

# Fuel Cell Applications

## DOE Truck Targets Workshop

Argonne National Lab

CREATING A ZERO-EMISSIONS WORLD  
POWERED BY TOYOTA HYDROGEN FUEL CELL TECHNOLOGY

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Toyota Motor North America

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# Presentation Key Topics



- Technology Portfolio
- ZEV Freight Movement
- Project PORTAL
- Scalability



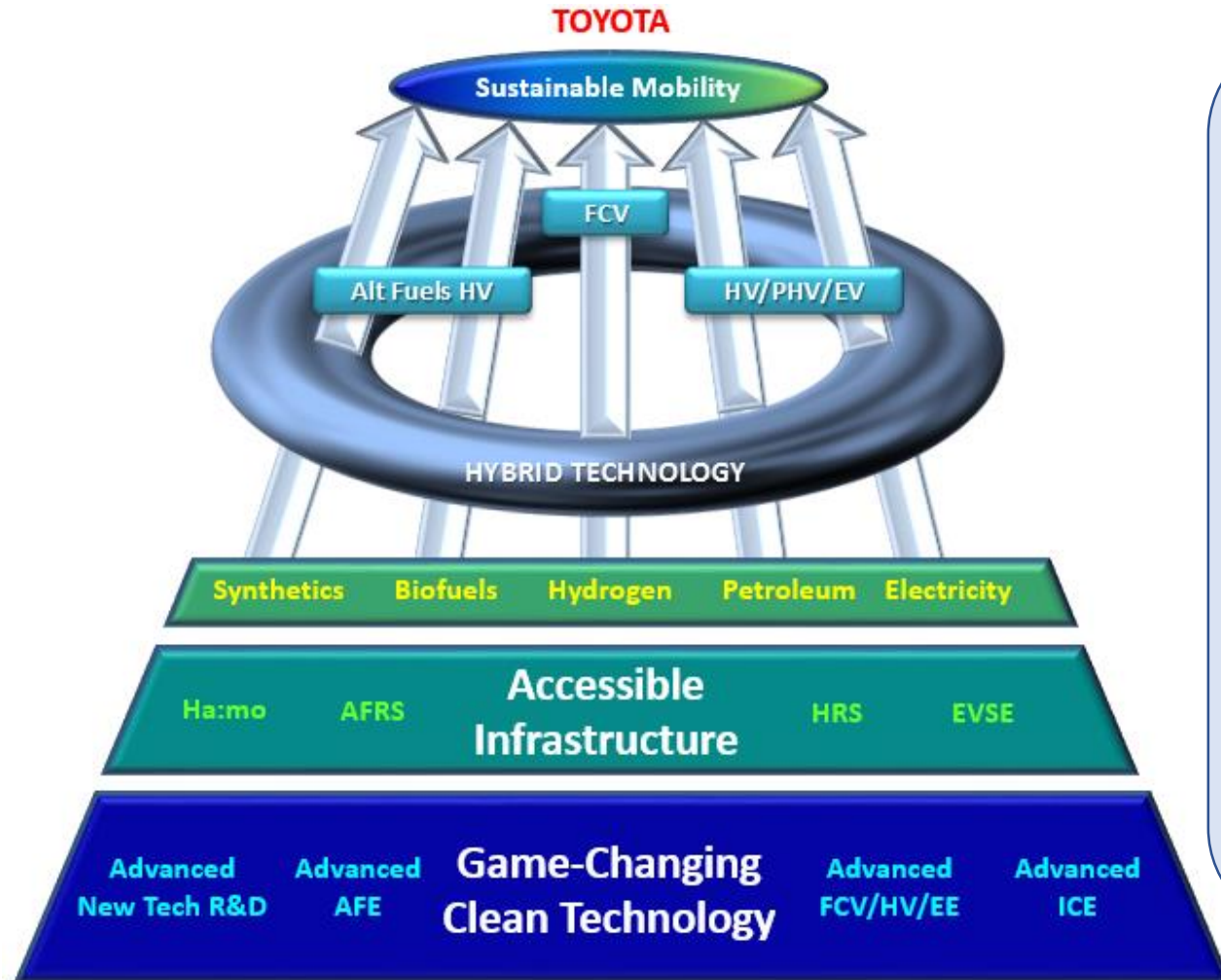


# Toyota Sustainable Mobility Philosophy



## TOYOTA ENVIRONMENTAL CHALLENGE 2050

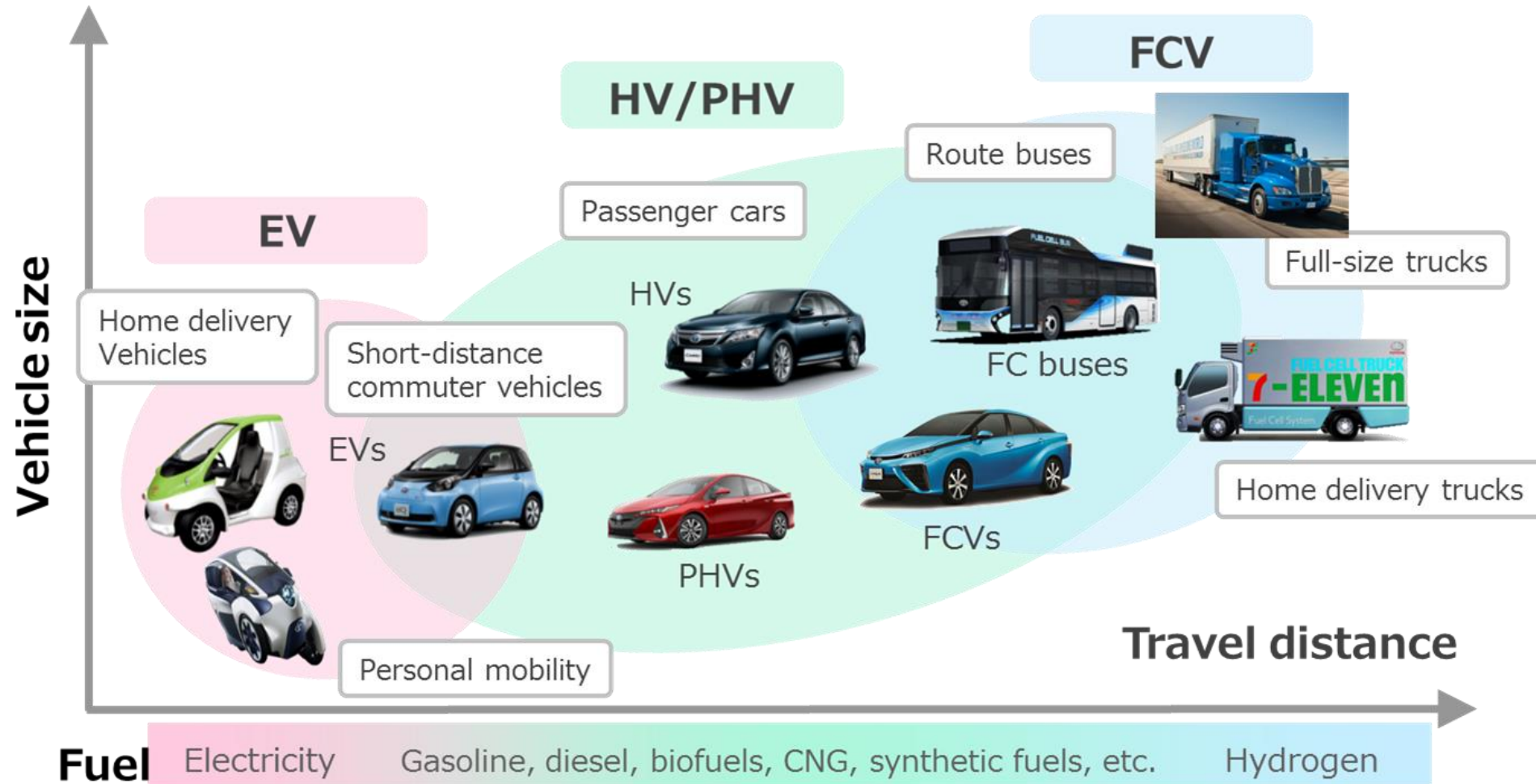
<b>CHALLENGE 1</b>	<b>CHALLENGE 2</b>
New Vehicle Zero CO <sub>2</sub> Emissions Challenge	Life Cycle Zero CO <sub>2</sub> Emissions Challenge
<b>CHALLENGE 3</b>	<b>CHALLENGE 4</b>
Plant Zero CO <sub>2</sub> Emissions Challenge	Challenge of Minimizing and Optimizing Water Usage
<b>CHALLENGE 5</b>	<b>CHALLENGE 6</b>
Challenge of Establishing a Recycling-based Society and Systems	Challenge of Establishing a Future Society in Harmony with Nature



