

# Why all the excitement about Electric Vehicles?



# Presenter info

- Tony Billera
  - 35 years in telecom, wireless, and IT product development and program mgt.
  - Senior Fellow at the Center for Advanced Transportation and Energy Solutions ([www.aboutCATES.org](http://www.aboutCATES.org))
    - Autonomous
    - Connected
    - Electric
    - Shared Vehicles
  - CTE Middle School para-educator
  - Experienced owner of 4 EVs:
    - KIA EV6 (250-300 mile range)
    - KIA Niro - sold (250-300 mile range)
    - FIAT 500e - sold (75-90 mile range)
    - BMW C Evolution motorcycle - sold

## CATES

Center for Advanced Transportation and Energy Solutions

**Call on CATES for technical and management consulting, policy advisory services, and contract research on small vehicle automation and electrification.**

**The End of Driving**  
Transportation Systems and Public Policy Planning for Autonomous Vehicles  
Bern Grush • John Niles

Foreword by Susan Shaheen, PhD, Adjunct Professor and Co-Director, Transportation Sustainability Research Center, University of California, Berkeley

- Offers a workable public transit solution design, including the traditional acquire-and-operate mode with the absorption of new technology as it is ready.
- Provides a step-by-step discussion of digital system designs and effective regulation-by-data approaches needed for a new urban mobility.
- Learning aids include case study scenarios, chapter objectives and discussion questions, sidebars, and a glossary.

While many transportation and city planners, researchers, students, practitioners, and political leaders are fixated with the technical nature and promise of vehicle automation, consensus still has yet often been on the impact that will result, or the policies and actions that those responsible for transportation systems should take.

*The End of Driving: Transportation Systems and Public Policy Planning for Autonomous Vehicles* explores both the potentials of vehicle automation technology and its barriers to forming coherent urban deployment. The book evaluates the case for deliberate development of automated public transportation and mobility-as-a-service as paths toward sustainable mobility, identifying critical approaches to the planning and management of vehicle automation technology. It serves as a reference for understanding the full life cycle of the multi-year transportation systems planning processes, including regulation, planning, and acquisition tools for regional transportation.

Application-oriented, research-based, and solution-oriented rather than predict-and-warn, the book concludes with a detailed discussion on the systems design needed for accomplishing the shift.

**Relates To:**  
Chikanikunt / Intelligent Vehicular Network and Communications: Fundamentals, Architecture and Solutions / 9780128020268  
Kaly / On-Road Intelligent Vehicular Mobility Planning for Intelligent Transportation Systems / 9780128037294  
Rossetti and Liu / Advances in Artificial Transportation Systems and Simulation / 9780128170481

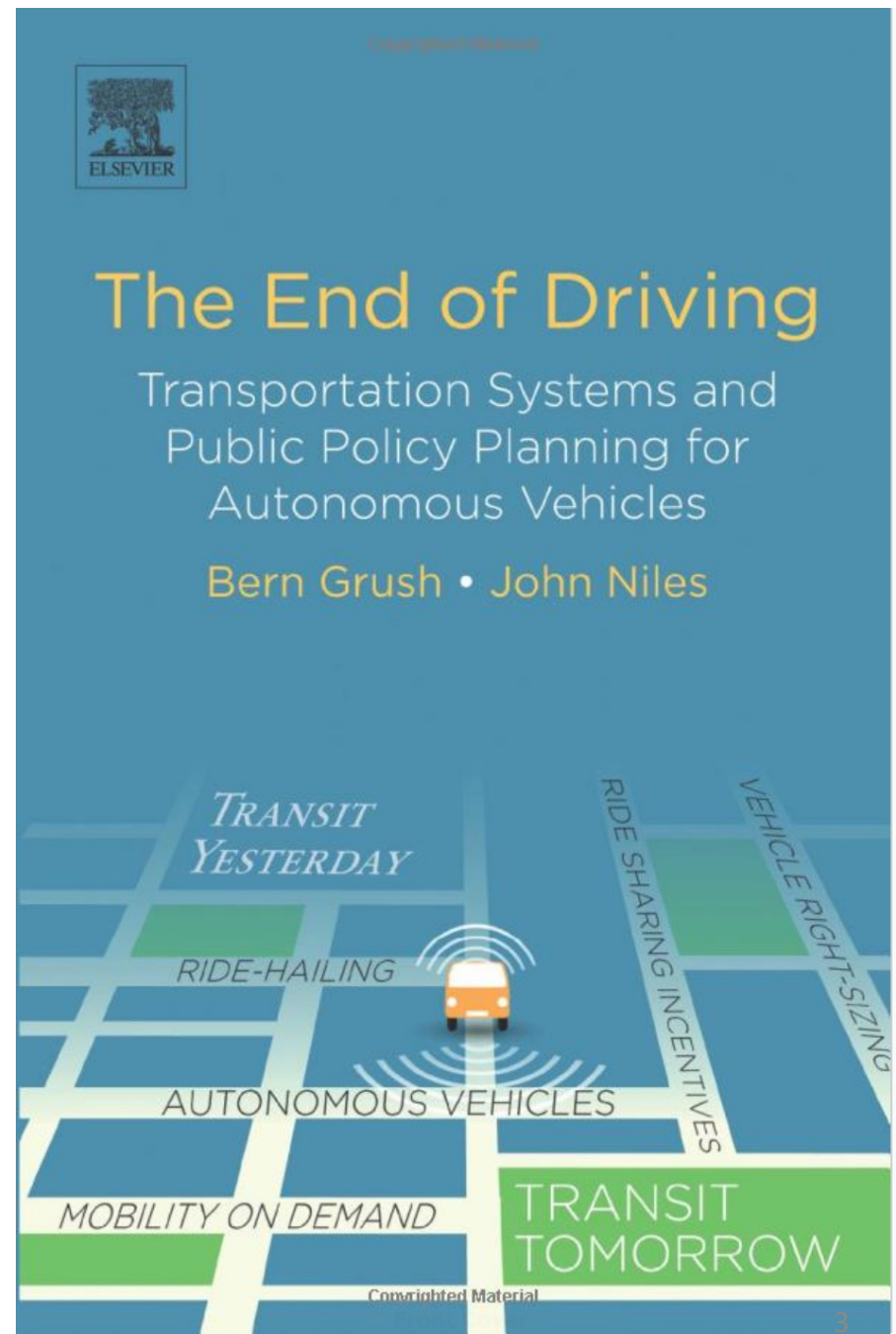
**The End of Driving**  
Grush • Niles

**The End of Driving**  
Transportation Systems and Public Policy Planning for Autonomous Vehicles  
Bern Grush • John Niles

TRANSIT YESTERDAY  
RIDE-HAILING  
RIDE SHARING INCIDENTI  
VEHICLE RIGHT-SIZING  
AUTONOMOUS VEHICLES

# The End of Driving: Transportation Systems and Public Policy Planning for Autonomous Vehicles

- explores the potential of vehicle automation technology
- the barriers to urban deployment
- evaluates the case of automated public transportation and mobility-as-a-service as paths toward sustainable mobility



# Why all the excitement about EVs?

1. **EVs Past**
2. **Why Now?**
3. **Batteries**
4. **EVs & Hybrid Efficiency**
5. **Owning an EV**
6. **Market Disruption**
7. **Charging Stations**
8. **Charging Networks**
9. **Tax Incentives**



# Early EVs



1919 Rauch & Lang  
Vintage Electric car



Battery Scooter  
London 1916

THE SATURDAY EVENING POST

A Four-Passenger Coupe with removable top which may be replaced with Leather Victoria or Buggy top. Exide, Waverley or National Batteries. Choice of solid or pneumatic tires.

Price \$2,250

*Waverley*

Perfection of  
Style and Service  
In an Electric

This is a vintage advertisement for a Waverley electric car. It features a detailed illustration of a four-passenger coupe with a dark, boxy body and spoked wheels. The car is shown from a side profile. The text is arranged around the car, providing details about its features and price. The Waverley logo is written in a large, elegant script. The overall tone is classic and professional.

*Studebaker*

ELECTRICS

VEHICLES OF GREAT UTILITY  
FOR THE BUSINESS MAN

ELECTRIC STANHOPE

This is a vintage advertisement for a Studebaker electric Stanhope. It features a detailed illustration of a two-seater electric car with a dark, boxy body and spoked wheels. The car is shown from a side profile. The text is arranged around the car, providing details about its features and price. The Studebaker logo is written in a large, elegant script. The overall tone is classic and professional.

# GM EV1      2,300 built 1996 - 1999

Movie : “Who killed the electric car?”





# Why all the excitement today?

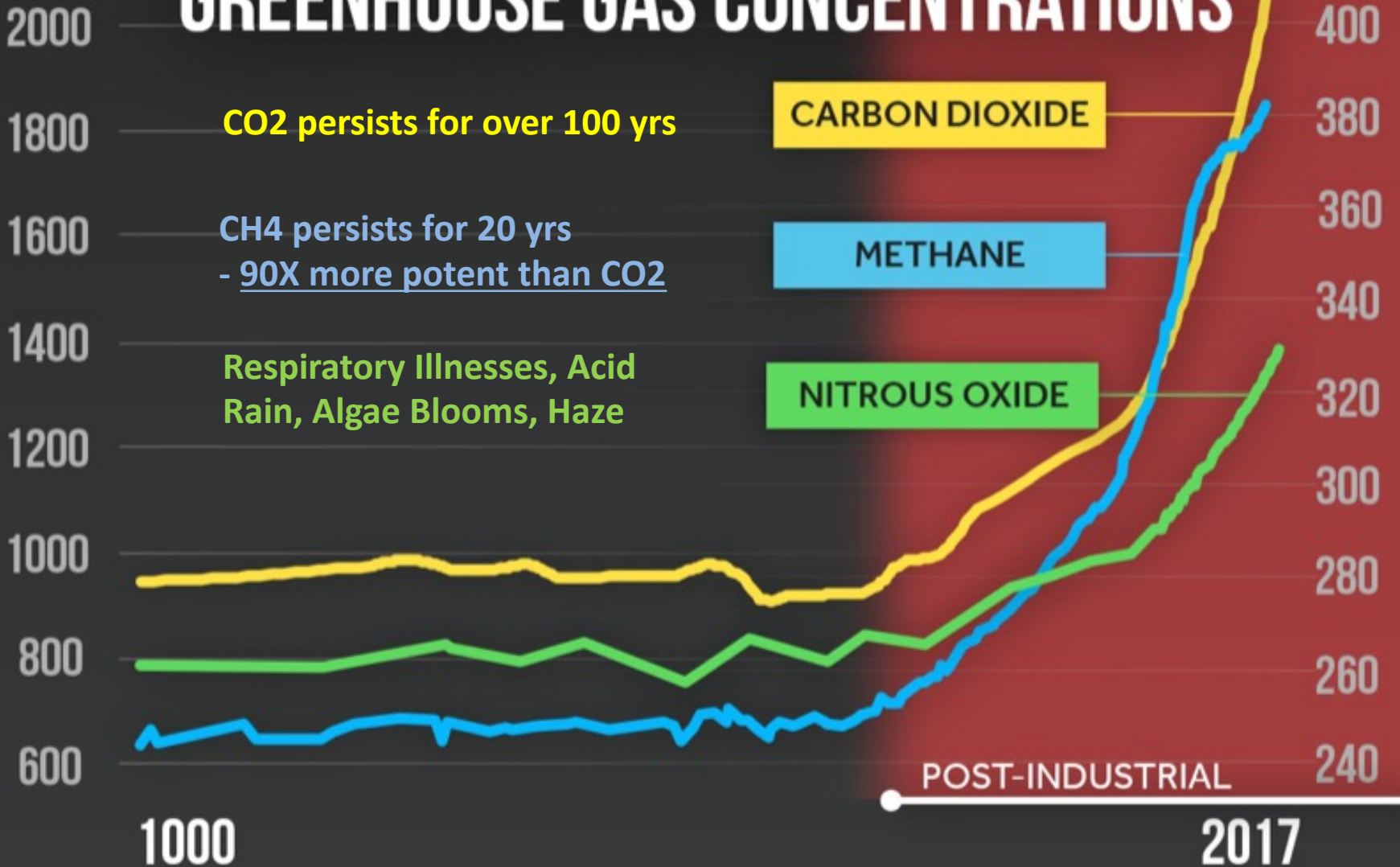
- Impacts of GHG emissions are recognized thru the climate science research and evidence, driving the urgent need to rapidly reduce anthropogenic co2 emissions
  - Transportation sector is largest share of U.S. co2 emissions at 27%
  - One gallon of gas or diesel emits about 21 lbs of co2
- Advanced Battery Technology
  - Lighter
  - Denser
  - Reliable
- Battery costs are falling thru mass production economies of scale and making electric vehicles more affordable and life cycle costs very compelling



CH<sub>4</sub> (ppb)

CO<sub>2</sub> (ppm), N<sub>2</sub>O (ppb)

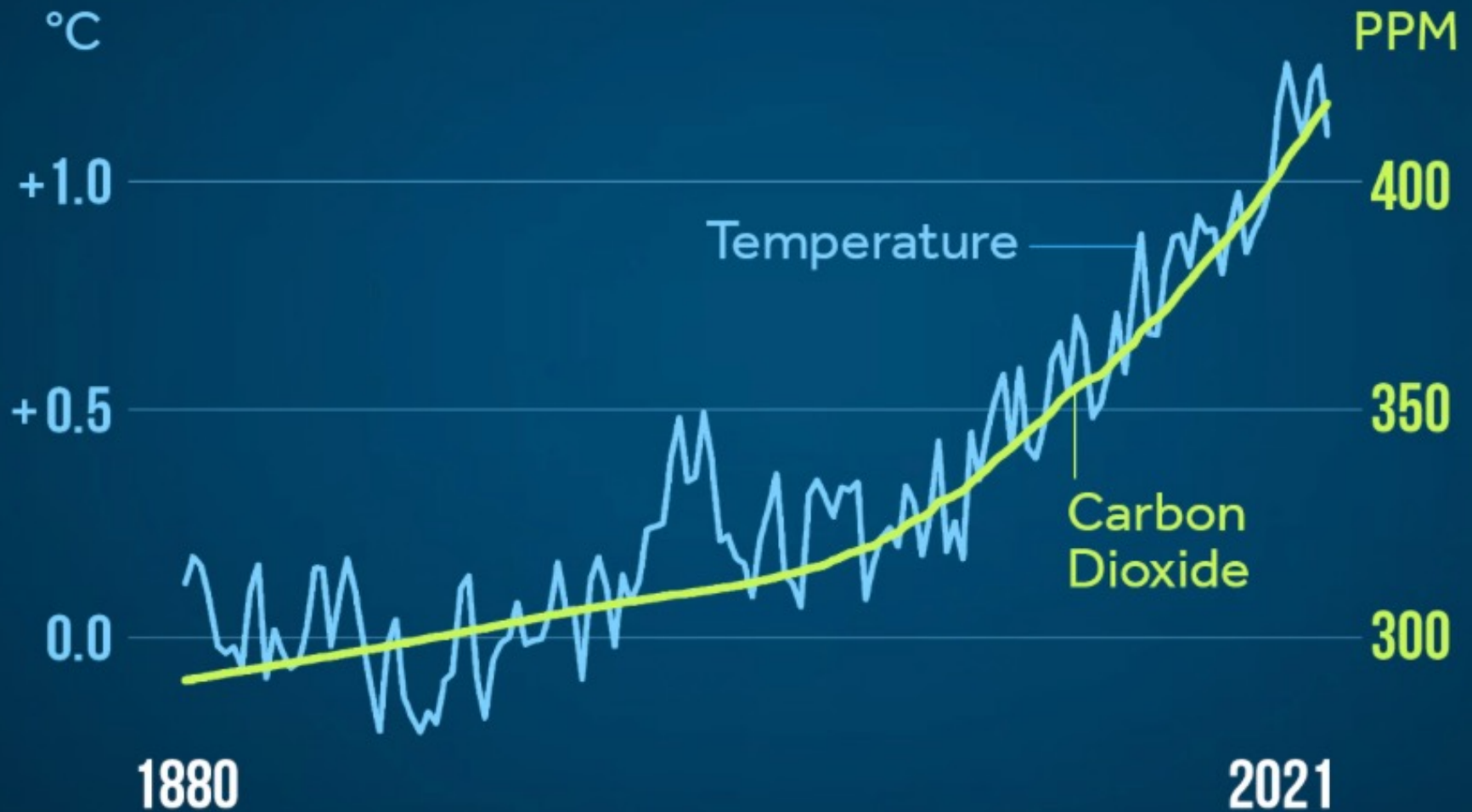
# GREENHOUSE GAS CONCENTRATIONS



Post-Industrial defined as 1750 and beyond  
Source: US EPA's Climate Change Indicators



# TEMPERATURE & CARBON DIOXIDE

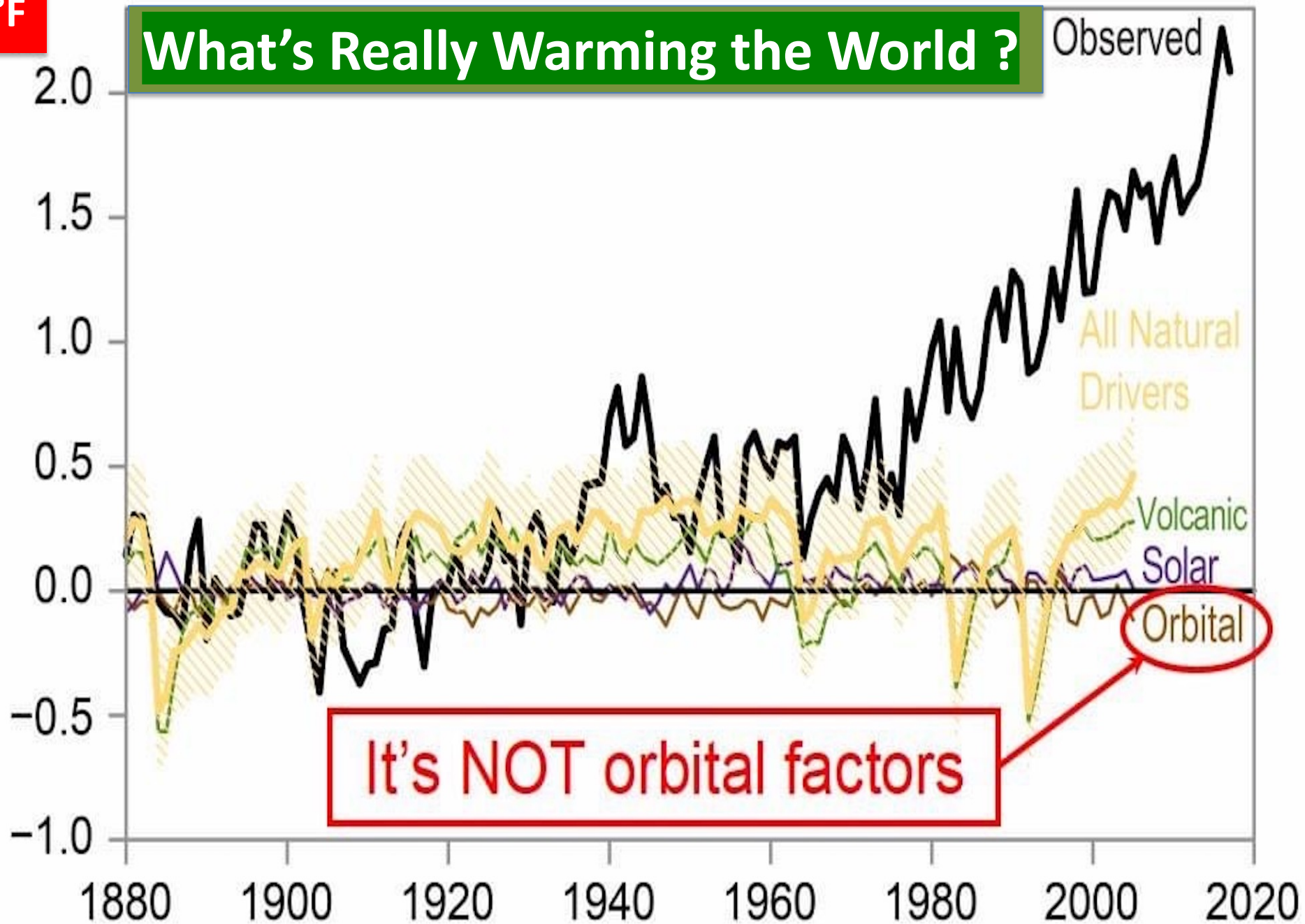


Global temperature anomalies averaged and adjusted to early industrial baseline (1881-1910)  
Source: NASA GISS, NOAA NCEI, ESRL

CLIMATE  CENTRAL

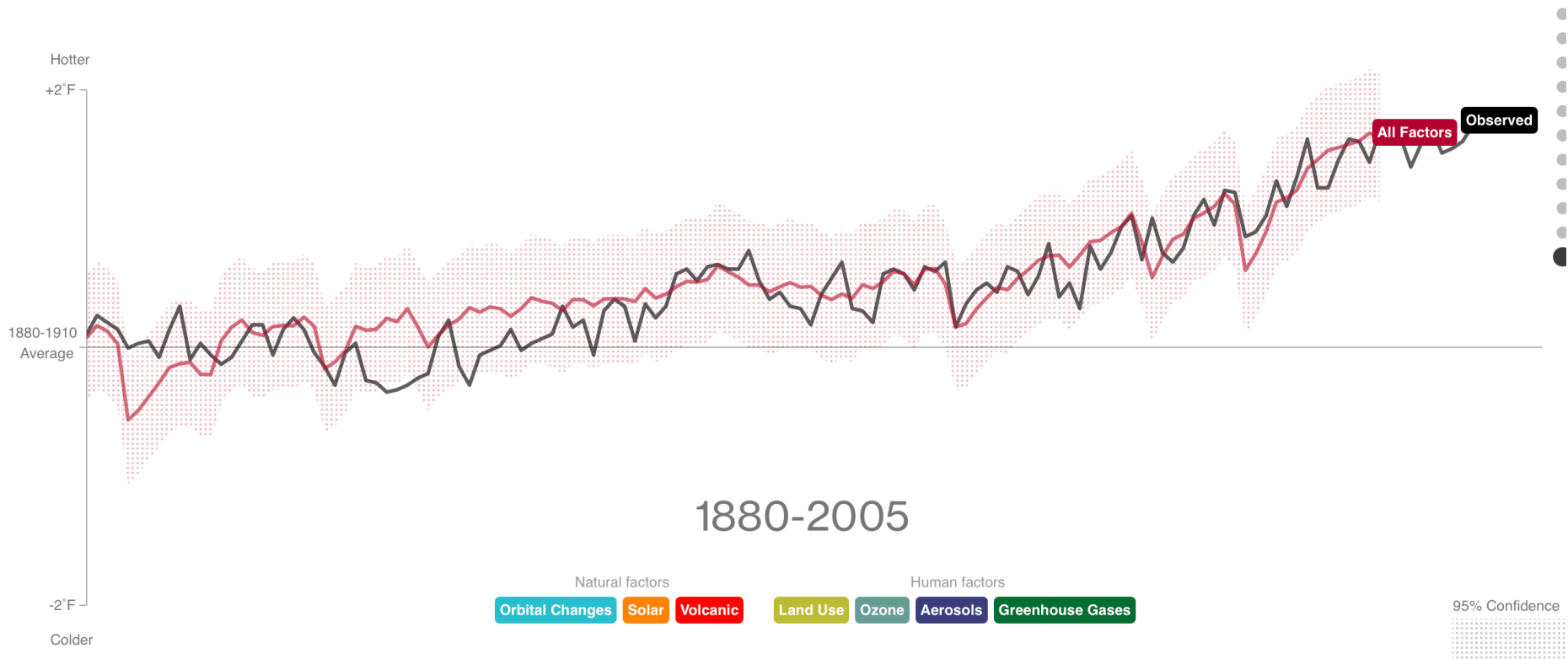
°F

# What's Really Warming the World ?



# • WHATS REALLY WARMING THE WORLD?

<https://www.bloomberg.com/graphics/2015-whats-warming-the-world/>



# Emissions per capita

Household lifestyle consumption emissions (tonnes of CO<sub>2</sub> per capita)\*\*



