FuelCell Energy
World Leader in Ultra-Clean Power

Thrust Area: Hybrid Fuel Cell/Turbine Power Systems

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PROSPECTS FOR ULTRA HIGH EFFICIENCY POWER GENERATION

In an era of electric power deregulation, environmental concerns with pollution and green-house effects, and ever rising fuel prices, there is an obvious need for power plants which are non-polluting, highly efficient, and easily sited.

FuelCell Energy, Inc. (FCE) has an innovative approach to this fundamental need with its proprietary and patented ultra high efficiency power plant design. At the core of this innovative power plant design (shown schematically in Figure 1) is FCE's commercial fuel cell technology, Direct FuelCell®(DFC®). The system extends the potential fuel savings of DFC® by combining a non-fired gas turbine and a network of heat exchangers to transfer waste heat from the fuel cell to the turbine, resulting in extra electricity and adding 10 to 15 percentage points to the efficiency of the DFC®.

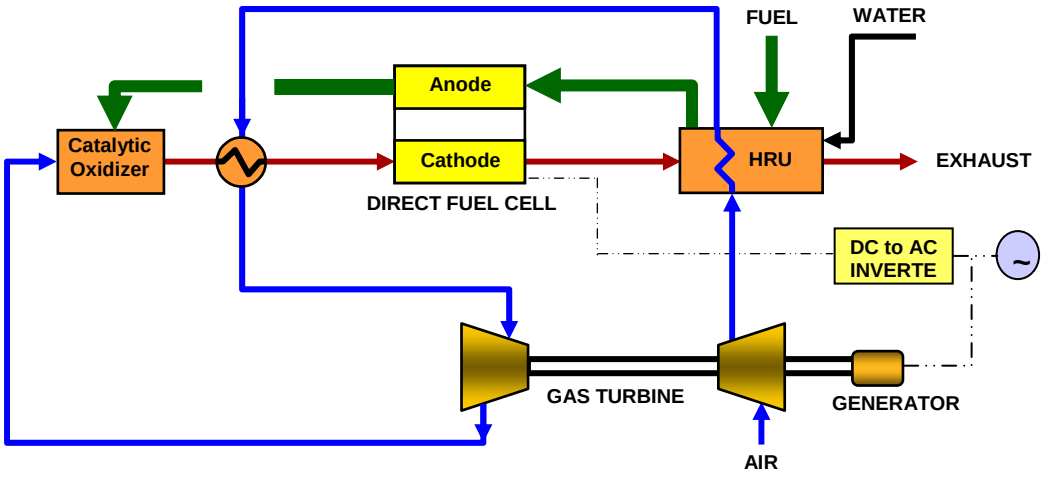

Figure 1. DFC/Turbine® Ultra High Efficiency System:

This novel design concept generates clean electric power at very high efficiency.

Benefits of the Hybrid Power Systems

Long-term reliability and sustainability of power generation is very important to the overall economic growth of the U.S. as well as the rest of the world. Adding new generation capacity is our next challenge, especially given stricter environmental and "not in my back yard" concerns. By providing a power

generation option which meets these siting constraints, Direct FuelCell /Turbine® (DFC/T®) hybrid systems are prime candidates for distributed power generation. The system is potentially low-cost, high in electrical efficiency, and non-polluting. This environmentally friendly and highly efficient technology is gentle to our planet, minimizes use of our fossil resources and reduces our dependence on imported energy. The potential economic and environmental benefits are summarized below:

- **Efficient Use of Energy Resources:** The DFC/T® produces power with much lower fuel consumption per kW electricity than other existing plants and, therefore, saves valuable natural resources. With most traditional technologies (gas turbine combined cycles and coal based applications), economies of scale are critical to obtaining high efficiency power generation. The DFC/T® is not dependent on economies of scale to achieve high efficiency. As a result, DFC/T® plants can achieve efficiencies previously unthinkable in small scale power generation.

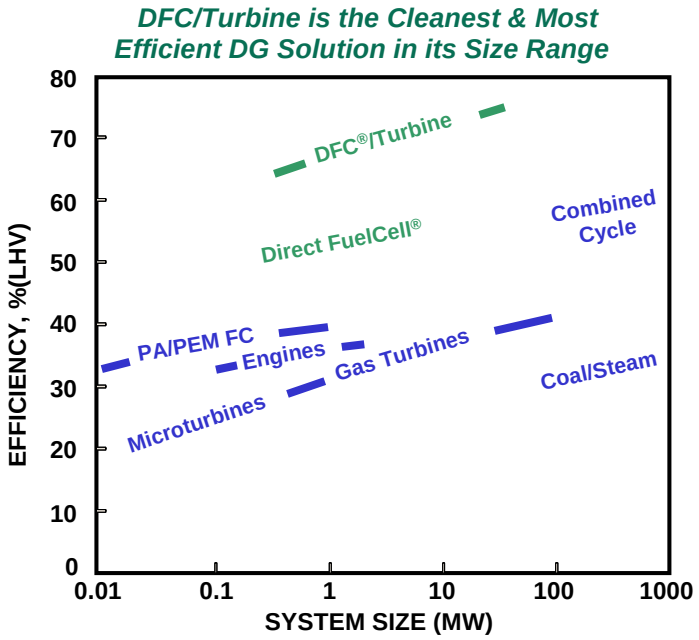

Figure 2. Power Generation Efficiency:

DFC/T® system uses less fuel per unit of electricity than other power generators.

- **Optimal Siting of Generation:** The DFC®/Turbine's small profile, low environmental impact, low noise, and ability to be sited in small distributed sizes will facilitate local permitting in grid congested areas and will open opportunities for siting in both rural and urban areas. These features make the DFC®/Turbine an excellent choice in the highly developed urban areas where new generation is typically most needed and where installing new transmission lines is the most challenging.