## 20+ Years of Toyota FCEV P/T Advancement & Scalability

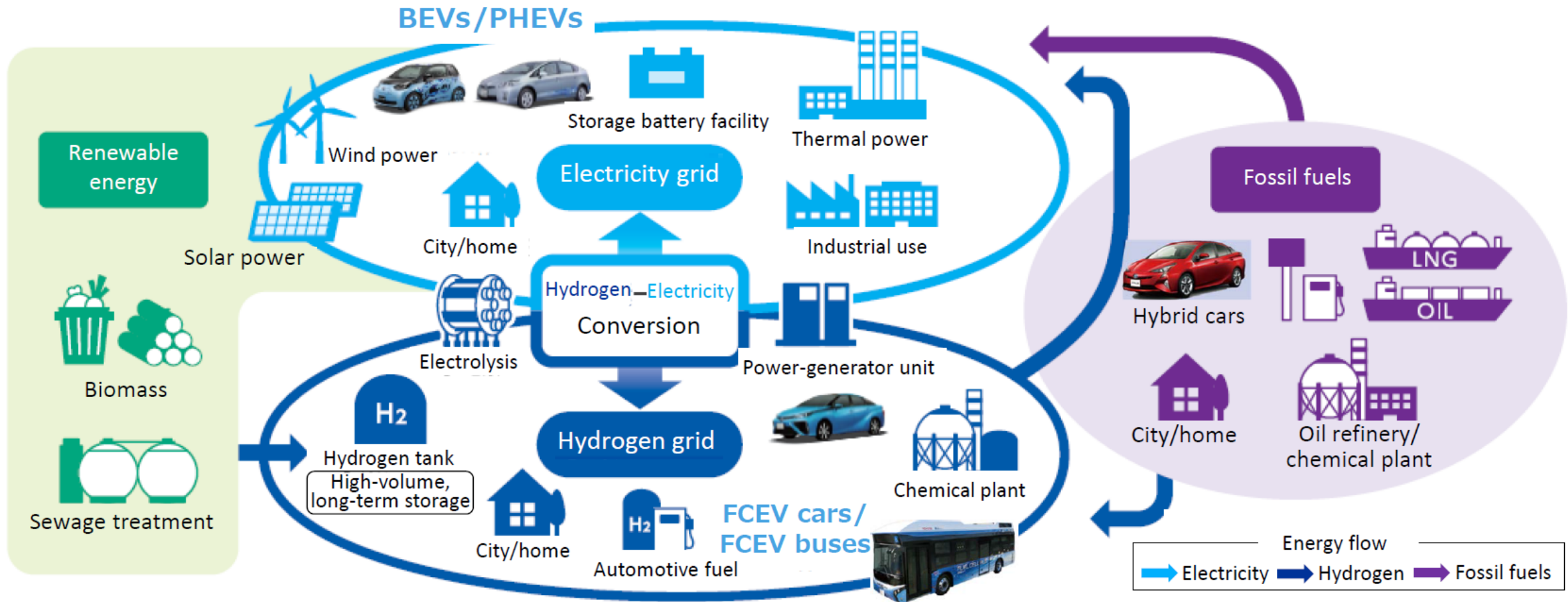


# Technology Portfolio



Toyota is developing all major advanced technologies – BEV, FC, PHV

# Energy Ecosystem



Toyota's portfolio approach is synergistic with a broad energy ecosystem



# Global Automotive Trend

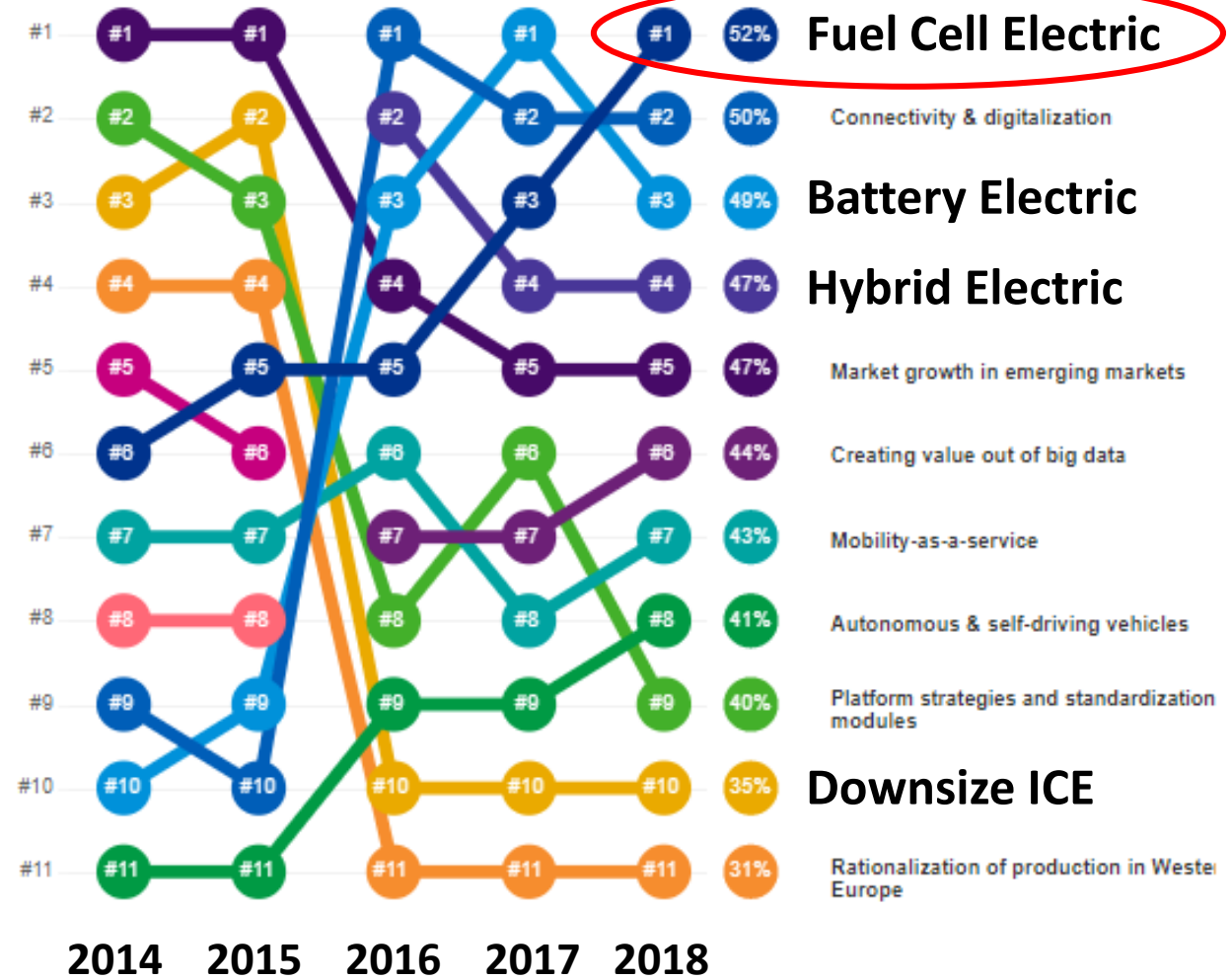


## I. Global Automotive Executive Survey 2018

- Rates FCEVs as the #1 priority in 2018

