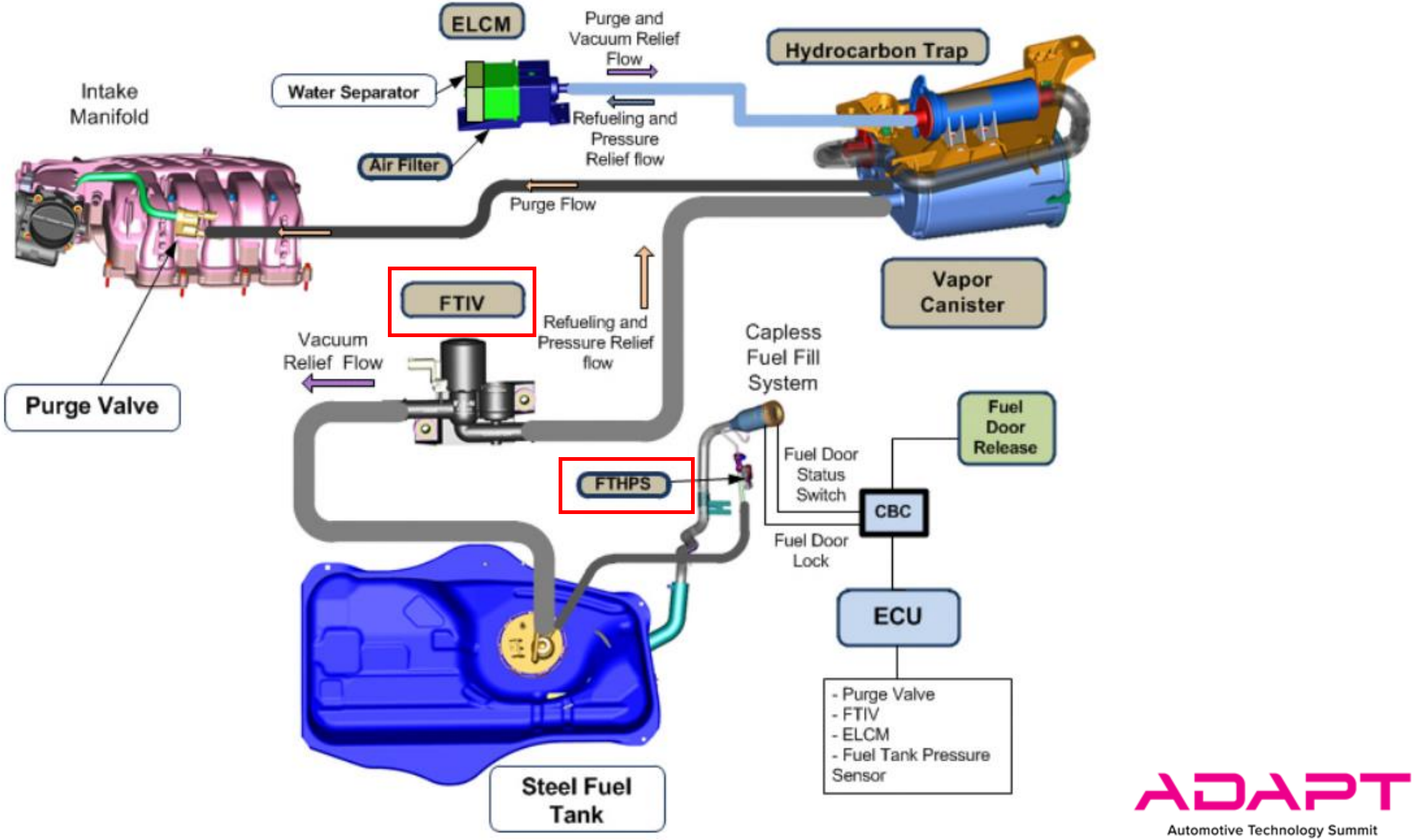

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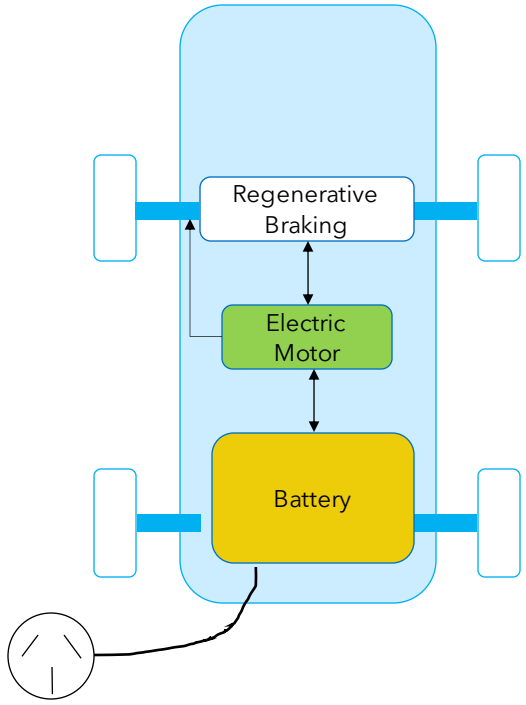
Types of Electric Vehicles - BEV

BEV
Battery Electric Vehicle



- Removes ICE
- Typical 200-250 mile range
- Electric HVAC “Heat Pump” cools/heats not only passenger compartment but HV battery system as well
- 12v battery as well as HV battery

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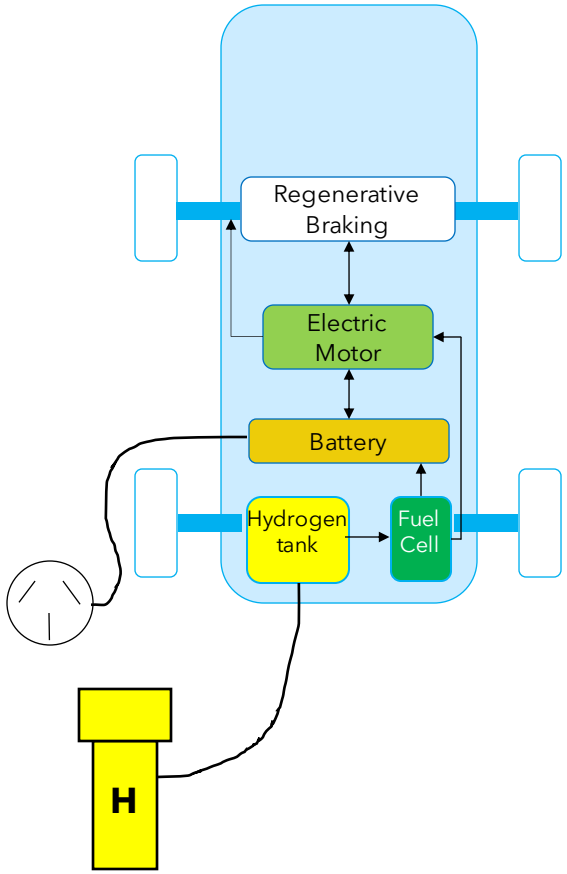
Types of Electric Vehicles - FCEV

FCEV
Fuel Cell
Electric Vehicle



- Uses Hydrogen to create electricity via Fuel Cell
- Smaller battery pack
- Up to 400 mile range
- Fuel time and process similar to ICE

- Add in-vehicle charging – PFCEV – adds 40 miles of electric range without consuming hydrogen
- Estimates are 82% less hydrogen required annually vs FCEV for most areas of California
- Mercedes-Benz GLC F-Cell in Germany since 2018 with market launch in Japan planned

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Hydrogen Infrastructure Issues

Heavy-Duty Market could help

MARCH 10, 2022

WASHINGTON – Today, U.S. Senators Chris Coons (D-Del.) and John Cornyn (R-Texas) introduced the Hydrogen for Trucks Act, a bipartisan bill to support the adoption of heavy-duty hydrogen fuel cell vehicles and hydrogen fueling stations. The legislation will soon be introduced by U.S. Representatives Katie Porter (D-Calif.) and Gus Bilirakis (R-Fla.) in the U.S. House of Representatives. The Hydrogen for Trucks Act is also cosponsored by Senators John Hickenlooper (D-Colo.) and Bill Cassidy, M.D. (R-La.) and Representatives Mike Doyle (D-Pa.) and Greg Pence (R-Ind.).

The Hydrogen for Trucks Act is the latest addition to the Coons-Cornyn Hydrogen Infrastructure Initiative, a package of bills to support the deployment of hydrogen technologies and cut emissions in hard-to-abate sectors. These carbon-intensive sectors—such as global shipping or the production of steel, cement, glass, and chemicals—face technological barriers that limit the adoption of other forms of clean energy.

"Deploying hydrogen technologies can make our economy more competitive while aligning with the urgent need to cut emissions," **said Senator Coons, co-chair of the bipartisan Senate Climate Solutions Caucus.** "It's more important now than ever for the United States to continue to diversify our energy sources. Hydrogen is a promising, low-carbon fuel source that has the potential to provide reliable energy for key sectors—including heavy-duty trucking—but early federal support will be critical to widespread adoption. By advancing this bill and others in the Hydrogen Infrastructure Initiative, we can bolster our country's effort to be a world leader in clean energy solutions."

"Hydrogen is a versatile energy source, but there are cost and infrastructure barriers to its everyday use in heavy industry sectors," **said Senator Cornyn.** "This legislation would help make new hydrogen technologies more affordable and accessible so businesses and consumers can overcome startup costs and utilize this reliable energy resource."

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How about Solid-State Hydrogen?

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Mythbuster Moment

Myth: BEV's are so simple we'll go out of business

Fact: Our industry needs to be prepared to service EV's

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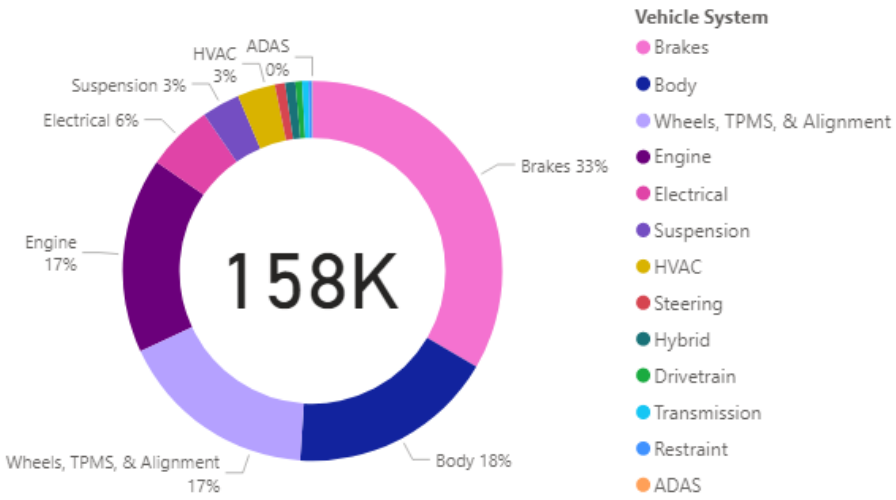
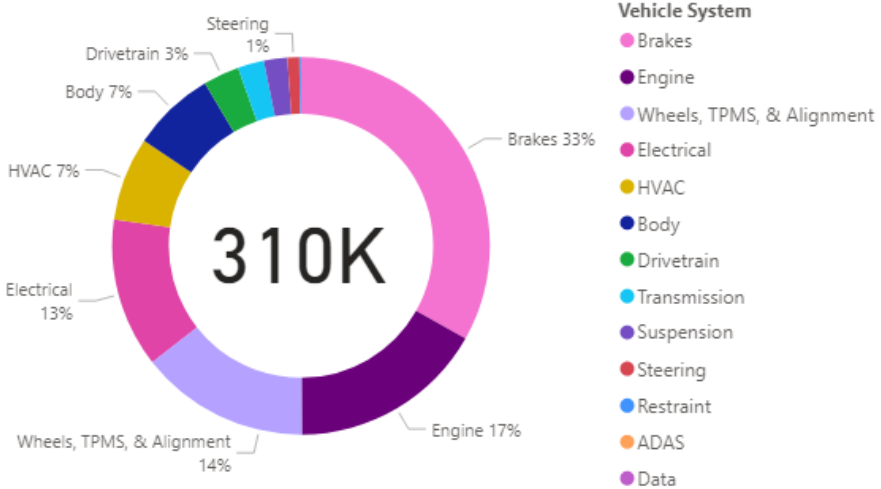
Mix of Repairs – Hybrid vs ICE-only

