



COLUMBIA - WILLAMETTE  
**CLEAN  
CITIES**

# Hydrogen Transportation

Joint Committee on Transportation  
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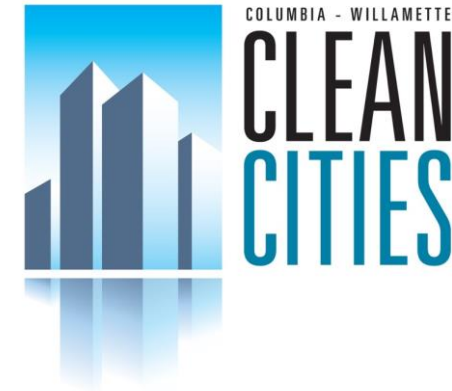
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# About Us

**We Are** a 501 (c) (3) nonprofit, and public-private partnership between the U.S. Department of Energy, national labs, and on-the-ground fleets throughout Oregon and Washington.

**Our Mission** is to provide resources, professional support, “fuel agnostic” expertise, and education and outreach to help our members navigate and adopt alternative fuel and fleet efficiency solutions.



# Our Core Focuses

## Education, Information, and Outreach

## Technical Assistance

## Trainings and Certifications

## Grants, Incentives, Deployments



Photo by Dennis Schroeder, NREL 33480

### School Districts Move to the Head of the Class with Propane

School districts across the country are under pressure to reduce their cost of operations and ensure their budgets are spent wisely. School bus fleets operate more than 675,000 buses in the United States, and many school districts have found the answer to their budget woes in the form of propane, or liquefied petroleum gas (LPG). Propane is a reliable, domestic fuel, and it's used in approximately 2% of school buses nationwide.



Unlike diesel engines, propane engines do not require advanced emissions controls and their related maintenance. Photo from MotorWeek/Maryland Public TV, NREL 17180

#### Propane's School Bus History

While propane has been used in buses for decades, recent technological advancements have made it more reliable than ever. Prior to 2007, all propane vehicles used vapor injection technology. In 2007, Blue Bird rolled out a propane school bus using direct liquid injection for the first time, and this was followed by Thomas Built Buses and Navistar. Liquid injection technology makes propane buses a more reliable option.

Since 2007, vehicle emissions standards have tightened for all vehicles. Propane vehicles meet these emissions standards without aftertreatment systems required for diesel vehicles. Because of this, and other reasons, many districts have found propane meets their criteria as an affordable, clean alternative.

#### Economic and Environmental Impacts

Propane is a domestic fuel created as a byproduct from crude oil refining and natural gas processing. Propane engines have simpler emissions controls, which allow them to meet U.S. Environmental Protection Agency standards. In addition, some school districts are reporting cost savings from reduced preventive maintenance such as oil changes (an effect also attributed to the fuel's clean-burning nature). Most significantly, propane also typically costs less than diesel fuel, particularly for fleets that work with their local propane marketers and equipment providers to install private

<sup>1</sup> Federal Highway Administration - Highway Statistics 2012, Table MV-10, [hwa.dot.gov/policyinformation/statistics/2012/pdf/mv10.pdf](http://hwa.dot.gov/policyinformation/statistics/2012/pdf/mv10.pdf)



VEHICLE TECHNOLOGIES OFFICE

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### Salem-Keizer Public Schools Selected by PGE for the Electric School Bus Project

May 5, 2020 | Bus, District News, Parents, Press Room, Schools, Staff, Students, Superintendent

Salem-Keizer Public Schools (SKPS) has been selected by [Portland General Electric](#) (PGE) as one of five school districts to participate in the 2020 School Bus Electrification Project.

The project will put the first five electric school buses on the road serving Oregon students in 2021.

Along with SKPS, the other district are Beaverton, Newberg, Portland and Reynolds. Each district will have an electric school bus to serve their students next year.

Using funding from the Oregon Clean Fuels Program, SKPS and the other school districts were chosen based on commitments to meet the needs of underserved communities and incorporate the buses more broadly into student education around climate science.

