THE ELECTRIFYING FUTURE OF TRANSPORTATION



Michael Knight
President TTI Semiconductor Group
SVP TTI Corporate Business Development

BY SHOW OF HANDS…

Who drives an electric vehicle today?

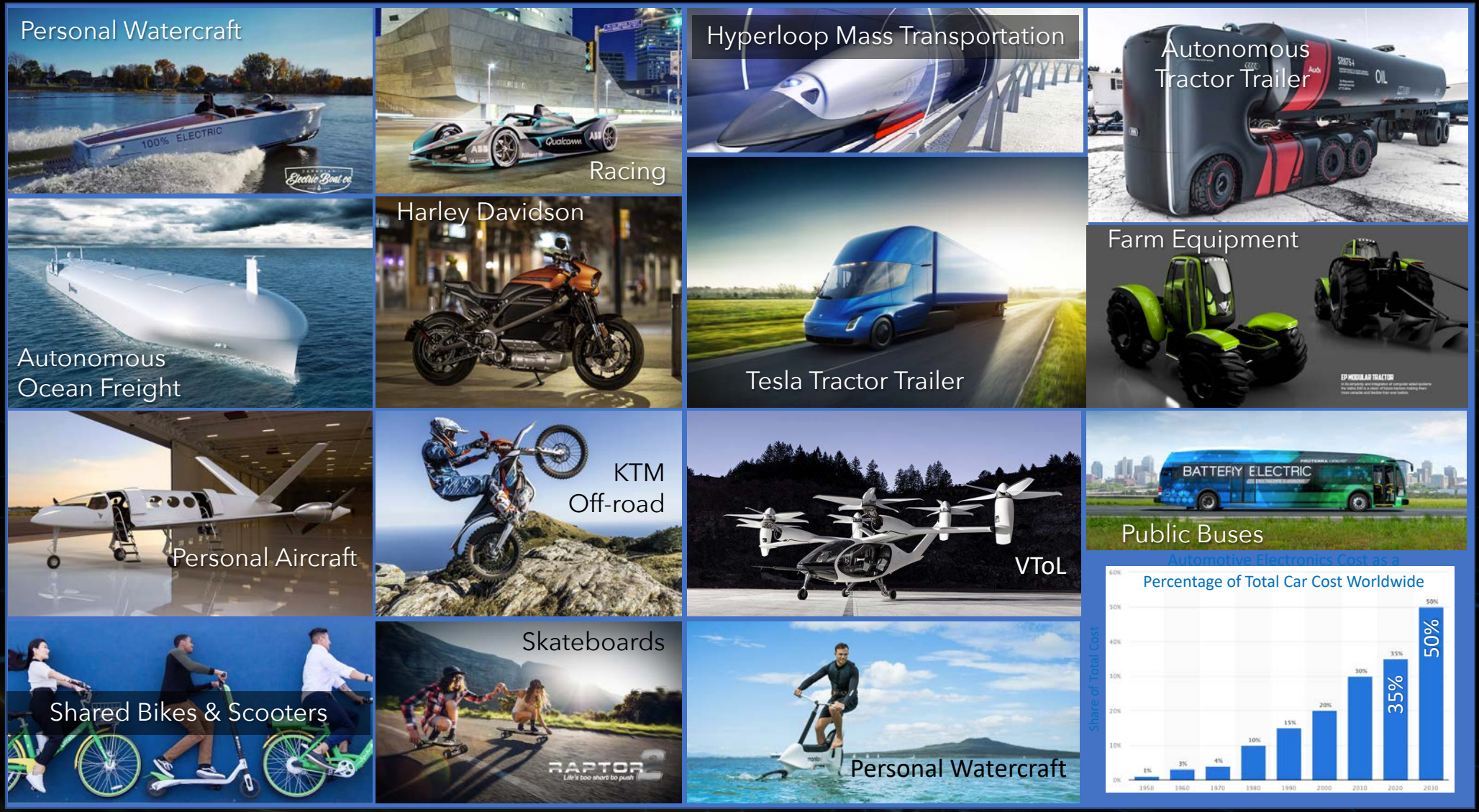
Who knows someone who drives an EV?

Who has decided that their next car will be an EV?

Who thinks that in your lifetime EV's will dominate?



WHETHER IT FLIES, FLOATS OR ROLLS, IT WILL BE ELECTRIC



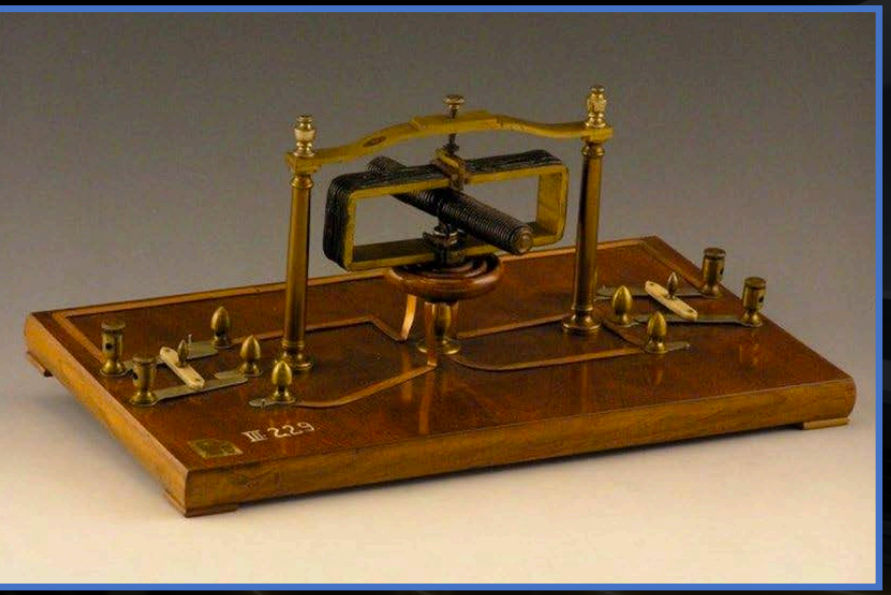
THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING



1800: FIRST BATTERY

Italian physicist, Alessandro Volta,
develops the voltaic pile to store electricity

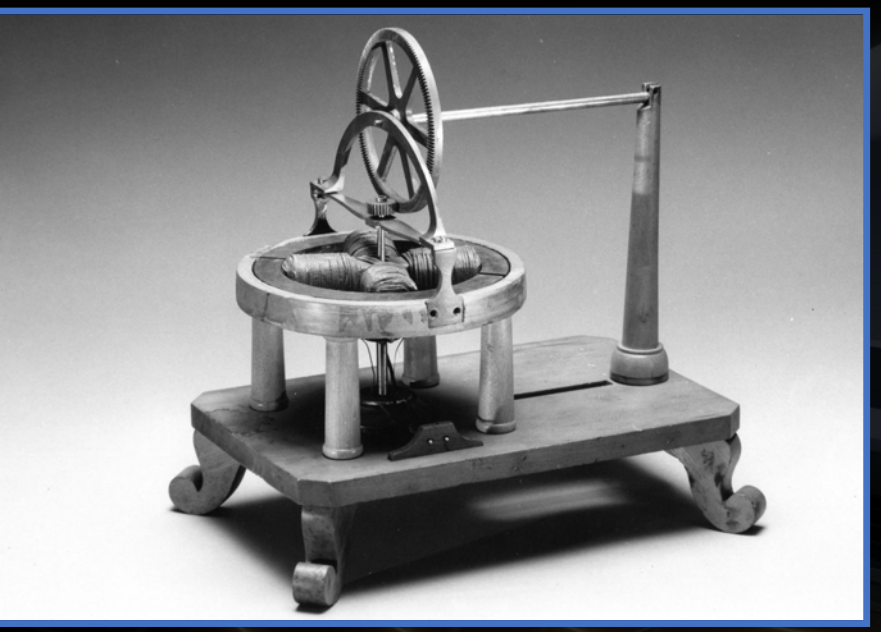
THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING



1828: FIRST ELECTRIC MOTOR

Hungarian inventor, engineer, physicist and Benedictine priest, Anyos Jelik, builds the first commutated rotary electric motor

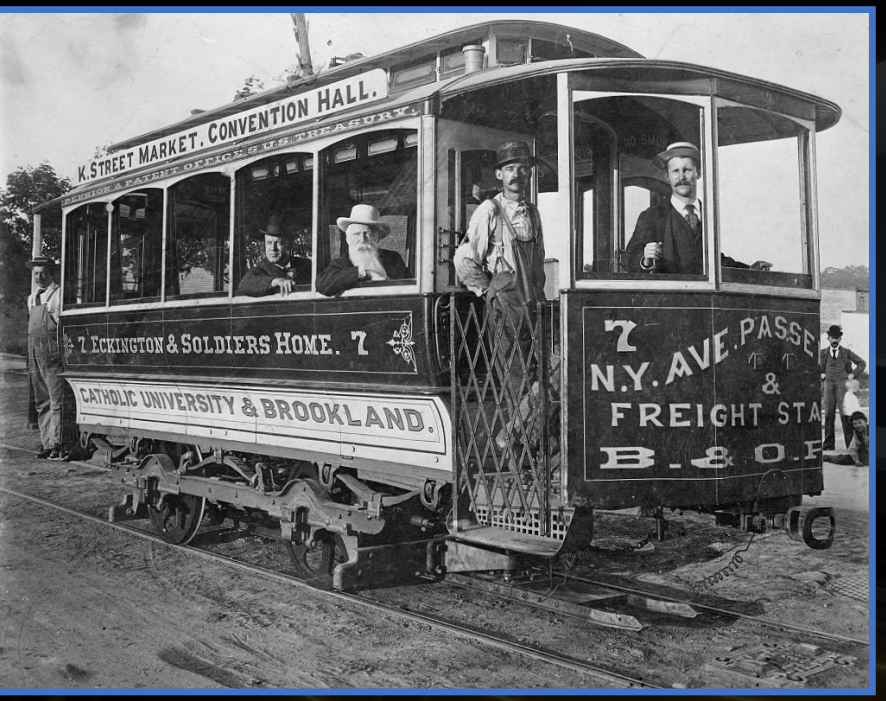
THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING



1837: FIRST U.S. ELECTRIC MOTOR

American blacksmith and inventor,
Thomas Davenport, patents the electric motor

THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING



1884: FIRST ELECTRIC TROLLEYS

The first commercial installation of an electric streetcar system in the U.S. completed in Cleveland, Ohio

THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING



1890: FIRST ELECTRIC CAR

Chemist William Morrison of Des Moines launches an electric car using 24 batteries of his own design, weighing 740 lbs with a total out put of 112 amps at 58 volts, and a charging time of 10 hours

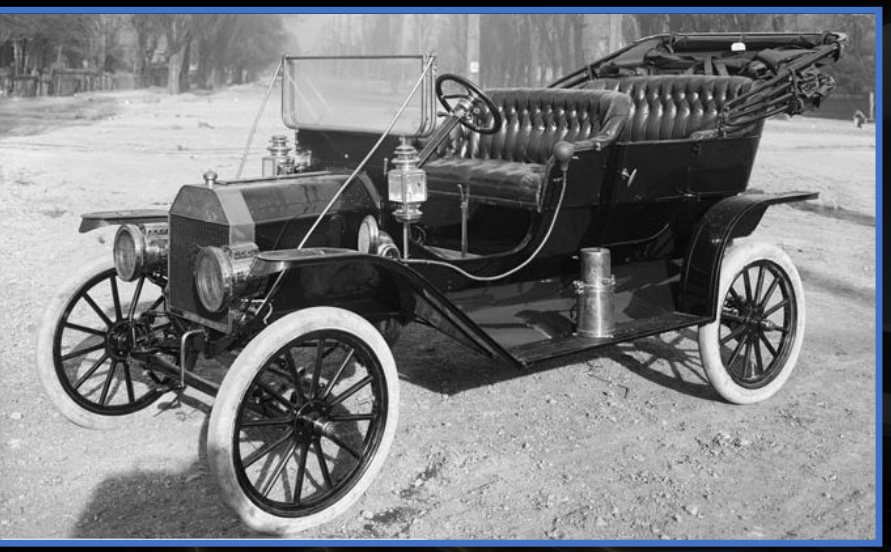
THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING



