Evaluation of Fuel Cell Powering of a Data Center

OVERVIEW

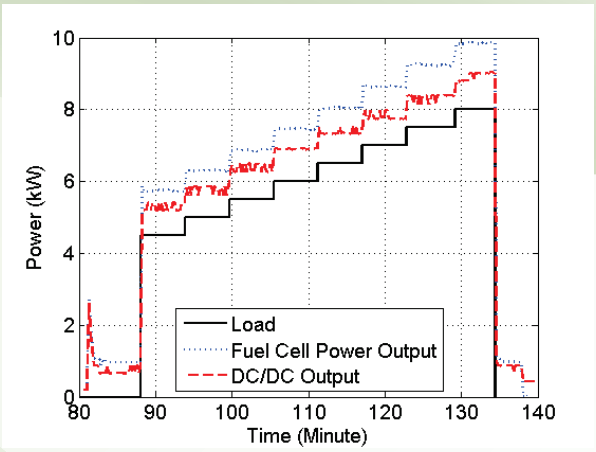
We experimentally validate the design and demonstrate the use of a 10kW Proton Exchange Membrane Fuel Cell (PEMFC) stack and system as the distributed power source to power a server rack, eliminating the power distribution system in the data center and the grid outside of the data center.

GOALS

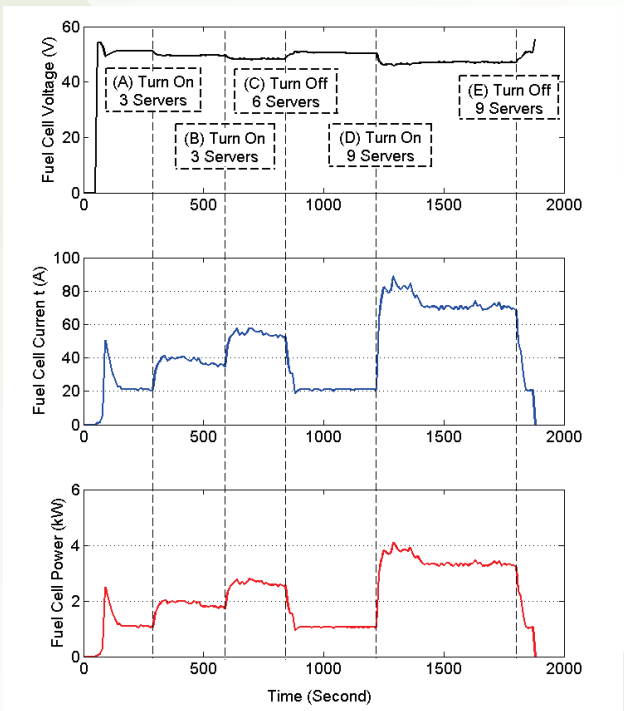
Typically, improving data center availability requires designing in more infrastructure; the antithesis of reducing costs. Is there a way to cut infrastructure, cost and emissions while improving energy efficiency and server availability? We consider and evaluate the integration of fuel cells with IT hardware with various architectural designs, essentially collapsing the entire energy supply chain, from power plant to power supply unit, into the confines of a single server cabinet.

RESULTS

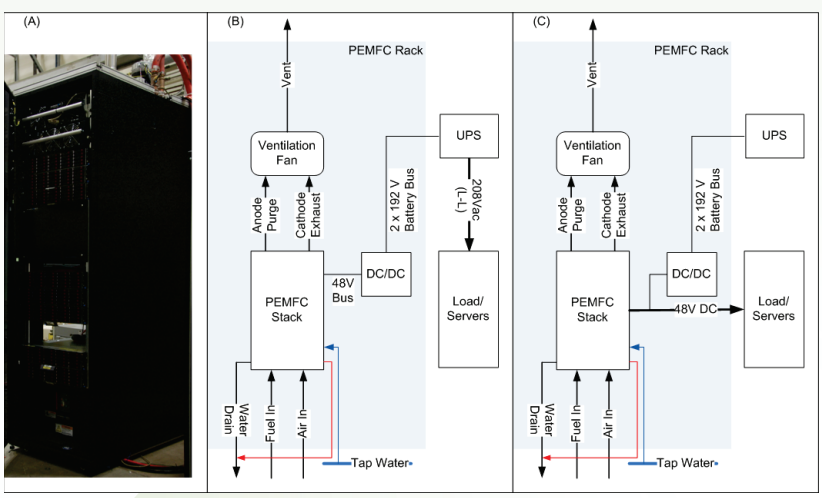
The PEMFC is found to respond quickly and reproducibly to both AC and DC load changes directly from the rack. By utilizing the fuel cell DC output, 53% energy efficiency in a single server rack can be achieved. We also carry out cost analysis to quantify the cost savings that could be achieved with fuel cells placed in each rack. We evaluate and characterize the performance and the dynamic load following capability of the fuel cell. In addition, direct DC power from the fuel cell system eliminates the capital cost and operating conversion losses from systems that use energy storage and AC/DC conversion equipment. Reducing components in the energy supply chain not only cuts cost but reduces points of maintenance and failure improving availability.



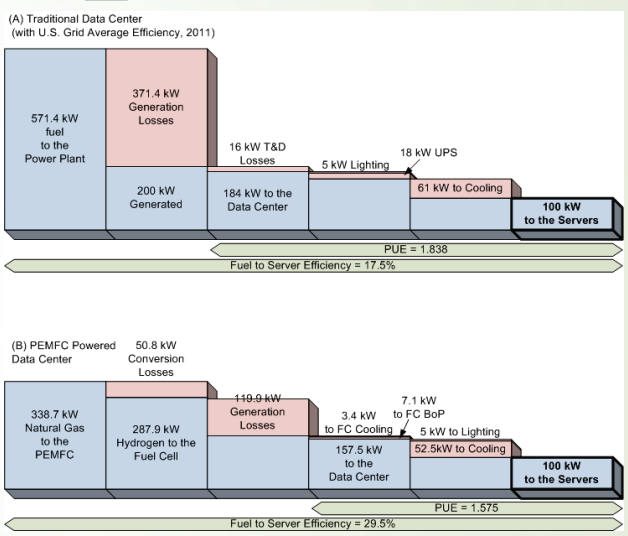
Fuel cell system response to AC step load.



Fuel cell system response to servers dynamic operation.



The experiment setup and schematics, (A) The testbed, (B) AC output configuration, and (C) DC output configuration.



(A) Traditional data center system losses, and (B) Fuel cell powered data center system losses.

PERSONNEL

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