2010 Toyota Prius - Gas/Hybrid - Repairs by System



2010 Toyota Corolla- Gasoline - Repairs by System



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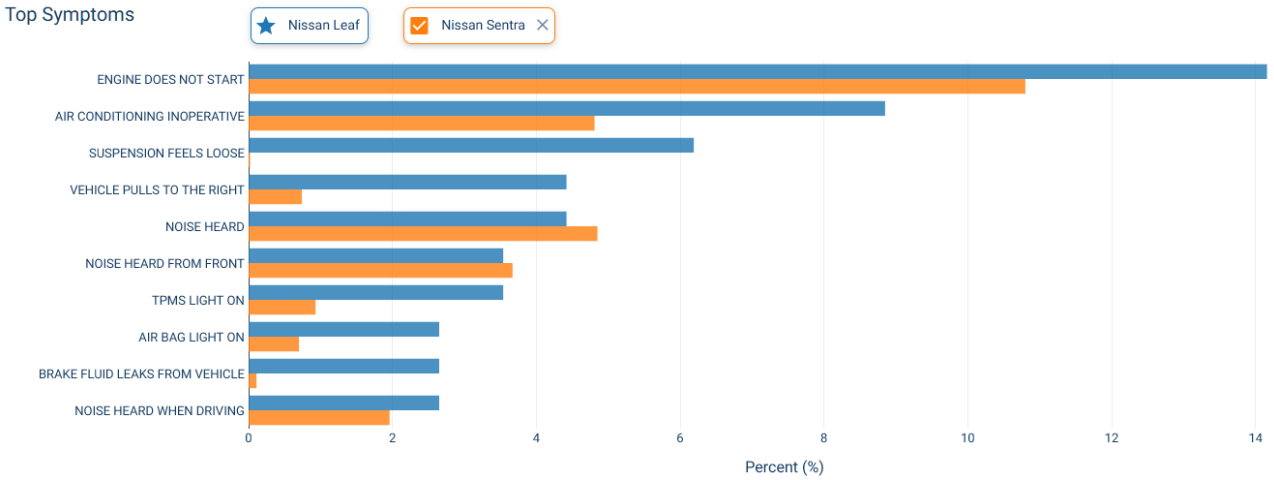
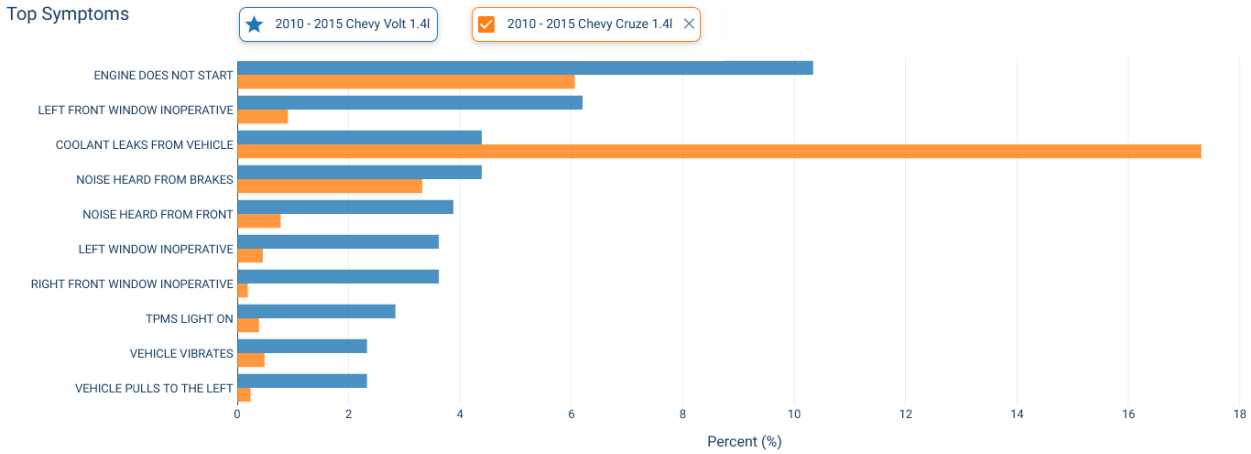
EV vs ICE – Customer Complaints

Nissan Leaf vs Nissan Sentra



Chevy Cruze vs Chevy Volt



Looking at the comparisons

- *"Engine does not start"* is the top complaint
- The rest is same typical complaints vehicle owners have
  - *"My Brakes Make Noise"*
  - *"The Car Pulls When Driving"*
  - *"The Windows Don't Work"*

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Lucid Air Traction Motor Unit

- Planetary Gear Housing
- Stator
- Rotor
- Cooling Manifold
- Motor Housing
- High-Voltage Inverter
- Gear Reduction System

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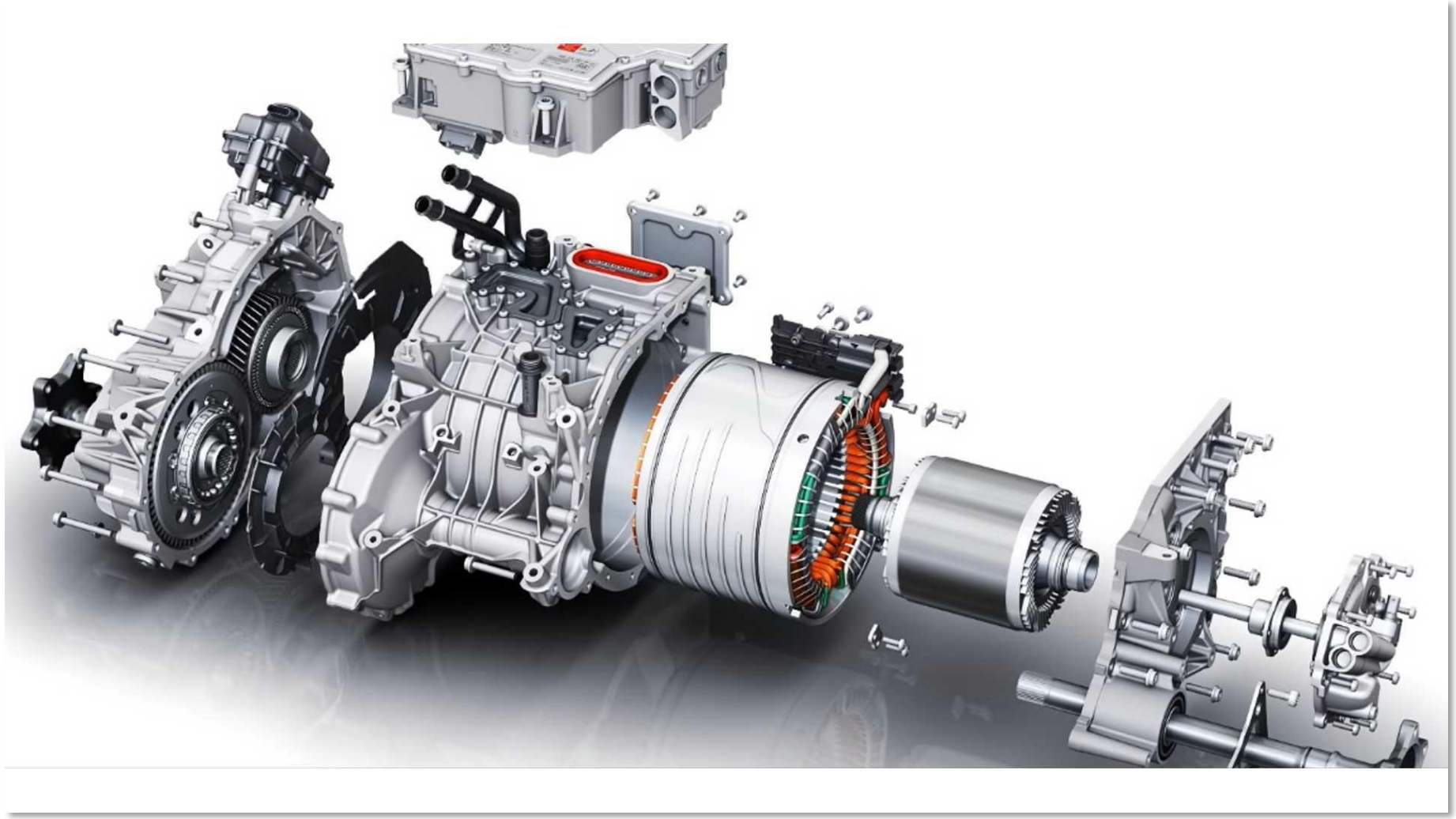
Tesla Transaxle Drive



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Other Applications of EV

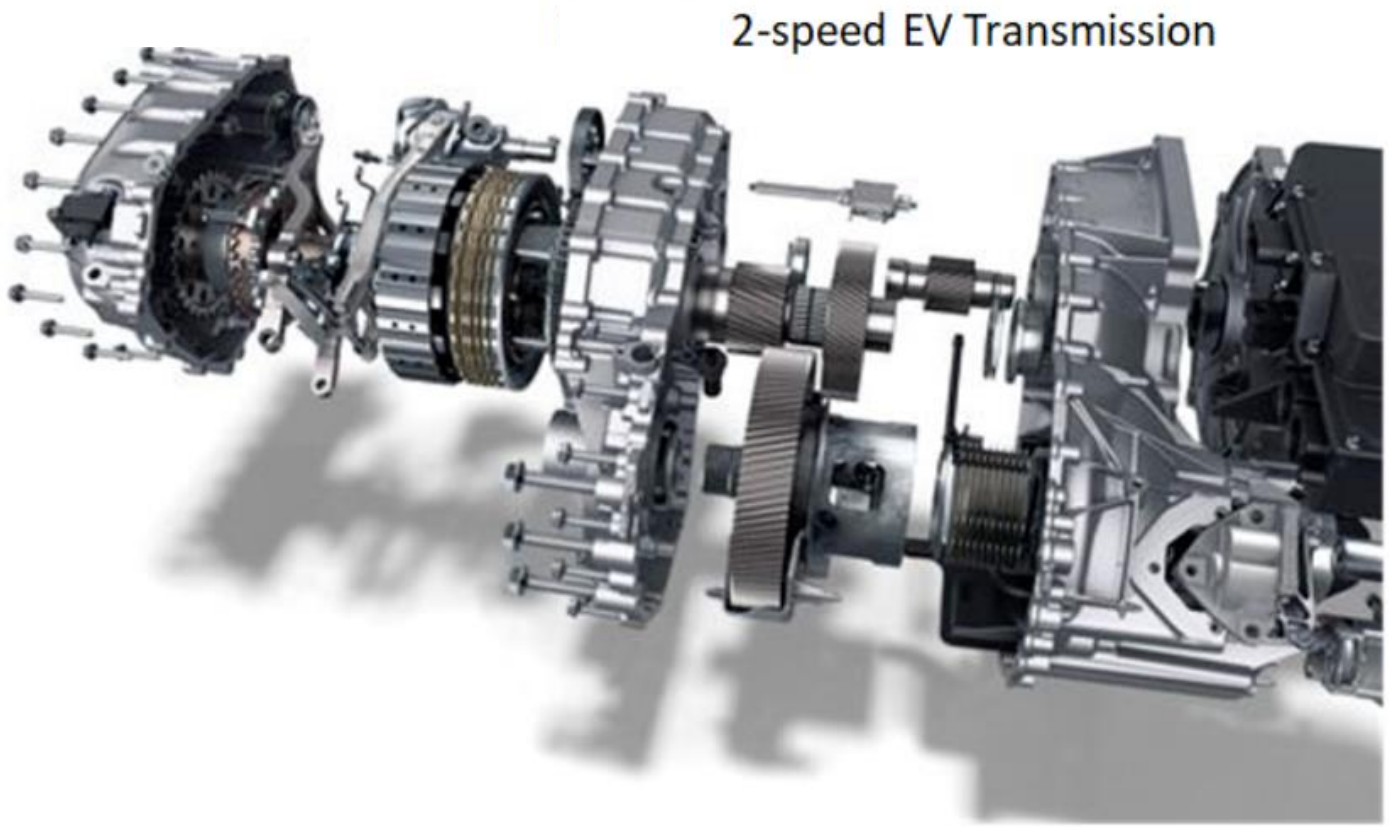
Wrangler Sahara 4xe PHEV

- 270hp 2.0L ICE + eMotors = 375hp/470 lb-ft torque
- 2 electric motors – one accessory belt driven and one taking place of torque converter
- 8 Speed Automatic Transmission
- 17.3 kwh battery capacity at 400 volts

Wrangler Magneto 2.0 Concept BEV

- 6 Speed Manual Transmission/2 speed transfer case
- 70kwh battery capacity drives an 800 volt electrical system
- 625 hp/850 lb-ft of torque
- 0-60 MPH in 2.0 seconds

2022 Audi e-tron



- 800 volt architecture
- Dual electric motors – 522/637 HP depending on model
- 2 speed transmission

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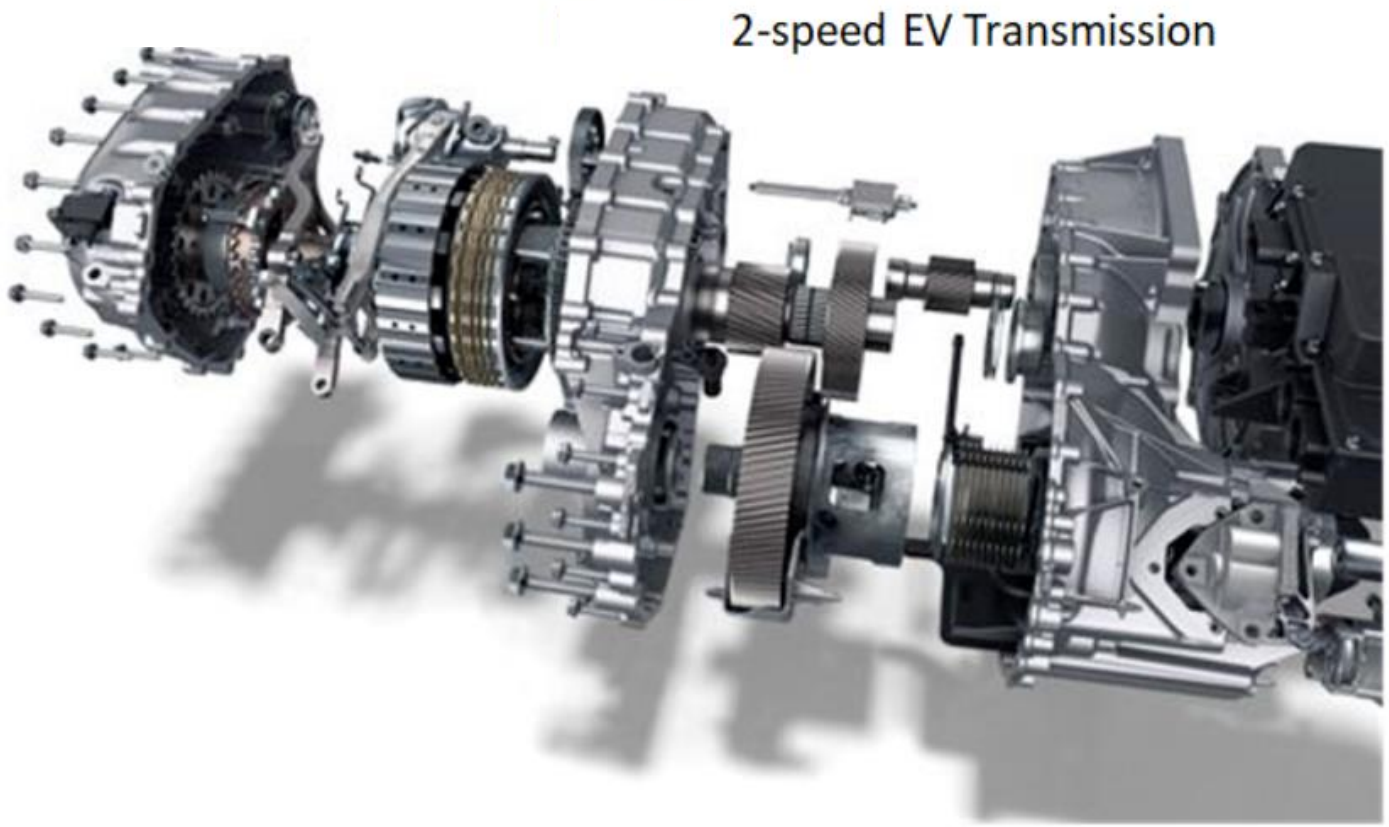
2022 Porsche Taycan Turbo



