

# Low-Carbon Pathways Transportation

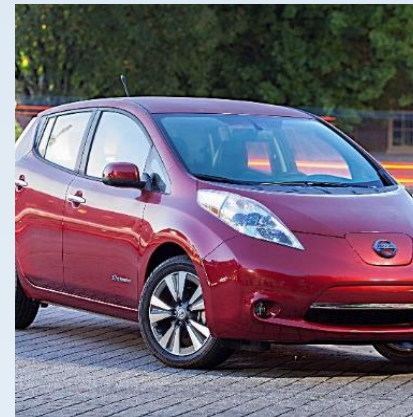
Eileen V. Quigley  
January 30, 2018

Clean Energy  
Transition



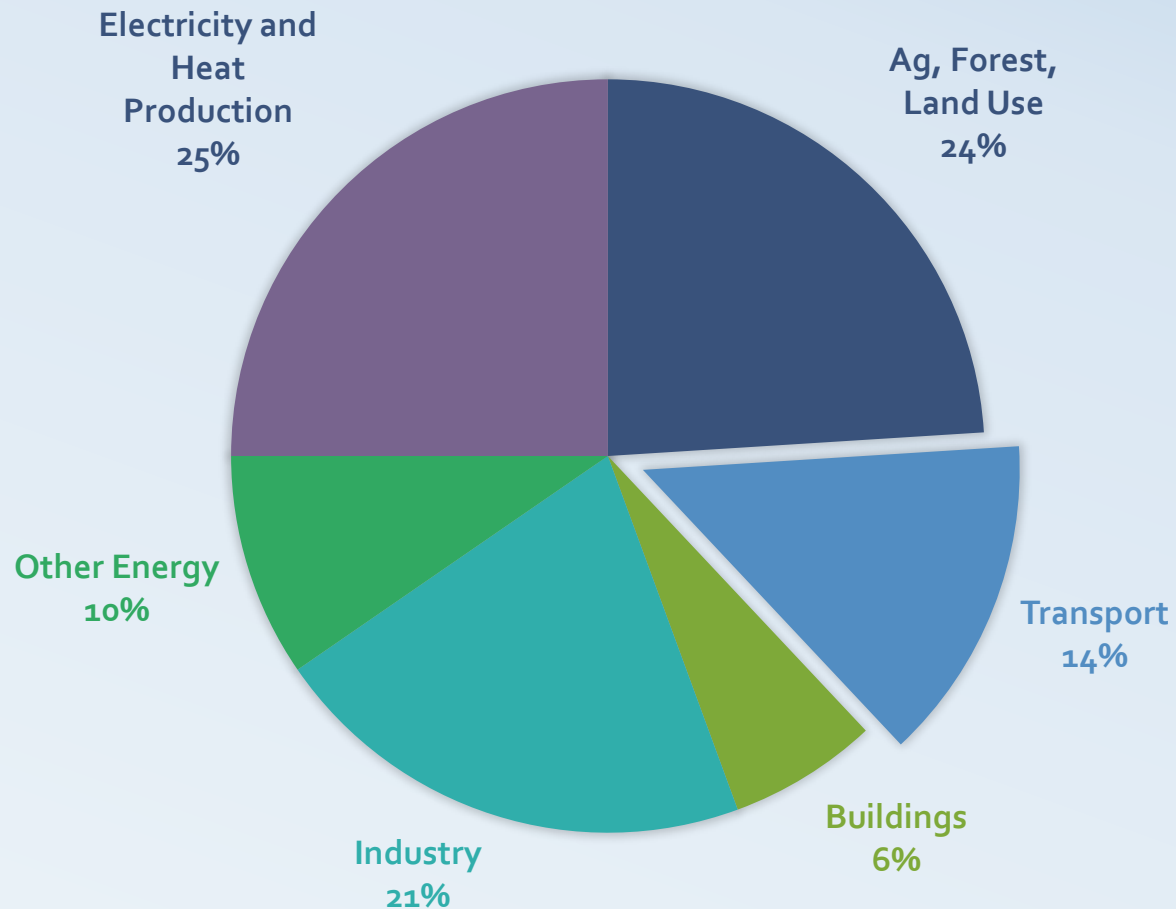
# Agenda

- Transport Sector
  - ✓ Brief overview freight, aviation, marine
  - ✓ Focus on passenger vehicles
- Low-Carbon Pathways
  - ✓ Fuel Efficiency
  - ✓ Fuel Switching
  - ✓ Limit Vehicle Miles Traveled
- Lower Carbon Energy Sources
  - ✓ Electrification
  - ✓ Hydrogen/CNG/LNG
  - ✓ Biofuels

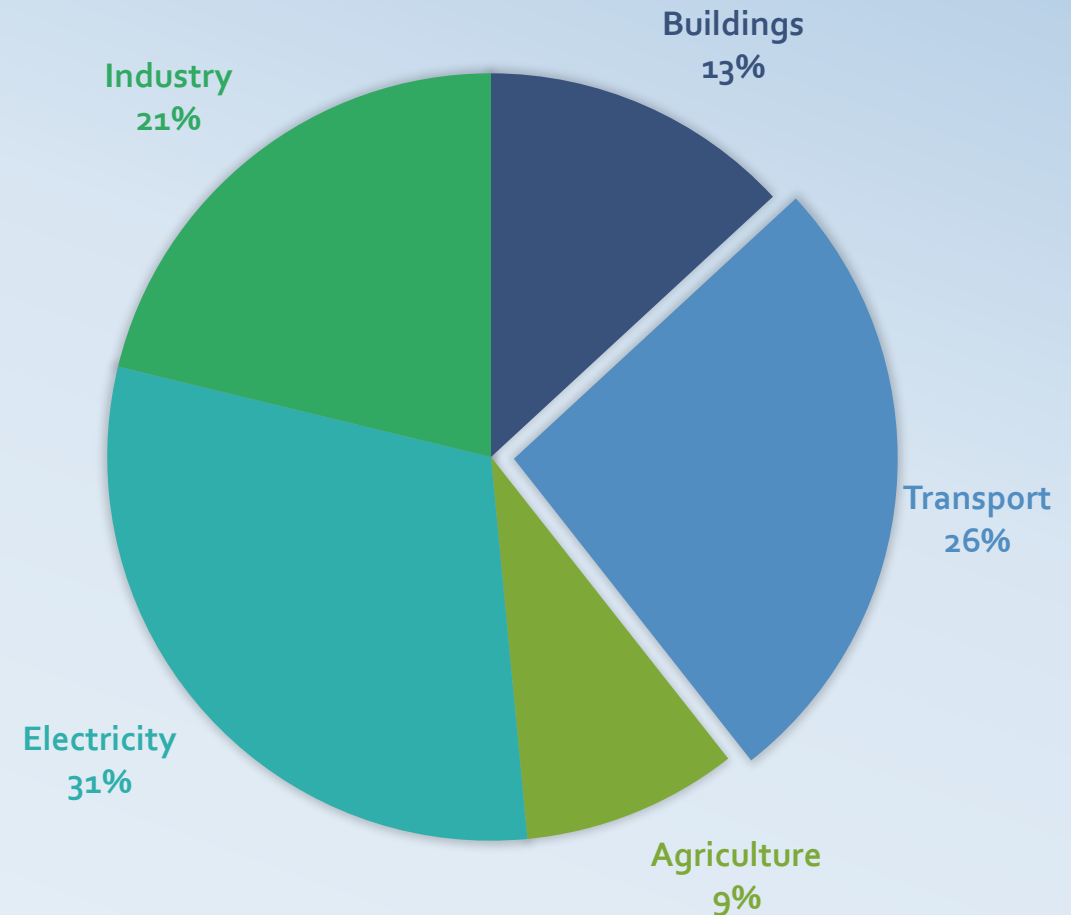


# Global & U.S. GHG Emissions by Sector

Global (2010)

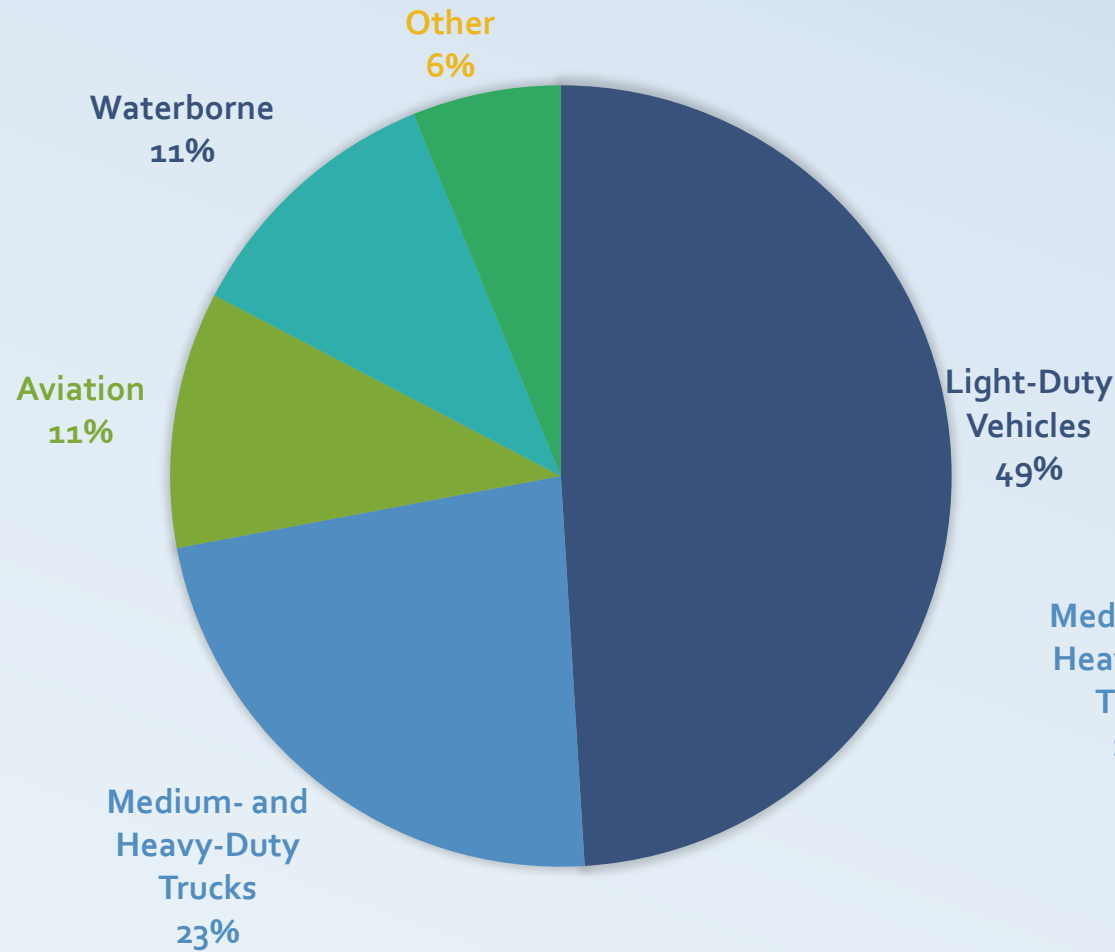


United States (2014)

