Commercial Applications for Stationary Fuel Cell Systems

Dan Stevenson, PE
CTA Energy Solutions
1500 Poly Drive
Billings, MT 59103

Abstract

The hydrogen fuel cell is arguably the future of power generation for fossil and renewable fuel sources alike. The work reported in this paper focuses on identification, evaluation and development of entry-market stationary fuel cell applications. Previous phases of the Big Sky Fuel Cell Program have focused on researching technology development and appropriate technologies for applications. The present work concentrates on implementing an application research and technology validation program.

There are two major tasks to be completed in this phase of the fuel cell program. The first is the implementation of a proton exchange membrane fuel cell demonstration and evaluation project. This project will install, demonstrate, and evaluate a 4.5 kilowatt PEM fuel cell system installed in a light commercial application. The installation will include innovative cogeneration techniques and an interpretive installation for public education regarding fuel cell technology and related technologies, such as hydrogen production, storage, and use. The demonstration project will be implemented at the West Entrance to Yellowstone National Park and will partially power the Entrance Station complex.

The second task is to identify and evaluate three applications for fuel cell powerplants. The evaluation process began with preliminary identification of target market types, and associated projects. Entry markets identified include Medical Centers, Telecommunication and Data Industries, Banking and Financial Data Processing, and Agricultural Waste to Energy projects.

Many projects were identified initially, and initial narrowing of the projects has been completed. Three projects representative of the identified entry markets for fuel cell technology have been identified, and their evaluation is underway. The projects include a Regional Medical Center, a Data Co-location Center, and a combined beef cattle feeding/processing operation and ethanol plant.

The evaluation of these projects is expected to lead to the development of additional demonstration and evaluation projects in future phases of work. Future work will include the development of the highest potential project as identified by the evaluation of the three projects in this phase.

Introduction

The purpose of the Big Sky Fuel Cell Program (BSFC) is to forward fuel cell technology commercialization through research and implementation of practical and visionary applications of fuel cell technology. The Program's familiarity with the technologies and the benefits that it will produce for the fuel cell industry will aid in technology development, validation, and commercialization. On a local front, economic development within the State of Montana based around the fuel cell industry has been a program mainstay.

The program is presently in its second round of funding. The first round explored the fuel cell technologies that exist, explored projects involving coal gasification to feed a fuel cell power plant, and investigated PEM fuel cell applications. Where the first phase of our program centered on building a general knowledge base about fuel cell technology, the second phase focuses on identifying and implementing actual fuel cell power plant projects.

The BSFC Program is working hard to bring energy alternatives, based on fuel cell focused distributed generation, to the energy industry. The Program's objective for the Phase 2 effort is to demonstrate the viability of fuel cell technology through an actual installation and also identify multiple projects with sound objects and feasibility for additional application research and demonstration of the technology. Work is presently underway on all fronts to make these efforts a resounding success.

Task One – PEM Fuel Cell Demonstration

The proton exchange membrane (PEM) fuel cell powerplant is leading the effort toward commercialization in the 1 to 50 kilowatt market. The commercial applications for distributed cogeneration in this product size range are nearly infinite. The BSFC has identified small, remote, commercial applications as an entry market for this technology, and initiated efforts to identify and evaluate a demonstration project that provides the maximum value possible for the fuel cell industry and the Hydrogen Program.

Project Goals

The goal of the PEM demonstration is to implement a 12-month demonstration of a PEM fuel cell to evaluate its performance in a practical, somewhat harsh environmental, application. The plant will be designed to fully utilize the fuel cell plant's heat production in space heating and domestic water heating cogeneration modes. The potential addition of a small snow-melt system for the fuel cell pad itself is presently being evaluated. The full use of the cogeneration capability is of high priority in this demonstration as maximizing the efficiency of the total plant efficiency is also a goal.

Site Selection

Selection of the demonstration site considered many variables that will affect the outcome of the project. These variables include:

1. The site's ability to allow powerplant installation with minimal risk to the operation of the facility.
2. The site's ability to allow effective powerplant integration electrically and thermally to achieve demonstration project goals.
3. The site's representation of small, remote commercial type loads.
4. The site owners' willingness to site and capacity to monitor the project.
5. The site's potential from the perspective of the fuel cell manufacturing partner. Sites with little public exposure were of little interest.
6. The site's ability to be an effective public education media regarding hydrogen and fuel cell technology.

Several project sites were considered for the demonstration project. These sites included cellular tower installations, small banking outlets, and remote water pumping stations.

The Selected Site

The location that was chosen was the West Entrance Station to Yellowstone National Park. The entrance station, located adjacent to West Yellowstone, Montana is the most traveled entrance to Yellowstone. The site consists of a 600-square foot office building housing the computer and security systems and Ranger offices for the entrance. There are also three entrance kiosks and an ambient air quality monitoring station served from the station's electrical service. The sites electrical service is provided by Fall River Electric Cooperative, a member of the distribution network established by H Power Corporation, a PEM fuel cell plant manufacturer. The facility has a nearly year-round requirement for space heating and also has a minimal domestic water heat requirement, both facilitating optimized cogeneration. The site is staffed by National Park Service staff and NPS electrical and mechanical technicians will be able to access and maintain the plant year-round along with Fall Rivers technicians. All parties involved in the project believe it to be the optimum location for this demonstration for the above technically-related reasons, but also because of the National Park Service's enthusiasm for the project and its public accessibility. The project installation will occur directly inside the Park, past the entrance

station, allowing Park visitors to park and visit the site easily. The demonstration site will be an interpretive installation including permanent media for public education.

