Repowering Mobility: Envisioning a New Future for Transportation Energy

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Agenda

- Decarbonizing Transportation
  - Freight
  - Aviation
  - Marine
  - Passenger Vehicles

- Transportation Pathways
  - Fuel Efficiency
  - Fuel Switching
  - Limit Vehicle Miles Traveled

- Lower Carbon Energy Sources
  - Electrification
  - Hydrogen/CNG/LNG
  - Biofuels
  - Autonomous Vehicles
Global & U.S. GHG Emissions by Sector

Global (2010)

- Electricity and Heat Production: 25%
- Ag, Forest, Land Use: 24%
- Industry: 21%
- Buildings: 6%
- Transport: 14%
- Other Energy: 10%

United States (2014)

- Electricity and Heat Production: 31%
- Industry: 21%
- Buildings: 13%
- Agriculture: 9%
- Transport: 26%
- Electricity: 31%
- Buildings: 13%
- Industry: 21%
- Transport: 26%
- Agriculture: 9%
- Other Energy: 10%
Global & U.S. Transportation Sector

Global (2010)
- Light-Duty Vehicles: 49%
- Medium and Heavy-Duty Trucks: 23%
- Aviation: 11%
- Waterborne: 11%
- Other: 6%

United States (2014)
- Light-Duty Vehicles: 61%
- Medium and Heavy-Duty Trucks: 23%
- Aviation: 8%
- Waterborne: 2%
- Other: 6%
Washington & Oregon GHG Emissions by Sector

Washington (2011)
- Transport: 46%
- Industrial: 17%
- Electricity: 17%
- Residential & Commercial: 10%
- Agriculture: 6%
- Waste: 4%

Oregon (2015)
- Residential & Commercial: 35%
- Transport: 37%
- Industrial: 20%
- Agriculture: 8%
- Waste: 4%
- Electricity: 17%


Transport constitutes a larger portion in Oregon (37%) compared to Washington (46%). Residential & Commercial emissions are also lower in Oregon (35%) compared to Washington (10%). The percentage of Industrial emissions is higher in Oregon (20%) than in Washington (17%). Agriculture emissions are slightly higher in Washington (6%) compared to Oregon (8%). Electricity emissions are similar in both states (17% for Washington and 17% for Oregon). Waste emissions are the lowest in both states (4% for Washington and 4% for Oregon).
Washington & Oregon Transportation Sector

Washington (2011)
- Onroad Gasoline: 50%
- Onroad Diesel: 20%
- Waterborne: 9%
- Aviation: 17%
- Other: 4%

Oregon (2015)
- Aviation: 9%
- Natural Gas: 1%
- Gasoline: 59%
- Diesel: 31%
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 Increases**
- Rail
- Marine

Clean Energy Transition
Vehicle Efficiency

**FUEL SAVING TECHNOLOGIES**

- Automated Manual Transmissions
- Electrification of Accessories
- Aerodynamics (Tractor and Trailer)
- Efficient Axle Designs
- Engine Downsizing and Waste Heat Recovery
- Low-Rolling Resistance Tires
Freight Vehicle Efficiency

❖ CAFE standards approved for 2022-2027 models.

❖ Reductions necessary to decrease truck fuel consumption 40% by 2025.

By 2027, fuel consumption and CO2 emissions lowered by up to:

- 24%
- 16%
- 16%

**TOTAL FUEL SAVINGS:**

$170 BILLION
Over lifetime of vehicles

**HOW TO GET THERE**

SOURCES OF OIL CONSUMPTION IN THE TRUCK SECTOR

- Tractor Trailers (6 mpg → 11 mpg)
- Vocational Vehicles (10 mpg → 14 mpg)
- Heavy-Duty Pickups and Vans (11 mpg → 16 mpg)

REDUCTION IN FUEL CONSUMPTION

-46%  -32%  -28%
Freight Fuel Switching

Figure 1: Required ZEV sales share for two different 80-in-50 scenarios. High-ZEV scenario includes no biofuels vs. Mixed scenario that includes 60% biofuels blends by 2050
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

- More efficient aircraft and engine design
- Various biojet feedstock pathways
- Streamlined flight operations
Context for Action on Aviation Fuels

- **Cost** – Reliance on petroleum causes challenging price swings; biggest factor in airline costs
- **Conflict** – Key driver for developing home-grown sustainable fuel supplies for the military
- **Climate** – Reduce the aviation industry’s carbon dioxide emissions
1. Improve fleet fuel efficiency by 1.5% per year from now until 2020.
2. Cap net emissions from 2020 through carbon neutral growth.
3. By 2050, net aviation carbon emissions will be half what they were in 2005.

- Known technology, operations, and infrastructure measures
- Economic measures
- Net emissions trajectory
- ‘No actions’ trajectory
- Biofuels and additional new-generation technologies
Fuel Switching

**Feedstock → Conversion Process → Fuel Logistics → End Use**

- **Oilseeds**
- **Forest Slash**
- **Solid Waste**
- **Algae**

**ASTM-Certified:**
- Fischer-Tropsch
  - HEFA
  - DSHC

**In development:**
- ATJ
- Green Diesel
- HDCJ
- Others

**Blending with fossil jet**
- Recertifying to ASTM standards
- Transporting to airport
- Delivering planeside

**Pathway**

**Supply Chain**
Marine

- **57% of total global freight** is transported by ships, the **most efficient** method of cargo transport.
- Business-as-usual forecasts project up to a **250% emission growth** by 2050.
- **85% of emissions are international**, so industry must be regulated globally.

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**Vehicle Efficiency**
- Ship and engine optimization
- Smart shipping

**Fuel Switching**
- Natural gas
- Wind (sails)
- Electric

**Increase Miles Travelled**
- Short-sea shipping
Marine-Ship and Propulsion Efficiency

Operational
- Weather routing 1-4%
- Autopilot upgrade 1-3%
- Speed reduction 10-30%

Auxiliary power
- Efficient pumps, fans 0-1%
- High efficiency lighting 0-1%
- Solar panel 0-3%

Aerodynamics
- Air lubrication 5-15%
- Wind engine 3-12%
- Kite 2-10%

Thrust efficiency
- Propeller polishing 3-8%
- Propeller upgrade 1-3%
- Prop/rudder retrofit 2-6%

Engine efficiency
- Waste heat recovery 6-8%
- Engine controls 0-1%
- Engine common rail 0-1%
- Engine speed de-rating 10-30%

Hydrodynamics
- Hull cleaning 1-10%
- Hull coating 1-5%
- Water flow optimization 1-4%
Marine Operations Efficiency

Intelligent ship tomorrow

- Remote control
- Autonomous operation

- E-Navigation
  - AIS
  - ECDIS

- Fully sensoried (ship awareness), feedback to operator
- EHM on all ship systems
  - Machinery, ship systems, payload systems, ...
- Predictive maintenance
- Remote expert support

- Fleet optimization for best profit
  - Total fleet routing
    - (revenue, cargo), weather, current, ship performance, bunker prices, maintenance schedules
- Decision support
  - (collision avoidance, risk mitigation, emergency reaction)

- Automatic mooring
- Automatic cargo handling and optimization

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Marine Fuel Switching

Figure 3: Global GHG Mitigation Potential from the Marine Shipping Sector

- Operations
- Ship & Propulsion
- Alternative Fuels and Power
- CO2 Emissions

Mitigation Potential from Baseline

Million Tones CO2 per year

2007

2050

Clean Energy Transition
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
"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
"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: 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.
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.
Autonomous Vehicles
Autonomous Vehicles
Thank you!

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