Medium- and Heavy-Duty Fuel Electric Cell Truck Action Plan for California

November 8, 2016

California FUEL CELL PARTNERSHIP
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952,000
trucks in California

Stakeholder Input Process

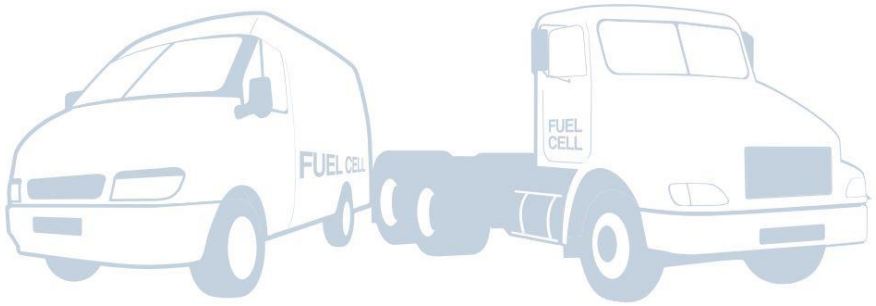
- Task force meetings for input, direction and decisions
- Interviews with stakeholders
  - Manufacturers, integrators, operators, fuel providers, component suppliers
- Focus groups – two facilitated workshops
  - Industry input and review of content
- Broad CaFCP membership input, review and approval
  - Working Group, Steering Team and Executive Board

How….

1. Successfully demonstrate fuel cell trucks to spur more development.

2. Establish the necessary hydrogen infrastructure for trucks.

3. Create a sustainable business case for truck manufacturers.



Initial Truck Vocations

Focus on two vehicle platforms and applications

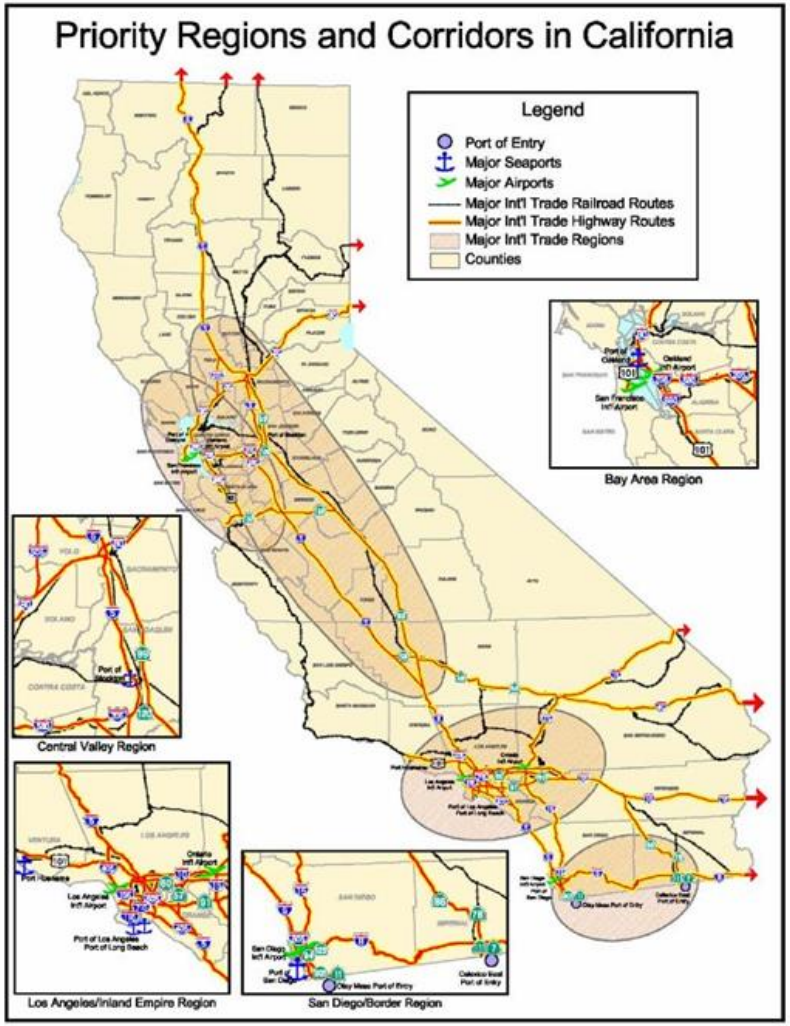
- Medium-Duty FCET platform: Class 4-6 last-mile package delivery trucks
- Heavy-Duty FCET platform: Class 7-8 short haul/drayage trucks

