



AFFORDABLE NATURAL GAS FUEL CELL POWER

Redox Power Systems



The Redox Cube — *The Future of Distributed Generation*

The Redox Cube is a 25 kW, natural gas fueled, stationary fuel cell power system. With a size of roughly one cubic meter and a weight under 450 kg, the Cube can be installed outdoors or indoors. The system takes advantage of our proprietary lower temperature, higher power cells and stacks, as well as an innovative fuel processor. The Cube is designed with mass production in mind, using a modular approach whereby key components can be tailored and packaged to deliver desired power levels. Redox technology provides the breakthroughs needed to cost-effectively convert natural gas or propane into electricity with high efficiency and low emissions. The Cube is ideal for distributed generation and presents new opportunities for alternative energy sources in commercial, industrial, residential, and even demanding datacenter applications. With the addition of a heat recovery module, combined heat and power (CHP) operation can boost the Cube's total electrical and thermal efficiency in excess of 80% percent.

Economic Benefits

- Higher power cell technology decreases the number of cells and ancillary components needed, which reduces system size and allows operational flexibility - can trade operational efficiencies and capital costs.
- High efficiency reduces fuel usage and shortens capital investment payback period.
- Lower operating temperature reduces capital costs while increasing reliability and lifetime.
- Smaller system size and weight result in reduced installation costs.

Environmental Benefits

- Low emissions: exhaust includes water and negligible CO, NO_x, and particulate matter.
- Low greenhouse gas emissions: high efficiency results in less than 1/2 the CO₂/kWh produced compared to typical internal combustion engines.
- Fewer rare earths and less overall material used in fabrication than competing SOFCs conserve scarce natural resources.

The Redox Technology — *Advanced Solid Oxide Fuel Cells (SOFCs)*

What Is A Fuel Cell? A fuel cell is a thin wafer with a cathode, electrolyte, and anode like a battery. But unlike a battery, a fuel cell electrochemically converts stored energy in externally provided fuel to electricity. Gaseous fuel flows across the anode, while air is blown across the cathode. There are several types of fuel cells, but most require pure hydrogen as fuel. SOFCs are a special class of fuel cells, which can utilize hydrocarbon fuels such as natural gas, propane, and sustainable biofuels in addition to hydrogen. In SOFCs, oxygen from the air travels through the solid electrolyte as an ion and oxidizes the fuel at the anode, which releases electrons to power an electrical load.

The Redox SOFC. Our SOFCs use advanced electrolyte materials with as much as 100 times the conductivity of traditional materials, which are combined in a proprietary electrolyte structure that overcomes stability issues and increases open circuit potential to result in higher efficiency. We also utilize cathodes consisting of nano-structured materials that enable high power densities at lower operating temperatures as high as 2 W/cm² at 650 °C. Supporting the electrolyte is a porous, conductive reduction-oxidation stable anode that allows for a simplified system design and enhanced performance and stability when using natural gas or propane. The lower operating temperature of our SOFC allows Redox to take advantage of conventional materials in the construction of stacks, or assemblies of multiple cells. The lower temperature operation also enables the Redox Cube's unique design with stacks arranged at the system periphery for ease of manufacturing and field maintenance. We are also working on lowering the operating temperature of our SOFCs below 500 °C while maintaining high power densities to enable faster system startup and enhanced load following capabilities.

Our Company

Redox develops distributed generation systems that will disrupt the way energy is delivered for commercial, industrial, and residential markets. With advanced solid oxide fuel cell technology inside every Redox product, we are able to drastically reduce the size, weight, and most importantly, the cost of reliable on-site generation of electricity while also providing high quality heat for combined heat and power (CHP) applications. The modular nature of our products lends itself to constructing systems with a broad range of power generation capacities and fuel options. The initial systems will work directly with natural gas or propane fuels.



