U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

USA Hybrid and Electric Vehicles – Market and R&D Activity

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September 17, 2019

TRANSPORTATION IS FUNDAMENTAL TO OUR WAY OF LIFE

50% of the weight and 37% of the value of goods are moved less than 100 miles between origin and destination

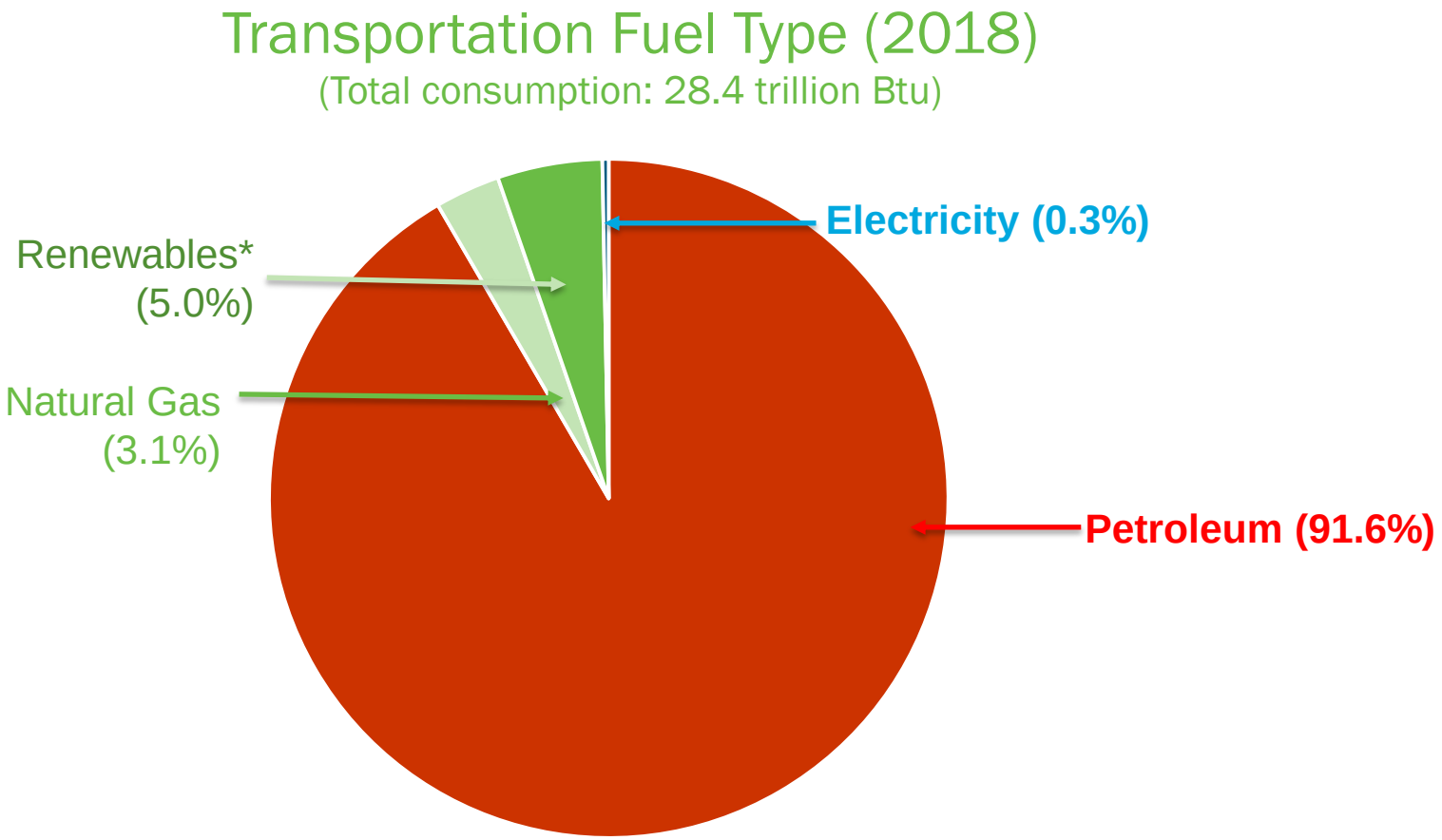
In 2018, USPS shipped 6.2 Billion packages – up from 4 Billion in 2014