1892: FIRST "THIRD RAIL" ELECTRIC TRAIN

The "L" is built in preparation for the 1893 World's Columbian Exposition

THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING



1908: MODEL T INTRODUCED

World's first mass-produced, internal combustion engine automobile

THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING



1900's: EV's BECOME COMMON PLACE

Anderson Electric Car company built EV's from 1909 to 1942; favored in cities because they didn't poop up the streets and scare the horses

THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING



1915: CLARA FORD GOES ELECTRIC

Henry Ford's wife drove a 1914 Detroit Electric Model 47 Broughan her entire life, as did Mina Edison

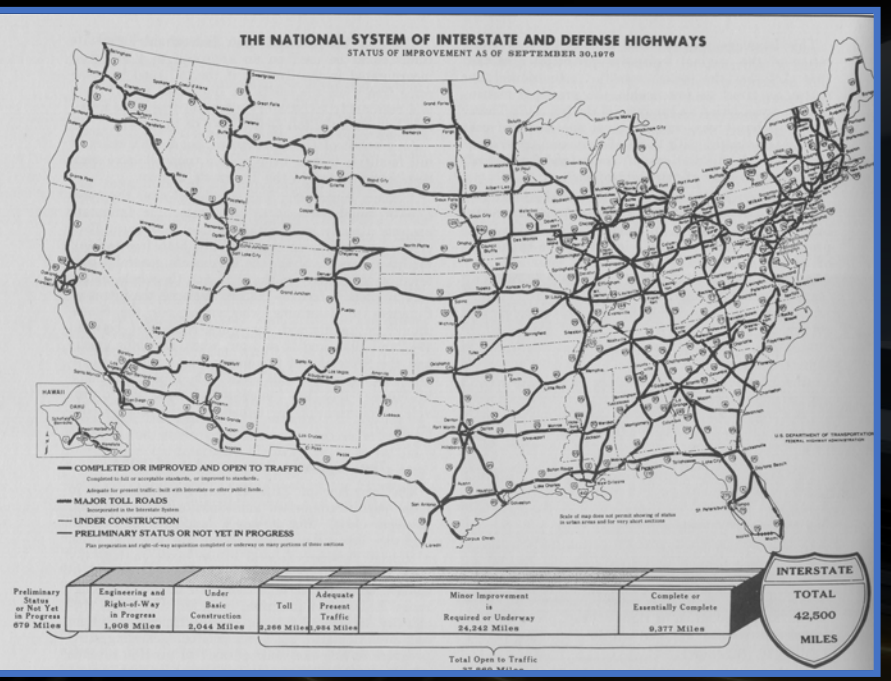
THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING



1940's: GM RIPS UP TROLLEY TRACKS

Trackways paved for roads setting American cities on a course for congestion and parking problems

THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING



1956: FEDERAL INTESTATE HIGHWAY PROGRAM

Original plan for 42,500 miles with the PA Turnpike as the first project launched the buildout of gas stations and motel chains, and killed the EV

THE ELECTRIC CAR: AN IDEA 200 YEARS IN THE MAKING

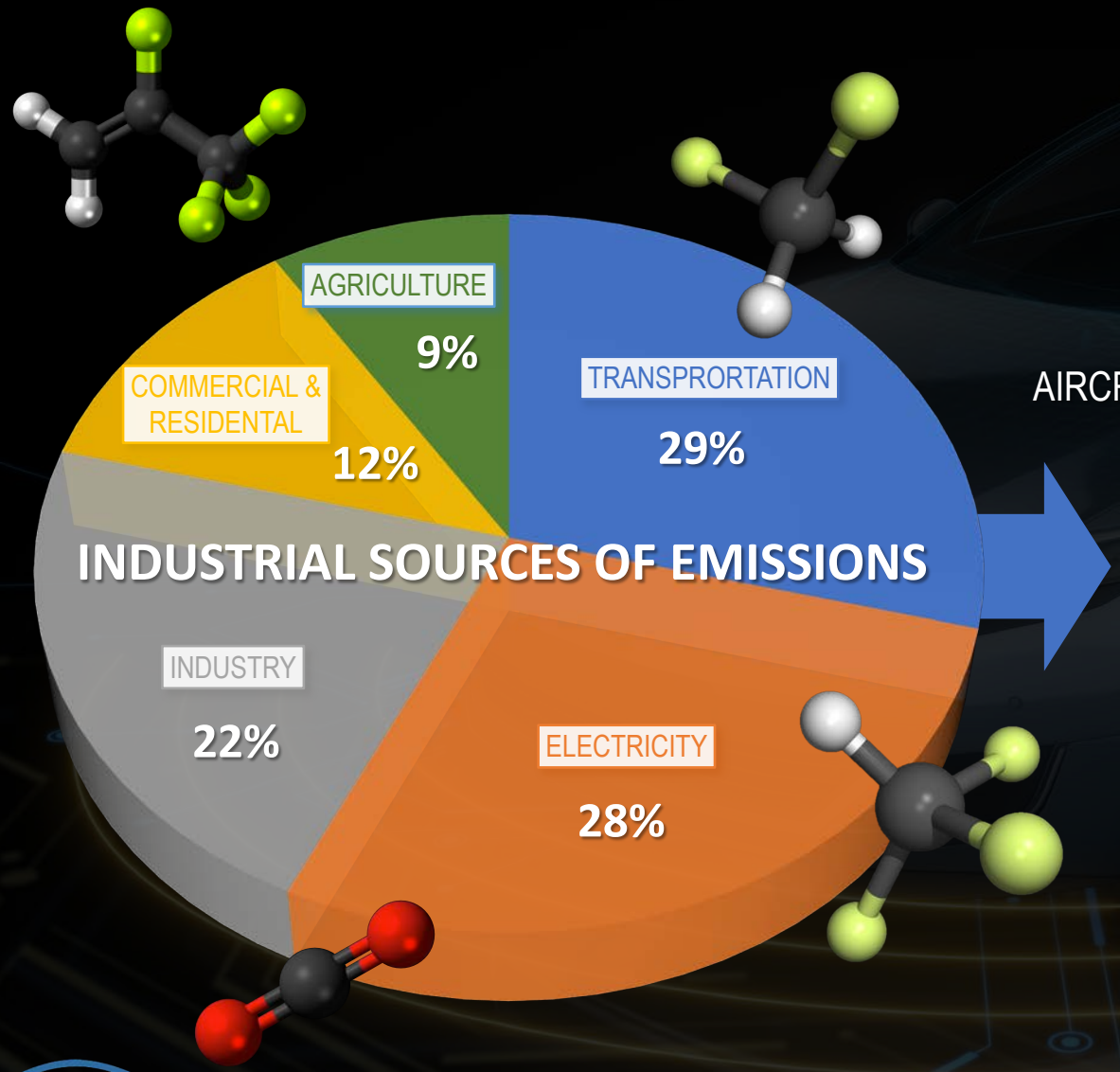


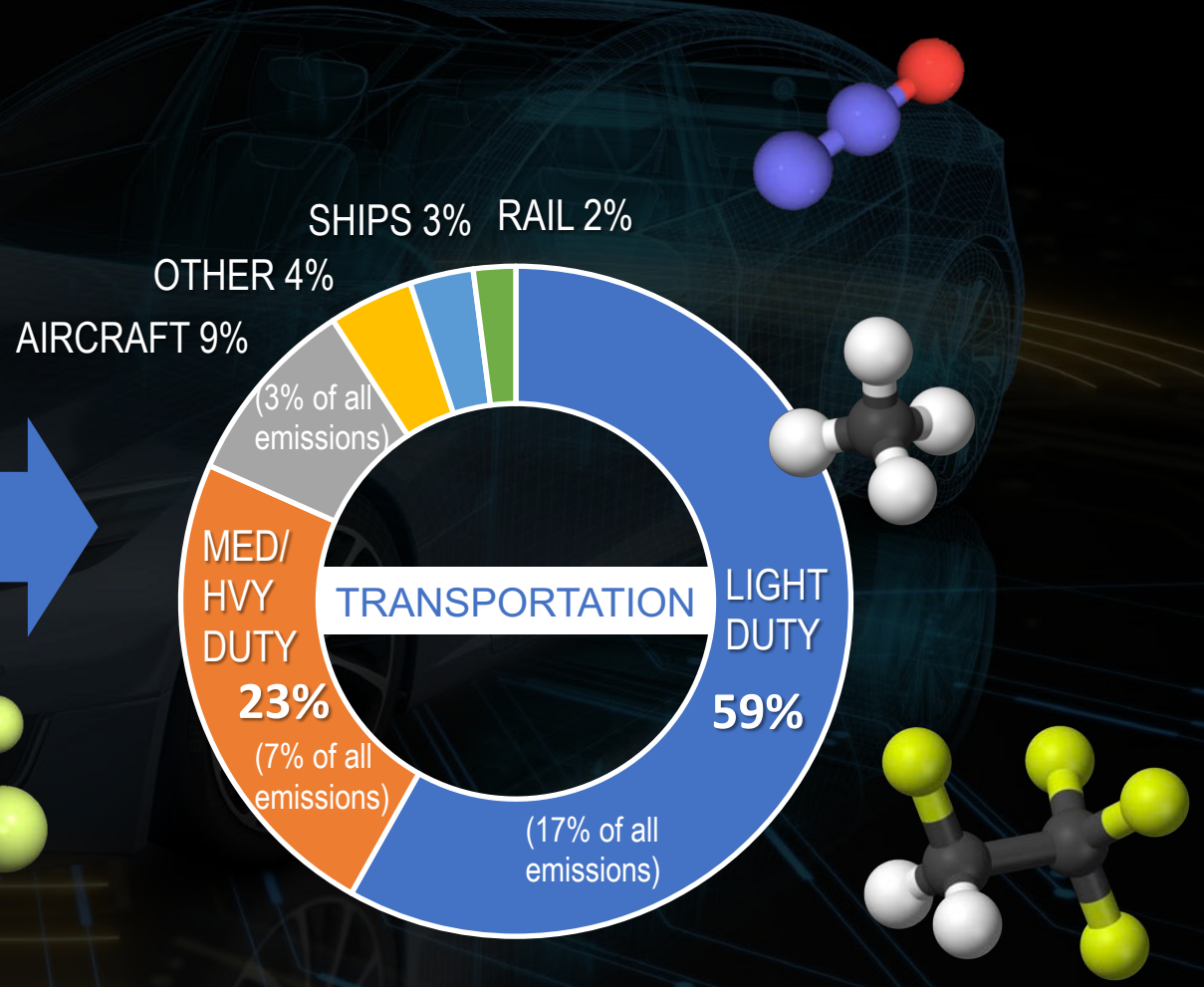
1990s: EV REVIVAL STARTED BY CARB

California Air Resources Board triggers a series of EV's including the GM EV1, Chrysler TEVan, Nissan Altra and even a Ford Ranger... all failed and were taken off the market before 2000

THE ENVIRONMENTAL ARGUMENT FOR ELECTRIC VEHICLES

U.S. Greenhouse Gas Emissions by Source





Source: U.S. Environmental Protection Agency

GREENHOUSE GAS EMISSION EXAMPLE

"IT ADDS UP!"