- 800 volt architecture
- Dual electric motors – 750 HP on Turbo S
- 2 speed transmission

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Other Systems on EV's

- Electric Blend Doors (no engine vacuum)
- Electric Steering Racks
- Electric Inverters
- Electric Converters
- Electric Brakes
- Electric A/C Compressors

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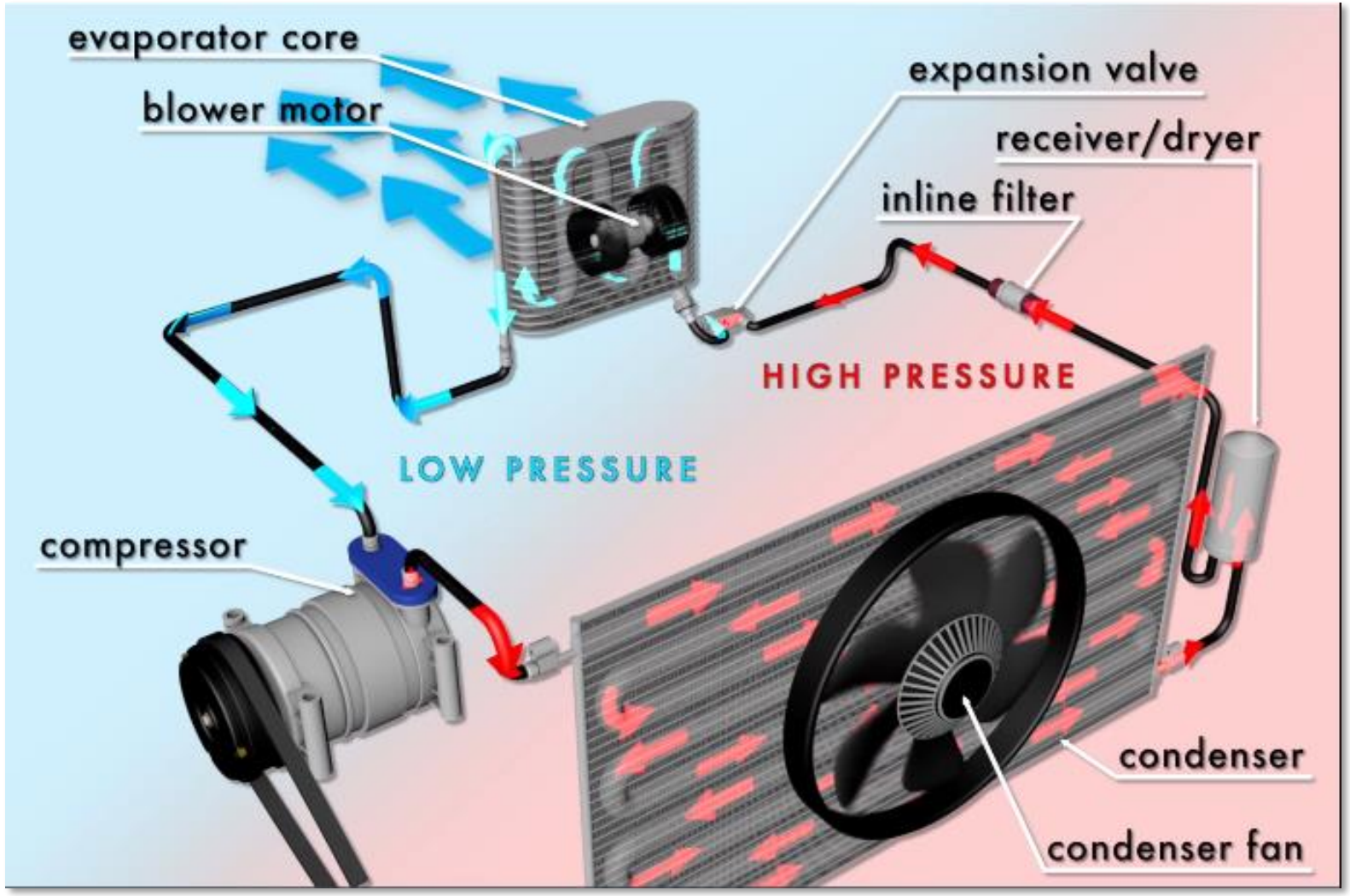
HVAC - Traditional



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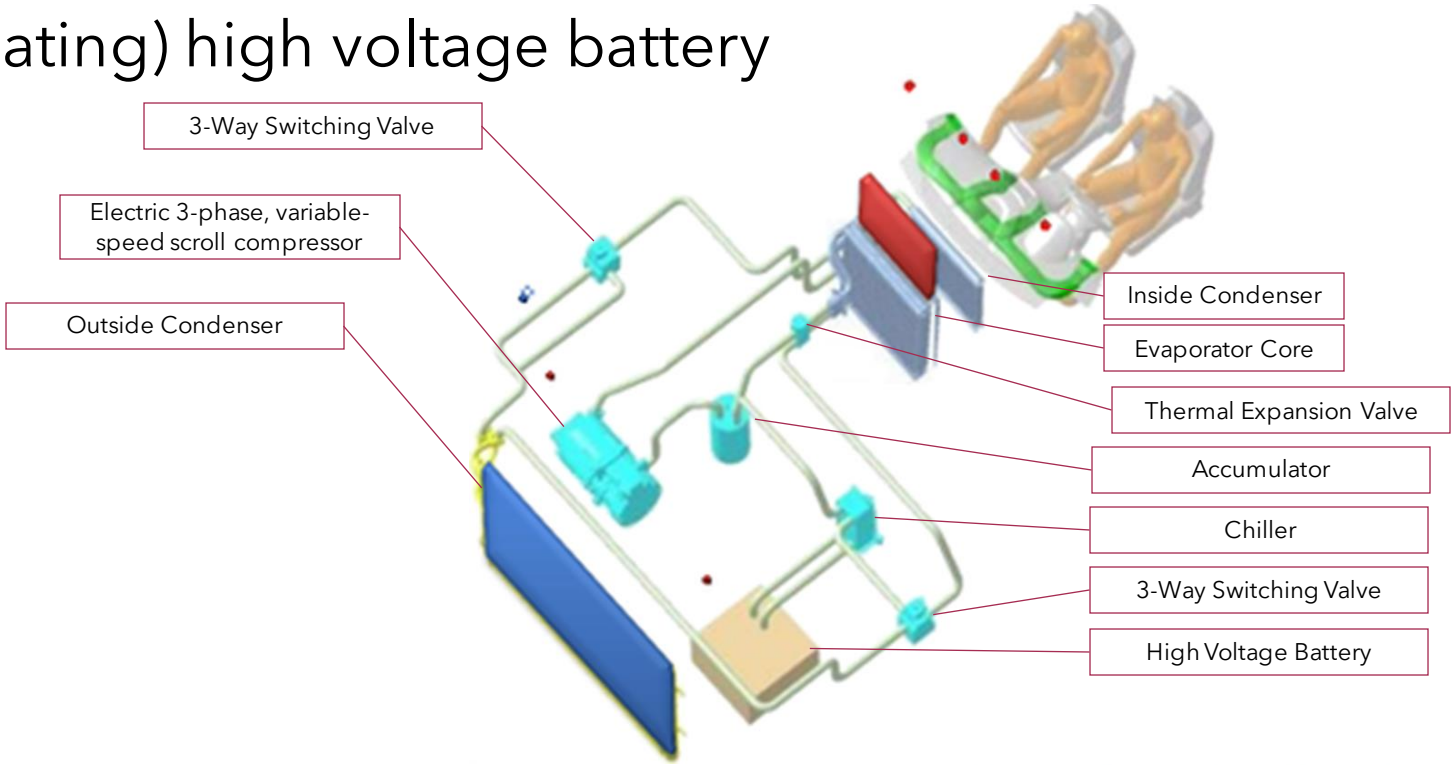
HVAC – New Responsibilities

- High voltage electric compressor
- Variable speed 3-phase (internal) on many
- Heat pump to provide heater
- Responsible for cooling (and heating) high voltage battery
- **Repair no longer optional!**



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Based on Analysis of 68,405 Repairs

Commonly Replaced
COMPONENTS

1.	Wheels	8,323
2.	Disc Brake Pad	7,966
3.	Brake Rotor	7,631
4.	Battery	6,236
5.	Air Conditioning Refrigerant	3,656
6.	Tire Valve Stem	2,688
7.	Tire Pressure Sensor	2,481
8.	Spark Plug	2,302
9.	Suspension Stabilizer Bar Link	2,258
10.	Oxygen Sensor	2,129

Common
DTCs

1.	P0130: O2 Sensor Bank 1 Sensor 1	864
2.	P2112: Throttle Actuator "A" Contr...	319
3.	P0442: EVAP System Leak Detecte...	186
4.	P0456: Evaporative Emissions Syst...	156
5.	P2450: Evaporative Emission Syste...	141
6.	P0400: Exhaust Gas Recirculation Fl...	92
7.	P0304: Cylinder 4 Misfire Detected	80
8.	P0a7c: Motor Electronics Over Tem...	79
9.	P1450	76
10.	B2278	70

Common
SYMPTOMS

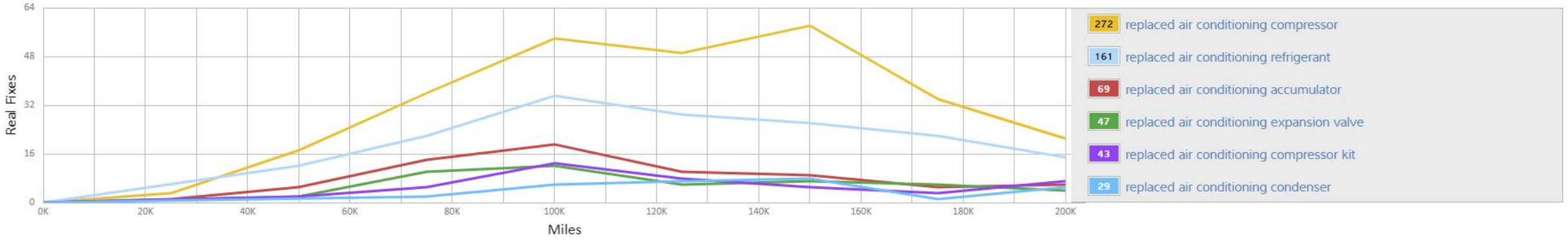
1.	Engine Does Not Start	1,169
2.	Air Conditioning Inoperative	1,039
3.	Noise Heard From Brakes	556
4.	Noise Heard From Front	478
5.	Noise Heard	457
6.	Tpms Light On	438
7.	Fluid Leaks From Vehicle	285
8.	Engine Runs Rough	205
9.	Noise Heard When Driving	201
10.	Blower Motor Inoperative	194

Top Search
LOOKUPS

1.	Firing Order
2.	Cabin Air Filter
3.	Ignition Switch
4.	Evaporative Emission System Canist...
5.	Drive Belt
6.	P2119
7.	Water Pump
8.	Throttle Body
9.	Starter
10.	Alternator

Print

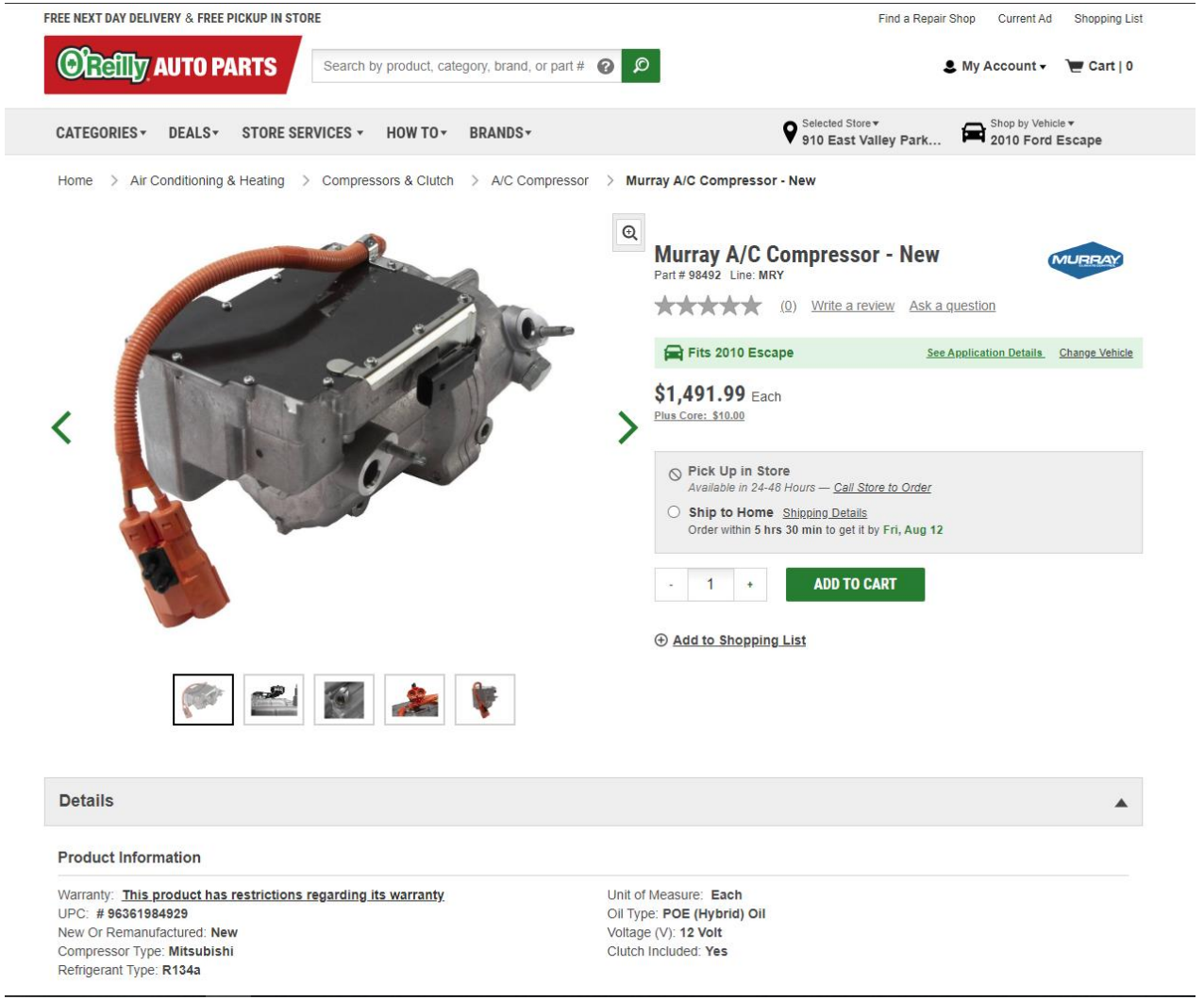
COMMON REPAIR PROCEDURES



Note: *Includes repairs between 1 and 200,000 miles*

Note: *You can select common fixes in the list above to show/hide them within the graph view.*