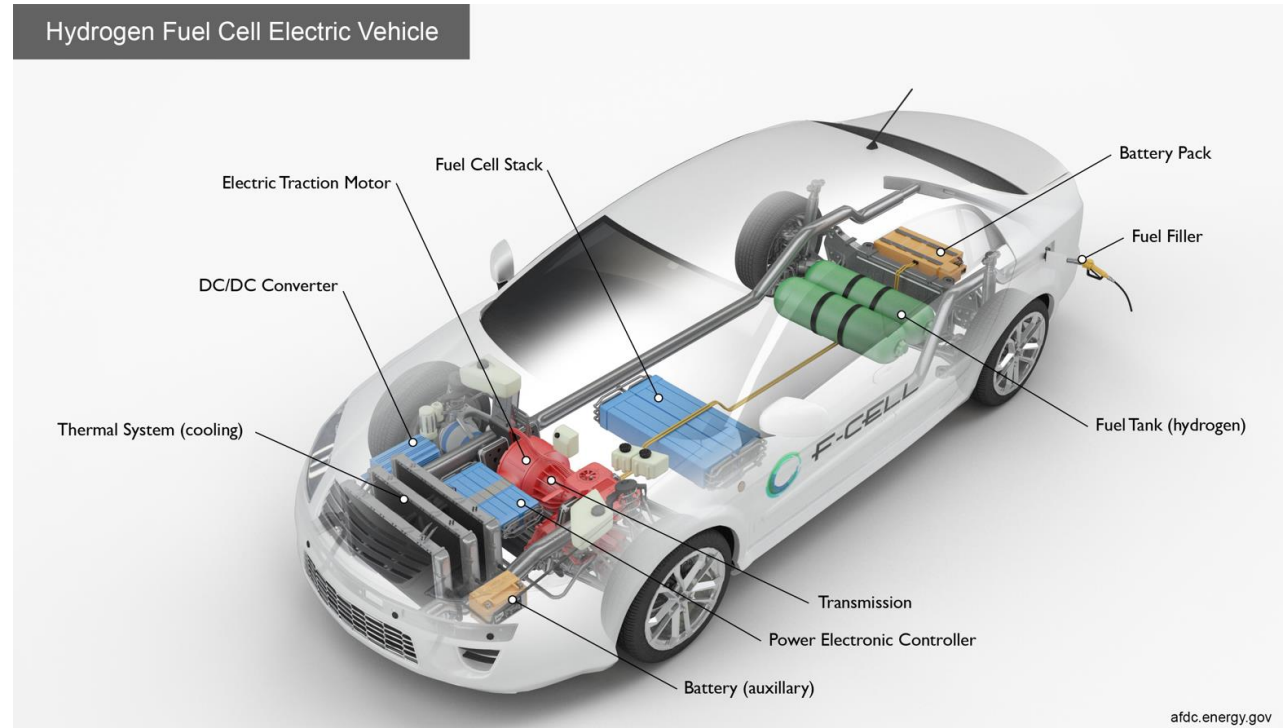


# Fuel Cell – the *other* EV

## Key Differences between Fuel Cell Electric Vehicles (FCEV) and internal combustion engine (ICE):

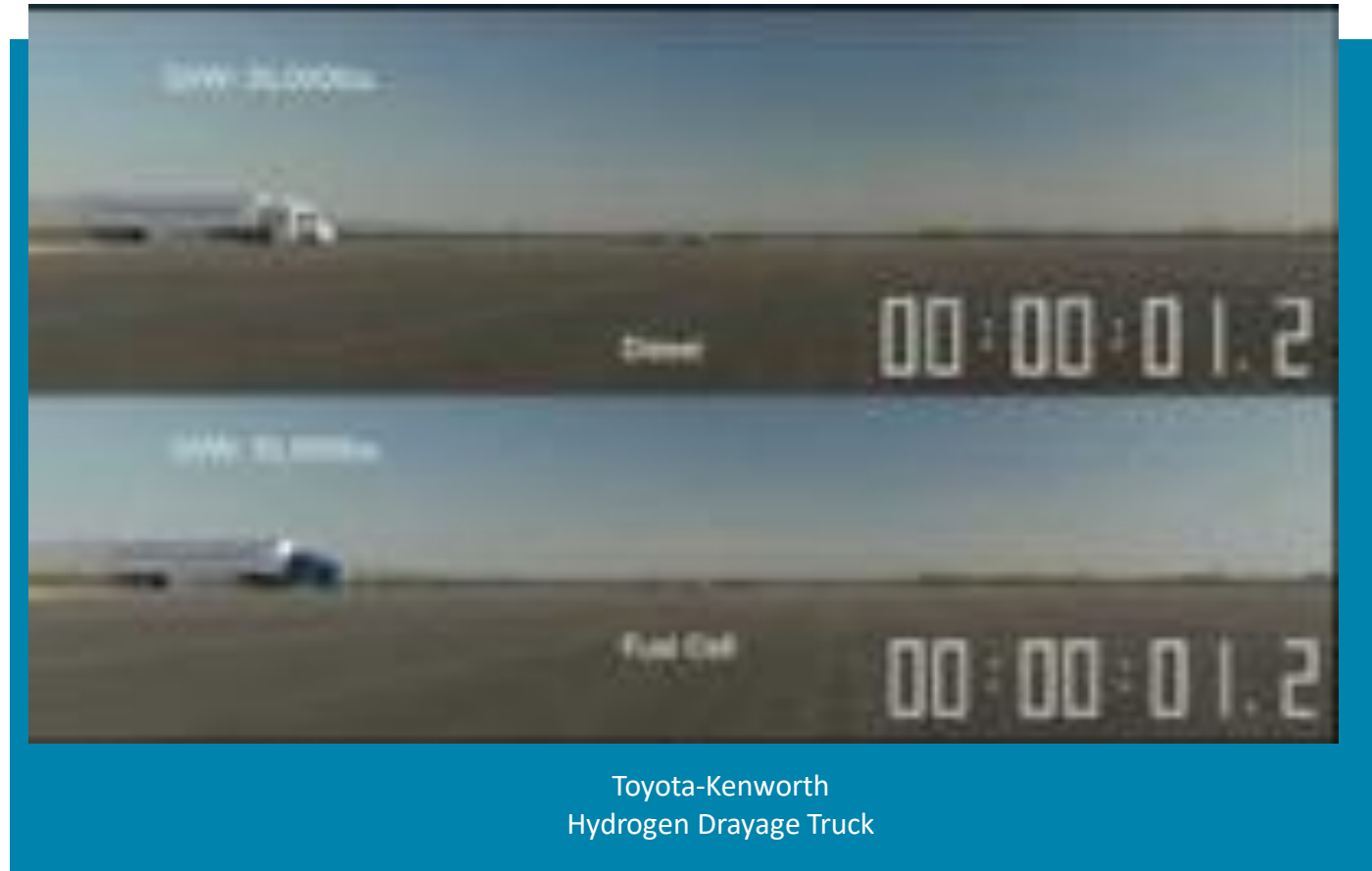
1. Employs a fuel cell(s)
2. Battery pack
3. Electric motors
4. Hydrogen storage tanks

