UNIGEN® Regenerative Fuel Cell For Uninterruptible Power Supply

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Objectives

Demonstrate hydrogen fuel cell based uninterruptible power supply with

- Economic viability
- Real world applications
- Regulatory code compliance

Achieve performance goals:

- Power output 3^{+}kW
- Run time of <240 hours per year typical
- Storage capacity of 50 hours
- Instantaneous operation upon grid failure
- Maintain digital equipment with continuous electrical supply

Technical Barriers

This project addresses the following technical barriers from the following sections of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year R,D&D Plan:

Technology Validation

- I. Hydrogen and Electricity Coproduction

Education

- B. Lack of Demonstrations or Examples of Real World Use

Hydrogen Codes and Standards

- O. Insurance Companies Recognize Current Standards

Approach

- Fabricate UNIGEN® Regenerative Fuel Cell (RFC) Uninterruptible Power Supply (UPS) using modular components allowing flexibility in power output, run time, and recharge time
- Demonstrate technology performing useful work in a high visibility location with access to decision makers that are key to realizing the common usage of hydrogen based systems
- Obtain permits for siting and operation of the UNIGEN® RFC UPS unit through co-authoring of new code with local authority

Accomplishments

- Completed development tests and preliminary design of UNIGEN® RFC UPS
- Established the Mohegan Energy, Environmental, Economics Education Center as the demonstration site
- Established working agreement with local authorities at Mohegan Sun to co-author codes for siting and operation at their facility

Future Directions

- Complete final design of 3-kW RFC UPS and fabricate
- Co-author a code to be adopted by the Mohegan Tribe for UNIGEN® RFC UPS
- Perform full system validation test at Proton
- Install UNIGEN® RFC UPS at Mohegan Energy, Environmental, Economics Education Center

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Introduction

The UNIGEN® Regenerative Fuel Cell (RFC) for Uninterruptible Power Supply (UPS) project was initiated in October of 2002 as part of the U.S. Department of Energy State Energy Program (DOE/SEP). The objective of the project is to demonstrate a fuel cell based UPS with economic viability. The UPS is required to provide 1-kW to 5-kW of high quality electrical power to digital equipment without interruption in case of a power outage in a real world application. The UNIGEN® RFC UPS being fabricated by Proton Energy Systems as part of the project provides 3 kW of electrical power without interruption during a loss of grid power using a proton exchange membrane (PEM) fuel cell that utilizes pure hydrogen for power generation and a PEM electrolyzer for refilling the hydrogen storage system after the grid has returned to normal.

A significant aspect of the demonstration phase is the permitting process for siting the unit. As there is no one inclusive regulation that applies to an RFC UPS, one needs to be developed as part of the project. The generation of the regulation is a collaborative effort between Proton Energy Systems and the Public Safety Office of the Mohegan Tribe. Once completed, the Mohegan Tribe will adopt the regulation just as existing National Fire Protection Association (NFPA) regulations for mature technologies are recognized today.

Approach

The project has three separate goals, each requiring its own approach. The goals and the approach taken to meet each of them are given in the following paragraphs.

Economic Viability. There are three main attributes to the regenerative fuel cell power system as it is used in a back-up power scenario. These are power output, run time, and recharge rate. The power output is determined by the size of the fuel cell. The runtime is determined by the capacity of the hydrogen storage portion of the system. The recharge rate is determined by the output rate of the electrolyzer used to generate the hydrogen. The approach of the Proton UNIGEN® system is to separate these attributes into modular components. The modular system components allow flexibility in meeting the particular needs of future end users by easily accommodating different output powers, back-up times, and recharge times. Modular component systems are fitted to the customer's need in a building block approach, enabling a "buy as you need" scenario. Modular components also allow capability for future expansion with maximum reuse of hardware, avoiding the need for total system reconfiguration. Modular components greatly simplify maintenance, as field repairs become a simple module swap.

