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 CO₂ emission factor is significantly reduced to 0.169 kg/kWh compared to the California grid average of 0.295 kg/kWh.

<table>
<thead>
<tr>
<th>SOFC System Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Output</td>
</tr>
<tr>
<td>Electric Efficiency</td>
</tr>
<tr>
<td>CO₂ Emission Factor</td>
</tr>
</tbody>
</table>

RECENT PUBLICATIONS


PERSONNEL

Graduate Students: Alejandra Hormaza-mejia, Rochelle Silverman; Maryam Asghari
Undergraduate Students: Mohamed Abdelrahman
Staff: Li Zhao
Principal Investigator: Jack Brouwer
National Fuel Cell Research Center
University of California, Irvine