10 things you should know about a hydrogen fueling infrastructure for automobiles

**Availability**

1. More than **40B kg** of hydrogen are produced globally each year – enough to fuel **130M fuel cell-electric vehicles (FCEVs)** annually.

2. **53%** of the hydrogen produced in the U.S. (enough to fuel 13M FCEVs) is already dedicated to transportation - removing sulfur from petroleum at refineries.

3. A large hydrogen production site exists today near almost every major U.S. and European city.
Leveraging Existing Hydrogen Production Sites

Large hydrogen production sites are already within reach of most major U.S. metropolitan areas (roughly 70% of the U.S. population)
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**Cost**

4. Near-term total cost (i.e. today's technology, at scale) of producing and dispensing hydrogen is equivalent to $2-3/gallon of gasoline according to industry studies (incl Shell)

5. U.S. DOE's long-term target for total hydrogen cost is equivalent to $1.00-1.50/gallon of gasoline; several pathways have potential to meet this target
Industry Studies of Hydrogen Production Costs
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Early Introduction

6. A $10-15 billion investment would establish an initial refueling infrastructure accessible within two miles anywhere in the top 100 metro areas - sufficient to support the first 1 million FCEVs - assumes 240 stations in LA and 240 in NYC.
U.S. Infrastructure Development
for First Million Fuel Cell Vehicles

- A $10-15B investment would establish a network of 12,000 stations providing fueling coverage to:
  - Top 100 urban areas
  - 130,000 miles of highway
LA Metro Area 2012+ Hydrogen Infrastructure

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

to: San Diego
Santa Barbara
Palm Springs
Las Vegas
Las Vegas
LA Metro Area 2012+ Hydrogen Infrastructure
Assumptions / Notes

- 30 stations in LA metro area
  - Fueling for 40,000 or more FCEVs
    - 1,500kg/day station capacity
    - 1,050kg/day average throughput (70% of capacity)
  - Serving area of over 15 million people
  - Refueling within 10 miles anywhere in metro area

- 10 stations to cover corridors to popular destination places
  - San Diego
  - Santa Barbara
  - Palm Springs
  - Las Vegas

- 40 stations total at cost of $130 million
  - $3.3 million per station
...into a National Infrastructure through Contiguous Dispersion

Stage 3
+ Add’l Hwy Arteries
+ Add’l Major Metro Areas

Stage 4
Buildout from the Northeast?
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**Well-to-Wheel**

7. A 2% increase in U.S. natural gas supply would support 10M FCEVs annually and reduce overall CO2 emissions by 50% on a “well-to-wheel” basis for every gasoline vehicle replaced.

8. A fuel cell vehicle operating on hydrogen produced from renewable sources of energy eliminates all exhaust emissions.
Well-to-Wheels Energy and Emission Results

- All FCEV and REEV options generally excellent
- A FCEV using H2 from NG reduces GHG emissions almost 60%
- For a given electricity grid mix, generally better to charge REEV battery than produce hydrogen for a FCEV
- To eliminate oil use FCEV
- To eliminate oil use and GHG emissions FCEV with renew H2

GHG = green house gases
FFV = flex fuel vehicle
NG SMR = natural gas steam methane reforming
FCEV = fuel cell electric vehicle
Electrol = electrolysis
U.S. Electricity Generation
Considerable Diversity

Hydrogen production from electrolysis results in GHG emissions that directly reflect the carbon content of the fuels used to create electricity in that particular region.

Source: EIA, Electric Power Annual 2000. (Numbers in parentheses are million kWh-hours generated in the state by utility and non-utility generators)
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**Bottom Line**

9. Early capitalization risk will be managed by balancing infrastructure availability with FCEV sales growth and concentrating initial sales in specific geographic regions (e.g., Los Angeles, New York, or Shanghai)

10. **Bottom line:** A hydrogen infrastructure is economically viable and doable - it requires the collective will of automakers AND energy suppliers AND governments
Project Driveway Refueling
Hydrogen 700bar (70MPa) Refueling Locations

- Current gap between existing and required fueling experience
- Major OEMs are developing 700 bar capability
Critical Infrastructure Next Steps...

- **Retail-like** refueling stations
  - Geographically targeted regions where automakers want to put vehicles
  - **700bar** fast-fill refueling
  - Operational with (or before) vehicles

- **Access** to key existing stations
  - Access agreements w/ consistent principles or
    - Gasoline-like liability terms or
    - Eliminate access agreements altogether
Critical Infrastructure Next Steps...

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

- **Funding Support and Incentives**
  - Stations and upgrades
  - Liability coverage (funded liability pool, liability cap) or
    - Full-service attendants to mitigate liability issues
  - Station operating costs/refueling costs