EV Technologies Overview

OPPORTUNITIES FOR NORTHWEST OHIO IN ELECTRIC VEHICLE TECHNOLOGY

AN INSTITUTE SERIES PRESENTATION

Mike Toole, PhD, PE(PA), F. ASCE

Dean, College of Engineering

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Overview

- EV v. Hybrid v. ICE (v. AV)
- Drivers of EV growth
- Relative Advantages to Consumers and Governments
- ICE parts v. EV parts
- How the Region will be different when EVs dominate
- How the Region can make the most from the EV opportunity

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Introduction: EV v. Hybrid

- Electric vehicles (EV) and Hybrid vehicles have electric motors and batteries to reduce or eliminate need for a traditional internal combustion engine (ICE).

- Hybrid vehicles contain both an ICE and an electric motor and battery.
  - Parallel hybrids blend the two propulsion sources.
  - Series hybrids are propelled by electric motor, which is recharged by ICE and regenerative braking.
  - Plug in hybrids are propelled by electric motor with a larger battery to reduce need for ICE recharge.

Source: www.caranddriver.com/features/a26390899/what-is-hybrid-car/

Introduction: EV v. AV

- Electric Vehicles (EV) only have electric motors and large capacity batteries. Regenerative braking provides limited range extension.
- Autonomous Vehicles (AV) use sensors, communication networks (to connect V2V and V2I), computers, and actuators to automate some portions of driving.
- EVs may have none of the technologies associated with AV.
- AVs that use electric motor propulsion have performance advantages but an AV need not be an EV or a hybrid.

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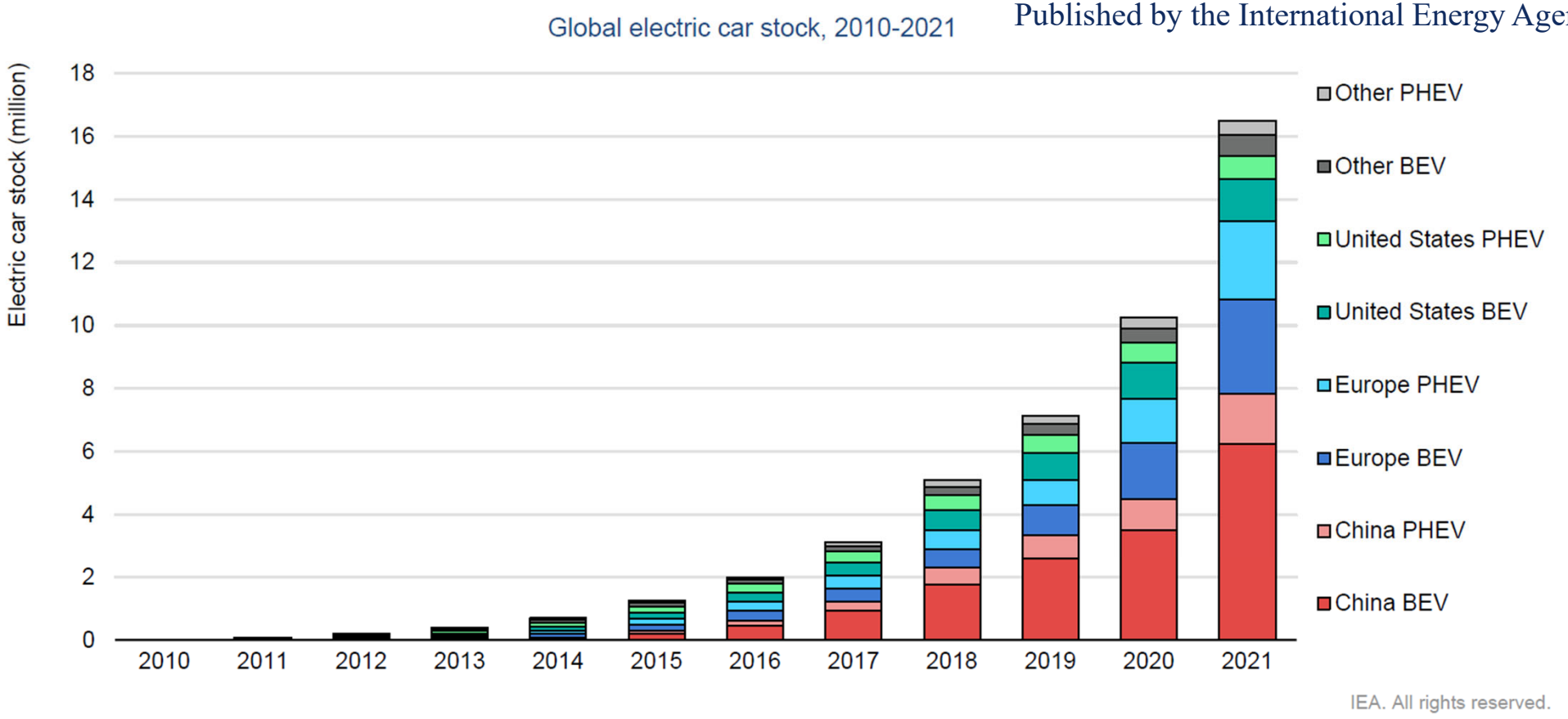
Global EV Sales are Increasing Exponentially