\*\* In G20 countries for which data is available

Visual journalism: Steven Bernard/@sdbernard and Chelsea Bruce-Lockhart/@C\_BruceLockhart

Source: Oxfam

© FT



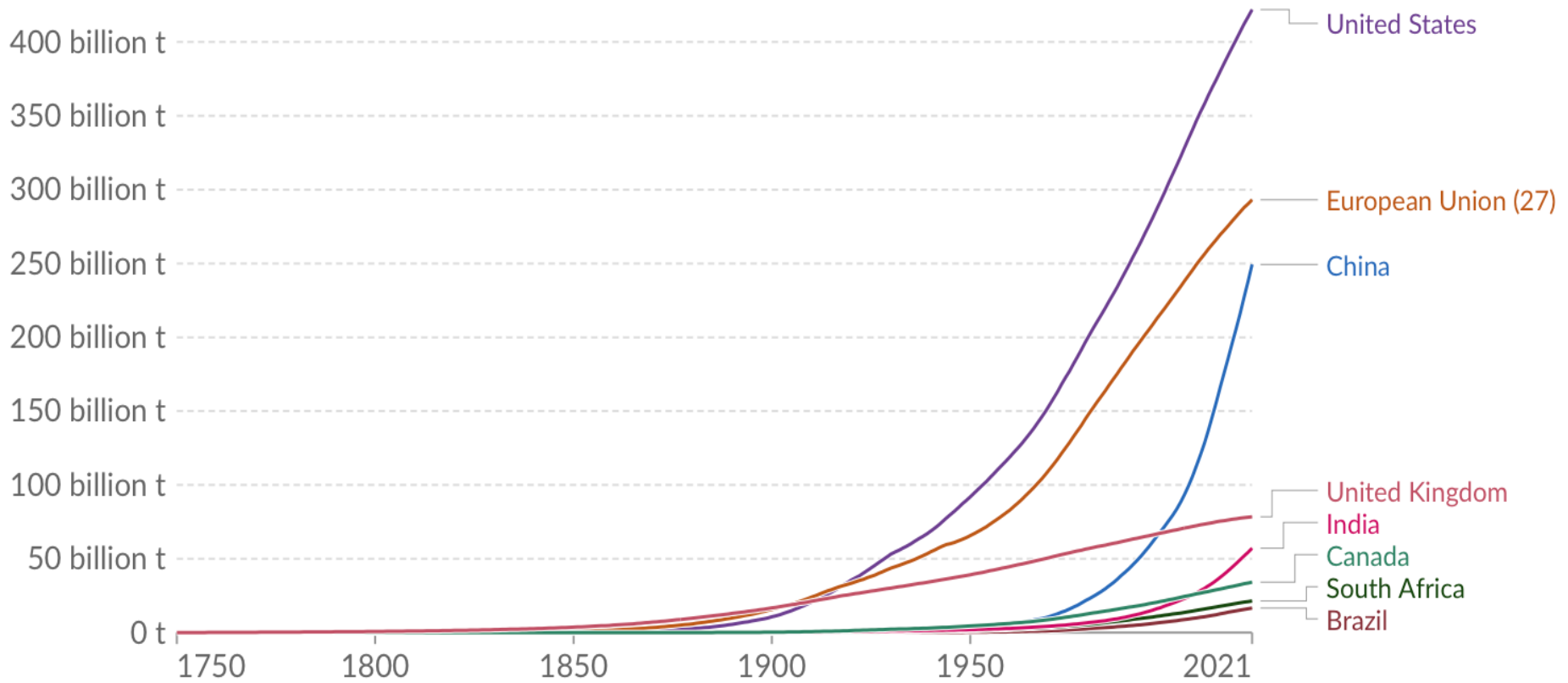
# Cumulative CO<sub>2</sub> emissions

Cumulative emissions are the running sum of CO<sub>2</sub> emissions produced from fossil fuels and industry since 1750. Land use change is not included.

[+ Add country or region](#)

All together ▼

Relative change



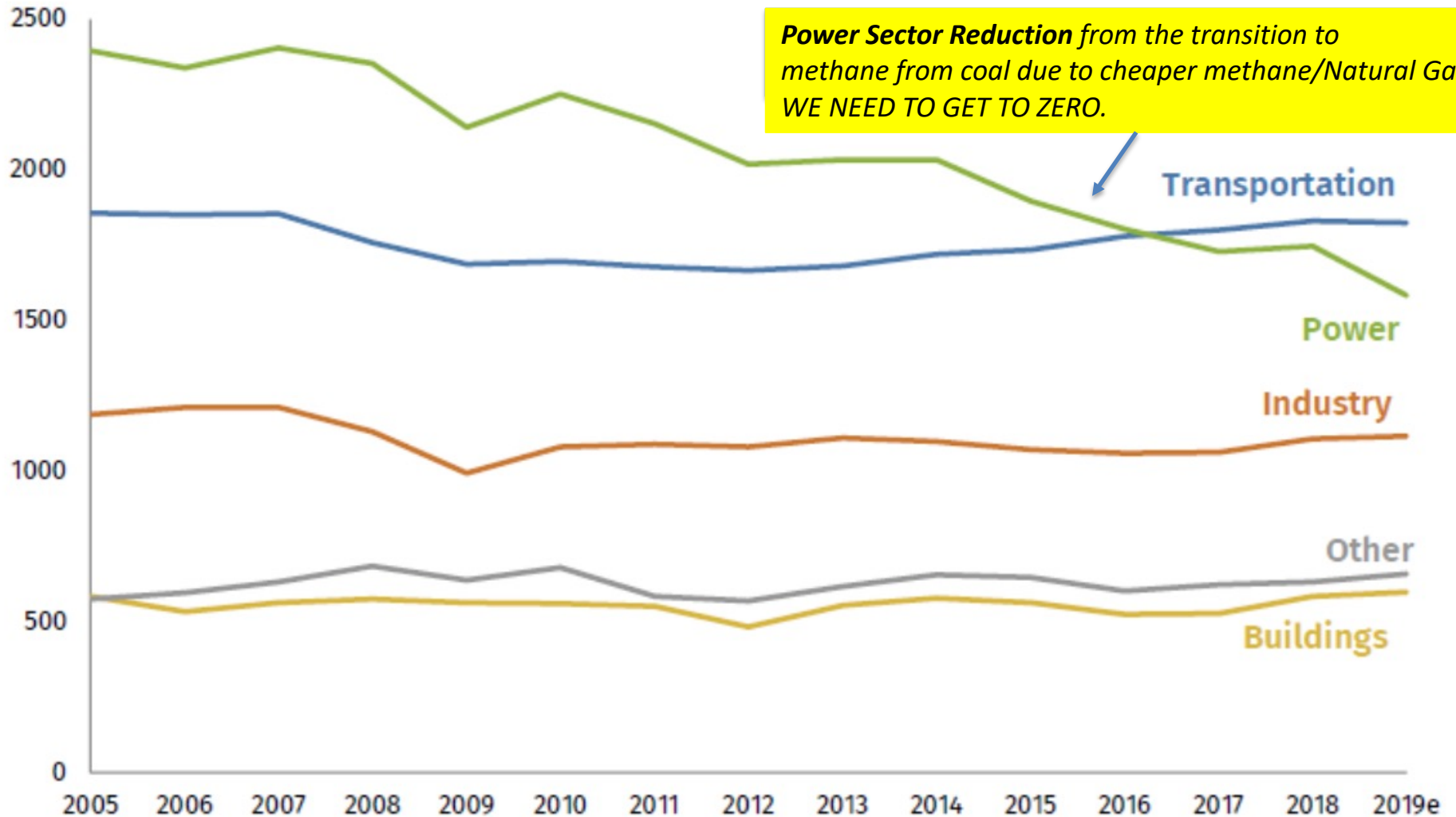
Source: Global Carbon Budget (2022)

OurWorldInData.org/co2-and-greenhouse-gas-emissions • CC BY



# Net US GHG emissions by sector

Million metric tons CO<sub>2</sub>e, IPCC definitions, excludes international bunkers

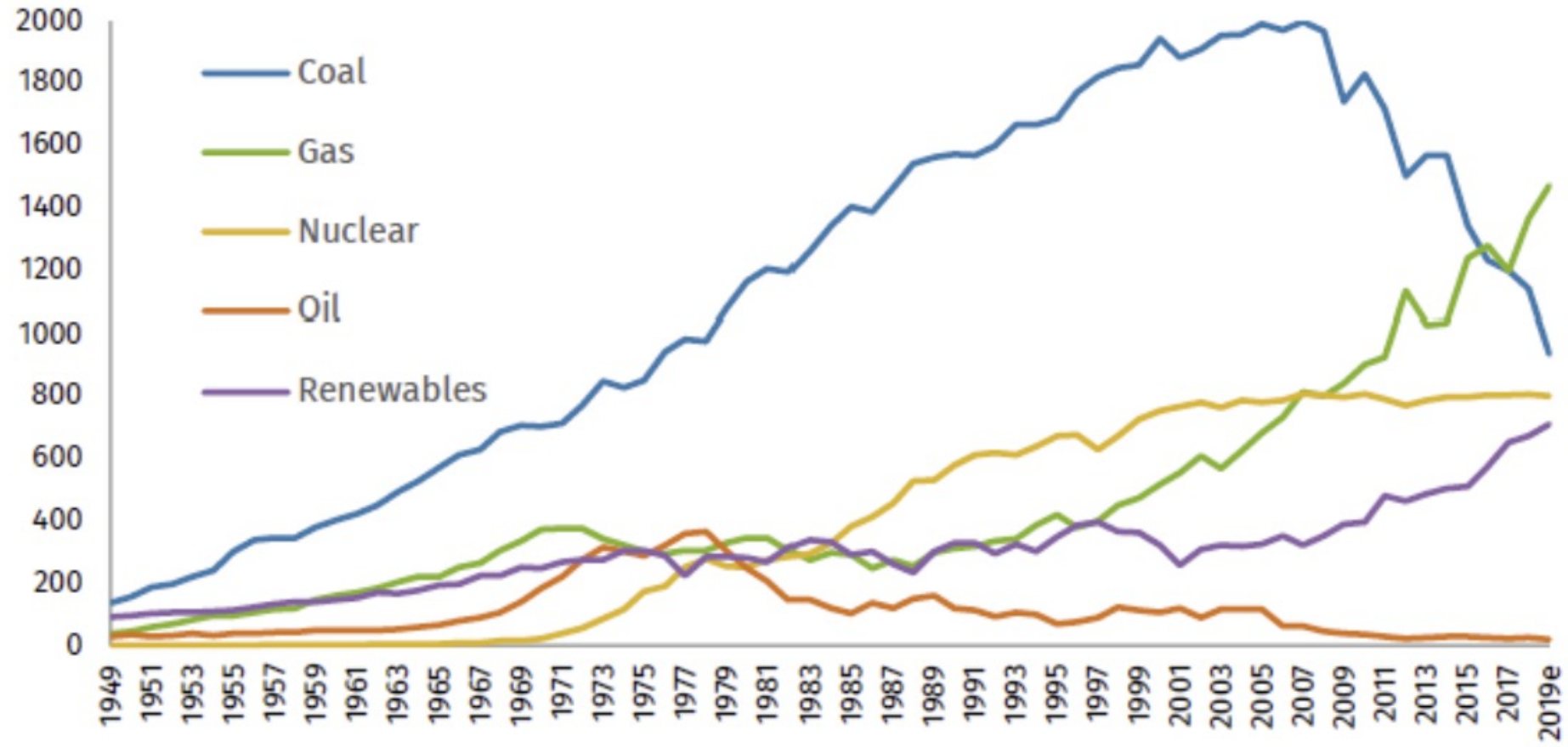


Source: Rhodium Climate Service

# Sources of Power Grid , United States

## US power generation by energy source

Billion kWh, electric power sector only, does not included distributed generation

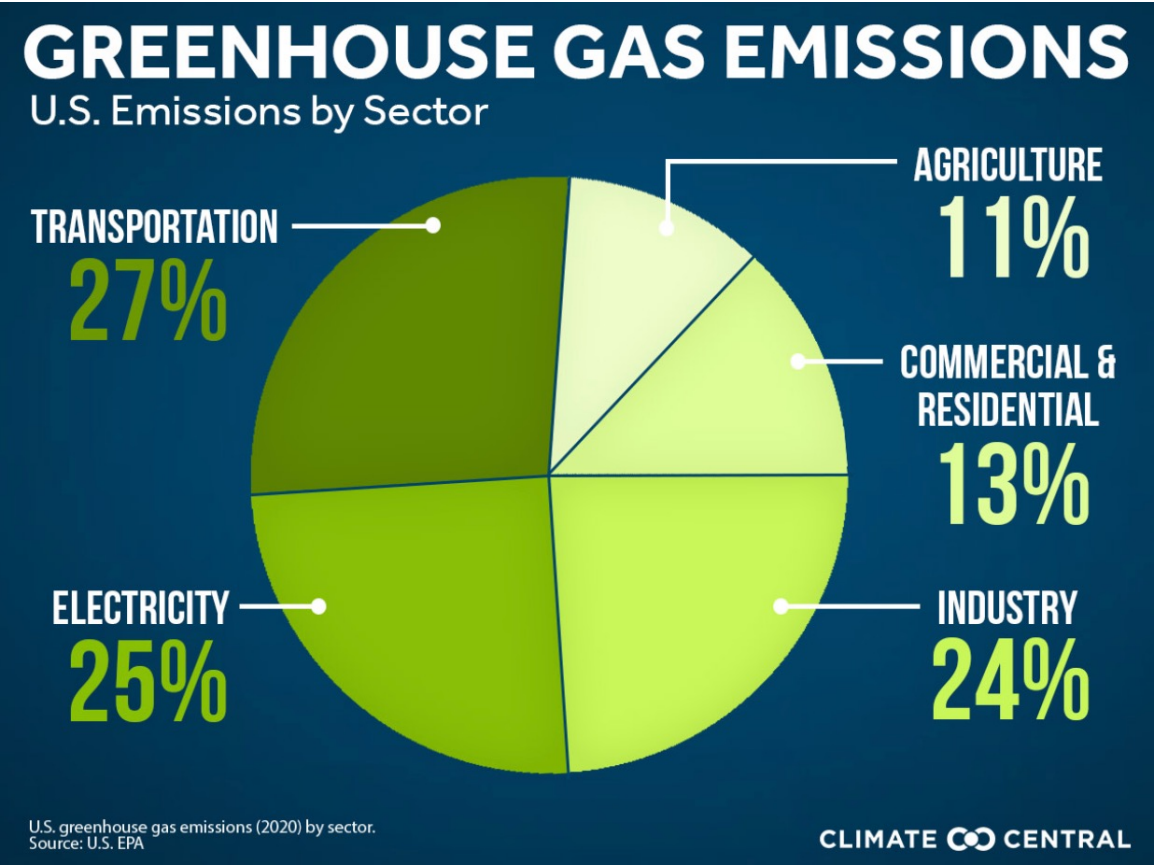


Source: Rhodium Climate Service

# Total U.S. Greenhouse Gas Emissions By Sector in 2019

## Transportation is largest share

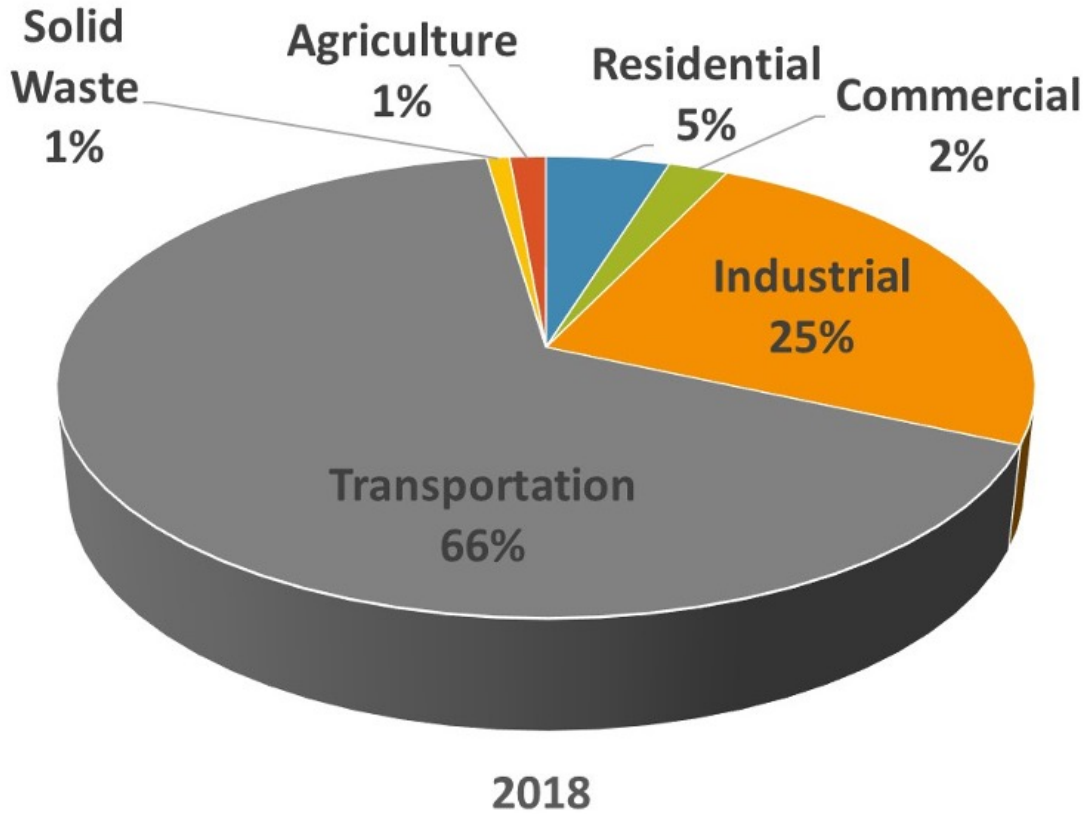
- Primarily :  
passenger cars, medium- and heavy-duty trucks, buses, and light-duty trucks
- commercial aircraft, ships, boats, and trains, as well as pipelines and lubricants





# Jefferson County 2018 Community Emissions By Sector

- Jefferson County / Port Townsend Climate Action Committee in 2020
- Transportation emissions increased 13% since 2005
- Electricity > 90% hydroelectric

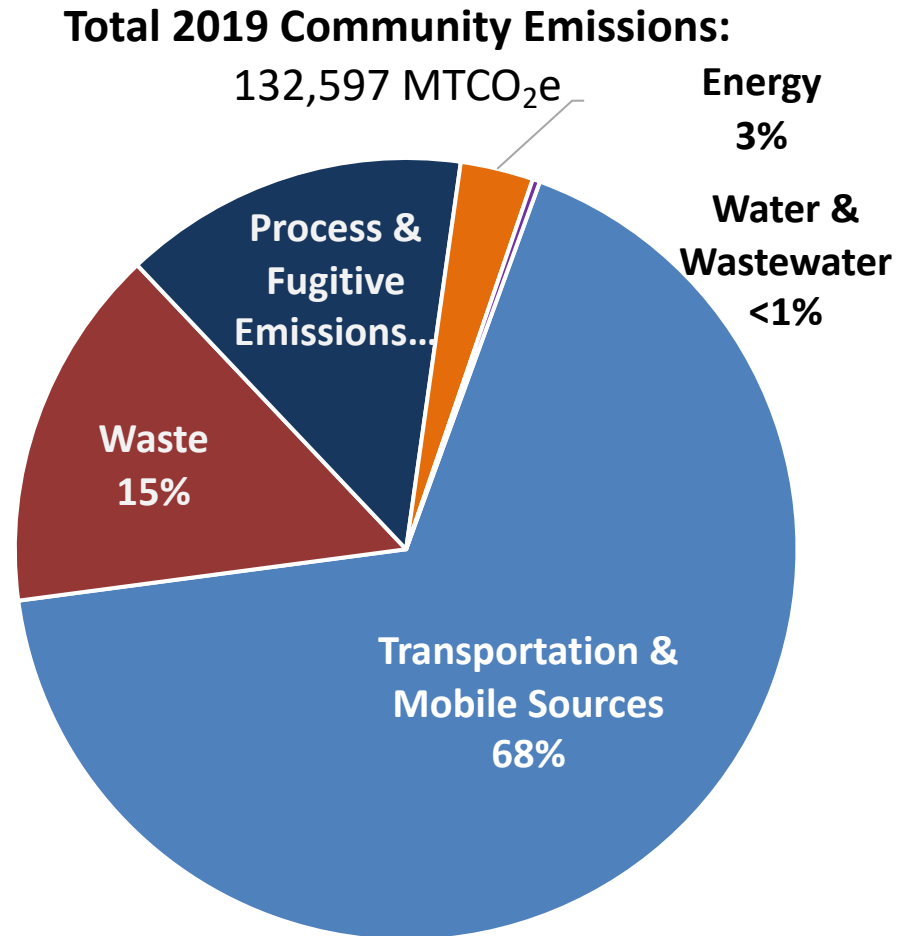


# Port Angeles Climate Resiliency Project

## Inventory Results: 2019 Community Snapshot

### Main Sources of Emissions (in order):

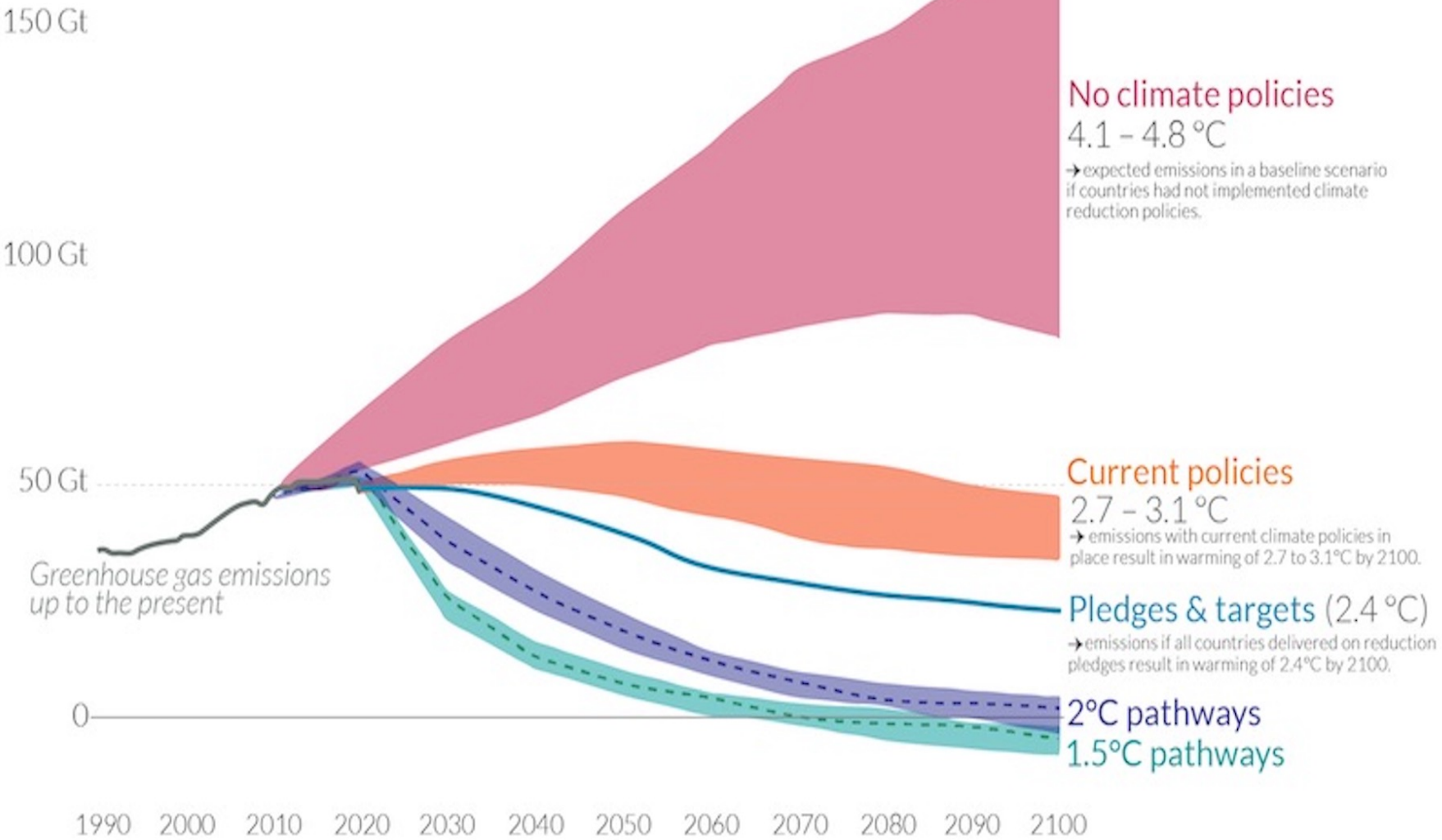
1. Transportation & mobile sources
2. Solid waste generation & landfill operations
3. Process & fugitive emissions (e.g., refrigerants)
4. Residential, Commercial, & Industrial Energy
5. Electricity > 90% hydroelectric



# Global greenhouse gas emissions and warming scenarios

- Each pathway comes with uncertainty, marked by the shading from low to high emissions under each scenario.
- Warming refers to the expected global temperature rise by 2100, relative to pre-industrial temperatures.