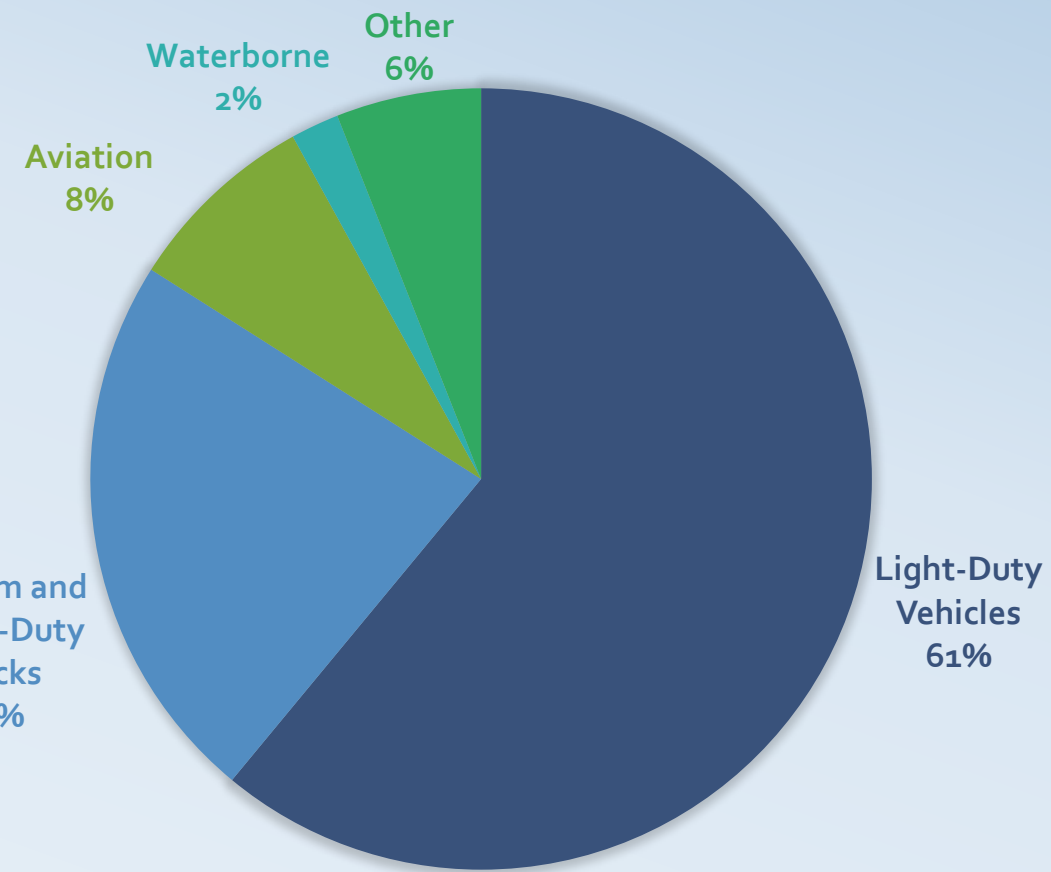


# Global & U.S. Transportation Sector

Global (2010)

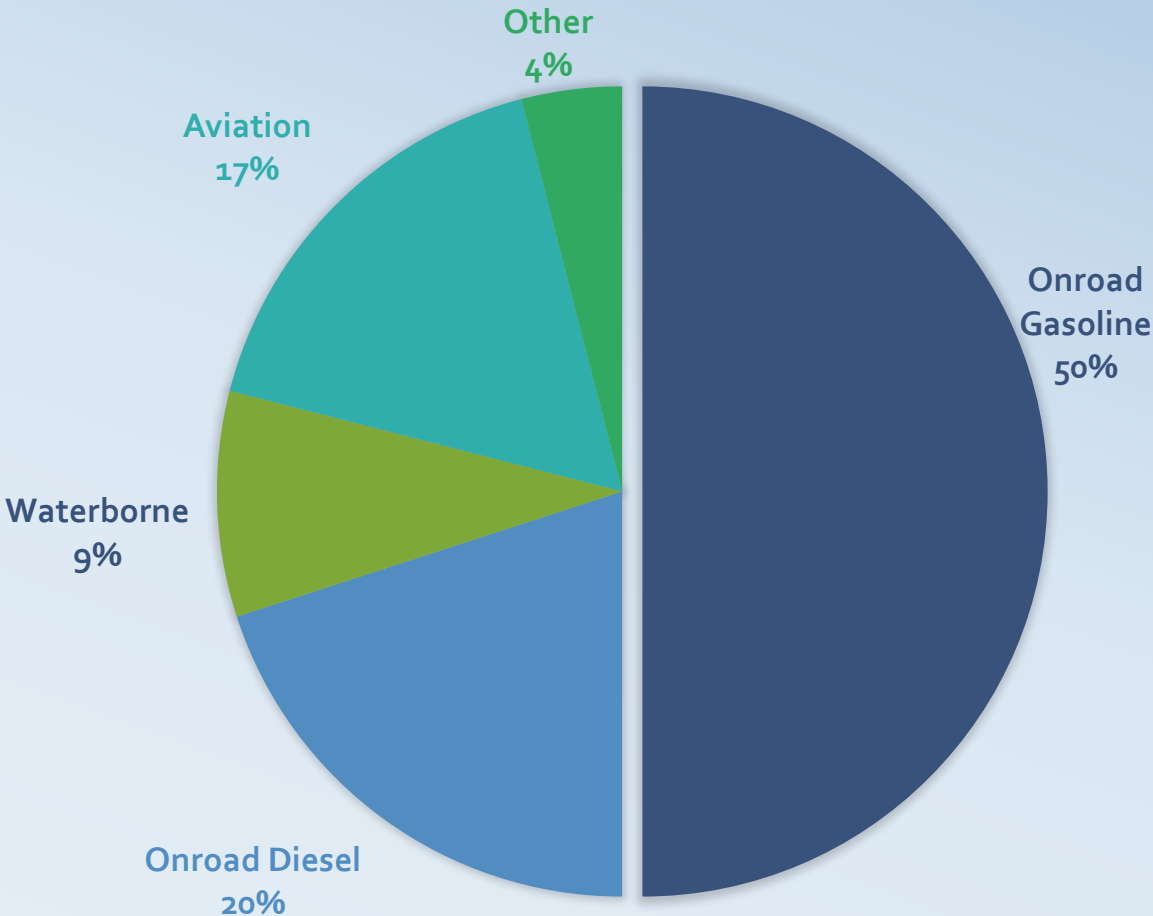
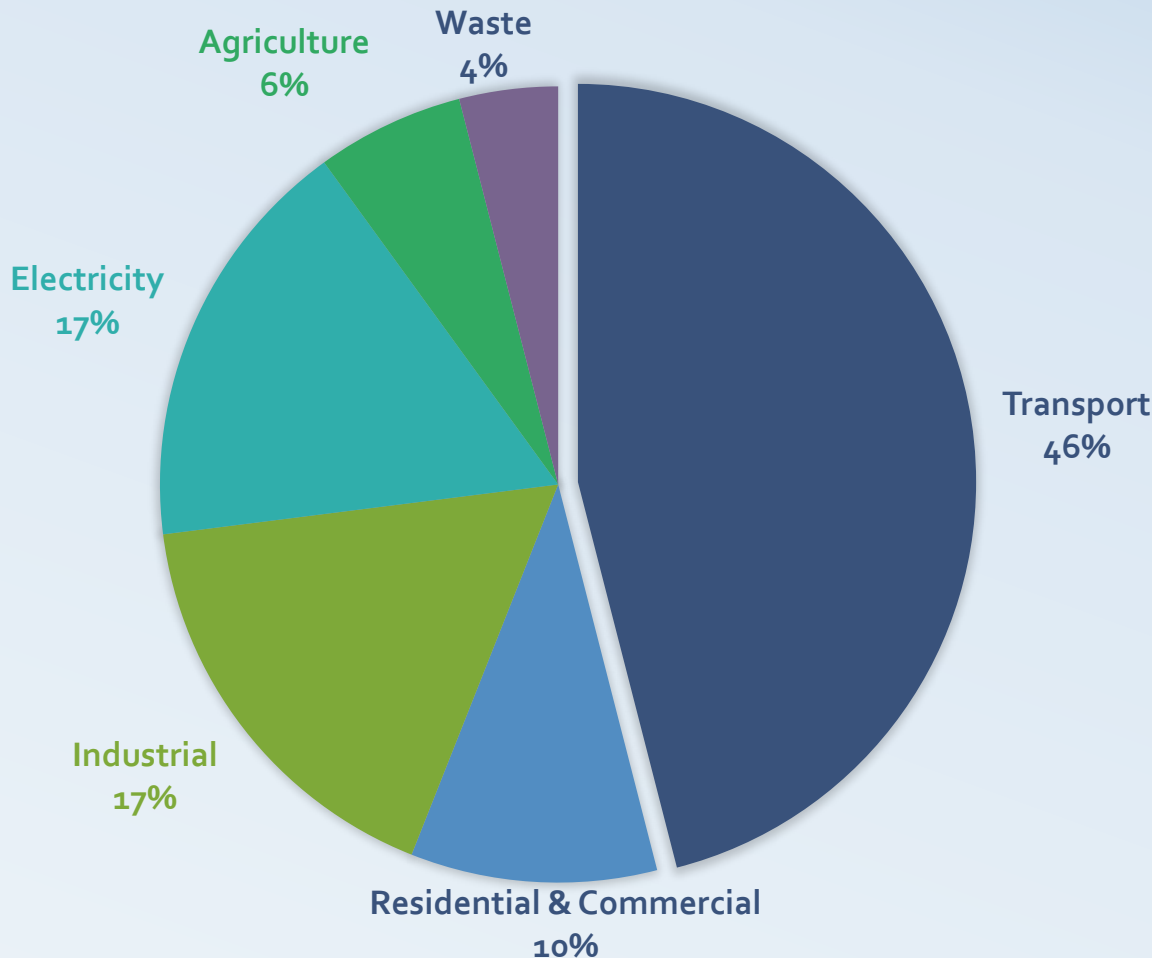