Real World Application. One of the significant challenges facing the common use of hydrogen-based technology is the general reluctance to adopt new technologies based on a lack of understanding and negative safety perception of hydrogen. Demonstrations outside the laboratories where the technologies are performing useful work in approachable atmospheres are key to breaking down these barriers. The approach to this aspect of the project is to site the RFC UPS where the potential for educational impact is greatest. The Mohegan Energy, Environmental, Economics Education Center provides a unique opportunity for showcasing the technology in a real world application. The Center receives about 1,000 visitors annually, with the majority being professionals, government representatives, and academics involved in the use, research, and industrial deployment of alternative energy technologies. Educating these decision makers is the first step in realizing the hydrogen economy future.

Regulatory Code Compliance. As with any new technology, one of the significant challenges is the acceptance by local officials who are chartered with ensuring safety of the general public. This is also the case with the UNIGEN® Regenerative Fuel Cell UPS. Local safety and fire officials are familiar with the regulations outlined in documents published by the NFPA. They use these guidelines when assessing the installation and operation of equipment at their facilities. Since hydrogen technology based equipment is relatively new, the current regulations do not provide the required guidance in all areas. The approach used in this project is to co-author a regulation with the local safety and fire officials, pulling applicable pieces from established regulations as they apply to the UNIGEN® RFC UPS. Having the demonstration at the Mohegan Sun facility offers a unique opportunity to accomplish this. The Mohegan Tribe is a recognized sovereign nation with its own governing body. As such, there is the ability to generate a new regulation that will be applicable to their facilities. The number of agencies and cognizant parties is small, so the authoring and adoption process has a shorter cycle time versus regulations covering the state or national levels.

Results

The UNIGEN® Regenerative Fuel Cell for Uninterruptible Power Supply demonstration project is making groundbreaking progress in all three of the key areas identified. The design and development of the modular components, establishment of a real world application for demonstration, and regulatory code generation are on a clear path leading to success of the project.

The modular system design has progressed through the preliminary phase by meeting the goal of a truly configurable system that will serve the needs of a variety of end users. The design of the system complies with the regulatory codes as they apply to each aspect of the technology. Development testing in the area of power transfer has resulted in a seamless transition from grid to fuel cell generated electrical power suitable for digital equipment.

The real world application in a high visibility location has been established. Agreement has been reached with the Mohegan Energy, Environmental, Economics Education Center Administrator that the UNIGEN® RFC UPS will provide needed back-up power to the Center's twin 200-kW PC25 fuel cells' monitoring and safety systems. Without these systems, the PC25s are required to shut down during a power outage. The UNIGEN® RFC UPS gets its power to recharge the hydrogen storage system from the PC25s as well. The notion of a fuel cell based UPS keeping a fuel cell based power plant online during conventional grid failures is one that will create a lasting impact on visitors to the Center.

The regulatory codes, as they apply to all types of hydrogen based equipment and codes pertaining to the design and installation of industrial equipment, have been reviewed for applicability to the UNIGEN® RFC UPS. A subset of these codes has been identified in draft form, and a preliminary siting plan has been developed. The Mohegan Sun Public Safety Official and the Fire Marshall have affirmed their support of the project and the generation of the new regulation. Once the regulation is complete and accepted by the Mohegan Tribal Government, it can be used as an example for other national associations in generation of standards for similar equipment.

Conclusions

The UNIGEN® Regenerative Fuel Cell for Uninterruptible Power Supply project is well on its way towards successful completion in September of 2004. Progress towards each of the three objectives has been positive, with results building upon one another. Development testing has yielded a design that will meet the performance objectives of the project. The modular component concept will enable economic viability in the future and has been designed for fuel cell based UPS system with power output in the 1 kW to 5 kW range. The barriers commonly associated with the public perception of hydrogen technology safety have been broken down through mutual cooperation and understanding of both the technology and the responsibility of the local authorities in keeping the public safe.