## II. Strong ZEV and emissions goals

- **Countries:** Non-EV sales bans
- **Auto Companies:** phase out non-EV production and sales
- **Local Regions:** Ports and Cities setting more stringent goals

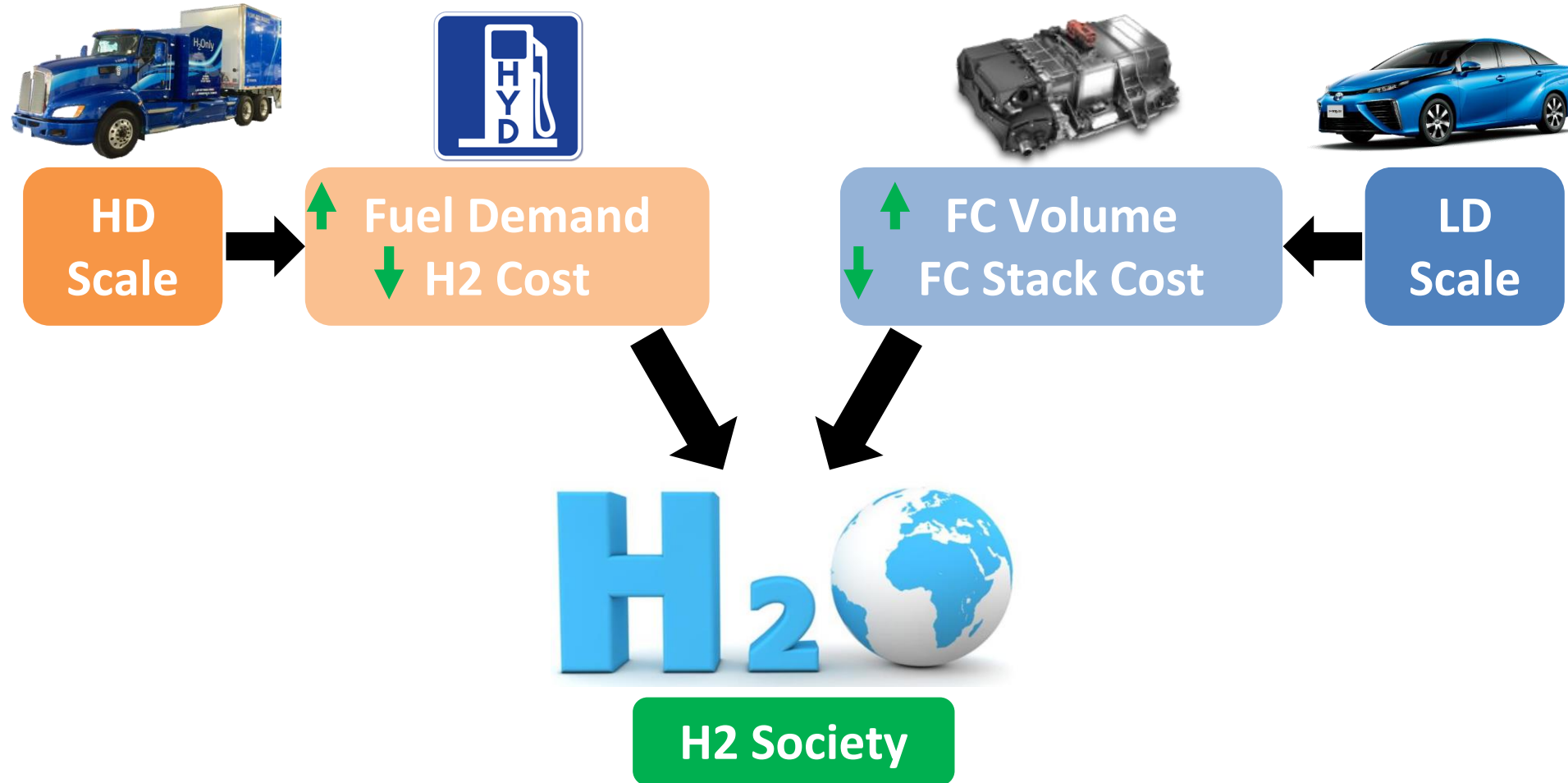


Note: Percentage of executives rating a trend as extremely important

Source: KPMG's Global Automotive Executive Survey 2018 | © KPMG Automotive Institute