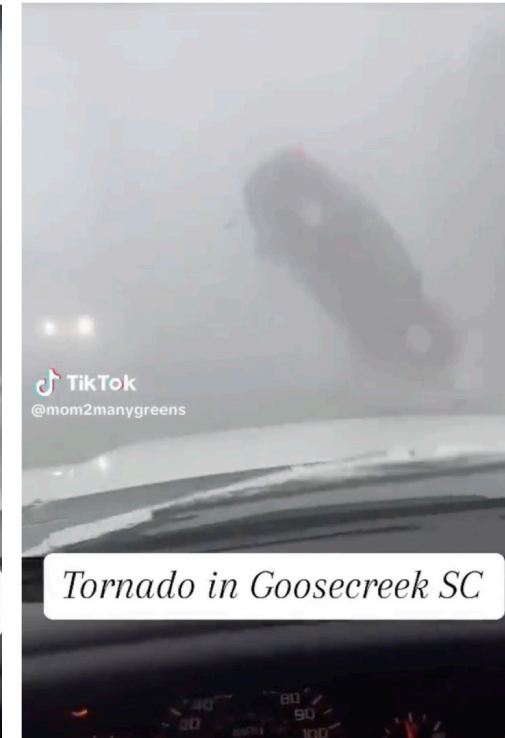
Annual global greenhouse gas emissions in gigatonnes of carbon dioxide-equivalents



# Inside Climate News August 23, 2023.....Connect the global dots

## “The Climate Crisis Is Here Now, Experts Warn, as Death Tolls From Summer Disasters Mount

- From the United States to China, to northern Europe, hundreds of people have died in devastating floods and fires around the world in recent weeks with thousands more displaced.”



@momtoomanygreens / Via [Twitter](#):  
[@csnetkova76](#)

@momtoomanygreens / Via [Twitter](#):  
[@csnetkova76](#)

**Every week another record.....  
“Historic” ...”Unprecedented”**



WEATHER

# The Pacific Northwest sets new records for daily high temperatures amid heat wave

August 16, 2023 · 5:49 PM ET

Heard on [All Things Considered](#)

By [Austin Amestoy](#)

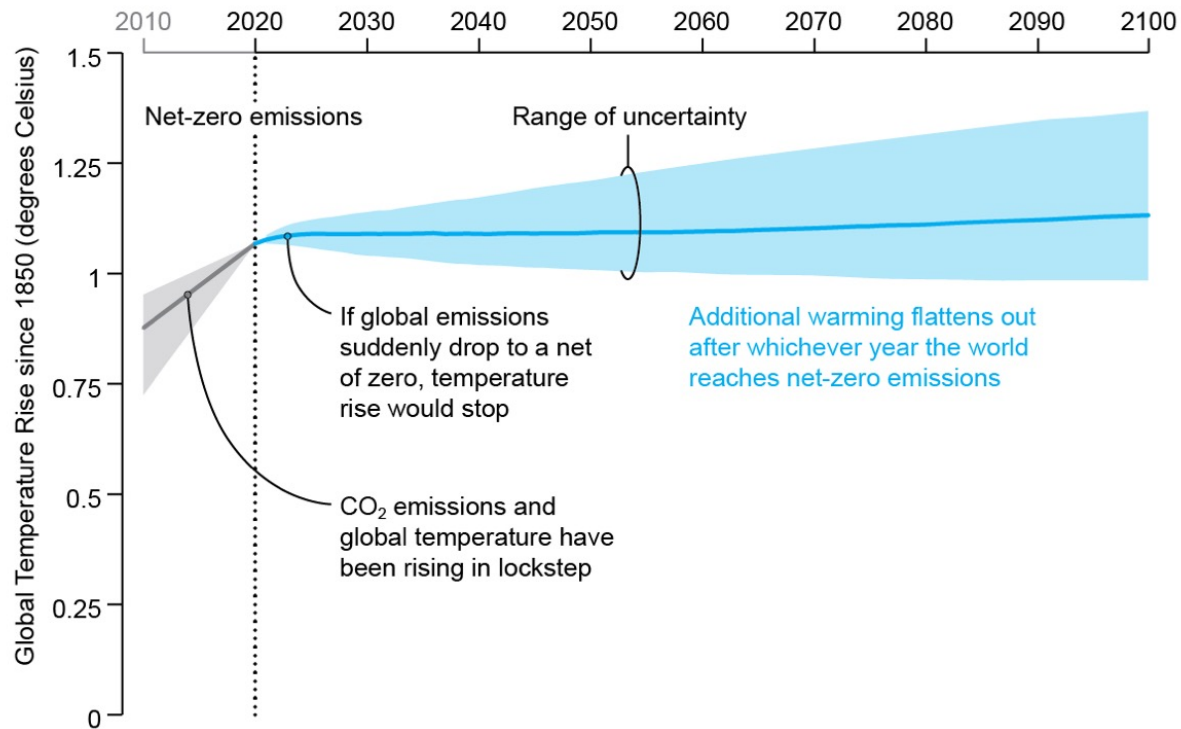
 **2-Minute Listen**

 **PLAYLIST**



The Pacific Northwest is in the middle of a record breaking heatwave. People unaccustomed to 100 degree-plus temperatures are trying to stay cool and nervously watching tinder dry forests.

# Urgency and Hope



Credit: Amanda Montañez; Source: IPCC, 2018: *Global Warming of 1.5°C: An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*, edited by V. Masson-Delmotte et al. Intergovernmental Panel on Climate Change

**“...As soon as CO<sub>2</sub> emissions stop rising, the atmospheric concentration of CO<sub>2</sub> levels off and starts to slowly fall because the oceans, soils and vegetation keep absorbing CO<sub>2</sub>, as they always do. Temperature doesn’t rise further. It also doesn’t drop, because atmospheric and ocean interactions adjust and balance out. The net effect is that “temperature does not go up or down,”**

# The Future of clean energy includes batteries

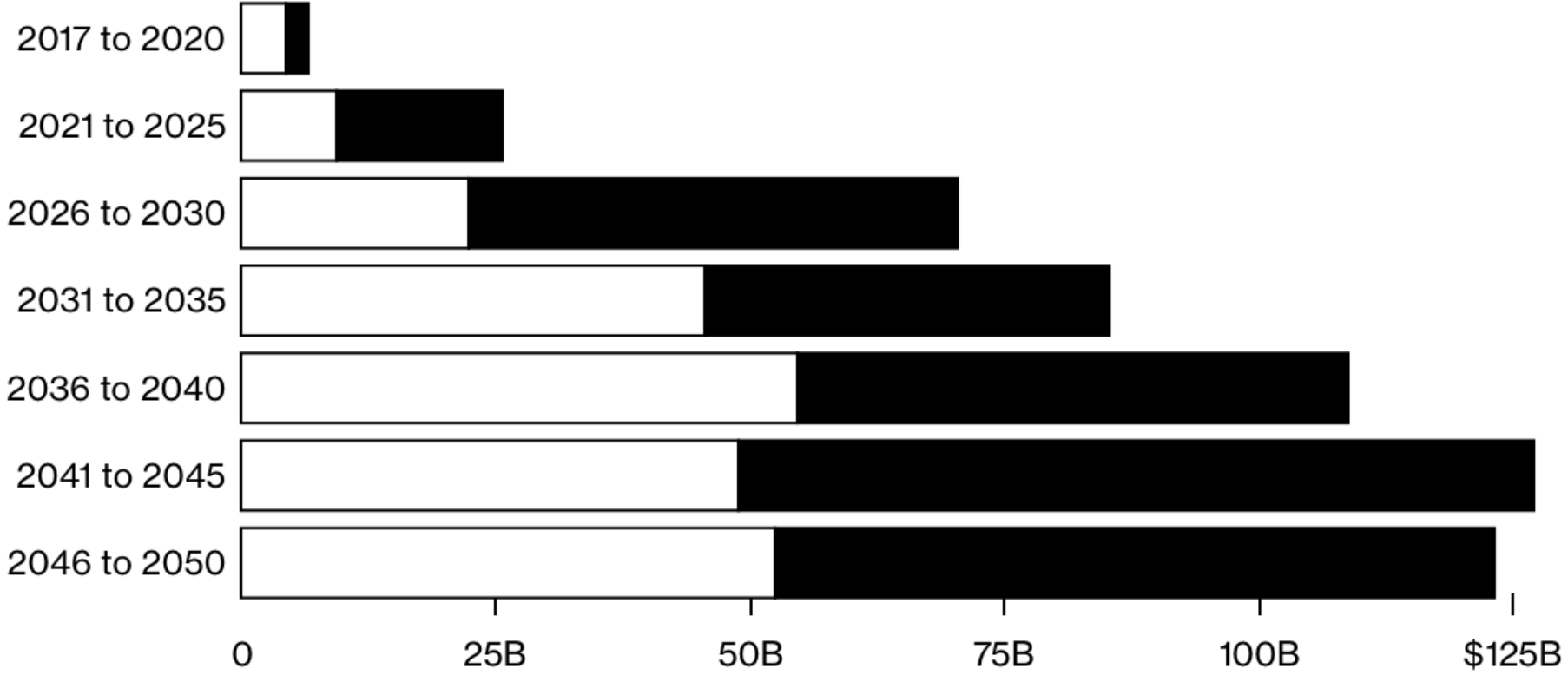


# Battery Investments

## Storage Spree

About \$548 billion may be invested in battery storage capacity by 2050

□ Small-scale batteries   ■ Utility-scale batteries



Source: Bloomberg NEF

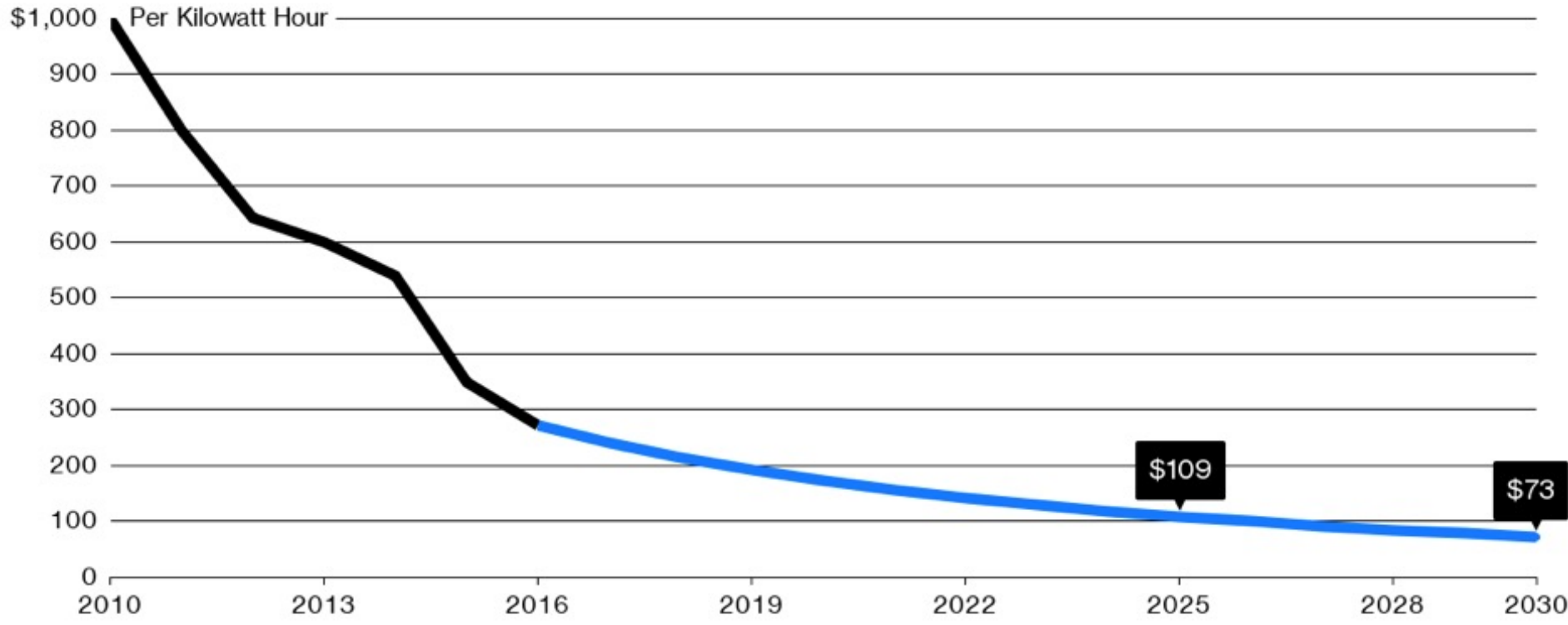


# Battery costs falling rapidly .....

## More Bang for Your Buck

Greater efficiency means a \$1,000 battery in 2010 will cost \$73 in 2030

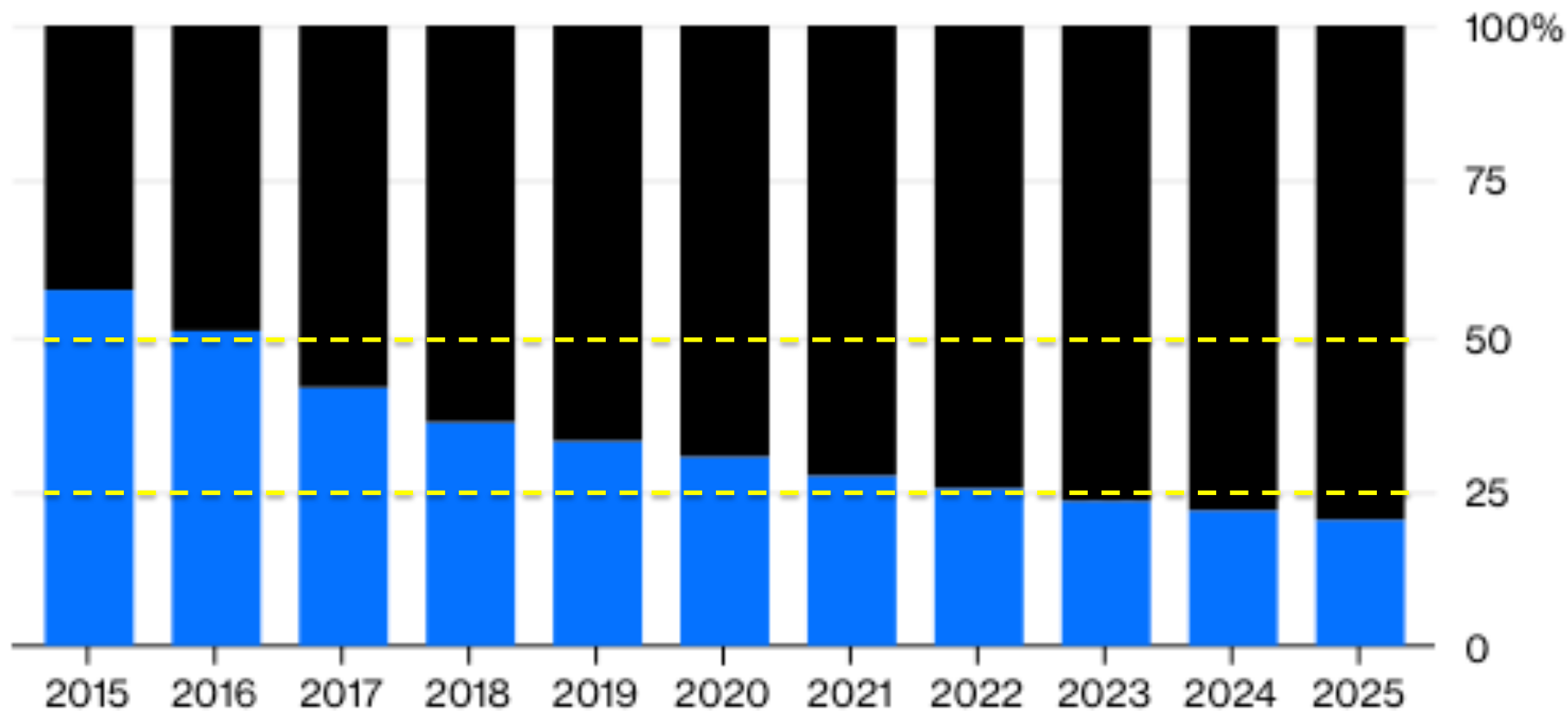
■ Average prices ■ Forecast



Source: Bloomberg New Energy Finance

# EV battery cost for U.S. medium-size car as a percentage of retail price

Battery Everything else



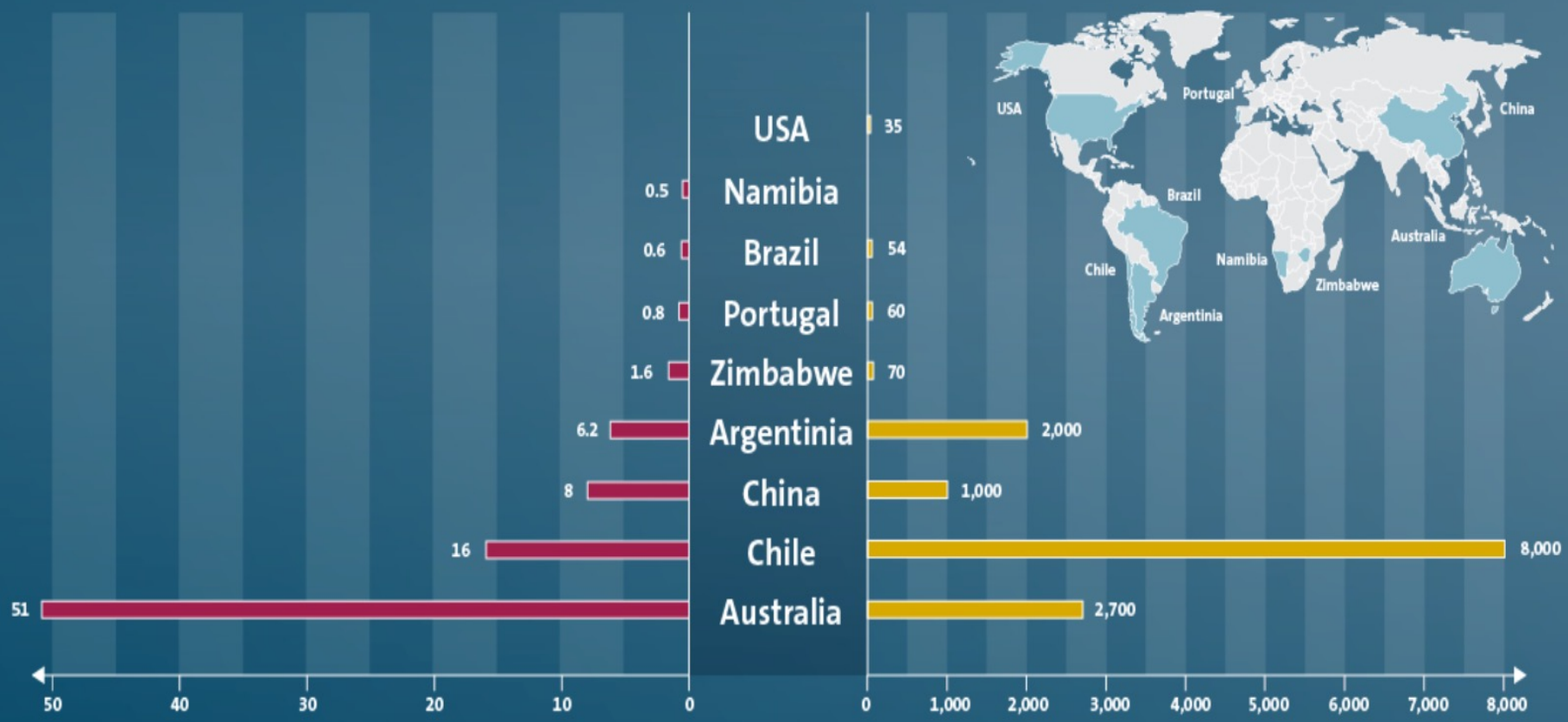
Source: BloombergNEF

Note: Includes profit margins and costs other than direct manufacturing costs.

# Where will the Lithium come from ?

## AUSTRALIA AND CHILE IN THE FRONT ROW

Countries with major Lithium production and reserves



source: USGS 2019

production (in 1,000t) ●

● reserves (in 1,000t)



## GM Will Suck Lithium from the Salton Sea to Make Batteries

“California Energy Commission’s estimate that the Salton Sea area could produce 600,000 tons of lithium per year, which is amazing since the entire world’s industry produced a mere 85,000 tons of lithium in all of 2019..”

