Solid Oxide Fuel Cell (SOFC) System for Mixed-Fuel Zero-Net-Energy (ZNE) Homes

OVERVIEW

In this project, we designed, tested and demonstrated an SOFC Micro-CHP system as a Distributed Generation (DG) prime mover that has high reliability and availability, high efficiency and ultra-low emissions for steady state operation. Energy balances and dynamic analyses of integrating a thermal storage system with the SOFC Micro-CHP system were carried out using a summer load profile of a residence in Southern California. The thermal storage system was found to mitigate the dynamics introduced from the electric water heater and smooth out the residential load profile. Additionally, the integrated thermal storage system and the SOFC Micro-CHP system was found to reduce the overall electricity import and thus the carbon emissions.

GOALS

To improve the energy efficiency and achieve zero-net energy goals, as well as to reduce environmental impacts, we demonstrated and evaluated the use of a 1.5 kW Solid Oxide Fuel Cell (SOFC) with Micro-combined heat and power (Micro-CHP) for powering residential homes.

RESULTS

The steady-state performance of a SolidPower BlueGEN™ 1.5 kW SOFC system was tested and characterized. The SOFC was operated at steady-state and powered by natural gas. The SOFC provided 1.5kW of electricity and 0.5 kW of thermal power from the waste heat stream. System efficiencies were measured to be 60% when used in normal operation mode over the course of the operation. Due to the superiorly high conversion efficiency of the 1.5kW SOFC system, the CO_2 emission factor is significantly reduced to 0.169 kg/kWh compared to the California grid average of 0.295 kg/kWh.

SOFC System Performance	
Electric Output	1.5 kW
Electric Efficiency	60%
CO_2 Emission Factor	0.169 kg/kWh

Experimental Setup of the 1.5kW SOFC System

BlueGen in a ZNE Home

RECENT PUBLICATIONS

Alejandra Hormaza-Mejia, Li Zhao, Jack Brouwer (2017). SOFC Micro-CHP System with Thermal Energy Storage in Residential Applications. Proceedings of the 14th International Conference on Power Engineering, PowerEnergy 2017-3142

Li Zhao, Jack Brouwer (2017). Economic Analysis and Implementation Strategies for SOFC Systems in Residential Applications. ECS Transactions, 78 (1) 275-285

PERSONNEL

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