	2014	2015	2016	2017	2018
n=	200	200	800	953	907

# Light-Duty and Heavy-Duty Synergy



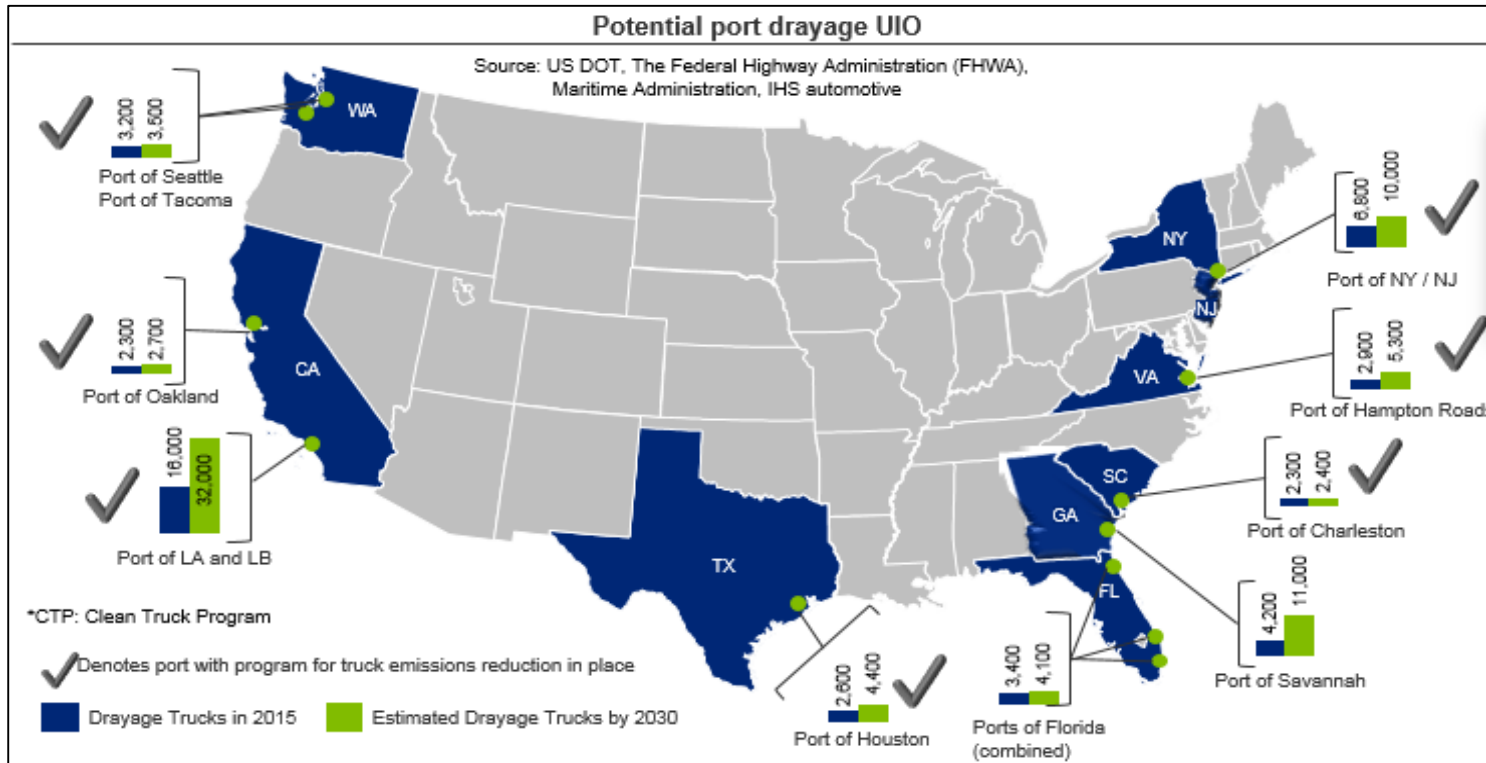
HD and LD markets can grow together synergistically to reduce H2 fuel and fuel cell stack costs which enables a hydrogen society

# Zero Emission MHDV Market pull



- Zero Emission MDHV: Large market pull
- High mileage, long idle time, low fuel economy  
-> ~~Higher emissions.~~

## Numerous Clean MHDV announcements





# The San Pedro Ports Solution



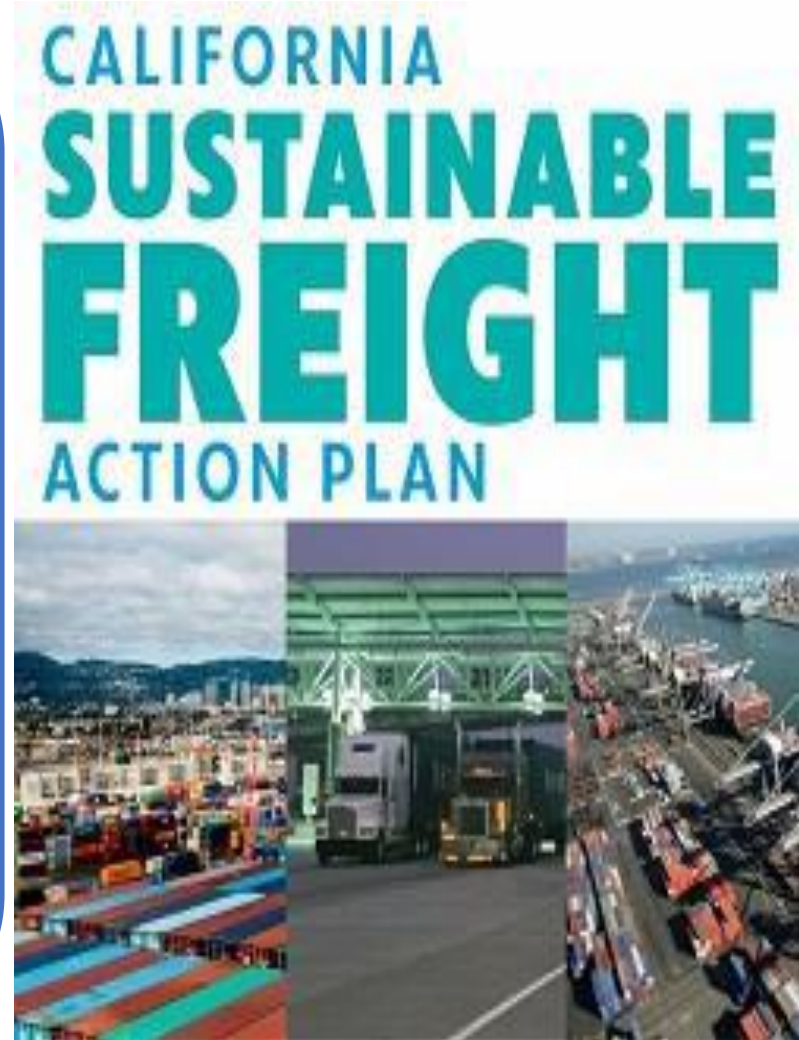
**Desire to expand while  
reducing emissions**