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Key Features

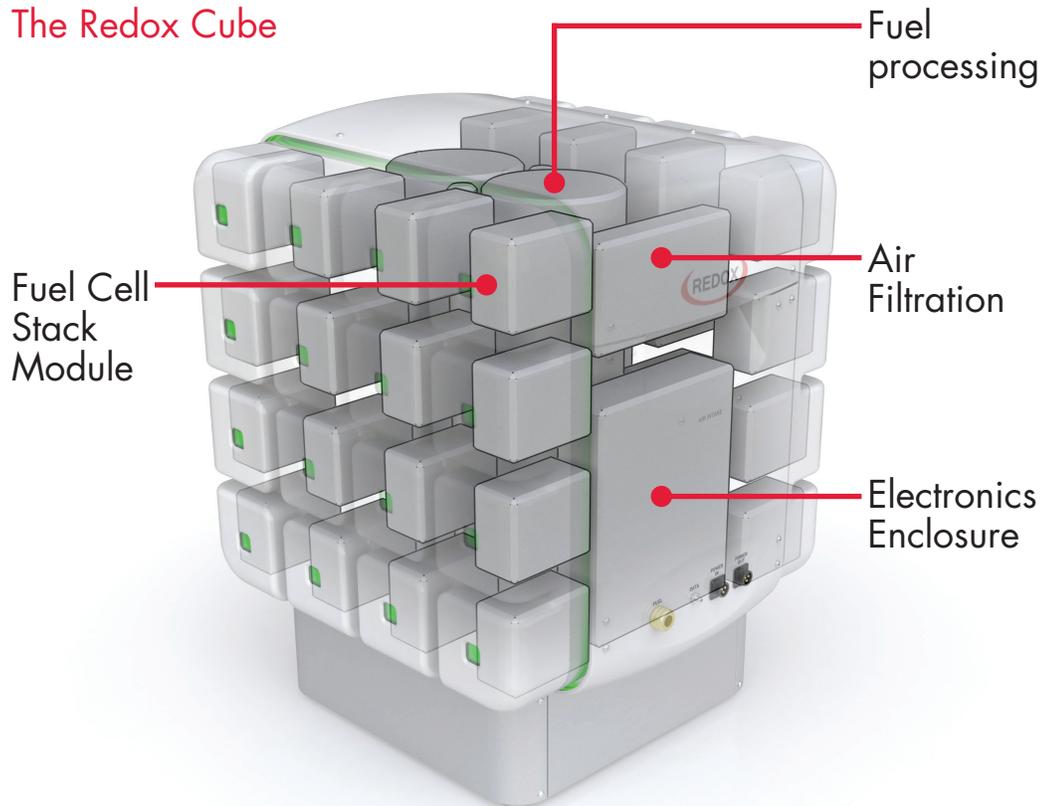
- **High Efficiency:** >54% electrical conversion efficiency, which can exceed 80% total electrical and thermal in CHP applications. Compared to traditional CHP options such as microturbines, the Redox Cube has a much higher electrical efficiency even at partial loads.
- **Conventional Fuels:** Redox SOFCs operate within the current fuel infrastructure, using natural gas or propane. Most fuel cells can only work on pure hydrogen.
- **High Power Density:** Redox cells have a 10 times higher power density at 100s of degrees Celsius lower operating temperature than the current SOFC market leader. Higher power densities mean fewer cells and components for reduced system size, weight, and cost.
- **Compact Size:** At ~1m³ the Cube is compact for more effective space utilization.
- **Low weight:** At under 450 kg, the Cube provides more flexible installation options.
- **Emissions/Noise:** Redox SOFCs operate quietly and produce negligible CO, NO_x, and particulate matter.
- **Greenhouse Gases:** The Redox Cube generates 335-360 kg of CO₂ per MWh which can decrease to 215-235 kg CO₂ per MWh in CHP implementation.
- **Water production:** The Redox Cube averages 7.5 liters of pure water produced per hour.
- **Modularity:** Systems can be interconnected to address power needs greater than 25 kW.
- **Manufacturing:** Products are manufactured with ISO-9001 partners.
- **Automated Maintenance Support:** Active monitoring via the Internet enables Redox network control to optimize power production and maintenance operations.



Redox Power Systems

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The Redox Cube



Cube System Specifications

System Outputs	
Rated Power (Net DC) †	25 kW
System Emissions	CO ₂ , 335-360 kg/MWh CO ₂ , (with CHP), 215-235 kg/MWh negligible CO, NO _x , SO _x
System Efficiency	
Efficiency (LHV, Net DC)	> 54%
Heat Rate (LHV)	< 6,350 BTU/kWh
System Inputs	
Natural Gas Supply Pressure	1 bar
Natural Gas Supply Flow Rate	75 Liters/minute
Water Consumption	None (after initial installation)
System Physical Attributes	
Dimensions (W x L x H) §	1 m" x 1 m" x 1.4 m"
Weight (dry)	~450 kg
System Connections	
Natural Gas Input	½" NPT (Female Receptacle)
Water Drain	¼" NPT (Female Receptacle)
Internet Connection	Wireless or Wired to LAN

† Designed to run continuously (not solely as backup power)

§ Height: 1 m (main body) + 0.4 m (base)

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