Technologies and fuel choices are expanding

Transportation costs are high—second only to housing expenses

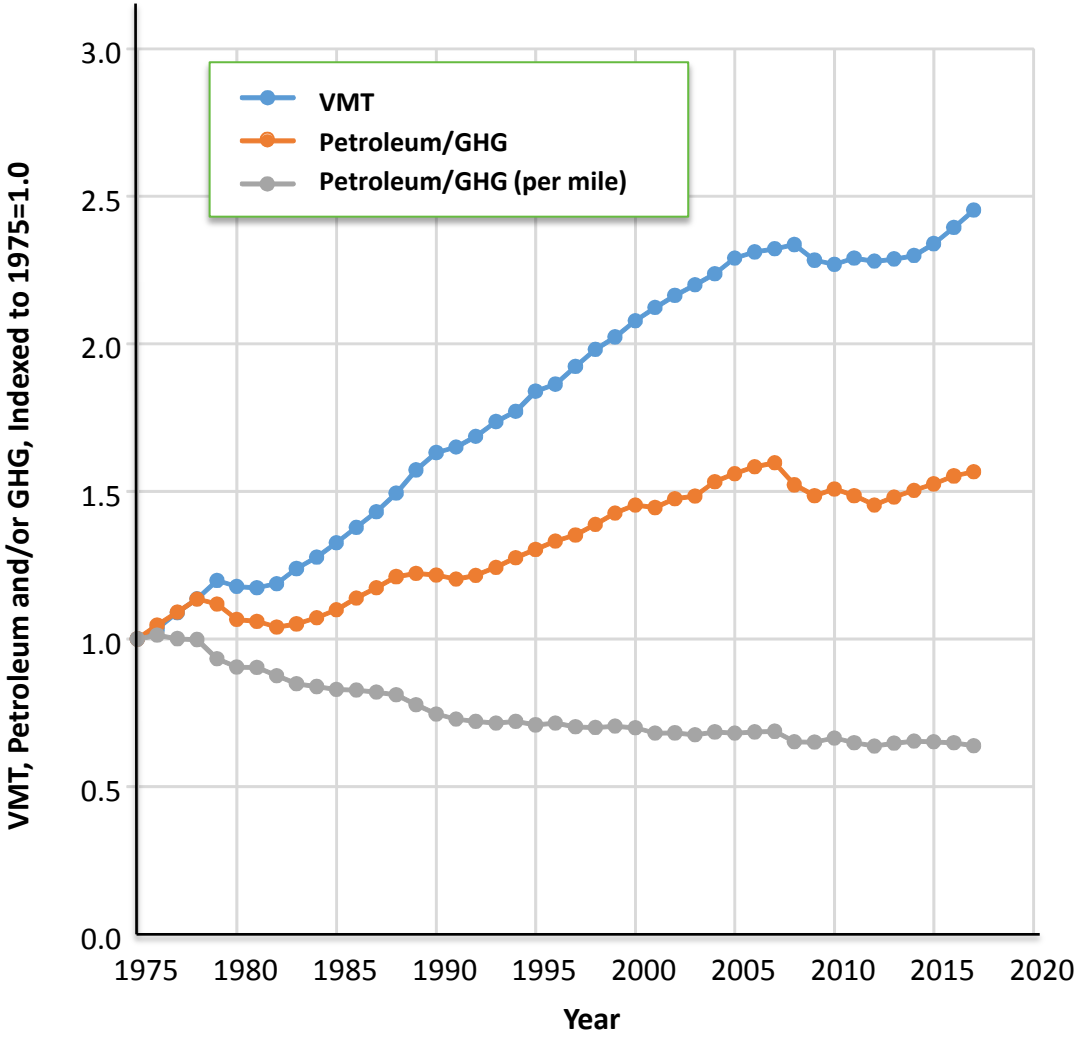
Transportation Energy Consumption (2018)

Petroleum Dominates Transportation Fuel Use



Source: Transportation Energy Data Book, edition 37 (January 2019), Table 2.03
**"Renewables" include hydro-electric, geothermal, wind, solar, and bio-mass energy.*

VMT, Petroleum, and Emissions (1975–2017)



Vehicle Miles Traveled (VMT) has increased about 150% over the past 40 years, but Petroleum Use and GHG Emissions have decreased about 40%

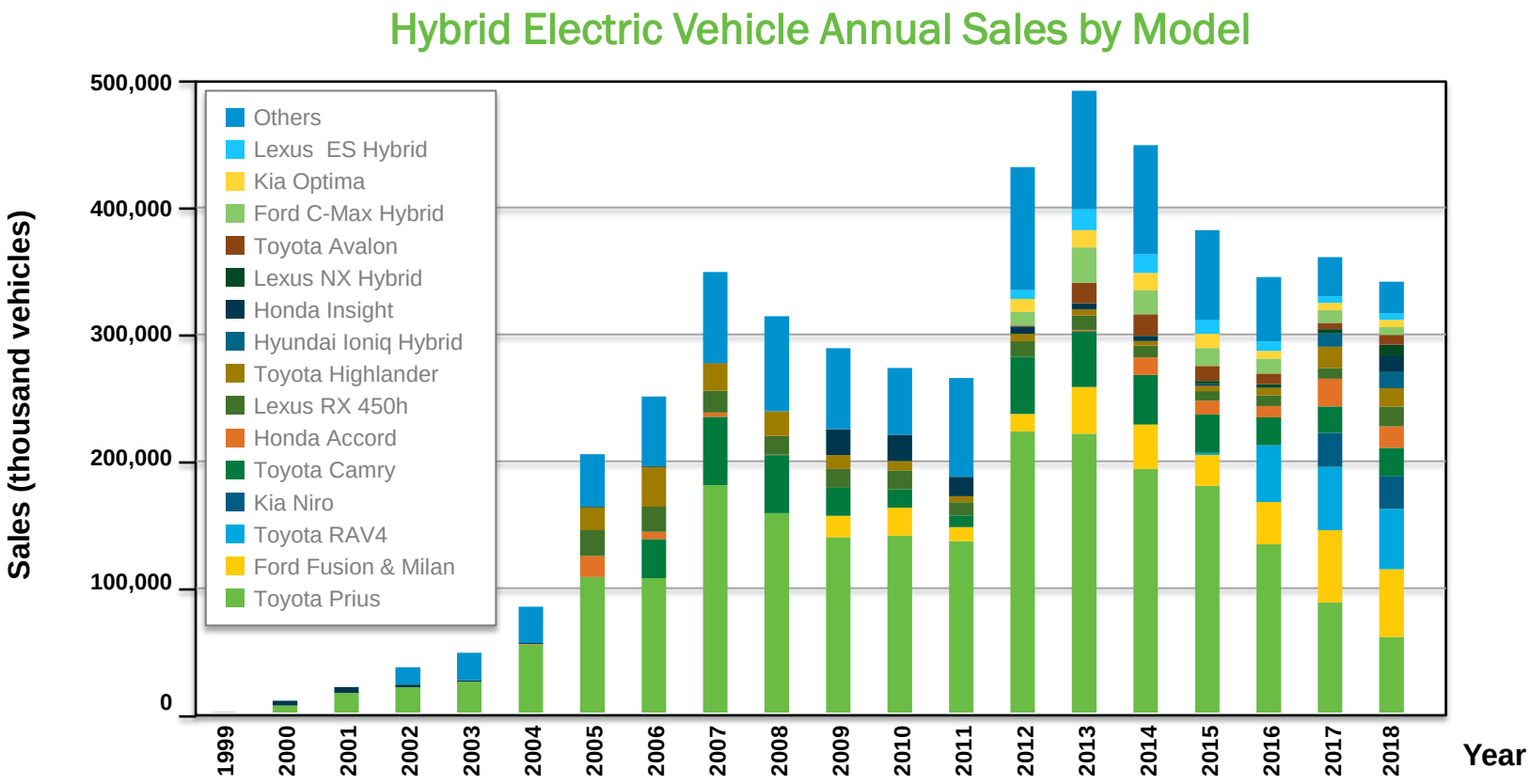
Advanced Vehicle Technology and Regulations have played a major role in this trend.