- **Reduced Pollution:** The system will provide for cleaner and healthier air in populated areas, accumulate emission credits, and support urban growth. It can also play a role in responding to concerns about greenhouse gas emissions. As shown in Figure 3, due to the high efficiency of the DFC/T system, it produces approximately half of the carbon dioxide of a conventional simple cycle gas turbines and far less carbon dioxide than any other fossil fuel-based power generation technology.

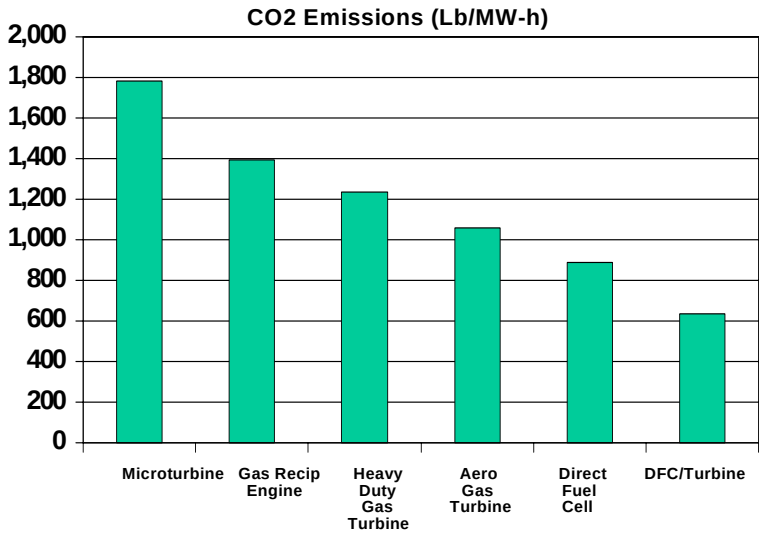

Figure 3. CO_2 Emissions by Technology

There are no appreciable NOx emissions from the DFC®/Turbine system. As shown in Figure 4, the DFC/T® has the potential to produce far less NO_x than any other fossil fuel fired system. This level of emissions performance allows the DFC/T® to be sited in urban/non-attainment areas where conventional power generation would be very difficult to permit and site.

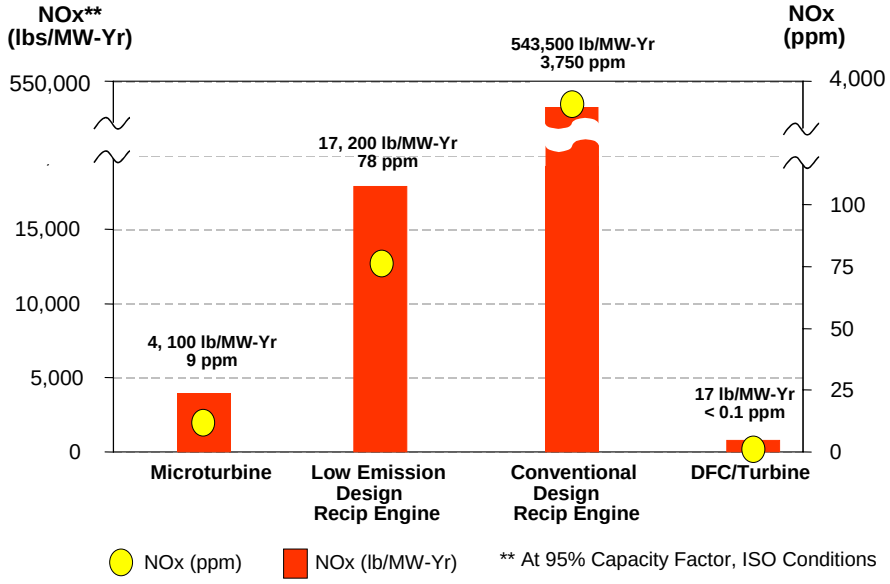

Figure 4. DFC/T® Has Low NOx Emissions Compared to Other Technologies

- **High quality power:** The inherent reliability of DFC/T® power indicates that it is capable of supporting industrial growth in high technology sectors such as computers, information technology and the communications industry, where a substantial premium is placed on reliability of the electric power.

- **Fuel flexibility:** In addition to the fossil based fuels such as natural gas and gasified coal, the hybrid system can utilize a variety of bio-mass derived fuels including landfill gas and digester gas. All of this is done at much higher efficiencies than conventional power plant technologies.

Status of Hybrid Power System Technology

FuelCell Energy, Inc. (FCE) recently completed a field demonstration of its packaged sub-megawatt (sub-MW) class Direct FuelCell/Turbine® (DFC/T®) alpha power plant unit. The power plant achieved a record-breaking electrical efficiency of 56% (based on the lower heating value of natural gas fuel), unmatched anywhere in the industry by distributed power generation products in its size range. Such an ultra-high efficiency is traditionally expected from large combined cycle systems (400 MW or greater which are too large for distributed generation applications). The demonstration at the Billings Clinic (Billings, MT) site was completed with over 8000 hr of operation. During this period, the power plant provided 1145 MWh of ultra-clean, reliable base load electricity for the hospital. The plant's overall availability, including hot standby and power generation periods, exceeded 91%, which is a great achievement for a first-of-a-kind alpha unit. Emission monitoring tests of the DFC/T system have shown compliance
with the most stringent environmental regulatory standards. Achievement of ultra high efficiency reveals the potential of the DFC/T concept for substantially reducing power generation cost while maintaining the green benefits of near zero emissions to the environment.

Figure 5. The First DFC/T® Power Plant during Factory Alpha Testing