Source: AutoWeek July 2021



*Estimated to be approximately 40 years of lithium for global EV battery production needs !*

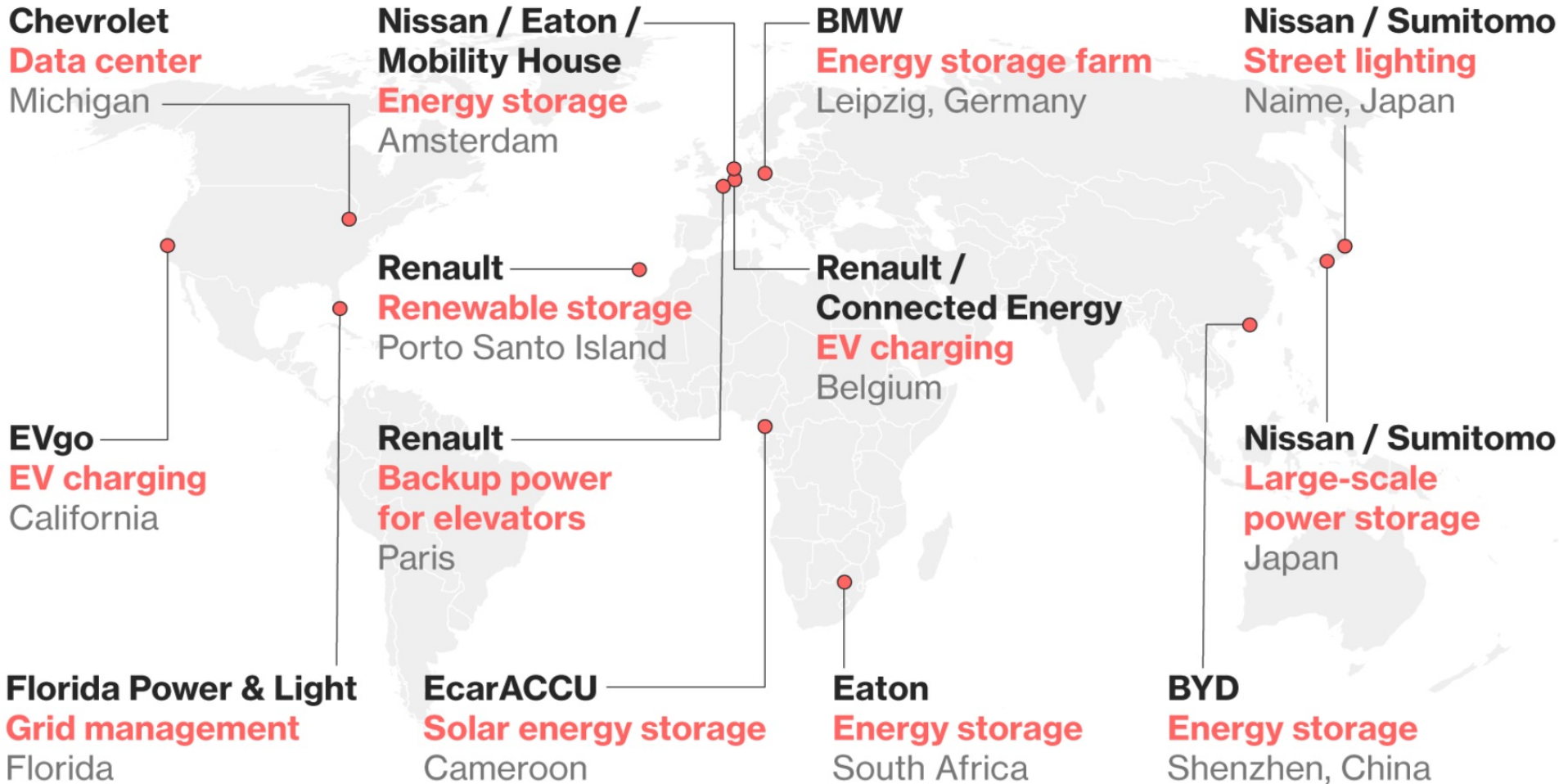




# What about the “old” batteries?- Re-purposing

## A New Lease on Life

Where electric-vehicle batteries are being used and tested for new roles



# What about the “old” batteries? – Re-cycling

## VW plans to scale up process to recover 95% of EV batteries' raw materials



STEPHEN EDELSTEIN

MARCH 10, 2021

9 COMMENTS



View Gallery

**V**olkswagen is just starting to ramp up production of electric cars based on its MEB platform, but the automaker is already thinking of how to recycle battery packs once those vehicles have reached the end of their lifecycles.

VW announced on Tuesday that it will scale up a process for recovering raw materials from used EV batteries. The automaker opened what it calls a pilot battery-recycling plant in Salzgitter, Germany, earlier this year, and hopes to open similar plants around the world.

# LITHIUM-ION BATTERY RECYCLING FINALLY TAKES OFF IN NORTH AMERICA AND EUROPE

Li-Cycle, Northvolt, and Ganfeng Lithium are among those building recycling plants, spurred by environmental and supply-chain concerns

**L**ATER THIS YEAR, the Canadian firm Li-Cycle will begin constructing a US \$175 million plant in Rochester, N.Y., on the grounds of what used to be the Eastman Kodak complex. When completed, it will be the largest lithium-ion battery-recycling plant in North America.

The plant will have an eventual capacity of 25 metric kilotons of input material, recovering 95 percent or more of the cobalt, nickel, lithium, and other valuable elements through the company's zero-wastewater, zero-emissions process. "We'll be one of the largest domestic sources of nickel and lithium, as well as the only source of cobalt in the United States," says Ajay Kochhar, Li-Cycle's cofounder and CEO.

## Ford, Redwood form 'circular' supply chain for EV battery materials

Sept 22, 2022 (Reuters) - Ford Motor Co (F.N) and startup Redwood Materials said on Wednesday they are partnering to form a "closed loop" or circular supply chain for electric vehicle batteries, from raw materials to recycling.

The aim is to lower the cost of EVs by reducing the dependence on imported materials, while also narrowing the environmental impact from mining and refining of battery materials.



CAR FINDER ▾

REVIEWS ▾

BEST CARS ▾

NEWS ▾

PRICES

MORE ▾

## Ford bets \$11.4B on battery plants, EV factories in biggest-ever investment



# Recycling ...It's Happening Now

## Base 1 EV Battery Recycling Facility

When fully operational in Q4 2022, the **facility** will **recycle** 30,000 metric tons of lithium-ion **batteries** and **manufacturing** scrap a year. That's about 70,000 ...



Construction Dive

<https://www.constructiondive.com> › news › turner-tea... ⋮

## Turner teams up on \$1B EV battery recycling plant

Dec 7, 2022 — Turner Construction, Kokosing Industrial and SSOE Group landed a \$1 billion design-build contract to construct an electric vehicle **battery** ...



live5news.com

<https://www.live5news.com> › 2022/12/13 › berkeley-co-... ⋮

## Berkeley Co. approves \$3.5B, 30-year deal with battery ...

Dec 12, 2022 — Berkeley County ...



Fast Company

<https://www.fastcompany.com> › the-largest-battery-recyc... ⋮

## The largest battery recycling plant in North America is ...

Jan 10, 2022 — Along with **recycling** old **batteries**, **battery** recyclers can **recycle** scrap that's produced at **battery factories**; in **Battery** Resourcers' case, it ...



Reuters

<https://www.reuters.com> › [markets](#) › [commodities](#) › [cirba...](#) ⋮

## [Cirba Solutions to pour \\$300 mln into South Carolina ...](#)

Mar 22, 2023 — U.S.-based Cirba Solutions will invest more than \$300 million in a lithium-ion EV **battery recycling plant** in South Carolina that will ...

### Our Plants - Lithion Technologies

Lithion deploys global **battery recycling plants**, through strategic partnerships and licensing of our proprietary technologies.



electrive.com

<https://www.electrive.com> › [2023/03/31](#) › [us-ascend-e...](#) ⋮

## [US: Ascend Elements opens battery recycling plant in Georgia](#)

Mar 31, 2023 — US: Ascend Elements opens **battery recycling plant** in Georgia ... The US American company Ascend Elements has opened its commercial-scale lithium- ...



Waste360

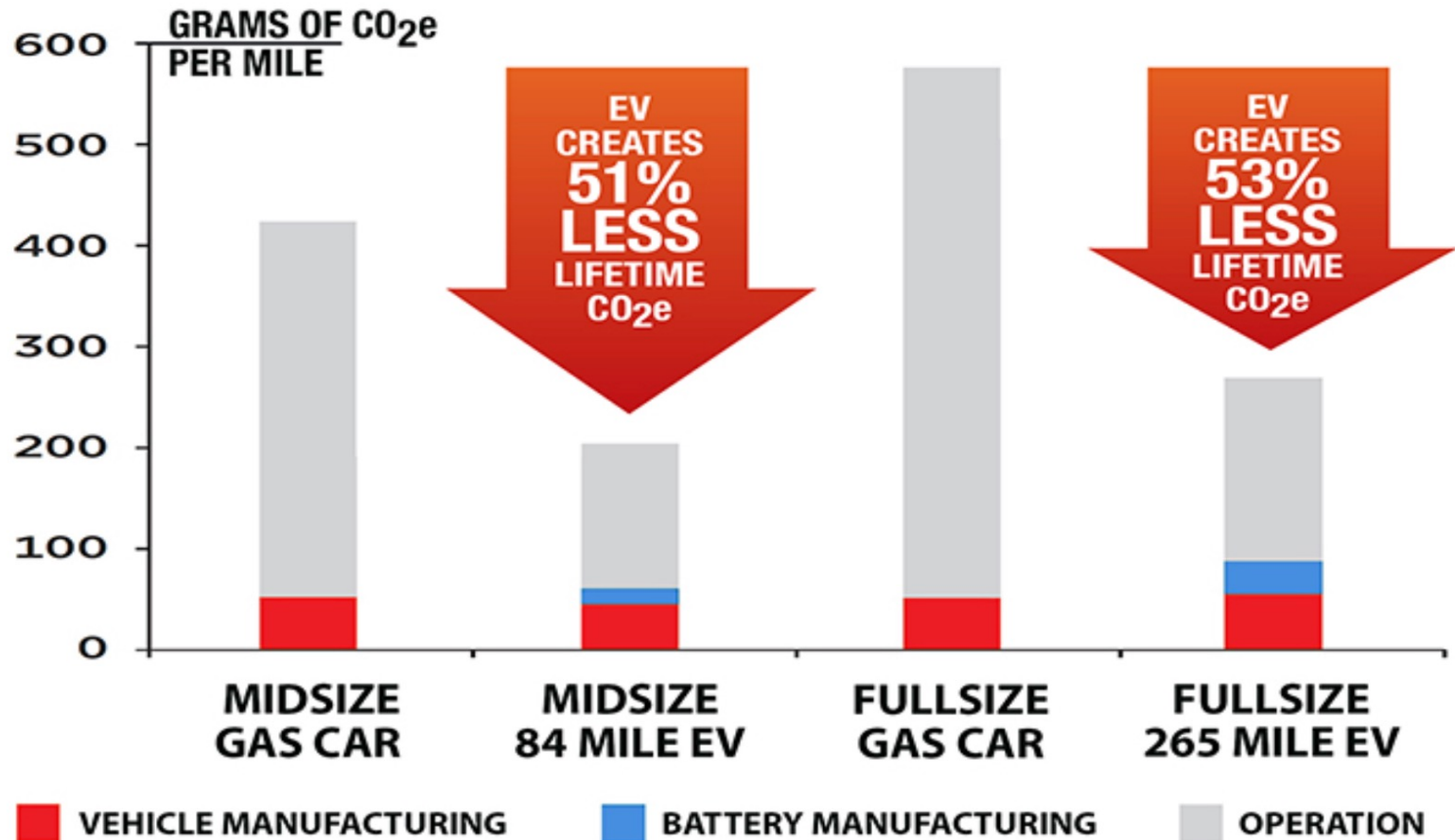
<https://www.waste360.com> › [recycling](#) › [nations-large...](#) ⋮

## [Nation's Largest EV Battery Recycling Plant Opens in ...](#)

Mar 30, 2023 — Ascend Elements has opened a new electric vehicle **battery facility** in Georgia, which measures out to be the largest **facility** of its type in ...

# CO2 Footprint of EV

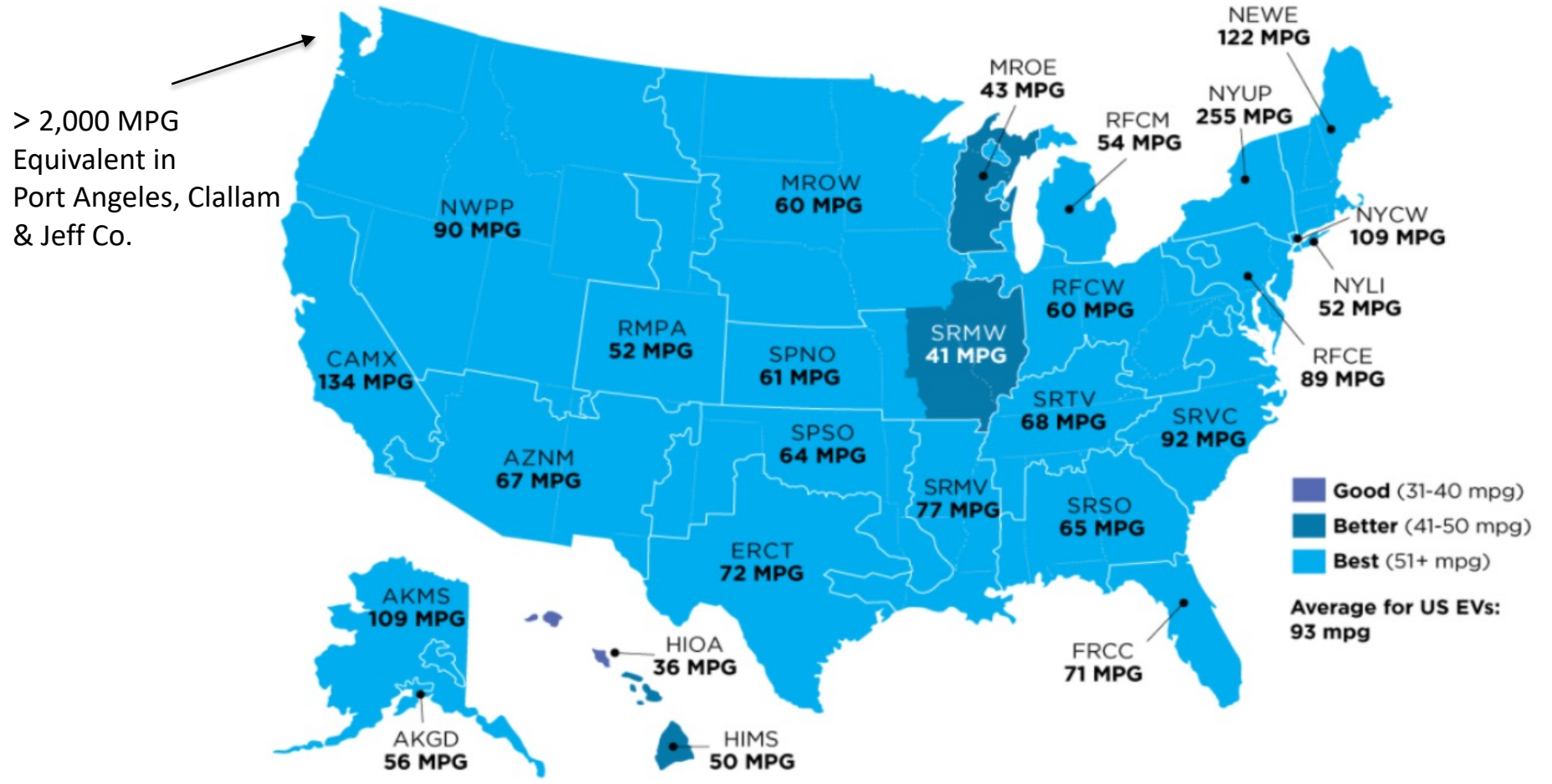
## LIFECYCLE GLOBAL WARMING EMISSIONS GAS VEHICLE VS. ELECTRIC VEHICLE



*Based on modeling of the two most popular BEVs available today and the regions where they are currently being sold, excess manufacturing emissions are offset within 6 to 16 months of average driving. OP is far lower.*

# Where you live makes a difference

## EV Emissions as Gasoline MPG Equivalent Average EV, 2021\*



\* based on 2019 reported electricity generation emissions

© Union of Concerned Scientists



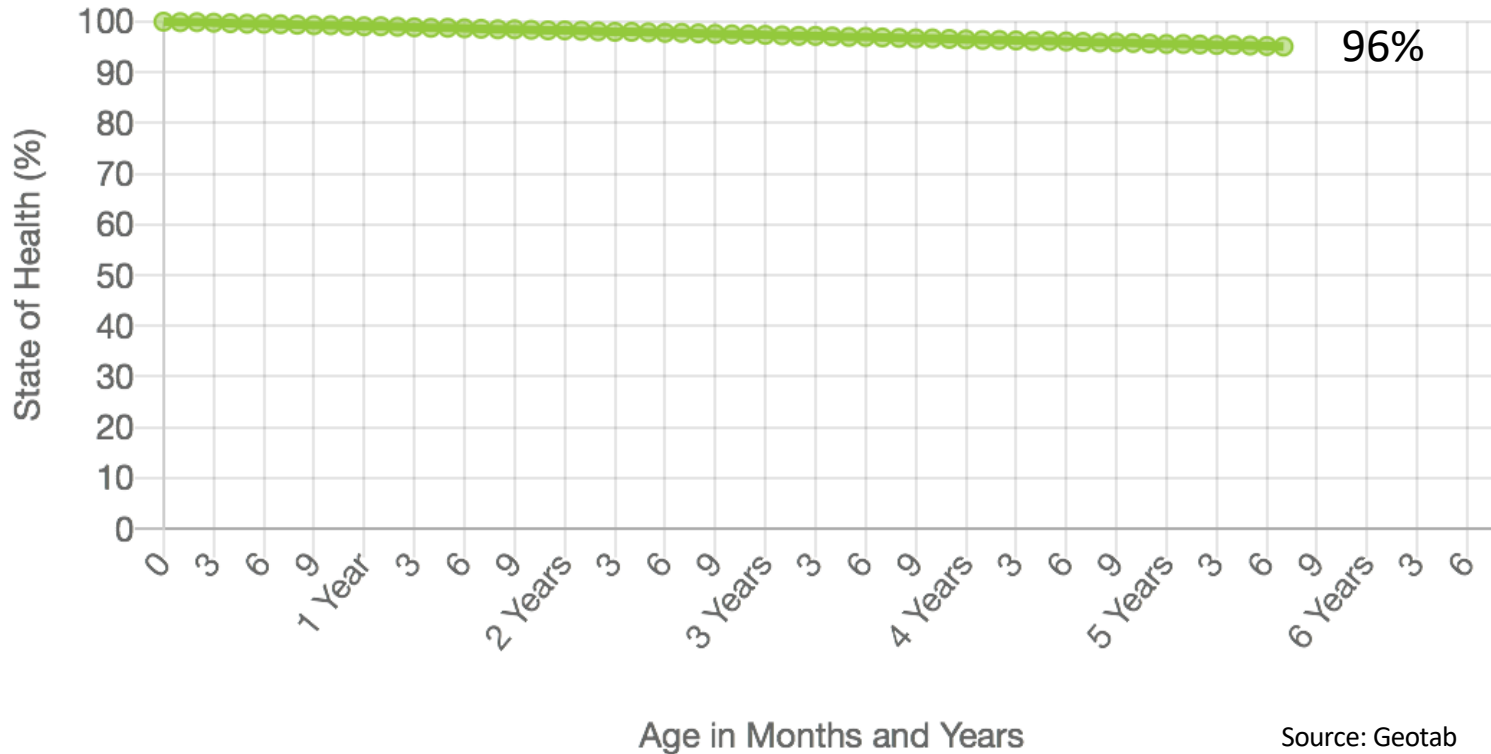
# What about Degradation?

Make & Model

Chevrolet Volt

Year

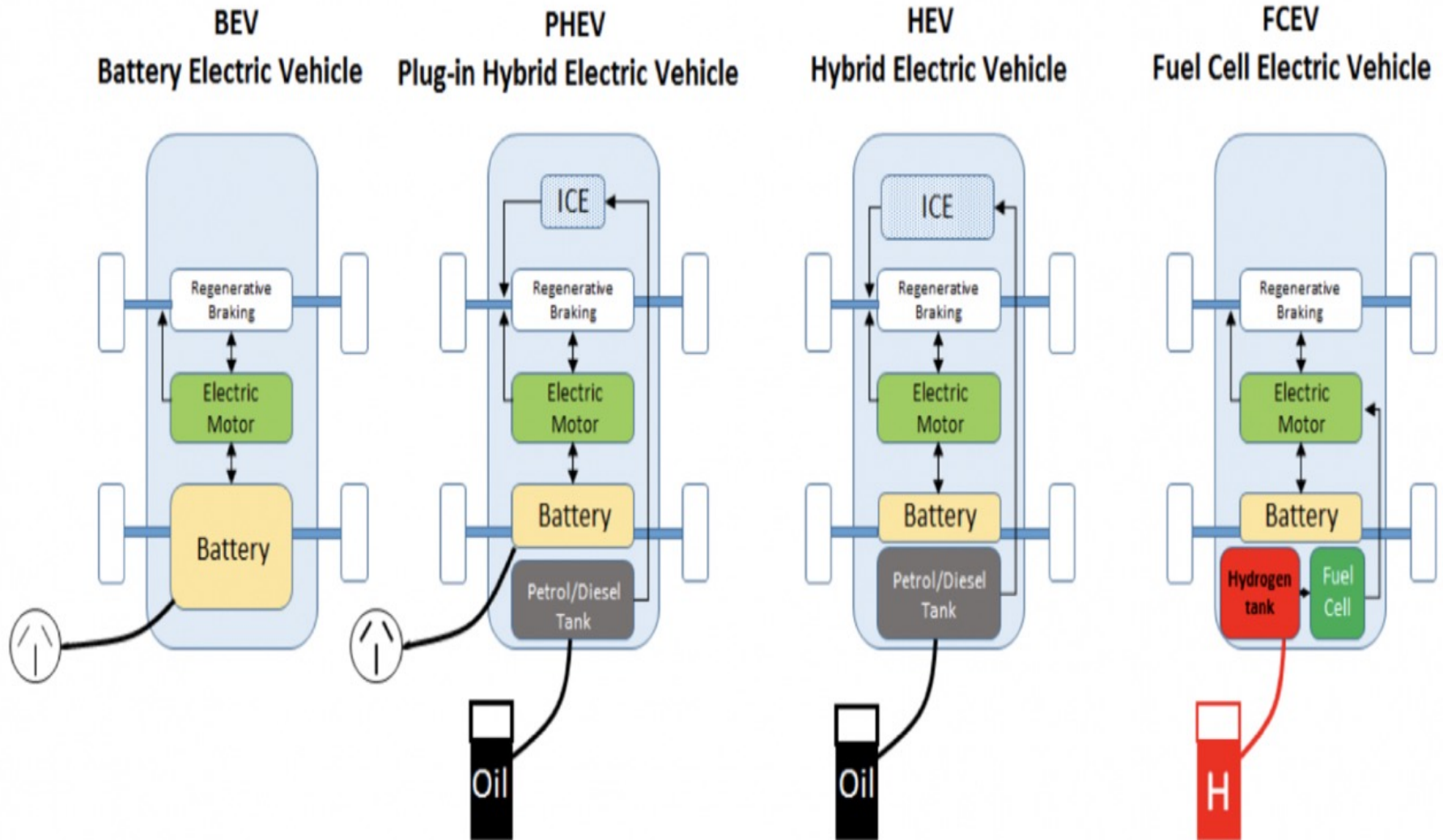
2014



## Causes:

- **Degradation increases if using DCFC frequently (DC fast charging)**
  - Battery Mgt Systems differ between vehicles  
Passive Thermal management systems (ex. Leaf)  
vs Active liquid cooled & heated (preferred)