United States (2014)





# Washington GHG Emissions by Sector & Transport Breakdown (2011)



# Low Carbon Solution Pathways



1. Increase **Vehicle Efficiency** to reduce energy consumed



2. Drive **Fuel Switching** to electricity, hydrogen, biofuels, biojet, and lower carbon fossil fuels



3. Reduce **Vehicle Miles Travelled (VMT)** land use, multi-modal transportation, and transit and other shifts in trucking, rail, & shipping

# Freight

- Trucks haul 70% of freight in the U.S.
- Make up 5% of vehicles, 23% of transportation emissions
- Fastest growing emission source in transportation sector



## Vehicle Efficiency

- CAFE standards

## Fuel Switching

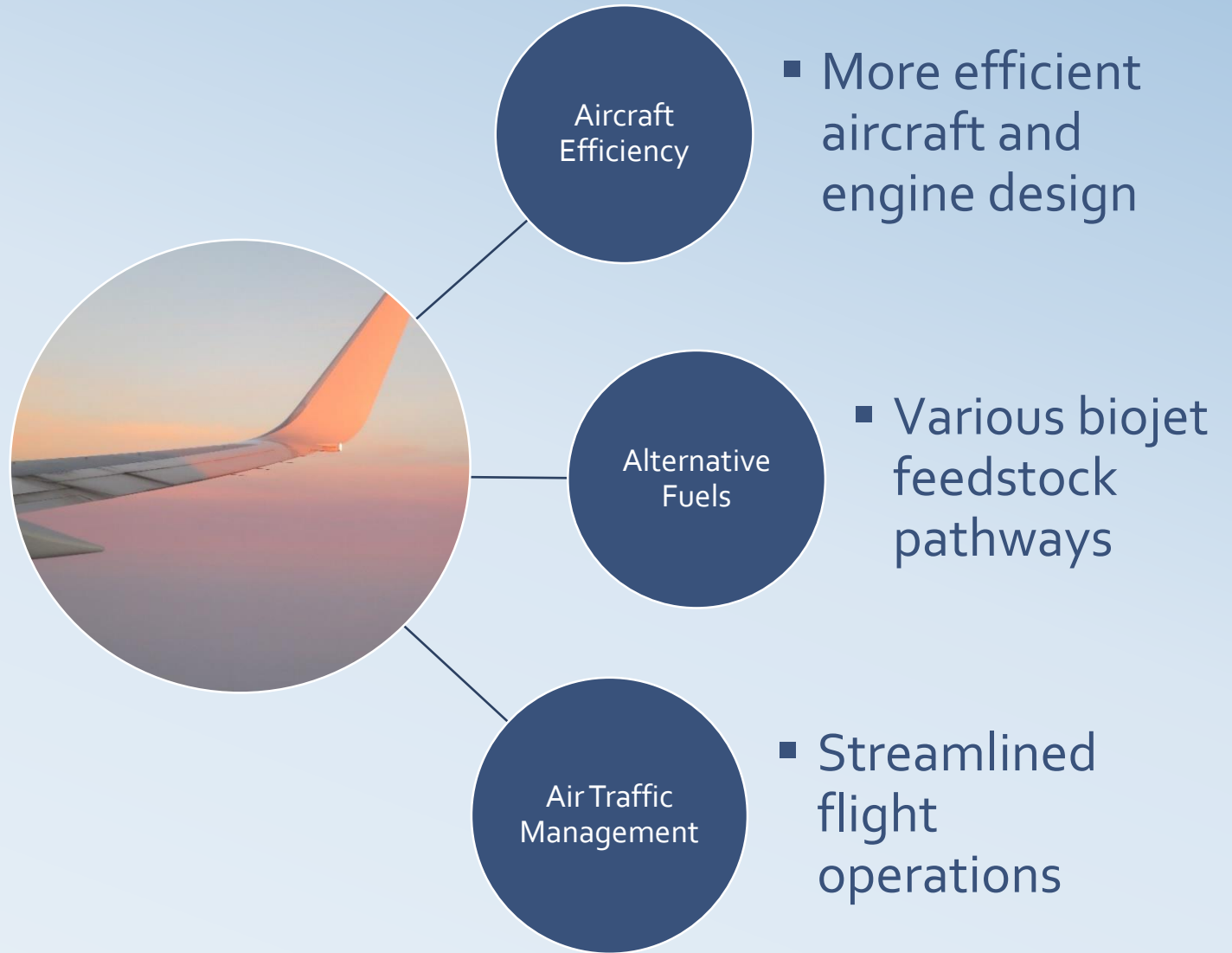
- Biofuel
- Battery electric
- Fuel cell

## Limit VMT

- Rail
- Marine

# Aviation

- Commercial aviation=2% of global GHG; projected to grow to 3-4.4% by 2050 without action
- Industry goal to reduce sector's emissions 50% by 2050
- June 2015 EPA finding under Clean Air Act





# Marine

- 57% of total global freight is transported by ships, the most efficient method of cargo transport
- 11% of total global transportation GHG emissions and petroleum consumption is marine shipping (5m barrels a day)
- Business-as-usual forecasts project up to a 250% emission growth by 2050
- 85% of emissions are international, so industry must be regulated globally



## Vehicle Efficiency

- Ship and engine optimization
- Smart shipping

## Fuel Switching

- Natural gas
- Wind (sails)
- Electric

## Increase Miles Travelled

- Short-sea shipping

# Passenger Vehicles

- Light duty vehicles account for 61% of transportation emissions in the U.S.
- United States EV sales increased 37% in 2016 compared to 2015.
- Autonomous vehicles are an emerging opportunity and challenge



## Vehicle Efficiency

- CAFE standards?
- Electric motors

## Fuel Switching

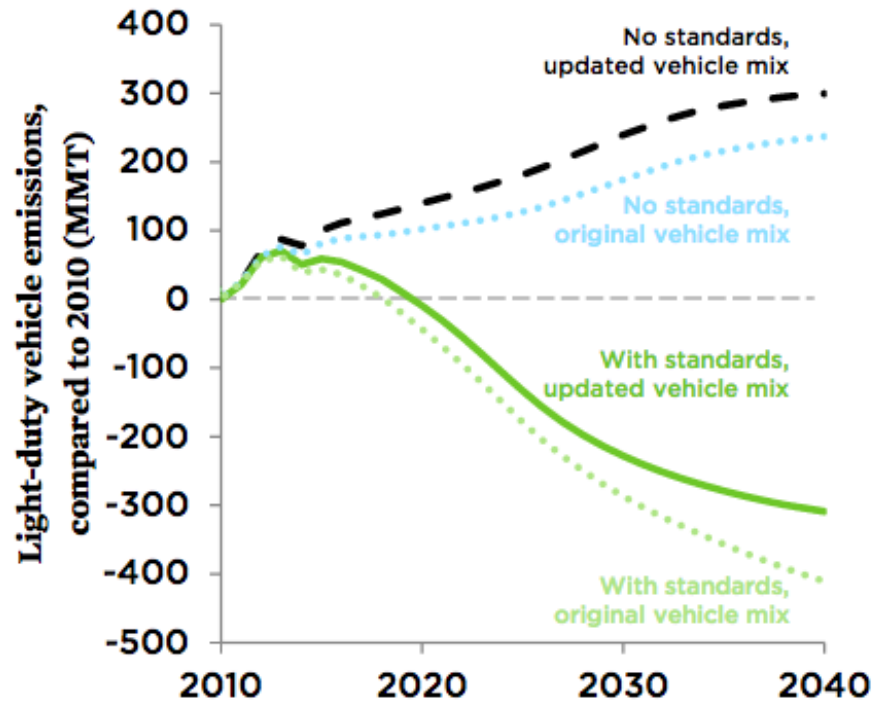
- Battery electric
- Biofuels
- Fuel cell

## Vehicle Miles Traveled

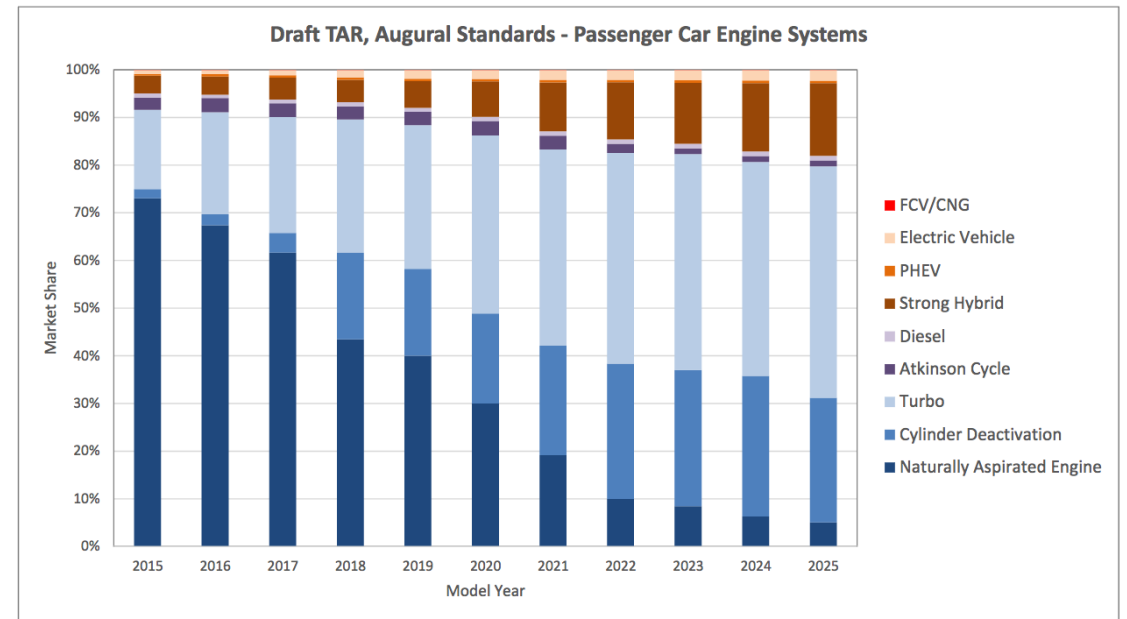
- Smart growth
- Multi-modal
- Shared mobility
- Transit