Source: *The Global EV Outlook 2022*
Published by the International Energy Agency (IEA)



Notes: BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle. Electric car stock in this figure refers to passenger light-duty vehicles.
"Other" includes Australia, Brazil, Canada, Chile, India, Japan, Korea, Malaysia, Mexico, New Zealand, South Africa and Thailand. Europe in this figure includes the EU27, Norway, Iceland, Switzerland and United Kingdom.
Sources: IEA analysis based on country submissions, complemented by ACEA; CAAM; EAFO; EV Volumes; Marklines.

“Drivers” of EV Growth

- Relative advantages for the consumer

- Relative advantages for the region and state
- → State policies and programs

- Relative advantages for the nation
- → Federal policies and programs

- ➔ Vehicle manufacturer plans

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EV Relative Advantages to Consumers

Advantages of EVs

- Zero emissions from the vehicle
- Not subject to high gas prices
- Faster acceleration
- Quieter
- No oil changes
- Longer brake life

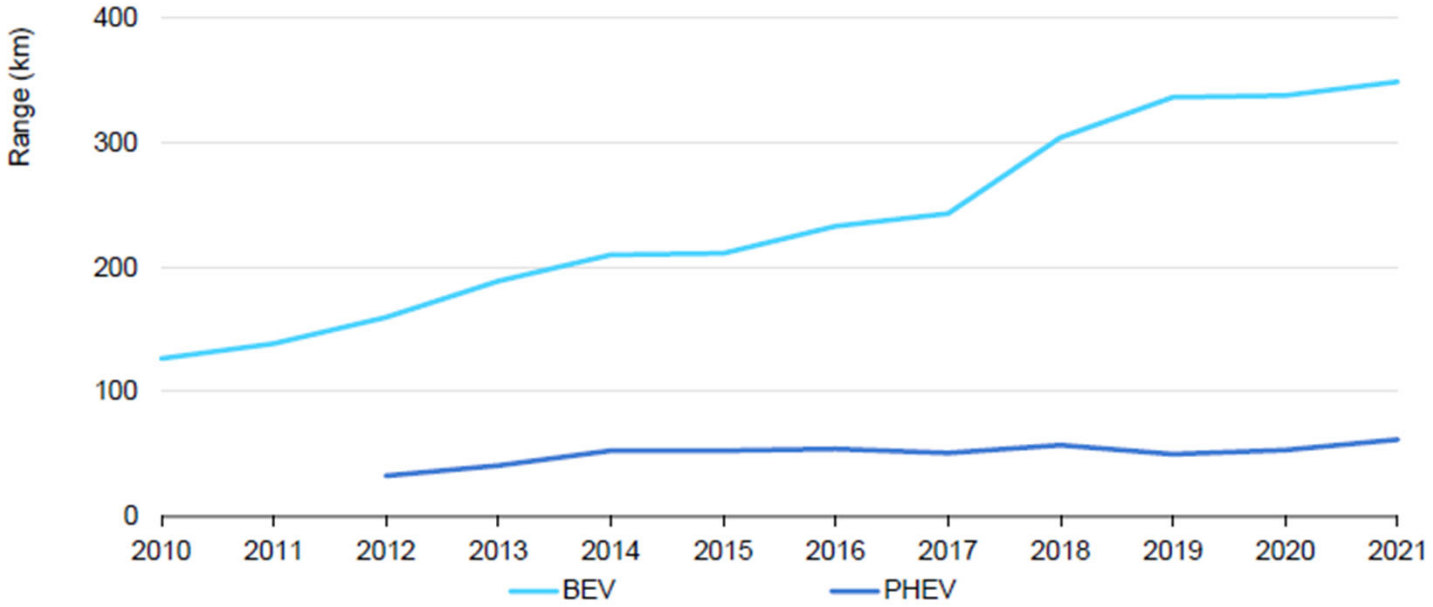
https://www.autoblog.com/article/best-electric-cars-suvs/

Disadvantages of EVs

- Higher initial cost
- Range anxiety (Changing stations that are not ubiquitous and charging takes longer than ICE refueling)
- Specialized maintenance expertise needed

Source: *The Global EV Outlook 2022*
Published by the International Energy Agency (IEA)

Evolution of average range of electric vehicles by powertrain



Notes: Range is sales-weighted and normalised to the Worldwide Harmonized Light Vehicle Test Procedure for all regions. Range for PHEVs refers to the all-electric electric drive range.

Sources: IEA analysis based on EV Volumes.