THE CHALLENGE

- 240 million LDV on the road in the U.S.
- 16M LDVs annual sales
- 10-15 years for annual sales penetration
- 10-15 years to turn over fleet

Sources:
Petroleum and GHG from EIA Monthly Review http://www.eia.gov/totalenergy/data/monthly
VMT from AFDC http://www.afdc.energy.gov/data/10315

HEV Sales (1999–2018)



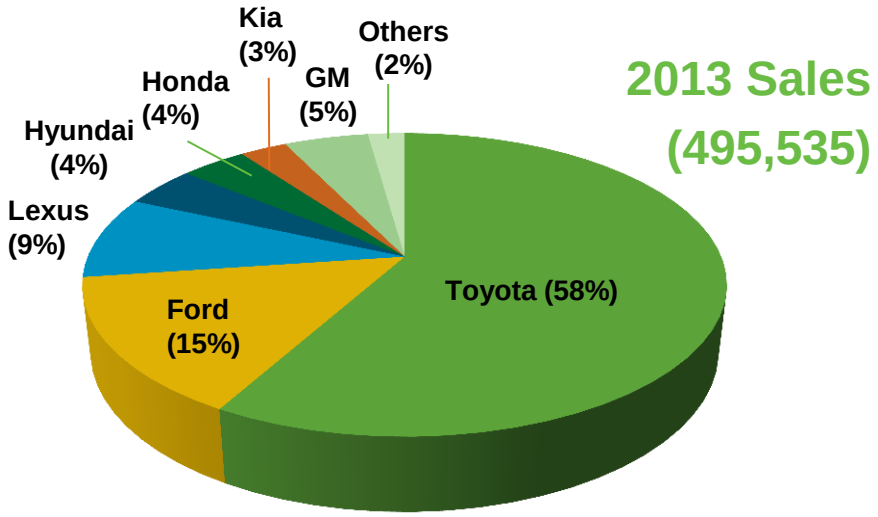
- 60 models available
- 343,219 sold in 2018
- 5% decrease over 2017

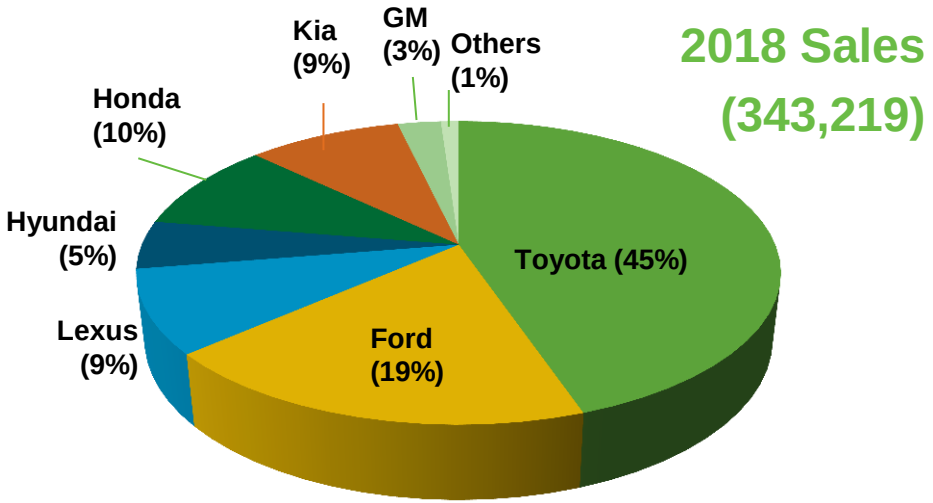
Source: Argonne National Laboratory Data

HEV Market Share (2013 vs. 2018)

HEV Market Share (by Automaker)