Electric HVAC Compressor - Escape



Based on Analysis of 371,548 Repairs

Commonly Replaced
COMPONENTS

1.	Disc Brake Pad	69,487
2.	Brake Rotor	56,307
3.	Wheels	50,069
4.	Headlight Bulb	33,859
5.	Battery	27,695
6.	Spark Plug	21,282
7.	Tire Valve Stem	20,668
8.	Wheel Hub Assembly	12,416
9.	Brake Caliper	11,836
10.	Headlight	11,809

Common
DTCs

1.	P0302: Cylinder 2 Misfire Detected	1,146
2.	P0301: Cylinder 1 Misfire Detected	1,140
3.	P0a80: Replace Hybrid Battery Pack	995
4.	P0300: Random Misfire Detected	822
5.	P0441: EVAP System Incorrect Purg...	699
6.	P0304: Cylinder 4 Misfire Detected	662
7.	P0455: Evaporative Emission Contr...	655
8.	P0401: Exhaust Gas Recirculation Fl...	545
9.	P0303: Cylinder 3 Misfire Detected	444
10.	P261b: Coolant Pump "B" Control ...	366

Common
SYMPTOMS

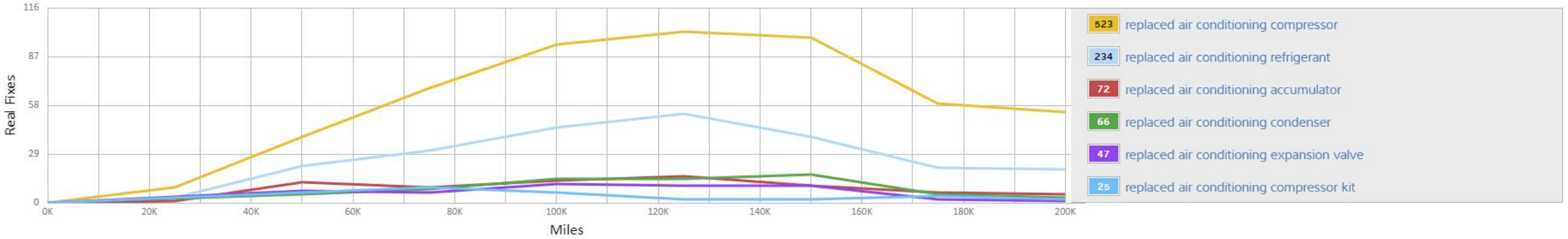
1.	Engine Does Not Start	4,954
2.	Noise Heard From Brakes	4,152
3.	Noise Heard	1,926
4.	Engine Runs Rough	1,799
5.	Tpms Light On	1,628
6.	Headlights Inoperative	1,415
7.	Noise Heard From Rear	1,148
8.	Air Conditioning Inoperative	1,137
9.	Oil Leaks From Engine	1,093
10.	Noise Heard When Driving	980

Top Search
LOOKUPS

1.	Battery
2.	Spark Plug
3.	Hybrid Battery
4.	P0401
5.	C1391
6.	Water Pump
7.	P261b
8.	Transmission Fluid
9.	Spark Plugs
10.	Wheel Bearing

Print

COMMON REPAIR PROCEDURES



Note: *Includes repairs between 1 and 200,000 miles*

Note: *You can select common fixes in the list above to show/hide them within the graph view.*

Electric HVAC Compressor - Prius

FREE NEXT DAY DELIVERY & FREE PICKUP IN STORE

Find a Repair Shop | Current Ad | Shopping List

O'Reilly AUTO PARTS

Search by product, category, brand, or part #

My Account | Cart | 0

CATEGORIES | DEALS | STORE SERVICES | HOW TO | BRANDS

Selected Store: 840 West Mission A...

Shop by Vehicle: 2010 Toyota Prius

Home > Air Conditioning & Heating > Compressors & Clutch > A/C Compressor > Import Direct A/C Compressor - New

Import Direct A/C Compressor - New

Part # 168301 Line: IAC

(0) Write a review Ask a question

Fits 2010 Prius — See Application Details | Change Vehicle

$1,447.99 Each

Plus Core: $10.00

FREE Next Day *Eligible*

FREE Pick Up in Store
Ready for pickup by 7:30 AM tomorrow

Ship to Home Shipping Details
FREE Next Day Delivery Eligible *if ordered within* 6 hrs 43 min

- 1 + ADD TO CART

Add to Shopping List

Details

Product Information

Warranty: RESTRICTIONS APPLY, LIMITED LIFETIME WARRANTY WITH ADDITIONAL ITEMS PURCHASED
Oil Type: **POE (Hybrid) Oil**
Gasket Or Seal Included: **Yes**
Refrigerant Type: **R134a**

Unit of Measure: **Each**
UPC: **# 96361623286**
New Or Remanufactured: **New**
Clutch Included: **Yes**

Maintenance Schedule (Model S)

Service Intervals

Your vehicle should generally be serviced on an as-needed basis. However, Tesla recommends the following maintenance items and intervals, as applicable to your vehicle, to ensure continued reliability and efficiency of your Model S.

- Brake fluid health check every 2 years (replace if necessary).
- A/C desiccant bag replacement every 3 years.
- Cabin air filter replacement every 3 years.
- Clean and lubricate brake calipers every year or 12,500 miles (20,000 km) if in an area where roads are salted during winter
- Rotate tires every 6,250 miles (10,000 km) or if tread depth difference is 2/32 in (1.5 mm) or greater, whichever comes first

Fluid Replacement Intervals

Your Battery coolant does not need to be replaced for the life of your vehicle under most circumstances. Brake fluid should be checked every 2 years, replacing if necessary*.

*If the vehicle is used for towing, the brake fluid should be replaced every 2 years regardless of the health check.

Note
Any damage caused by opening the Battery coolant reservoir is excluded from the warranty.

Ford Mustang Mach-E Maintenance Schedule

6 MONTHS | 12 MONTHS | 36 MONTHS | 200,000 | 220,000 | 240,000

EVERY 6 MONTHS

CLEAN & INSPECT
- BODY & DOOR DRAIN HOLES

INSPECT
- BATTERY [2]
- COOLANT LEVEL
- COOLANT STRENGTH
- PARKING BRAKE
- SEAT/SAFETY BELTS [5]
- WARNING LIGHTS & GAUGES [6]
- WINDOW WASHER FLUID LEVEL
- WINDSHIELD WIPER & WASHER SYSTEMS [7]

INSPECT/LUBRICATE
- DOOR RUBBER WEATHERSTRIPS

LUBRICATE
- DOOR HINGES & LOCKS

EVERY 12 MONTHS

CHECK
- HALF SHAFT DUST BOOTS

INSPECT
- BRAKE SYSTEM [11]
- COOLANT LEVEL
- COOLANT STRENGTH
- STEERING SYSTEM [12]
- WHEELS [10]

PERFORM
- MULTI-POINT INSPECTION (RECOMMENDED)

ROTATE
- TIRES [9]

EVERY 36 MONTHS

REPLACE
- BRAKE FLUID [13,14]

MULTI-POINT INSPECTION

CHECK
- EXTERIOR LAMPS
- HALF SHAFT DUST BOOTS
- HORN OPERATION
- OIL & FLUID [3]
- RADIATOR, COOLERS, HEATER & A/C HOSES
- TURN SIGNALS & HAZARD WARNING LIGHTS

INSPECT
- BATTERY [2]
- STEERING SYSTEM
- TIRES/SPARE TIRE [4]

150,000 MILES

REPLACE
- OMATIC TRANSAXLE FLUID

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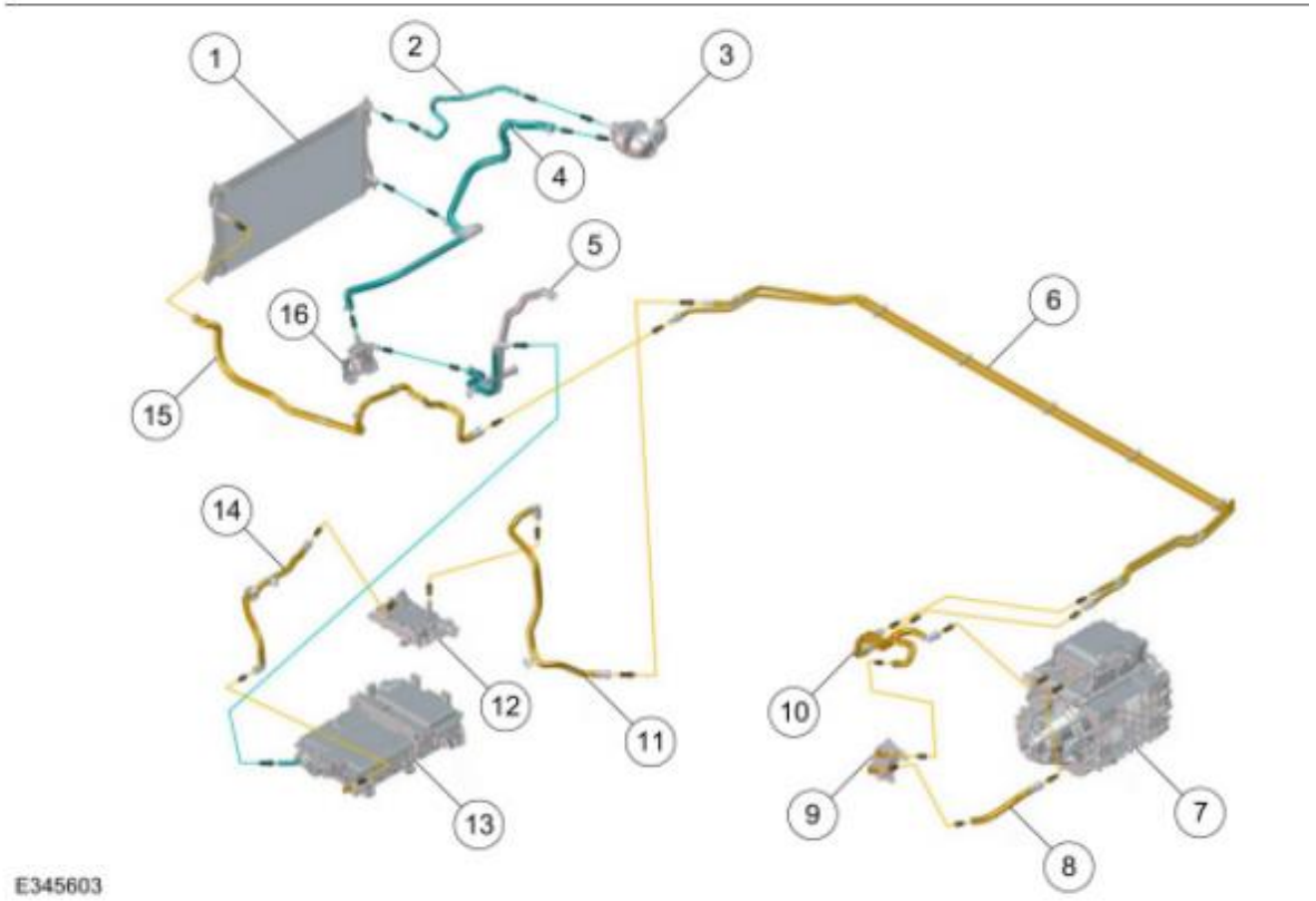
Ford Mustang Mach-E Cooling System

Cooling system components.



Item	Part Number	Description
1	--	Radiator
2	--	Radiator overflow hose
3	--	Coolant expansion tank
4	--	Radiator outlet hose
5	--	SOBDM inlet hose
6	--	Rear electric drive unit lower coolant hose
7	--	Rear electric drive unit
8	--	Rear electric drive unit oil cooler inlet hose
9	--	Rear electric drive unit oil cooler
10	--	Rear electric drive unit oil cooler outlet hose
11	--	DC/DC converter outlet hose
12	--	DC/DC converter
13	--	SOBDM (Secondary On-Board Diagnostic Control Module A)
14	--	DC/DC converter inlet hose
15	--	Radiator inlet hose
16	--	Motor electronics

What do I need to know?

Make sure the vehicle is in a mode it can be serviced!

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HYBRID
SYNERGY
DRIVE
Stay Away!

Know when and how to disable HV circuits

Is Your DVOM Category 3?

Digital Hybrid Multimeter CAT III (1,000 V, CAT IV 600 V Safety Rating)

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Do You have the Recommended PPE?

