أديبك ADIPEC
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Abu Dhabi, UAE

DECARBONISING TODAY'S ENERGY SYSTEMS

CASE STUDY

Pioneering carbonate fuel cells at scale to reduce industrial emissions

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Pioneering carbonate fuel cells at scale to reduce industrial emissions

CONTEXT

Fuel cells are heralded as one of the cleanest energy sources because they convert fuels like hydrogen and natural gas directly into electricity, bypassing the internal combustion process that generates smog and other pollutants.

Molten carbonate fuel cell (MCFC) design is a particular type of fuel cell technology that can capture industrial CO2 emissions while generating electricity and hydrogen. This technology is versatile, providing power for various applications, including transportation, industrial, commercial and residential buildings, and long-term energy storage for the grid in reversible systems.

Despite its potential, the technology has not yet seen widespread adoption. A successful pilot plant run by Esso Nederland BV, an ExxonMobil affiliate, with FuelCell Energy, could accelerate the commercialisation of MCFC design.

ADVANCEMENTS IN CARBON CAPTURE TECHNOLOGY

Since 2016, ExxonMobil and FuelCell Energy have been leading efforts in global-scale carbon capture using MCFC design, focusing on both gas-fired and coal-fired plants. MCFCs are renowned for their high efficiency and fuel flexibility, making them suitable for large-scale power generation and combined heat and power applications.

In December 2023, ExxonMobil chose its Rotterdam Manufacturing Complex in the Netherlands to host a pilot plant featuring an optimised design of MCFC for large-scale installations. This plan aims to test the design that captures carbon while simultaneously generating electricity and hydrogen.

US$26.55 bn
Estimated market size of global fuel cell technology by 2028[2]

US$416mn
Estimated market size of the MCFC technology in 2024[8]

37.4 Gt
Amount of global CO_2 emissions from fossil fuels and industry in 2023[5]

US$13.5 tn
Estimated amount of investment needed to reach net zero by 2050[6]

Organisations involved

- **ExxonMobil**
- FuelCell Energy
- Esso Nederland BV

Industry

Energy

Location

Europe, North Sea

Visit **ExxonMobil** at **Stand #A142** in the Atrium, during ADIPEC 2024, taking place in Abu Dhabi from 4-7 November.

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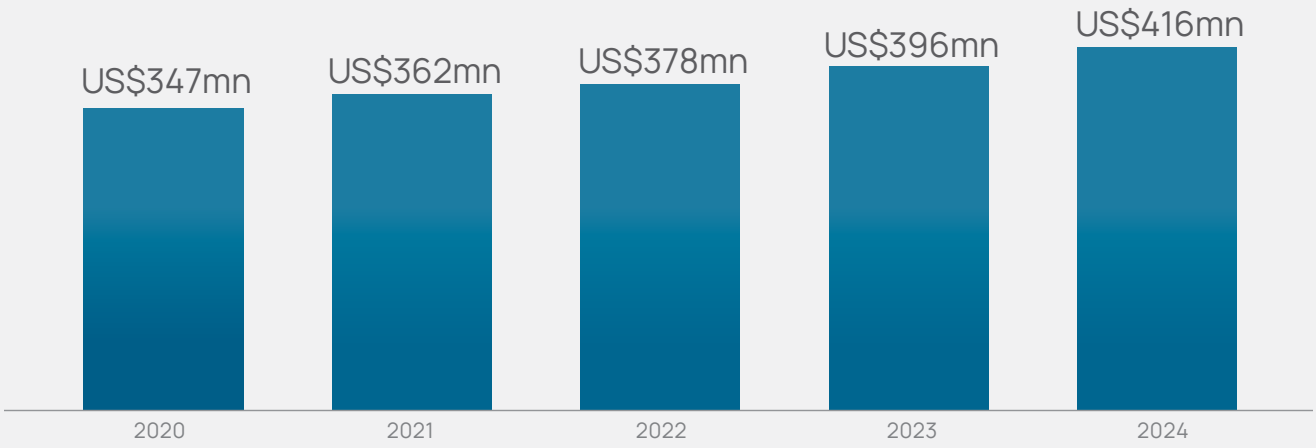
Technology that promises economically viable decarbonisation solutions

Global market size for molten carbonate fuel cells (MCFC) design in US$ million



Note: All figures in US million dollars

Source: Molten Carbonate Fuel Cells Market 2021-2025 report by Technavio

This dual-purpose approach enhances the economics of carbon capture, making it particularly attractive to gas-fired power plant operators. Initial results are promising, leading to an extension of the joint development agreement in April 2024 to accelerate commercialisation efforts.

Compared to conventional combustion-based power plants, which typically operate at 33% to 35% efficiency, fuel cell systems can achieve efficiencies of up to 60% or higher with cogeneration. Moreover, MCFC design can achieve electrical efficiencies of around 50%, and when waste heat is utilised, overall efficiencies can reach up to 85%[7].

The modular nature of MCFC design supports carbon capture across various deployment scales. According to the US Department of Energy, the typical stack size of MCFC ranges from 300kW to 3MW[9]. These fuel cells offer 50% more electrical efficiency than traditional methods and are commonly used in electric utility and distributed generation. They are more energy-efficient than combustion engines, making them a crucial component of the energy transition.

As technical readiness for broad-scale implementation advances, this technology holds promise for providing economically viable decarbonisation solutions across various industries, contributing to the broader goal of achieving a net-zero future. It aims to streamline the capture process, introducing additional value streams that reduce the overall cost of carbon capture and storage.

Geoff Richardson, Senior Vice President of Commercial and Business Development for ExxonMobil Low Carbon Solutions, highlighted the technology's unique advantage, saying: "This technology not only captures CO2 but also produces low-carbon power, heat, and hydrogen as co-products."

Jason Few, President and CEO of FuelCell Energy, added: "Capturing carbon at the source is a highly efficient way to decarbonise heavy industry. The technology's ability to produce electricity while simultaneously capturing carbon represents a transformative advancement for the industry."

Fuel cells are increasingly recognised throughout the energy supply chain as pivotal to greening energy sources. Their application, particularly when powered by green hydrogen, represents a leading technology for mitigating climate change.

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Achieving commercial viability at scale presents a crucial opportunity to advance future energy systems while rapidly decarbonising current energy infrastructures. As global demand for power rises, collaborations across sectors are essential for accelerating emission reductions and fostering sustainable energy solutions. Fuel cell technologies like the MCFC being piloted through the FuelCell Energy, ExxonMobil, and Esso Nederland BV collaboration, are well-positioned to play a critical role in achieving a low-emission future.

> Capturing carbon at the source is a highly efficient way to decarbonise heavy industry. The technology represents a transformative advancement for the industry.

Jason Few
Chief Executive Officer and Energy President, FuelCell

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