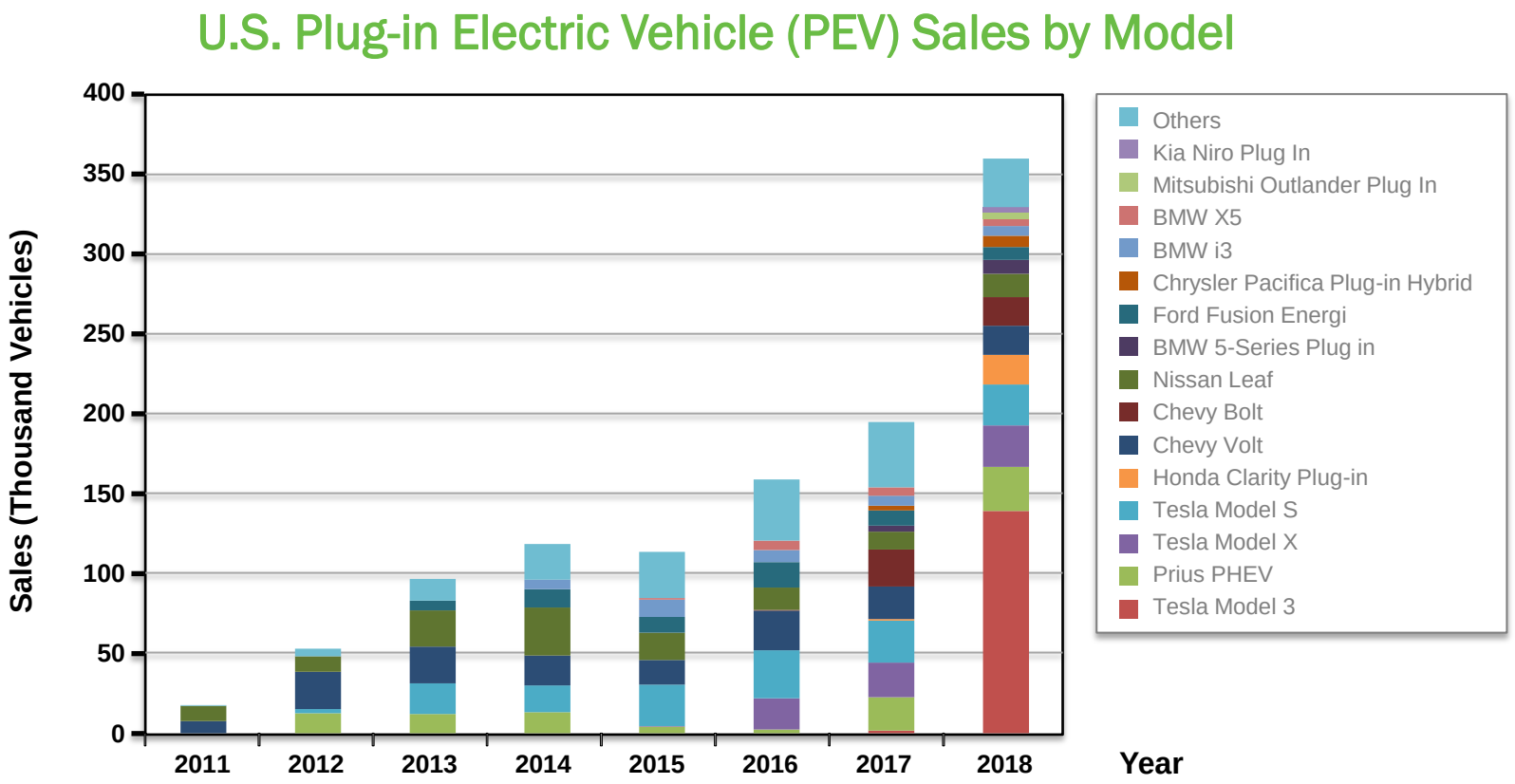
- Over 2013–2018, HEV sales shrank from 495,535 to 343,219 (31% loss).
- Toyota still held the top market share in 2018 (45%), but it was smaller than in 2013 (58%).
- In 2018, Toyota, Ford and Lexus accounted for about 73% of the HEV market (down from 82% in 2013).





Source: Argonne National Laboratory Data

PEV Sales (2011–2018)



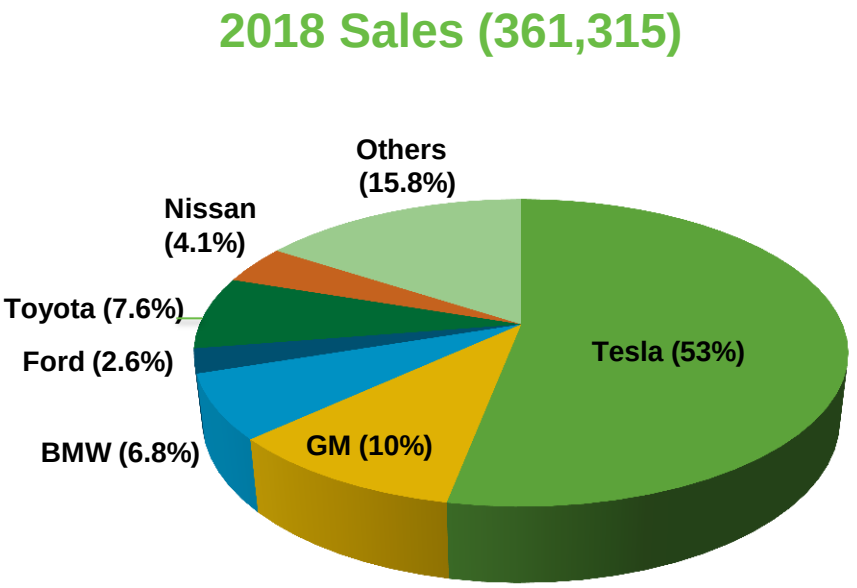
- 52 models available
- 361,315 sold in 2018
- 85% increase over the 2017 sales (195,581).

