The Love’s Family of Companies

OCTA State of the Art H2 Fueling Station
Love’s Travel Stops & Country Stores

#18
Forbes List of America’s Largest Private Companies

Over 500
Travel Stops, Terminals and CNG Stations

$16
Billion Annual Revenue

25,000
Employees Nationwide

Gemini Motor Transport
650 trucks / 13 million gallons of fuel daily

Trillium

#2
Largest Distributor of CNG in the U.S.

200
Owned or Operated Heavy-Duty CNG Stations

Design / Build Maintenance Own or Operate Renewable

Transit Agencies Municipalities Trucking Companies Waste Haulers

Musket Corporation
Wholesale fuel supply, trading and logistics
The “other” electric bus

Hydrogen storage = energy storage (1250kWh)

High voltage battery

Air conditioning with high voltage battery cooler

Main cooling

Hydrogen storage

Why?

• Range
• Performance
• Refueling Rate

PEM electrical motor

Fuel Cell unit = on board charging system

Electrical compartment KEB

Brake resistor

Vapour exhaust

Converters
Challenges

- **Price**
- **Area/Availability**
- **Redundancy**
- **Speed**
- **Entry Effort**

**The 5 & 5 Challenge**

Dispensed price < $5/kg
- Cost of H2 (delivered or on-site)
- Operating costs (utilities, O&M)
- Capital recovery
- Margin

Speed of fueling > 5 kg/min
- Gas compression not sufficient today
- Cannot rely on LDV tricks for Buses at scale
Challenges (cont)

Area / Availability

- Compressors – Storage – Dispensing + On-site production
- H2 supply suitable for FCs not available everywhere & limited as market grows

Redundancy / Resiliency / Renewables

- Days worth of stored energy on site and backup power for 100% fueling
- Longer vehicle range, shorter refuels
- Solar/wind or renewable natural gas
Entry Effort

Too difficult to get started with FCEBs

Difficulty Level

Startup

Full Fleet

Fuel Cell Electric

Battery Electric
Hydrogen station equipment

**Delivery**
- **Gaseous**
  - Gaseous compressed storage
  - Smaller footprint
  - Flexible placement
  - Least storage capacity
- **Liquid**
  - Liquid storage
  - Vaporizer
  - Greater storage capacity
  - Larger footprint
  - Fuel boil off potential

**Production**
- **Electrolysis**
  - Electrical supply
  - H2O purifier
  - Electrolyzer
  - On site production
  - Carbon credits
  - Larger footprint
  - More expensive
- **SMR**
  - NG supply
  - SMR unit
  - PSA
  - On site production
  - Larger capacity
  - More expensive
- **Pipeline**
  - H2 supply
  - Scrubber
  - Larger capacity
  - Larger footprint
  - More equip.

- Compressor
- Buffer storage
- Booster compression (opt)
- Chiller
- Dispenser
Production-Electrolysis

ONSITE ELECTROLYSIS

ELECTRICITY

Storage

COMP. H2
GAS

COMP. H2
GAS

H2 veh

SOLAR or WIND ELECTROLYTIC HYDROGEN

Wind Turbine

PV Array

electrolyzer

compressor

storage

H2 veh

Courtesy of International Energy Agency and Princeton University
Production-SMR

CENTRALIZED REFORMING
TRUCK DELIVERY

ONSITE REFORMING

Courtesy of International Energy Agency and Princeton University
H2 Delivery

Liquid H2 Trailer

Gas H2 Trailer
### PARSE for H2@Scale

#### Table: Buses kg/day Area (stalls) Price ($/kg) Area (stalls) Price ($/kg) Area (stalls) Price ($/kg) Area (stalls) Price ($/kg)

<table>
<thead>
<tr>
<th>Buses</th>
<th>kg/day</th>
<th>Area (stalls)</th>
<th>Price ($/kg)</th>
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<th>Price ($/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>150</td>
<td>2</td>
<td>13.30</td>
<td>3</td>
<td>14.00</td>
<td>5</td>
<td>9.00</td>
<td>5</td>
<td>13.80</td>
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<tr>
<td>35</td>
<td>1000</td>
<td>10</td>
<td>11.10</td>
<td>8</td>
<td>9.60</td>
<td>26</td>
<td>5.50</td>
<td>26</td>
<td>10.40</td>
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<tr>
<td>200</td>
<td>6000</td>
<td>37</td>
<td>9.00</td>
<td>12</td>
<td>7.40</td>
<td>139</td>
<td>4.50</td>
<td>139</td>
<td>9.40</td>
</tr>
</tbody>
</table>

#### Price
- Entry Effort: Full
- Area/Avail: Entry Effort
- Redundancy: Full
- Speed: Full
- Entry effort: Full
OCTA
30 kg per vehicle in 6+ minutes
• From 2 dispensers simultaneously
• Up to 1,500 kg/day
# H2 Production

## Hydrogen Refueling Station

<table>
<thead>
<tr>
<th>Pre-cooling and Dispensing</th>
<th>High/Medium Pressure Hydrogen</th>
<th>Low Pressure Hydrogen</th>
<th>Hydrogen Supply Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigeration Unit</td>
<td>High Pressure / Booster Compressor</td>
<td>Low Pressure Storage</td>
<td>Pipeline</td>
</tr>
<tr>
<td>Onboard tank (700 bar)</td>
<td>High/Medium Pressure Buffer Storage</td>
<td>Low Pressure Compressor</td>
<td>Distributed Production Unit (80-100 kg/day)</td>
</tr>
</tbody>
</table>

- **Onboard tank (700 bar)**
- **Dispenser**
- **Vaporizer**
- **High Pressure Cryo-Pump**
- **Low Pressure Compressor**
- **High Pressure Buffer Storage**
- **Low Pressure Storage**
- **Pipeline**
- **Distributed Production Unit (80-100 kg/day)**
- **Gaseous Tube-Trailer**
- **Cryogenic Storage**

**Trillium**

A Love's Company