In California, 40% of greenhouse gas emissions are sourced from the transportation sector. Heavy-duty trucking makes up 21% of these emissions and 26% of statewide emissions of oxides of nitrogen (NOx). Therefore, the State is implementing the Advanced Clean Trucks (ACT) regulation, to drive adoption of zero-emission Class 8 truck tractors as a percentage of sales in California by 2030. In response, Class 8 truck OEMs are investing in the development of fuel cell electric trucks (FCETs) to meet market needs.

**Benefits:**
- Comparable Range to CNG
- Comparable Payload to Diesel
- Multi-shift Operation
- Quick Refueling
- Ease of Operation
- No Self-Discharge
- Zero Emissions

**Hydrogen and Infrastructure**

Hydrogen fuel storage shows 0% degradation over time, meaning no loss of fuel when parked, which unique among zero emission technologies. Hydrogen as a fuel requires minimal change to fueling logistics and shift operation compared to diesel and natural gas. The ability to refuel vehicles in rapid succession means fleets have similar operator experience as diesel and CNG. Figure 1 shows that a long-haul Class 8 hydrogen truck can achieve an approximate 280-mile range after 10 minutes of refueling, whereas an equivalent 350kW DC fast charger would only provide sufficient charge to travel 30 miles in the same 10 minute refueling time. The future case for hydrogen will be similar to diesel as far as time at the pump, whereas even with a 1,500 kW DC fast charger, battery electric trucks (BETs) still fill only at about ¼ of the rate as a modern diesel vehicle – charging to approximately 250 miles in 10 minutes.

**Improving Economics**

In a white paper produced by Ballard and Deloitte, it conservatively estimates the Total Cost of Ownership for commercial hydrogen vehicles will fall by more than 50% in the next 10 years. The cost of fuel is estimated at more than 40% of the total cost of operating a commercial truck, not including driver costs. It is vitally important that the cost of hydrogen fuel decreases to a level that will support the commercialization of FCETs. DOE estimates hydrogen cost at $5.00/kg.

In their most recent report, NREL found the average cost of hydrogen incurred by the Stark Area Regional Transit Authority (SARTA) was $5.27 per kilogram (kg). Bloomberg recently estimated the cost of producing renewable hydrogen could decrease to $1.40/kg as soon as 2030, which would support a pump price approaching $4.00/kg for renewable hydrogen. The result is a lower overall cost than BETs and comparable cost to CNG/LNG/Diesel trucks for urban and port operation.
Key Features and Performance

FCETs are performing well in pre-commercial testing in real world port and freight applications. Multiple OEMs are validating that FCETs are a 1-to-1 zero emission replacement for Class 8 diesel trucks both in terms of vehicle performance and operations. Active FCET projects include:

<table>
<thead>
<tr>
<th>Project Name</th>
<th>OEM</th>
<th># of FCETs</th>
<th>Deployment Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZEET T</td>
<td>Multiple</td>
<td>6</td>
<td>2016-2020</td>
</tr>
<tr>
<td>Project Portal</td>
<td>Toyota</td>
<td>2</td>
<td>2017-2018</td>
</tr>
<tr>
<td>Shore-to-Store</td>
<td>Toyota/Kenworth</td>
<td>10</td>
<td>2019-2020</td>
</tr>
<tr>
<td>XCIENT</td>
<td>Hyundai</td>
<td>1,600</td>
<td>2020-2025</td>
</tr>
</tbody>
</table>

Fuel cell powertrains offer distinct advantages over incumbent powertrains, including zero tailpipe emissions, zero well-to-wheel GHG emissions (when using renewable hydrogen), higher energy efficiency, and reduced noise. For goods movement, FCETs have several advantages over BETs: longer driving range, quick refueling, near-conventional payload capacity, and improved performance in extreme temperatures. The latest generation of fuel cells are capable of starting and operating at temperatures of -25°C (-13°F), with continued development towards even lower temperatures.

Prolonged fuel cell durability in demanding environments has been proven in transit bus fleets where fuel cells far-surpassed 30,000 hours of operation over the course of 8 years at TFL in London, UKixvi and AC Transit in the San Francisco East Bay in Northern California.

FCETs provide a comparable freight capacity to diesel, whereas BETs will have a significantly reduced payload as shown in Figure 2.xivi

Available Funding

Recently, the California Energy Commission (CEC) announced $47.5 million available in 2020 for zero emission medium/heavy-duty vehicles and infrastructure.xix The Volkswagen Mitigation Trust will provide $90 million in funding for Zero-Emission Class 8 Freight and Port Drayage Trucks. The first $27 million installment is now available statewide on a first-come, first-served basis; up to $200,000 per truck.xviii

The California Air Resources Board and CEC will jointly release a $40 million solicitation for a Zero-Emission Drayage Truck Pilot project seeking large-scale deployments of battery electric and fuel cell electric Class 8 trucks plus supporting fueling infrastructure. Additionally, the CEC is proposing to invest $134.8 million in medium/heavy-duty zero emission vehicles and infrastructure from July 2020 through December 2023. For more information on the most current funding opportunities, contact the California Hydrogen Business Council at www.californiahydrogen.org.