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More Bang for the Buck

BY MICHAEL F. COOPER, PE

A DISCUSSION OF FUEL CELLS FOR BUILDINGS AND THE REGULATORY ENVIRONMENT GOVERNERING THEM

"The nice thing about standards is that there are so many to choose from."
Andres S. Tannenbaum

INTRODUCTION

One of the hottest topics in the engineering community is alternative energy. Every time we visit the gas station, we are reminded of our dependence on petroleum-based fuels, and the cost of this dependence. One alternative energy source that is receiving a lot of attention is the fuel cell. At one time, fuel cells were thought of only for the transportation industry. Part of the new technology that could finally render the internal combustion engine obsolete. The small electronics industry has also been looking at fuel cells to help advance their product offerings. In recent years, however, it has become apparent that fuel cell applications are as viable, if not more so, in the construction industry, as a way of powering buildings.

When we talk about fuel cells for buildings, three key ideas come to mind. First, they are a highly attractive on-site power generation technology. They are highly efficient, have minimal environmental impact, and are applicable across a wide range of power requirements. Second, there are some markets that are more attractive than others. Areas where the cost of electricity is high, such as California or New York, are viable initial markets. Building projects that require high levels of electricity, heating, and cooling are also attractive. Such projects would include hospitality facilities, advanced office centers, hospitals, and laboratories. Finally, a thorough understanding the regulatory environment of fuel cell applications in buildings must be obtained before pursuing such systems. This third idea is the focus of this article.

THE REGULATORY ENVIRONMENT

It is important to note that, even though fuel cell technologies are relatively new, they still require the approval of local building code officials and other authorities having jurisdiction. What you are likely to find is that the applicable codes and standards are, in many cases, lagging behind the technology itself. For this reason, municipalities and other authorities are conducting reviews in a more cautious manner than if a more traditional building were being proposed. It is recommended that additional review time be allocated in the project schedule. Further, it is strongly recommended that the designer and building owner meet with the building officials as soon as possible to discuss the project. When building officials are made "part of the team," they will have a better understanding of the proposed systems and

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HARLEYELLIS | Corporation
26913 Northwestern Hwy.
Suite 200
Southfield, Michigan
48034-3476 | USA
Contact: Judy Little

248.262.1500 (telephone)
248.262.1515 (facsimile)
www.harleyellis.com

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operating parameters, and in turn, help facilitate a quicker and easier review process. The good news is that codes and standards for fuel cell applications in buildings are catching up to the technology. Agencies and organizations are working diligently to update existing regulations and create new ones to help govern the anticipated increase in fuel cell building systems. The purpose of this article is to provide an introduction to some of the key codes and standards that apply to fuel cell building systems. As you review the information, keep in mind that fuel cell emissions occur primarily from the fuel processor, and are usually far below existing regulatory limits.

INTERNATIONAL MECHANICAL CODE (IMC) SECTION 924 (2000)

This code section mandates that fuel cell systems with a power output less than one megawatt must be tested in accordance with American National Standards Institute (ANSI) Standard Z21.83 (we'll discuss this standard in just a moment), and installed in accordance with the system manufacturer's requirements. Larger fuel cell systems must be documented to be "equivalent" from a health and safety standpoint to other technologies currently accepted in the code.

You can see that there is a limitation to the size of fuel cell systems that are governed by this code section. It is expected that as this code evolves, this limitation will be written out and larger systems will be governed by it as well.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) STANDARD Z21.83 (1998)

This standard provides construction, performance, and safety criteria for packaged fuel cell power plants with capacities less than one megawatt, operating on natural gas or liquefied petroleum.

Here, there are limitations to both the size of fuel cell systems governed and the input fuel source. Revisions have already been proposed that would increase the scope of this standard beyond natural gas and liquefied petroleum input fuels, and also include criteria for ventilation and piping design.

CANADIAN STANDARDS ASSOCIATION (CSA) STANDARD FC-1

This standard claims to be a planned replacement for ANSI Standard Z21.83. It provides construction, performance, and safety criteria for packaged fuel cell power plants with capacities less than ten megawatts.

This standard has widened that range of fuel cell systems governed ten fold, and excluded limitations related to input fuels. At present, it is not certain whether this standard will replace the ANSI standard, or perhaps exist as an additional independent document.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARD 853 (2003)

This standard addresses the design, construction, and installation of stationary fuel cell power plants of all sizes, including both packaged and field constructed systems. Criteria includes system configuration and siting, fuel supply, ventilation, and fire protection.

This standard, like many NFPA standards, is comprehensive and applicable to a very broad range of systems.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARD 70, ARTICLE 692 (2002)

Standard 70 is commonly referred to as the National Electric Code. It addresses packaged fuel cell system installation, wiring, circuit protection, and connections to other systems. Unlike some of the other regulations discussed, this standard does not address the fuel cell system itself, but rather the electrical infrastructure associated with the system.