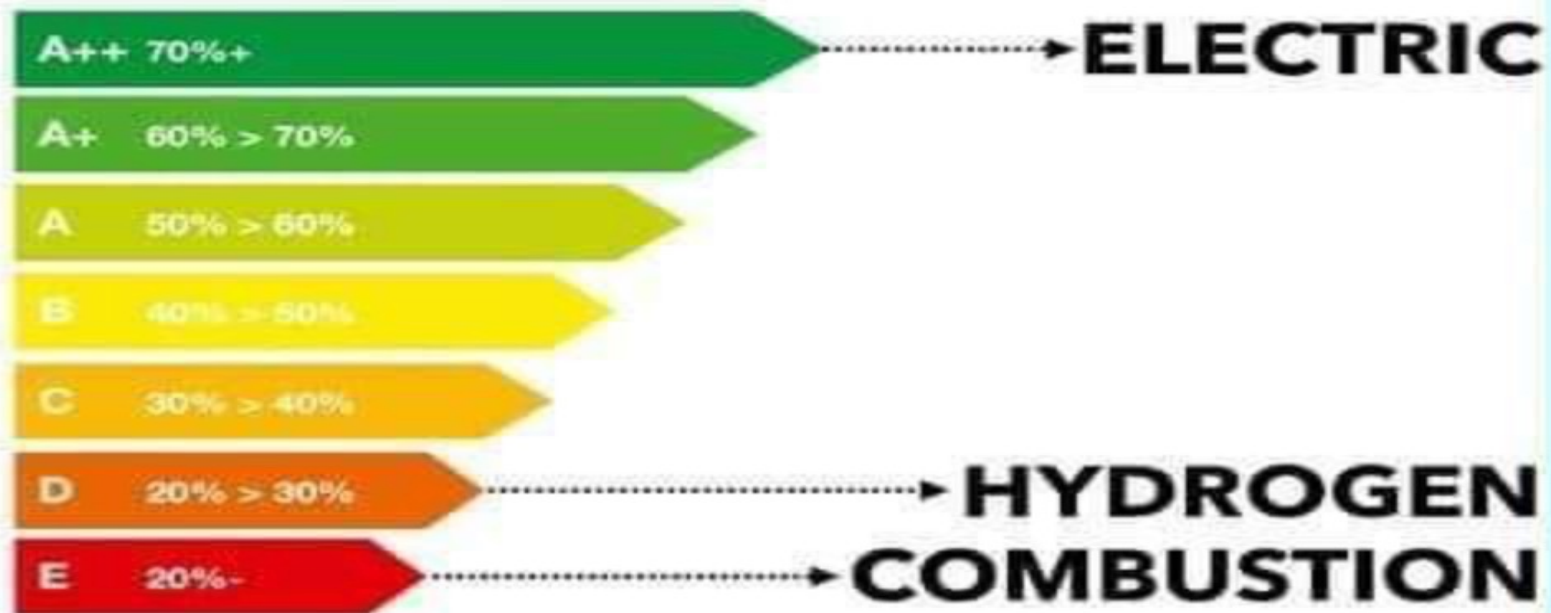
# Types of Electrified Vehicles Today





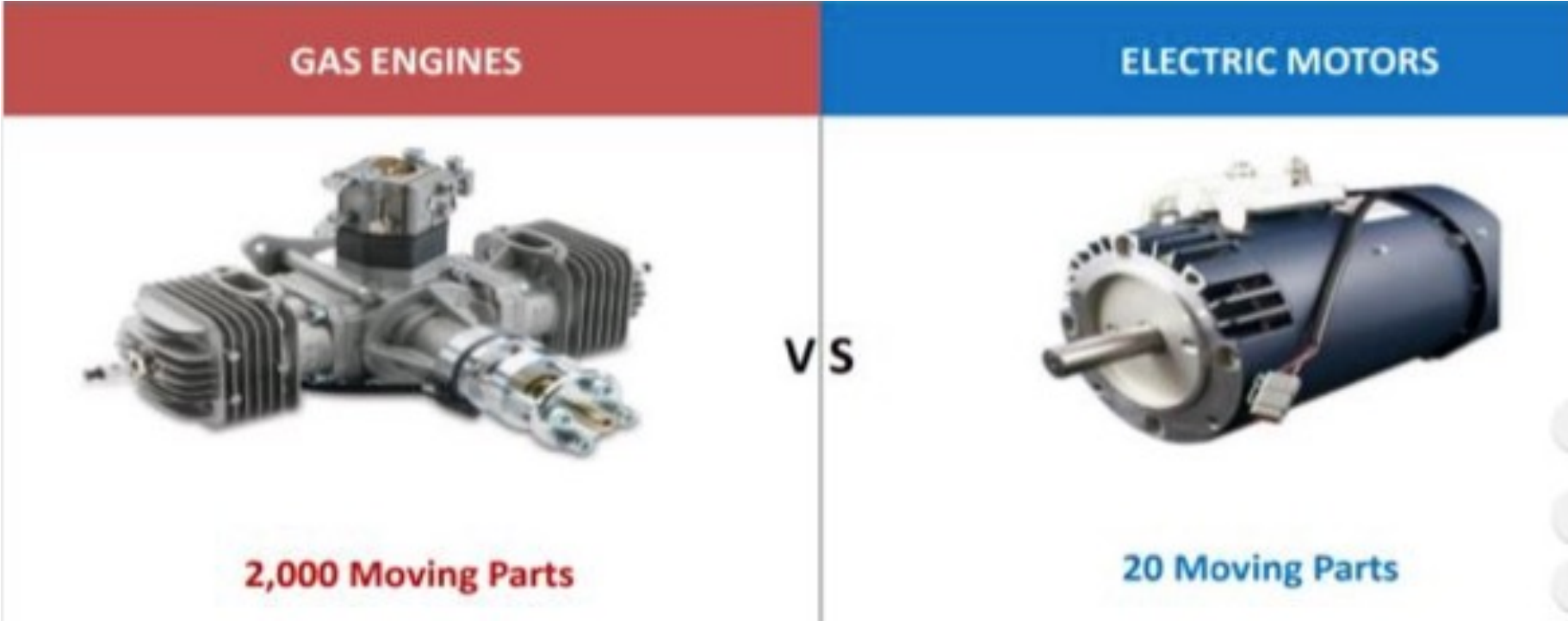
# ENERGY EFFICIENCY LABEL

## VEHICLES



The World requires your Leadership and contribution in order to better use the energy and ensure the transition from fossil sources to renewable sources. Hence, it is important to realize 30% of the energy contained in the fuel of a conventional vehicle (know as 'ICE' Internal Combustion Engine) is actually used to power the car. Even worse, when adding the required energy to produce the final product (fuel) and its transport, the efficiency drops to 13% whereas an electric vehicle obtains a general score of 73%.

# Battery Electric Simplicity & Efficiency



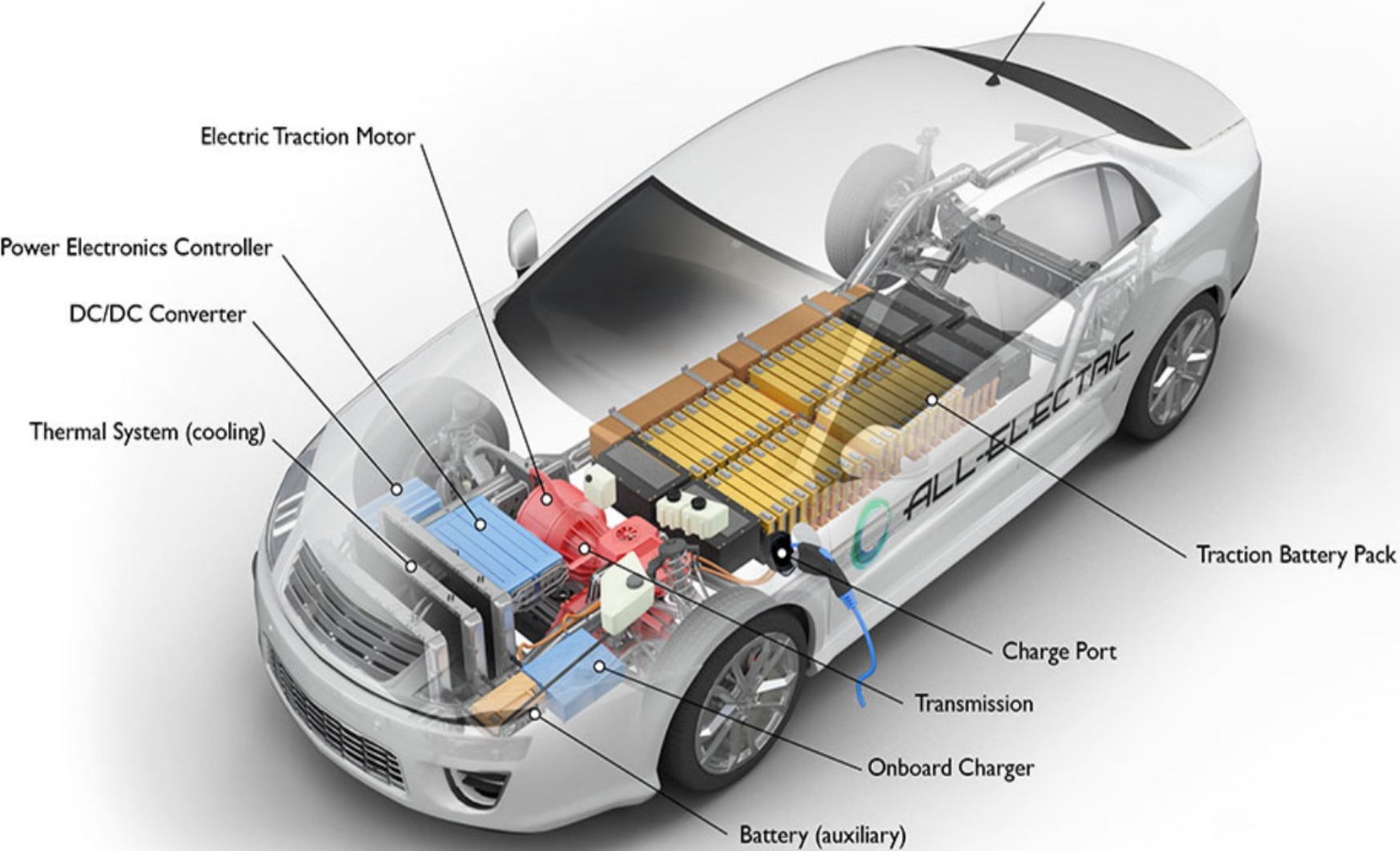
## Energy Efficiency



Large amount of energy lost as heat




# 100% Battery Electric Simple Design



# Owning an EV

- Highly reliable – 20 moving parts vs 2000 (ICE)

## Maintenance Schedule for your 2017 Chevrolet Bolt EV

 Certified Service	7,500 miles	15,000 miles	22,500 miles	30,000 miles	37,500 miles	45,000 miles	52,500 miles	60,000 miles	67,500 miles	75,000 miles	82,500 miles	90,000 miles	97,500 miles	105,000 miles	112,500 miles	120,000 miles	127,500 miles	135,000 miles	142,500 miles	150,000 miles	
	Rotate tires, if recommended for the vehicle, and perform Required Services.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Replace passenger compartment air filter (or 2 years, whichever comes first).			✓			✓			✓			✓			✓				✓		
Drain and fill vehicle coolant circuits.																					✓

# Owning an EV

	ICE (Internal Combustion Engine)	Electric Vehicle
Fuel @ 10,000 miles	\$1,600 (25 mpg @ \$4/gal)	\$285 (3.5 miles/Kwh @\$0.10/kwh)
Total Fuel \$ at 100,000 mi.	\$16,000	\$2,850
Oil Changes	\$60 every 5,000 miles	\$0
Brakes	\$500 to \$800 every 50k	\$0 (over 200k+)
Radiator Flush	\$100 every 100k	\$0
Timing Belt	\$1000 every 60k	\$0
Alternator	\$500 every 100k	\$0
Water pump	\$500 every 90k	\$0
Transmission service	\$200 every 60k	\$0
Battery Coolant Flush	-	\$300 Once every 10 yrs or 100k
Spark plugs, spark plug wires, fuel filters, ...	<b>??\$? Repairs ?\$??</b>	
<b>Total fuel &amp; maint. @100k</b>	<b><u>~ \$19,700+</u></b>	<b><u>~ \$3,150</u></b>

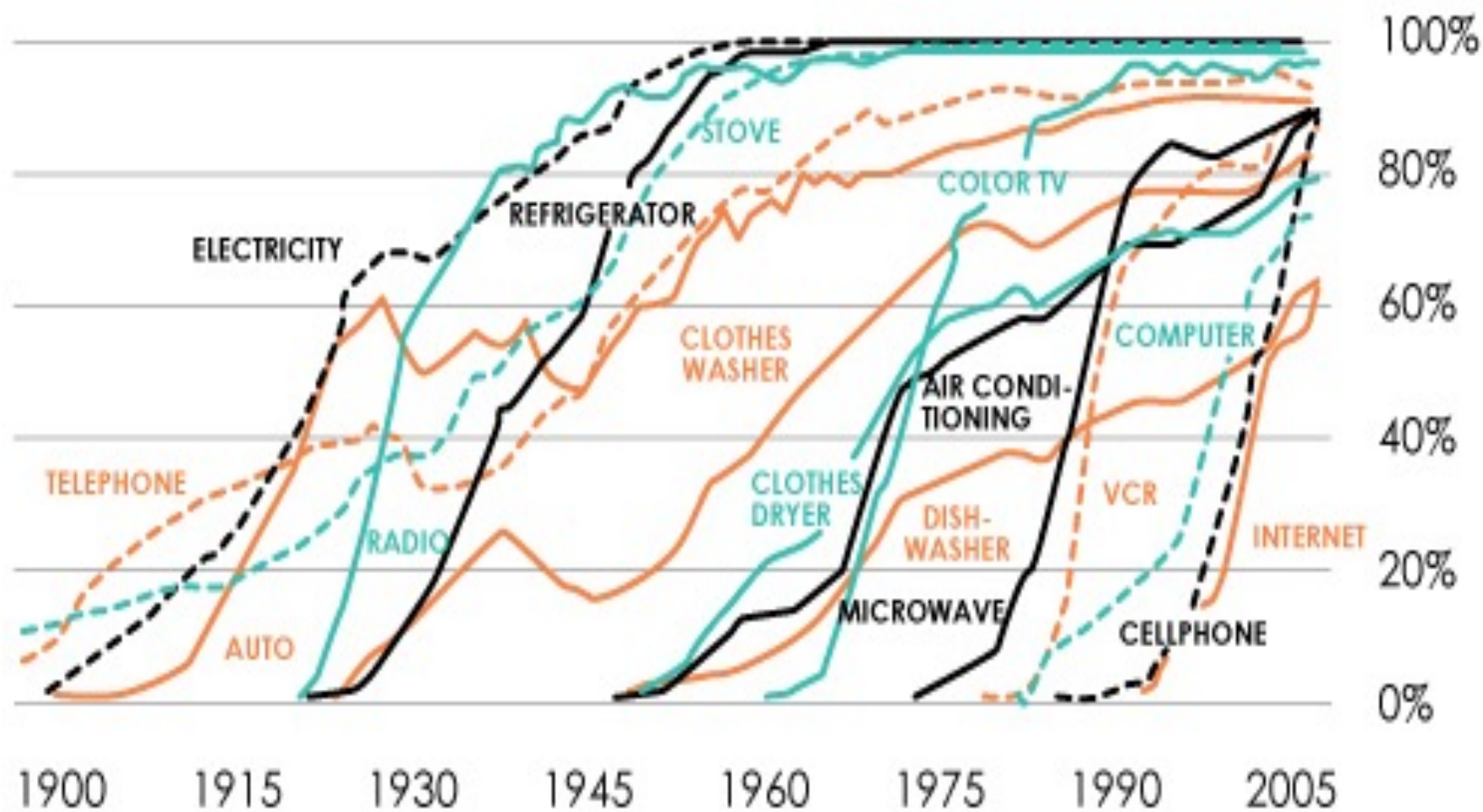
VS

**Decreasing Battery \$,  
Increasing Production Volumes,  
Consumer Comprehending  
Benefits,  
Regulations**



**Market Transition**

# New Technologies and Mainstream Adoption



Source: Michael Felton, *The New York Times*

[www.earlyinvesting.com](http://www.earlyinvesting.com)



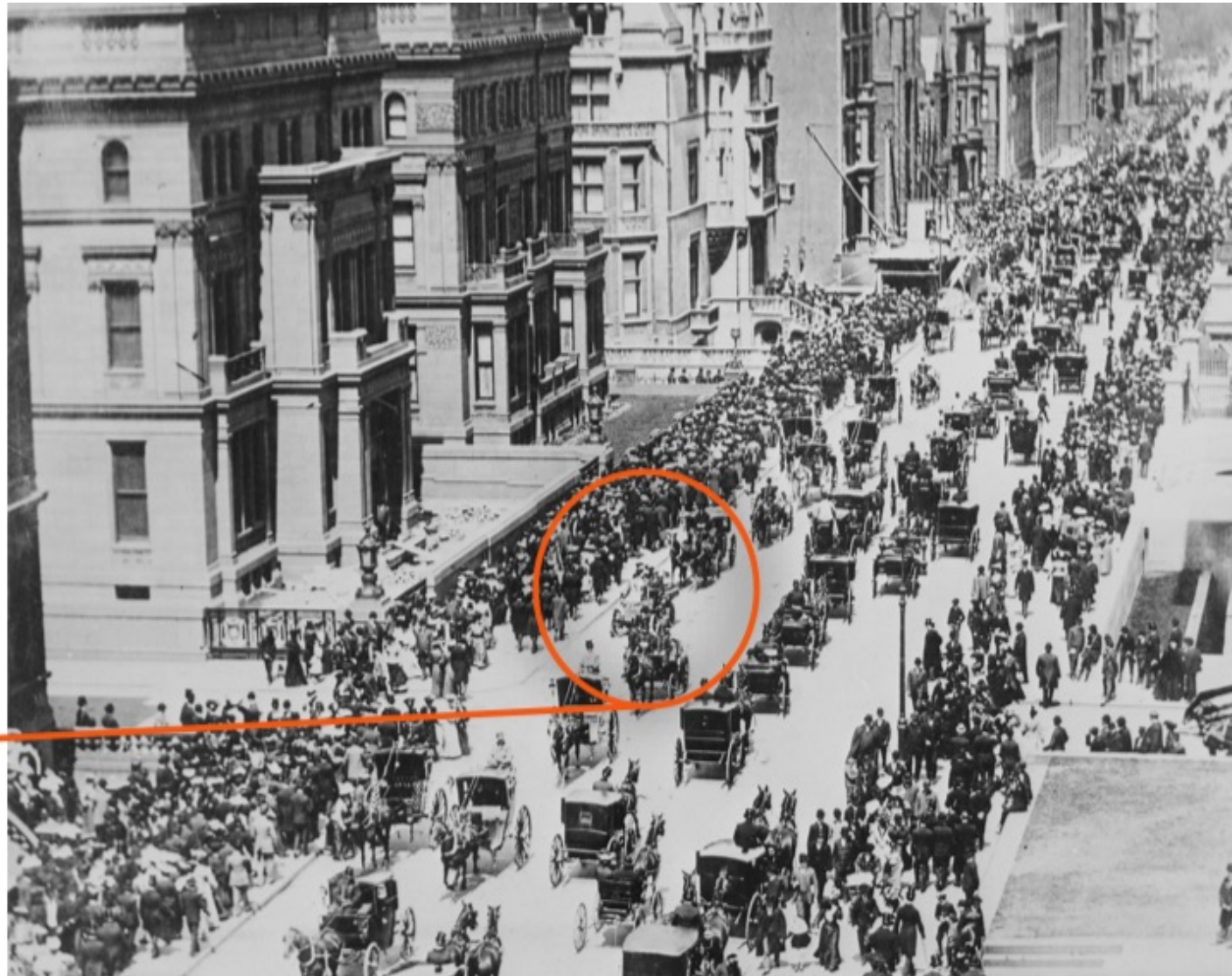
# Speed of Disruption

5<sup>th</sup> AVE NYC

1900

Where is

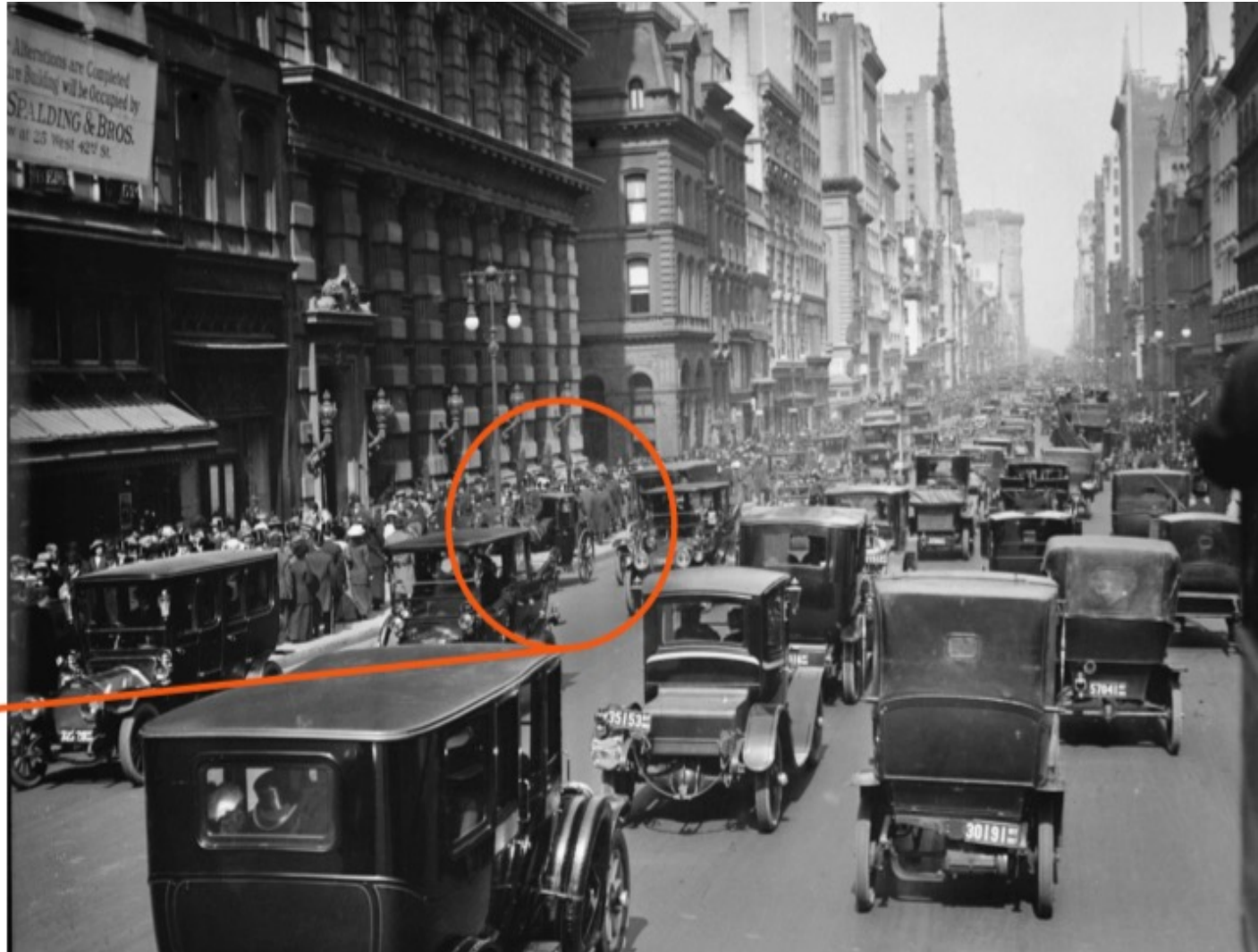
the  
car?