**High impact to  
disadvantaged communities**

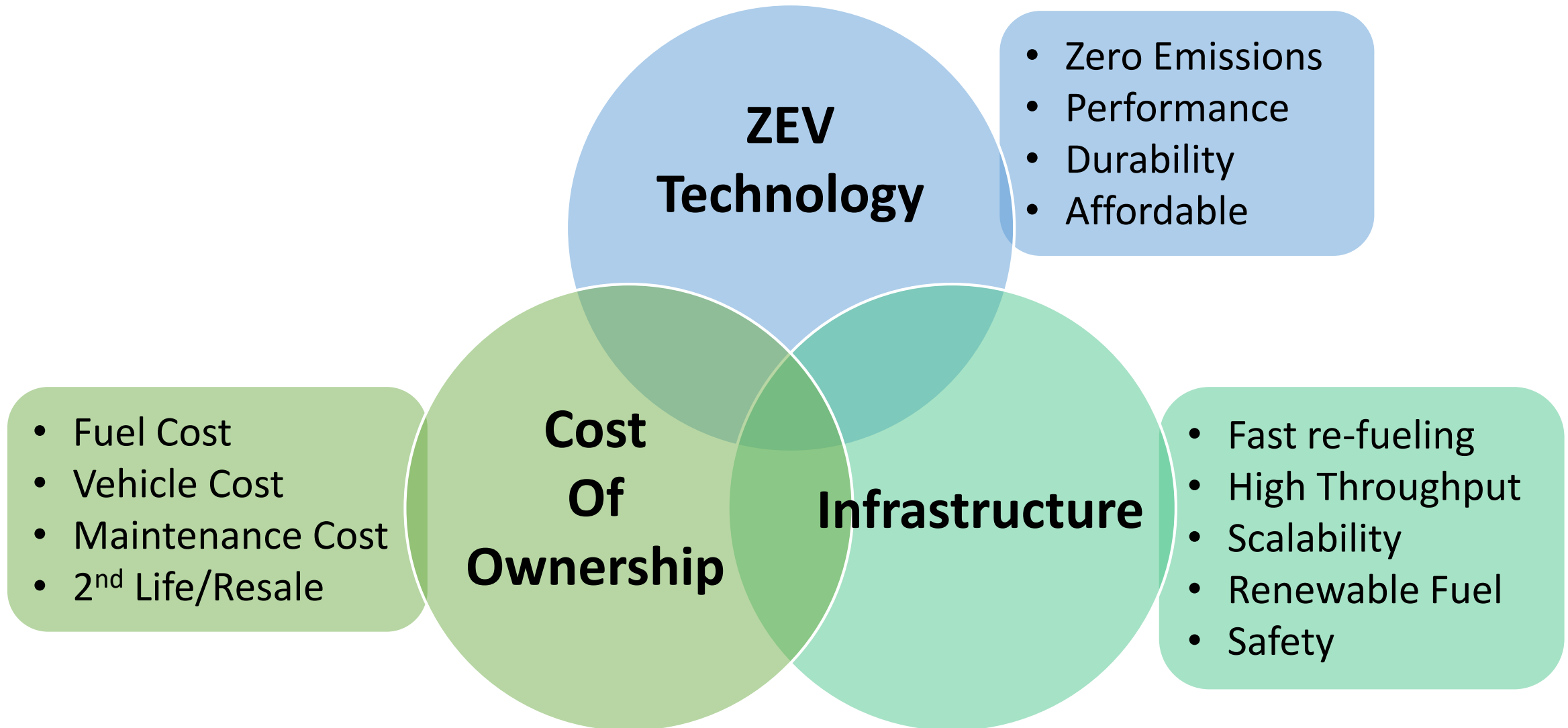
**Clean Air Action Plan**

- 2030: Terminal Trucks ZEV
- 2035: All Trucks ZEV

**Requires ZEV solution**

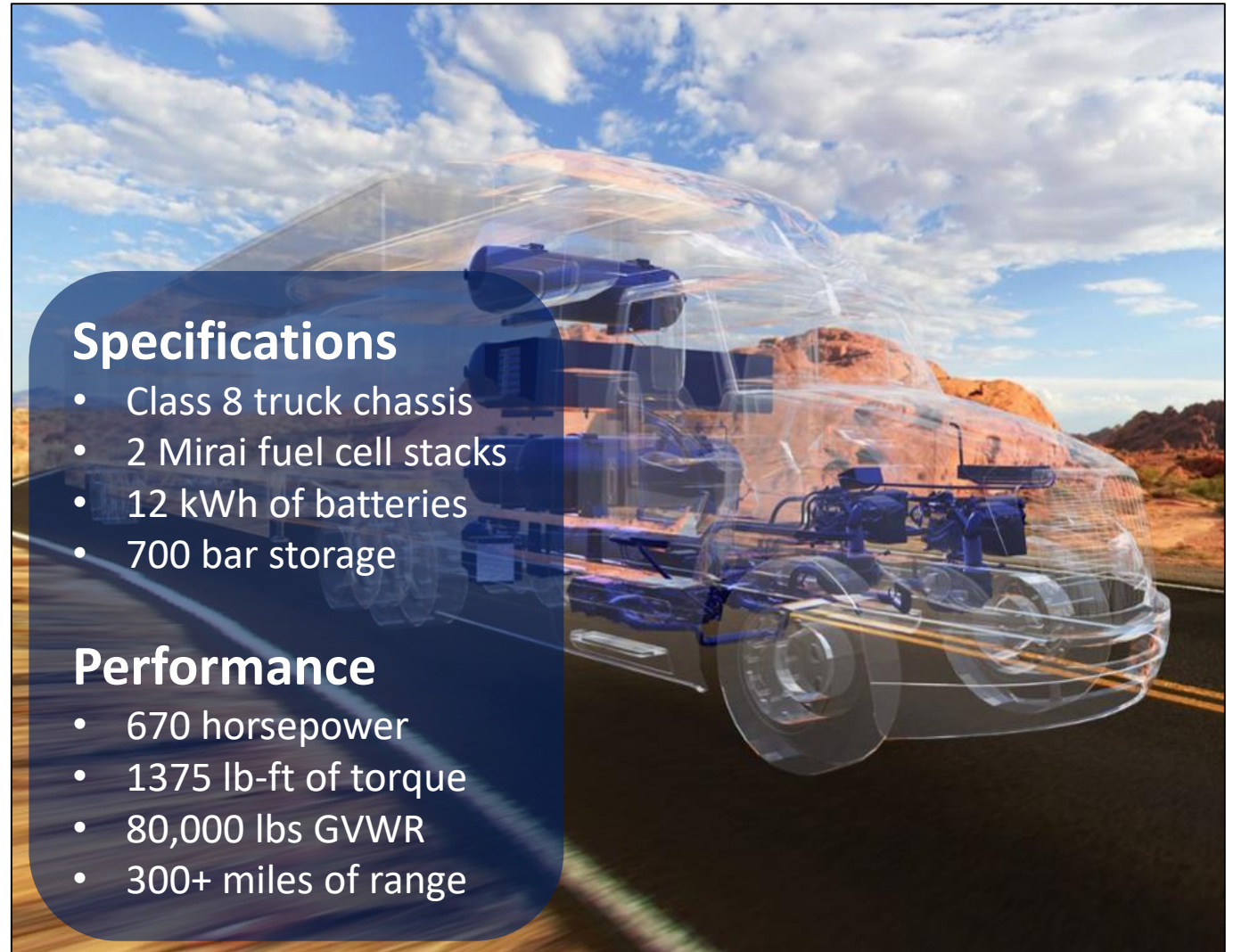
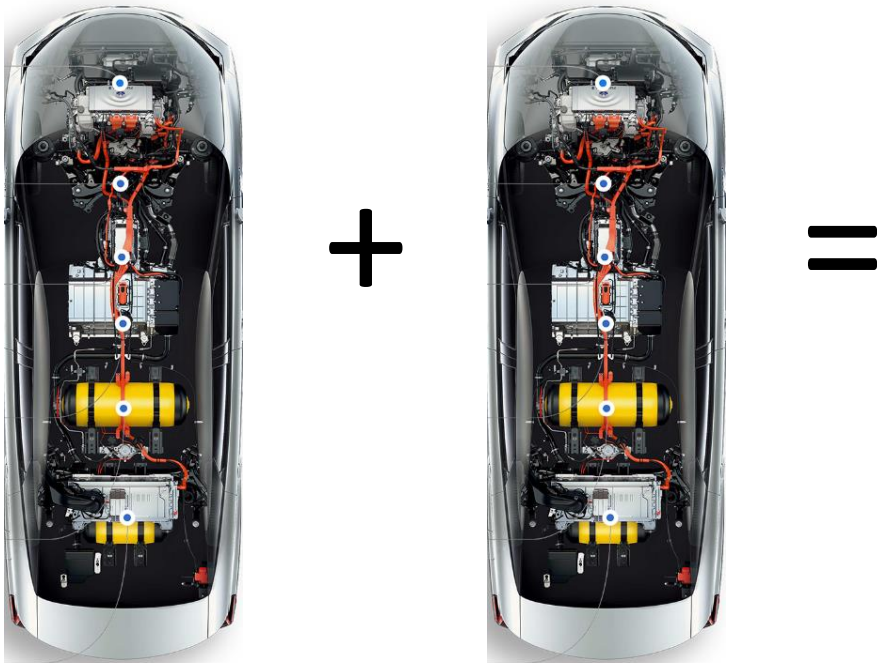