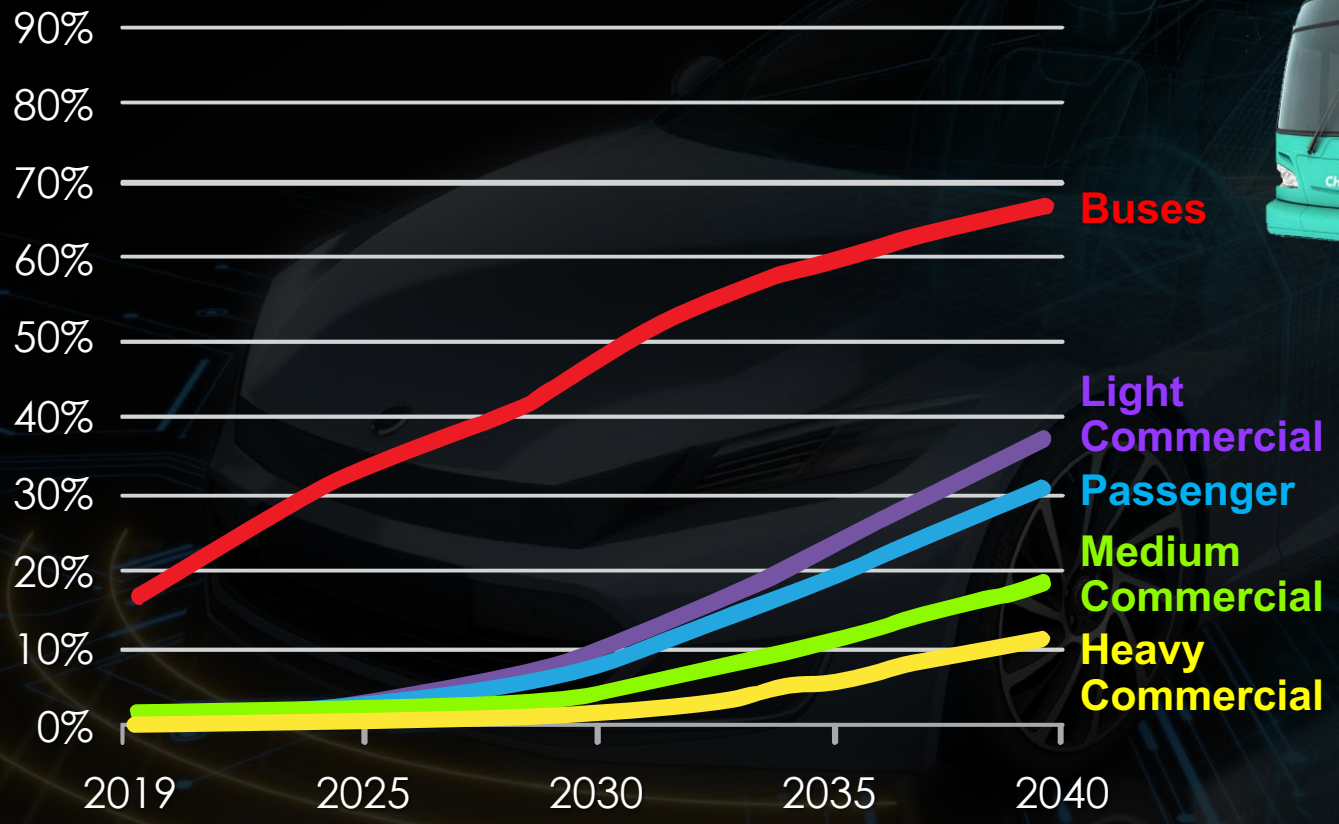


PER DAY

PER YEAR



FORECASTED EV SHARE of GLOBAL FLEET by SEGMENT



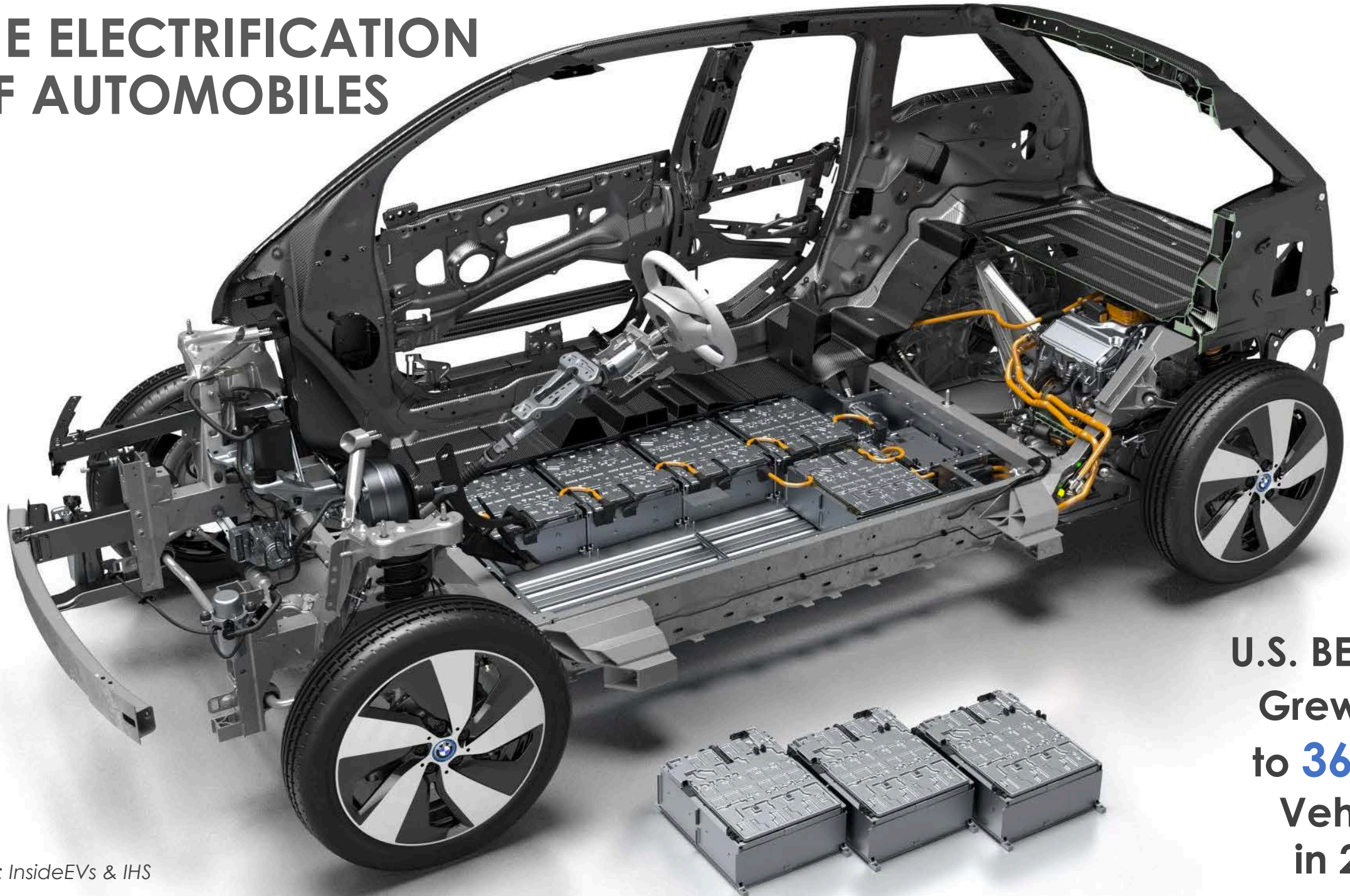
Source: BloombergNEF







THE ELECTRIFICATION OF AUTOMOBILES



U.S. BEV Sales Grew 81% to 361,307 Vehicles in 2018

Source: InsideEVs & IHS

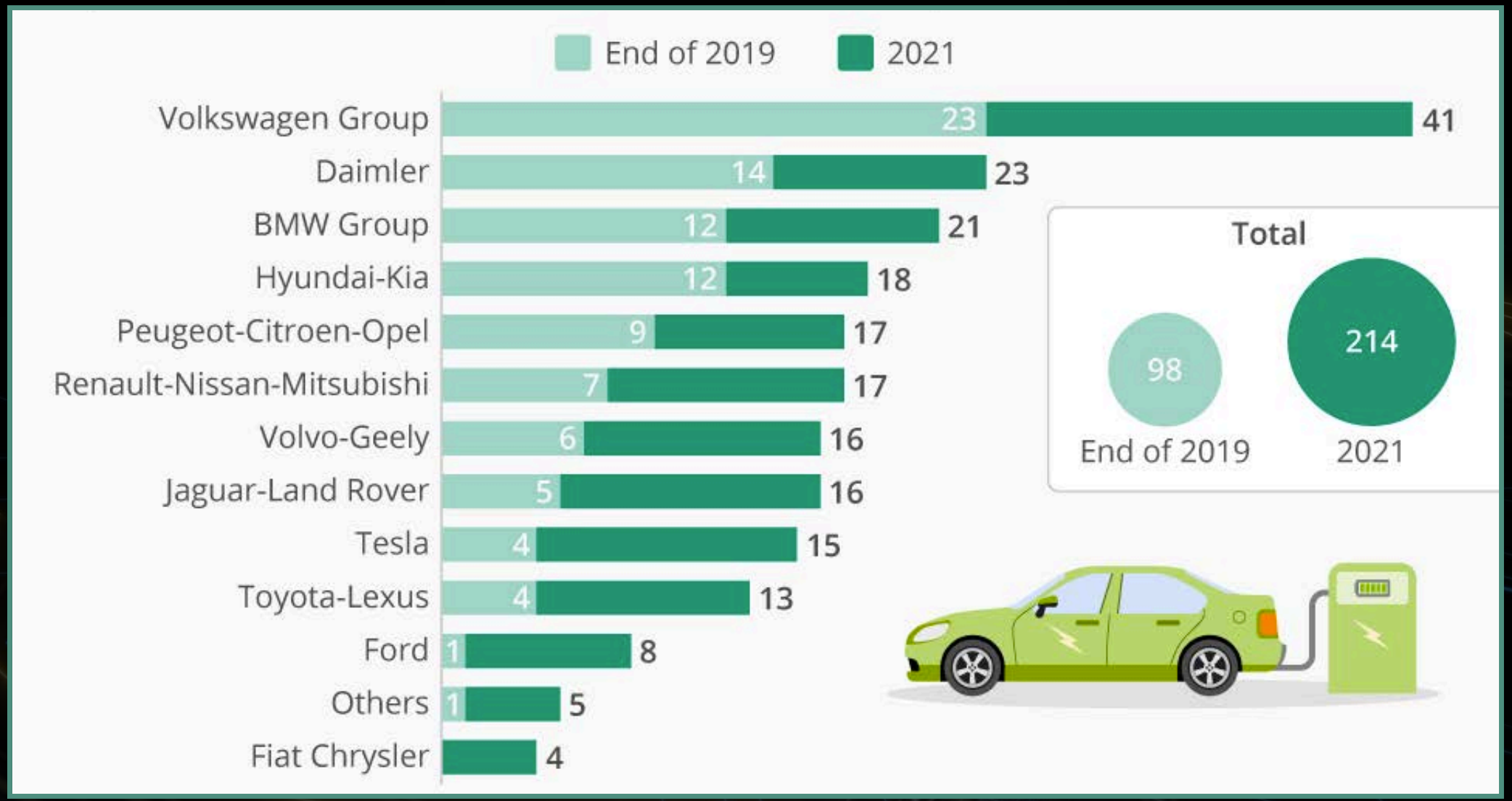
CURRENT EV AUTOMOTIVE FORECASTS

90 MILLION TOTAL CARS SOLD GLOBALLY IN 2019



			
EV's SOLD in 2019	330K	400K	1.3M
EV MODELS ON ROADS in 2020	64	100	96
EV's SOLD in 2025 22% of TOTAL AUTO	1.4M	4.0M	4.8M
CHARGING STATIONS in 2025	69K	184K	400K

