



### Why Solid Oxide Fuel Cells?

Ceramic Fuel Cells Limited (CFCL) is developing Solid Oxide Fuel Cell (SOFC) products to provide reliable, energy efficient and low-emission electricity from widely available natural gas and renewable fuels. CFCL's products & technology can be utilised in many different markets, from domestic electricity generation, to remote area power supplies, as well as auxiliary power units.

In Europe, Japan and other parts of the world, there is an increasing market demand for Combined Heat & Power (CHP) products and distributed generation units that co-generate electricity and heat for domestic use. As their name applies, these appliances produce heat for space heating and hot water, as well as electricity which can be used around the home and fed back into the electricity grid. Distributed generation sources may include photovoltaic cells (solar) and micro-wind turbines. These technologies are highly visible and well known; however they depend on weather conditions and cannot provide stable base load electricity all year round. There are also several types of CHP products being developed, based on a range of technologies including Stirling engines and internal combustion engines. CHP units can range in size from less than 1kW up to 6MW and above. CFCL is focussed on providing solutions for the 1 to 5kW range of CHP units - known as micro-CHP (m-CHP).

Low temperature fuel cells, which typically include: Polymer Electrolyte Fuel Cell (PEFC), Phosphoric Acid Fuel Cells (PAFC), Proton Exchange Membrane Fuel Cell (PEMFC) and Alkaline Fuel Cells (AFC) typically have the following characteristics:

- Lower electrical efficiencies (up to 40%) when using natural gas a primary fuel.
- Often use expensive precious metals (such as platinum) to improve performance.
- Can be rapidly thermally cycled making them better suited to transportation applications.
- Require a relatively pure supply of hydrogen as a fuel, which means that a separate process is required to convert other fuels to hydrogen.

Whereas SOFC systems:

- Operate at higher temperature, which reduces the need for expensive precious metals (such as platinum).
- Can operate on a number of different hydrocarbon fuels, chiefly natural gas.
- Have a longer start up time and therefore are better suited for continuous operation.
- Can exhibit very good electrical efficiencies (up to 70%).
- As a result of high operating temperatures, SOFCs can be combined with heat recovery technologies to create a total system efficiency of up to 85%.
- Near zero emissions and quiet operation with low maintenance requirements compared to existing generation technologies.

Because CFCL's SOFC system can be connected to a regular natural gas network, the fuel cells do not need a separate hydrogen infrastructure for operation. Hydrogen infrastructure is essentially the equipment and process required to convert hydrocarbon fuel sources into hydrogen gas and deliver this pure hydrogen to the customer. For instance, a separate hydrogen pipeline network. With SOFC powered CHP units the heat generated from the fuel cells can be easily integrated with heat exchangers to pre-heat water and ventilation air to maximise the overall system efficiency. CFCL's fuel cell technologies are best positioned to generate electricity efficiently without the need for expensive infrastructure programmes and complex appliance integration.