



Fuel cell and CHP unit

Ceres Power Catalyst of change

By Nick Lerner

A fuel cell based domestic combined heat and power unit designed and developed for volume production derives technical and business benefits from Dassault Systèmes (DS) technology.

Modern domestic boilers are highly efficient and generate heat at greater than 90% efficiency. However, electricity supplies to domestic installations lose as much as 65% of their energy through heat loss at either generation or distribution.

A WASTE OF ENERGY

According to the International Energy Agency, more efficient production and use of energy could be the single largest and most cost-effective contributor to reductions in CO₂ emissions. The adoption of Combined Heat and Power (CHP), which utilises the thermal energy that is normally wasted, significantly improves energy supply efficiency.

The World Business Council for Sustainable Development states that buildings consume 40% of the world's primary energy, making it the most energy-hungry sector. The use of a Ceres Power CHP unit installed in a home is a

compelling alternative to centralised generation with its associated transmission and heat losses.

Mass-market deployment of Ceres Power CHP products generating electricity and heat at the point of use would reduce the need for investment in centralised power stations and grid infrastructure. The high efficiency energy conversion of the fuel cell also improves energy security by reducing the overall use of scarce resources and by having the capability to operate on a range of conventional and alternative fuels.

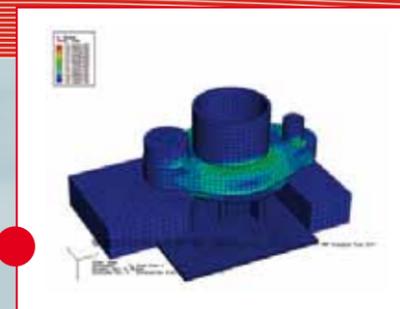
GREEN BOX

Ceres Power's unique metal supported fuel cell at the heart of a complex generation and exchange system is an electrochemical engine that makes heat and electricity. Fuel such as mains natural gas passes over the anode side and air passes over the cathode. Sandwiched

between the anode and cathode is the very thin, gas tight, electrolyte layer. An external circuit connects the anode to the cathode and provides the mechanism to power electrical devices. Finally, modern power conversion technology allows the Direct Current electricity from a fuel cell to be exported to the UK national electricity grid and provide the consumer further reward for their investment when they are generating excess electricity.

The combination of the materials used to make the fuel cell components, the type of fuel used and the operating temperature allow electricity to be generated directly via a chemical reaction rather than burning the fuel and then using a more traditional and inefficient mechanical generation. Ceres Power use DYMOLA and Abaqus to simulate and evaluate the potential and behaviour of design options without having to build physical prototypes.

Mark Selby, Senior Engineer at Ceres Power explained: "We evaluate alternative designs with DYMOLA because it allows us to simulate performance, and cost benefit analysis in a virtual environment. This helps us to make better-informed decisions about how to optimise products. This not only reduces the need to make physical prototypes, but it also lets us measure the implication of decisions at various production levels. This is because alternative technologies become



Bolted manifold gasket stress



Stack Endplate deflection during assembly



Ceres fuel cell stack

in practice

CeresPower

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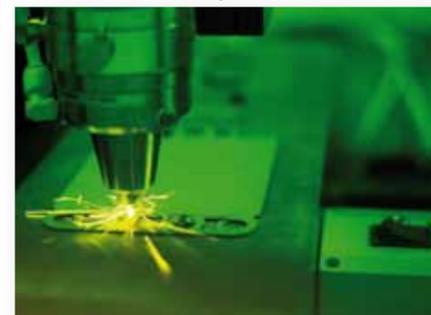
available at different production volumes. DYMOLA provides insight into the effects of changing a component specification or arrangement, in this context. The software also reveals its implications for the control system which is developed against the same models using co-simulation technology. This re-use of effort is vital to being a competitive company."

POWER LINES

"DYMOLA takes out guess work so that physical prototypes have predictable performance. This means that we build far fewer prototypes than would otherwise be required, saving thousands of hours in the development cycle."

"Risk is reduced with this methodology and high level decision support is introduced because DYMOLA is able to simulate in real-time, the precise operational characteristics of design options. It also allows us to introduce 'faults' to check system response and take appropriate design or control programming decisions."

Ceres Fuel cell laser welding



DYMOLA and Abaqus are key to our product development and offer significant technical and commercial benefits.

DYMOLA demonstrates great benefits to Ceres Power's communication with its supply chain by allowing very accurate target specifications to be issued and balances to be introduced on target cost/performance criteria. Mark commented: "There is always a trade off between price and performance in the supply chain, DYMOLA helps us to get maximum value at the best possible price while fully understanding both commercial and technical cost benefit choices, and their implications."

THE POWER OF THREE

DYMOLA is of benefit in three distinct areas at Ceres Power. In the Advanced Engineering environment it helps develop and support component design through the simulated application of physics. In relation to Control Systems development, it allows functions to be observed and programmed and their effects monitored and developed. In a systems integration role DYMOLA reveals inter-relationships and ensures that electric and mechanical systems and the software that links them all work in harmony.

Another aspect of Product Lifecycle Management, PLM, at Ceres Power was explained by Matt Harrington, Ceres Power Lead Engineer. He

spoke about the use of Abaqus FEA software from SIMULIA. "Abaqus is used alongside DYMOLA to simulate mechanical forces and resultant stresses arising through manufacturing and assembly. Furthermore, by integration with third party CFD software, component and assembly responses to thermal and pressure differentials can clearly be visualised and functional designs enhanced. A common use is assembly simulation of gasket sealing stresses integrated with endplate designs. A new application is current field visualisation around electrical contacts within the fuel cell, further illustrating the range and versatility of the Abaqus FEA solution."

Matt concluded: Abaqus allows mechanical engineering simulation, in great detail, to continually improve understanding and functional performance of our Fuel Cell Stack. This is at a supporting sub level to DYMOLA which invaluablely provides overall system operability simulations.

Together DYMOLA and Abaqus FEA are enabling Ceres Power to develop and perfect a highly efficient, price competitive, advanced fuel cell based CHP system that will be making a strong contribution towards lowering our carbon footprint into the future •]

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www.cerespower.com
www.claytex.co.uk