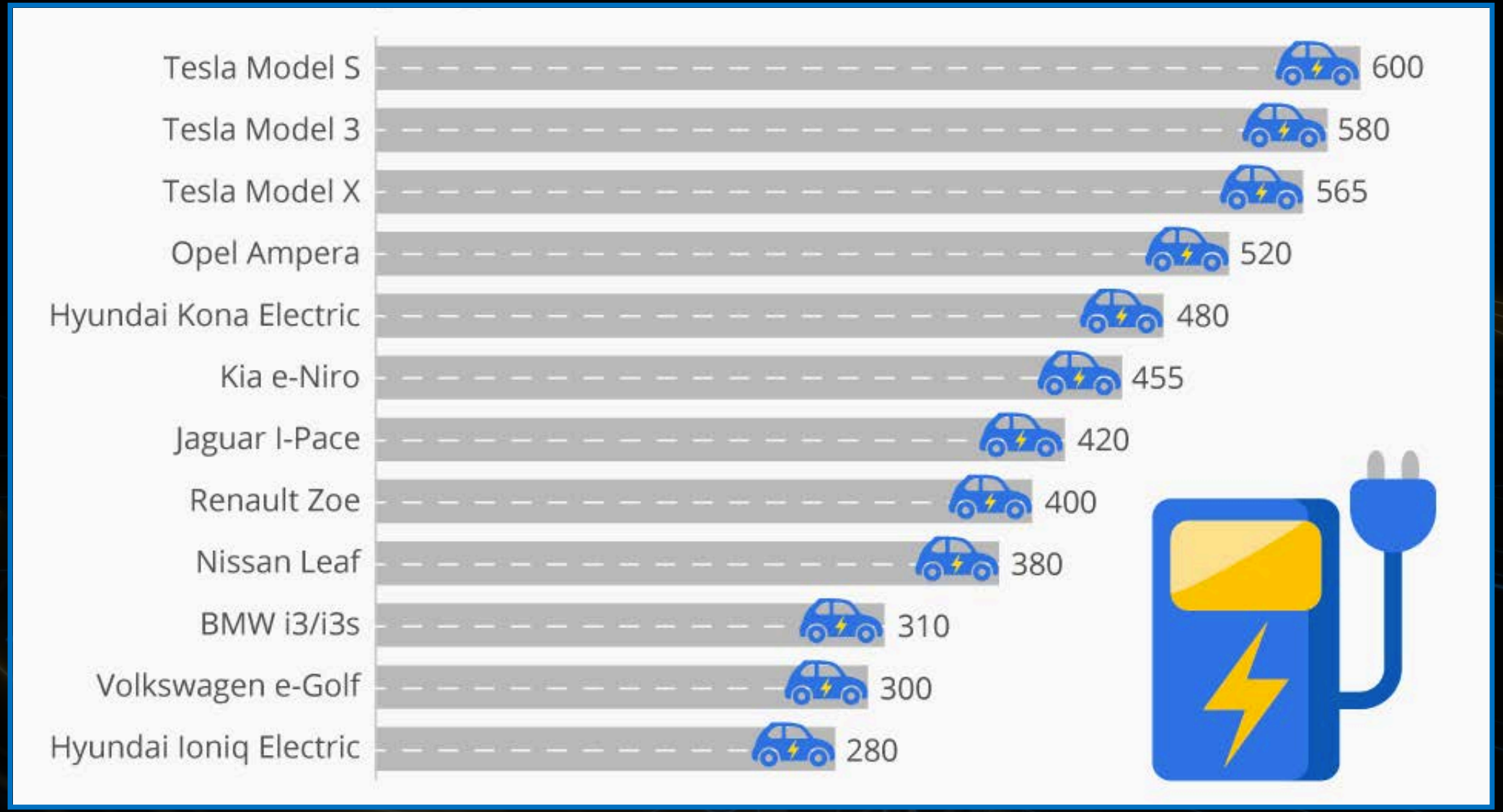
EV MODELS WILL TRIPLE IN EUROPE BY 2021



Source: Statista

CURRENT EV RANGE LEADERS

UNITS = KILOMETERS



Source: Statista

17% – 21% of gasoline is converted to power by an internal combustion engine (ICE) compared to **59% – 62%** of electricity in an EV

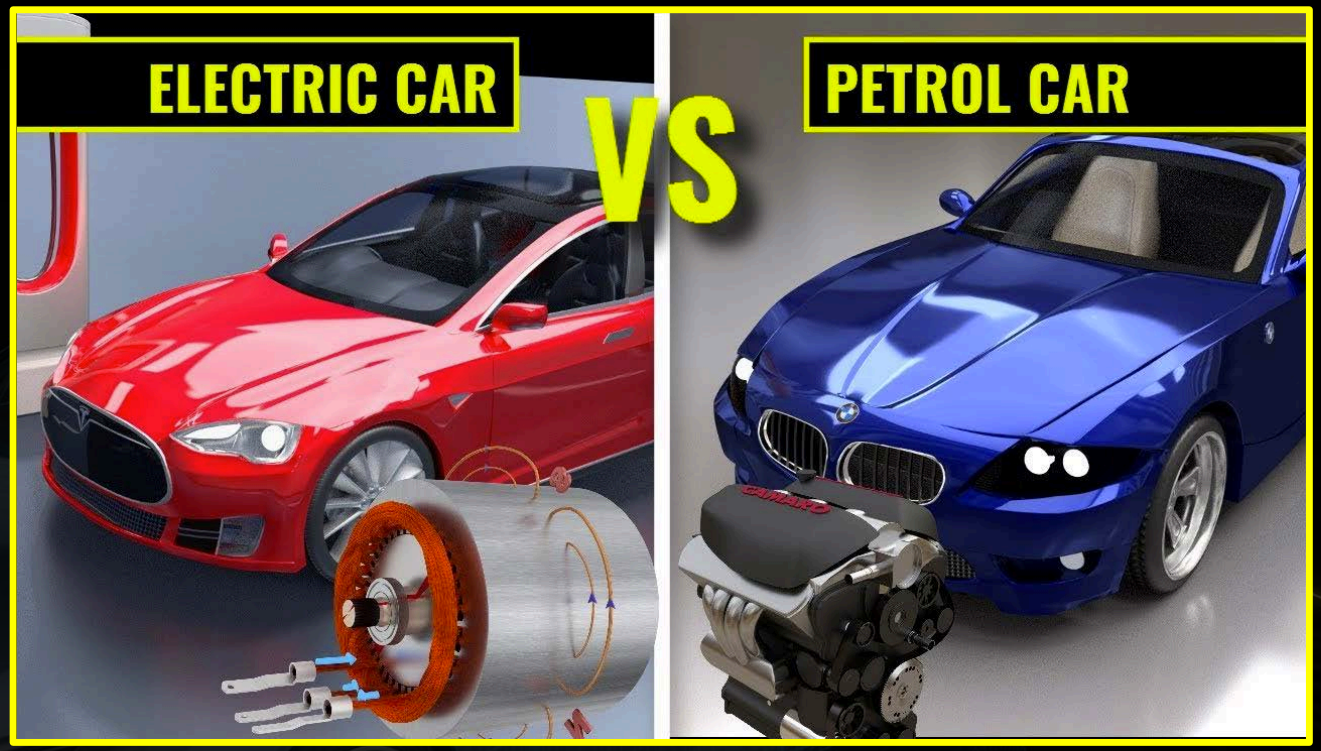
Average MPG today is **24.7 vs 100** MPGe(quivalents) for an EV

EV's to be **7%** of the **259M** cars and light trucks on U.S. roads by 2030

Annual sales of EVs will exceed **3.5M** vehicles or **+20%** of the total

Well-to-Wheel Emissions:

EV's emit half the CO2 of ICE's even when taking into account much of the grid electricity is fossil fuel generated



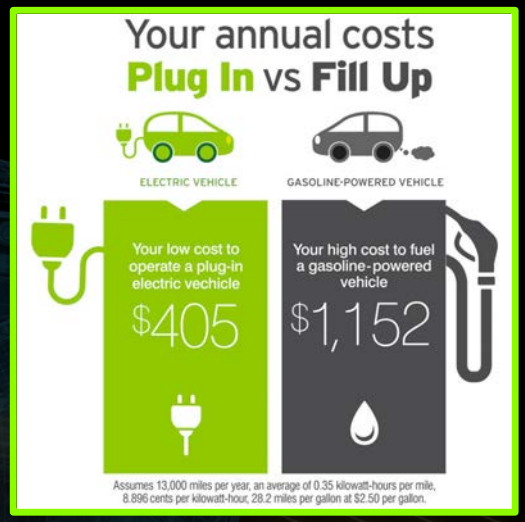
INTERNATIONAL ENERGY AGENCY

The world's fleet of electric vehicles **grew 54%** to approximately **3.1 million** in 2017

The number of **electric vehicles** on the road around the world **will** hit **125 million by 2030**

The IEA says **government policy** will continue to be the linchpin for electric vehicle adoption

THE CASE FOR ELECTRIC CARS



- Electric Vehicles cost less over the life of the vehicle
- An internal combustion engine (ICE) has a maintenance cost of 6¢ per mile versus 3¢ per mile for an EV
- ICE drivetrain has 200 moving parts vs Tesla drivetrain of 17 moving parts
- Tesla owners highest brand loyalty level - 80% will buy or lease another
- The Tesla P90D accelerates from 0 – 60 mph in 2.6 seconds
- Electric vehicles produce no tailpipe emissions... no direct greenhouse gases
- California and New Jersey offer incentives to purchase an EV
- From 2010 - 2018 the average lithium-ion battery pack price dropped 85%
- Battery range increases15% per year on average with no cost increase

EV CAR IMPACT ON THE FOSSIL FUEL INDUSTRY

Global oil and gas revenues were **$3.3T** in 2019 (3.8% of the global $86T GDP) employing **4M** people across **350K** businesses



Oil use for automobiles **peaks** mid 2020's at the latest, and related tech will decline



Global oil usage is **93M** barrels per day

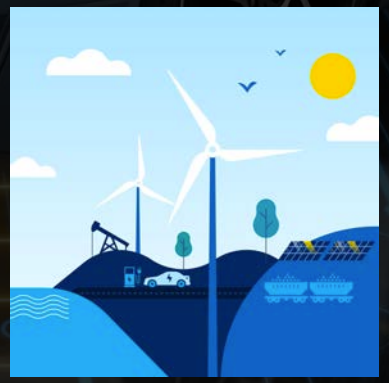
The U.S. consumes **20.5M** barrels per day and produces **17.8M** per day (Source: IEA)



Coal is responsible for **65%** of the CO^2 emitted by the electric power sector



Today, electric cars and buses are displacing 280K barrels of oil per day – equivalent to what Greece consumes in one day



3 MILLION BARRELS Displaced per day by EV cars in **2040**

RECENT ELECTRIC VEHICLE ANNOUNCEMENTS

- Ford Mustang Mach E arrives late 2020, electrifying one of the biggest brands in the automotive industry
- Ford Europe announces 2022 is their EV tipping point
- All Cadillacs will be electrified by 2030
- $5,000 EV incentive in New Jersey
- Tesla sold +360,000 vehicles globally in 2019
- Tesla Model 3 is now more popular than the entry level cars from Audi, BMW and Mercedes combined
- NYC, the largest public busing network, will run on all electric buses by 2040
- BYD in China is producing 30K EV cars per month
- Mike Bloomberg plan would make all new U.S. cars electric by 2035… "Clean Cars For All"





THE EV's OF CES 2020













JEEP PRESIDENT CHRISTIAN MEUNIER SAYS ALL ELECTRIC BY 2022





GEN 2 EV's WILL BE PURPOSE BUILT BY START-UPS WITH ALTERNATIVE BUSINESS MODELS

THE UPCOMING ELECTRIC PICKUP TRUCK WARS
LEAD BY NON-TRADITIONAL AUTOMAKERS



TESLA

CYBERTRUCK *Launches late 2021*

- Tri-motor, AWD pickup with a 500-mile range, 14K Lb towing ability, going 0-60 in 2.9 seconds with a tri-motor price of $69K and a full self-driving add-on for $7K



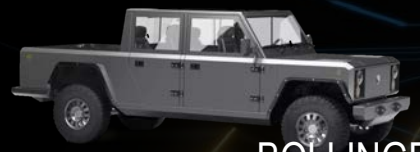
RIVIAN

RIVIAN *Launches Q4 2020*

- R1T is a quad motor, AWD pickup with 400-mile range, 11K Lb towing capacity, level 4 autonomous capability going 0-60 in 3 seconds with a base price of $69K
- $2B invested by companies like Amazon and Ford and pre-orders from individuals of 10K pickups and 100K electric delivery vans from Amazon



ATLIS



BOLLINGER

BOLLINGER MOTORS *Launches Q1 2021*

- B2 is a dual motor, AWD pickup with 250-mile range, 7.5K Lb towing ability, 640 horsepower going 0-60 in 4 seconds with only one price... $125K



TESLA

ATLIS MOTOR VEHICLES *Launches Q4 2020*

- XT1 is an AWD pickup with 300 – 500 mile range, 6K – 17K towing ability, made in Arizona with a base price of $45K... May adopt a subscription model



FORD



ELECTRIC DELIVERY COMING TO YOUR NEIGHBORHOOD

























LAST MILE TRANSPORTATION MARKET

78% growth through 2030 in urban last-mile deliveries
Adding **11** minutes to daily commutes and **+30%** CO^2