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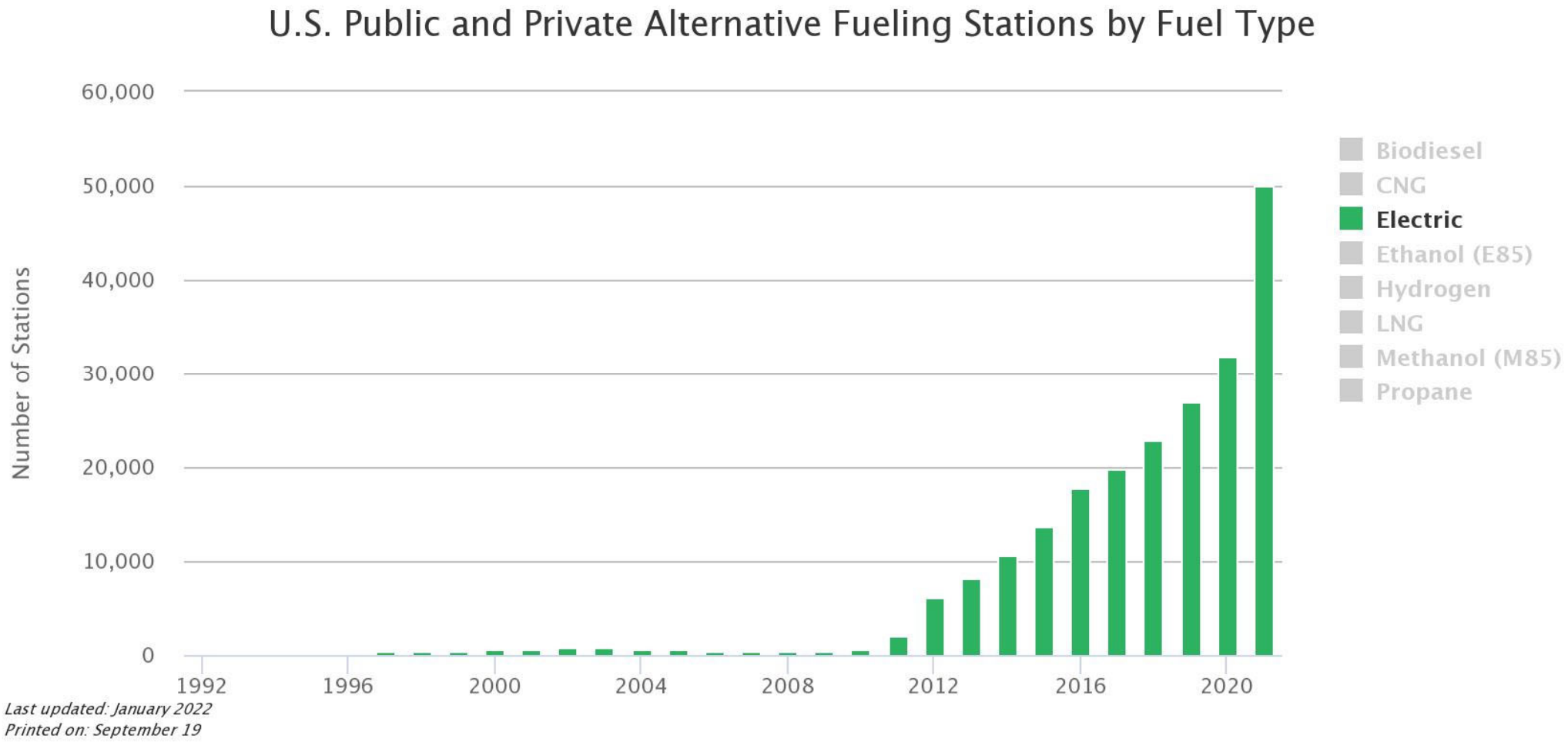
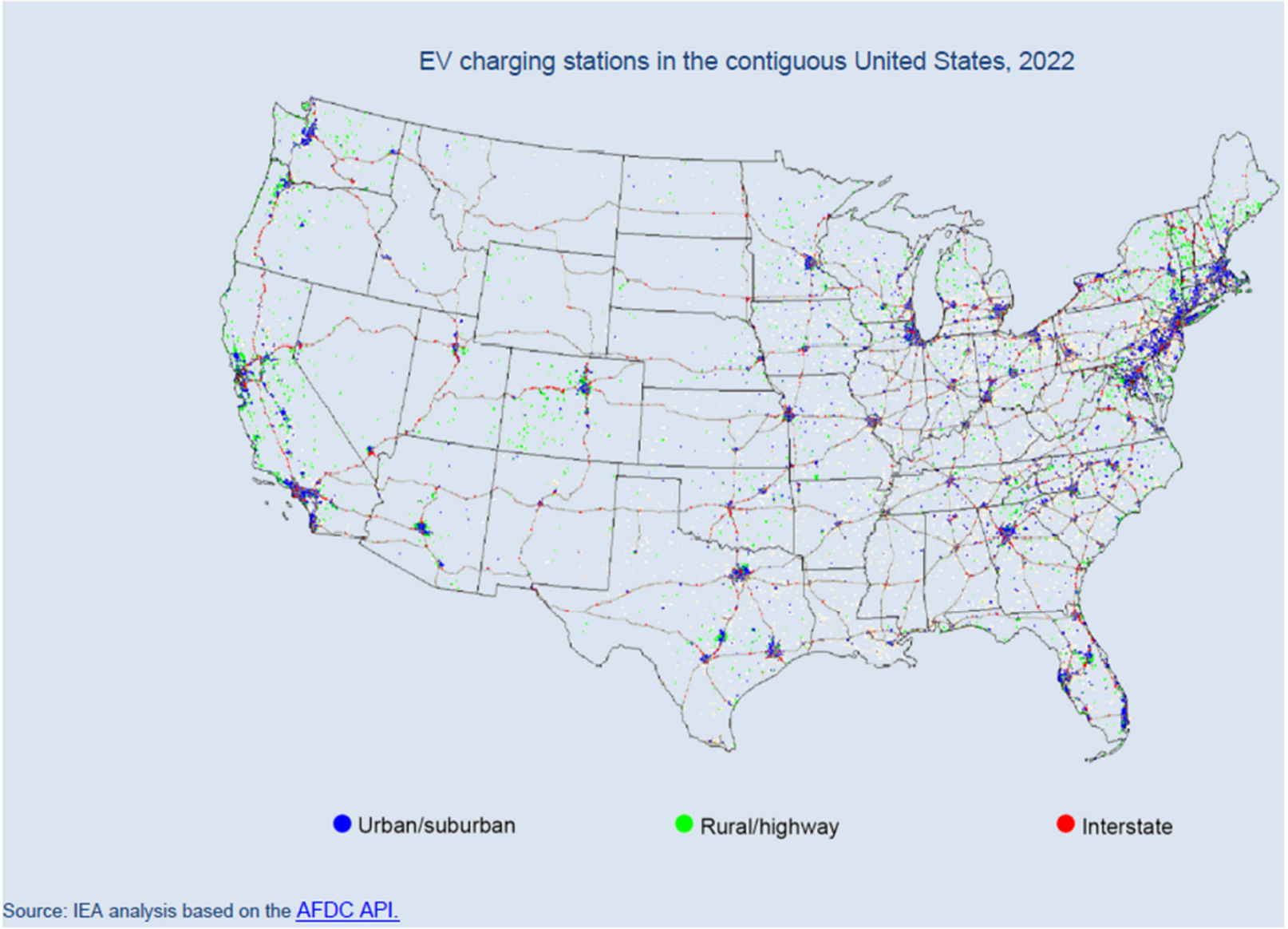
https://afdc.energy.gov/data/10332