# Key Elements for Clean Trucks





- Leverage Mirai components from 2 vehicles
- Benchmark current class 8 truck performance



**Specifications**

- Class 8 truck chassis
- 2 Mirai fuel cell stacks
- 12 kWh of batteries
- 700 bar storage

**Performance**

- 670 horsepower
- 1375 lb-ft of torque
- 80,000 lbs GVWR
- 300+ miles of range



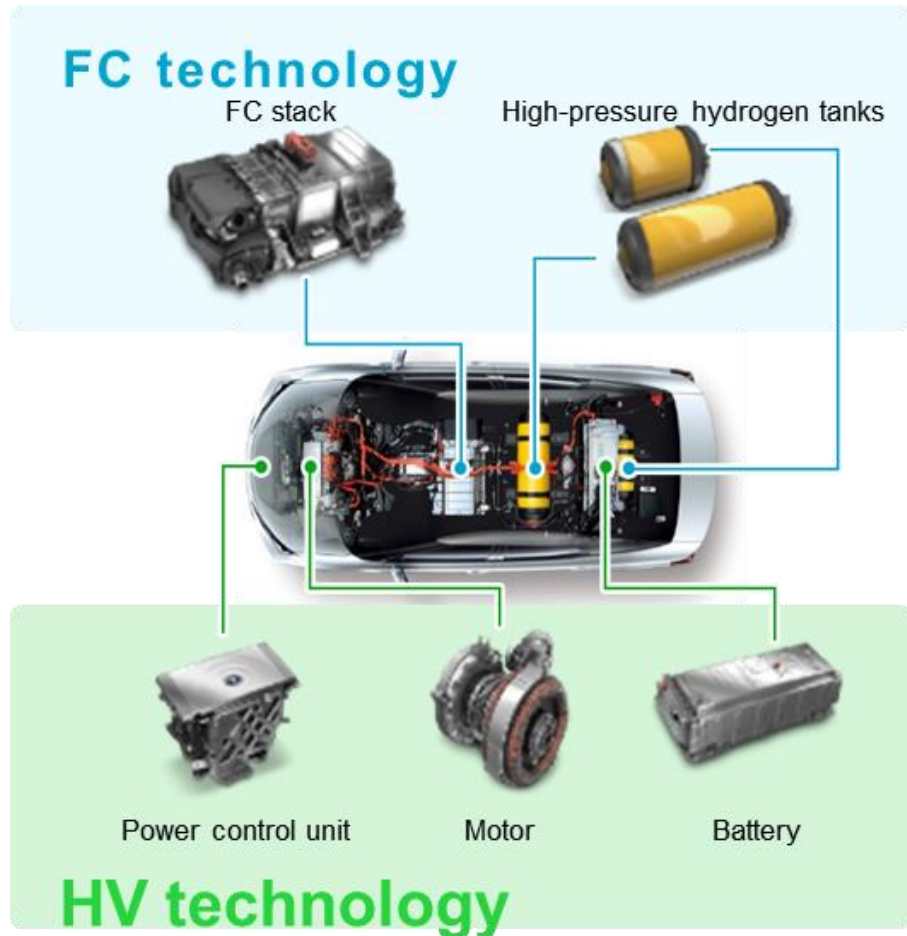
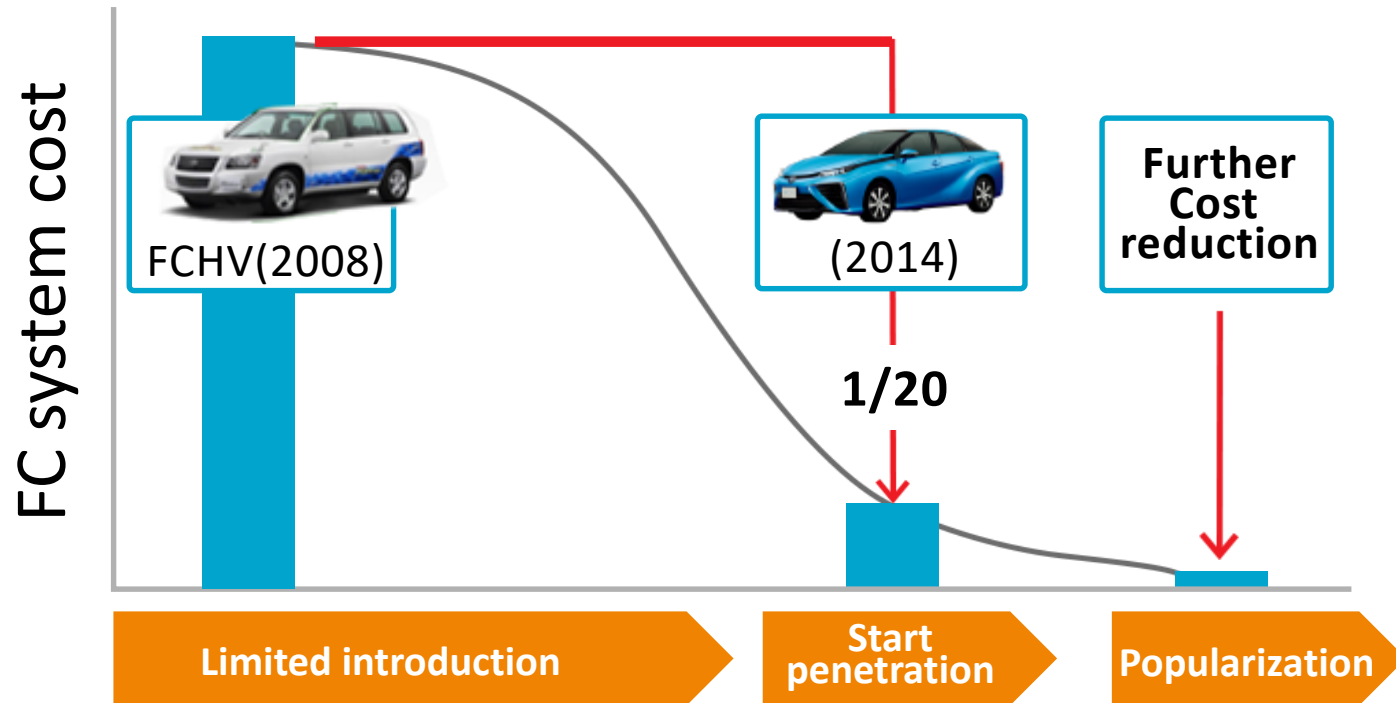
# Performance: Drag Test