URBANIZATION

60%
people living in cities in 2030

20-35%
congestion increase since 2010



CUSTOMERS

2.1B
people shopping online this year

20%
online retail share by 2023



PRODUCTS

10%
per year WW e-grocery growth

32%
of furniture sold online in U.S. by 2023



DELIVERY

20-40%
growth in same day delivery

10%
per year growth in instant delivery



TECHNOLOGY

14-35%
xEV share of new car sales globally

2024
year in which most OEMs release L4/5

UNITED STATES POSTAL SERVICE



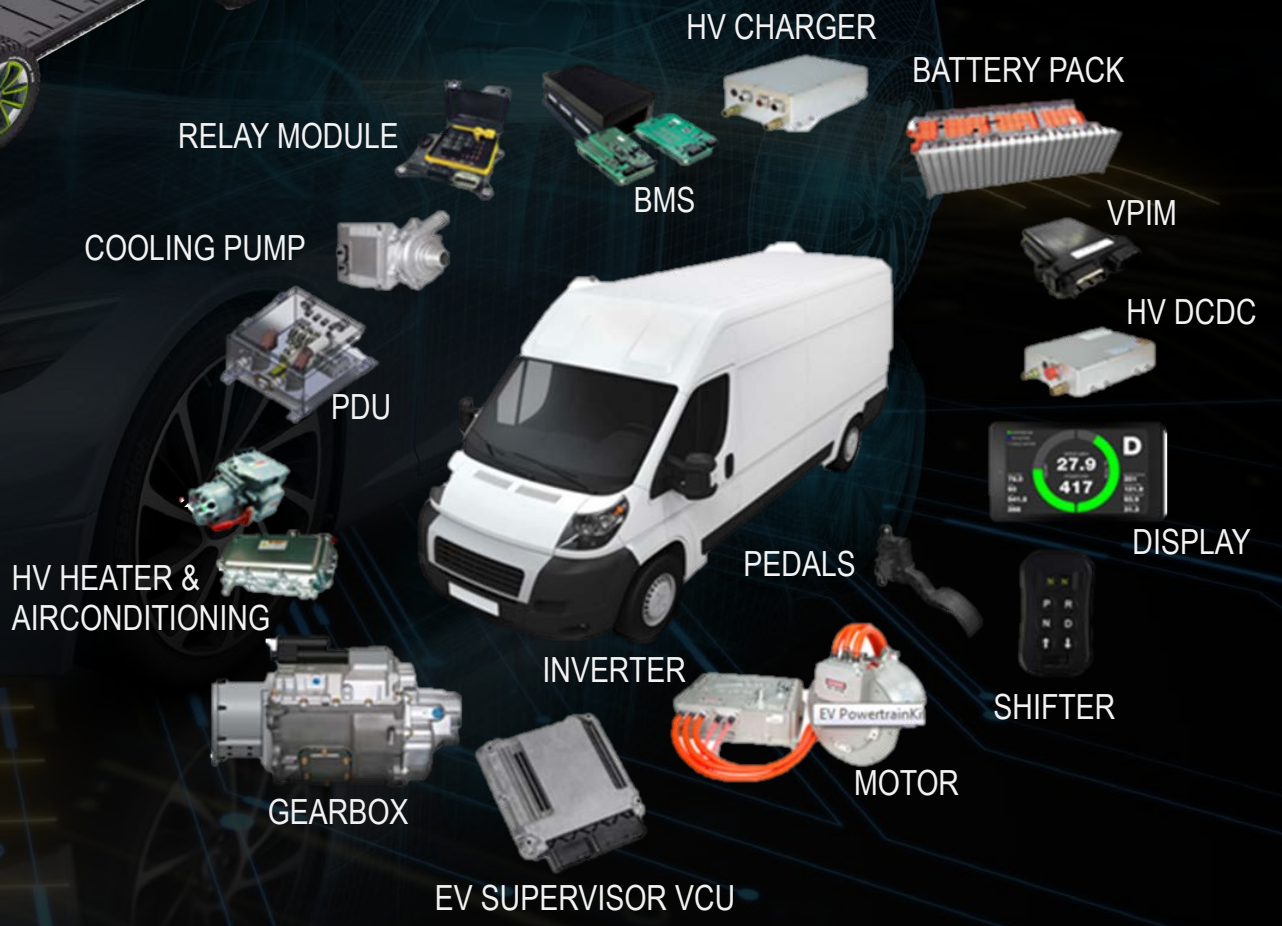
- Long history of using EV's, beginning in Buffalo in 1899
- Current fleet of 140K vehicles built by Grumman on Chevy chassis between 1987 and 1994
  - **No A/C, air bags or anti lock breaks; too small for e-commerce**
  - **Prone to catching fire – 34 did so in 2019**
- Four suppliers competing on a $6B request-for-proposal
  - **180K vans at $25K to $35K each over 5 to 7 years**
  - **Bid due mid year and all to be built in the United States**
  - **Mahindra Automotive of India – mild hybrid**
  - **Karsan (Turkish) and Morgan Olson (US) – plug-in hybrid**
  - **Oshkosh (US) and Ford (US) – ice based on Ford Transit**
  - **Workhorse (US start-up) – full battery electric**

EV SUB SYSTEM TECHNOLOGIES

- Battery Packs
- DC/DC Converters
- Electric Motors
- Inverters
- On-Board Charging
- HV Heaters
- HV Air Conditioning
- Power Distribution Units
- Battery Management Systems







ELECTRIC AUTOMOBILE IP&E COMPONENT MARKET VALUE

High-Voltage Cable Assemblies ▪ Capacitors ▪ Diodes ▪ Inductors ▪ MOSFETs ▪ Circuit Protection

Optoelectronics ▪ Resistors ▪ Connectors ▪ Sensors ▪ Supercapacitors ▪ Magnetics ▪ Relays



PASSIVES	$400
CONNECTORS	$300
E-MECH	$100
2020 GLOBAL EV UNITS	4,000,000
RELATED GLOBAL IPE TAM	$2.8B

Source: TTI TBU Estimates

Total Auto Component Consumption in 2020…

Semiconductors = $68B

Sensors = $33B

Source: Lucintel

Build It And They Will Come!?



"VW subsidiary, ElectricfyAmerica, to spend $2B installing fast EV charging stations in the U.S."

"BP buys Charge Master – 6,500 charging stations in the U.K."

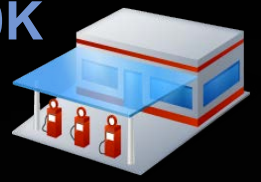
"Shell partners with Ionity to install 30,000 chargers in Shell stations across Europe"

"BMW & Porsche Reveal Prototype EV Fast Charger That Gives 62 Miles of Range in 3 Minutes"

"PG&E to install 7,500 EV charging stations at apartment and office buildings in California"

CHARGING STATIONS FOR EV AUTOMOBILES

TODAYS U.S. PUMP PICTURE

150K  x 1.2M  ÷ 270M  = **225 Cars Per Pump** at sub 5 min fill rate

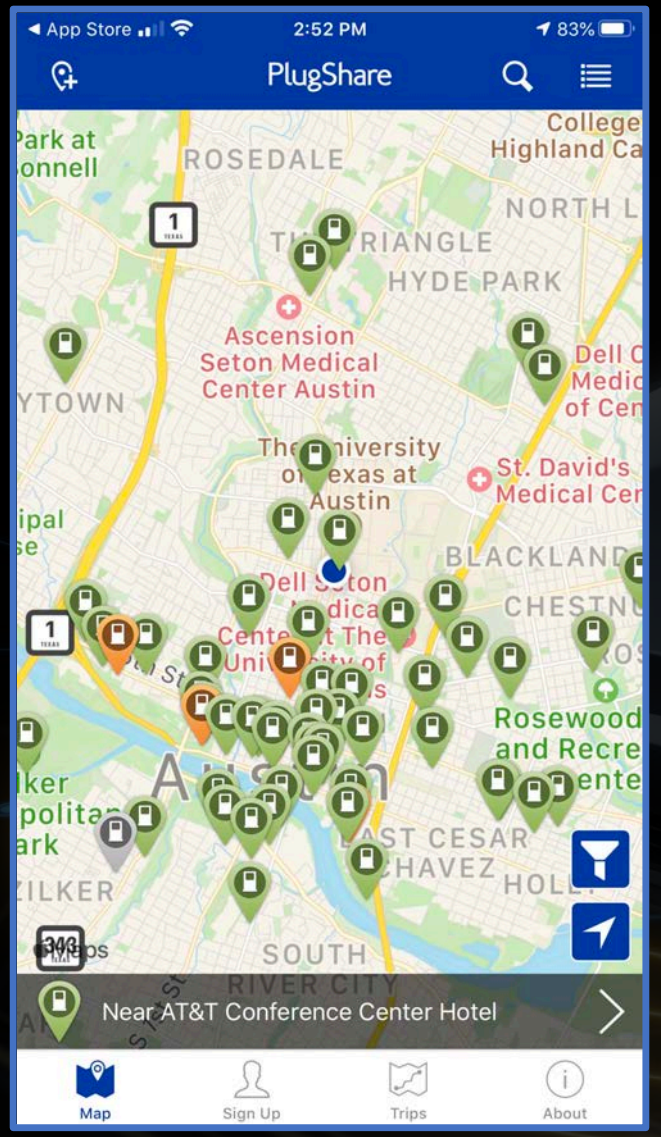


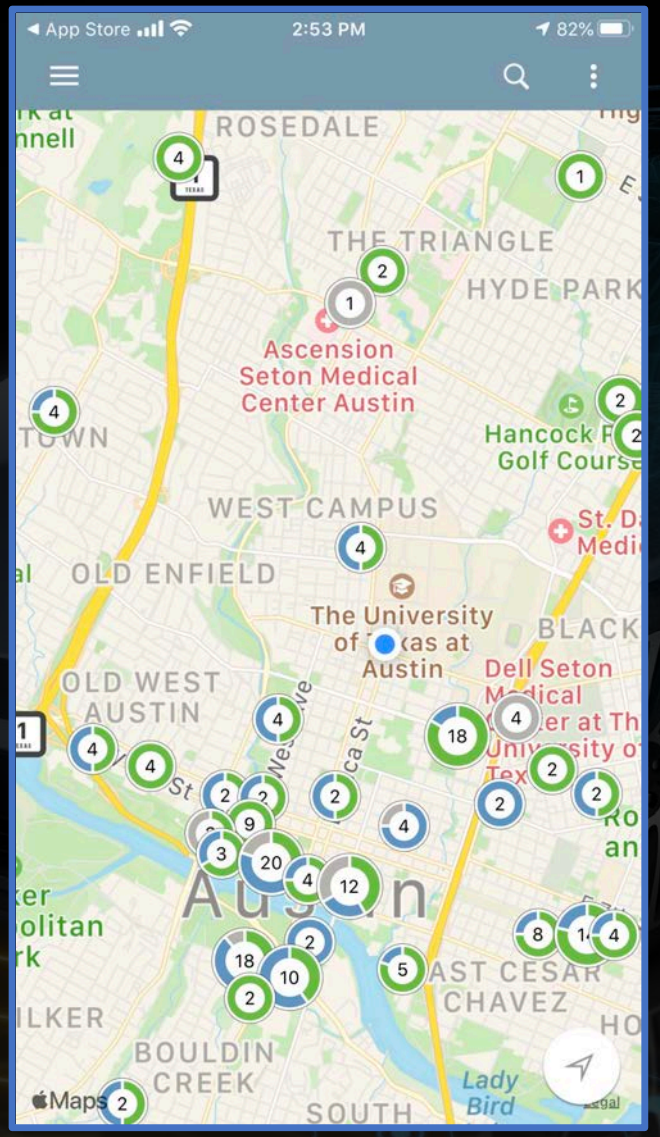
1M plug-in ev's in the U.S. in 2018 (of 156M) and 16K charging stations

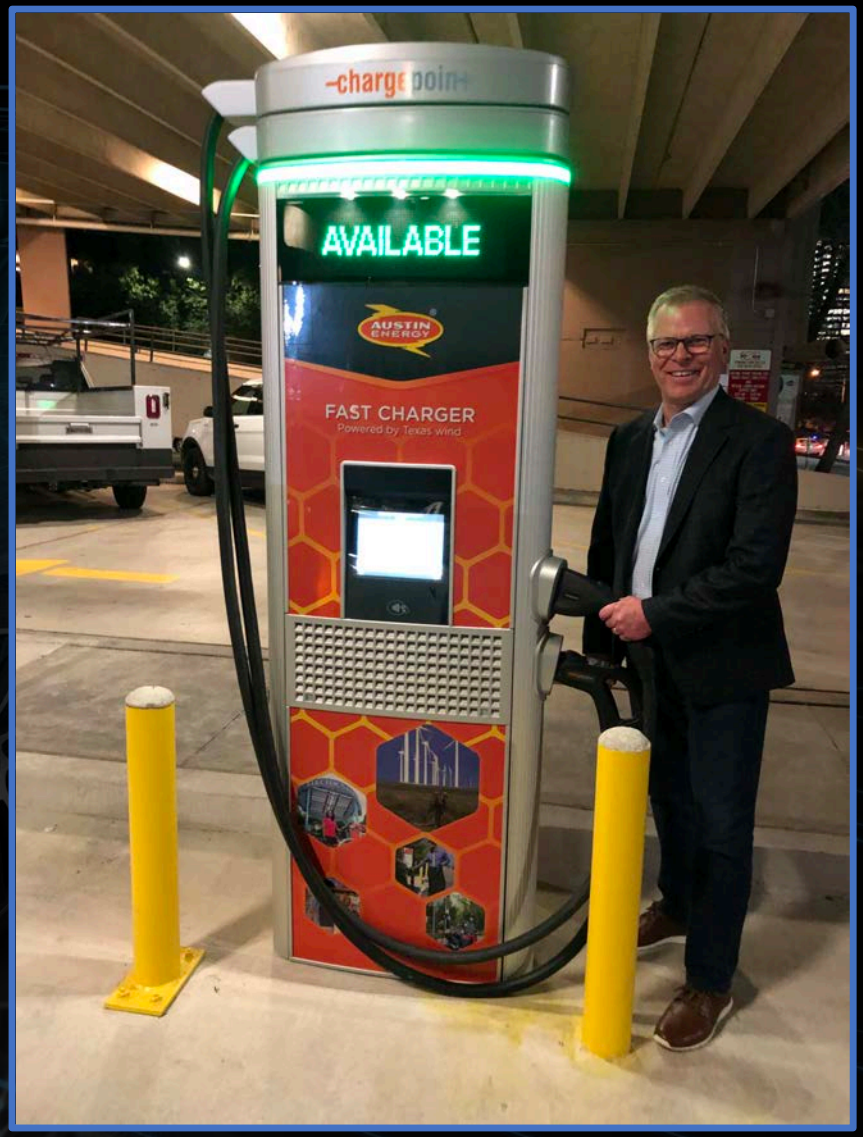
GTM Research sees **40 Million EV charging stations and a $18.64B infrastructure market size worldwide by 2030**

