Home and Neighborhood Refueling as a New Paradigm for Hydrogen Vehicles

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INTRODUCTION

Problem definition

The potential benefits of hydrogen as a transportation fuel will not be achieved until hydrogen takes a substantial market share as an energy carrier for vehicles. The analysis conducted by National Research Council [1] indicates that large scale centralized hydrogen production and pipeline delivery is the most efficient way of supplying hydrogen for vehicles in the long run. However, in the near and mid-term, demand for hydrogen is insufficient to justify the huge amount of investment in such an infrastructure system. This dilemma has been phrased as a "chicken and egg" allegory [2].

Motivation

As an alternative, a home refueling strategy based on the existing natural gas supply system, or the grid provides an appealing hydrogen pathway, especially during the early stage of market penetration. Additionally, home refueling is an important perceived benefit for many consumers, because it avoids the need to visit refueling stations [3]. The home refueling strategy, either at a single or multi-family level, appears particularly attractive and more cost competitive if configured as a home refueling/cogeneration system that simultaneously provides electricity and heat for residences, as well as hydrogen for a vehicle.

HOME REFUELING CONFIGURATION

We consider a home refueling strategy based on a home refueling/cogeneration system that simultaneously provides electricity and heat for residences, as well as hydrogen for a vehicle [4].

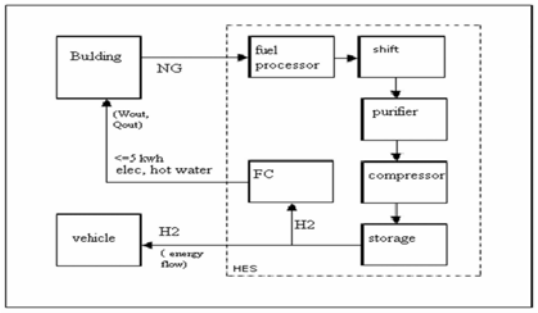

Figure 1: schematic of a home refueling/cogeneration system

NEIGHBORHOOD REFUELING

Besides cogeneration systems for single family buildings, systems for multi- family level neighborhood refueling and small scale commercial applications will be analyzed in this project.
Main justifying reasons includes:
❖Scale may be critical for economic competitiveness. Multi-family systems are likely to be more economically attractive than single family systems [5].
❖Multi- family level neighborhood refueling and small scale commercial cogeneration systems offer publicly accessible refueling options, without which consumers may feel uncomfortable to adopt the home refueling technologies.

IMPORTANT QUESTIONS

❖What is the technical, environmental, and economic performance of the technologies, as compared to other options for home heating, electricity and hydrogen?
❖How much will consumers value the benefits associated with home refueling?
❖How and to what extent will policy and regulation impact the commercialization of these systems?

PROJECT OBJECTIVE

Overall, this project aims at informing private and public decision-makers about the opportunities, challenges and the early-market dynamics of commercializing home refueling technologies.
Four tasks will be carried out:
❖Literature review and integration
❖Engineering/economic modeling
❖A case study
❖Policy analysis

METHODOLOGY

An engineering and economic model is developed and utilized in this project to evaluate home refueling/cogeneration systems. Electricity and hot water load profile for a typical household in the US will be used as main input in simulating the systems to gain insight into the commercialization of those systems.
Major tasks include modeling the systems to simulate steady state system performance, estimating the cost of electricity, heat and hydrogen from the systems in dollars per unit of energy and dollars per unit of hydrogen, and comparing the results to alternatives (e.g., grid electricity and natural gas). The life cycle air pollution and green house gas (GHG) emissions per unit of energy and per unit of hydrogen will be analyzed as well.

Another major task of this project is to overview existing policies relevant to the home refueling strategy, and to evaluate their impacts on the commercialization of the technologies. Furthermore, the study of the interaction between policies and the home refueling strategy will enhance the understanding of the contribution of the strategy to achieving various policy goals. Existing policies with implications for home hydrogen refueling could include the federal Energy Policy Act of 2005 – Section 808, California Low Carbon Fuel Standard, SB 1505, and the ZEV regulations [6].

SUMMARY

A number of companies have been investing in home refueling technologies, and several demonstration projects are underway. However, a thorough feasibility study, or an economic analysis of cogeneration systems studied in this project are still unavailable.
This project aims at narrowing this gap by developing and utilizing an engineering/economic model to simulate steady state system performance and estimate the cost of electricity, heat and hydrogen from the systems. The economic viability and environmental impact of the systems compared with alternatives (e.g., grid electricity and natural gas) will also be assessed.
Policy analysis will be conducted as well to inform private and public decision-makers about the opportunities, challenges and the early-market dynamics of commercializing home refueling technologies.

REFFERENCES

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