VIII.13 Geographically-Based Hydrogen Demand and Infrastructure Deployment Scenario Analysis

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Objectives

- Identify best infrastructure scenarios to meet key transition scenarios.
- Identify hydrogen infrastructure implementation issues.

Technical Barriers

This project addresses the following technical barriers from the Technology Validation and Systems Analysis sections of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

Technology Validation

(C) Lack of Hydrogen Refueling Infrastructure Performance and Availability Data

Systems Analysis

(A) Future Market Behavior

Contribution to Achievement of DOE Systems Analysis Milestones

This project will contribute to achievement of the following DOE Systems Analysis milestones from the Systems Analysis section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- **Milestone 1:** Complete evaluation of the factors that most impact hydrogen fuel and vehicles. (3Q, 2005)
- **Milestone 5:** Complete analysis and studies of resource/feedstock, production/delivery and existing infrastructure for various hydrogen scenarios. (4Q, 2009)

Accomplishments

- Determined that strategic placement of stations can maximize public access and minimize the number of stations required. Each urban area has unique characteristics that must be closely analyzed to promote strategic placement and optimize infrastructure access.
- Established a target for infrastructure, which should be equal to approximately 7% of gasoline stations, to provide adequate transitional consumer access.

Introduction

Three vehicle penetration scenarios were developed for the production and sale of 2, 5, and 10 million fuel cell vehicles by 2025 with industry input (industry meetings with DOE, January 2007). Based on those results, the HyTrans Model [1] estimated the number of hydrogen fueling stations that would be constructed between 2012 and 2025. This analysis estimates the spatial distribution of those stations necessary to support the 5 million vehicle scenario, based on demographic demand patterns for hydrogen fuel cell vehicles and a strategy of focusing development on specific regions of the U.S. that may have high hydrogen demand. The results show that stations may develop in New York and Los Angeles in the near term, then spread to other urban areas over time and eventually lead to a national infrastructure. Further, in these cities, targeted locations are developed to maximize consumer access to the stations.

The project identifies siting considerations for hydrogen fueling stations in urban areas and aligns the geographic demand analysis (from FY 2006) with the HyTrans penetration scenarios. A possible phased development of station deployment resulting in an interconnected hydrogen infrastructure is presented.

Approach

Twenty urban areas with the highest potential for hydrogen vehicle demand (based on the FY 2006 demand analysis) were identified. A geographic

information system that used HyTrans estimates (reference) as the target for total hydrogen vehicles and infrastructure deployed in three phases (2012 to 2015, 2016 to 2019, and 2020 to 2025) was used to effect a phased introduction of hydrogen infrastructure into these cities. The results represent one single possible scenario (of many possible scenarios) of this phased development.

We used the list of key urban areas at a resolution-of-census tract to repeat, at the urban level, the national approach of combining attributes to evaluate hydrogen demand (see our FY 2006 H_2 annual report).

These demand results were combined with other criteria that coincide with consumer patterns to define a "network" of station locations for each phase of deployment:

- Census tracts with 3,000 or more registered vehicles.
- Along roads with high traffic (more than 200,000 vehicles per day).
- In highest demand areas (as defined by the urban area demand analysis).
- Near retail centers.
- Along major and secondary roads.
- Balanced station coverage.
- Near major civic airports.

Results

Table 1 summarizes the infrastructure deployment for the locations selected.

These station numbers align with the targets set forth by the HyTrans analysis. The stations presented in the 2020-2025 timeframe represent roughly 7% of the gasoline stations in those urban areas and are designed to support 5 million total hydrogen vehicles on the road in those locations. Figure 1 shows a sample infrastructure for Los Angeles in the 2016-2019 timeframe.

Once stations are located in the urban areas, the population with access was calculated. A summary of the population coverage within 5 and 10 miles of a station for the Los Angeles and New York areas is shown in Table 2.

This scenario indicates that, by 2025, a high percentage of the population will have access to stations within 5 and 10 miles of their homes. Results also indicate that the addition of stations starts to have diminishing impacts. The analysis for Los Angeles shows that the infrastructure growth from 400 to 751 stations between 2019 and 2025 provides access to only a very small additional population. Therefore, a target of hydrogen stations being equal to roughly 7% of gasoline stations in a given area seems to be a good threshold for hydrogen infrastructure, if the stations are strategically placed to maximize access.