IEA (International Energy Agency) predicts that there could be **220M EV cars on the road worldwide by 2030**… about 10% of the total car population

GETTING CHARGED UP IN AUSTIN









Wireless Charging

- **1.7M** cars will ship in 2020 with built-in wireless charging
- Work and home will be dominant EV charging points
- Wireless EV charging market for parked cars to grow from **$8M** in 2020 to **$407M** in 2025, a **117% CAGR**

ELECTRIC VEHICLES and the POWER GRID







- The State Grid Corporation of China has energized its most powerful line using solar and wind power
- 1.1M volt direct current that sets world record for voltage, distance and power can transmit 12 gigawatts at 97% efficiency
- Equivalent of 25,000 train loads of coal





- 2 major + 2 minor grids that are 90% efficient
- 3,195 utilities: <1,000 generate power
- 12,861 kWh annual energy usage per person
- 9% of the US GDP spent on energy
- 63% of energy on the grid comes from fossil fuels

The U.S. power grid isn't ready… 60,000 EV's in Texas (0.25% of annual vehicle registrations) simultaneously doing a fast recharge (100kW in 5 minutes) would consume 72 gigawatts which is equal to today's peak consumption rate

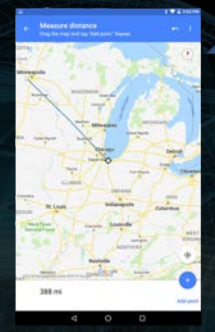
EV AUTOMOBILE TIPPING POINT



BATTERY
CAPACITY



CHARGER
AVAILABILITY



RANGE
+300 miles



BATTERY
CO$T



CHARGING
TIME



TOTAL COST
of OWNERSHIP

FOR ANY WHO DOUBT THAT EV WILL ONE DAY REPLACE ICE

Global Automakers are Investing $300B on Electric Vehicles
and are Spending Millions Advertising Them







Three Separate Advertisements for Electric Vehicles Run During the Super Bowl

TODAY'S AUTONOMOUS ELECTRIC VEHICLE LANDSCAPE

5G and Satellite Constellations are Major Enablers and Accelerators





AUTONOMOUS CAR LEADERS

Waymo, Uber, Zoox, GM, Tesla, Baidu

90% LESS ACCIDENTS

2M LESS PEOPLE GO TO EMERGENCY ROOMS

30K LIVES SAVED

$260B SAVED

the Electrification of Transportation

"Takin' it to the Streets"

THE RISE OF THE CONNECTED, SHARED, SELF DRIVING CAR

100% of New Cars Will be Connected by 2025

75% of New Cars Will be Autonomous by 2035

RETAIL DELIVERY: THE $96B LOCAL DELIVERY INDUSTRY WILL BE UPENDED

Models indicate delivery-bots could operate at 96% below today's costs



TIME: WE'LL GAIN AN EXTRA MONTH OF PRODUCTIVE TIME EACH YEAR

The average worker spends 250 hours per year commuting



REAL ESTATE: AVERAGE OF 60% URBAN LAND IS DEDICATED TO CARS

Automated car sharing could reduce total vehicles by 85%



THE RISE OF THE CONNECTED, SHARED, SELF DRIVING CAR

100% of New Cars Will be Connected by 2025

75% of New Cars Will be Autonomous by 2035

ENERGY: CONSUMPTION WILL BE DRASTICALLY REDUCED

40% of gasoline in urban area is consumed looking for parking spots



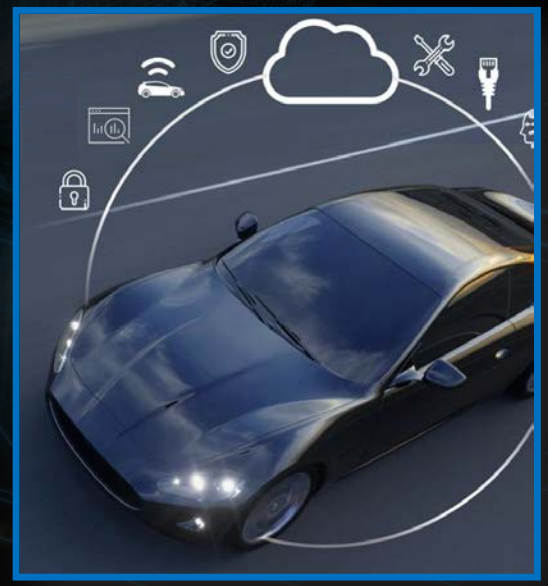
SMARTPHONES & APPS: THE MOST DOWNLOADED APPS WILL BE CAR RELATED

The percentage of vehicles that connect to mobile devices will increase from 4% to 75%



WIRELESS CONNECTIVITY: CARS WILL BE JUDGED BY THEIR SENSORS & CPUs

20% of the value of new vehicles ($600bn) will come from connectivity in 2025



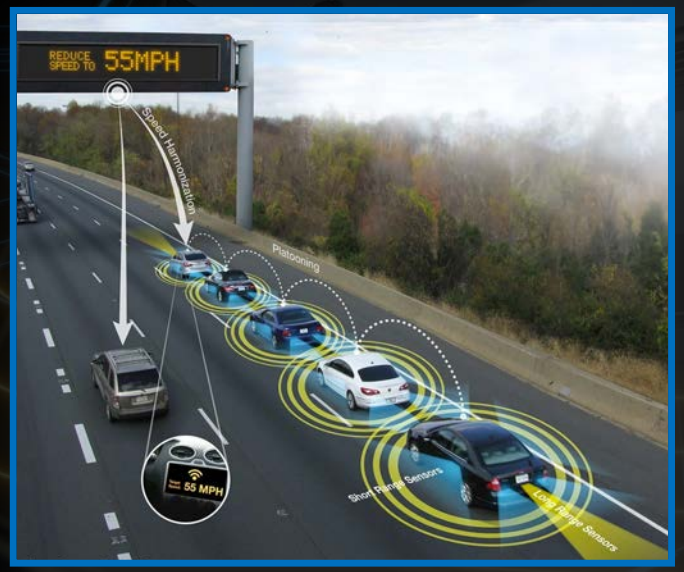
THE RISE OF THE CONNECTED, SHARED, SELF DRIVING CAR

