

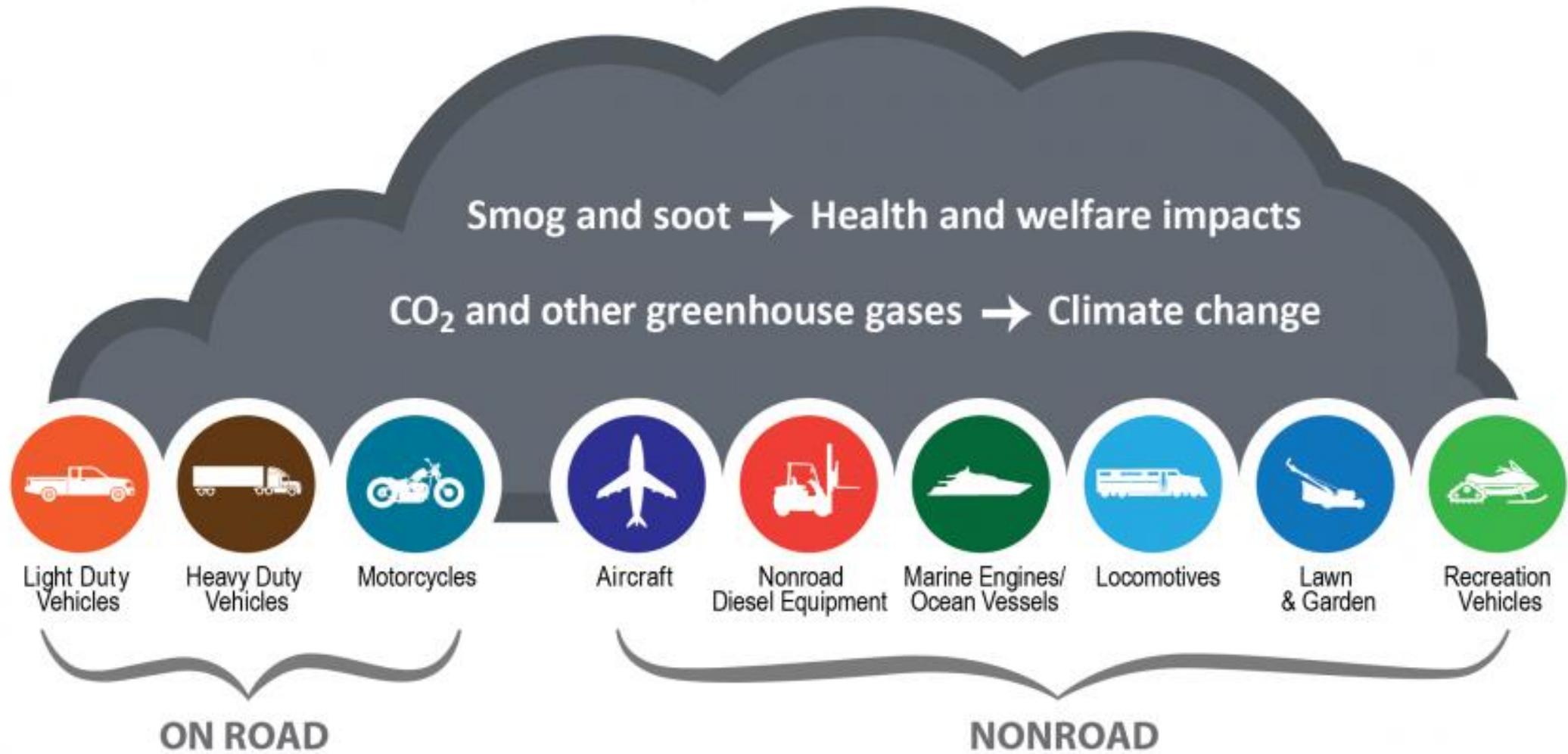
Nonroad & H2 Fuel Cells: An EPA Overview

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Sources of Transportation Air Pollution



Nonroad based on EPA Regulation

The nonroad equipment market is extremely diverse and complex, with over 200 categories of assorted subsector applications, making nonroad complex and unique.