The Fuel Cell Powerplant

The fuel cell plant will be provided by H Power Corporation through Fall River Electrical Cooperative, the local H Power distributor. The power plant will be a propane-fueled PEM fuel cell with an average electrical capacity of 4.5 kilowatts. Cogeneration will be accomplished with commercially available equipment.

Task Schedule and Progress

The PEM demonstration is progressing well with the Site Selection and Fuel Cell Manufacturing Partner both completed. A September 1, 2001 delivery on the fuel cell plant is anticipated. Work related to the installation of the fuel cell plant is proceeding and the site is expected to be complete and ready to receive the fuel cell upon delivery. Project completion is expected by September 15, 2001.

Task Two – Commercial Project Identification

Commercialization of fuel cell systems is dependent upon the effective identification of the highest potential entry market segments. The second task in this Phase of work is to identify entry market segments and potential application research/demonstration projects for fuel cell technology. The focus of the BSFC is on near-term technology applications (next 5 years) as well as intermediate-term applications that may be value-added for western region states.

The Market Segments

Many projects were identified and a preliminary round of elimination has taken place. The three projects that were selected for conceptual develop are focused on commercialization of fuel cell technology in the western states region, particularly Montana. The target market segments include:

Regional Medical Centers-

Medical Centers are becoming increasingly sensitive to power quality and reliability. The nature of these facilities also facilitates cogeneration with high temperature fuel cell technologies. The power plant heat rejection rate matches baseline thermal requirements well in this application. The potential of waste-to-energy syn-gas production is also a future consideration with Medical Centers as medical waste is an expensive and hazardous disposal issue. However, the state of the

waste-to-energy processes available are neither economic, nor well-tested in this application. Complication of a first large-scale fuel cell demonstration with one of these technologies would complicate the project to the point of unacceptable risk levels.

Data Centers-

The propagation of Data Centers throughout the Northwest U.S. is a sign of continued growth in the digital age and also a significant burden on the already overtaxed Western grid generation and transmission capacity. The power use density for these facilities can be in excess of 100 watts per square foot resulting in very high electrical demands for a relatively small facility. These same facilities are extremely dependent on premium quality and highly reliability power. The potential for cogeneration at these facilities is low, however the development of the Data Center Campus concept allows cogeneration to be implements beyond the confines of the Data Center in surrounding process, office, or hospitality relate buildings.

Agricultural Waste to Energy

Agriculture in the western U.S. has suffered economically in recent history, spurring a new movement in the area of vertically integrated product production and combined energy and agriculture production facilities. Several developers are working on projects in the Northwest to integrate cattle feeding and processing with ethanol production and other value-added production processes. The process of looking at the entire agricultural and energy production cycles together reveals some exciting synergies that may very well include on-site generation of electric and thermal energy with a fuel cell plant. The environmental and economic benefits of an integrated agricultural and energy plant could revolutionize both industries in Montana.

Project Identification

Projects have been identified and application models, economics and project concepts will be developed for each of the above market segments. Future work in the BSFC program will be focused on implementation of these projects, or the model developed for the market segment.

Based on the evaluations, the projects will be prioritized by potential for fuel cell commercialization and benefits such as economic development and operational improvement in the market segment. Funding for the highest priority project will be pursued for near-term implementation.

Conclusions

The Big Sky Fuel Cell Program's second phase is estimated to be complete in September 2001. With its completion, the second phase will deliver an operating proton exchange membrane hydrogen fuel cell demonstration project. This project will be accessible by over one million visitors to Yellowstone National Park annually and will be designed to maximize public

education about hydrogen and fuel cell technology. In addition to the PEM demonstration, three commercial fuel cell projects will be identified and evaluated as models for fuel cell technology's early market entry. This project identification work and the social and economic benefit that will be identified is the impetus for future work within the BSFC Program.

The BSFC Program is focused on solving present and near-term energy issues as well as assisting long-range project types through implementation. Public education and economic development also remain important objectives of the Program.

Future Work

The future work to be completed by this Program is contingent upon the Technical Advisory Team's review of the work in this phase. Pending review the following are suggested future work items:

Short term work goals:

1. Develop a business plan based on the current state of fuel cell technology and projected development to commercialize stationary systems in the building industry. Develop this business plan in coordination with fuel cell manufacturers by First Quarter 2002.
2. Using the information gathered and project concepts developed in the current phase of our work (Phase Two), implement a minimum of two, preferably four, major (250kW or greater) commercial fuel cell demonstrations by Second Quarter-2003. These projects will be strategically chosen to aid commercialization.
3. Based on the results of project testing programs and monitoring of the above installations, provide critical feedback to fuel cell developers to improve product for the building industry. Have building industry data incorporated into the major manufacturers technology by Third Quarter 2004.

Long term work goals:

1. Execute additional demonstration projects to penetrate additional entry markets. The Vision of our program is to methodically assist in the commercialization and deployment of fuel cell technology**.** By Fourth Quarter 2005, have fuel cell technology sufficiently demonstrated to entry markets to facilitate commercial deployment of the technology.
2. Develop a deployment team vertically integrated in the energy, equipment sales/service, and building construction industry to smoothly integrate the technology into construction projects. Develop this plan for immediate transition to system commercialization from testing – Early Fourth Quarter 2005.
3. Build on the accumulated experience to make fuel cell technology a reality in the building and construction industries.
4. Develop a waste to energy and hydrogen generation and infrastructure component to our work. A milestone is being determined.

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