DOE HFTO Workshop: Hydrogen Infrastructure Strategies

Stakeholder Panel: Vehicle OEMs

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1.17.2024

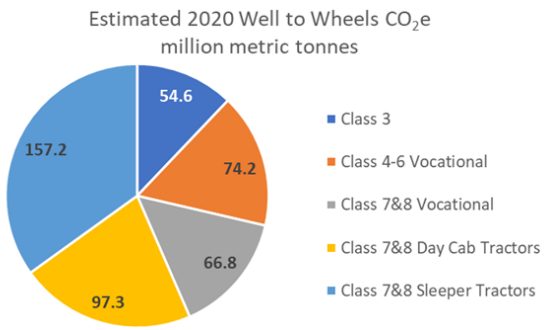
DOE SuperTruck 3 – Project Goal

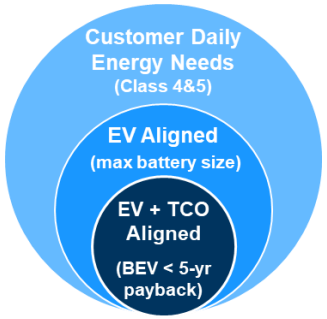
- Develop a ZEV Fuel Cell propulsion system for Ford Super Duty Chassis Cab vocation applications.
- Demonstrate ZEV capability without compromised customer attributes including 10k payload, 300-mile range and SAEJ2601 refueling times.
- Evaluate the technology in real-world environments with three fleet customers (varied vocations and locations) to provide insight into fuel cell durability, usage, efficiency, refueling, and operating costs.
- Evaluate GHG and TCO utilizing H2 infrastructure and economy projections for comparison with today's ICE products.

Super Duty Chassis Cab ZEV Fuel Cell

DOE SuperTruck 3 – Relevance and Potential Impact

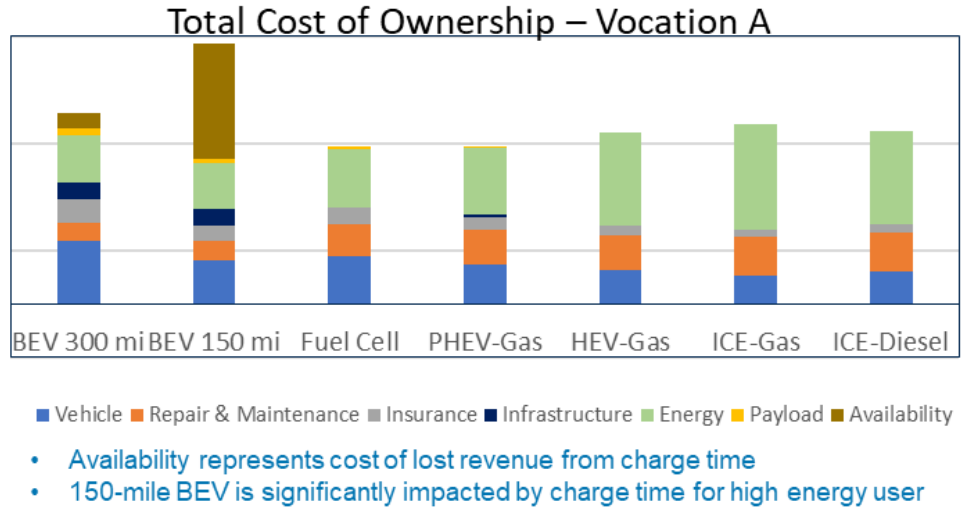
- **The vocational CV market is a smaller but still significant portion of the CV CO2/GHG contributions but presents unique decarbonization challenges.**
  - Work trucks operate in rugged environments, with high payload demands and in some cases 24/7 uptime requirements.
  - BEV's are challenged to meet the energy demands (>300 kWh) and/or uptime requirements.
  - The class 3-6 Chassis Cab vocational market is especially important to Ford as a leader in this segment.





- **Fuel Cell powertrain offers favorable attributes**
  - Zero emissions
  - Minimal payload compromise and re-fill time similar to ICE
  - Favorable TCO (amortizing down time) for high energy users

- **Overall Goals**
  - Achieve 300 mile range and maintain customer payload
  - Meet high energy daily usage / full capability in hot and cold ambient
  - Off-road capable / steep grade capable
  - Meet or exceed gas ICE TCO