TABLE 1. Hydrogen Fueling Station Deployment Scenario

	Initial Introduction	Targeted Regional Growth	Inter-Regional Expansion
Urban Area	2012-2015 Stations	2016-2019 Stations	2020-2025 Stations
New York	20	200	554
Los Angeles	40	400	751
Chicago		135	316
Washington			265
San Francisco/ Sacramento		78	181
Philadelphia		58	136
Boston		127	296
Detroit		90	210
Dallas		92	215
Houston			192
Atlanta		74	173
Miami			50
Seattle		27	63
Phoenix			99
Minneapolis/St. Paul			98
Cleveland			83
Denver			88
St. Louis			85
Portland			55
Orlando			35
Total	60	1,281	3,945

TABLE 2. Sample of Population with Access to Proposed Hydrogen Infrastructure

Urban Area	2012-2015 Stations		2016-2019 Stations		2020-2025 Stations	
	5 miles	10 miles	5 miles	10 miles	5 miles	10 miles
Los Angeles	51%	88%	83%	94%	89%	95%
New York	31%	66%	73%	76%	88%	95%

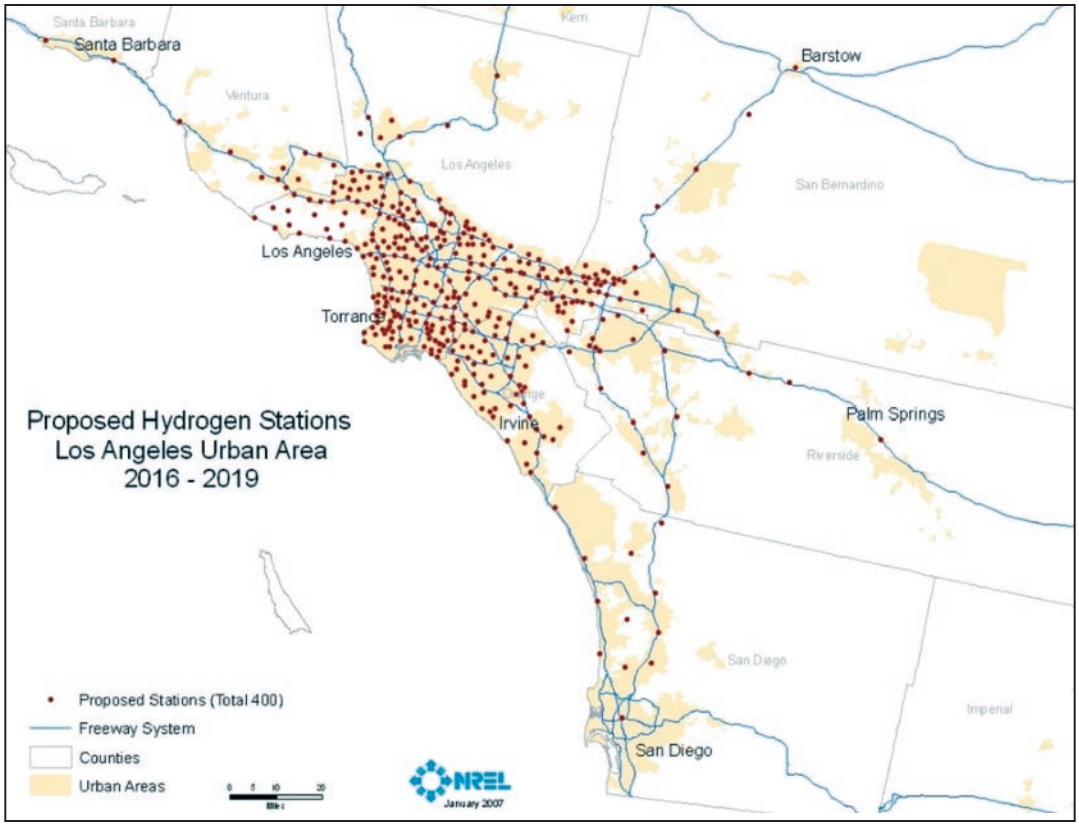

FIGURE 1. Proposed Hydrogen Stations, Los Angeles Urban Area, 2016-2019

Conclusions and Future Directions

This analysis identifies specific locations for hydrogen fueling stations considering the projected demand for hydrogen fuel under three scenarios between 2012 and 2025.

To best match hydrogen supply with emerging demand during the market transition–maximizing use of available resources–individual hydrogen fueling stations must be sited as precisely as possible, based on predicted demand. Although there is no "one size fits all" solution, this analysis considers each geographic area's unique properties and pattern of population density, as these factors shape potential hydrogen demand and dictate optimal station placement.

The result of the demand and supply sides of the analysis is a possible network, by 2025, of 4,000 stations that facilitate hydrogen-powered travel within and between key demand centers. In the key urban areas, the numbers of hydrogen stations represent 7% of the gasoline stations. Optimal station placement typically puts more than 90% of the urban area populations within 10 miles of a hydrogen station. This network lays the groundwork for a national infrastructure that begins with high demand areas and eventually allows for interstate and cross-country travel.

Special Recognitions & Awards/Patents Issued

1. DOE Hydrogen Program R&D Award, 2007.

FY 2007 Publications/Presentations

1. Poster: 2007 DOE Hydrogen Program Review, May 2007, Todd Ramsden.

2. Presentation: Geographically Based Hydrogen Demand & Infrastructure Rollout Scenario Analysis, Transition Scenario Analysis Meeting, January 2007, Margo Melendez.

3. Presentation: Geographically Based Hydrogen Demand & Infrastructure Analysis, Fuel Cell Seminar, November 2006, Margo Melendez.

References

1. Integrated Analysis of Market Transformation Scenarios Using HyTrans, David L. Greene and Paul N. Leiby of ORNL, and David Bowman of EconoTech, June 2007.