Major nonroad transportation modes consist of marine vessels, locomotives, and airplanes.

Other nonroad modes include construction, agriculture, industrial, lawn and garden, commercial applications, snowmobiles and alternative terrain vehicles (ATVs), logging equipment, and equipment used at oil fields.

Marine engines, locomotives, and aircraft are regulated separately from nonroad diesel engines at EPA.

What We Know

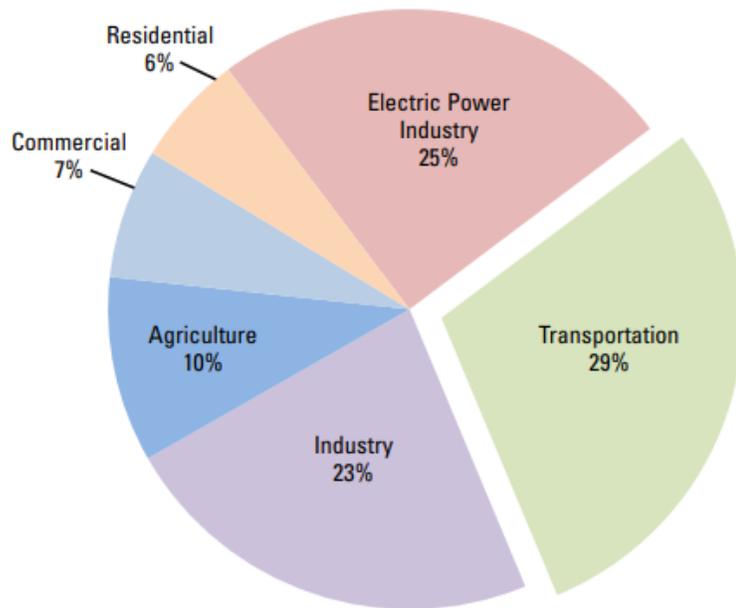
Nonroad diesel engines contribute to our nation's air pollution.

Nonroad diesel engines used in construction, agricultural, and industrial applications are projected to continue to contribute large amounts of diesel emissions.

Diesel emissions can lead to serious health problems such as premature mortality, aggravation of respiratory and cardiovascular disease, aggravation of existing asthma, acute respiratory symptoms, chronic bronchitis, and decreased lung function.

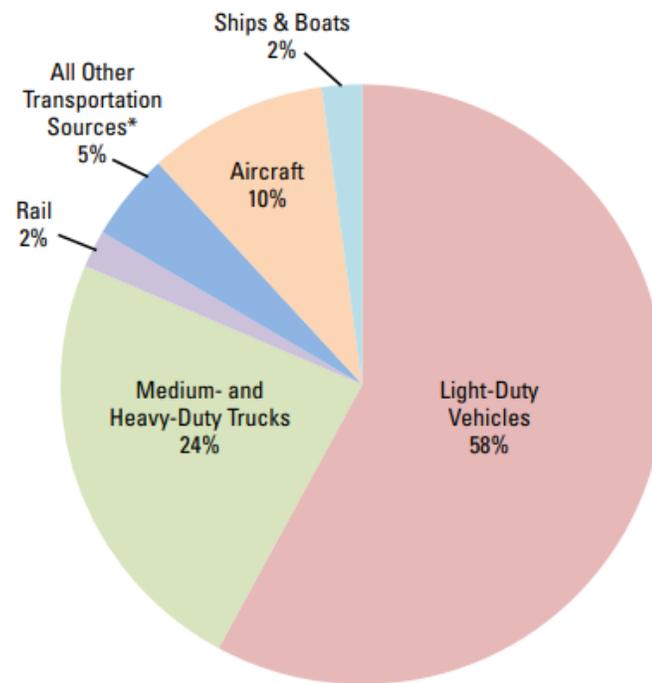
Diesel exhaust is likely to be carcinogenic to humans by inhalation.