Source: *The Global EV Outlook 2022*
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CHARGING STATIONS

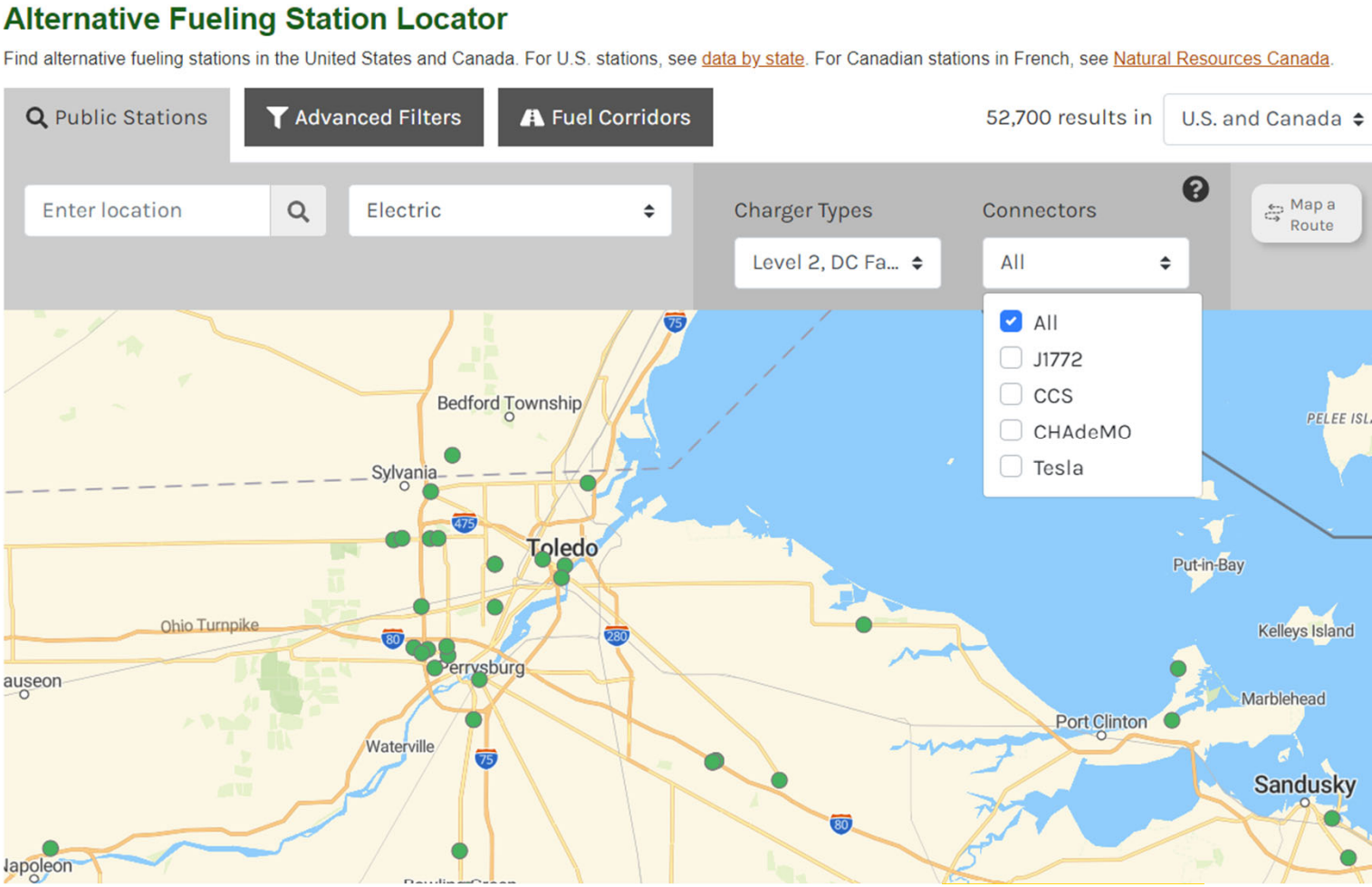
https://afdc.energy.gov/stations/#/find/nearest

