V.G.15 Mass Production Cost Estimation for Direct H_2 PEM Fuel Cell System for Automotive Applications

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Objectives

- Identify the lowest cost system design and manufacturing methods for an 80 kW_e direct-H_2 automotive polymer electrolyte membrane (PEM) fuel cell system based on three technology levels:
  - Current status
  - 2010 projected performance
  - 2015 projected performance
- Determine costs for these three technology level systems at five production rates:
  - 100 vehicles per year for 4 consecutive years
  - 30,000 vehicles per year
  - 80,000 vehicles per year
  - 130,000 vehicles per year
  - 500,000 vehicles per year
- Analyze, quantify and document the impact of fuel cell system performance on cost
  - Use cost results to guide future component development

Technical Barriers

This project addresses the following technical barrier from the Fuel Cells section (3.4.4.2) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

(B) Cost

Approach

There are four main steps to our project approach: literature review, system design and layout, DFMA® costing, and review and adjustment. Our approach will be based on detailed, rigorous and consistent system design, which will provide a solid foundation for a methodical, step-by-step breakdown of component costs.

The first step in the power system cost estimation process is a literature review. Cost estimates are made from calculations based on hundreds or thousands of individual minor assumptions regarding the materials, design, and methods of construction of the power system. Thus, the best way to achieve an accurate cost estimate of the total system is through a thorough understanding of the many different ways of fabricating each system element. Consequently, Directed Technologies, Inc. (DTI) will review patents, conduct document searches, and interview researchers and engineers to document the myriad assumptions that go into a comprehensive cost study. These materials, along with design and manufacturing metrics from industry and researchers, will help us construct the costing algorithms for our model. While the bulk of the literature review occurs at the beginning of the project, data will be gathered throughout the project.

The second step is system design and layout. Three different system designs will be modeled using HYSYS® process modeling software: one that reflects currently available technology, one corresponding to projected 2010 technology, and a third for projected 2015 technology. Armed with a detailed system design and a clear set of technical parameters for each of the three systems, DTI will prepare a conceptual design of each subsystem and element within the power system. These elements will be tabulated in a detailed bill of materials listing all parts in the power system. The bill of materials provides structure for the cost estimation calculations and will be used as an index for the remainder of the cost estimation process.

Emphasizing a realistic and complete cost assessment, DTI will next use the DFMA® techniques to

derive costs for all elements in the bill of materials for each of the three technology levels. We will adjust for the five different production rates by varying material cost, lot size, setup costs, manufacturing methods, markup rates, etc. and compile a full cost breakdown for each component. A summation of these component costs, plus assembly costs and adjustment for markup, will provide realistic system cost numbers for each of the 15 combinations of technology levels and production rates. Key elements will be examined in more detail than minor elements. Subsystem designs, already altered based on technology level, may be adjusted to better match manufacturing methods chosen for a specified annual rate of production.

In the fourth and final step, DTI will conduct a careful review of the cost analysis. In addition to catching any errors that may have been made, we'll re-examine each of the assumptions made on the first pass, applying the knowledge gained during the project to ensure accuracy and consistency throughout. The resulting adjustments will not be limited to improving the accuracy of the existing model, but may also include component or system redesign that further lowers production costs. This process will yield a realistic model that is both accurate and built on cost-efficient design.

FY 2006 Publications/Presentations

1. Mass Production Cost Estimation for Direct H_2 PEM Fuel Cell System for Automotive Applications – poster presentation FCP 37 at the 2006 DOE Hydrogen Program Annual Merit Review and Peer Evaluation.