Source: Argonne National Laboratory Data

PEV Market Share (2018)

PEV Market Share (by Automaker)

- In 2018, 52 PEV models were available for sale in the U.S.
- Tesla held the top market share (53%)
- The 2018 PEV sales leaders represented 70% of sales
  - Tesla Model 3 (139,782)
  - Prius PHEV (27,595)
  - Tesla Model X (26,100)
  - Tesla Model S (25,745)
  - Honda Clarity Plug-in (18,602)
  - Chevrolet Volt (18,306)
  - Chevrolet Bolt (18,019)
- Sales were 85% more in 2018 than in 2017.



Source: Argonne National Laboratory Data

Industry

- **Tesla became the top seller of luxury cars in the U.S.**
  - From January to November 2018, Tesla Model 3 sold about 114,160 units.
- **GM plans to double its allocated resources for EVs and autonomous vehicles in 2019-20.**
- **Ford plans to spend $11 billion on 40 PEVs over 2018 -2022.**
- **Mazda vehicles mix, by 2030, will be HEVs 95%, PEVs 5%.**
- **Daimler will develop >10 PEVs by 2022, with associated charging infrastructure ("ecosystem").**
- **Volvo will have five new full EVs in its lineup by 2021.**
- **Electric scooters debuted in cities across the U.S. (Bird, Lime).**
  - Smartphone apps for rental.
- **MD/HD vehicle manufacturers are entering the EV market.**
  - Daimler deployed its first all-electric truck.
  - Volvo Trucks plans to begin demonstrations of all-electric VNR heavy-duty trucks.

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Electric trucks coming from Daimler, Freightliner, Volvo, and others

Eric C. Evarts 18 Comments Jun 7, 2018

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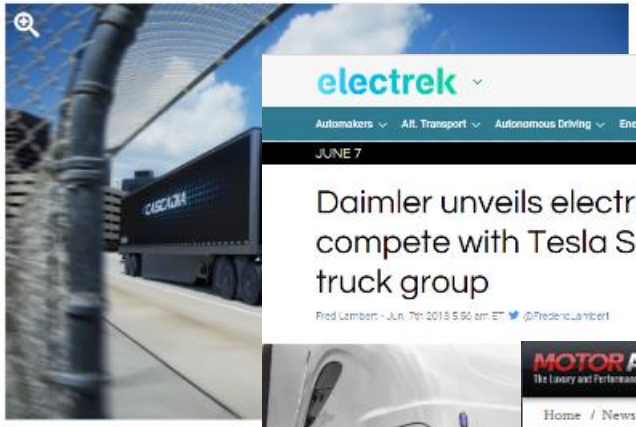
Green Car Reports



Freightliner eCascadia electric semi-truck

It's not even on the road yet and the Tesla

WIRED SUBSCRIBE

ALEX DAVIES TRANSPORTATION 11.16.17 11:28 PM

MEET THE TESLA SEMITRUCK, ELON MUSK'S MOST ELECTRIFYING GAMBLE YET

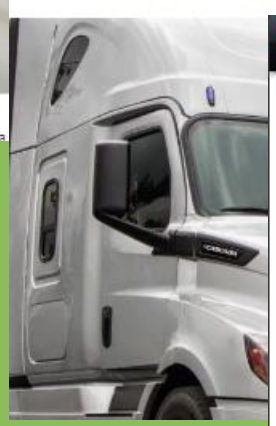
electrek

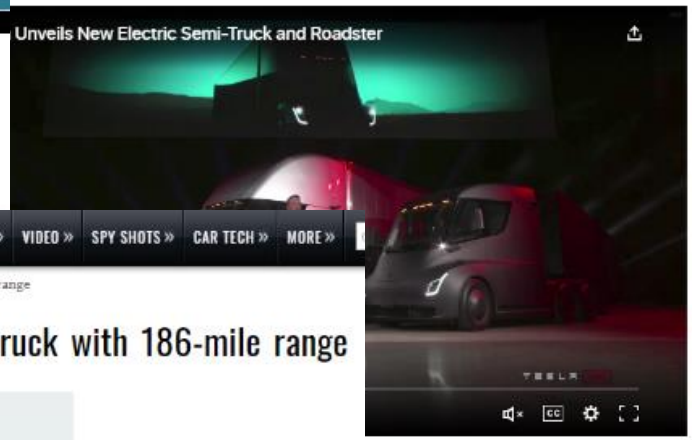
Automakers | Alt. Transport | Autonomous Driving | Energy

JUNE 7

Daimler unveils electric eCascadia semi truck to compete with Tesla Semi, launches electric truck group

Fred Lambert - Jun. 7th 2018 5:50 am ET @FredericLambert





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Volvo introduces electric delivery/garbage truck with 186-mile range

Sean Szymkowski 0 Comments May 25, 2018

Volvo Truck FL electric commercial truck

Volvo Trucks has introduced its first battery-electric truck meant for commercial duty; the FL. The company said the FL will bring the benefits of battery-electric

big, and tonight he showed off his
ric Tesla Semi. Powered by a massive
,000 pounds, it can ramble 500 miles
tself—on the highway, at least.[1]

ill start in 2019.