Speeds

- Level 1 (~4 mph)
- Level 2 (~20 mph)
- Level 3/DC Fast (~250 mph)

Types

- J1772 (Level 1, 2)
- CCS (Level 3)
- CHAdeMO (Level 3)
- Tesla



EV Relative Advantages to Governments

Advantages of EVs

- Zero emissions from the vehicle
- Fewer emissions from the “fuel”
  (~zero if electricity from renewables)
- Not subject to gas supply and price issues

https://www.autoblog.com/article/best-electric-cars-suvs/

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Source: *The Global EV Outlook 2022*
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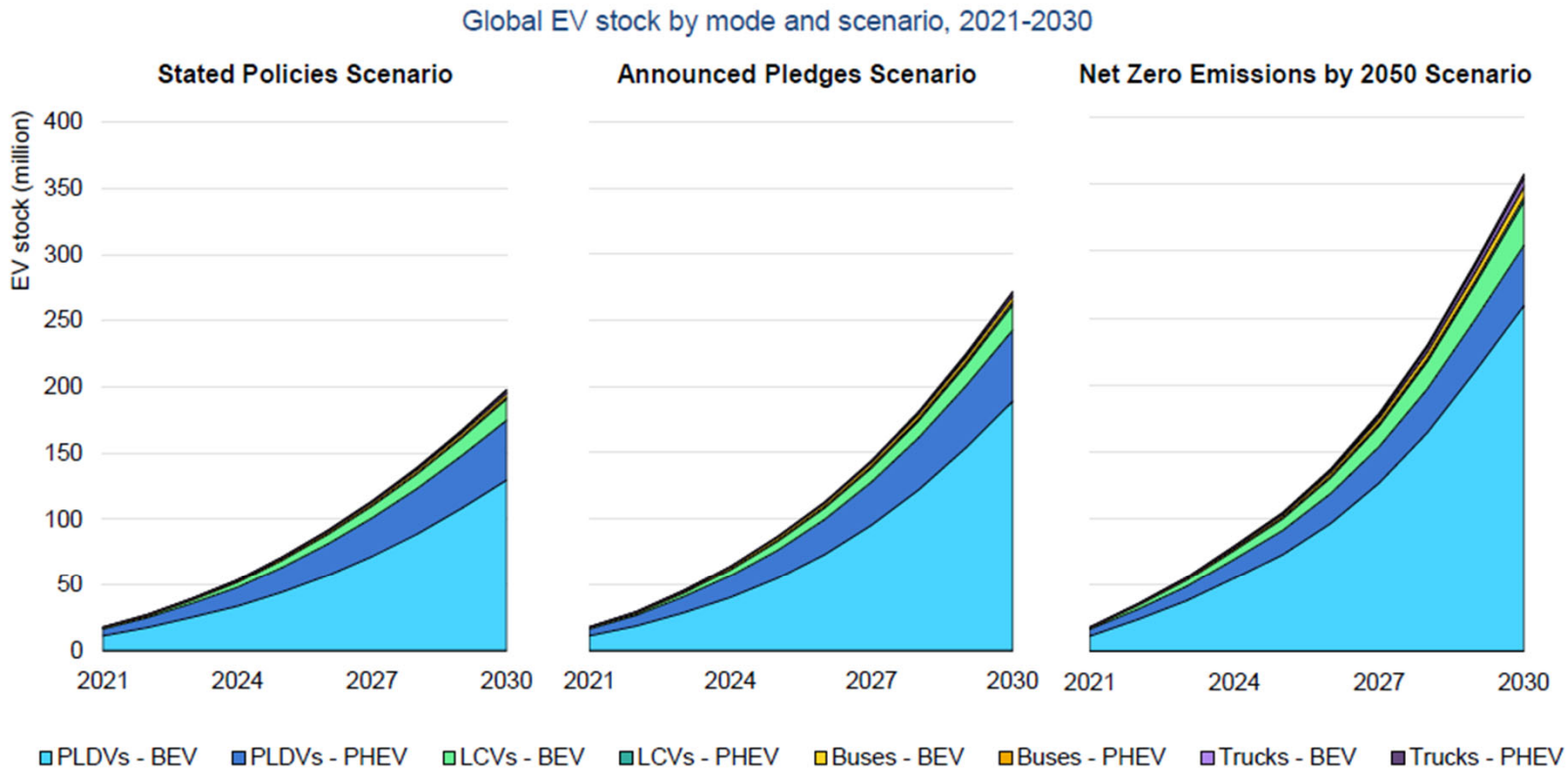
Recent trends in EV sales and government policies bring projected EV adoption closer to being on track with the trajectory to net zero emissions by 2050