# CAFE Standards

FIGURE 2. Global warming emissions reductions under light-duty vehicle standards, compared to 2010



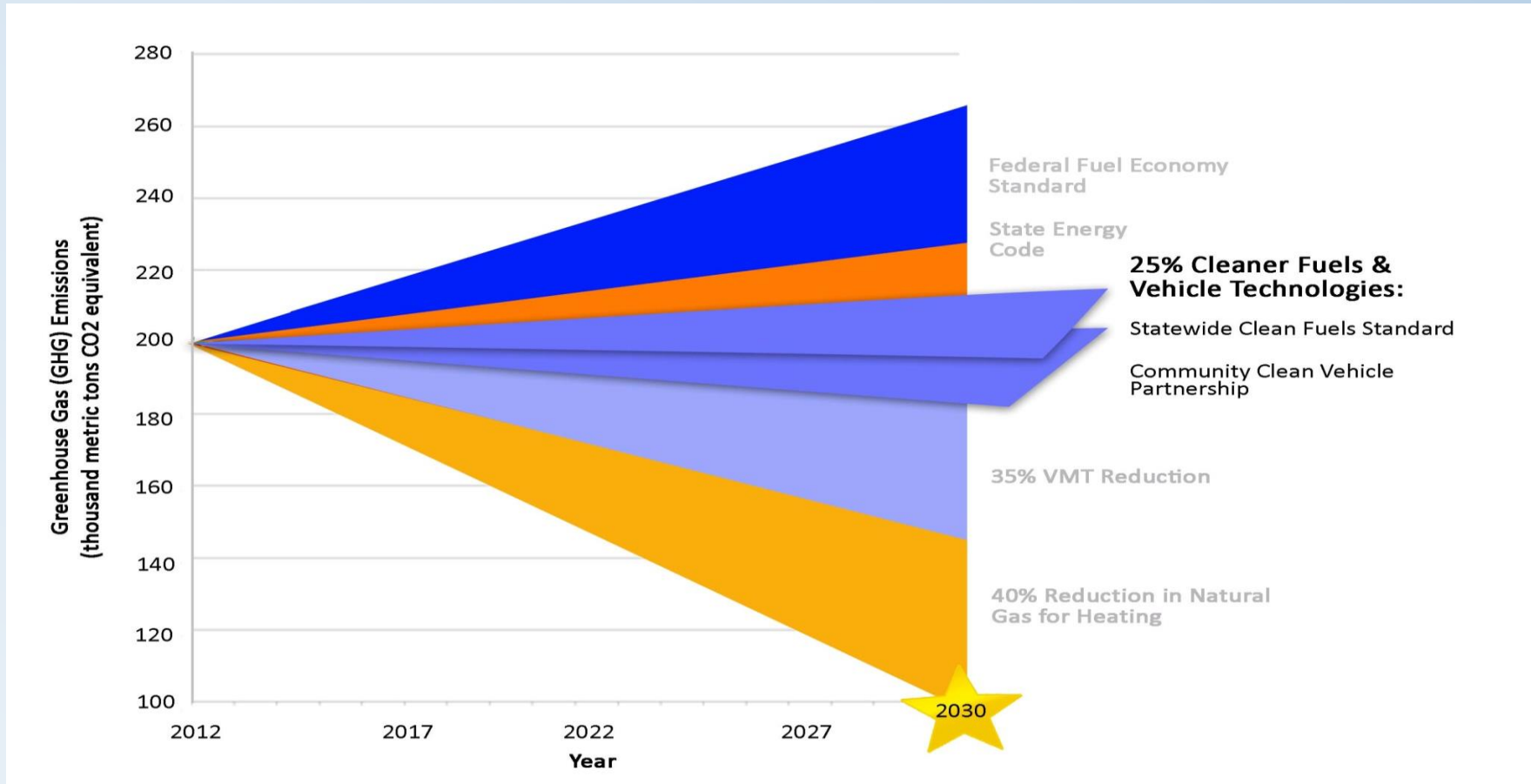
**Turbo engines, Hybrids, or Cylinder Deac.**  
**will be effective pathways for many cars**



“No other federal policy is delivering greater oil savings, consumer benefits, and global warming emissions reductions than these two rounds of standards.”

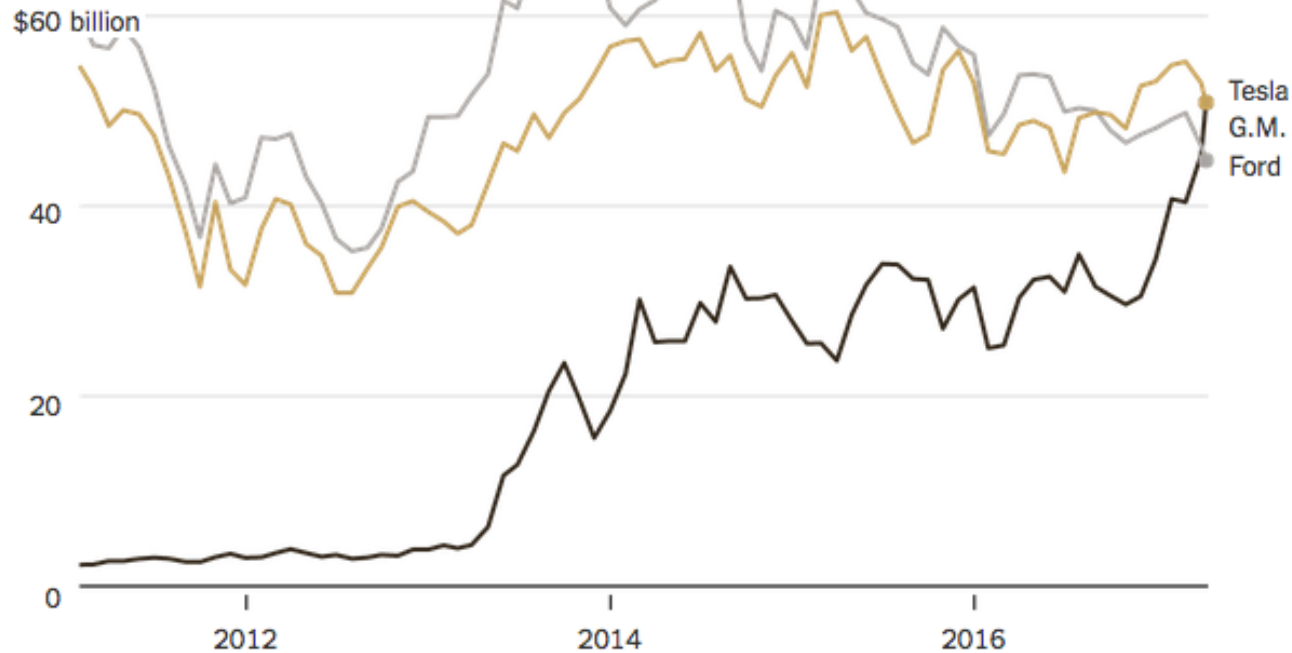
-Union of Concerned Scientists

# Importance of CAFE to Shoreline's Goal 25% Cleaner Fuels & Vehicle Technologies



# CAFE Standards?

Market capitalization



Tesla's stock valuation has soared since the company went public in 2010, recently surpassing Ford's and, on Monday, G.M.'s.

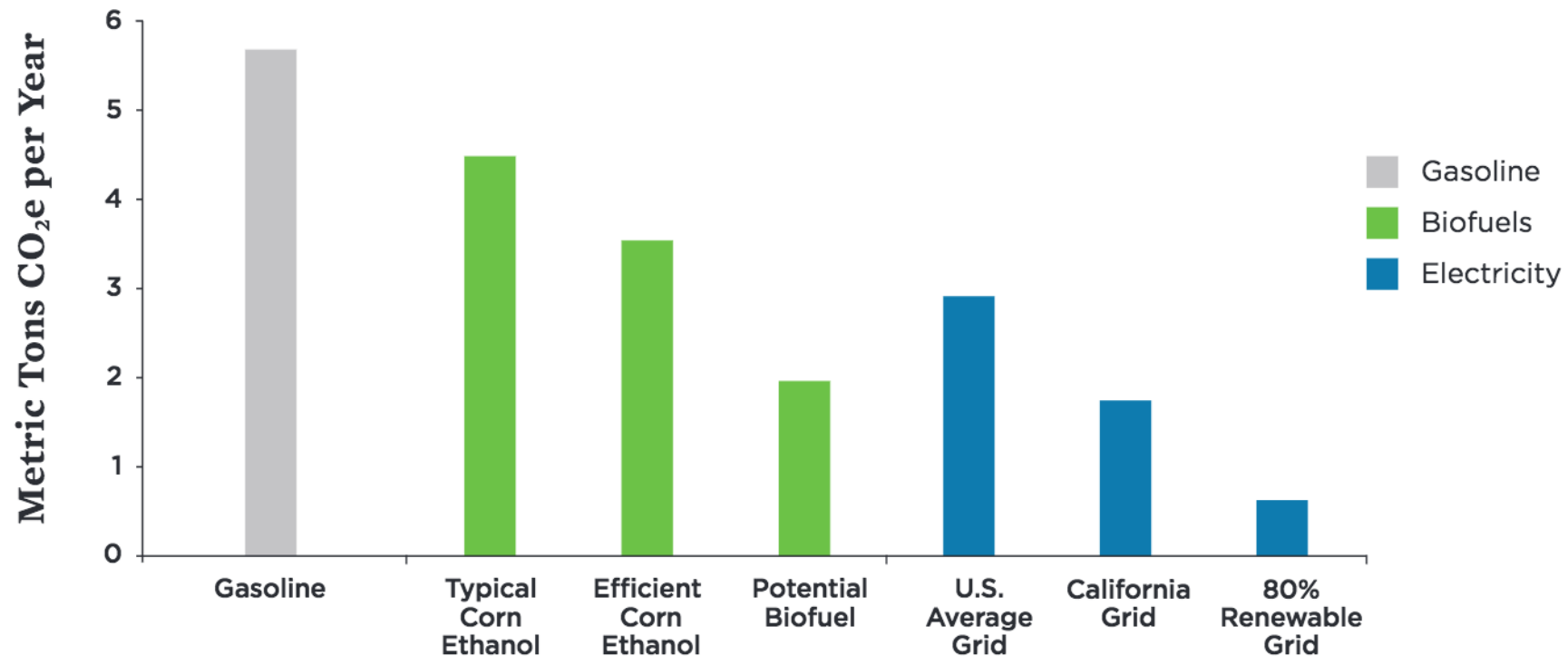
"The Trump EPA will need to navigate a **minefield of legal and technical obstacles** if it tries to withdraw or weaken the standards, and missteps will bring near-certain defeat in the courts."

