Scalable Hydrogen Fueling for Transit Applications

Al Cioffi
Plug Power is the Leader in Hydrogen and Fuel Cell Technology

- 3.5x revenue growth since 2013
- 1st to create a market for HFC technology
- 26K+ units in the field
- 20MM+ Hydrogen fuelings
- 220MM+ operating hours
- 150 HFC patents
- 80% Blue Chip Customer Base
- 70% reduction in cost profile since 2013
- 20MM+ Hydrogen fuelings
Conventional Wisdom of Electrical Infrastructure

- FCEV (Fuel Cell Electric Vehicle)
- BEV (Battery Electric Vehicle)

Effort and Cost vs. Fleet Size
1. Initial costs and efforts are much lower than have been portrayed.

2. Crossover point occurs at a smaller fleet size.

Fleet Size

Effort and Cost

FCEV

BEV
Hydrogen Solutions

- Hydrogen can be delivered
  - Liquid form \([\text{LH}_2]\)
  - Gaseous form \([\text{GH}_2]\)
- Hydrogen can be generated on-site
  - Steam Methane Reformer
  - Electrolyzer
- Hydrogen can be renewable/de-carbonized
Delivered Gas Solution – A Starter Solution

- GH2 Trailer
- Optional Compression
- Optional Storage
- Indoor/Outdoor Dispenser

- As little as $500K investment
- Higher per kG costs
- 1 to 4 buses

All components can be re-used to expand system capacity
Delivered Liquid Solution – Fleet Expansion

- GH2 trailer remains as a back-up
- As little as $1.5M investment
- 5 to 100 buses

Low Capital and per kG costs are realized with Liquid H2 Solution
On-Site Generation Solutions – Fleet Expansion

- Electrolyzer and/or Reformer
- GH2 as back-up
- As little as $1.75M investment
- 1 – 100 buses

Green solutions
Independent of delivered fuel
Hybrid Solutions – Flexible and Forgiving

- Hybrid LH2/Reformer/Electrolyzer
- GH2 and LH2 as back-up
- As little as $2.5M investment
- 25 to 100’s buses

Broad range of customizations to assure the most cost effective solutions
Hydrogen Infrastructure Planning Considerations

- Fleet conversion and expansion plans
  - How many fuel cell vehicles to start at how many locations
  - Current and future locations
  - Ultimate fleet size per location
  - Timing
- Access to water, electricity, and gas
  - Rates
  - Renewability
  - Stability of supply
- LCFS and Renewable energy credits
- Contractor selection
  - H2 experience
  - Turn-key
  - Service Level Agreements
- Hydrogen infrastructure expansion can adapt as your plans change (or recover from errors)
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