Notes: PLDVs = passenger light-duty vehicles; BEV = battery electric vehicle; LCVs = light commercial vehicles; PHEV = plug-in hybrid electric vehicle. The figure does not include electric two/three-wheelers. For reference, total road vehicle stock (excluding two/three-wheelers) in 2030 is 2 billion in the Stated Policies Scenario, 2 billion in the Announced Pledges Scenario and 1.8 billion in the Net Zero Emissions by 2050 Scenario.

"In the United States, also a key EV market, the federal government announced its first targets that include 50% EV sales by 2030 and 500 000 public chargers. The targets are underpinned by existing incentives, and new funding packages of USD 7.5 billion to build charging infrastructure and USD 3 billion for advanced battery supply chains in the Infrastructure Investment and Jobs Act."

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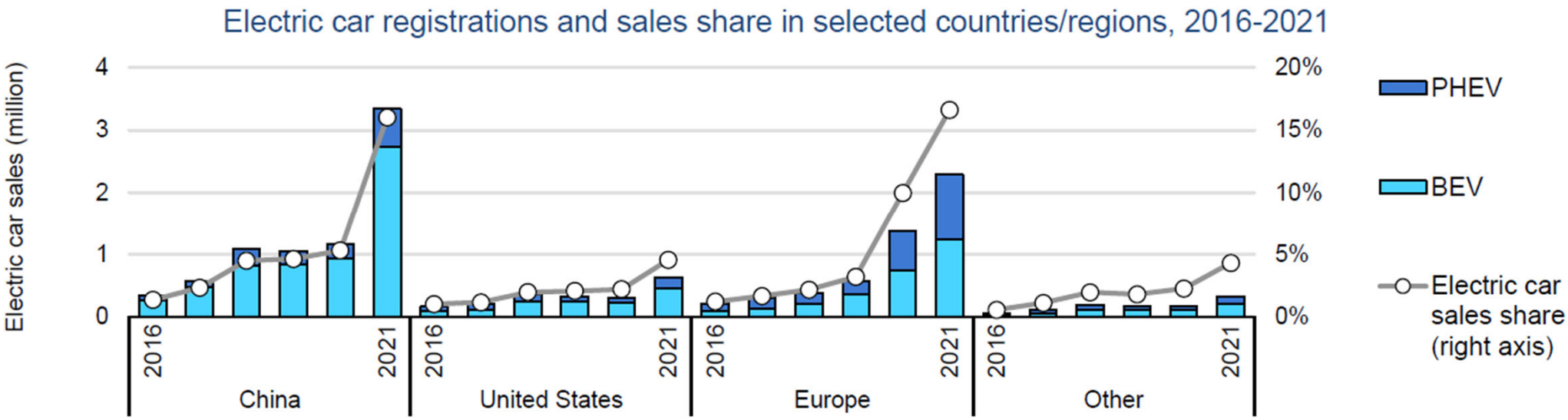
Disadvantages of EVs

- Need to finance and manage charging station networks
- Potential grid resiliency issues
- Disruption of markets (global competition)
- Disruption of supply chains (global competition and geopolitical issues), especially batteries

But Sales Growth Varies across the Globe



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“Drivers” of EV Growth

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Major automakers accelerate electrification plans and aim for a fully electric future

In recent years, automakers have been progressively fleshing out business strategies that consider electrification not only as a way to comply with policy regulations or respond to government incentives, but also as an opportunity to capture market share and maintain a competitive edge. Looking forward, one can expect increasingly aggressive pricing and the development of a wider range of models. In some market, the combined ambitions of OEMs are more ambitious than government announcements (see Chapter 3).