Policy Activities

FEDERAL (U.S. Department of Energy)

- **$19 million to 12 cost-shared projects focused on batteries and electrification technologies to enable extreme fast charging.**
- **$80 million for early-stage research of advanced vehicle technologies.**
- **New initiatives**
  - Next-Generation “Low Cobalt/No Cobalt” Cathodes ($24 million over 3 years)
  - Battery Recycling Prize ($5.5 million)
  - Lithium-ion Battery Recycling R&D Center ($15 million over 3 years)

STATE

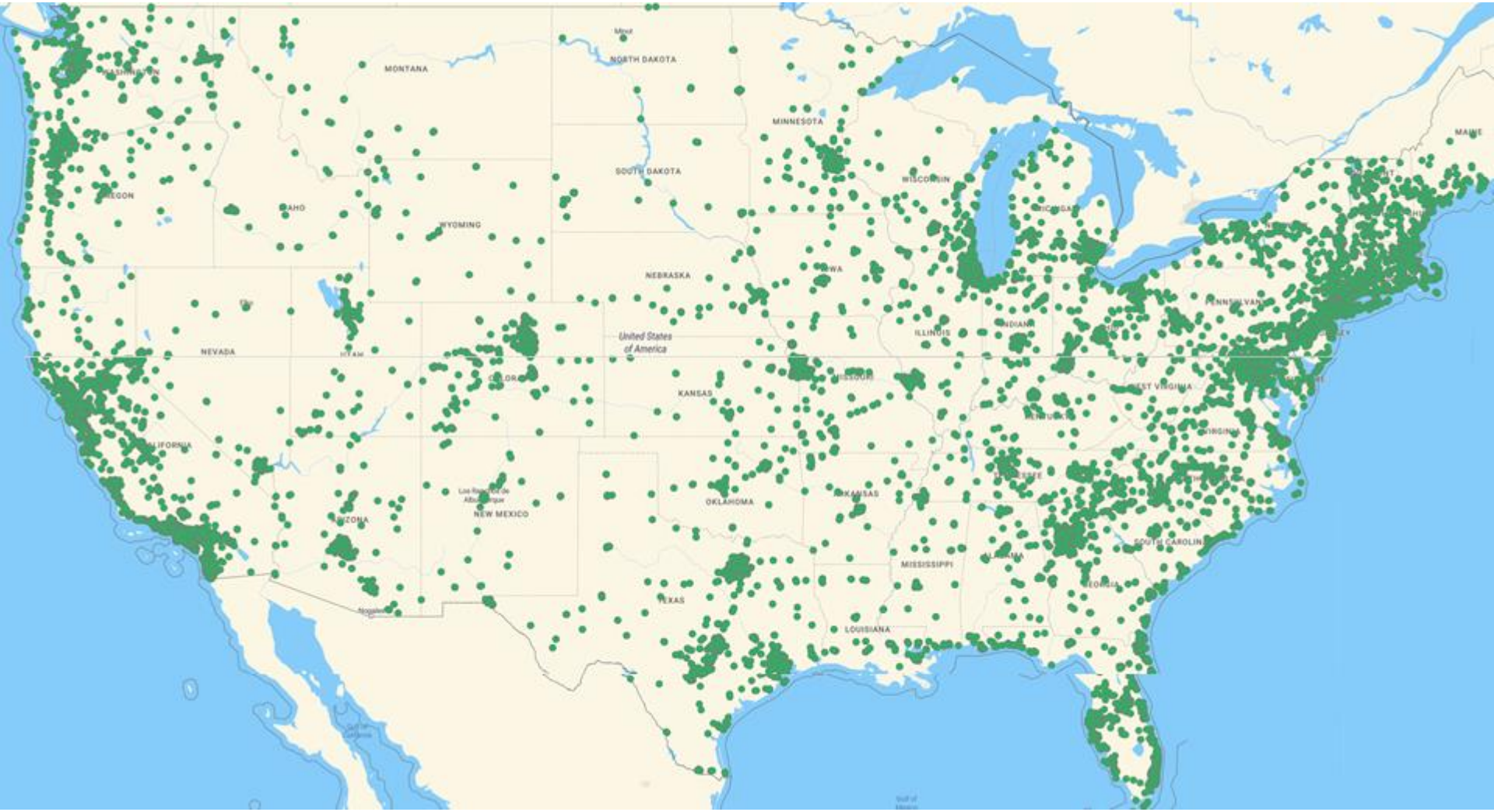
- **California Executive Order B-48-18**
  - all state entities to work with the private sector and government to put at least 5 million zero-emission vehicles (ZEVs) on California roads by 2030.
- ***Electrify America:* $200-million investment in zero emission vehicle (ZEV) infrastructure as well as education and awareness in California**
- **Maryland Bill SB 1234**
  - requires a percentage of its light-duty vehicles fleet purchases are to be ZEVs.
- ***EVolve NY*: New York Power Authority**
  - Committed up to $250 million (through 2025) for various EV initiatives.

Charging Stations available

Number of Charging Stations			
Chargers	2017	2018	Change
AC Level 1 Chargers	1,300 (2,604)	1,031 (2,029)	-21% (-22%)
AC Level 2 Chargers	15,639 (38,264)	19,008 (48,818)	+22% (+28%)
Fast Chargers	2,232 (6,267)	2,620 (9,626)	+17% (+54%)
Superchargers (incl. in Fast Chargers)	394 (2,831)	594 (5,413)	+51% (+91%)
Totals	17,219 (47,135)	20,959 (60,535)	+22% (+28%)

* Excluding private chargers, data from the U.S. Department of Energy Alternative Fuels Data Center, accessed January 7, 2019. http://www.afdc.energy.gov/fuels/electricity_locations.html