Source: Hydrogenics

Source: CTE

Demonstrations

- Focus on
  - South Coast air basin
  - San Joaquin Valley
  - San Francisco Bay Area
- Start with truck vocations that return to home base
- Use lessons learned from fuel cell buses
- Determine metrics that do not change



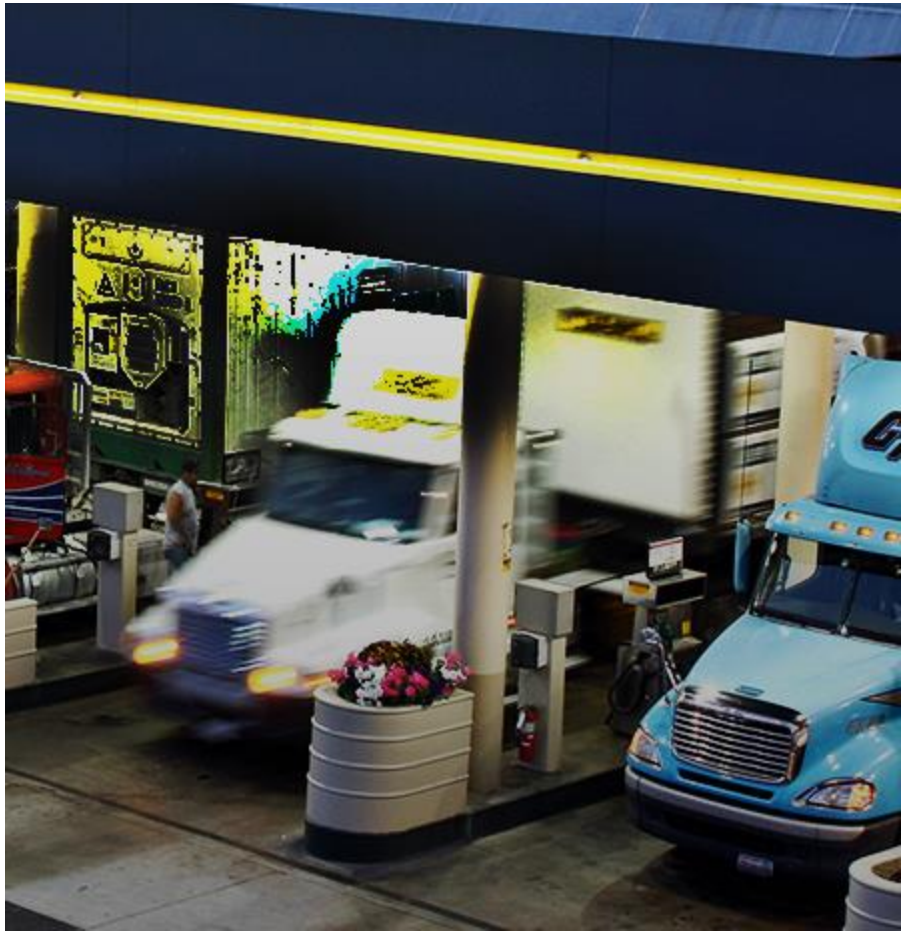
Proposed Target Metrics

Parameter	MD FCET	Baseline	HD FCET	Baseline
Miles between fueling	>125	400	100-200	400
Performance	0 to 60 in 26 seconds	0 to 60 in 12 seconds	400HP / 1,200-1,800 ft-lbs torque	400HP / 1,200-1,800 ft-lbs torque
Top speed (mph)	65	85	62-65	62-65
Refueling interval	Daily	Multiple days	1-2 days	2-4 days
Operates for	12 hours	14 hours	10-14 hrs	10-14 hrs
Route flexibility	95%	100%	100%	100%
Grades	15% - launch to top cruising speed of 20 mph in 3 sec	15% - launch to top cruising speed of 20 mph in 3 sec	6.5%	6.5%
Durability (miles)	TBD	300k	>500k	>500k
Durability (hours)	>5000			
Durability (years)	10-12	22	8+	10+
Availability	95%	>98%	90%*	90%*
Warranty	TBD	3 yrs/50k mi	TBD	3 yrs/300k mi

Five Priority Recommendations

- Transfer the lessons learned from implementing and operating fuel cell bus programs to truck vocations, especially as these lessons relate to technology, and help identify or reduce risk to the financial community (*industry*).
- Conduct data collection using a consistent set of fleet operation variables for comparison, feasibility assessments, and decision making; this should be a basic requirement for all government-funded truck projects (*government and industry collaboratively*).
- Prove the reliability of MD and HD FCETs to show the cost-per-mile economics of transported freight; this is critical to the sustainable operation of this technology (*industry*).
- Establish targets and priorities for future MD and HD FCEV funding programs (*federal government*).
- Initiate, expand, and direct national efforts to perform in-depth studies of fuel cell technology in trucks to understand the components of the total cost of ownership and opportunities for cost reduction (*federal government*).