In 2021, several major automakers have announced plans to accelerate the transition to a fully electric future by developing new product lines as well as converting existing manufacturing capacity. Key examples include:

Toyota, the world's largest car manufacturer, announced the roll-out of 30 BEV models and a goal of reaching 3.5 million annual sales of electric cars by 2030. Lexus aims to achieve 100% BEV sales globally in 2035.

Volkswagen announced that all-electric vehicles would exceed 70% of European and 50% of Chinese and US sales by 2030, and that by 2040, nearly 100% should be zero emissions vehicles.

Ford expects one-thid of its sales to be fully electric by 2026 and 50% by 2030, building on the success of its F-150 electric model, and to move to all-electric in Europe by 2030.

Volvo committed to becoming a fully electric car company by 2030.

Geely targets around 30% of electric cars in sales by 2025.

BMW aims for 50% of its vehicles sold to be fully electric by 2030 or earlier.

Mercedes announced that from 2025, all newly launched vehicles will be fully electric.

General Motors aims for 30 EV models and for installed BEV production capacity of 1 million units in North America by 2025 and for carbon neutrality in 2040.

Stellantis targets 100% of sales in Europe and 50% of sales in the United States to be BEVs by 2030.

Hyundai targets sales of 1.9 million BEVs annually by 2030 to secure a 7% global market share, and to end sales of ICE vehicles in Europe in 2035.

Kia aims to increase sales of BEVs to 1.2 million in 2030.

In China, some automakers are adjusting to reflect the goal of carbon peaking by 2030. Dongfeng plans to electrify 100% of its new models of main passenger car brands by 2024. BYD announced that it would only produce BEVs and PHEVs from April 2022 onwards.

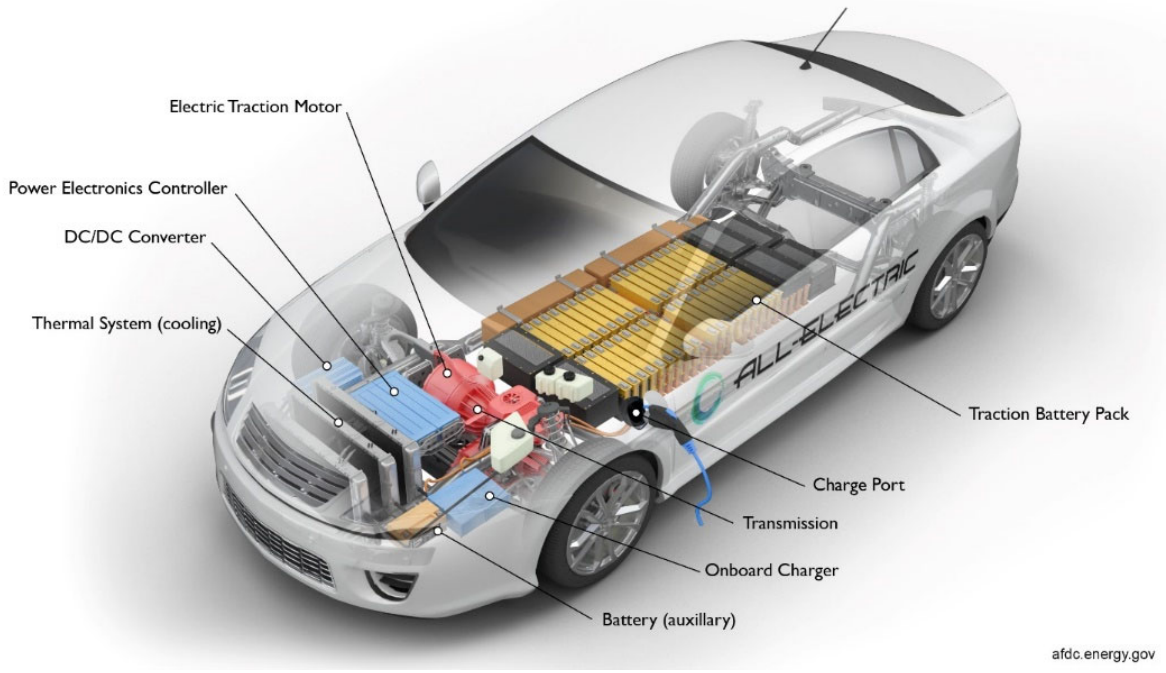
What EVs have that ICEs don't have

Large capacity battery
Electric motor
Power electronics
Charging port

What ICEs have that EVs don't have

Gas tanks
Fuel pumps and lines
Starter motor
Combustion chambers and sparkplugs
Pistons and crankshafts
Engines with hundreds of moving parts
Multispeed transmissions
Radiators and hoses
Exhaust pipes and mufflers