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[http://pressroom.toyota.com/video\\_display.cfm?video\\_id=34150](http://pressroom.toyota.com/video_display.cfm?video_id=34150)

## Toyota Fuel Cell Cost Reduction



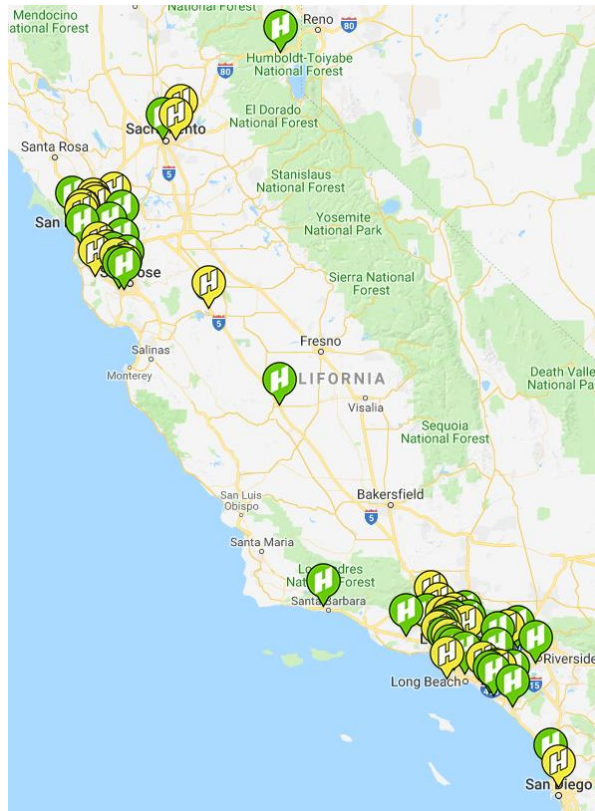
- Achieved significant cost reduction from Mirai development
- Leverage Mirai technology in Portal to reduce cost

# Infrastructure: Light-Duty and Heavy-Duty



## California Light Duty Station Network

- Executive Order:  
200 stations by 2025
- 35 current open retail
- ~30 additional stations funded