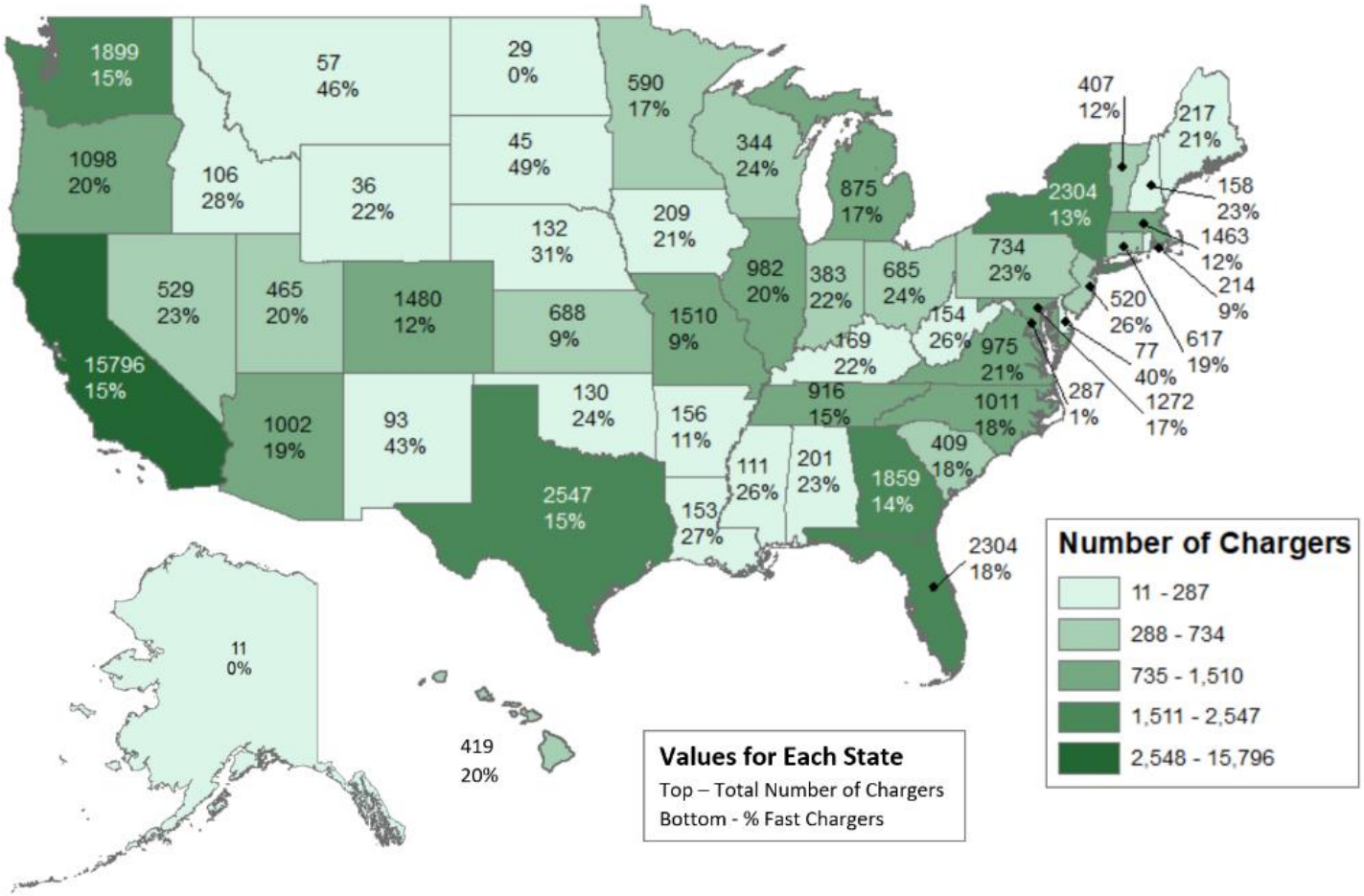
U.S. Electric Charging Stations



Source: http://www.afdc.energy.gov/fuels/electricity_locations.html

State-level Distribution of Charging Stations

- California leads other states in the number of charging stations by an order of magnitude



Source: http://www.afdc.energy.gov/data

DOE Batteries & Electrification Program

Structure, Budget, and Information Resources

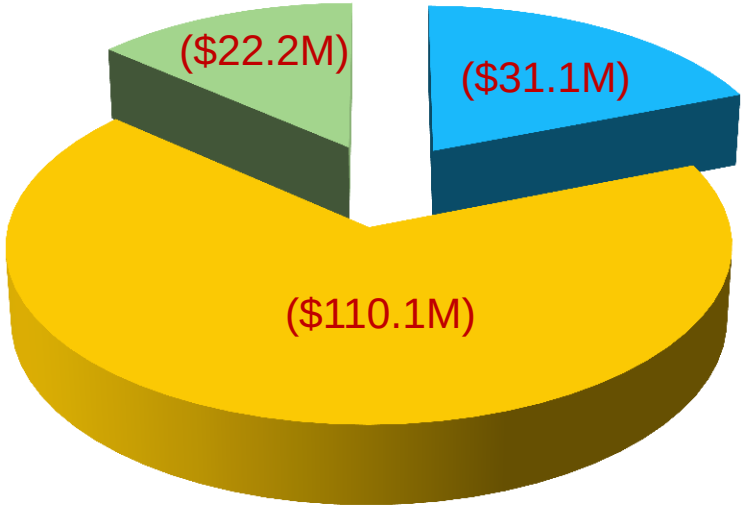
FY 2019 ($163.4M)