*-Bob Sussman, Senior Policy Counsel to EPA Administrator 2009-2013*



# Fuel Switching

FIGURE 1. Compared with Gasoline, Alternatives Are Clean and Getting Cleaner



*A typical car produces 6.7 metric tons of global warming pollution each year, once emissions from oil extraction and refining are added to tailpipe emissions. Biofuels and electricity are cleaner, and have the potential for dramatic improvements in the future.*

# Fuel Switching: Biofuels

FIGURE 16. Efficiency and Non-food-based Feedstocks Can Make Biofuels Even Cleaner

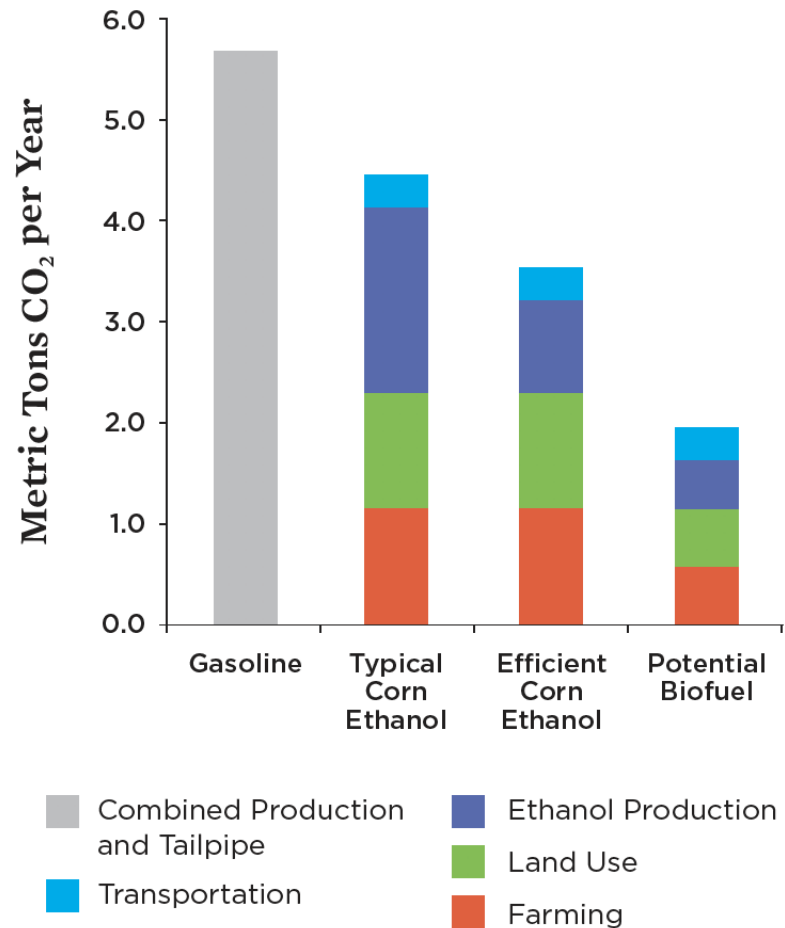
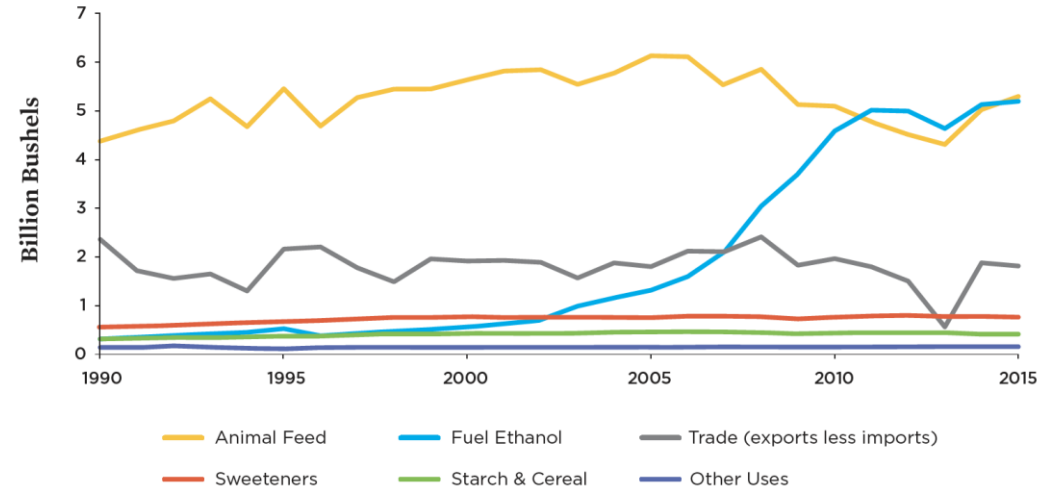
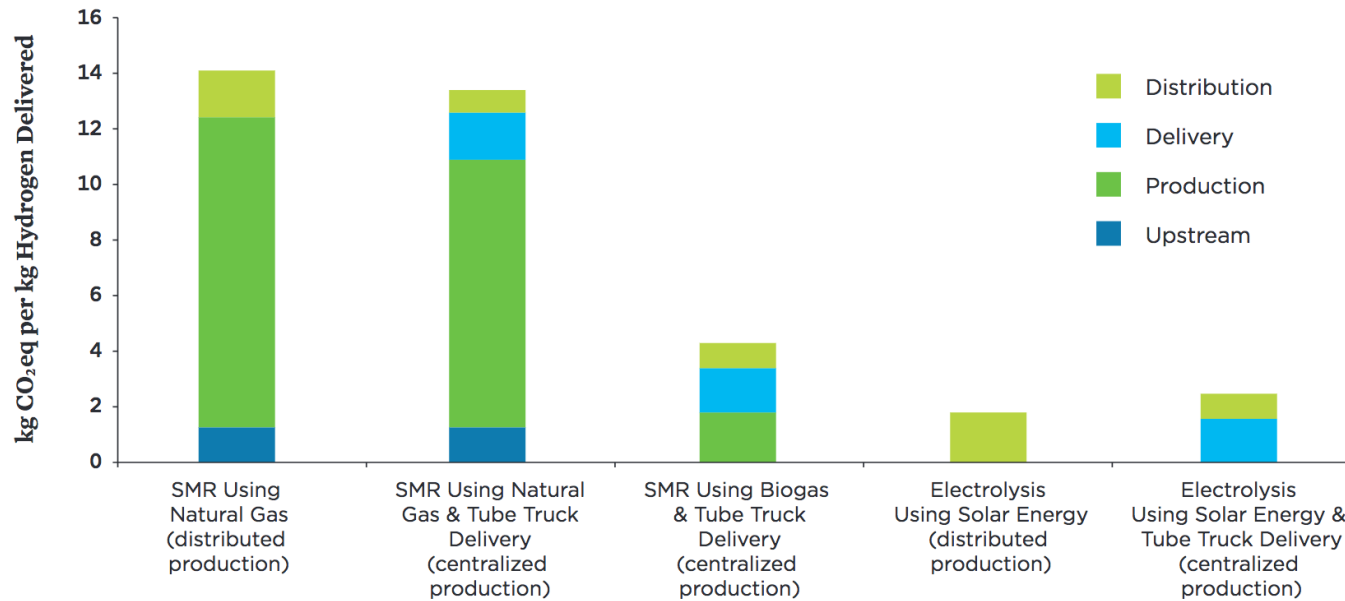


FIGURE 13. Uses of U.S. Corn



# Fuel Switching: Hydrogen

Global Warming Emissions from Different Hydrogen Production Pathways

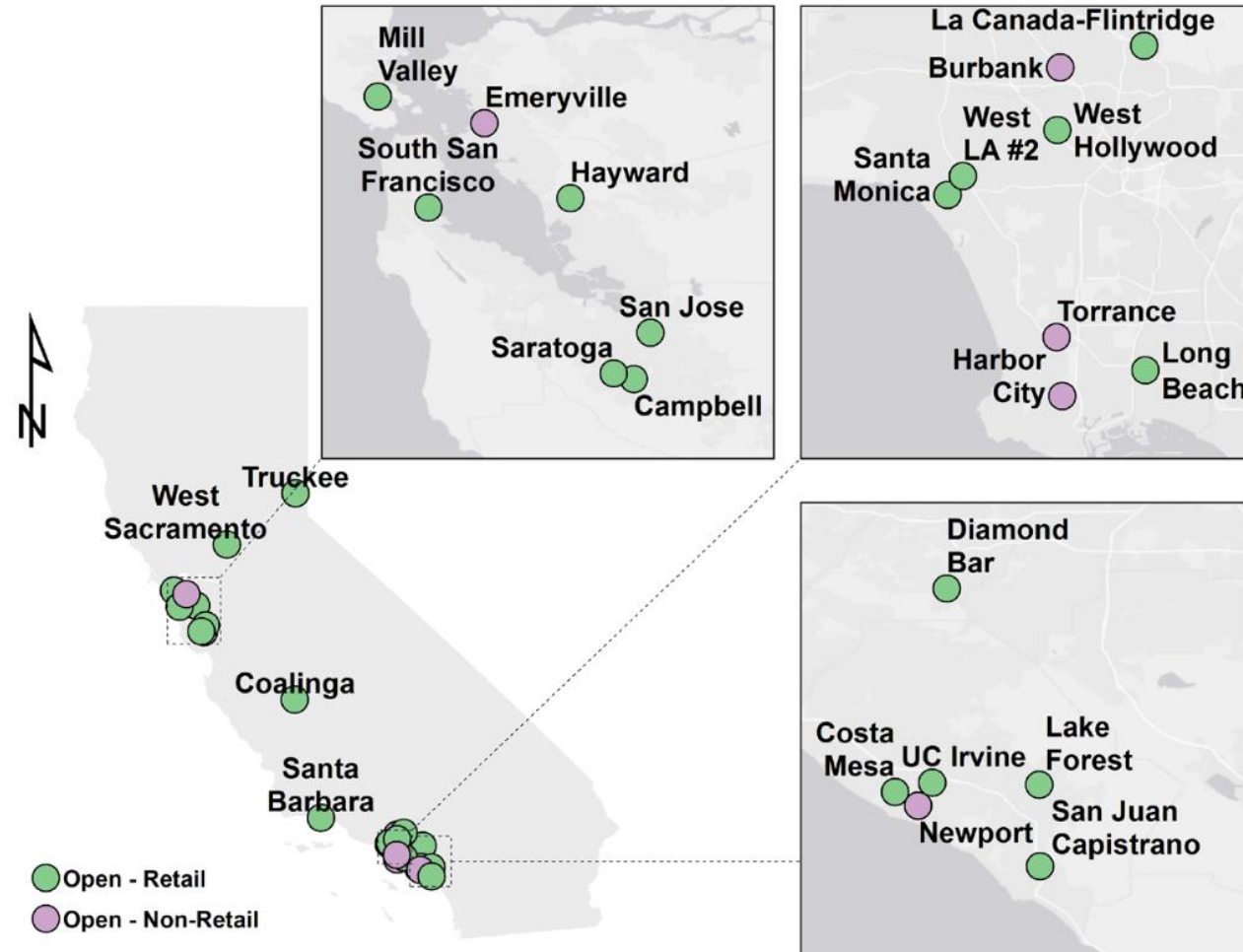


*When hydrogen gas for use in fuel cell electric vehicles is produced from a renewable resource such as solar energy or biogas, it will result in much less global warming pollution than hydrogen produced from natural gas (a fossil fuel)—even if the hydrogen must be trucked to refueling stations. The best option would be distributed (or local) production powered by renewable energy, which eliminates the need for trucking.*



