NREL Alt Fuel Lessons Learned
-- Hydrogen Infrastructure --

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Gap Between Existing and Required H₂ Fueling Experience

• Very limited access to today’s stations
  – Stations not made available or…
  – No-go access contracts/liability clauses or …
  – Assurance of access by customers/drivers
    • “OEM x vehicles/drivers have priority over OEM y”
    • e.g. “Can’t fuel on Tuesday and Thursday afternoons 4-7pm”

• Very limited availability of 700bar fueling
  – Every major OEM is developing 700bar capability (GM vehicles since 2004)
  – With only two exceptions, 700bar is the baseline

• Current stations are largely behind-the-fence, demo-like, and lagging in technology availability (note: vehicle technology refreshed every 3-4 years)

➡ Build a new generation of hydrogen stations that inspire confidence in our ability to establish a hydrogen infrastructure
Additional Observations (I could be wrong)

Energy Companies:
• $$$$$
• But, not necessarily from the retail business (and only ~10% stations are company owned/operated)
• Don’t do station/technology development (exceptions are e.g. Chevron’s onsite reformer work)
• They do have land (retail sites)
• Don’t perceive an Early Mover Advantage
• Not in a hurry to shift environmental burden upstream (?)

Industrial Gas Companies (and other equipment suppliers):
• Station and fueling technology experts
• $
• Don’t do retail (dealing with general public/liability is new)
• Don’t have land (requires complex/time-consuming effort to establish partnerships)
• Don’t have renewable expertise (yet) – renewable requirement for state funding drives different technology solutions – no in-house expertise/resources – results in a complex/costly/time-consuming effort (or no bid for state funding)
Hydrogen Refueling Infrastructure: Need for Broadened Perspective

Current mindset:
• Provide enough hydrogen for the vehicle miles driven
  (assuming vehicles will travel to a single station or few stations)
• Strive for high station utilization for relevant field experience

Automaker Perspective:
• Consumers move about the coverage region, and therefore, determine their own patterns for where they want to refuel -- efforts to match a station's supply with overall vehicle demand will be inaccurate
• Vehicles are far too costly to leave stranded due to an underbuilt infrastructure
• Early customers are too valuable to hydrogen outreach efforts to risk dissatisfaction

Broadened Perspective:
• Hydrogen stations are a critical element in building market pull for a hydrogen future -- which means serving the consumer/driver -- which means focusing on consumer access to fuel rather than fuel availability.

This is about more than just fueling vehicles – this is about building a market!
• Can’t wait to deploy fueling stations once the market signal is clear – these stations have a key roll in making that market signal emerge
Critical Infrastructure Next Steps…

• **Compelling, retail-like refueling stations**
  - Geographically targeted regions where automakers want to put vehicles
  - 700bar fast-fill refueling
  - Compelling station designs (customer and technology perspectives)
  - Robust hydrogen capacity and throughput – designed for growth
  - Operational with (or before) vehicles

• **Access to all stations**
  - All-OEM access
  - Address liability exposure
    - Straight-forward access agreements w/ consistent principles or
    - Eliminate access agreements altogether

• **Expedient station approval and permitting process**
  - State-wide consistency and local adherence
  - Community support

• **Funding Support and Incentives/Enablers**
  - Stations, station technology and capacity upgrades, operating costs
  - Liability coverage/solution (funded liability pool, liability cap)
  - Assurance stations will be there on time - supply base

This is about more than just fueling vehicles – this is about building a market!

• Can’t wait to deploy fueling stations once the market signal is clear – these stations have a key roll in making that market signal emerge
Fuel Cell Commercialization Overview (Conceptual)

**Technology Development**
- Technology development and validation under real world conditions
  - So. California
  - U.S. Northeast

**Pilot Commercialization**
- Technology refinement and early market preparation
  - So. California
  - No. California
  - U.S. Northeast

**Early Commercialization**
- Commercial deployment into mass market
  - Region 1
  - Region 2

**OEM/Vehicles**
- Yr 1: 100 veh / OEM
- Yr 2: 1,000+ veh / OEM (ZEV 7500)
- Yr 5: Launch Build-up: to 10,000 veh / yr / OEM

**Energy/Infrastructure**
- First "retail-like" Stations in U.S.
  - Region 1: 10 stations
  - Region 2: 40 stations
  - Region 1: 18 stations
  - Region 2: 40 stations (per metro area)

- Planning and execution of next phase infrastructure must begin now
- Early deployment of fueling infrastructure will influence vehicle deployments

New Calif ZEV Ruling: 2012-2014 → 7,500 FCEV
LA Metro Area 2010+
Hydrogen Infrastructure (Conceptual)

- 30 stations in LA Metro Area (illustrative placement)
- 10 stations for Destination Corridors

Average distance to metro station = 3.6 miles

To: San Diego, Santa Barbara, Palm Springs & Las Vegas
LA Metro Area 2010+
Hydrogen Infrastructure (Conceptual)

High-profile market areas and 700bar Refueling Priorities

- To: San Diego, Santa Barbara, Palm Springs & Las Vegas
- 30 stations in LA Metro Area (illustrative placement)
- Average distance to metro station = 3.6 miles
- 10 stations for Destination Corridors

To: San Diego, Santa Barbara, Palm Springs & Las Vegas
NYC Metro Area 2010+
Hydrogen Infrastructure (Conceptual)

- 30 stations in NYC Metro Area (illustrative placement)
- 10 stations for Destination Corridors

To: Boston, Philadelphia, Baltimore, WDC, Atlantic City
Gas-Friendly to Gas-Free

FUEL EFFICIENCY  E85 ETHANOL  HYBRID  ELECTRIC  FUEL CELL