100% of New Cars Will be Connected by 2025

75% of New Cars Will be Autonomous by 2035

INFRASTRUCTURE: MUCH OF THE $160B IN ANNUAL TRANSPORTATION SPENDING WILL BE REROUTED TO TECH

Coordinated vehicles could increase highway efficiency by up to 500%



HEALTH: DEMAND FOR ORGAN REPLACEMENTS WILL SKYROCKET

81% of traffic accidents could be mitigated using connectivity and sensors

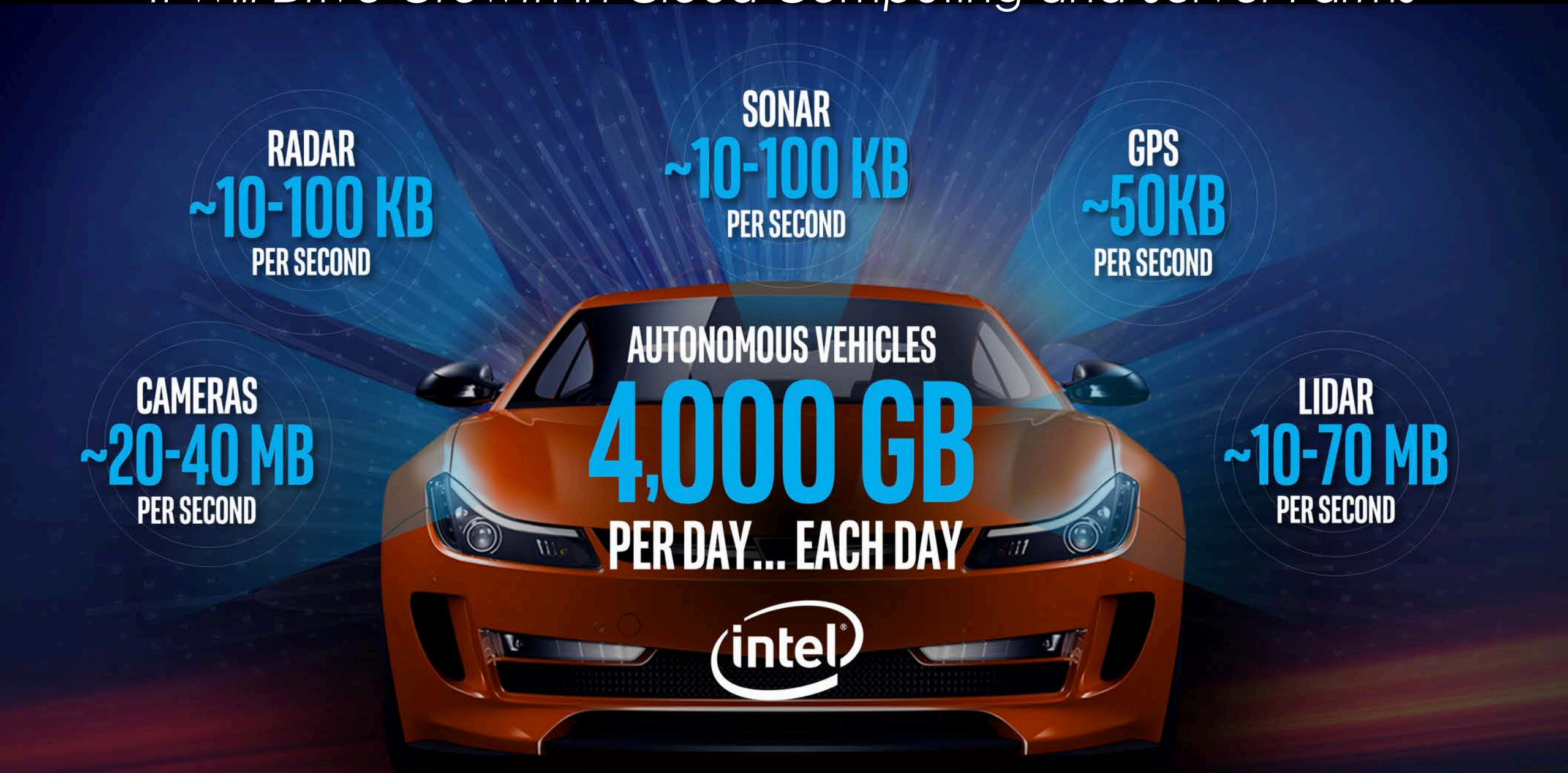


SELF DRIVING TRUCKS WILL ACCLIMATE US TO A FUTURE WHERE EVERYTHING IS SELF DRIVING

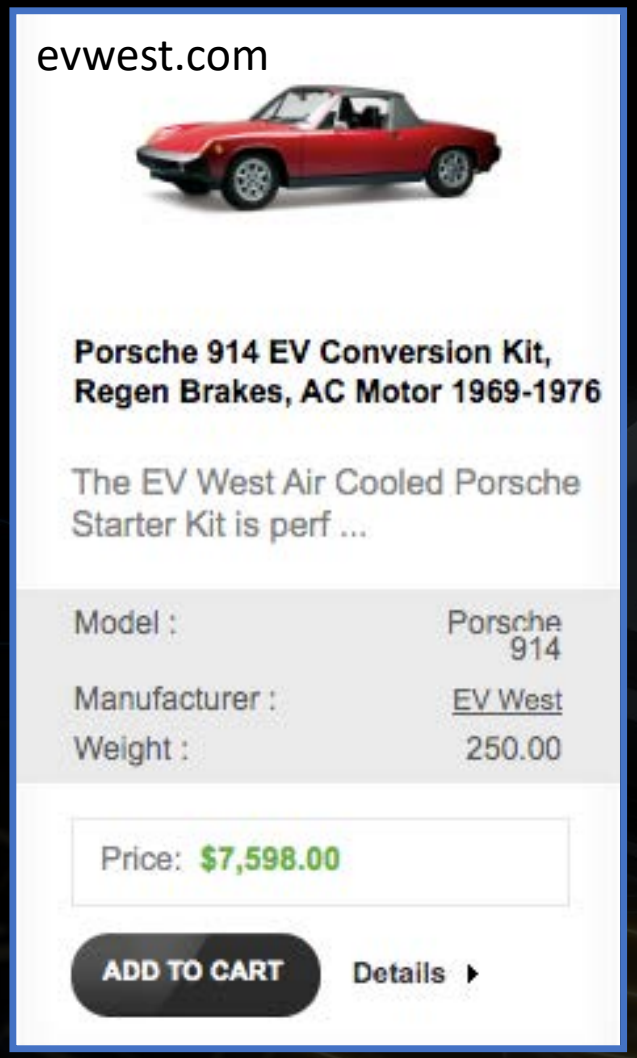


WHY AUTONOMOUS VEHICLE DATA GENERATION MATTERS

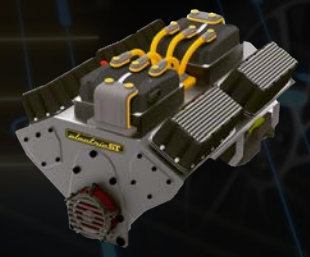
It Will Drive Growth in Cloud Computing and Server Farms



AUTOMOTIVE AFTER MARKET RAMIFICATIONS



- ICE-based U.S. automotive aftermarket valued at $296B in 2018
- Entire market, including medium and heavy duty, is $392B
- The global market is estimated at $723B in 2020
- Average age of the U.S. vehicle fleet up 10% in 10 years (IHS)
  - 14M cars are more than 25 years old, up from 8M in 2020 (IHS)
  - Number of cars between 16 and 24 years old is 44M, up from 26M
- The rise of electric vehicles will shrink this business quickly
  - Fewer moving parts, less mechanical and more electrical
  - 75% of auto repair done by independents, 25% by dealerships
- New companies enabling conversion of ICE to electric
  - XL Hybrids, Odyne Systems, EVDrive, ALTe Technologies, Altigreen Propulsion Labs, A123 Systems
- Conversion kits cost ≅ $6K in parts + $1K to $3K for batteries
- Electric crate motors matching GM big block engines ≅ $60K





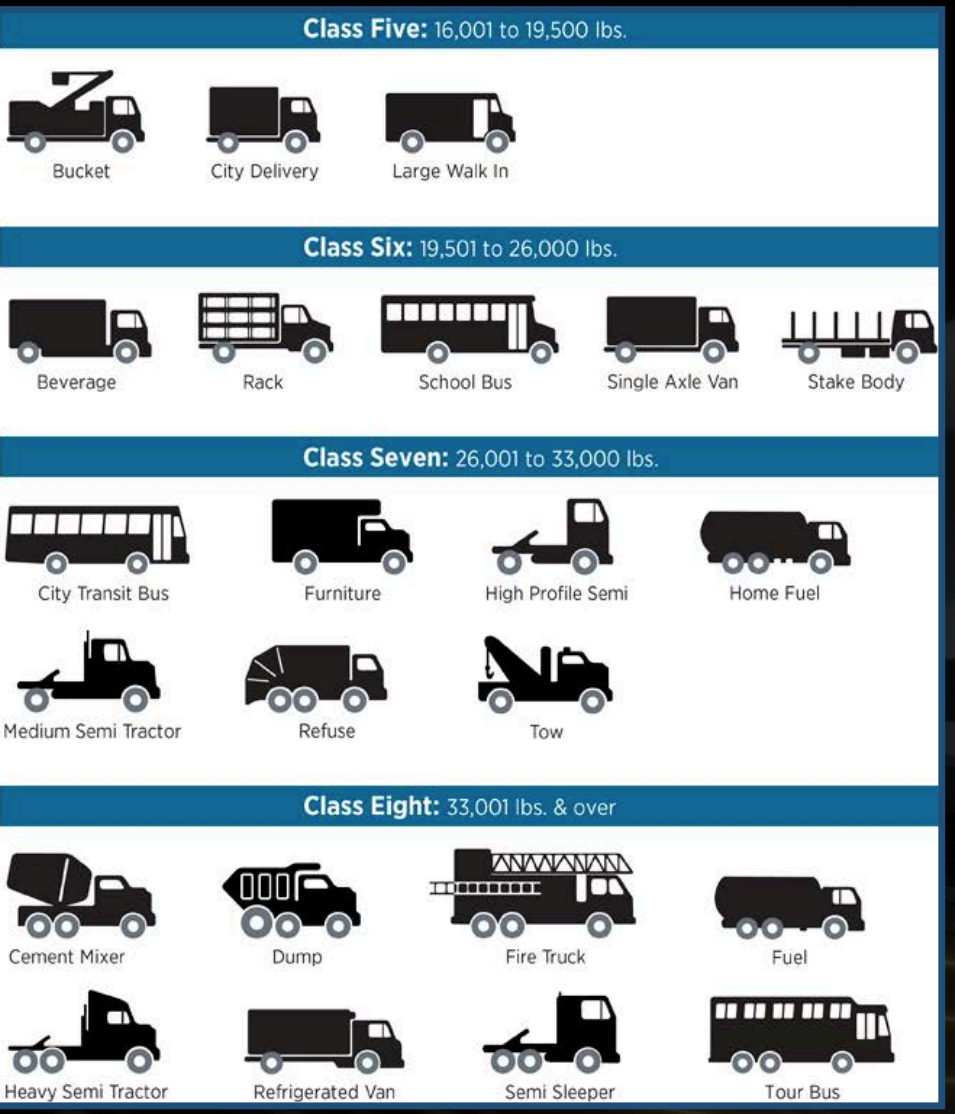
SELF DRIVING CARS APPEAR IN THE "SOUPA" BOWL FOR THE FIRST TIME



HYBRID & FULL ELECTRIC TRUCKS HIT THE HIGHWAYS



HEAVY DUTY TRUCK MARKET OVERVIEW



- Made up of Class 5, Class 6, Class 7 & Class 8
- Global sales in 2018 of $132B growing to $184B by 2025… **4.7% CAGR**
- Fuel, wages, maintenance and tires account for 62% of total fleet operations cost

Traditional Class 8 Truck Leaders

Daimler AG (Freightliner & Western Star): **38.1%**
PACCAR (Peterbilt & Kenworth): **30.4%**
Volvo (Volvo & Mack): **16.9%**
International (Navistar): **13.7%**

Source: Statista





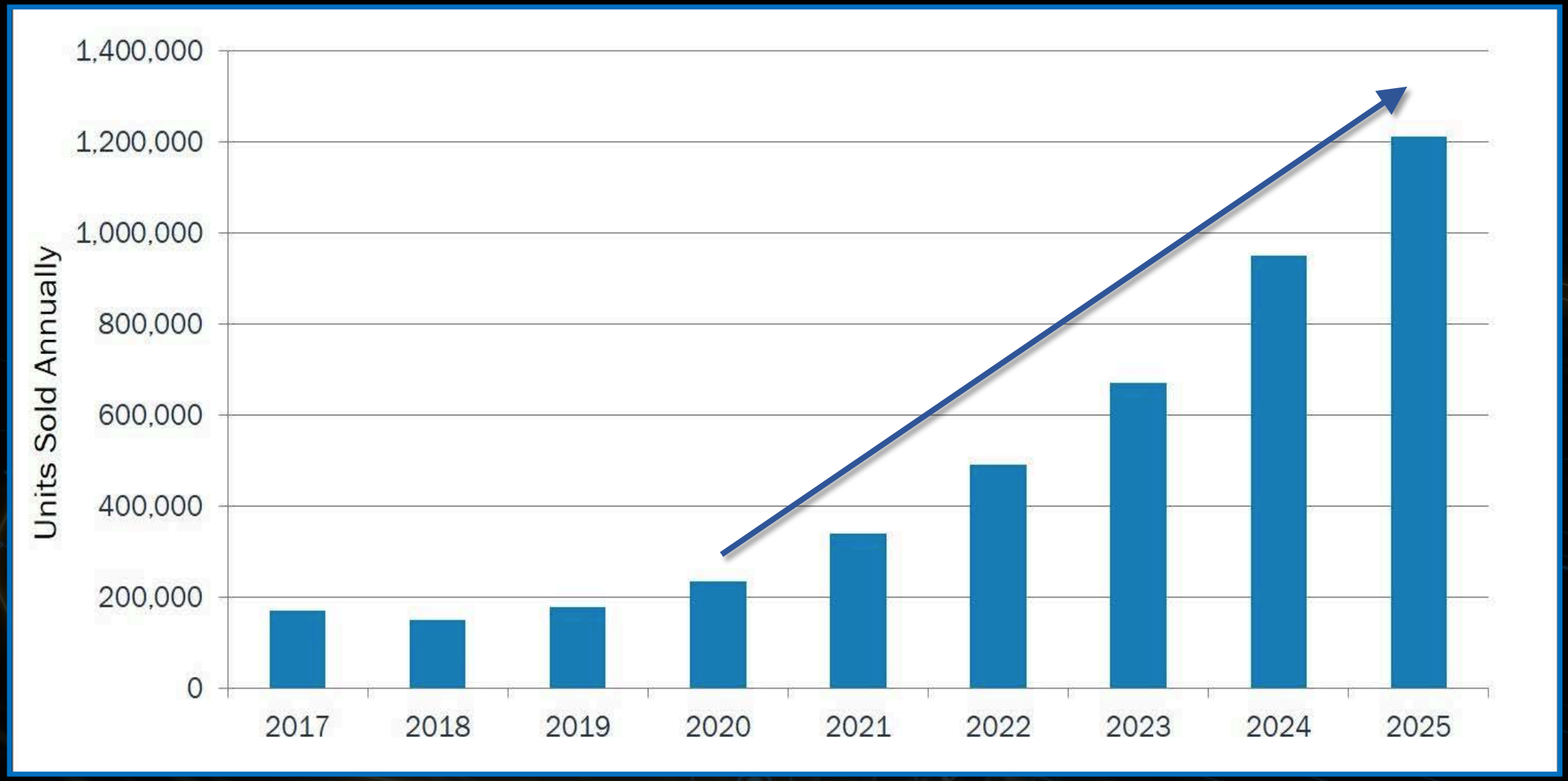


the Electrification of Transportation

"Takin' it to the Streets"

GLOBAL BATTERY ELECTRIC TRUCK MARKET FORECAST

PRODUCTION RAMP STARTS IN EARNEST THIS YEAR



Source: Interact Analysis

DAMILER ELECTRIC TRUCKS

- Has 40% share of North America's $39B heavy-duty truck market
- Launching eCascadia and the Freightliner eM2 106 in late 2021, both of which will be built in Portland, Oregon



TESLA ELECTRIC TRUCKS

- Production to begin late 2020
- 500-600 mile range model priced at $180K, a 30% premium over an equivalent Class 8 diesel day cab
- Projected two year payback period from maintenance and fuel savings
- Uses four electric motors and accelerates from 0-60 mph in 20 seconds with a full, 40 ton load



VOLVO ELECTRIC TRUCKS

- Production and sales of the VNR series will begin late 2020
- Part of Volvo's Low-Impact Green Heavy Transport Solutions (LIGHTS)
- Running a $90M pilot program, half of which is funded by California Air Resource Board
- Will offer a leasing program that includes insurance and maintenance



NIKOLA HYBRID ELECTRIC TRUCKS

- Arizona based Nikola introducing a fully electric and a hydrogen fuel cell electric Class 8 truck with 500 to 700 mile transport range and 5,000 lbs lighter than Tesla
- Production start scheduled in 2021
- Pre-orders of 14K trucks, 800 of which are from Anheuser-Busch
- Building 700 hydrogen fueling stations coast-to-coast that will use renewable energy sources to extract hydrogen from water at each station



ELECTRIC CITY BUSES







- Only 650 e-Buses on the road in the US (1/3rd in California) versus +400K in China
- An e-Bus saves a city on average +$150K in fuel, maintenance, and health care expenses annually
- 33% of public transit buses globally will be all electric by 2045
- Proterra will produce 700 buses this year to deploy in NYC, Dallas, Washington DC and the JFK and San Jose Airports
  - +$10K in IP&E content per bus

WIRELESS CHARGING IS COMMON IN EUROPE



ELECTRIC SCHOOL BUSES

THE LION ELECTRIC CO.