# Hydrogen Fueling Network in California

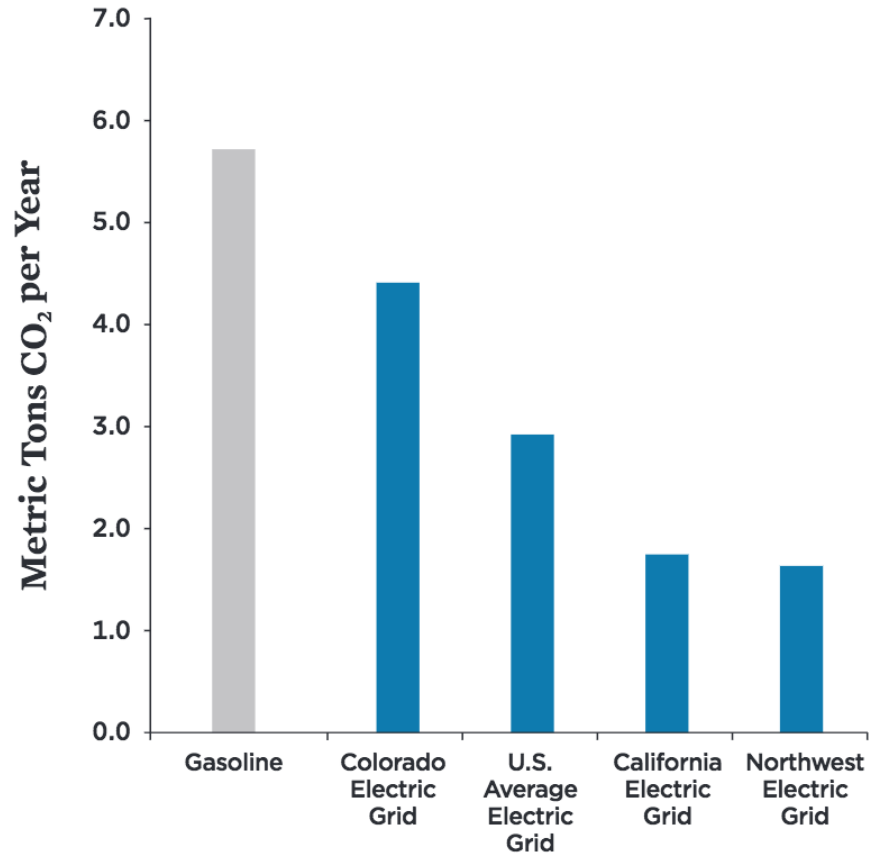
**Figure ES1: California's Currently Open Hydrogen Fueling Network**





# Fuel Switching: Electricity

FIGURE 19. Electricity Is Cleaner than Gasoline



*Cars that run on gasoline put out more emissions than even electric cars charged in areas where coal is the biggest source of electricity. When electricity is created from cleaner sources, emissions are reduced further.*



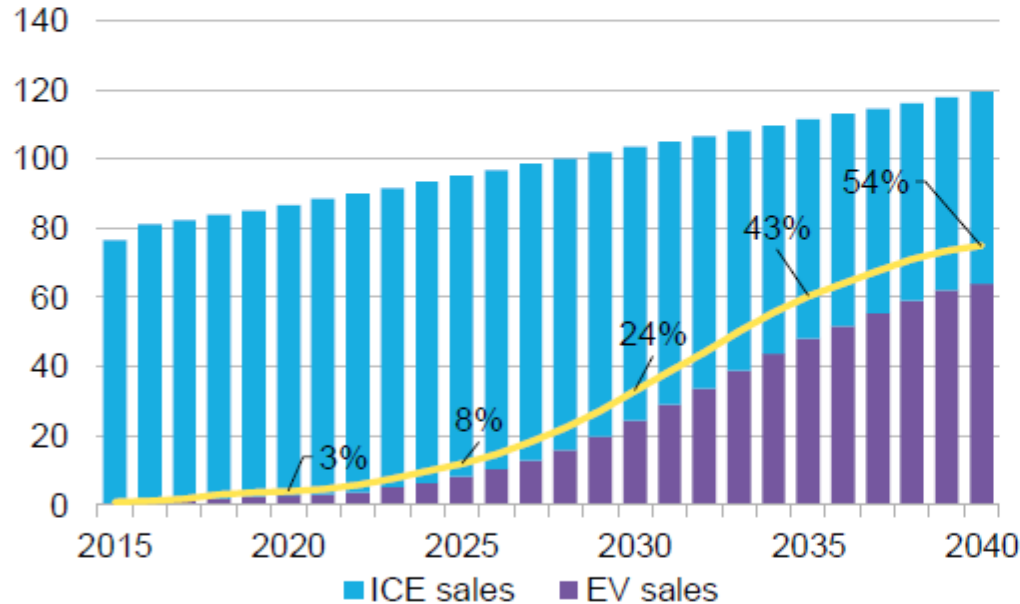


# Bloomberg 2040 EV Outlook

## Electric vehicle outlook to 2040

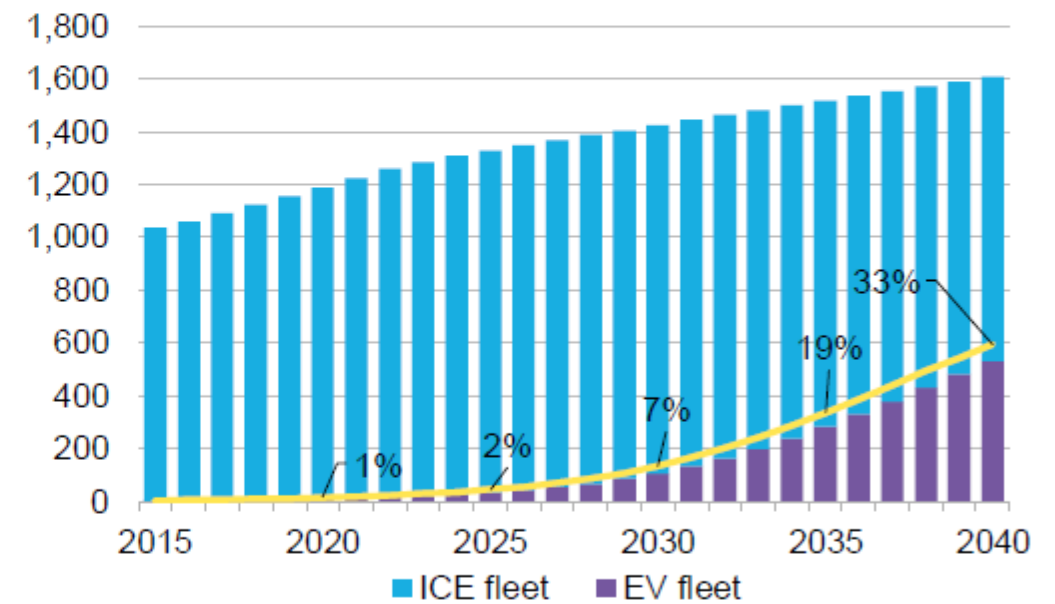
### Annual global light duty vehicle sales