# Speed of Disruption

5<sup>th</sup> AVE NYC  
1913

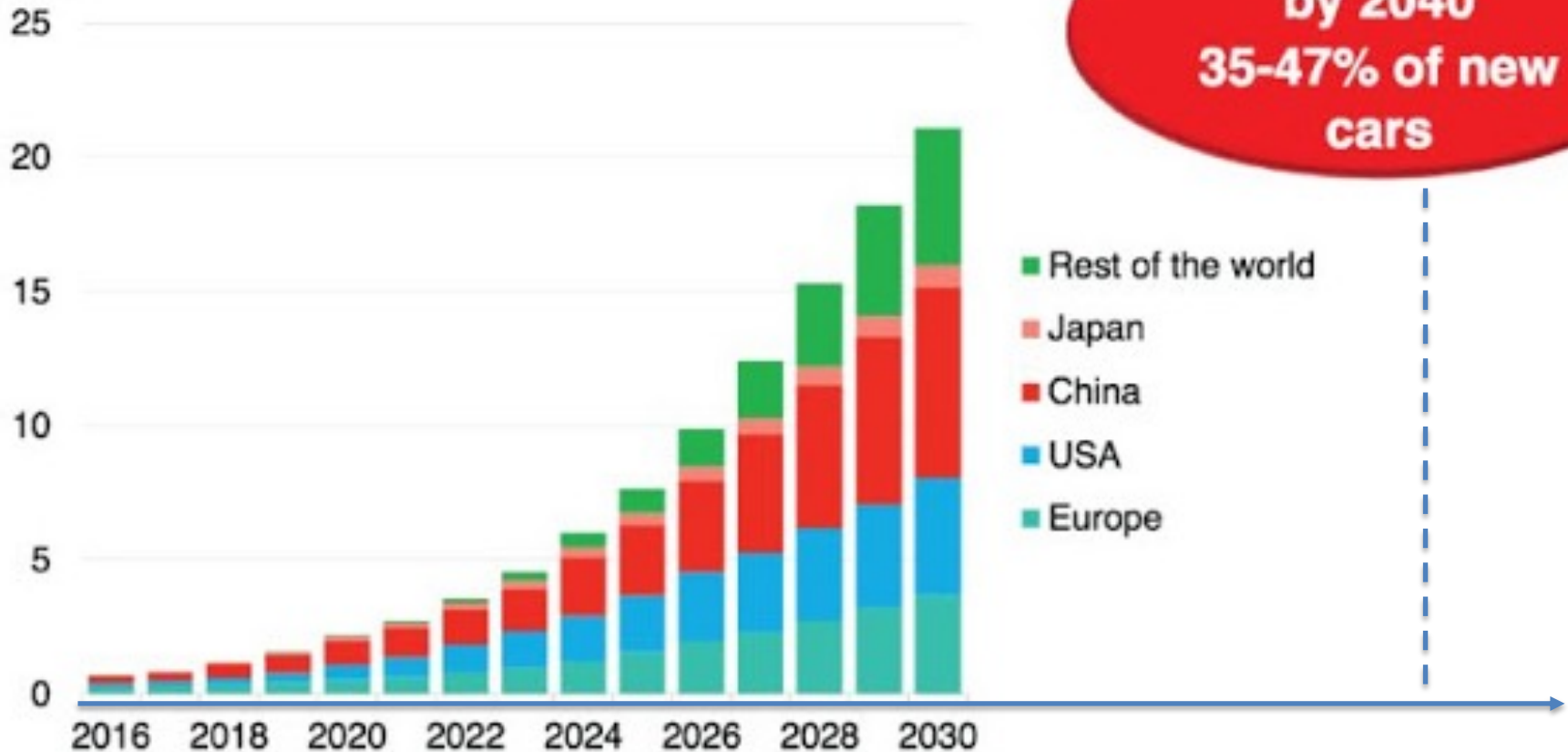
Where is  
the  
horse?



# The Rise of Electric Cars

BNEF sees more than 20 million sales by 2030

Millions

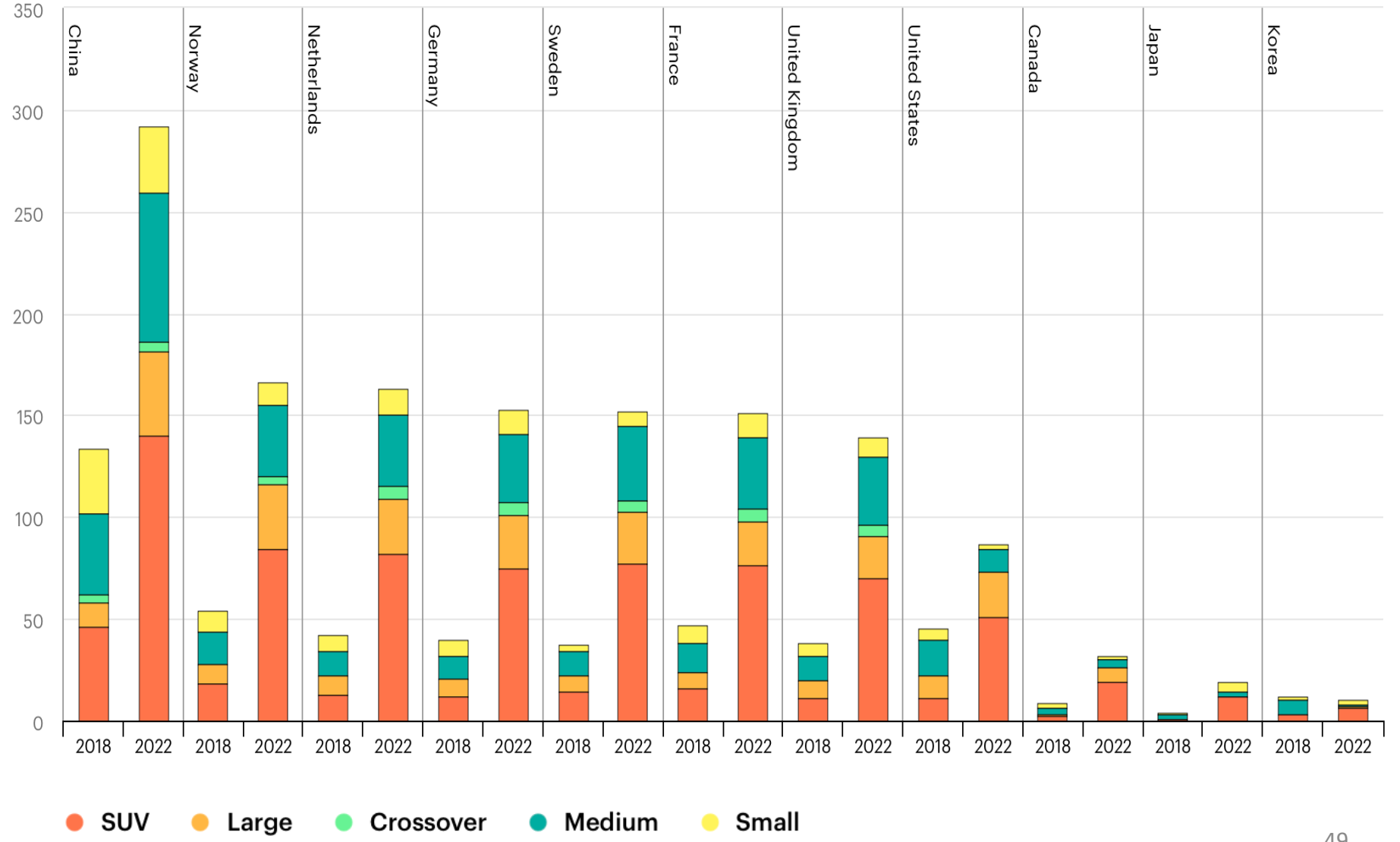


Source : Bloomberg New Energy Fund

➤ **By 2025 EVs projected to be priced equal to or less than gasoline vehicles**

# EV Models Available by Size, 2022

models available





# EV Models -U.S. Availability 2022/23 - 33 models (+ versions)

- by 2025 there will be over 2X more, at least three more light trucks

Audi	e-tron GT quattro 20" (2022)	AWD	Hyundai	Ioniq 5 SE SR RWD 19" (2022)	RWD	Porsche	Taycan (79 kWh) 19" (2022)	RWD
Audi	RS e-tron GT quattro 20" (2022)	AWD	Hyundai	Ioniq 5 SE RWD 19" (2022)	RWD	Porsche	Taycan (93 kWh) 19" (2022)	RWD
Audi	e-tron quattro 20" (2022)	AWD	Hyundai	Ioniq 5 SE AWD 19" (2022)	AWD	Porsche	Taycan 4S (79 kWh) 19" (2022)	AWD
Audi	e-tron Sportback quattro 20" (2022)	AWD	Hyundai	Ioniq 5 SEL RWD 19" (2022)	RWD	Porsche	Taycan 4S (93 kWh) 19" (2022)	AWD
Audi	e-tron S 20" (2022)	AWD	Hyundai	Ioniq 5 SEL AWD 19" (2022)	AWD	Porsche	Taycan GTS (93 kWh) 20" (2022)	AWD
Audi	e-tron S 21" (2022)	AWD	Hyundai	Ioniq 5 Limited RWD 19" (2022)	RWD	Porsche	Taycan Turbo (93 kWh) 20" (2022)	AWD
Audi	e-tron S Sportback 20" (2022)	AWD	Hyundai	Ioniq 5 Limited AWD 20" (2022)	AWD	Porsche	Taycan Turbo S (93 kWh) 21" (2022)	AWD
Audi	e-tron S Sportback 21" (2022)	AWD	Hyundai	IONIQ Electric (2021)	FWD	Porsche	Taycan 4 Cross Turismo 19" (2022)	AWD
Audi	Q4 40 e-tron 19" (2022)	RWD	Hyundai	Kona Electric (2022)	FWD	Porsche	Taycan 4S Cross Turismo 19" (2022)	AWD
Audi	Q4 50 e-tron quattro 19" (2022)	AWD	Jaguar	I-PACE EV400 (2022)	AWD	Porsche	Taycan GTS Sport Turismo 20" (2022)	AWD
Audi	Q4 Sportback 50 e-tron quattro 20" (2022)	AWD	Kia	EV6 Light RWD SR 19" (2022)	RWD	Porsche	Taycan Turbo Cross Turismo 20" (2022)	AWD
BMW	i4 eDrive40 18" (2022)	RWD	Kia	EV6 Wind RWD LR 19" (2022)	RWD	Porsche	Taycan Turbo S Cross Turismo 20" (2022)	AWD
BMW	i4 M50 19" (2022)	AWD	Kia	EV6 Wind AWD LR 19" (2022)	AWD	Rivian	R1S (Large pack, 21") (2022)	AWD
BMW	iX xDrive50 20" (2022)	AWD	Kia	EV6 GT-Line RWD LR 19" (2022)	RWD	Rivian	R1T (Large pack, 21") (2022)	AWD
Cadillac	Lyriq Debut Edition (2023)	RWD	Kia	EV6 GT-Line AWD LR 19" (2022)	AWD	Tesla	Model 3 RWD 18" (2022)	RWD
Chevrolet	Bolt EV (2022)	FWD	Kia	EV6 First Edition AWD LR 20" (2022)	AWD	Tesla	Model 3 RWD 19" (2022)	RWD
Chevrolet	Bolt EUV (2022)	FWD	Kia	Niro EV (2022)	FWD	Tesla	Model 3 Long Range AWD 18" (2022)	AWD
Ford	F-150 Pro SR 18" (2022)	AWD	Lucid	Air Dream Edition Performance 19" (2022)	AWD	Tesla	Model 3 Long Range AWD 19" (2022)	AWD
Ford	F-150 Pro ER (fleets) 18" (2022)	AWD	Lucid	Air Dream Edition Performance 21" (2022)	AWD	Tesla	Model 3 Perf. LR AWD 20" (2022)	AWD
Ford	F-150 Lightning XLT SR 18" (2022)	AWD	Lucid	Air Dream Edition Range 19" (2022)	AWD	Tesla	Model S LR AWD 19" (2022)	AWD
Ford	F-150 Lightning XLT ER 20" (2022)	AWD	Lucid	Air Dream Edition Range 21" (2022)	AWD	Tesla	Model S LR AWD 21" (2022)	AWD
Ford	F-150 Lightning Lariat SR 20" (2022)	AWD	Lucid	Air Grand Touring 19" (2022)	AWD	Tesla	Model S Plaid 19" (2022)	AWD
Ford	F-150 Lightning Lariat ER 20" (2022)	AWD	Lucid	Air Grand Touring 21" (2022)	AWD	Tesla	Model S Plaid 21" (2022)	AWD
Ford	F-150 Lightning Platinum ER 22" (2022)	AWD	Mazda	MX-30 (2022)	FWD	Tesla	Model X LR AWD 20" (2022)	AWD
Ford	Mustang Mach-E Select SR RWD 18" (2022)	RWD	Mercedes	EQS 450+ (RWD; 20") (2022)	RWD	Tesla	Model X LR AWD 22" (2022)	AWD
Ford	Mustang Mach-E Select SR AWD 18" (2022)	AWD	Mercedes	EQS 580 4MATIC (AWD; 21") (2022)	AWD	Tesla	Model X Plaid 20" (2022)	AWD
Ford	Mustang Mach-E Premium SR RWD 19" (2022)	RWD	MINI	Cooper SE (2022)	FWD	Tesla	Model X Plaid 22" (2022)	AWD
Ford	Mustang Mach-E Premium SR AWD 19" (2022)	AWD	Nissan	Ariya Venture+ FWD 19" (2023)	FWD	Tesla	Model Y Long Range AWD 19" (2022)	AWD
Ford	Mustang Mach-E Premium ER RWD 19" (2022)	RWD	Nissan	Ariya Evolve+ FWD 19" (2023)	FWD	Tesla	Model Y Long Range AWD 20" (2022)	AWD
Ford	Mustang Mach-E Premium ER AWD 19" (2022)	AWD	Nissan	Ariya Premiere FWD 19" (limited) (2023)	FWD	Tesla	Model Y Perf. LR AWD 21" (2022)	AWD
Ford	Mustang Mach-E Route 1 ER RWD 18" (2022)	RWD	Nissan	Ariya Platinum+ e-4ORCE AWD 19" (2023)	AWD	Volvo	C40 Recharge (2022)	AWD
Ford	Mustang Mach-E Route 1 ER AWD 18" (2022)	AWD	Nissan	LEAF S (40 kWh) (2022)	FWD	Volvo	XC40 Recharge (2022)	AWD
Ford	Mustang Mach-E GT ER AWD 20" (2022)	AWD	Nissan	LEAF e+ S (62 kWh) (2022)	FWD	Volkswagen	ID.4 Pro 19" (2022)	RWD
Ford	Mustang Mach-E GT Perf. ER AWD 20" (2022)	AWD	Nissan	LEAF e+ SV (62 kWh) (2022)	FWD	Volkswagen	ID.4 Pro S 19" (2022)	RWD
GMC	Hummer EV Pickup (Edition 1) (2022)	AWD	Polestar	2 Single Motor 19" (2022)	FWD	Volkswagen	ID.4 AWD Pro 19" (2022)	AWD
			Polestar	2 Dual Motor 19" (2022)	AWD	Volkswagen	ID.4 AWD Pro S 19" (2022)	AWD

Subaru Solterra

Toyota b24X



# Cities & Municipalities





# Trucking



# GM Acquires 25 Percent Stake in Pure Watercraft to Accelerate All-Electric Boating

Agreement combines GM technology with Pure Watercraft propulsion systems to expand all-electric marine transportation





# Vehicle to Load (V2L)

- Worksite
- Camping
- Residential back up
- Christmas lights.....



FORD F150 LIGHTNING REAR V2L SOCKET POSITION. IMAGE: FORD.

# Performance - Instant Torque!



## Chevrolet Bolt

0-60 MPH

6.3 sec

QUARTER MILE

14.9 sec @ 93.1 mph





# Benefits - Driving an EV is Fun!

- **Instant Power**, 100% torque at 0 RPM! Bolt is 0 – 60mph in 6.3 Seconds!
- Low Center of Gravity – **handles curves better**
- **Silent** – no transmission – direct drive
- **Pre-heat or Pre-air condition** while charging & before leaving home
- Heating and Cooling sitting in ferry line – no “idling”
- **Leave home with a “full tank”**
  - – no gas station stops or oil checks (no drips)
- **Regenerative Braking** - “One Pedal Driving” – **Minimal brake pad wear!**

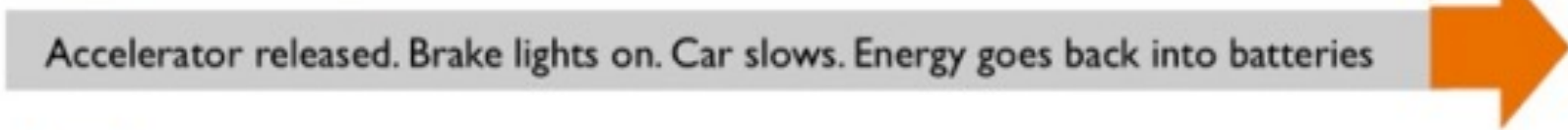
# Regenerative Braking – “one pedal driving”

- Electric motor acts like a generator when decelerating
- Greatly reduces brake wear

Regular Car



Model S

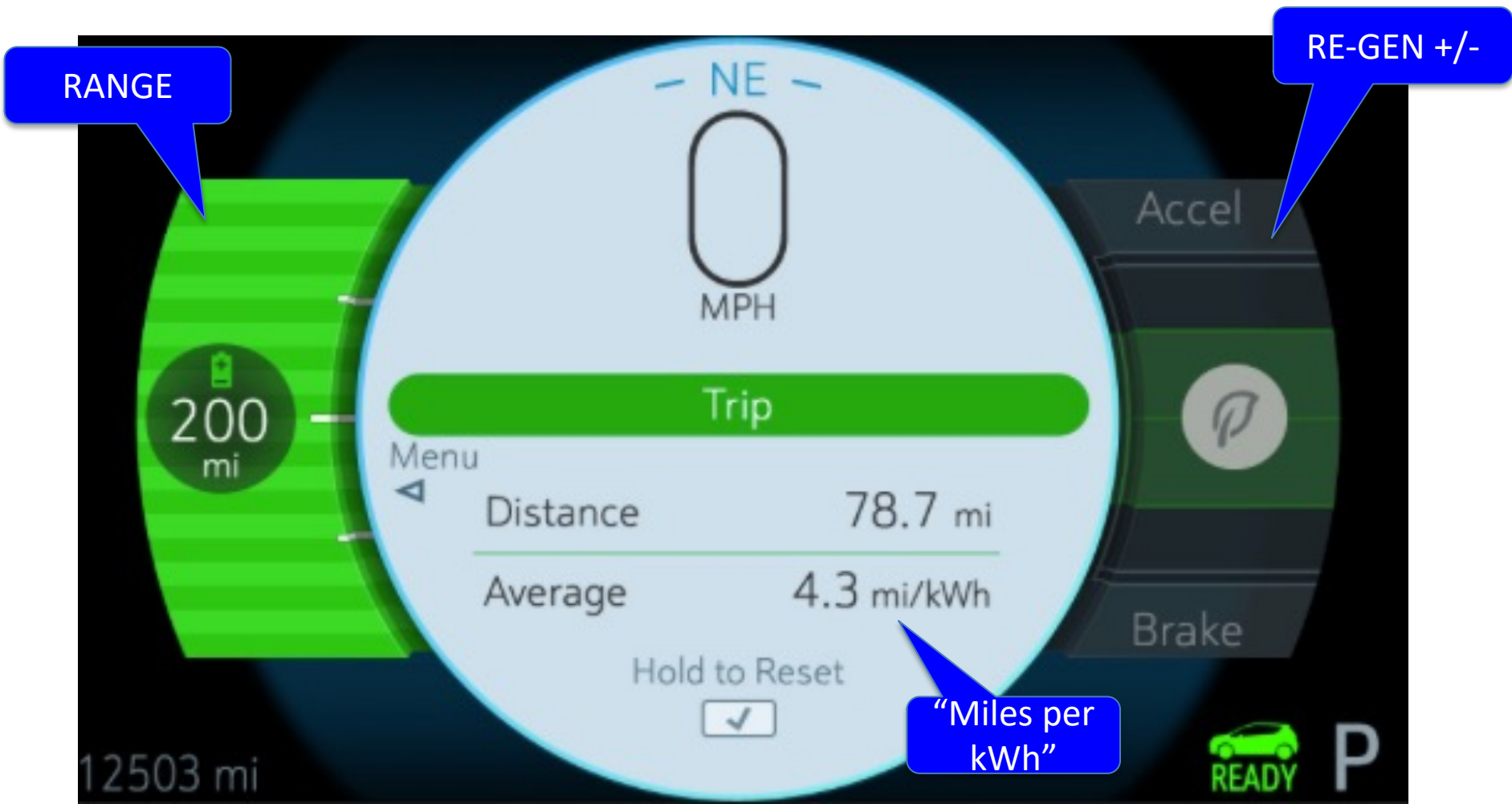


Brakes applied



 = Distance brakes are being applied

# Simple to operate

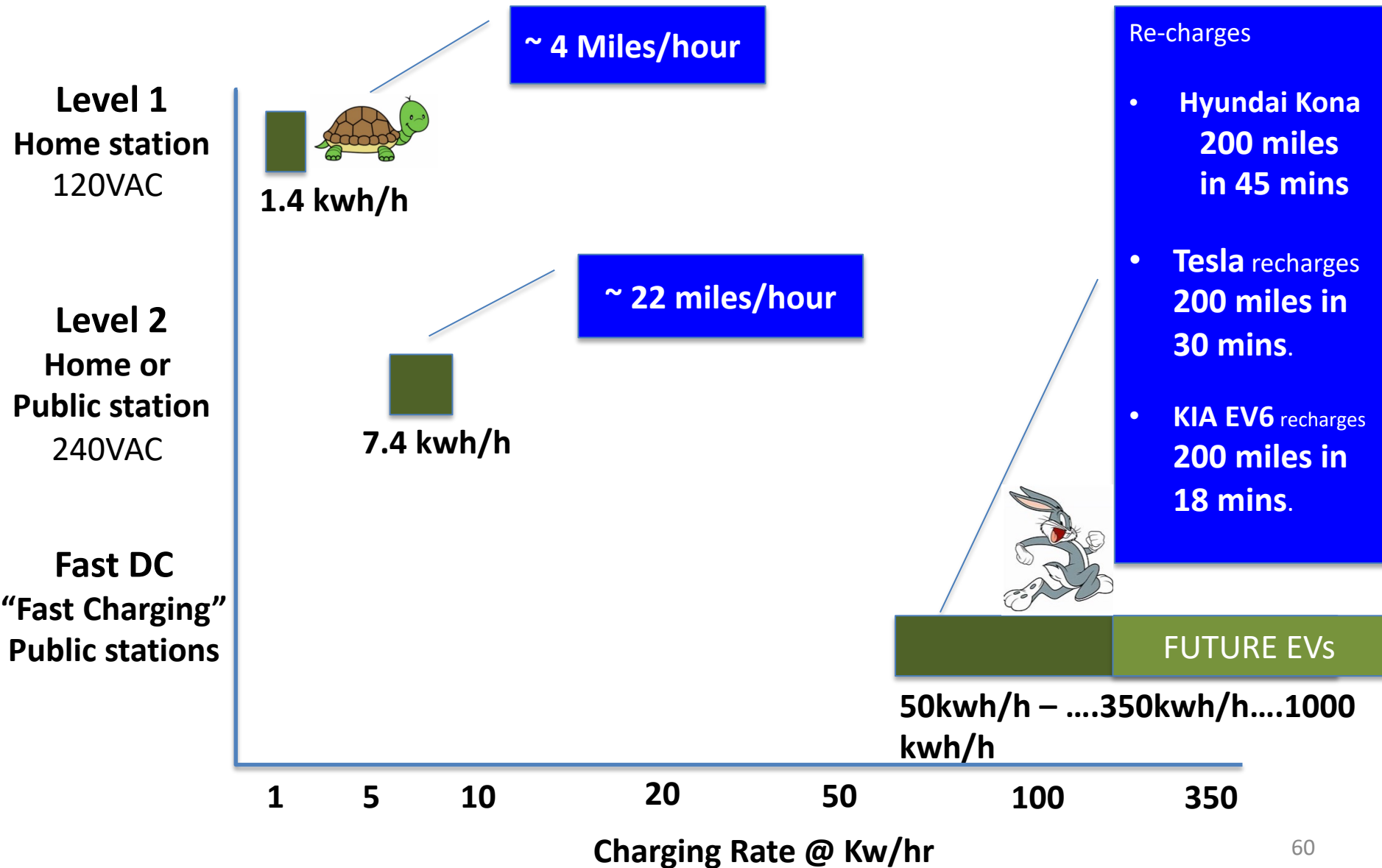


- No oil pressure
- No water temp
- No engine coolant
- No water pump or alternator
- No belts to adjust or replace
- No exhaust system to rust