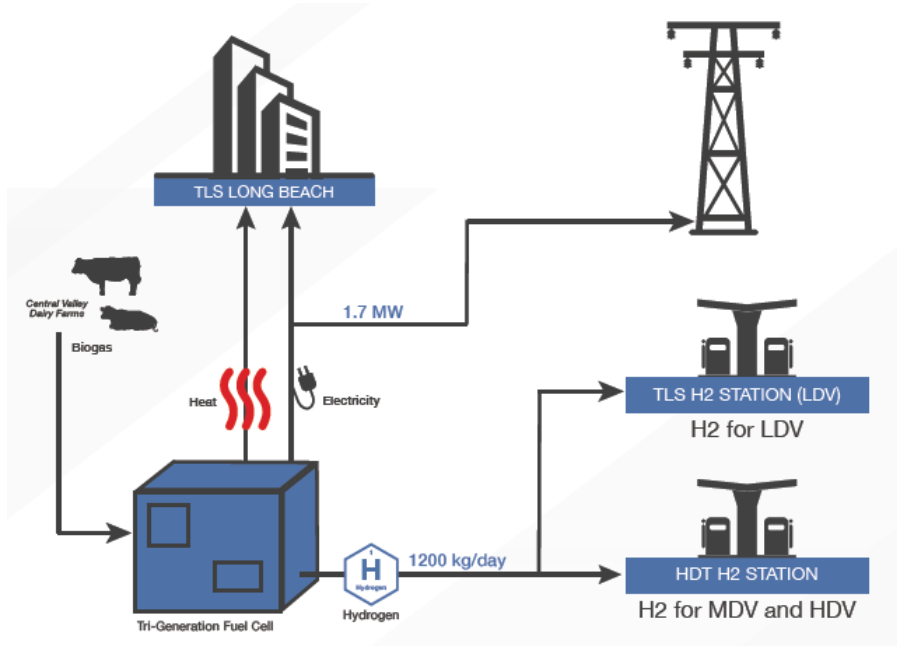
## Heavy-Duty Stations



Station in POLB  
(Air Liquide) - *currently operating*

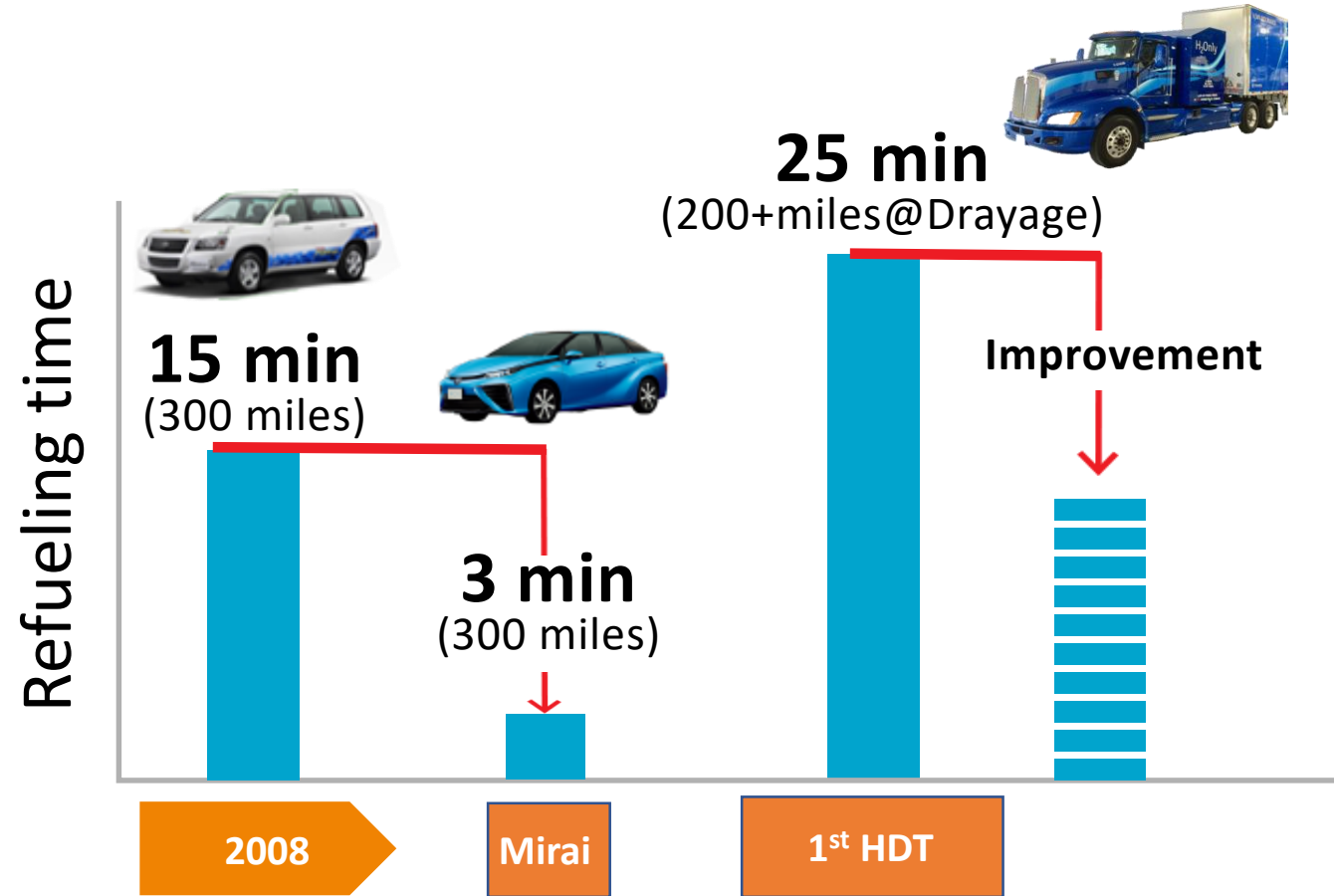
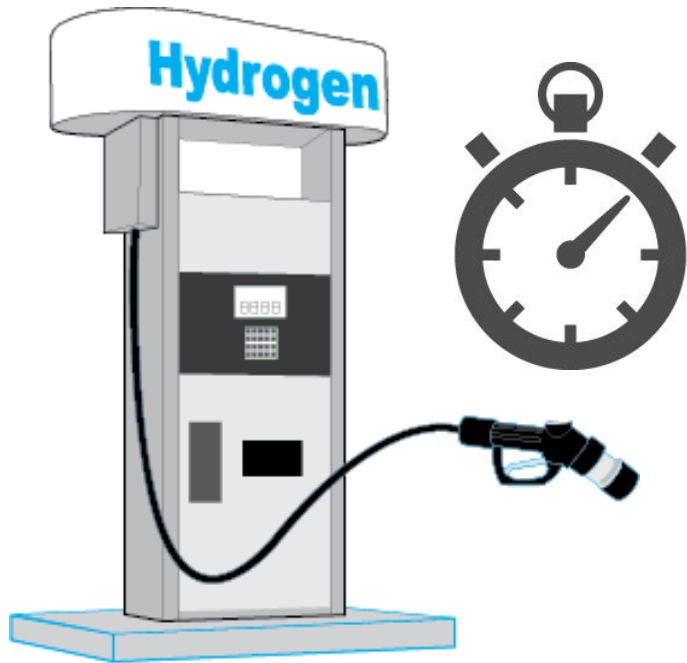
Tri-generation Station in POLB  
(Shell, Fuel Cell Energy) - *Q1 2020*

- 100% renewable hydrogen and electricity production
- Awarded \$8MM grant from the California Energy Commission





# Infrastructure: Refueling time



- Expect practical refueling time for FCET
- Requires new development and collaboration (similar to LD)

# Scalability of ZEV Technology



## Mobility Applications



## Infrastructure Considerations



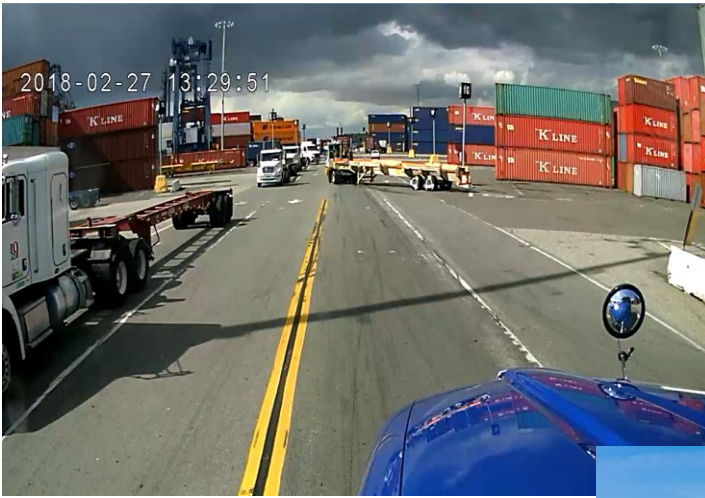
<b>FCEV:</b> 1 H2 Station	Regional Station Network	National Station Network
<b>BEV:</b> Depot charging	Numerous Depot/Fast Charge Locations	National Charging Demand

## Key Points

- FC technology is a viable ZEV solution across a broad range of applications
- H2 fueling infrastructure is scalable and meets the needs of end users
- EV charging infrastructure quickly realizes grid constraints and high demand charges when scaled up



# PORTAL in Action





# CREATING A ZERO-EMISSIONS WORLD

PIONEERING THE PATH TOWARDS A NEW ERA OF PORT PROGRESS



TOYOTA

Thank you!

James Kast  
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HEAVY-DUTY PROGRESS POWERED BY **TOYOTA** HYDROGEN FUEL CELL TECHNOLOGY

# Video Links

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Project Unveiling

[http://pressroom.toyota.com/video\\_display.cfm?video\\_id=34149](http://pressroom.toyota.com/video_display.cfm?video_id=34149)

Truck build and drag test

<https://www.youtube.com/watch?v=E3993-Pczhl>

Drag test

[http://pressroom.toyota.com/video\\_display.cfm?video\\_id=34150](http://pressroom.toyota.com/video_display.cfm?video_id=34150)