REMOTE ALASKA POWER PROGRAM

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Abstract

Until only a few years ago large-scale production of fuel cell devices was prohibited by the high cost of raw materials. Thanks to advancements made at our National Labs these costs have dropped considerably and have made possible the commercial production of fuel cell systems. Once commercialized, these Proton Exchange Membrane, or PEM fuel cell power systems will revolutionize the concept of distributed generation. The approach for this project is to integrate a PEM fuel cell stack, diesel reformer and balance of plant to provide clean and efficient grid-quality electricity to remote areas of Alaska. The goal is to demonstrate a cost-effective and efficient system that when commercially introduced will replace inefficient, polluting diesel generators in remote areas.

Summary of Approach and Rationale

Rationale

The purpose of this program is to accelerate the development of proton exchange membrane fuel cell (PEMFC) systems for use in distributed power generation applications, begin the development of a renewable hydrogen infrastructure, and promote the commercialization of these technologies.

Remote areas of Alaska already depend on distributed generation to supply their power needs. In most cases diesel generators are the prime source of electricity.

These generators are often deployed in triplicate to ensure reliability, are expensive to operate and maintain and are a significant source of pollution. The cost of electricity in many villages exceeds 50 cents per kilowatt-hour and can reach as high as 80 cents per kilowatt-hour or even more.

The combination of these factors clearly points to the need for clean, reliable and cost-effective power in the remote villages of Alaska. PEMFC systems, designed to endure the harsh arctic climate, will address this need by offering increased fuel efficiency while relying on the current infrastructure (heating oil tanks). It is estimated that the co-production of heat and electricity has the potential to reduce the amount of diesel used by 40 percent. Further, heat generated by the fuel cell system can be captured to meet household heating needs which typically represent about 60% of total household energy demand.

Approach

The approach for this project is to integrate a PEM fuel cell stack, diesel reformer, power electronics and balance of plant to provide clean and efficient grid-quality electricity to remote areas currently supplied by diesel generators. The work being done for the Alaska Remote Area Program is a natural extension of Plug Power’s commercialization efforts already underway for natural gas and propane residential fuel cell systems.

Plug Power’s approach towards commercialization is to design and develop a commercial appliance based on fuel cell technology. We are not a research institution. Instead, we function as an integrator, and to a large degree, designer of sophisticated technology provided, in many instances, by others. For example, the residential fuel cell unit has three basic processes: 1. the *fuel reformer* which extracts hydrogen from a common fuel source such as natural gas, propane or diesel; 2. the *fuel cell stack*, the heart of the fuel cell which produces electricity utilizing the hydrogen in a chemical versus a combustion process; and 3. a *power conditioner* which changes the generated electricity from direct current to alternating current. Plug Power has established design criteria for each process and is working along parallel paths with multiple suppliers for fuel reformers and power conditioning equipment. Plug Power’s principal focus is on stack development and system-level design and integration.

Plug Power is on schedule to commercialize 7-kilowatt residential fuel cell systems in 2001. Along this path we are installing and studying hundreds of field units throughout 1999 and 2000 in preparation for this major commercial launch. The systems being deployed this year and next will give us real world data on system efficiencies, i.e. reformer, stack, balance of plant and inverter efficiencies. Through these and other efforts, Plug Power is advancing the state of the PEMFC technology to produce reliable and efficient systems.

Plug Power is currently the leading developer of PEM fuel cell systems in the United States. Plug Power, headquartered in Latham, N.Y., is a privately held company whose investors include: DTE Energy Co, the parent of Detroit Edison, Michigan's largest electric utility; Mechanical Technology Inc., an early developer of fuel cell technologies; Southern California Gas Co., the nation's largest natural gas distribution utility; and General Electric. In February 1999 Plug Power entered into an agreement with General Electric Power Systems. GE Fuel Cell Systems was created as a joint venture to market, sell, distribute and service residential fuel cells throughout the world.

Past Results

Not applicable. This program was initiated with a start date of July 15, 1999.

Current Year Results

Plug Power delivered a fully integrated 7kW fuel cell system in September of 1998 to Sandia National Lab. The system operates on hydrogen and produces grid-quality AC power. The system was not optimized for efficiency, rather it demonstrated proof -of-concept for system functionality and integration. Sandia and University of Alaska personnel received training on system operation at Plug Power's facility prior to shipment of the unit. The system has been operated by Sandia and UAF personnel since its delivery to SNL in Livermore.