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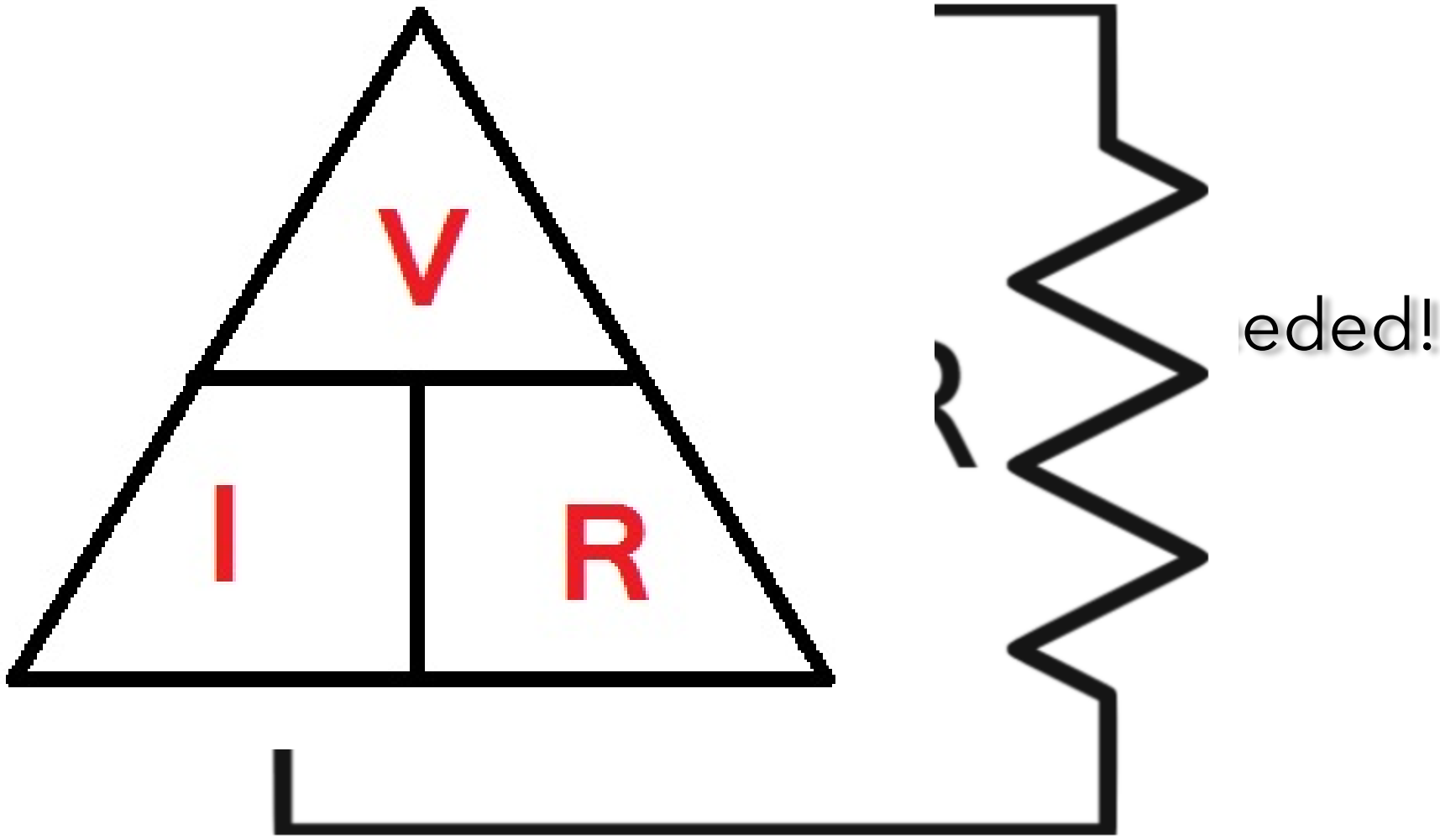
Get to know Ohm's Law!

Servicing El



eded!

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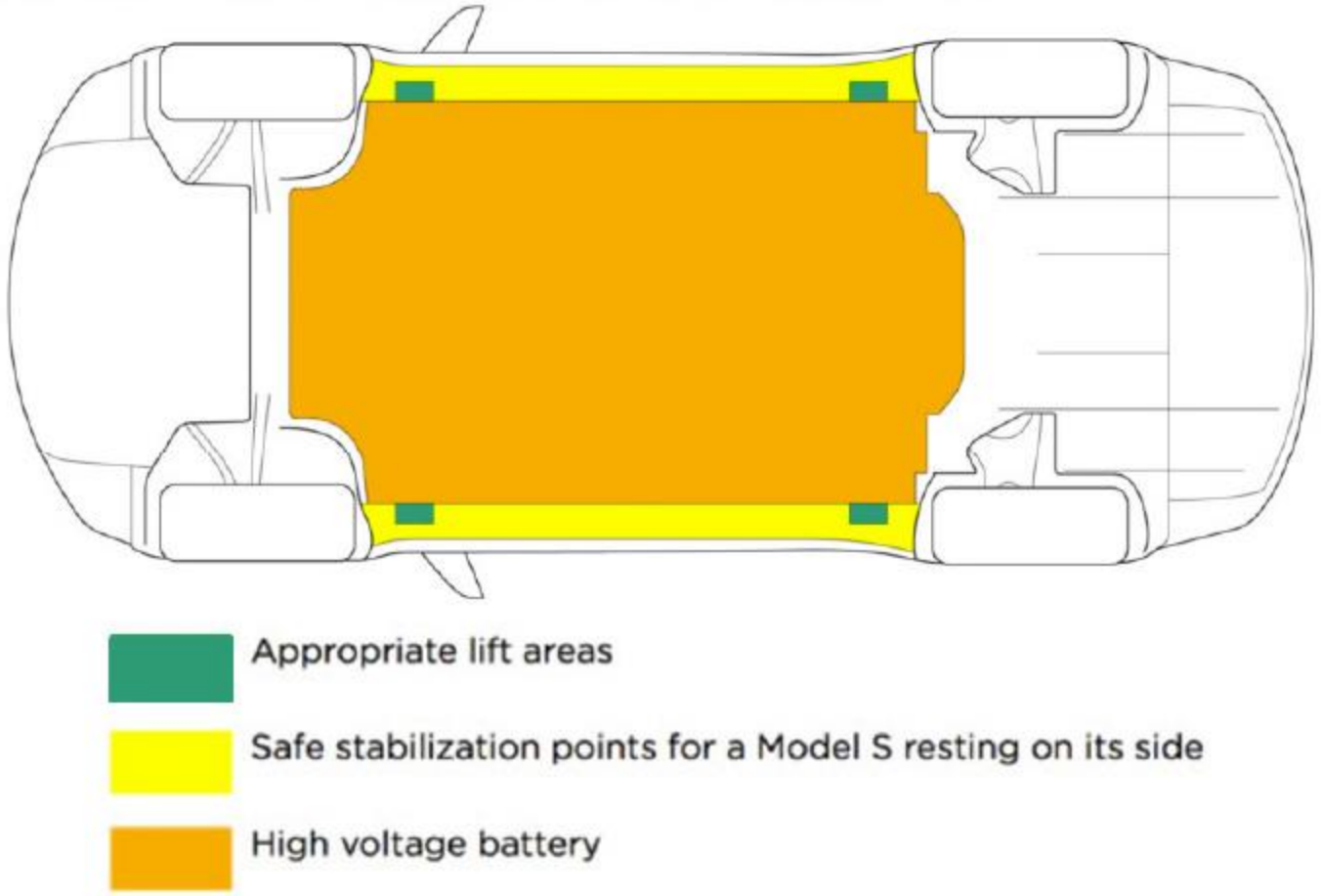
Know your Lift Points!



Get to know your Service Information!

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PRECAUTION [08/2014 -]

PRECAUTION [08/2014 -]

1. **PRECAUTIONS FOR INSPECTING HYBRID CONTROL SYSTEM**

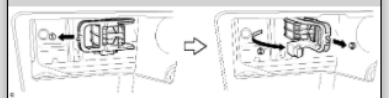
a. Before inspecting the high-voltage system or disconnecting the low voltage connector of the inverter with converter assembly or electric vehicle charger assembly, take safety precautions such as wearing insulated gloves and removing the service plug grip to prevent electrical shocks. After removing the service plug grip, put it in your pocket to prevent other technicians from accidentally reconnecting it while you are working on the high-voltage system.

NOTE:

- *After turning the power switch off, waiting time may be required before disconnecting the cable from the negative (-) auxiliary battery terminal. Therefore, make sure to read the disconnecting the cable from the negative (-) auxiliary battery terminal notices before proceeding with work. Refer to PRECAUTION [08/2014 -] .*
- *After removing the service plug grip, turning the power switch on (READY) may cause a malfunction. Do not turn the power switch on (READY) unless instructed by the repair manual.*

b. After disconnecting the service plug grip, wait for at least 10 minutes before touching any of the high-voltage connectors or terminals.

Fig 1: Removing Service Plug Grip



Courtesy of © TOYOTA, LICENSE AGREEMENT TMS1002

View Full-Screen

HINT:

Waiting for at least 10 minutes is required to discharge the high-voltage capacitor inside the inverter with converter assembly and electric vehicle charger assembly.

c. Check the voltage at the terminals in the inspection point in the inverter with converter assembly.

WARNING: *Be sure to wear insulated gloves.*

Based on Analysis of 1,725 Repairs

Commonly Replaced
COMPONENTS

1.	Wheels	645
2.	Tire Valve Stem	186
3.	Tire Pressure Monitor System	127
4.	Tire Pressure Sensor	117
5.	Disc Brake Pad	81
6.	Brake Rotor	71
7.	Battery	61
8.	Air Conditioning Refrigerant	39
9.	Remote Keyless Entry Transmitter ...	37
10.	Fuse Holder	36

Common
DTCs

1.	C0040: Brake Pedal Switch "A"	1
2.	P0402: Exhaust Gas Recirculation F...	1

Common
SYMPTOMS

1.	Tpms Light On	9
2.	Engine Does Not Start	6
3.	Noise Heard From Brakes	6
4.	Noise Heard	5
5.	Noise Heard From Rear	5
6.	Vehicle Vibrates	5
7.	Suspension Feels Loose	4
8.	Vehicle Pulls To The Right	4
9.	Air Bag Light On	2
10.	Noise Heard When Driving	2

Top Search
LOOKUPS

We are busy collecting service analytics for this vehicle.

Real Fixes

Top fixes and failure counts

SureTrack®

Top Repairs

Top fixes graphed over mileage

SureTrack®

Causes & Fixes

ProView: Interactive related codes, symptoms, and fixes

SureTrack®

Specifications

OEM specifications

OEM Info

OEM Testing

OEM Test procedures

OEM Info

Guided Component Testing

Guided component tests

SureTrack®

Component Connector

Connector views and pin-outs

SureTrack®

Component Location

Component location diagrams

SureTrack®

Component Operation

Component operation and description

SureTrack®

Wiring Diagrams

OEM and interactive wiring diagrams

OEM Info

Remove & Replace

OEM R&R procedures

OEM Info

Parts & Labor

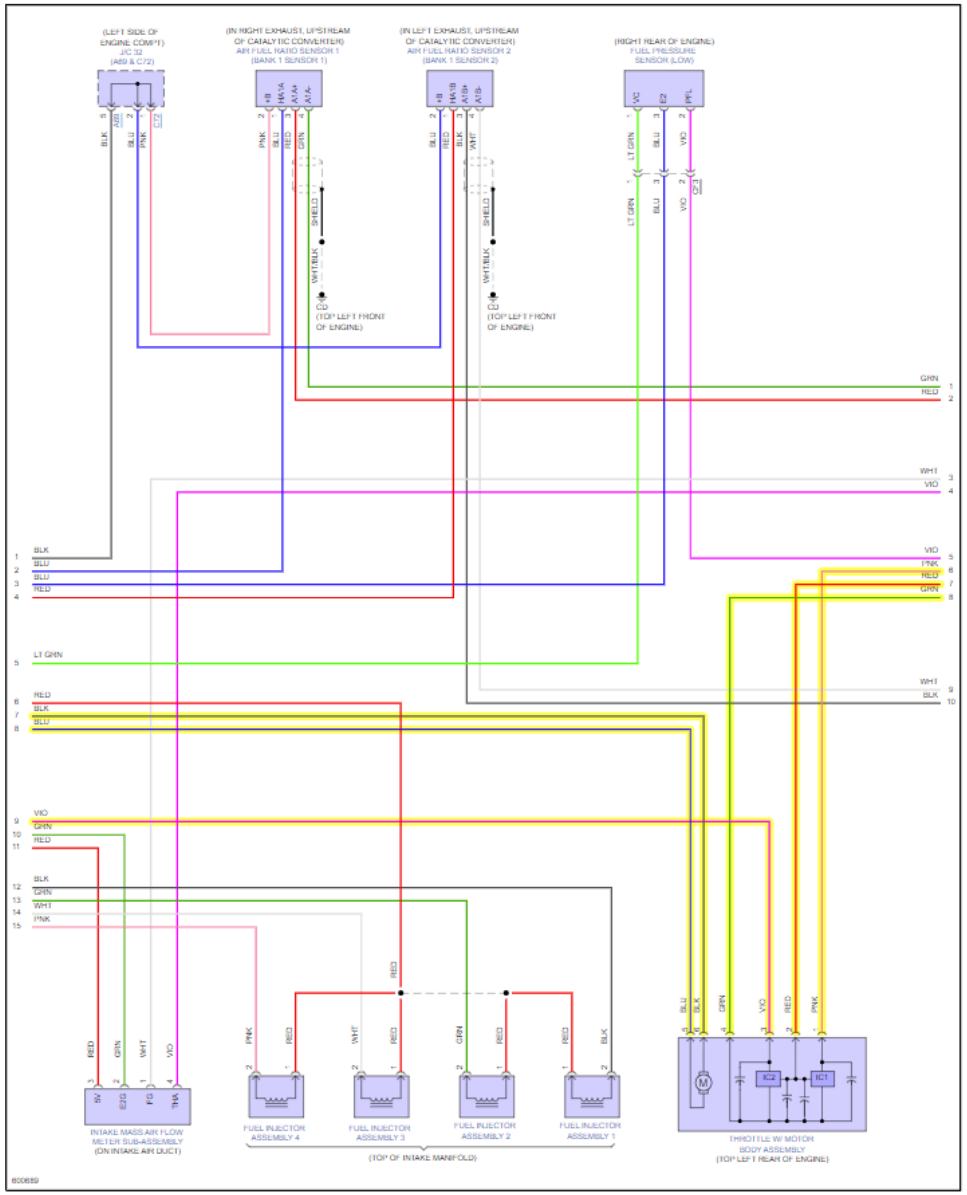
Replacement labor time and parts cost

OEM Info

History

Fig 6: 2.5L Hybrid, Engine Controls Circuit (6 of 7)

Print



History

Fig 6: 2.5L Hybrid, Engine Controls Circuit (6 of 7)