Fast Facts Transportation GHG Emissions (1990-2019)



Share of U.S. GHG Emissions by Sector, 2019^{3,4}

Note: Totals may not add to 100% due to rounding.



Share of U.S. Transportation Sector GHG Emissions by Source, 2019^{4,5}

Note: Totals may not add to 100% due to rounding.

- The transportation sector is one of the largest contributors to U.S. GHG emissions.
- It accounted for the largest portion (29%) of total U.S. GHG emissions in 2019.
- Nonroad sector comprises of nearly 20% of GHG emissions from transportation.

Nonroad Subsector Impact

About 90% of CO₂ emissions from the nonroad sector (excluding marine, locomotives, and air) are from 5 subsectors: construction/mining, agriculture, industrial, lawn/garden, and commercial applications.

Nonroad Top 5 Subsectors	Percent of CO₂ Emissions in Nonroad	Percent of Engines¹
Construction/Mining	34%	2.5%
Agriculture	20%	3%
Industrial	13%	1.5%
Lawn/Garden	12%	74%
Commercial	10%	~1%

Hydrogen Fuel Cells & Nonroad





Why is EPA Interested?



H₂ Fuel Cells

Advantages

Zero tailpipe emissions

Fuel efficient

Minimal noise

Quick & simple refueling

Modular, scalable

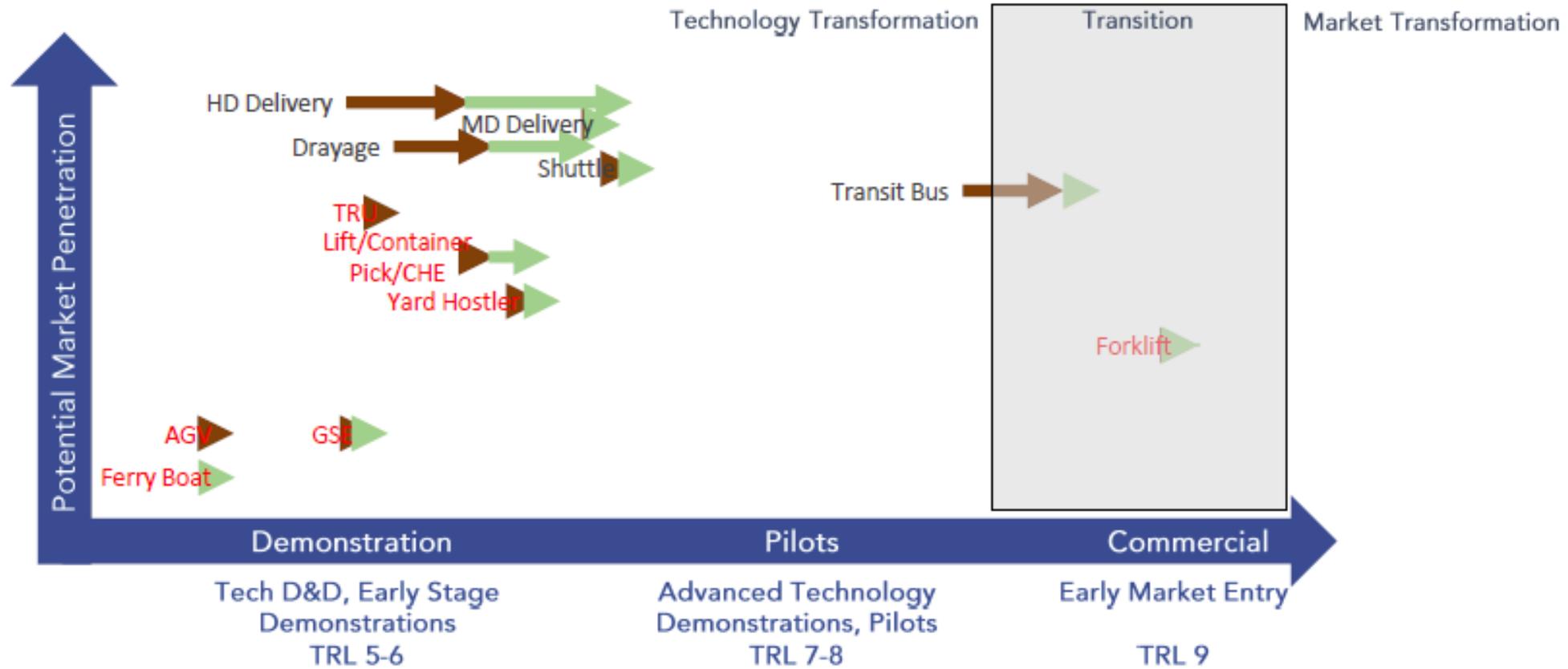
More efficient than combustion engines

Disadvantages

- Expensive (production, storage, transport)
- Can be sensitive to fuel impurities
- H₂ is highly flammable
- Most H₂ is mostly produced by SMR which emits CO₂ & CH₄ leaks
- Not as efficient as batteries

FCEV Technology Readiness Levels – 2019 Update

2018 Progress →
2019 Progress →



Key: Off-road shown in red
AGV = automated guided vehicle
GSE = ground support equipment
CHE = cargo handling equipment
TRU = transport refrigeration unit

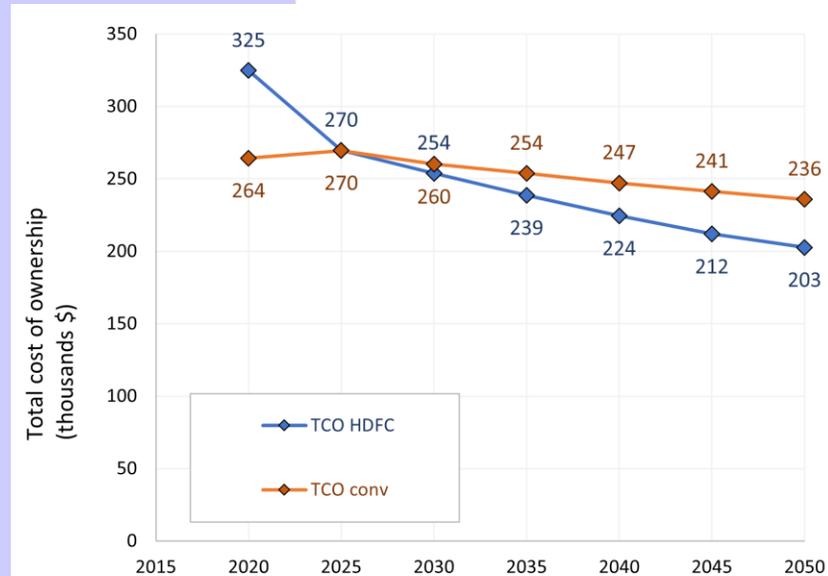
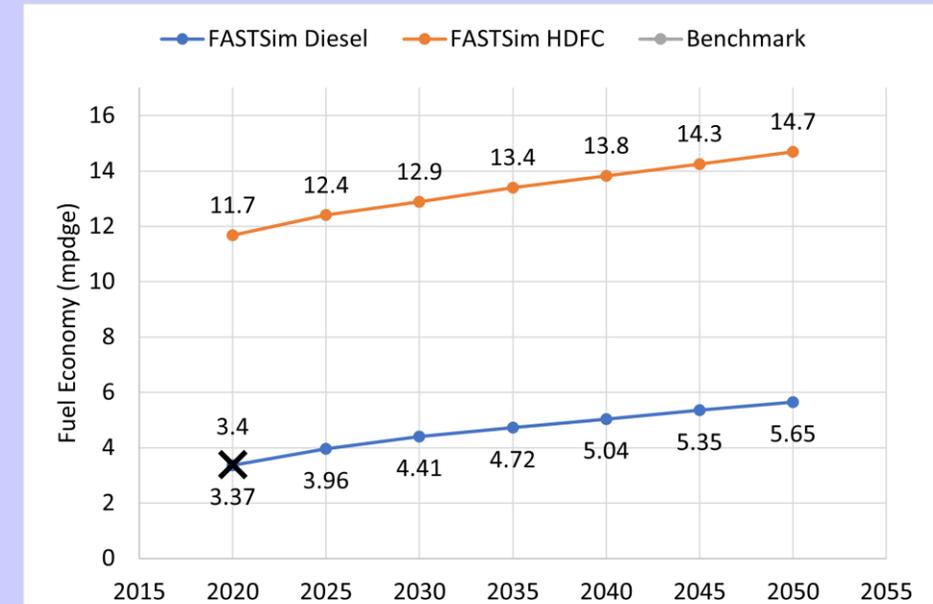