million vehicles



### Global light duty vehicle fleet

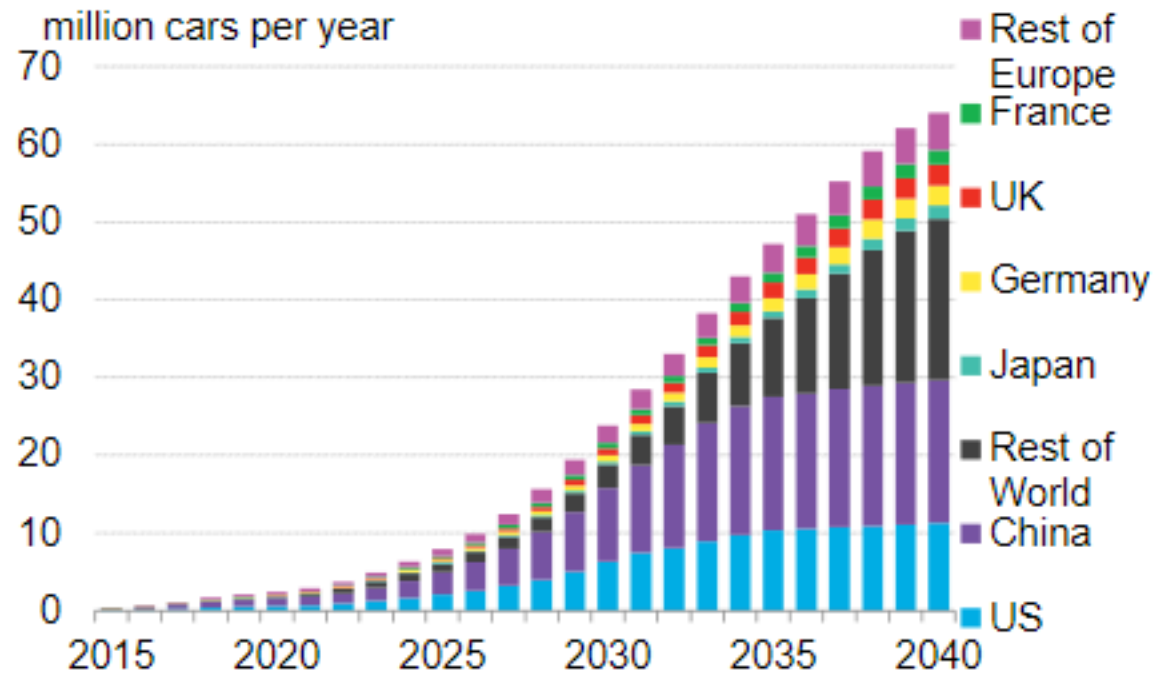
million cars on road



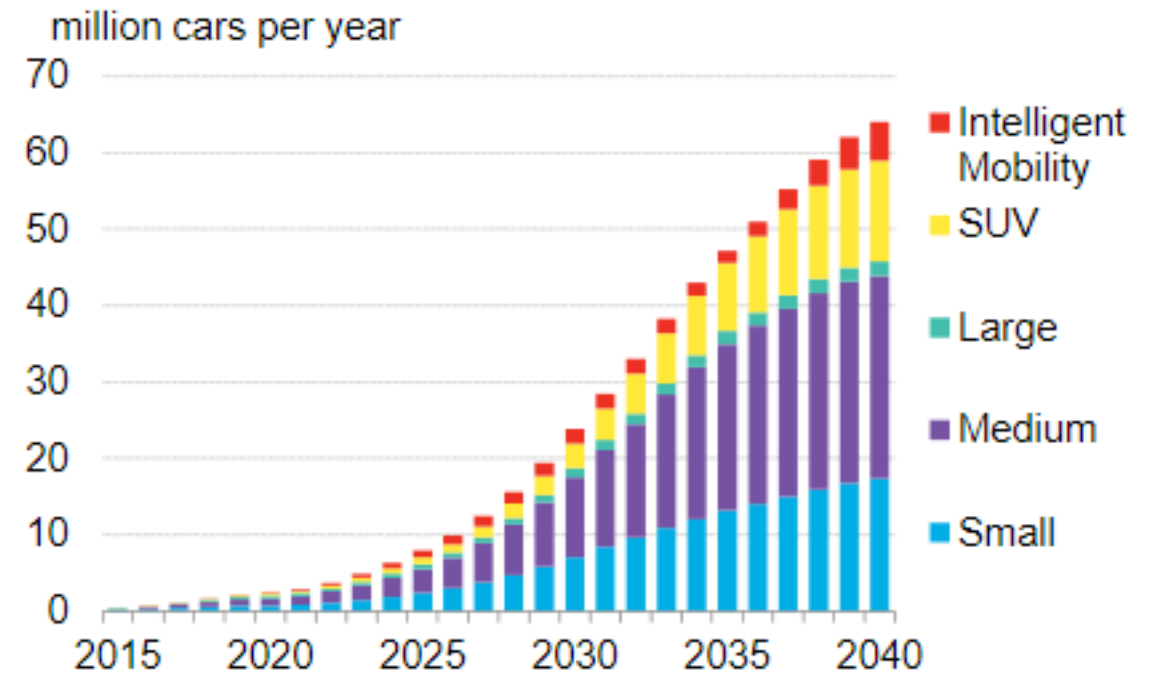
Source: Bloomberg New Energy Finance EVO 2017

# Bloomberg Global EV Sales Estimates

**Figure 3: Annual global EV sales by market**



**Figure 4: Annual global EV sales by vehicle class**



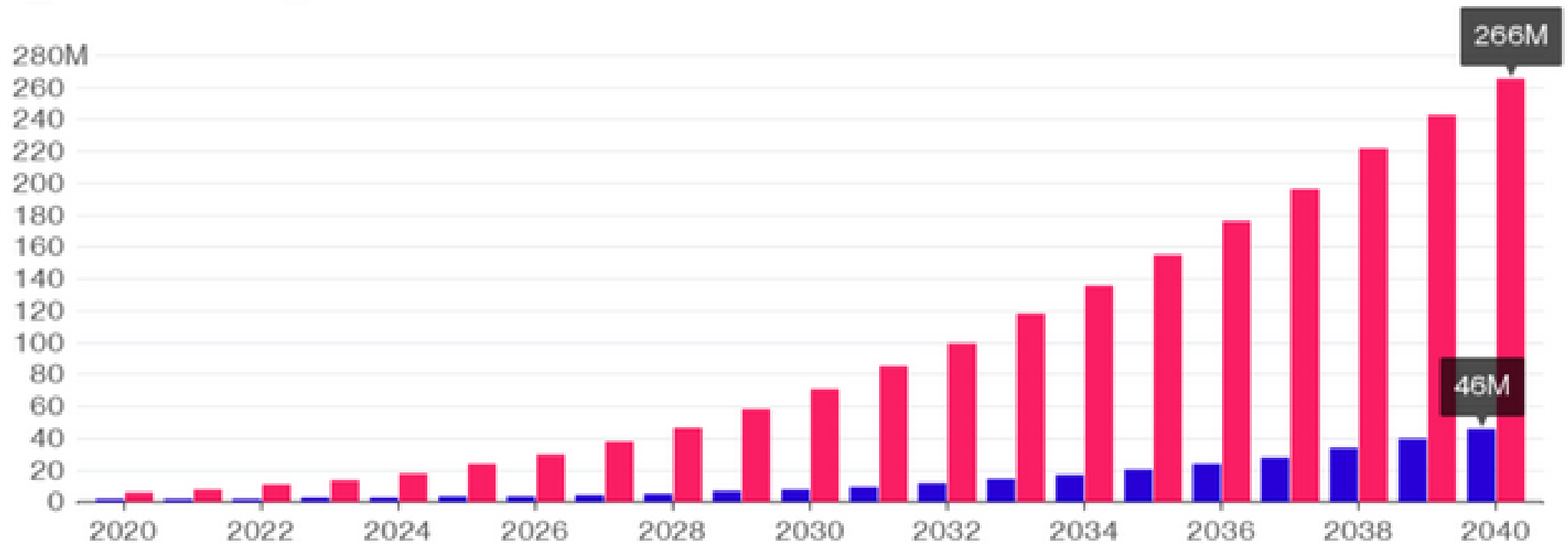
Source: Bloomberg New Energy Finance. For a detailed description of the 'intelligent mobility' segment, see the methodology.

# Impact of Electric Vehicles on Oil

## Growing Expectations

OPEC's electric vehicle forecast grew by almost 500% last year

■ 2015 Forecast ■ 2016 Forecast

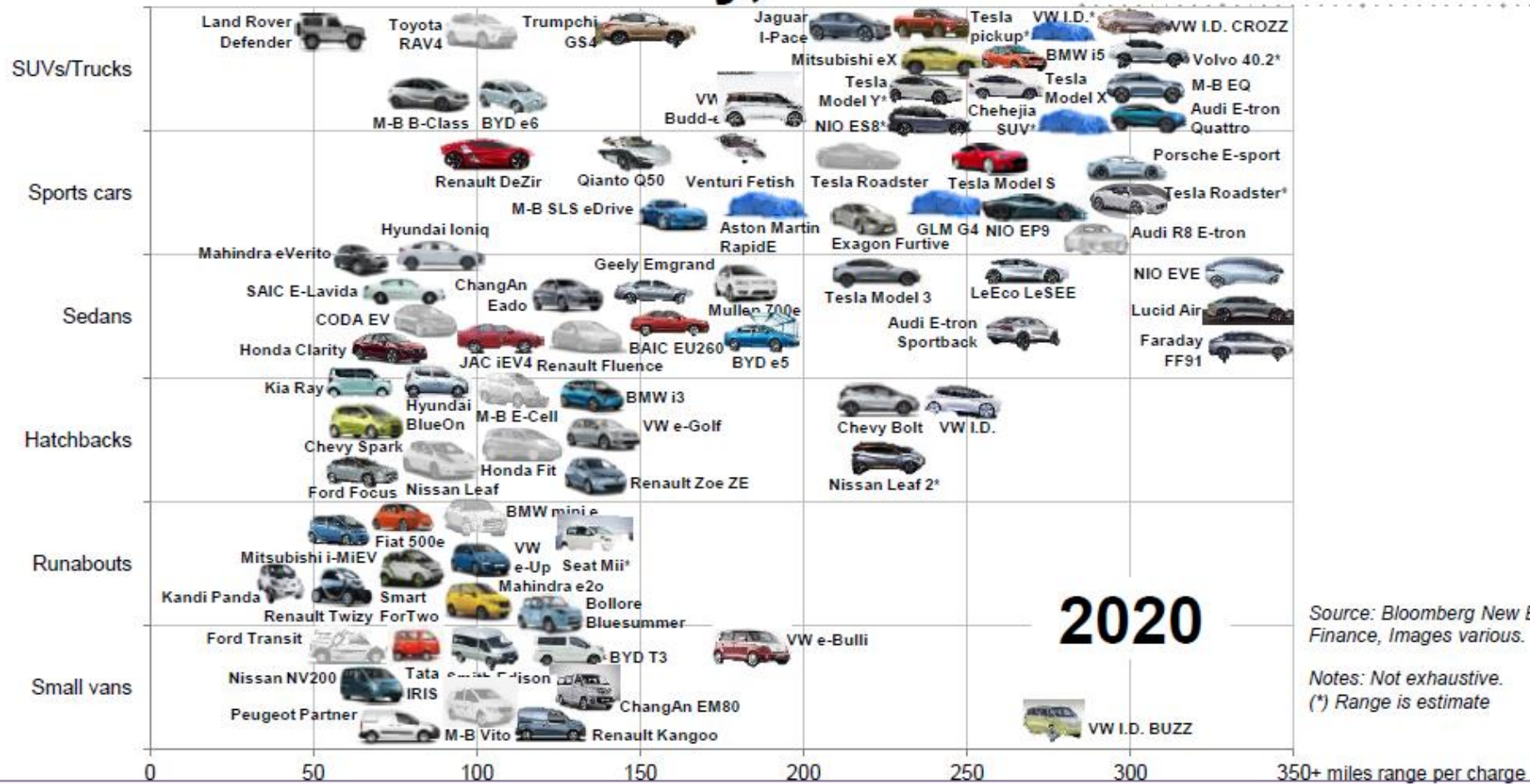


Source: Bloomberg New Energy Finance

Bloomberg 

# Battery Electric Vehicle Model Availability

## BEV model availability, 2008-20



Source: Bloomberg New Energy Finance, Images various.