Instead of smog, the byproduct of driving is water vapor



# The Appeal of Hydrogen Vehicles/Equipment

- Total Cost of Ownership trending down
- Zero tail pipe emissions
- Resilience - ability to produce fuel and energy in place
- Work well in fleets of all fuel types
- Performance
  - Quick refueling times
  - Extreme weather performance
  - Power and efficiency



<https://www.youtube.com/watch?v=mEycPDd2bW0>



# Where H2 is Thriving

## Freight



## Mass Transit



Best vehicle applications for hydrogen fuel-cell:

- Need for large amounts of continuous power
- Need for longer ranges
- Need for quick refueling

## Fleet Vehicles



## Material Handling



# Fuel Cell Transportation in Oregon

1

Vehicles

0

Fueling Infrastructure

## Barriers

1. Needs collaborative planning between public and private sectors for fueling infrastructure
2. Funding for fueling infrastructure
3. Incentives to consumers and fleet operators for vehicles/equipment

# Conclusion

1. Hydrogen vehicles excel in heavy-duty applications, all weather conditions, and have quick refueling times
2. Hydrogen vehicles work well as a zero-emission alternative and can augment battery electric fleets
3. There are barriers facing FCEV deployment in Oregon which require leadership from policymakers
4. FCEVs are new and developing – give them time and support to mature
5. We need both light duty and heavy-duty FCEVs







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Thank You

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# Heavy Duty Trucks

*Light duty needs heavy duty; heavy duty needs light duty*

## Fuel Cell Electric Trucks

- Advanced Clean Truck rule
- Fueling infrastructure projects
  - 3 heavy duty H2 stations
    - More being announced
  - Ontario, Wilmington and Port of Long Beach
  - 1-2 temporary fuelers
- CARB & CEC heavy duty funds
  - Include heavy duty infrastructure



## Truck automakers & others

- Toyota-Hino alliance
- Daimler-Volvo alliance
- Nikola Motor
- Hyundai
- Cummins



# Additional Information

1. **Routes require 1.5 BEBs for every standard bus replaced on routes, while FCEBs are a 1:1 replacement.** Foothill Transit in California found that to replace buses along a major 42-mile bus route, they would need 34 BEBs or 23 FCEBs. That is 1.5 BEBs per every FCEB.
2. **Infrastructure costs are lower for FCEBs with scale of fleet deployment.** Foothill Transit estimated that it would cost \$4 million for a hydrogen fueling station which could serve up to 30 buses. The infrastructure required for BEBs would cost \$10.95 million.
3. **Foothill Transit found that Fuel Cell buses have comparable costs per-mile for fuel and maintenance.**

Fuel Cost/Mile/Bus		Annual	Scheduled Maintenance per Mile		Annual Cost
Fuel Cell	\$1.00	\$1,305,111.63	Fuel Cell	\$0.12	\$156,613.40
BEB/kW	\$0.76	\$986,664.39	BEB	\$0.04	\$52,204.47

4. **Mid-life replacement costs per bus were a fraction for FCEBs (\$30k/bus) vs. BEBs (\$200k/bus).**
5. **In total, Foothill Transit estimated in this analysis that FCEBs would save the agency nearly \$13 million compared to BEBs over 12 years of useful bus life.**

# Stations Getting Bigger, Costing Less

