# FUEL CELL MODELING

## LG FUEL CELL SYSTEMS REFINES SOFTWARE TO SIMULATE FLOW TRAITS

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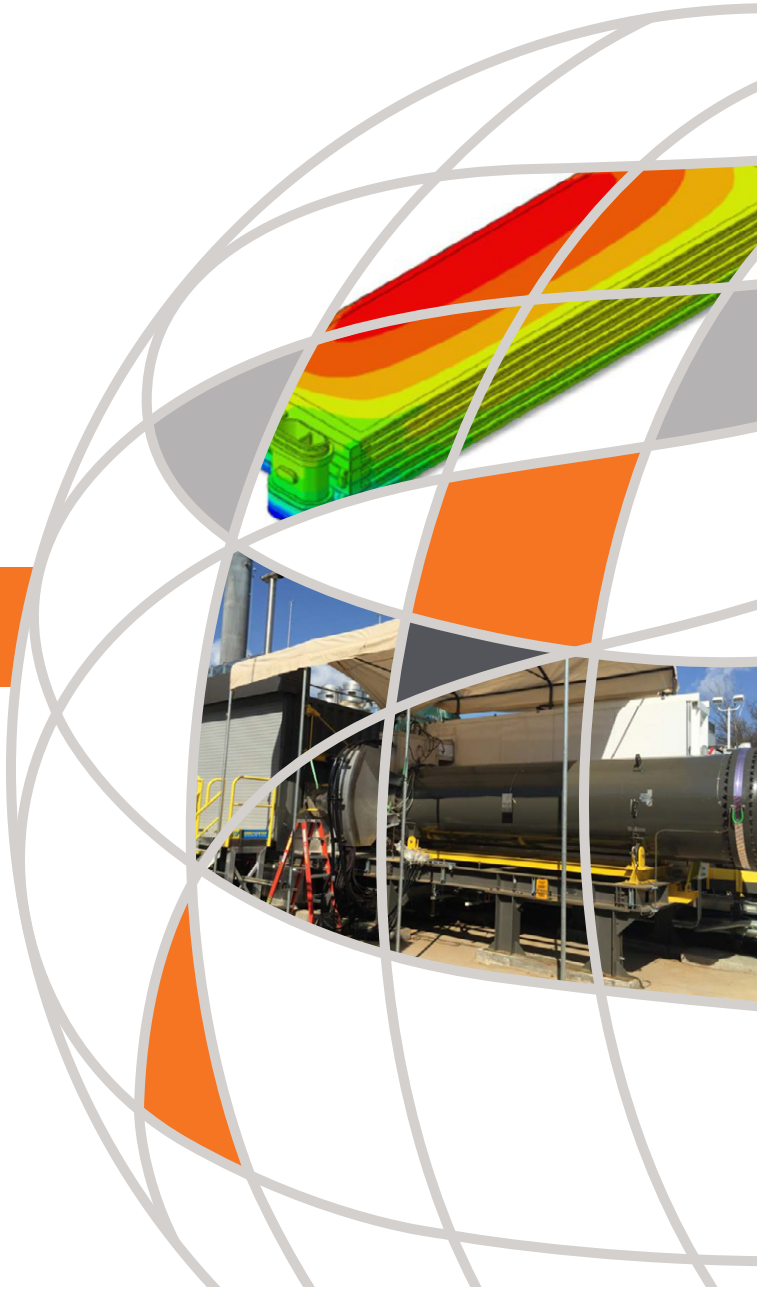
— *Carlos Martinez Baca, Ph.D., LGFCS*

With electricity demand ever increasing, there is a robust market for new power generation technologies. To compete in this market, LG Fuel Cell Systems is developing a stationary power generation system based on high-temperature solid-oxide fuel cells. SOFCs are efficient electrochemical devices that use hydrocarbon fuels to produce electrical power. To support product design and development, LGFCS has developed a SOFC multi-physics code (MPC) for performance calculations of its fuel cell structure. The MPC is based upon a computational fluid dynamics (CFD) software package, which has been enhanced with new models that allow for coupled simulations of the fluid flow, porous flow, heat transfer, chemical, electrochemical and current flow processes that occur in SOFCs.

LGFCS uses resources from AweSim, including access to a supercomputer, to run the larger MPC models that are between one- and ten-million grid cells in size and are run in parallel using between 12 and 96 cores.



## VIRTUAL DESIGNS. REAL BENEFITS.

Simulations have been validated successfully against LGFCS' experimental data. The MPC provides invaluable performance information, which drives design improvements, as well as enhancement in fuel cell components, substrates, multi-cells and peripheral stack components.

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## THE CHALLENGE

LG Fuel Cell Systems Inc. addressed the need for a clean and efficient power source in distributed power generation applications by developing a hybrid stationary power generation system based on solid-oxide fuel cells (SOFCs). SOFCs are efficient electrochemical devices that produce power from hydrocarbon fuels. Electrochemical and chemical reactions occur in each cell and generate electrical power and heat. With many different processes going on at once in hundreds of interconnected cells, LGFCS needed a way to simulate fluid flow, porous flow, heat transfer and other processes that occur with the SOFCs.

## THE APPROACH

To support product design and development activities, LGFCS developed a multi-physics code (MPC) based on computational fluid dynamics software. Simulations of single-cell, five-cell, substrate and multi-cell models have been validated successfully against LGFCS' experimental data. The MPC provides invaluable performance information, which drives design improvements, as well as enhancement in the fuel cell components, substrates, multi-cells and peripheral stack components. However, some of the larger MPC models are between one and ten million grid cells in size. For this, they needed serious computing power.

## THE SOLUTION

Through a partnership with AweSim, LGFCS has been running the larger MPC models on the Ohio Supercomputer Systems, running in parallel using between 12 and 96 cores. A wide range of simulations have been run, from highly detailed models of electrochemistry and SOFC design to models of the peripheral components inside the LGFCS system. Multi-cell simulations run with help from AweSim have been used for a variety of purposes, including verifying on-design operation, analyzing off-design transients and performing analysis of new designs and operating modes.