Over 250 all-electric school buses to date, with more than 3 million miles logged

MARKET DRIVER

95% of school buses in U.S. run on diesel… ***there is no safe level of exposure to diesel exhaust for children***

- 26 million kids ride 485,000 diesel school buses in the United States every day
- eBuses today cost on average $120K more than a diesel equivalent but have a lifetime fuel and maintenance savings of $170K to $240K
- Most school bus companies have an eBus in the works... lead by Lion Electric, Blue Bird, Navistar and an alliance between Thomas Built and Daimler
- Goal is for all school buses to be electric by 2030

HEAVY DUTY AG, MINING and CONSTRUCTION



- Global “off-highway” vehicle market estimated at $380B
- The EV portion was $4.1B in 2019 forecasted to grow to $29.8B by 2027
- Global agriculture vehicle market $139B in 2018 growing 6-9% per year
- Global construction equipment forecast of $289B by 2020 – 9.2% CAGR
- U.S. construction equipment $56B in 2016 forecasted to be $89B in 2020
- Dump truck market alone $6.3B in 2018 to $10.8B by 2026
- Global mining vehicles $107B in 2017 forecasted to grow to $188B by 2025

Sources: Grand View Research, Markets & Markets, Allied Market Research, Statista

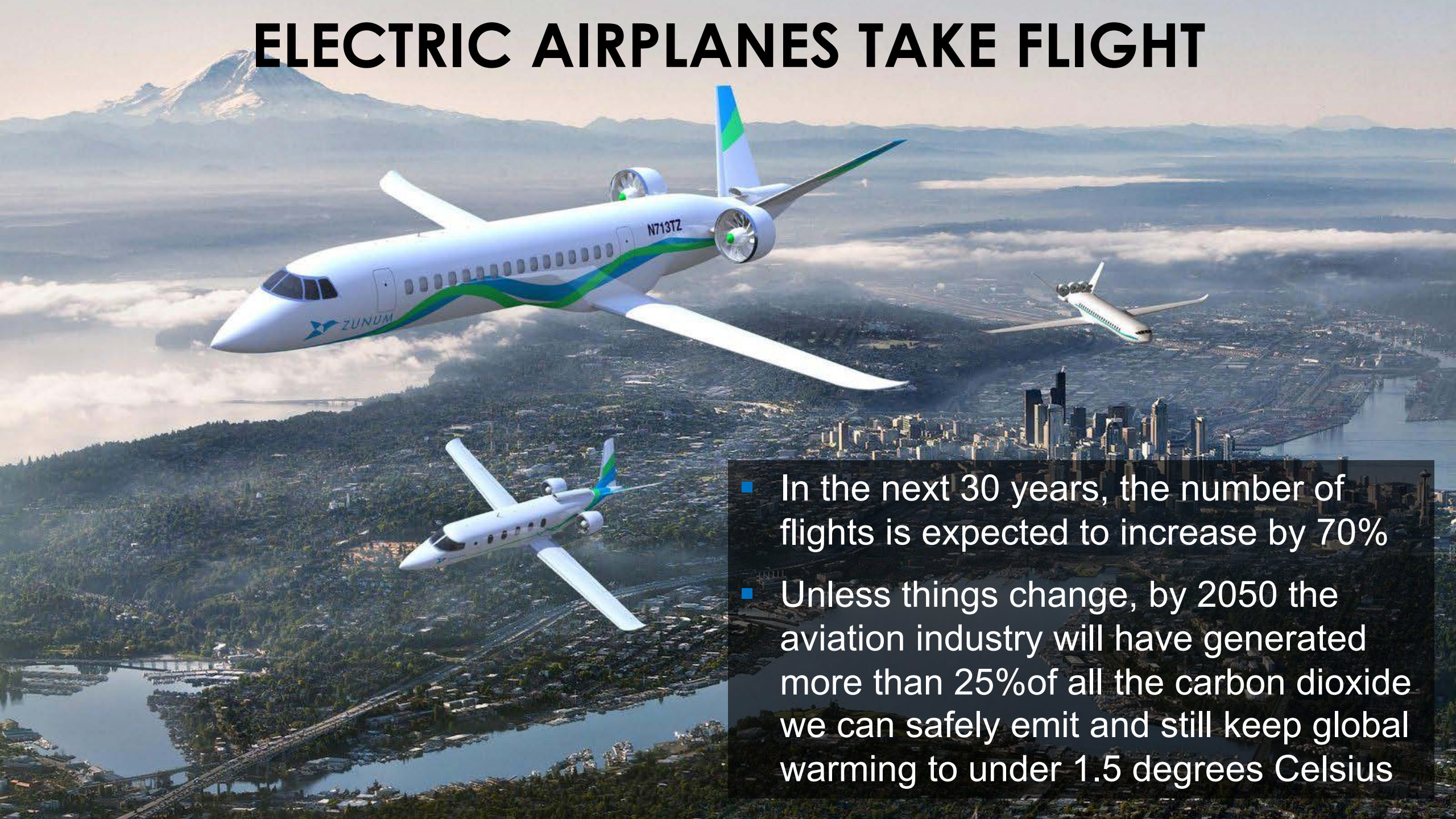
THE QUIET RISE OF THE ELECTRIC MOTORCYLE



- First electric motorcycle patent in 1895
- Global motorcycle sales:
  - 62M built in 2018 with sales +$100B
  - Sales forecast for 2023 is $135B
- U.S. sales were $8B in 2016 and forecasted to be $11B by 2025
- Global electric motorcycle sales were $5B in 2019 and forecasted to grow to $7B by 2024... a 5 year CAGR of 4.6%
- There are 46 motorcycle manufacturers in the U.S. and 17 of them are making electric motorcycle... majority are start-ups

Sources: Market Watch, Mordor Research, Statista

ELECTRIC AIRPLANES TAKE FLIGHT



- In the next 30 years, the number of flights is expected to increase by 70%
- Unless things change, by 2050 the aviation industry will have generated more than 25%of all the carbon dioxide we can safely emit and still keep global warming to under 1.5 degrees Celsius

THE FLYING ELECTRIC PASSENGER VEHICLE IS COMING

Over 100 Companies Investing Over $1 Billion



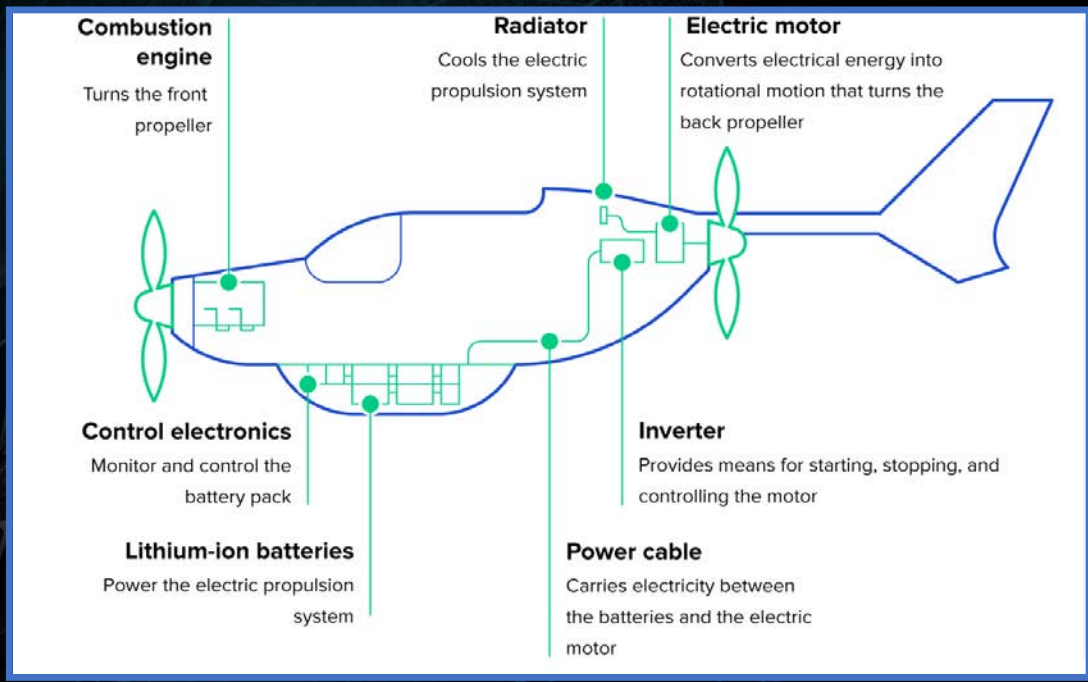
Uber trials in Dallas and LA begin this year and Toyota will debut their flying taxi at the Tokyo Olympics

THE ALL ELECTRIC PASSENGER PLANE

Hundreds of millions of dollars being poured into hundreds of electric aircraft projects by big name companies and start-ups

Six Leading Innovators That You Have Never Heard Of

MagniX (Seattle, WA): drop-in electric motor replacement for small private passenger planes like Cessnas



Range	Fuel Consumption	Maintenance Cost
200 miles	<55% unmodified	50% less

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Pipistrel (Slovania): first FAA-certified electric plane in the U.S. It can remain airborne for one hour at a cost of $5 and it take 45 minutes to achieve a full charge on its 220-pound 21-kWh battery

Ampaire (Los Angeles, CA): hybrid electric – 50 planes ordered for a backlog value of $70M

Bye Aerospace (Denver, CO): pilot training elecric planes

Zunum Aero (Bothell, WA): First plane will be a hybrid 12 seater for the regional jet market



EVIATION (Israel)

"Huge battery with some plane painted on it"

On a single charge, can fly 650 miles at 10,000 feet with a cruising speed of 276 miles mph

The estimated per-hour operating cost is $165, or roughly 7 cents per available seat mile

Weighs 14K lbs, 8.2K lbs of which is the battery (900 kWh lithium-ion) which charges in 3 hours

BATTERIES ARE CLIPPING THE WINGS OF ELECTRIC PLANES

- Could be decades away from reality... many experts say battery technology is still at least three decades away from the needed improvements, barring a big chemistry breakthrough
- Batteries are roughly 40x heavier than liquid fuel for the same amount of energy output
- Cars can manage the weight on the ground, but an airplane must fight gravity to take off and stay in the sky
- Once in the air, a plane gets lighter as it burns fuel, but as batteries drain of power they remain just as heavy as they were on takeoff, and they also take up to 20% more space than jet fuel, cutting into valuable cargo and passenger areas
- Approximately 45% of global flights are under 500 miles, which is a practical range for today's electric technologies



Orville Wright kept the first ever powered aircraft aloft for 120 feet of travel

What was most important happened after, as inventors and pilots around the world improved on the Wright Brothers' attempt

Lindbergh's trans-Atlantic flight from New York to Paris happened less than 25 years later

A RISING ELECTRIC TIDE FLOATS ALL BOATS



- Global market $5.2B in 2019 to $15.6B on 2030
- Ramp driven by International Maritime Organization's ruling on reducing sulfur emissions
- Today, mainly runabouts, yachts and ferries... by 2025, tankers, cargo ships and fishing boats

ElectraCraft ELECTRIC POWER BOATS · Nidec · GREENLINE YACHTS · Ruban bleu

BY SHOW OF HANDS…

Who has changed their mind about the viability of EV?

Who is now seriously thinking that their next buy will be EV?

Who wants to be the first passenger in an electric VTOL?

Who wants to sell into a fast-growing multi $B market?

Who thinks Cameron English has changed his mind about hydrogen versus full electric?

Who wants to ride in an elevator with Walt?


WELCOME BACK TO THE EoT FUTURE