Outline of Fueling Options

HTAC Subgroup

12/6/16
Objectives

Provide a first order assessment of a range of fuel cell vehicle fueling alternatives to determine
- A rough comparison of costs and financial risks
- Technical and regulatory challenges
- Potential for facilitating consumer adoption of FCVs

Provide a basis to determine if further work is merited and if so, suggestions for scope of work
Alternatives to be explored

• Central
• Portable
• Delivery
• Home
<table>
<thead>
<tr>
<th>Type</th>
<th>Brief Description</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>High capacity, permanent fueling stations acting as replacements to traditional gas stations.</td>
<td>Able to amortize over large base of vehicles</td>
<td>High capital cost</td>
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<td>Standardized operation</td>
<td>High investment risk</td>
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<td>Familiar to customers</td>
<td>Requires volume base (chicken &amp; egg)</td>
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<td>Large impact of single station outage</td>
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<tr>
<td>Mobile</td>
<td>Small to medium scale (10-20) trailer based refueling with multiple possible temporary sites.</td>
<td>Web based planning, logistics</td>
<td>Regulations may not support deployment</td>
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<td>Low tech, lower capital</td>
<td>Unfamiliar consumer process for fueling</td>
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<td>Footprint adapts to vehicle base</td>
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<td>Capital can be redeployed</td>
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<td>Delivery</td>
<td>Truck based delivery to homes over night. Note: could be the same equipment as Mobile.</td>
<td>Web based planning and logistics</td>
<td>Regulations may not support deployment</td>
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<td></td>
<td></td>
<td>Low tech, lower capital</td>
<td>Home fueling equipment not developed (e.g. Hose, etc.)</td>
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<td>Consumer convenience</td>
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<td>Home</td>
<td>Small, low capacity home based refueling devices.</td>
<td>Convenience</td>
<td>Regulations may not support deployment</td>
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<td>Confidence of minimum mileage / fuel</td>
<td>Unfamiliar process</td>
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<td>Cost? (Potential)</td>
<td>Additional capital purchase</td>
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<td>Independence</td>
<td>Small filling capacity (~1kg/day)</td>
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</tbody>
</table>
Hypothetical Mobile Elements

• Truck based tube trailer with 10,000 psi H2, dispenser, no compression
• Capable of "bumping" FCVs to 50%-80% of full tank
• Deployed to sites that are pre-approved by authorities and have agreements with land owner for usage, e.g. Big box lots, government, car dealers, etc.
• Deployment locations may change based on location of FCV fleet, traffic patterns, etc.
• FCV car app connected real time with all locations and planned, next day locations. App could also "tell" the stations where they planned to refuel, for better logistic preparations.
• Central H2 depot could have additional tube trailers to refuel in high demand to accomplish "hot swapping" if needed.
• H2 gas quality sampling at central tube depot.
Hypothetical Delivery Elements

• Ideally the same equipment used in Mobile fueling would be used at night for Delivery fueling
  - Truck based tube trailer with 10,000 psi H2, dispenser, no compression
  - Capable of "bumping" FCVs to 50%-80% of full tank
  - Central tube depot
• Deliveries performed overnight and scheduled day before via internet.
• FCV owner equipment would consist of fueling interface if car not parked within access to road.
• Alternative to owner equipment could be requirement to park at curbside.
Hypothetical Home Elements

- Home refueling device either electrolyzer or reformer based capable of ~1kg per 10 hours and up to 5000 psi dispensing pressure
- Dispensing nozzle.
- Refueling service / access (for reformer, if not using natural gas as input fuel)
- Interface software between car and home refueled for automated filling and monitoring.
- Optional: heat exchange into hot water heater
Conceptual Home Refueler Example

- Input fuel: methanol-water mix.
- 10 hour capacity: ~1kg H2
- Maximum output pressure: 5,000 psi
- High pressure storage: none (storage on board FCV only)
- Approximate dimensions: 80cm X 30cm X 30cm, not including fuel tank
- Retail price: ~$5,000 not including nozzle
- Maintenance: annual compressor
Key Subgroup Work Streams

• Gathering existing data, organizing and assessing it.
• Interviews with stakeholders and experts.
• Synthesizing information.
Target Results

• Cost comparisons between each alternative.
• Identification / validation of advantages and challenges with each approach.
• Assessment of how the different fueling methods may or may not assist with adoption and expansion of FCVs, compared to current status.
Status

- Some data gathered on electrolyzers and reformers
- Multiple calls to Honda, no response
- Contacted Toyota. Internal discussion / consideration
- Sub-group not yet formed