All-Electric Vehicle



https://afdc.energy.gov/vehicles/how-do-all-electric-cars-work

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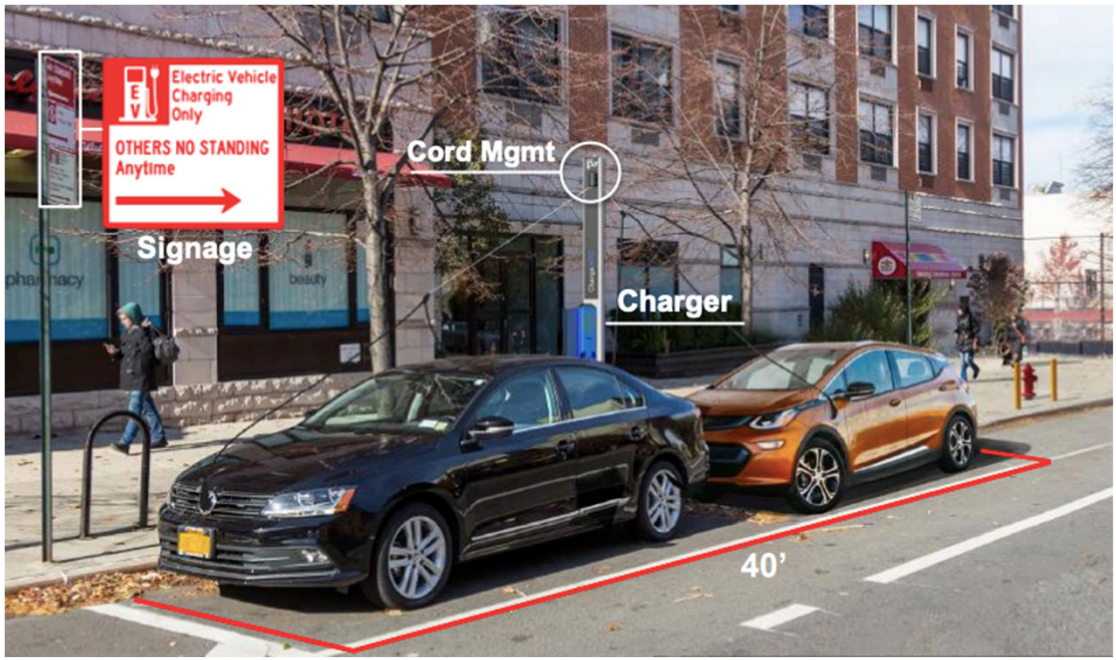
How will the Region be Different when EVs Dominate?

- Air quality and vehicle noise levels will improve
- A lot more charging stations will needed: public, work, home
- Fewer gas stations will be needed
- Fewer specialized auto service businesses: oil changes, transmissions, mufflers…
- Daily load cycles on electrical grid may change



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Managing Supply Chain Changes due to EVs

"With fewer parts and lower mechanical complexity in their propulsion systems, EVs will significantly erode employment in the production of engines, transmissions, exhaust, and conventional fuel systems."

United Auto Workers, "Taking the High Road."

"The rise of EVs poses a particular risk for auto suppliers. Major systems that are essential to vehicles with internal combustion engines are absent from EVs. Makers of exhaust systems, fuel systems, and transmissions face the prospect of disruption as EVs become more mainstream. Those lacking financial flexibility and digital wherewithal are likely to struggle the most. … OEMs and suppliers alike should start preparing for that future today."

https://www.pwc.com/us/en/industries/industrial-products/library/electric-vehicles-supply-chain.html

How Can the Region Maximize Opportunities Associated with EVs?

- Avoid unemployment and empty manufacturing plants by helping ICE parts manufacturers transition to EV parts.
- Enable workforce retraining.
- Avoid unemployment and empty retail facilities by helping gas and auto service retail locations transition.
- Avoid lost vehicle sales to regions with greater EV selection by making auto dealers confident there will be sufficient charging stations.

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Workforce Retraining Needs

- Recap of EV's differences
  - No combustion
  - Fewer moving parts
  - More power electronics
  - Heavy battery
- Educational/Training implications for
  - Vehicle Design and Manufacturing
    - Mechatronics (intersection of mech. and elect. eng.)
    - Power Electronics (elect. eng.)
    - Material science/engineering
  - Vehicle Repair

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Summary

- EVs will come to dominate ICEs over the next two decades.
- EVs have compelling advantages over ICEs for drivers and governments.
- EVs have compelling **dis**advantages over ICEs for drivers and governments.
- ICE parts manufacturers and service providers must start transitioning to EVs soon.
- Workforce retraining will be an important part of the transition.
- We can do this Toledo!