Plans for Future Work

Plug Power's fuel cells will provide homes and small businesses a compact, efficient, reliable, clean, and economically advantageous method of meeting their electricity requirement. Plug Power's initial commercial units will operate on natural gas, propane, or methanol and are expected to achieve 40% electrical efficiency. When excess heat generated by the fuel cell is captured and used for hot water or heating, overall efficiency can exceed 70%.

Fuel cell systems can be sized to match consumers' specific energy requirements and in many regions, will provide an attractive alternative to grid-supplied power. Another major benefit is the elimination of the cost and inconvenience associated with power outages. To date, fuel cells have not been a viable option for small-scale power generation due to their relatively high cost. However, due to technical and production advances by Plug Power, GE Fuel Cell Systems expects to offer residential-sized systems which will compete favorably with the existing grid, extending the market from niche applications to mainstream grid displacement.
In the case of the Alaska market, fuel cells have the promise of providing reliable, cost-effective and environmentally clean power.

Under Phase II of this program, the goal is to connect the reformer and fuel cell system delivered under Phase I and demonstrate operation from diesel in to electricity out. Energy and mass balances and the steps necessary to integrate the system for co-generation will be evaluated. Phase III will involve full system integration with a diesel reformer. The complete system will be fully functional for deployment in Alaska.

Goals and Basis for Goals

Goals

The principle goal for this program is to accelerate those technologies and requisite infrastructures compatible with and needed for a renewable hydrogen economy. This program will serve as an energy test-bed to validate PEMFC technologies and their applicability to remote distributed generation. The overriding goal of the program is to demonstrate a clean and efficient means of producing grid quality electricity through a fuel cell system configured to operate in the Arctic climate. Plug Power is participating in this program to gain experience and knowledge required for building systems to serve the unique needs of Alaskan residents and to commercialize these fuel cell systems. It is estimated that the market size in Alaska alone is approximately 800 megawatts of capacity. Technologies developed through this program will not only give rise to commercial product for Alaska, but also other markets where the climate is similar or where diesel is the fuel of choice. Clearly, our goal in participating in the Alaska Program is to further our next-generation of commercial systems beyond natural gas and propane.

Basis for Goals

The need to move away from fossil fuel resources and develop both the technologies and the infrastructure needed to implement a carbon-less society provides the underlying basis for this work. Using hydrogen technologies in combination with hybrid diesel systems to provide remote power reduces the economic and environmental burdens experienced by areas constrained by climate and infrastructure.

Status of Economic Evaluation

The basis for an economic evaluation of the fuel cell system lies in the efficiency of complete system and its overall cost from capital to installation and maintenance. It is envisioned that the efficiency measurements of the complete system, from the reformer and stack to the inverter will be quantified in the last pahse of the program when the system is deployed in Alaska for test and evaluation. Results from this will determine the overall economic viability of a fuel cell system versus diesel generation.

The expected range for the diesel fuel cell system's electrical efficiency is approximately of 35 - 40%. Compared to diesel generation with an approximate efficiency of 25%. Fuel cell technology offers a much higher overall efficiency when the waste heat is captured and used for water and space heating. It is estimated that this could drive overall efficiencies above 70%. Any economic evaluation of fuel cell technology must quantify the amount of heat available for heating purposes. An estimate of the average annual electric load in an Alaskan home is 2.9 kW, 1.6 kW for electric appliances and 1.3 kW for hot water and space heating. Capturing and using waste heat from the fuel cell could significantly lower kilowatt demand and therefore lower diesel consumption. This increased efficiency in diesel use translates into direct dollars saved at the household level and can lower the storage cost of diesel on a macro scale. Also, savings will be gained due to the reliability of a fuel cell system. The redundancy factor in deploying diesel generators to ensure reliability is diminished through fuel cell use.

An economic analysis should also take into account the environmental benefits of decreased diesel fuel consumption, i.e. a reduction in pollution emissions and oil spills. Further, it will be important to quantify total life cycle costs of a fuel cell system compared to a diesel generator (diesel generators needed major overhaul every 10,000 - 12,000 hours) and have a much shorter total life expectancy.

Major Barriers to Meeting Goals

1. Developing a reliable diesel and/or kerosene reformer
2. Overall cost reduction – capital, installation, and maintenance costs are all factors when competing with diesel electric generators.
3. Convincing the end user that this is an appropriate technology.
4. Time
5. Money

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