Electric Drive

- ❑ Power Electronics
- ❑ Electric Motors
- ❑ Traction Drive Systems

Grid & Infrastructure

- ❑ Modeling & Simulation
- ❑ Grid Integration
- ❑ Cybersecurity

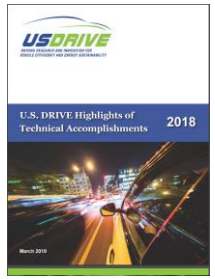


Battery R&D

- ❑ Materials R&D
- ❑ Battery Development
- ❑ Advanced Processing
- ❑ Extreme fast-charging
- ❑ Low Cobalt/No Cobalt
- ❑ Battery Recycling R&D Center
- ❑ Battery Recycling Prize

Resources

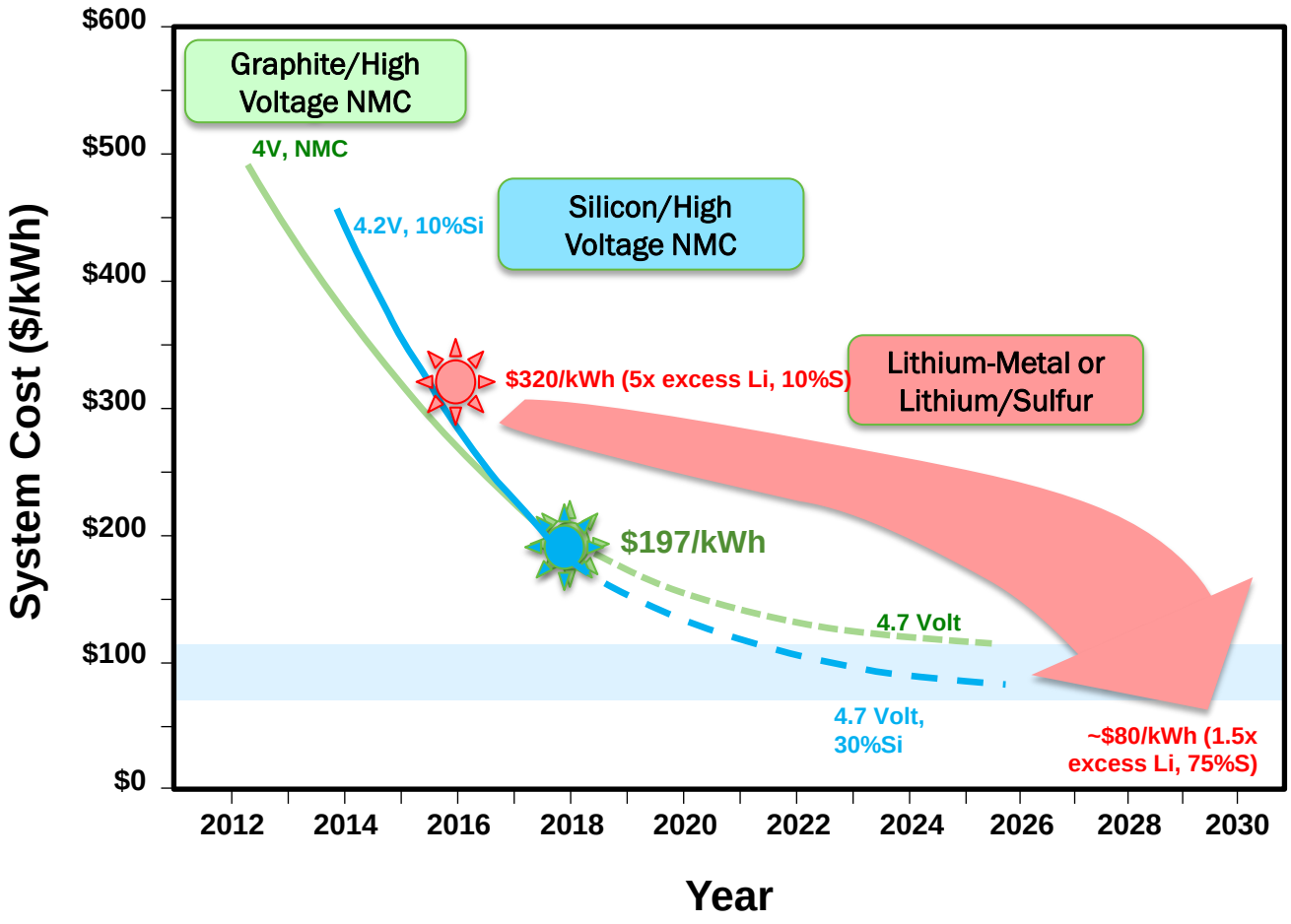
- ❑ VTO Annual Merit Review Report
  https://www.energy.gov/eere/vehicles/downloads/2018-annual-merit-review-report
- ❑ R&D Annual Progress Reports
  https://www.energy.gov/eere/vehicles/annual-progress-reports
- ❑ R&D Roadmaps
  https://www.energy.gov/sites/prod/files/2016/11/f34/US%20DRIVE%20Partnership%20Plan%20with%20ADDENDUM_NOV%202016.pdf
- ❑ R&D Highlights (USCAR)
  https://www.energy.gov/sites/prod/files/2019/04/f61/2018_U.S._DRIVE_Annual_Accomplishments_Report.pdf



Battery Cost Reduction

$197 | **Cost per kWh for modeled battery down from $1000/kWh in 2008.**

- Results based on prototype cells & modules meeting DOE/USABC performance targets.
- Detailed USABC battery cost model used to estimate the cost of PEV battery packs assuming that 100,000 batteries are manufactured annually.



Questions?

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https://afdc.energy.gov