When looking at the electrical infrastructure, we often consider emergency power. One of the potential benefits of fuel cell systems is their ability to provide emergency power provisions. It is important to note that at present, NFPA Standard 110 (Emergency Power Systems) only allows rotating equipment to satisfy the emergency power equipment requirement. The equivalency clause may allow fuel cells to be used, if acceptable to the authorities having jurisdiction. If you are considering such an application, it is recommended that you contact the authorities as soon as possible.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) PERFORMANCE TEST CODE 50 (2002)

This "code" introduces definitions and provides test methods and procedures for characterizing the performance of overall fuel cell power systems. This code applies to complete systems, and does not address individual system components. It also excludes a discussion of emissions, reliability, and safety related issues.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE) STANDARD P1457 (2003)

This standard establishes uniform criteria for interconnecting distributed power generation systems, including fuel cells, with an electric utility grid. It outlines interconnect classifications, performance and safety criteria, and procedures for operation, safety, testing, and maintenance of the interconnection. The standard is not concerned about the fuel cell system itself, but rather the interconnection of the system to the local electric utility grid.

This document addresses a critical issue. While most municipalities will allow power generation system connections to their utility grid system, they almost always have requirements that must be adhered to. Many of these requirements can impact the facility design. An early discussion with the local utility company can save both time and money down the road.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE) STANDARD P1614

This standard is currently a work in progress. When complete, it will provide guidelines for monitoring, information exchange, and control for distributed resources, including fuel cells, that are interconnected with electric power systems. If enacted, this standard would be complimentary to IEEE Standard P1457. Standard P1457 concerns the interconnection, while Standard P1614 would address the system itself.

UNITED LABORATORIES STANDARD 1741 (2002)

At present, this standard provides requirements that distributed generators must satisfy in order to operate properly, whether operating independently or interconnected to a utility grid system. Plans are in place to modify this standard to include fuel cell systems specifically by adopting the requirements of IEEE Standard P1457.

FUEL CELLS AND SUSTAINABLE BUILDING DESIGN

More municipalities each year are mandating sustainable design as part of their building design requirements. For this reason, it is becoming less of an option, and more a part of the regulatory environment. When we speak of sustainable building design, the Leadership in Energy and Environmental Design (LEED) standard almost always comes up. Sponsored by the United States Green Building Council, LEED is a voluntary, consensus based national standard for developing high performance sustainable buildings. It provides a quantitative rating system for new construction and major renovation building projects. As we'll see, the application of fuel cell systems can be a tremendous help in achieving a LEED certified project.

The LEED rating system offers a total of 69 possible points in six broad categories. A minimum of 26 points is required for a base level certification. Point totals of 33, 39, and 52 will yield a silver level, gold level, and platinum level certification, respectively. The six categories include:

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality
- Innovation and Design Process

The Energy and Atmosphere (EA) and Innovation and Design Process (ID) categories are highlighted because this is where fuel cells provide the greatest impact.

EA Credit 1 (Optimized Energy Performance) calls for a reduction in design energy cost as compared to the budget for energy systems regulated by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 90.1. Up to 10 points are available for savings up to 60% for new buildings and 50% for existing buildings. With their high operating efficiency, fuel cells can be a key contributor to a building energy cost reduction strategy.

ID Credits 1 and 2 (Innovation in Design) provide points for exceptional performance above and beyond the requirements of the LEED rating system. This would include reduced energy consumption of non-regulated systems (i.e. plug loads, exterior lighting, etc.) and reduced greenhouse gas emissions with respect to those of the local utility company. Again, fuel cells, by virtue of their high efficiency, can help reduce energy consumption. They also have extremely low emissions, helping on this end as well.

FUEL CELL VS. CONVENTIONAL POWER SYSTEM COMPARISON

Fuel Cells

- Direct conversion of chemical energy
- 89-90% fuel energy put to use
- <1 oz. pollution per 1,000 kW-hours

Conventional Power

- 2-step conversion of chemical energy
- 30-40% fuel energy put to use
- 25 lbs. pollution per1,000 kW-hours

Fuel cell systems can demand up to 50% less input energy than conventional power generation systems. This coupled with substantially reduced emissions makes fuel cells an attractive alternative for sustainable building projects.

CONCLUSION

Fuel cells are a viable power generation alternative for buildings. They offer higher operating efficiencies and significantly lower greenhouse gas emissions. The most attractive initial markets include those areas with relatively high electricity costs, and those regions with complex building projects demanding substantial natural resources. It is widely believed that once the cost of fuel cell systems falls to $1500 per kW, they will become a more mainstream power generation strategy. Until that time, there use will likely be more infrequent. One of the key factors in the successful implementation of fuel cell building systems is a thorough understanding of the regulatory environment, the codes and standards that govern their application. This includes the practice of sustainable building design. Though still largely under development, they are improving every year, and will ultimately help an increasing number of people take advantage of this exciting new technology.

ABOUT THE AUTHOR

Michael F. Cooper, PE is a Principal and Senior Mechanical Engineer at HarleyEllis and has more than 15 years of experience in the design and management of technology-based building projects.

Mike graduated from the University of Phoenix with a Masters degree in Business Administration and from the University of Michigan with a Bachelor Science in Mechanical Engineering.

If you have questions about fuel cells, contact Mike at 248-233-0146 or mfcooper@harleyellis.com.

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