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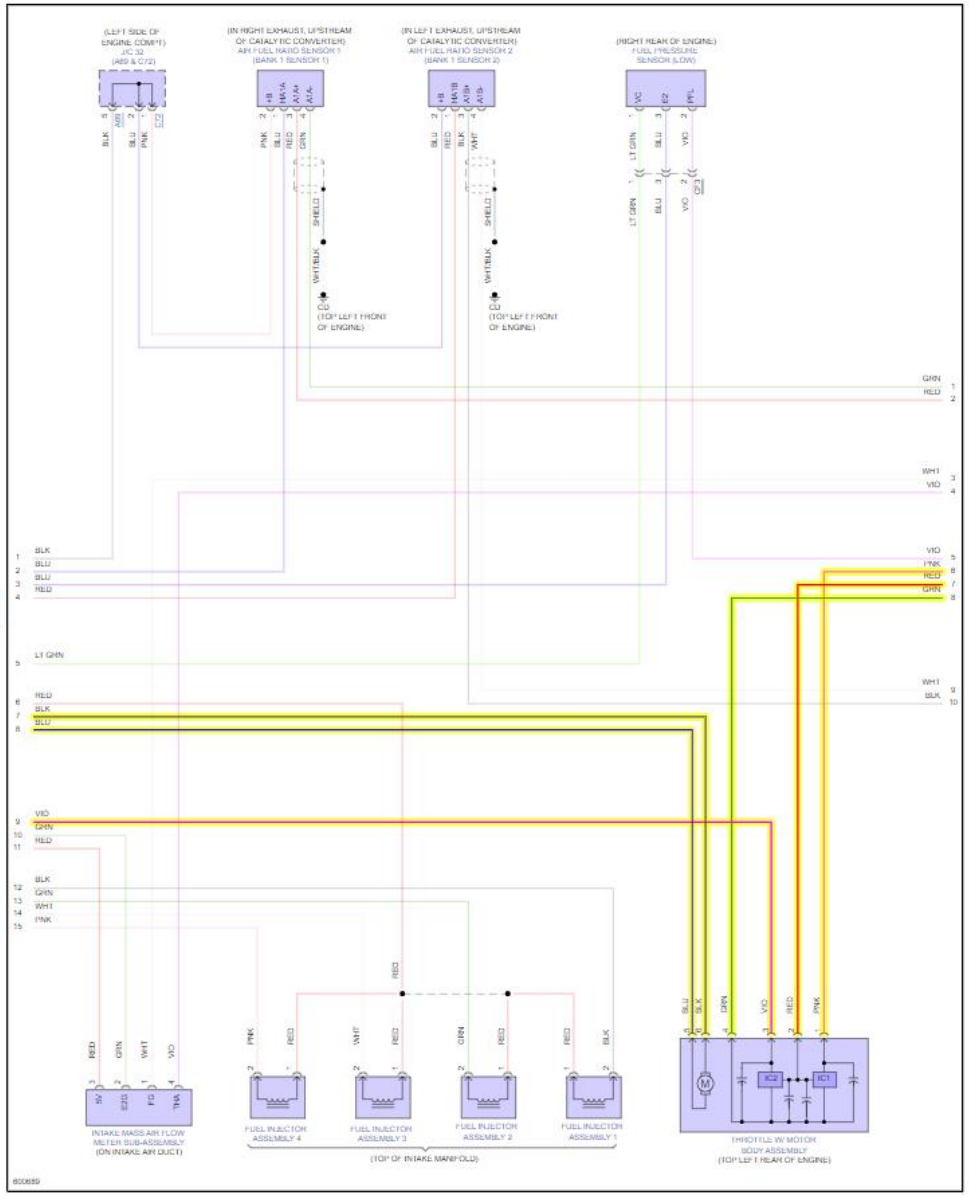

History

Fig 6: 2.5L Hybrid, Engine Controls Circuit (6 of 7)

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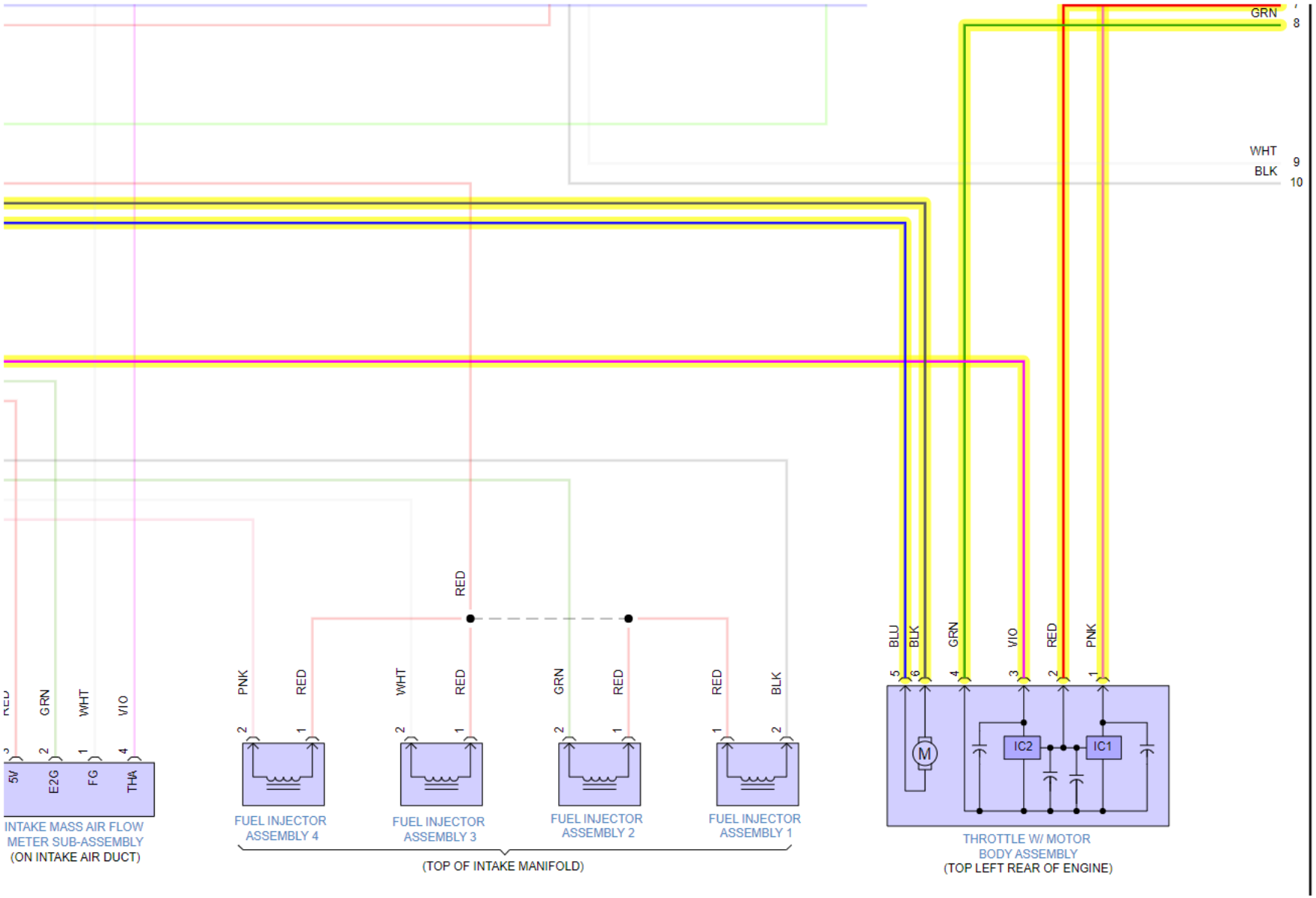
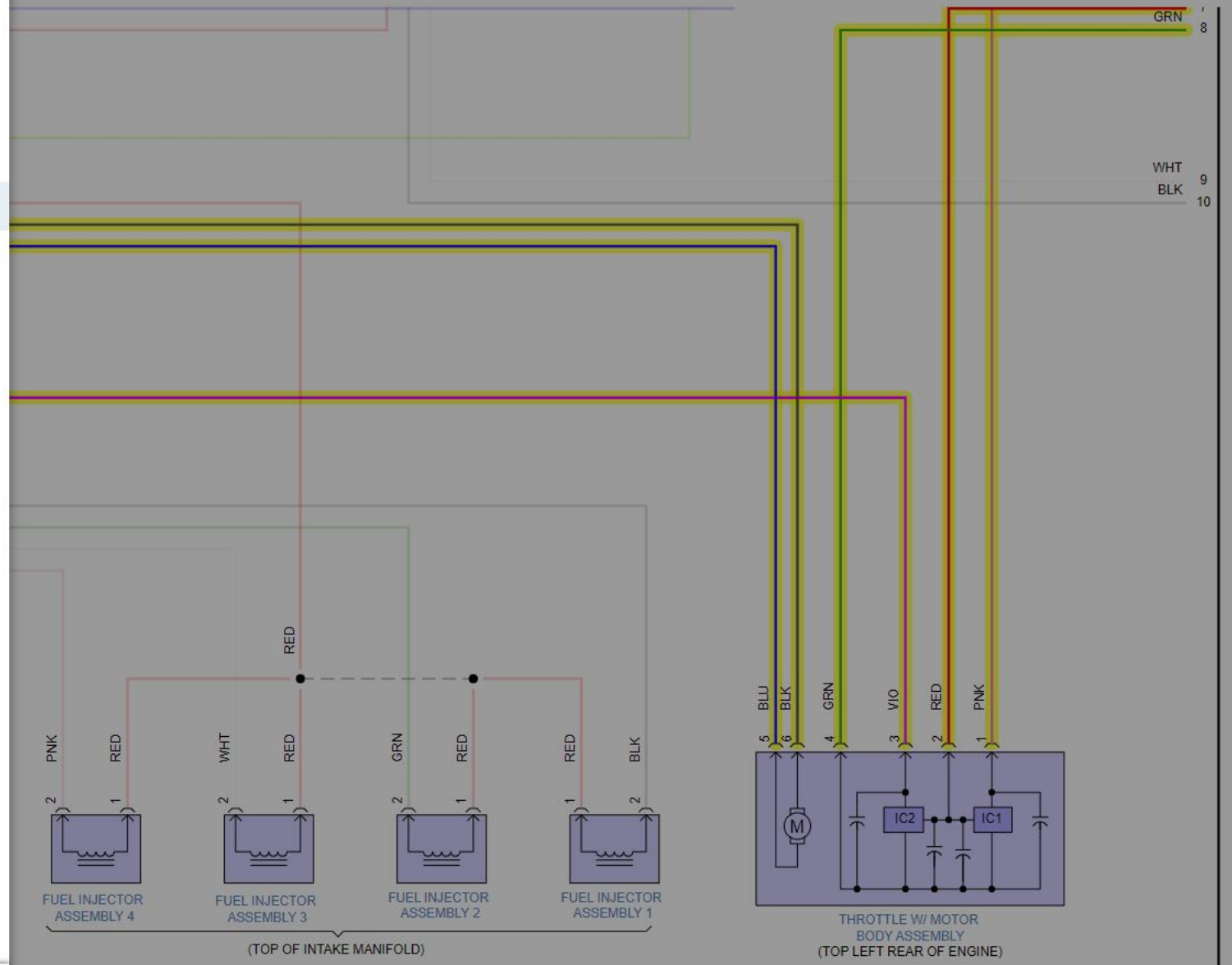


Throttle Body

New Search

Fig 6: 2.5L Hybrid, Engine Controls Circuit (6 of 7)

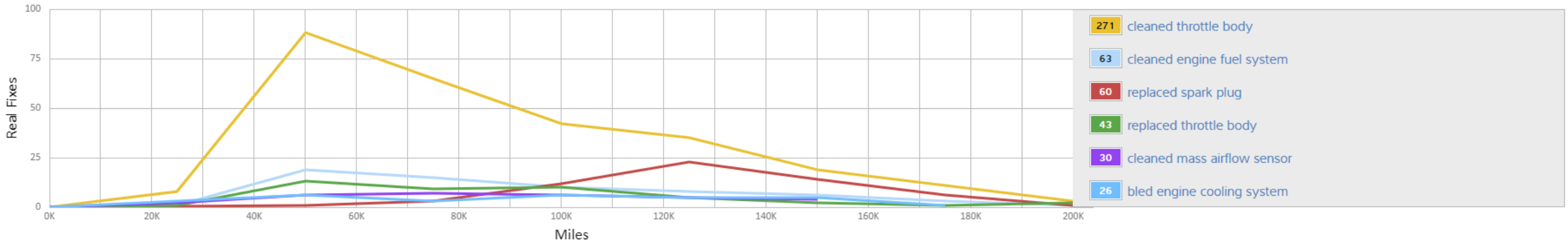
Print



Top Repairs

Print

COMMON REPAIR PROCEDURES



Note: *Includes repairs between 1 and 200,000 miles*

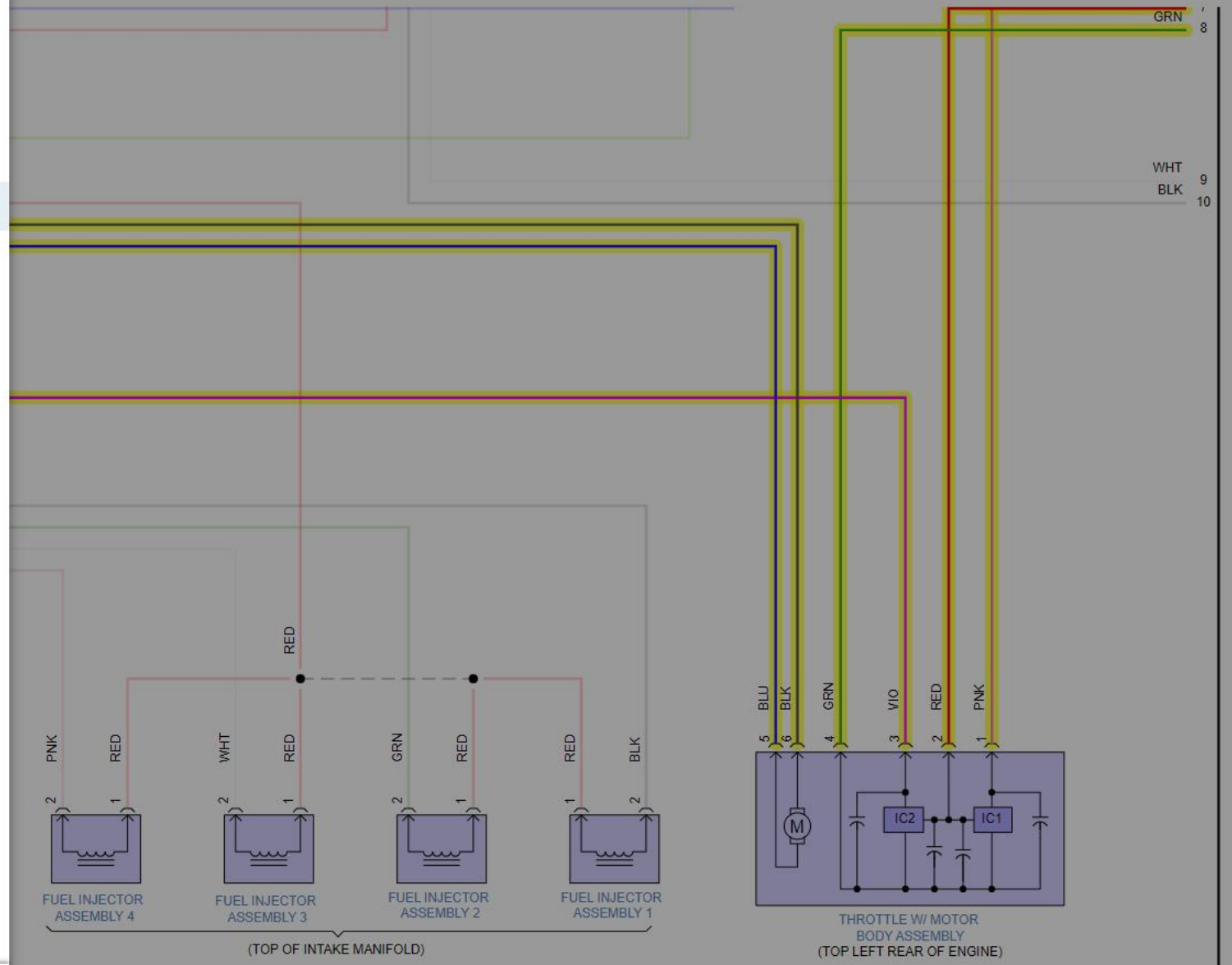
Note: *You can select common fixes in the list above to show/hide them within the graph view.*