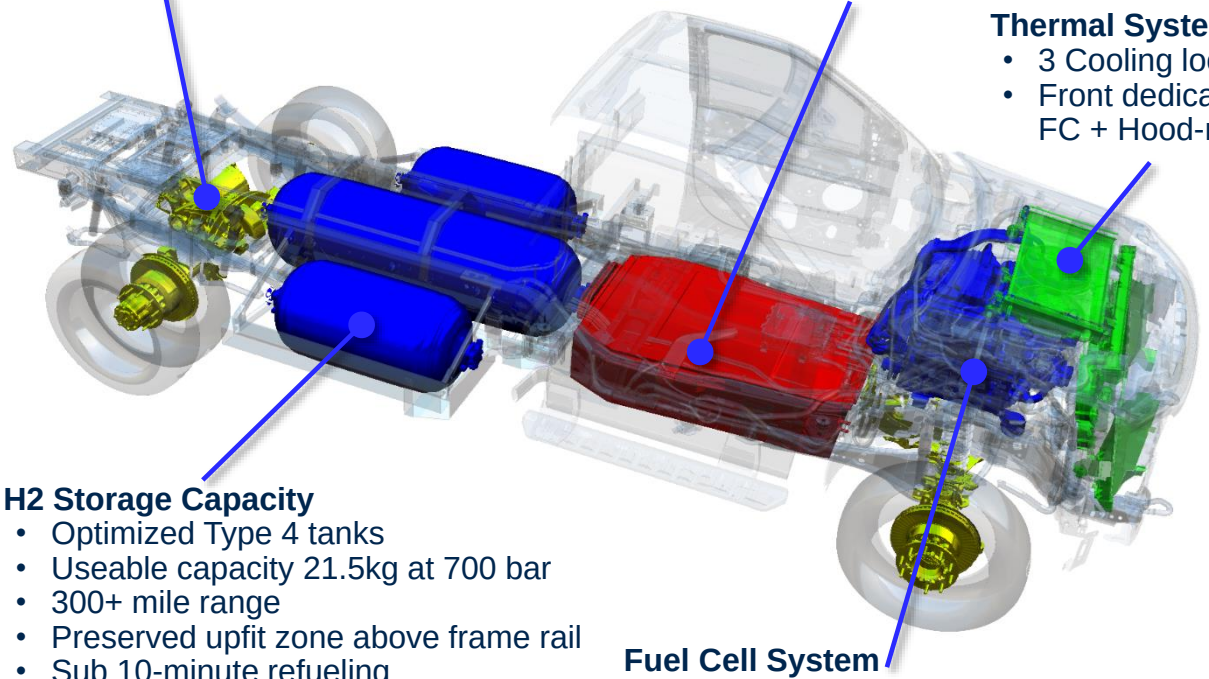
Medium Duty Vocation Applications are important to Ford and challenging for BEV.
Fuel Cell is the better ZEV solution for "work trucks"

DOE SuperTruck 3 – Pilot Vehicle

FCEV Super Duty F550 Chassis Cab

Pilot Attribute Priorities

- Performance equivalent to 7.3L gasoline P/T
- 10,000 lb payload / 20,000 lb towing capacity
- Meet or exceed 7.3L gas performance feel and launch capability
- 300+ mile range in shorter wheelbase variant
- Segment-comparable off-road capability
- Comparable refueling time (<10 minutes)
- Minimal upfitter zone reduction
- Comparable cold climate starting capability



Twin eAxles
- 300kW peak / 200kW continuous power (each)
- 13,000Nm Peak wheel torque (each)

HV Battery
- 350kW peak power
- Transient fill-in for slower fuel cell response
- 40kWHr usable energy for >140kW power demand

Thermal System
- 3 Cooling loops
- Front dedicated HTR for FC + Hood-mounted LTR

H2 Storage Capacity
- Optimized Type 4 tanks
- Useable capacity 21.5kg at 700 bar
- 300+ mile range
- Preserved upfit zone above frame rail
- Sub 10-minute refueling

Fuel Cell System
- Optimized 2-row stack & BOP
- 140kW continuous power @38°C

DOE SuperTruck 3 – Remaining Challenges and Barriers

- **Challenges**
  - Extreme cold weather operation
    - » Fuel cell, battery and propulsion system operating strategies are being developed to ensure robust operation in extreme cold climates.
  - Ford Super Duty Lifetime Durability
    - » Developing new accelerated durability tests that represent the appropriate use cases and stressors (different from ICE)
  - Local infrastructure deployment
  - ICE parity in MD CV applications (including TCO, uptime, payload)
- **Barriers**
  - H2 infrastructure
  - H2 cost (Green H2 scale)

H2 barriers must be resolved before industry-wide implementation and adoption

What is required to implement a hydrogen infrastructure for MD/HD vehicles?

- The USCAR members (Ford, General Motors, and Stellantis) recognize the commercial MD vehicle (class 3 to 6 van/truck with 10K to 26K lbs. GVWR) market as a critical segment for the economy and emissions. The USCAR members united on a Whitepaper regarding the ***NECESSITY FOR H2 REFUELING STATIONS FOR MD FCEVs IN THE US*** (8/23/23) – see site: https://uscar.org/technologies-teams/hydrogen-fuel-cell/

- USCAR Whitepaper – Hydrogen Infrastructure Development Needs:
  - Engage H2 station, infrastructure, energy suppliers, and stakeholders to upgrade existing LD H2 refueling stations and/or include future funding to allow filling 10kg-35kg for MD FCEVs.
  - Support the required tools and devices (e.g., HyStep) to evaluate H2 refueling stations.
  - Advance the development of high flow fueling protocols and interfaces (e.g., receptacles).
  - Encourage and analyze interaction of LD/MD/HD FCEVs with highly adaptable H2 stations.
  - Determine H2 station deployment and location strategy to accelerate MD FCEV adoption.
  - Incorporate lessons learned for LD H2 stations to improve customer utilization.

- **Ultimately, we need a H2 station network that is not limited to a vehicle class or application but rather highly compatible, flexible, and reliable to maximize utilization for stations and vehicles.**

We need to change the sequential "chicken and egg" mindset to a collaborative deployment.


Ford