

The applications of Fuel Cell in transportation (Vehicle in general and Bus in special)

Le Ngoc Bich



Fuelling the Fuel cell vehicle (Hydrogen infrastructures)

- The big question when a new vehicle type is introduced that will not necessarily utilize the existing refueling infrastructure is, how does one fund an entirely new infrastructure?
- Consumers will not buy a vehicle that cannot be conveniently fueled.
- Solving the problem:



Fuelling the Fuel cell vehicle (Hydrogen infrastructures)

- Develop a backbone:

Government could fund the “backbone” of a hydrogen infrastructure, funding installation of regional hydrogen refueling centers. Private funding would then step in to develop the local fueling stations connected to that backbone.



Fuelling the Fuel cell vehicle (Hydrogen infrastructures)

- Hydrogen supply centers: Develop early hydrogen supply centers in connection with demonstrations of both transportation and stationary fuel cells. This approach would spread the investment costs over the two fuel cell applications.



Fuelling the Fuel cell vehicle (Hydrogen infrastructures)

- The hydrogen production, storage, and dispensing infrastructure consists of the following main components: (*ref the infrastructure at SunLine Transit Agency*)
 - Water electrolysis systems
 - Partial oxidation reforming of natural gas
 - Tube trailer
 - Tanks for storage of compressed hydrogen
 - Fueling station that dispenses compressed hydrogen



Fuelling the Fuel cell vehicle (Hydrogen infrastructures)

- Hydrogen production in this system is accomplished by splitting water into hydrogen and oxygen using Stuart Energy's proprietary electrolysis technology. The resulting hydrogen gas is dried, purified, compressed, and sent to storage, while the oxygen is vented to the atmosphere.

Fuelling the Fuel cell vehicle (Hydrogen infrastructures)



SunLine's FIBA tube trailer and ASME tanks for CH₂ storage

Fuelling the Fuel cell vehicle (Hydrogen infrastructures)



Stuart Energy's modular compressed hydrogen station



Fuelling the Fuel cell vehicle (Hydrogen infrastructures)

- A second source of hydrogen for SunLine's fleet of fuel cell buses will be produced through onsite partial oxidation reforming of natural gas. The system includes the following components:
 - Model 4200 NG-A UOB™ reformer/CO shift reactor skid



Fuelling the Fuel cell vehicle (Hydrogen infrastructures)

- Pressure Swing Adsorption (PSA) purification unit
- Integrated automatic Programmable Logic Controller (PLC) controls
- Pressure Dynamics 2-stage hydrogen compressor
- Pressure vessels for hydrogen storage

Fuelling the Fuel cell vehicle (Hydrogen infrastructures)



**HbT's Model 4200 NG-A natural gas reformer system at
SunLine Transit Agency**

Fuelling the Fuel cell vehicle (Hydrogen infrastructures)

. Cost of Hydrogen Fueling Infrastructure Installed at SunLine

Infrastructure Component	System	Manufacturer / Model	Estimated Equipment Cost
H₂ Production, Clean-up, and Compression	Electrolyzer	Stuart Energy P3-1A	Unknown / Proprietary
	Compressor	CompAir Reavell 5000	Included in Stuart Energy package
	Nat. Gas Reformer	Hydrogen Burner Technologies 4200 NG-A	\$450,000
	Compressor	Pressure Dynamics	Included in HBT package
H₂ Storage	Tube Trailer Cylinders (104,000 SCF)	Fiba Technologies	\$104,000
	Stationary Cylinders (14,000 SCF)	Not Available	\$54,000
H₂ / Hythane Dispensing	Hydrogen / Hythane Mixer and Dispenser	Fueling Technologies Inc. HYDH5210	\$32,000



The roles of Government in Fuel Cell Bus

- Should Governments Help? If So, How?

Developing transportation fuel cells and accompanying infrastructure highlighted many remaining challenges to creating a successful long-term transportation fuel cell market. Following is the propose ways the government may help:



The roles of Government in Fuel Cell Bus

- Fund basic R&D, vehicle demonstrations
- Developing hydrogen infrastructure
- Developing hydrogen sources
- Early purchasing
- Education



Fund basic R&D, vehicle demonstrations

- Respondents stressed the need for major funding of basic fuel cell R&D, to help industry address the big remaining challenges of cost, durability and reliability.



Developing hydrogen infrastructure

- Related to the above suggestion is government support for development of an initial hydrogen infrastructure.
- Government fund hydrogen supply centers, which could serve as initial building blocks for early fuel cell vehicle deployment and would support continued investment by the private sector.



Developing hydrogen sources

- The government needs to focus on developing hydrogen sources.
- Government support would help the drive to develop lower cost hydrogen generation capability.
- Government should support development of renewable sources, to ensure that the shift to fuel cell vehicles will reap the greatest best environmental benefit.



Early purchasing

- Fuel cell manufacturers and auto companies, urged the government to become an early purchaser of fuel cell vehicles.



Education

- Government should have a role in educating the public about hydrogen.



Conclusions

- Fuel cell vehicles promise increased fuel economy and zero emissions.
- Serious challenges in technology performance, weight reduction, and cost still must be overcome.
- For cost problem, with additional technology breakthroughs and at high production levels it is estimated that they could approach the low costs of current IC engine vehicles. In addition, the cost of IC engine vehicles will likely increase as they are required to meet progressively lower emissions standards and better fuel economy requirements.



References

- [1] JoAnn Milliken *National Laboratory R&D Meeting, Department of Energy Transportation Fuel Cell Program*
- [2] *Projected Automotive Fuel Cell Use In California*, California Energy Commission
- [3] *Fuel Cell Bus Demonstration Projects*, U.S. Department of Energy
- [4] *Fuel Cell Transit Bus Coordination and Evaluation Plan California Fuel Cell Transit Evaluation Team* , National Renewable Energy Laboratory, United States Department of Energy.
- [5] *A Survey of Expert Opinion on the Future of Transportation Fuel Cells and Fuel Cell Infrastructure*, Northeast Advanced Vehicle Consortium.
- [6] Leslie Eudy and Richard Parish *Hydrogen Fuel Cell Bus Evaluation*.