Throttle Body

New Search

Fig 6: 2.5L Hybrid, Engine Controls Circuit (6 of 7)

Print



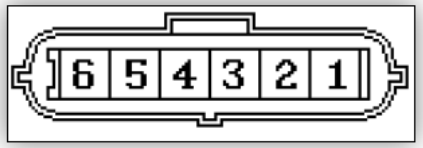
Component Connector

Print

Throttle Control System,Throttle Motor,Engine

Connector

View: Harness Side, Backprobing Throttle Position Sensor



Pin Assignment	Wire Color
1=TP Sensor Signal # 1	Pink
2=5 Volt Reference	Red
3=TP Sensor Signal # 2	Violet
4=Sensor Ground	Green
5=Throttle Motor (-)	Blue
6=Throttle Motor (+)	Black

Throttle Control System,Throttle Position Sensor,Engine

Throttle Body

New Search

Fig 6: 2.5L Hybrid, Engine Controls Circuit (6 of 7)

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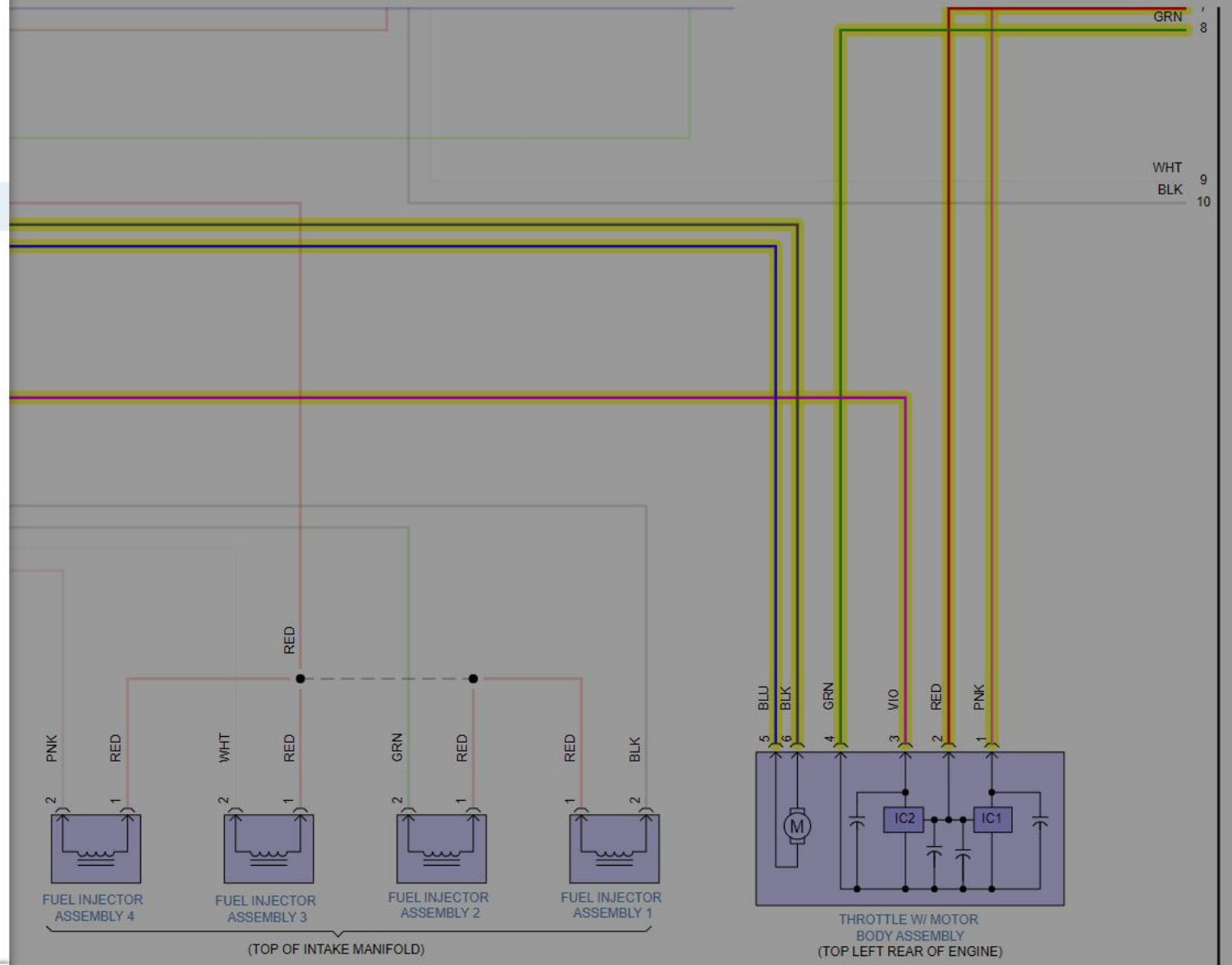
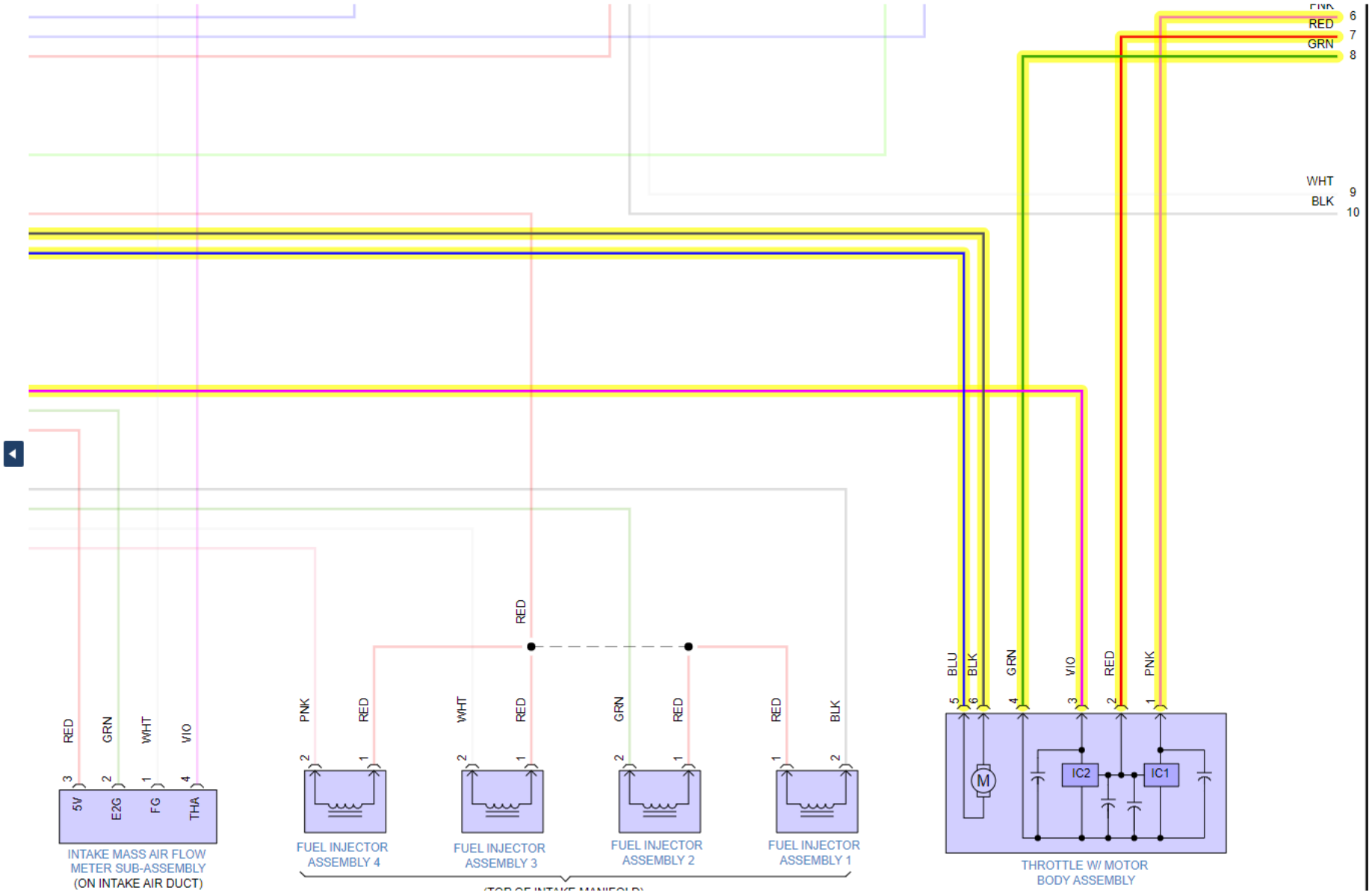


History

Fig 6: 2.5L Hybrid, Engine Controls Circuit (6 of 7)

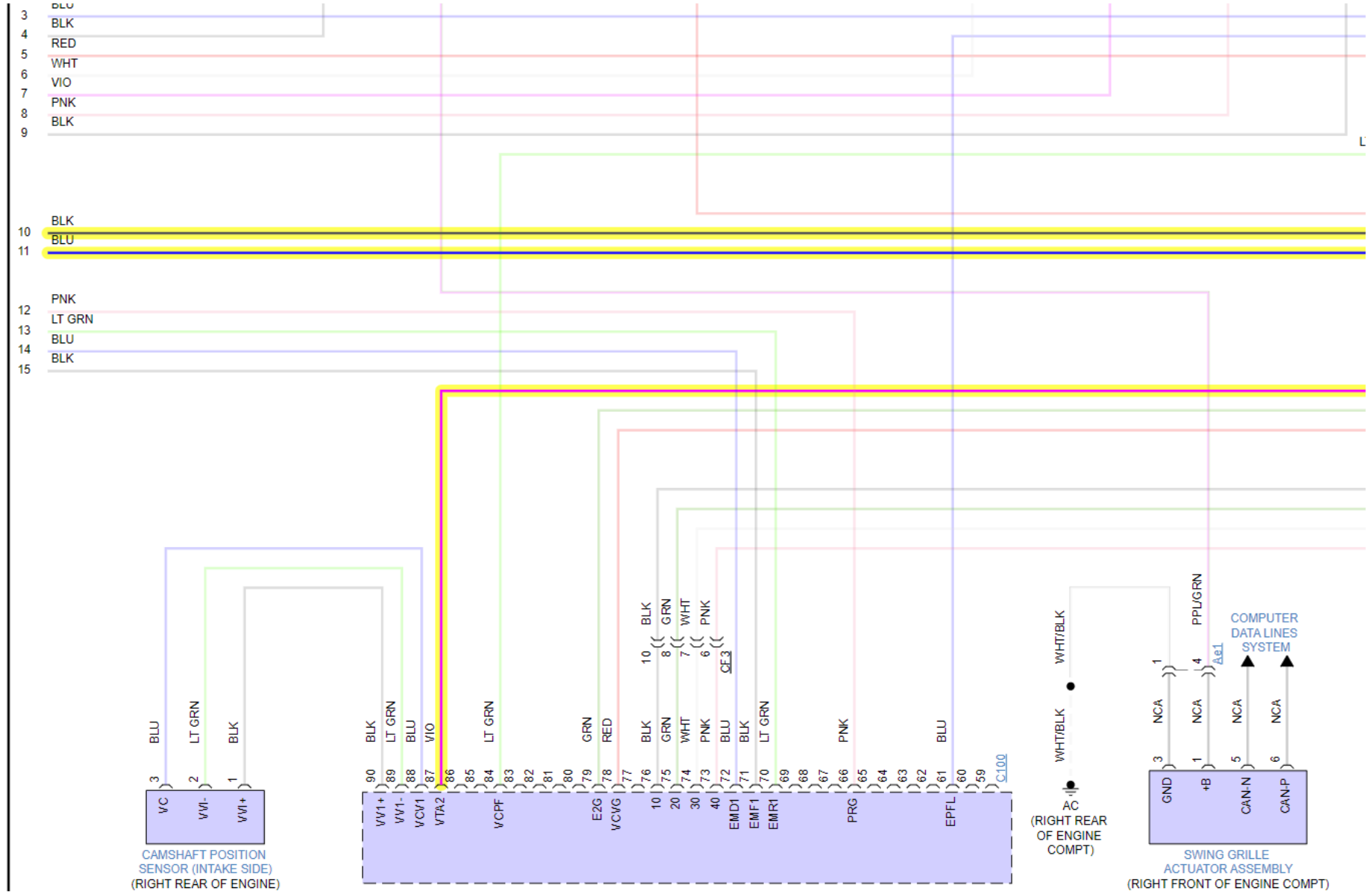
Print



History

Fig 5: 2.5L Hybrid, Engine Controls Circuit (5 of 7)