Current EPA Projects & Funding Opportunities

EPA-NREL Collaboration on Yard Tractors

Project Scope

- Extended the NREL T3CO framework to evaluate fuel cell cost and performance for off-road & nonroad vehicles
- **Yard tractor used as a test case**
- Parameterized modeling with real-world duty cycles
 - 64 instrumented yard tractors from 5 port terminals
- Estimated projected energy efficiency, initial cost and TCO from 2020 to 2050



Fuel Cells at Ports

Purpose: To develop a report that characterizes fuel cell technology applications at ports, how they can be best utilized.

Fuel cell technologies have the potential to replace diesel engines across a variety of sectors (i.e. marine, rail, and nonroad) and thus significantly reduce diesel emissions at ports.



Project Overview: Assessment of Fuel Cells at Ports

Report Contents:

- Detail background information on fuel cells
- Identify current applications of fuel cells across U.S. ports
- Emissions and cost effectiveness analysis of fuel cells
- Economic analysis of fuel cells



Outcomes:

- Assist EPA and port stakeholders in evaluating the technology
- Estimate potential emissions impacts for nonroad, marine, and heavy-duty applications
- Guide the use of these technologies in the DERA program

**Note: Expect to Publicly Release
this Report Fall 2021**

Diesel Emissions Reduction Act: A Pathway for Funding

DERA authorizes funding assistance to reduce diesel emissions from legacy engines and provide health & environmental benefits to target areas.

There are 4 components to DERA: national and tribal competitive grants, school bus rebates, and noncompetitive state grants.



DERA Cost-Share Funding

- Fuel cells can be funded as a replacement for certain vehicles and equipment.
- Funding levels vary based on the technology cost share.
 - Diesel Vehicle - up to 25 %
 - Alternative Fuel/Hybrid - up to 25%
 - Engine Certified to meet CARB Optional Low-NOx Standard - up to 50%
 - Vehicle/Equipment Replacements w/Zero Tailpipe Emission - up to 45%
 - Drayage Replacement (MY 2013 or newer) - up to 50%
 - Engine Replacement w/Zero Tailpipe Emission - up to 60%

Note: DERA grant priorities and cost share could change for FY2022

<https://www.epa.gov/cleandiesel>

DERA & Fuel Cells

- One fuel cell project funded w/DERA.
 - In 2017, awarded the replacement of two transit buses to H₂ fuel cells in Canton, OH
- Currently, DERA can provide funding for fuel cell transit/shuttle buses, drayage trucks, terminal-tractors/yard-hostlers, stationary generators, and forklifts.
- EPA welcomes fuel cell technology applications



Photo Credit: SARTA



What's Next?



Continue to see demonstration projects across a variety of nonroad applications for H₂ fuel cells

We are interested in learning about technologies ready for commercial sale/use.

Thank You

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