Notes: Not exhaustive.  
(\*) Range is estimate

# 2017 Electric Car Models

- [EMVC SOLO](#) \$15,500, 16 kWh battery, 100 miles (EPA), 150 MPGe, kW motor
- [Mitsubishi i-MiEV](#) \$23,845, 16 kWh battery, 59 miles (EPA), 112 MPGe, 49 kW motor
- [Ford Focus Electric](#) \$29,995, 33.5 kWh battery, 115 miles (EPA), 107 MPGe, 107 kW motor
- [Nissan Leaf](#) \$31,545, 30 kWh battery, 107 miles (EPA), 112 MPGe, 80 kW motor
- [Fiat 500e](#) \$32,780, 24 kWh battery, 84 miles (EPA), 112 MPGe, 83 kW motor
- [Kia Soul EV](#) \$32,800, 27 kWh battery, 93 miles (EPA), 105 MPGe, 81 kW motor
- [Chevrolet Bolt EV](#) \$37,495, 60 kWh battery, 238 miles (EPA), 119 MPGe, 150 kW motor
- [Mercedes-Benz B250e](#) \$40,825, 28 kWh battery, 87 miles (EPA), 84 MPGe, 132 kW motor
- [BMW i3](#) \$43,395, 22-33 kWh battery, 81-114 miles, 118-124 MPGe, 125 kW motor
- [Tesla Model S](#) \$69,200-\$135,700, 60-100 kWh battery, 210-315 miles (EPA), 98-104 MPGe, 234-396 kW motor



# Brown's EV target for California

- 5 million EVs by 2030
- \$2.5B in next 8 years
- 250,000 charging
- 200 hydrogen fueling





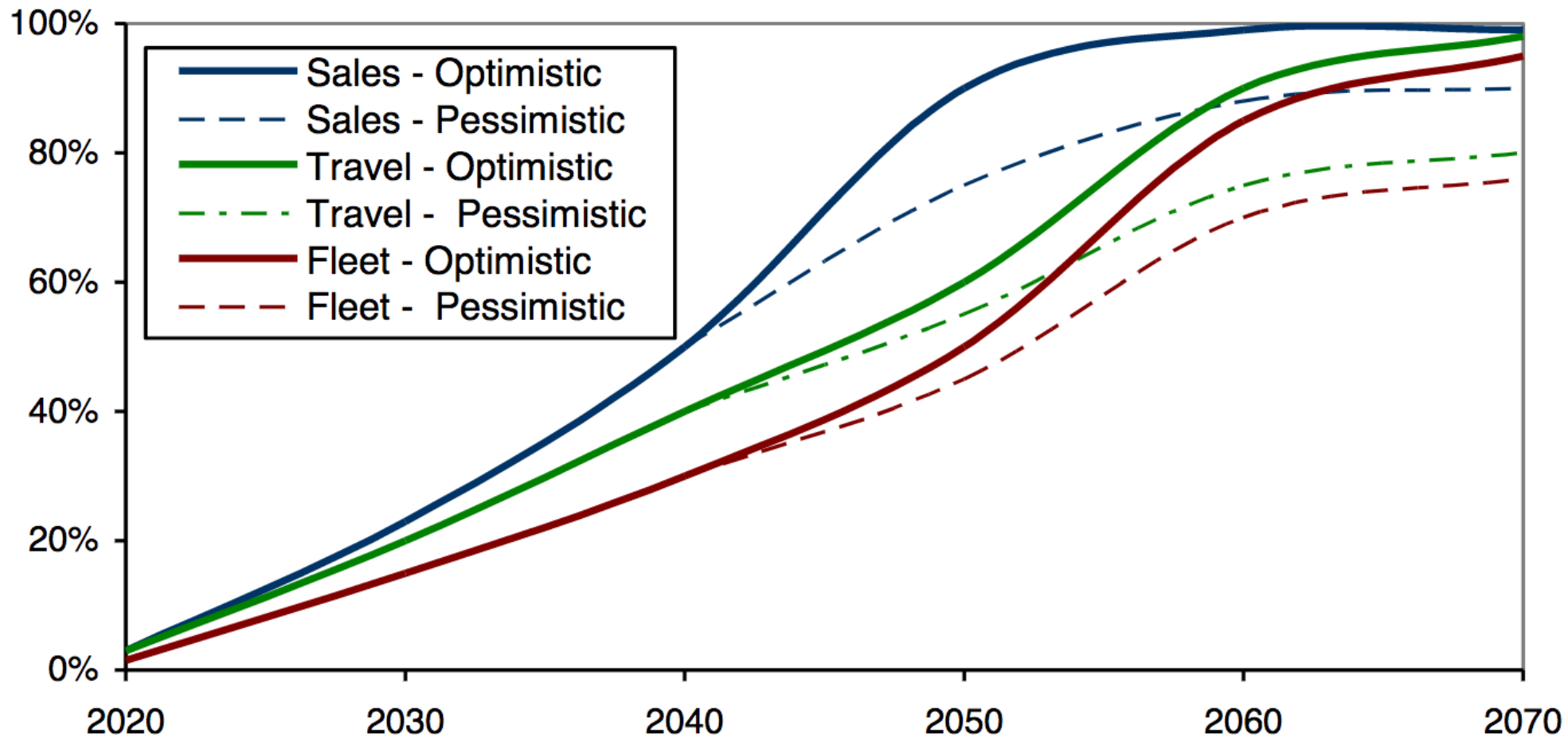
# Electric Bus Market



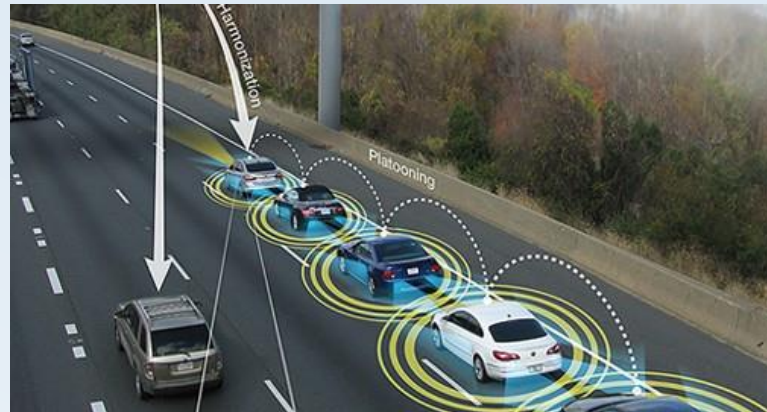


# Autonomous Vehicles

**Figure 1** Autonomous Vehicle Sales, Fleet and Travel Projections (Based on Table 6)



# Promise Safety; Free Up Parking, Roads



# AVs Free Up Time for Other Pursuits





# Cause Traffic and More Driving



# AVs and Sociolinguistic Cues



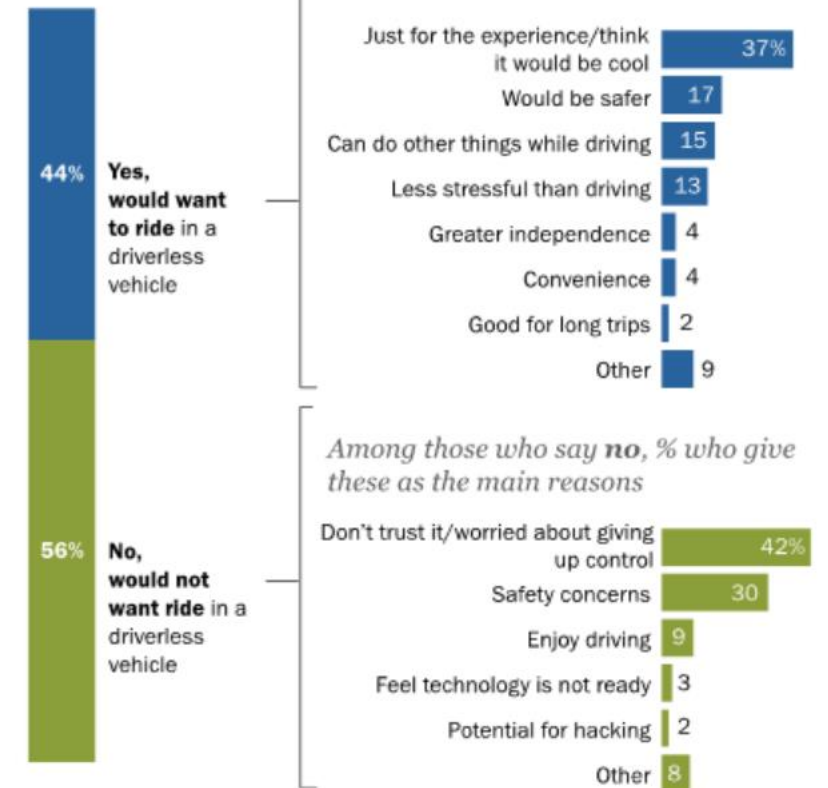


# Public Wariness

- More than 1/2 worried
- Only 15% prefer AVs
- Fear of crashes
- Love to drive

## Slight majority of Americans would not want to ride in a driverless vehicle if given the chance; safety concerns, lack of trust lead their list of concerns

% of U.S. adults who say they would/would not want to ride in a driverless vehicle



Note: Respondents who did not give an answer are not shown. Verbatim responses have been coded into categories; figures may add to more than 100% because multiple responses were allowed.

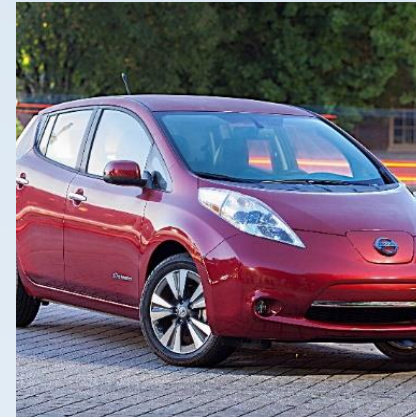
Source: Survey conducted May 1-15, 2017.

"Automation in Everyday Life"

PEW RESEARCH CENTER

# Summary

- Less mobile all renewable future
- Transport electrification burden solar and wind
- Challenge of replacing oil
- Challenge of expanding population





# Thank you

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Transitioning from Fossil Fuel to Clean Energy

[www.cleanenergytransition.net](http://www.cleanenergytransition.net)