# Charging Networks



# Charging Stations

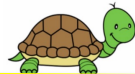




# Charging Stations



Slow



Faster

Fast

Outlet

**Level 1**  
110VAC, 1.4 Kw

- Toaster
- Stereo
- TV
- Lamps



Wall

**Level 2**  
220VAC, 3.3 - 7.4 Kw,

- Ovens, ranges, and cooktops
- Clothes dryers
- Furnaces
- Electric Water heaters



NEMA 14-50

**Fast DC “Fast Charge”**

- CCS
- CHAdeMO
- Tesla

High Voltage DC  
50 kw – 350kw

Vehicle Connection



J-1772



J-1772



CCS/SAE

CHAdeMO

Tesla

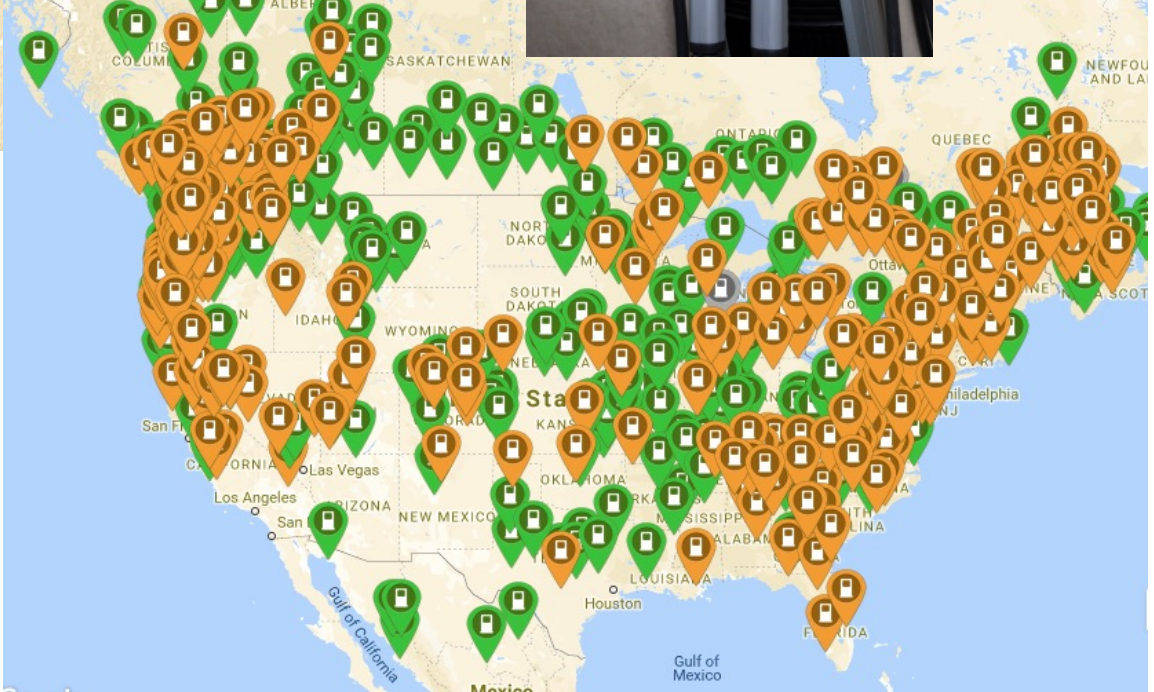
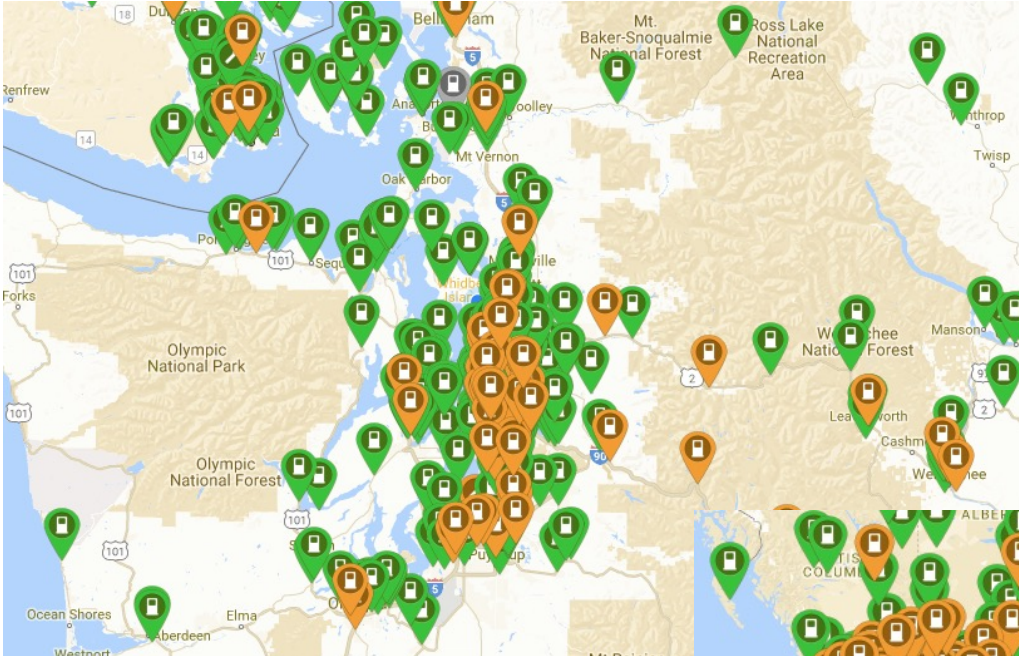
Charging Equipment



Home

Public

# Public Charging Networks



-chargepoint+

EVgo



SemaConnect

blink







# Using a Public Charging Station with Smartphone

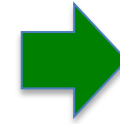
Find a charging station



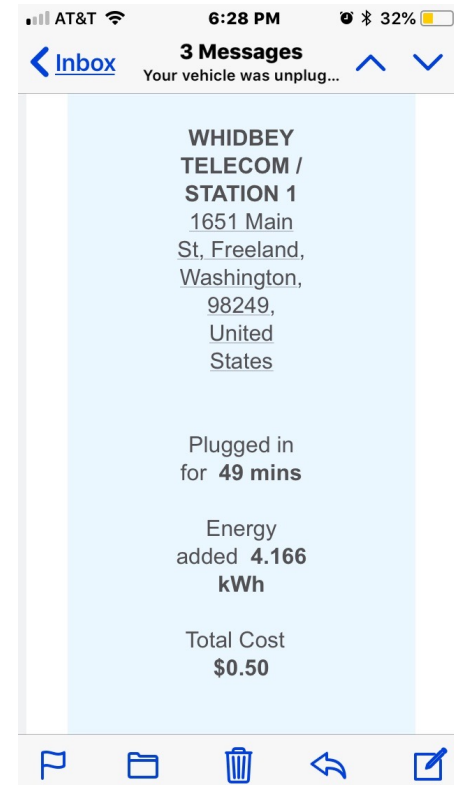
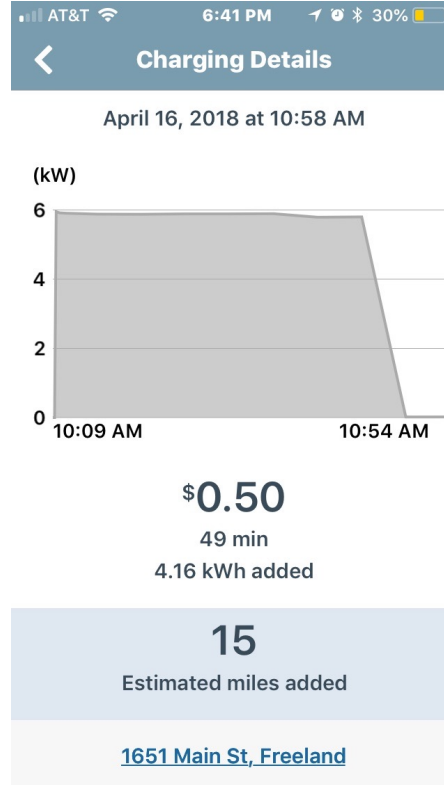
Connect, Activate, & Pay (App, RFID, Credit Card)



Monitor charging & Notify complete



Payment confirmation





# The Future - EV Charging Stations & Convenience Stores



- ◆ Shell converts UK gas stations to EV charging, featuring nine 175-kW chargers, demonstrating a way for stations to adapt to the EV age.
- ◆ The 175-kW chargers can charge most EVs from 0% to 80% state of charge in 10 minutes.



# Changing Paradigm



[CURRENT CONTEST](#)

[STORE LOCATOR](#)

[OUR PRODUCTS](#)

[WORKING WITH US](#)

[ABOUT US](#)

## the evolution made easy

OUR NEW EV CHARGERS MEAN YOU CAN CHARGE  
YOUR CAR WHILE YOU RECHARGE, TOO.



# Changing Paradigm



**Food**

**Drinks**

**7REWARDS**

**Order 7NOW Delivery**

**Shop 7Collection**



# Are they affordable ?

Base price (MSRP + DST and after Tax Credit)

2023 Chevrolet Bolt EV 1LT 17-inch	259	\$19 995
2023 Chevrolet Bolt EUV LT 17-inch	247	\$21 295
2023 Nissan Leaf S (40 kWh) 16-inch	149	\$29 135
2024 MINI Cooper SE Hardtop 2 door 16-inch	114	\$31 895
2023 Volkswagen ID.4 Standard 19-inch	209	\$32 790
2023 Hyundai Kona Electric 17-inch	258	\$34 885
2023 Mazda MX-30 18-inch	100	\$35 485
2023 Nissan Leaf e+ SV Plus (60 kWh) 17-inch	212	\$37 135
2023 Volkswagen ID.4 Pro 19-inch	275	\$37 790
2023 Volkswagen ID.4 S 20-inch	209	\$37 790
2023 Tesla Model 3 RWD 18-inch	272	\$38 130
2023 Tesla Model 3 RWD 19-inch	267	\$39 630
2023 Kia Niro EV 17-inch	253	\$40 875
2023 Ford Mustang Mach-E Select SR LFP RWD 18-inch	250	\$41 045
2023 Volkswagen ID.4 AWD Pro 19-inch	255	\$41 590
2023 Tesla Model Y AWD (4680) 19-inch	279	\$41 630
2023 Hyundai Ioniq 6 SE RWD Standard Range 18-inch	240	\$42 715
2023 Hyundai Ioniq 5 SE SR RWD 19-inch	220	\$42 785
2023 Volkswagen ID.4 Pro S 20-inch	275	\$42 790
2023 Toyota bZ4X XLE FWD 18-inch	252	\$43 335
2023 Tesla Model Y AWD (4680) 20-inch	269	\$43 630
2023 Kia EV6 RWD SR 19-inch	232	\$43 925
2023 Ford Mustang Mach-E Select SR LFP AWD 18-inch	226	\$44 045
2023 Nissan Ariya Engage FWD (63 kWh) 19-inch	216	\$44 525
2023 Tesla Model Y Long Range AWD 19-inch	330	\$44 630
2023 Ford Mustang Mach-E Premium SR LFP RWD 19-inch	250	\$45 045
2023 Tesla Model 3 Long Range AWD 18-inch	333	\$45 130
2023 Toyota bZ4X XLE AWD 18-inch	228	\$45 415
2023 Subaru Solterra Premium AWD 18-inch	228	\$46 220
2023 Volkswagen ID.4 AWD Pro S 20-inch	255	\$46 590
2023 Hyundai Ioniq 6 SE RWD Long Range 18-inch	361	\$46 615
2023 Tesla Model Y Long Range AWD 20-inch	318	\$46 630
2023 Tesla Model 3 Long Range AWD 19-inch	315	\$46 630
2023 Hyundai Ioniq 5 SE RWD 19-inch	303	\$46 835



# Are they affordable? - Used EV prices - Ads from Paramount Motors Seattle



## 2021 Volkswagen ID.4

### 1st Edition

1st Edition 4dr Crossover

Price

**\$29,995**

Mileage

**31,130**



## 2018 Chevrolet Bolt EV LT

LT 4dr Hatchback

Price

**\$17,995**

Mileage

**44,110**



## 2021 MINI Hardtop 2

### Door Cooper SE

Cooper SE 2dr Hatchback

Price

**\$25,995**

Mileage

**19,639**



## 2020 Nissan LEAF SV

SV 4dr Hatchback

Price

**\$18,995**

Mileage

**12,756**



# Federal Tax Incentives

## Who Qualifies

- credit up to \$7,500  
new, qualified plug-in EV or fuel cell electric vehicle (FCV).
- individuals and their businesses.
- modified adjusted gross income (AGI) may not exceed:
  - \$300,000 for married couples filing jointly
  - \$225,000 for heads of households
  - \$150,000 for all other filers

# Federal Tax Incentives – Jobs to USA

## Qualified Vehicles

- Have a battery capacity of at least 7 kilowatt hours
- Have a gross vehicle weight rating of less than 14,000 pounds
- Be made by a qualified manufacturer.
  - (FCVs do not need to be made by a qualified manufacturer to be eligible)
- Undergo final assembly in North America
- Meet critical mineral and battery component requirements
- You buy the vehicle new
- (MSRP) can't exceed:
  - \$80,000 for vans, sport utility vehicles and pickup trucks
  - \$55,000 for other vehicles

# Federal Tax Incentives – Jobs to USA

- **For vehicles placed in service April 18, 2023 and after:**
- Vehicles will have to meet .....new critical mineral and battery component requirements for a credit up to:
- \$3,750 if the vehicle meets the critical minerals requirement only
- \$3,750 if the vehicle meets the battery components requirement only
- \$7,500 if the vehicle meets both
- A vehicle that doesn't meet either requirement will not be eligible for a credit.

# Federal Tax Incentives – FuelEconomy.gov

## Model Year

From:

To: (optional)

Select Make

- ✓ All
- BMW
- Cadillac
- Chevrolet
- Chrysler
- Ford
- Jeep
- Lincoln
- Rivian
- Tesla
- Volkswagen

*Several offshore automakers have plans to manufacture EVs in US due to the new US legislation*

### Federal Tax Credits for Plug-in Electric and Fuel Cell Electric Vehicles Placed in Service in 2023 or After

(Vehicles placed in service on or after April 18, 2023)

<https://fueleconomy.gov/feg/tax2023.shtml>



## **Washington State EV Incentive** - New light vehicles = 6.8 % sales tax in Washington

### **Washington Tax Credits**

Washington state offers tax credits in the form of tax exemptions for new and used clean/alternative fuel vehicles. Some plug-in hybrids qualify for the exemption, but the sale price or value for a **new vehicle cannot exceed \$45,000**, including delivery and other fees. That said, the tax exemption only covers a portion of the purchase price.

As of August 2023, the amount is \$15,000 for a new vehicle sold or leased.

### **Washington Tax Credits for Buying Used EVs**

Used car buyers in Washington may be eligible for a used EV tax exemption if their chosen **vehicle's purchase price is \$30,000 or less**. Like the new EV exemption, the state does not cover the entire purchase price. Instead, **Washington exempts up to \$16,000 of the used sales or leased price.**

### **Washington Credits for Installing Home Charging Stations**

Washington offers tax exemptions for “anyone who purchases an electric vehicle battery or fuel cell, or installs an electric vehicle battery, fuel cell charging station, or hydrogen fueling stations.”

- Power Utility Co may offer REBATE for home charging station

# Drive Electric

- Performance
- Fuel and Maintenance savings (\$0.03/mile @ \$0.09/kwh)
- Reduce climate disaster for children & grandchildren.....



# Thank you !

Favorite Links :

[jeffersoncan.org](http://jeffersoncan.org)

[coltura.org](http://coltura.org)

[cityofpa.us/1010/Climate-Resiliency-Plan](http://cityofpa.us/1010/Climate-Resiliency-Plan)

[Olyclimate.org](http://Olyclimate.org)

[www.aboutCATES.org](http://www.aboutCATES.org)

Tony Billera

[www.linkedin.com/in/tonybillera](http://www.linkedin.com/in/tonybillera)

[tony.billera@gmail.com](mailto:tony.billera@gmail.com)



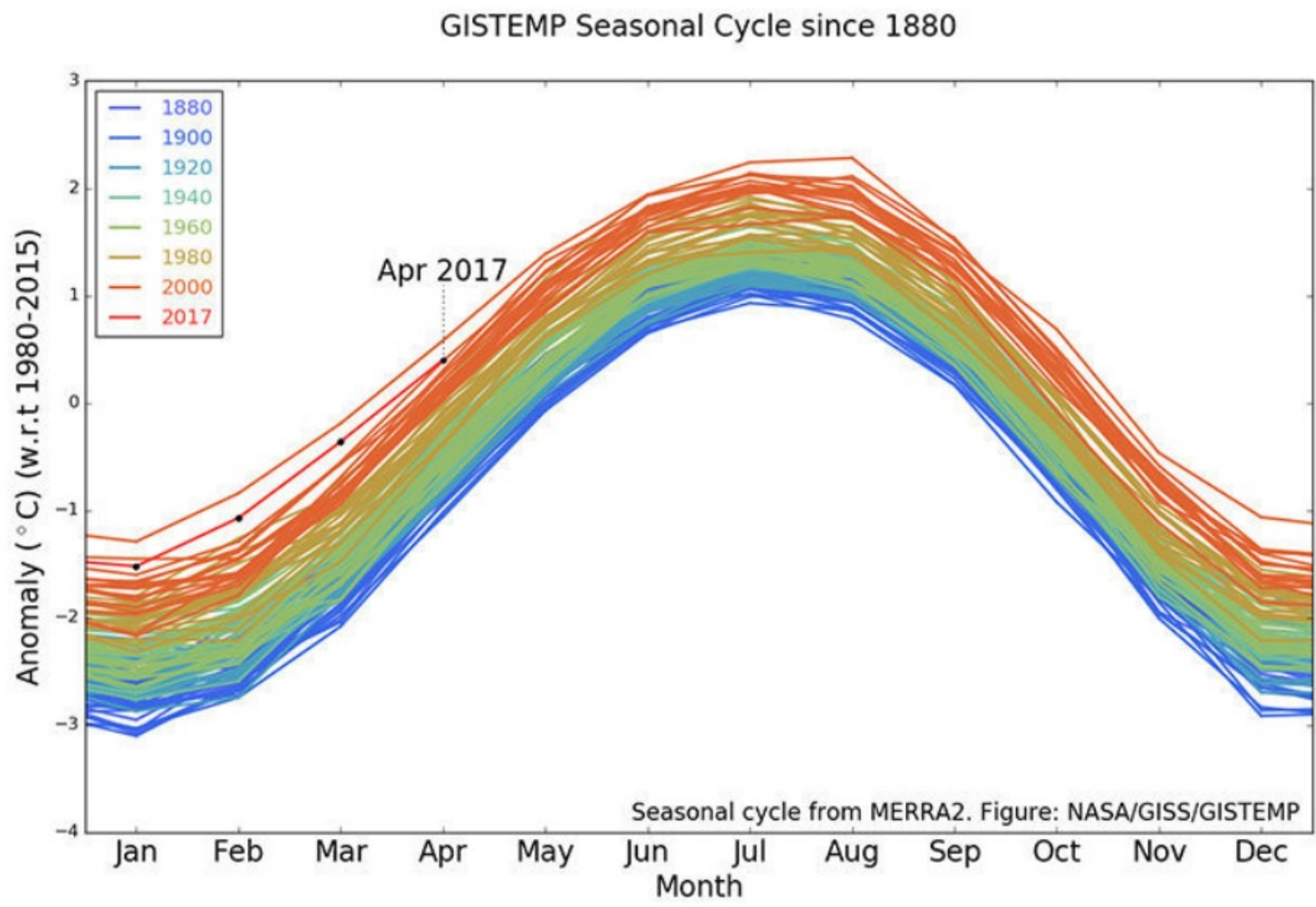
# Appendix



- WHATS REALLY WARMING THE WORLD?