Print



History

Fig 1: 2.5L Hybrid, Engine Controls Circuit (1 of 7)

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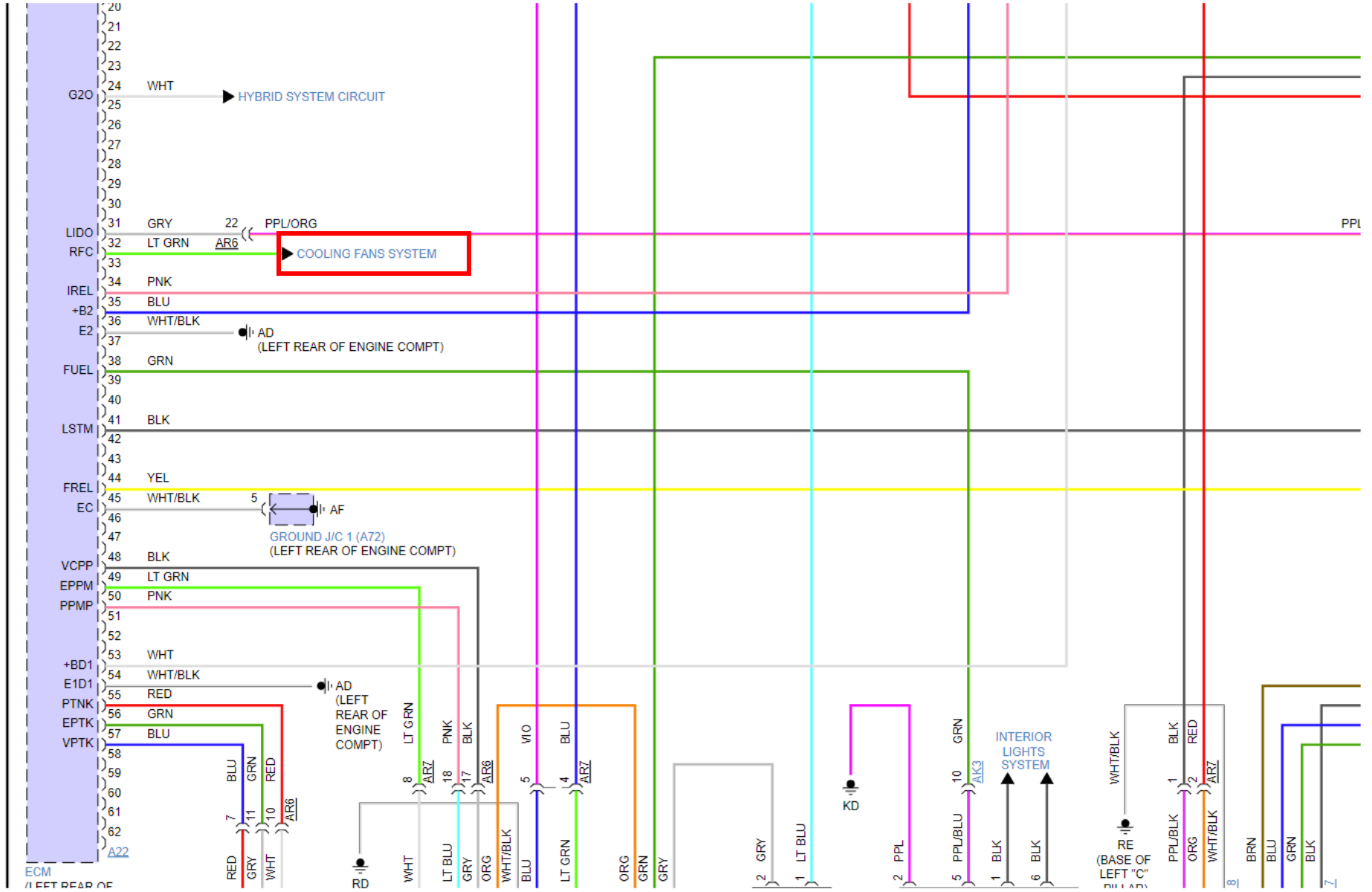
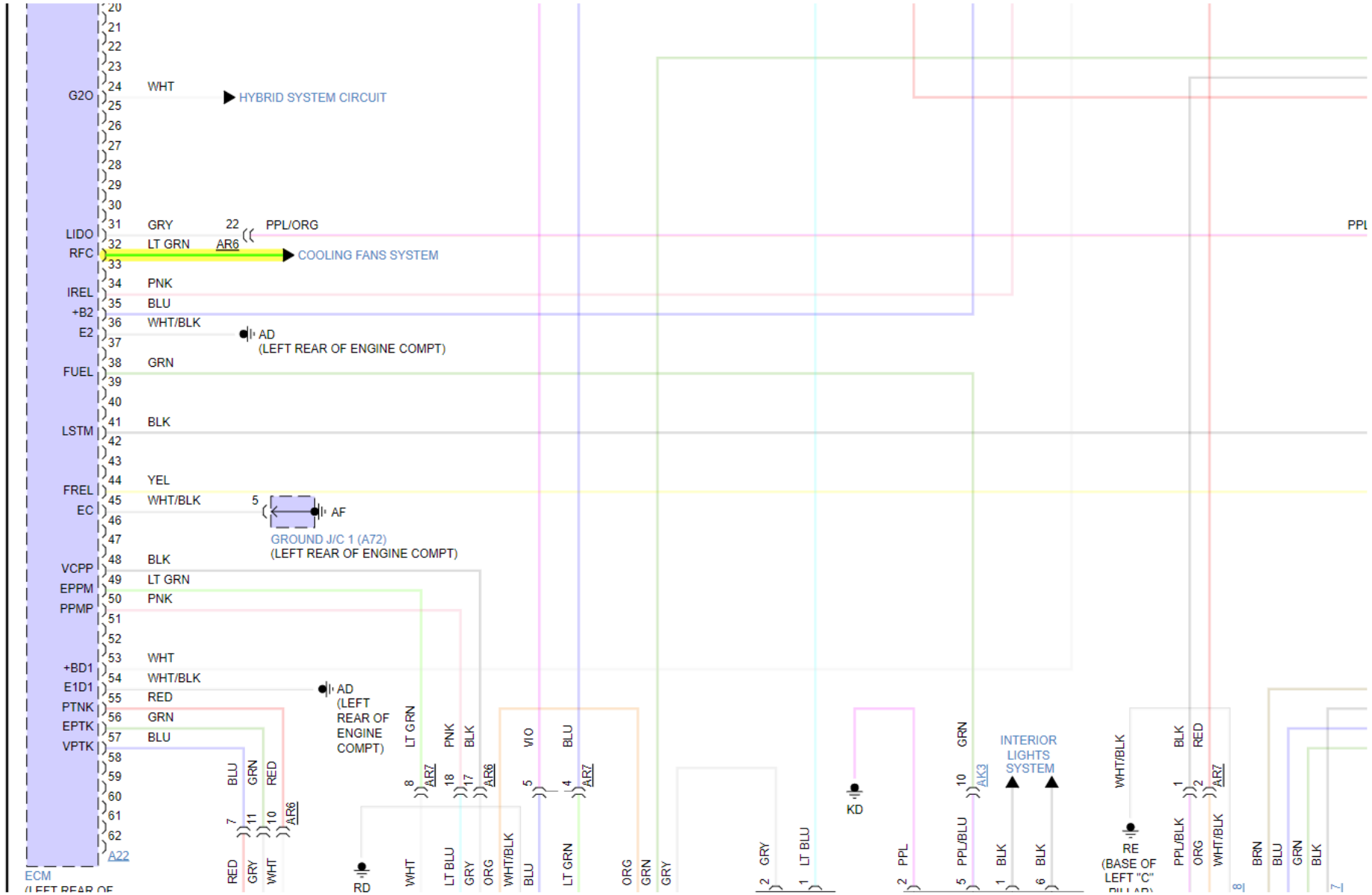


History

Fig 1: 2.5L Hybrid, Engine Controls Circuit (1 of 7)

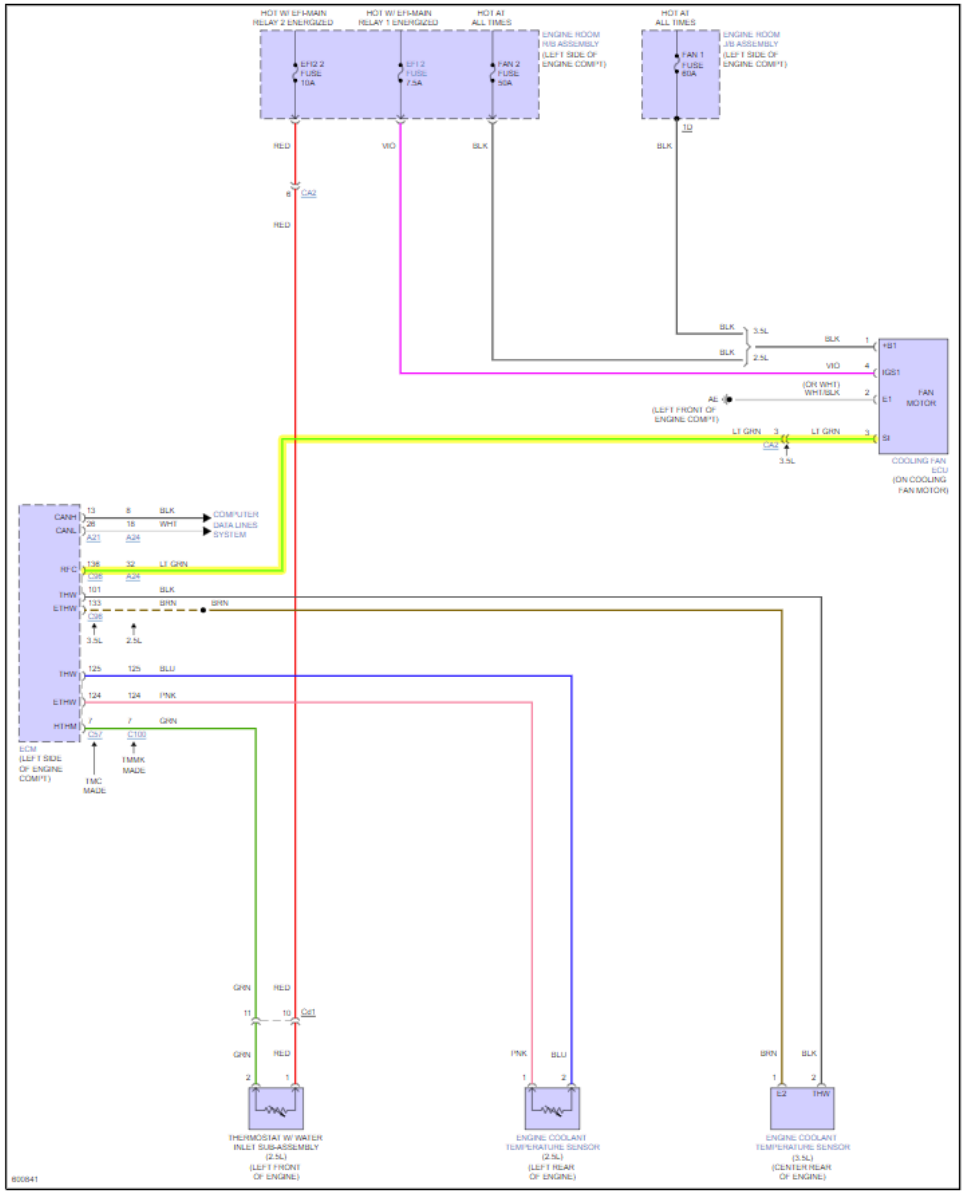
Print



History

Fig 2: Cooling Fan Circuit, Except Hybrid

Print



We Have the Information – and You are Using It!

Year	Make	Model	Submodel	lookups
2010	Toyota	Prius	Base	42714
2008	Toyota	Prius	Base	30259
2007	Toyota	Prius	Base	25679
2017	Chevrolet	Silverado 1500	LT	16971
2009	Toyota	Prius	Base	16564
2007	Toyota	Camry	Hybrid	15623
2019	RAM	1500	Big Horn	14864
2011	Hyundai	Sonata	Hybrid	14845
2013	Chevrolet	Malibu	Eco	13718
2012	Hyundai	Sonata	Hybrid	11307
2009	Toyota	Camry	Hybrid	11263
2018	Chevrolet	Silverado 1500	LT	10756
2010	Ford	Fusion	Hybrid	9378
2012	Ford	Fusion	Hybrid	8304
2008	Nissan	Altima	Hybrid	8101
2008	Toyota	Camry	Hybrid	7515
2016	Chevrolet	Silverado 1500	LT	7467
2013	Toyota	Prius	Four	7410
2013	Ford	C-Max	Hybrid SE	7117
2010	Nissan	Altima	Hybrid	7071
2008	Ford	Escape	Hybrid	6968
2011	Ford	Fusion	Hybrid	6836
2009	Nissan	Altima	Hybrid	6712

Year	Make	Model	Submodel	lookups
2012	Toyota	Prius	Four	6610
2017	GMC	Sierra 1500	SLT	6499
2006	Toyota	Highlander	Hybrid	6450
2018	GMC	Sierra 1500	SLT	6167
2013	Toyota	Prius	Five	6163
2018	Chevrolet	Silverado 1500	LTZ	6124
2009	Ford	Escape	Hybrid	6091
2011	Nissan	Altima	Hybrid	6064
2012	Toyota	Prius	Two	5972
2010	Ford	Escape	Hybrid	5939
2012	Toyota	Prius	Five	5696
2009	Chevrolet	Malibu	Hybrid	5607
2011	Toyota	Camry	Hybrid	5553
2007	Nissan	Altima	Hybrid	5330
2015	Toyota	Highlander	Hybrid Limited	5294
2013	Ford	C-Max	Hybrid SEL	5244
2011	Ford	Escape	Hybrid	5240
2021	RAM	1500	Big Horn	5098
2020	RAM	1500	Big Horn	5048
2010	Toyota	Camry	Hybrid	5022
2020	Jeep	Wrangler	Unlimited Sahar	4922
2008	Toyota	Prius	Touring	4734
2014	Chevrolet	Malibu	Eco	4657

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In Summary

EV's are not coming – they're here

There will be plenty to work on

Tools, Information and Training are available to meet the new challenges

Internal Combustion Engines are still dominant

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Q&A