Infrastructure

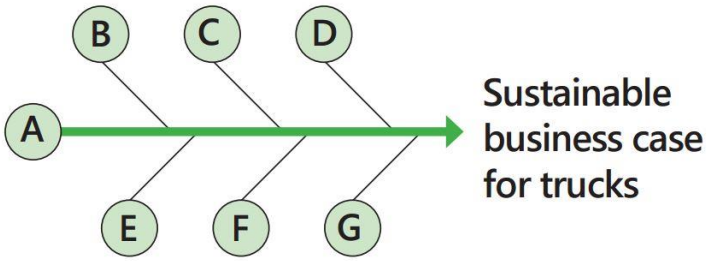


- Trucks use dedicated fueling stations
- A small fleet will need more capacity than today's retail stations
- H35 is currently sufficient for trucks
- Lessons learned from fuel cell bus fueling transfer to trucking

Four Priority Recommendations

- Fund initial private or commercial hydrogen fueling infrastructure, with consideration of public funding for station operation and maintenance (O&M) in early years (*state government*).
- Develop the current SAE J2601/2 TIR "Fueling Protocol for Gaseous Hydrogen Powered Heavy Duty Vehicles" to the level of a full standard and generate data to resolve SAE J2601 not including 35 MPa fueling (6-10 kg) to address the current gaps in fueling protocol codes and standards (*government and industry collaboratively*).
- Consolidate funded truck projects and development of commercial HD fueling infrastructure, so stations have higher throughput, reducing the cost of fuel and capital expense of infrastructure (*industry and government collaboratively*).
- Support FCEB Centers of Excellence to prove infrastructure and fuel cost reduction, and develop expertise and understanding about hydrogen fueling for large fleets (*federal and state government*).

Sustainable business case



A. Meets customer requirements
B. Favorable operating environment
C. Regulatory stability for product planning
D. OEM "essentials"
   - Essential enablers
   - Revenue to sustain operations
   - Return on investment + profit
E. Incentives support the path to sustainable sales
F. Reliable, accessible, and affordable fueling
G. Go/no-go milestones
   - Some truck vocations may never transition to ZEV technology
   - Provide time for iterations to meet minimum requirements

The bottom line assumption is that the TCO should be competitive with conventional technology

Five Priority Recommendations

- Build a better mutual understanding of the truck manufacturing product creation process in the context of FCET technology development (*government and industry collaboratively*).
- When setting targets, stakeholders should assume a timeline of 7-15 years for developing new truck platforms with completely new propulsion and power train systems in their decision-making process (*government and industry collaboratively*).
- Establish separate stakeholder groups (drayage and package delivery) to discuss and provide realistic market information about the baseline requirements for vehicle technology, operational cycles, supplier expectations, etc. (*industry*).
- Assess options for developing a ZEV credit or long-term incentive strategy for MD and HD ZEVs to encourage truck integrators and OEMs to invest in the RD&D of fuel cell technology in trucks (*federal and state government*).
- Assess corporate operating structure options to create economic benefits for MD and HD FCET operators and initiate within the next 5-to-10 years (*government and industry collaboratively*).

Four Focus Areas

1. Accelerating demonstration of FCEV technology in MD package delivery and HD short-haul trucks
2. Developing permanent hydrogen fueling infrastructure for California's FCET demonstration projects
3. Initiating funded FCET demonstration projects
4. Continue and expand public-private partnerships

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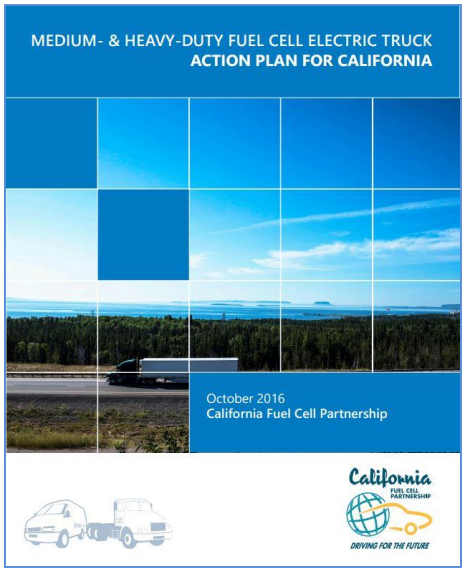

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