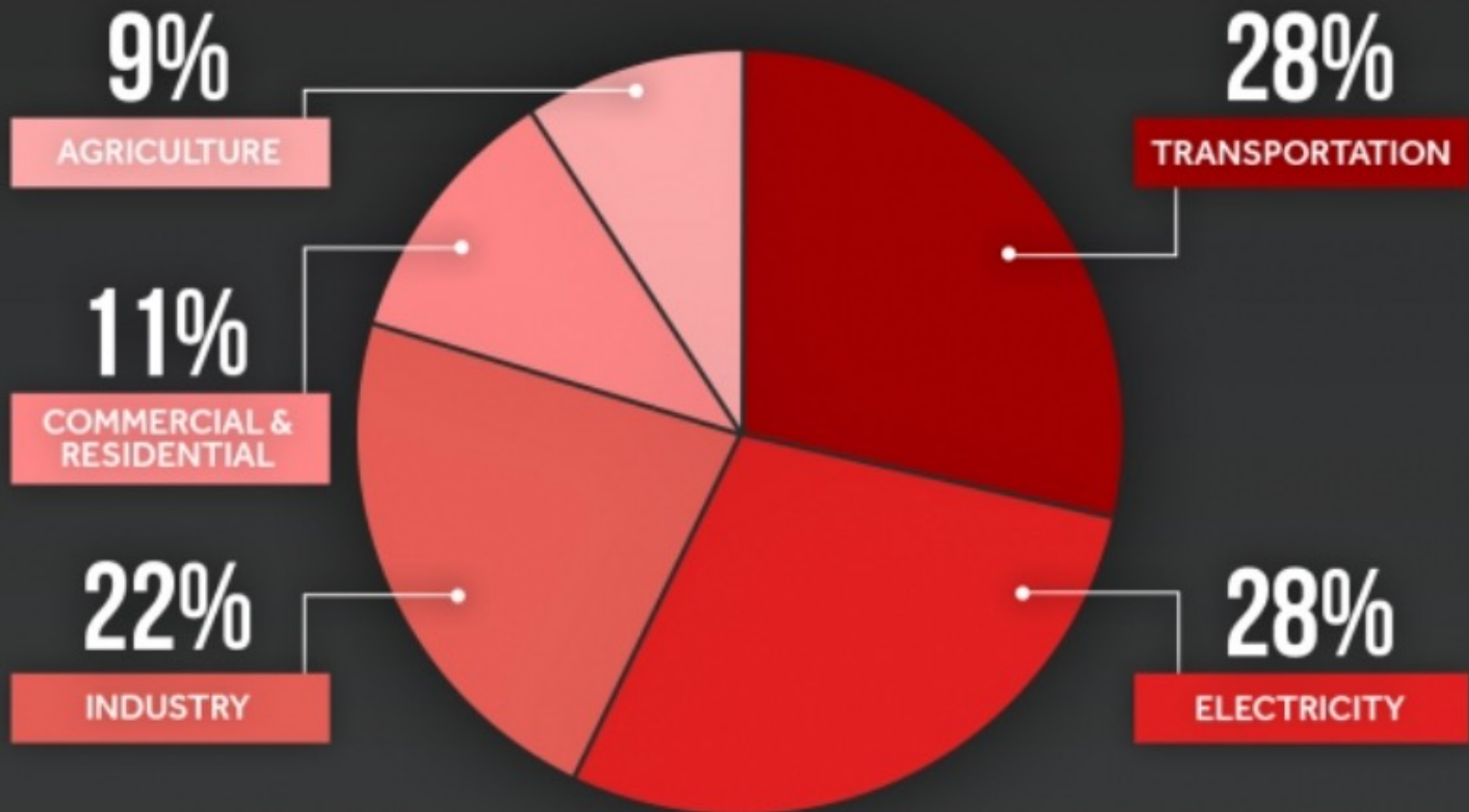
<https://www.bloomberg.com/graphics/2015-whats-warming-the-world/>

# Increasing temperatures



# GREENHOUSE GAS SOURCES

United States Greenhouse Gas Emissions by Sector



Source: US EPA

CLIMATE  CENTRAL

# Port Angeles Climate Resiliency Project

## Inventory Results: 2019 Community Snapshot

### Main Sources of Emissions (in order):

1. Transportation & mobile sources
2. Solid waste generation & landfill operations
3. Process & fugitive emissions (e.g., refrigerants)

### Major Data Sources

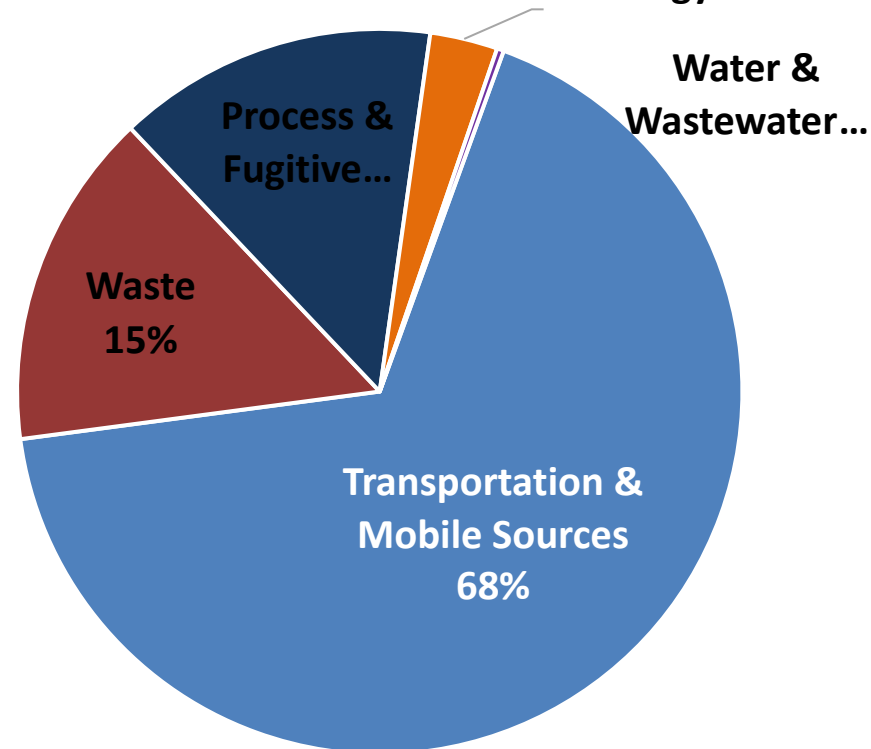
- City of Port Angeles Public Works & Utilities (Energy, Solid Waste, Water & Wastewater)
- Port of Port Angeles & Black Ball Ferry
- Washington State Department of Transportation (WSDOT)
- U.S. Energy Information Administration

### Key Considerations

- Propane data downscaled from state-level usage data; scaled based on households
- No commercial/industrial propane estimates available -
- Vehicle mileage data was downscaled from annual county-level data from WSDOT

### Total 2019 Community Emissions:

132,597 MTCO<sub>2</sub>e Energy...





## Inventory Results: Detailed Community Findings

### Major Drivers of Emissions:

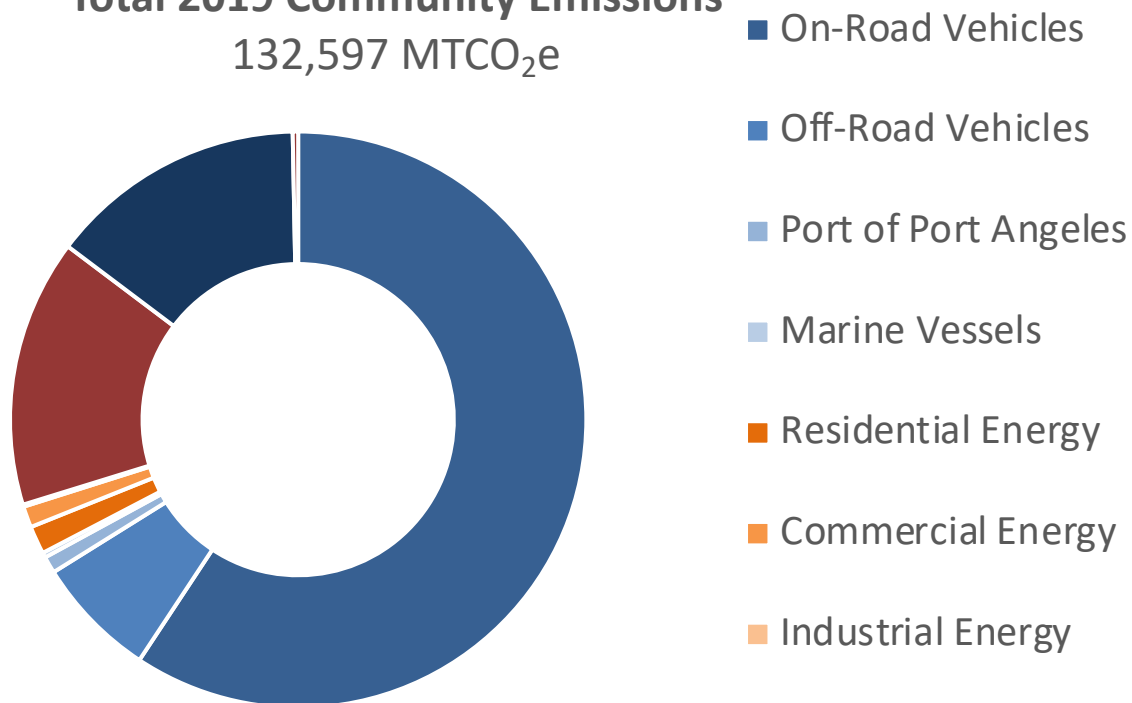
- On-road cars, motorcycles, SUVs, and trucks (59%)
- Solid waste generation & landfill operations (15%)
- Refrigerant leakage & electricity losses (14%)

Government operations make up  
~**1% of total emissions\***

*\*The government operations inventory is still being finalized to include results from an upcoming employee commute survey*

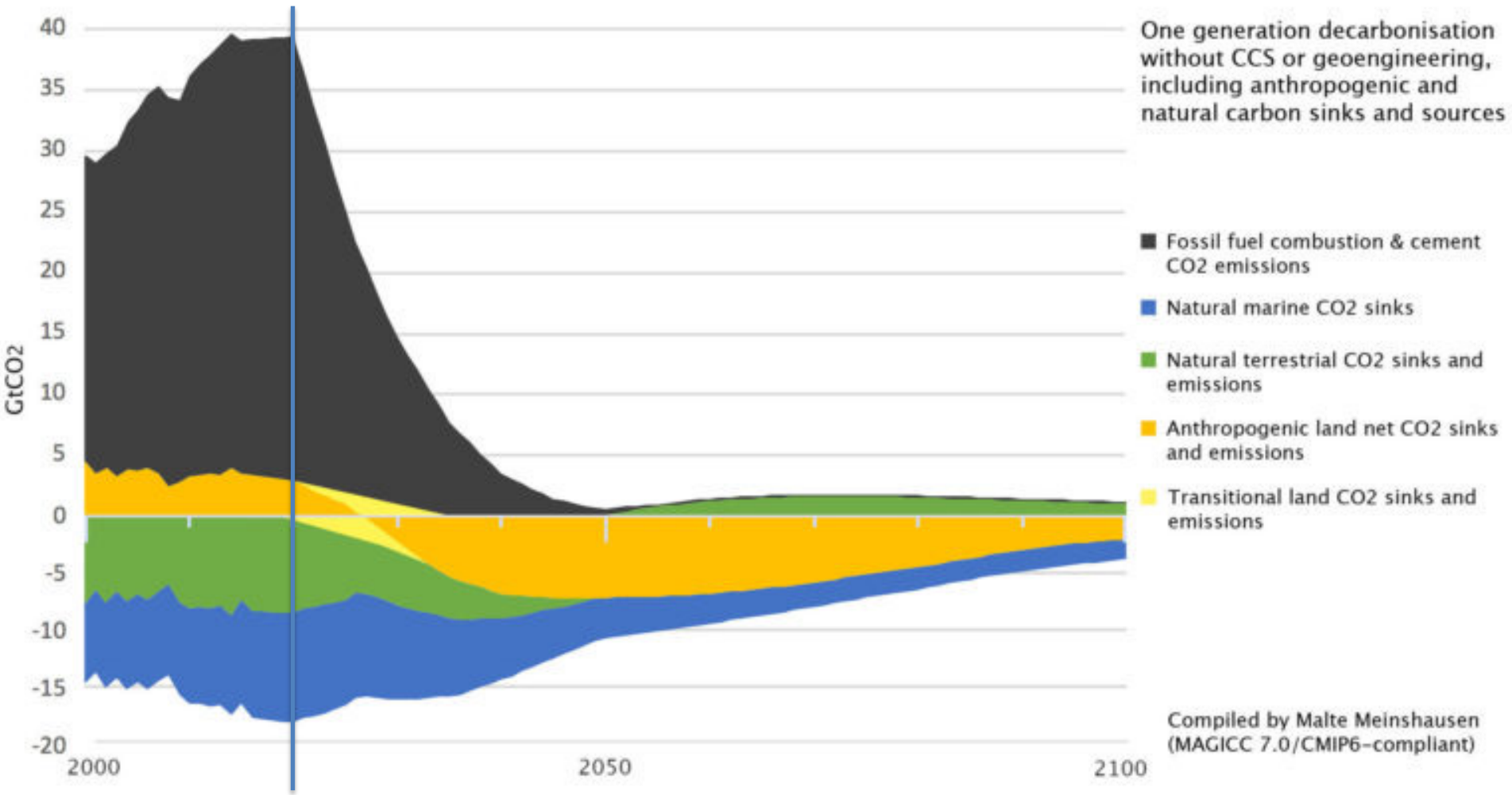
### Total 2019 Community Emissions

132,597 MTCO<sub>2</sub>e



# Decarbonization urgency

*Best case still 2C - 3.5C (3.6 - 6F) by 2100  
Assuming no GHG extraction CCS tech  
or geoengineering*



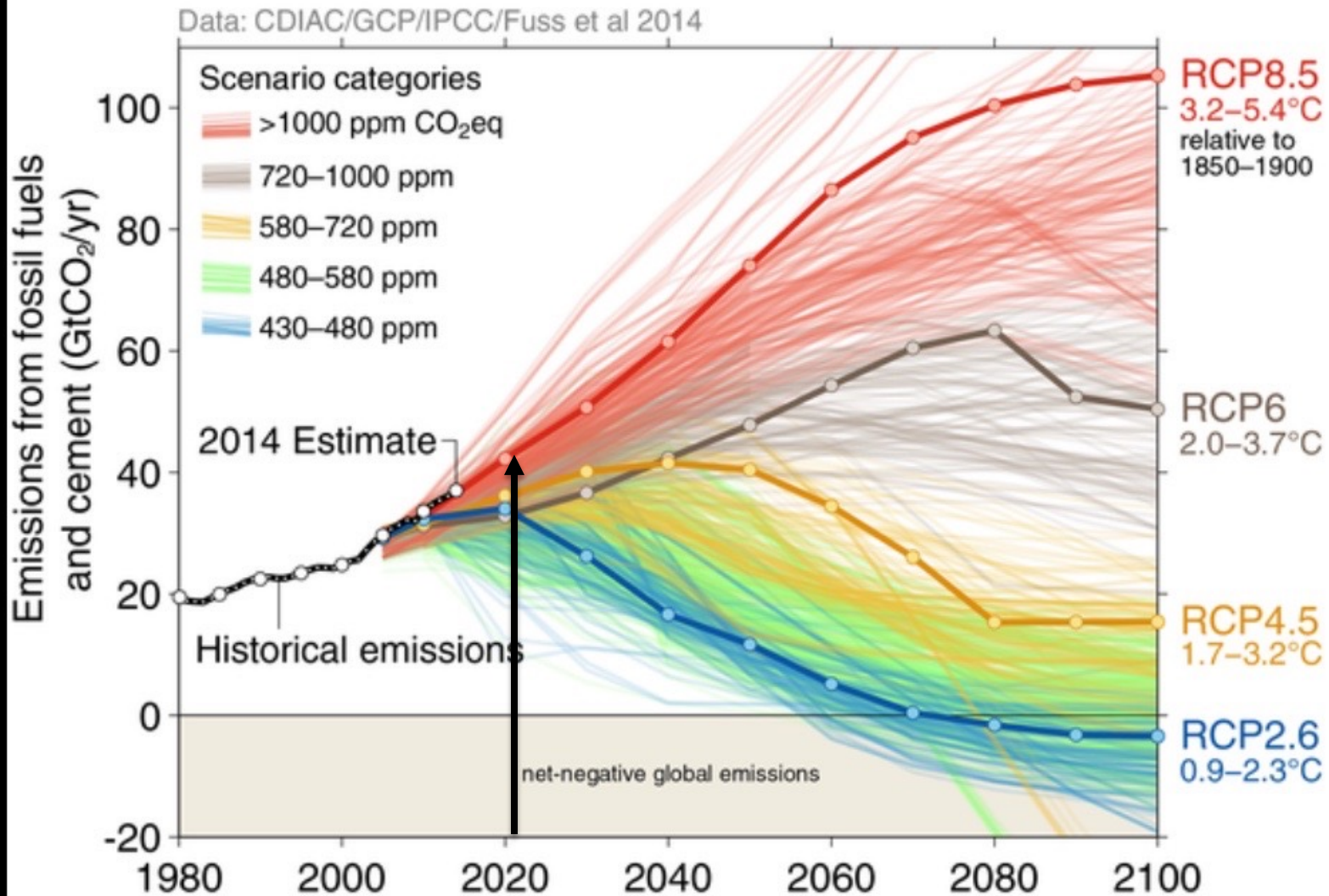
One generation decarbonisation without CCS or geoengineering, including anthropogenic and natural carbon sinks and sources

- Fossil fuel combustion & cement CO2 emissions
- Natural marine CO2 sinks
- Natural terrestrial CO2 sinks and emissions
- Anthropogenic land net CO2 sinks and emissions
- Transitional land CO2 sinks and emissions

Compiled by Malte Meinshausen (MAGICC 7.0/CMIP6-compliant)

# Climate Models

## - Representative Concentration Pathways (RCP)



5.7 -  
9.7F

3.6 -  
6.6F

3.0 -  
5.7F

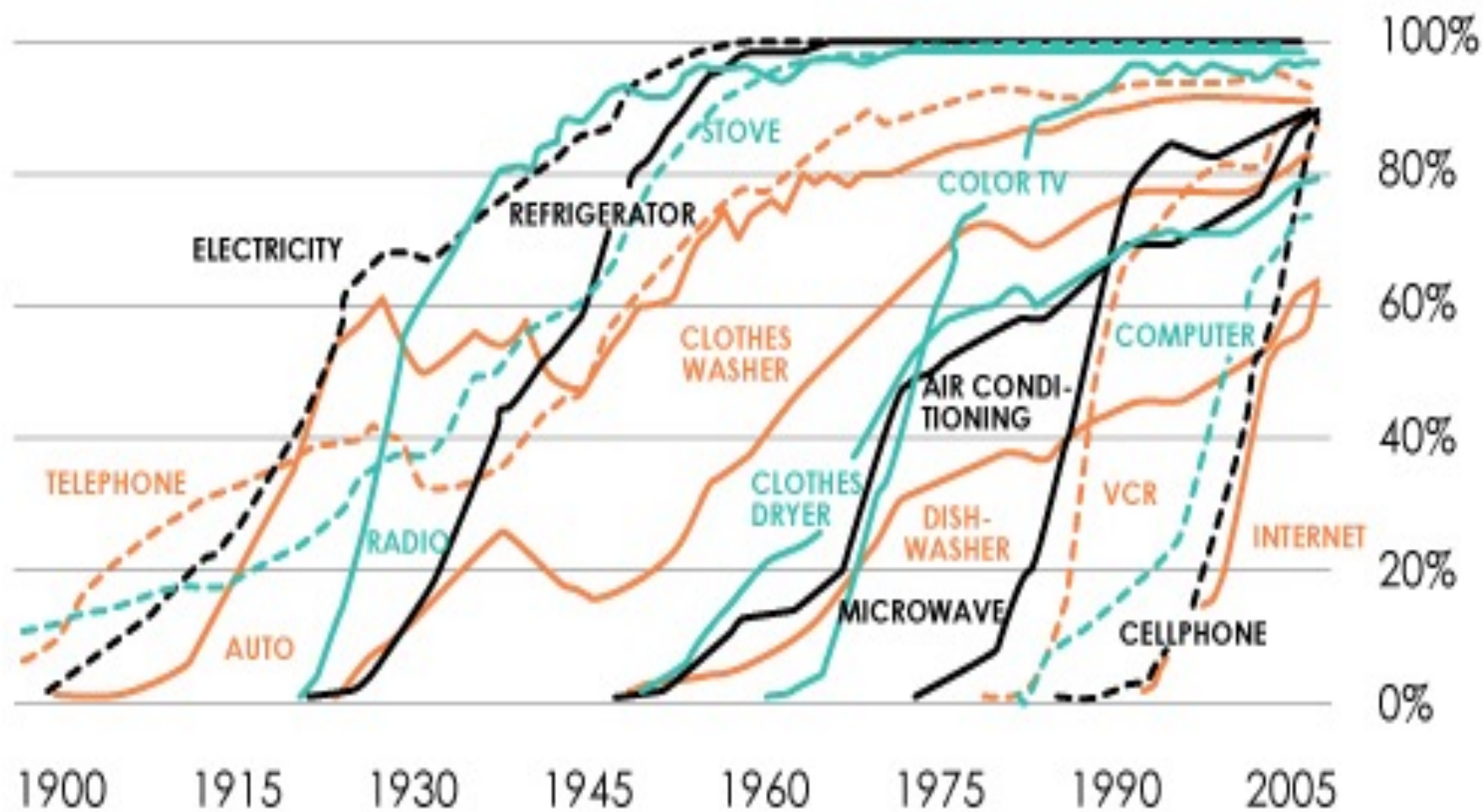
1.6 -  
4.1F

# Quickest Production Cars (0—60)

Car <sup>1</sup>	Model Year	Test Results	Noted specs
<u>Porsche 918 Spyder</u>	2015	2.1 sec	<u>naturally aspirated</u>
<u>Tesla Model S P100D</u>	2017 <sup>[xi]</sup>	2.28 sec	<u>All-electric</u> , with 5 seats
<u>Lamborghini Huracán Performante</u> <sup>[viii]</sup>	2018	2.3 sec	Naturally aspirated
<u>Porsche Taycan Turbo S</u> <sup>[xii]</sup>	2020	2.4 sec	<u>All-electric</u> , with 4 seats
<u>Tesla Model S Performance w/Ludicrous Model</u>	2020	2.4 sec	<u>All-electric</u> , with 5 seats



# New Technologies and Mainstream Adoption



Source: Michael Felton, *The New York Times*

[www.earlyinvesting.com](http://www.earlyinvesting.com)

# Mobile apps & Networks – Fast DC

The image shows a screenshot of the PlugShare mobile application interface. At the top, there is a navigation bar with a back arrow, a home icon, and the URL "plugshare.com". Below the navigation bar is the PlugShare logo.

The main content area is a map of the Pacific Northwest region, showing charging locations marked with orange pins. The map includes labels for various geographical features and reservations, such as "COLVILLE RESERVATION", "YAKAMA INDIAN RESERVATION", "NEZ PERCE RESERVATION", "Kootenai National Forest", "BLACKFEET INDIAN RESERVATION", "Payette National Forest", "Salmon-Challis National Forest", and "Yellowstone National Forest". Major cities like "Yakima", "Spokane", "Wenatchee", "Nampa", "Twin Falls", "Pocatello", "Bozeman", and "Helena" are also labeled.

On the left side, there is a sidebar with a search bar and a "Filters" section. The search bar contains the text "Search for a Charging Location". The "Filters" section is expanded, showing "Showing Filters for Use My Current Location". Below this, there are "Plugs (1 of 8)" with a "Toggle All" button. The plug types listed are:

- Supercharger
- CCS/SAE (checked)
- CHAdEMO
- J-1772
- Tesla
- Tesla (Roadster)
- NEMA 14-50
- Wall

Below the plug types, there are "Location Filters (2 of 5)":

- Show Locations That Require Payment (checked)
- Show In-Use Locations (checked)
- Show Restricted Locations
- Show Residential Locations
- Show Coming Soon Locations



# Electric Vehicles are Quick!

