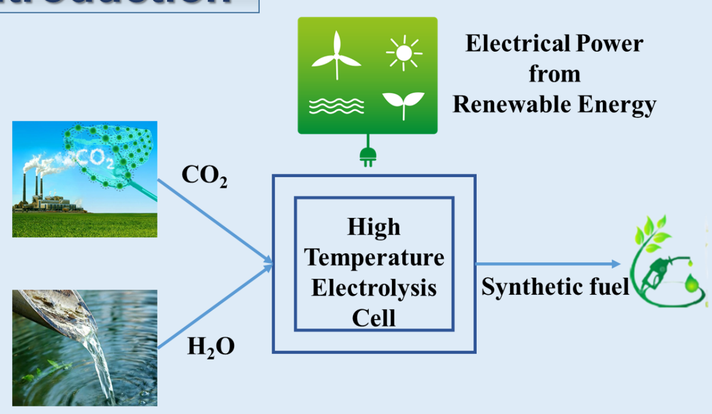
Future Economic Perspective of Power-to-gas System based on Molten Carbonate Electrolyzer

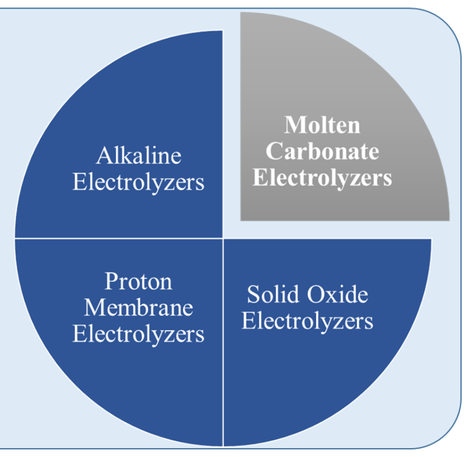
Introduction



The **Power to gas** technology is now encountering some economic implementation challenges that necessitate in-depth research. A series of studies were performed to investigate the economic aspect of the Power-to-Gas, focusing on the three well-known electrolyzers.

All studies revealed that synthetic natural gas produced from renewables is still non-competitive with conventional natural gas at the current stage.

Power-to-gas systems based on Molten Carbonate electrolyzers are not currently in the field of economic research. This technology is in the research and development stage, so all research focuses on the technical rather than the economic aspects.



Objective

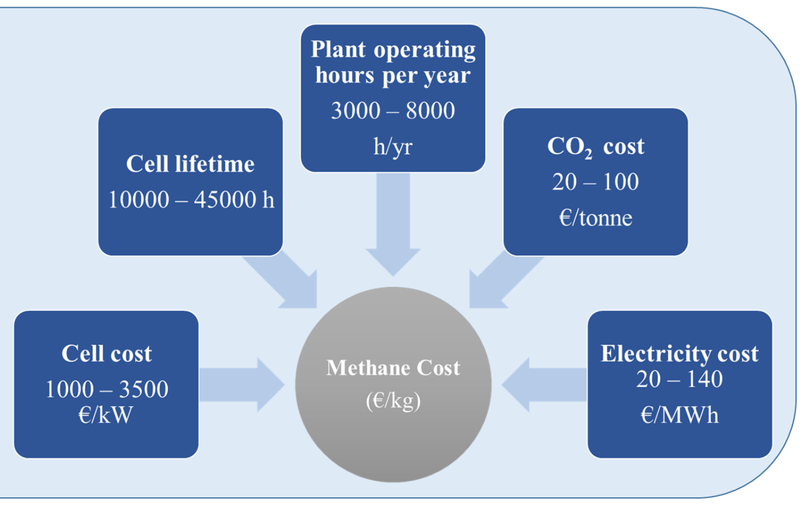
This work aims to **assess the economic feasibility** of such technology based on the previous study outcomes and provide a **future perspective on being competitive with conventional natural gas.**

Method

Economic assessment is performed for a developed process simulation consisting of the electrolyzer and all the balance of plant equipment.

It evaluates the **current capital and operating expenses** of the process as well as investigates the **impact of different parameters** on the **final methane production cost**.

In this work, a profound parametric study is performed by developing a VBA excel code.



Results

As inspired by the parametric study performed in previous research, the best conditions for having an approximate competitive methane selling price with the current market price are to have:

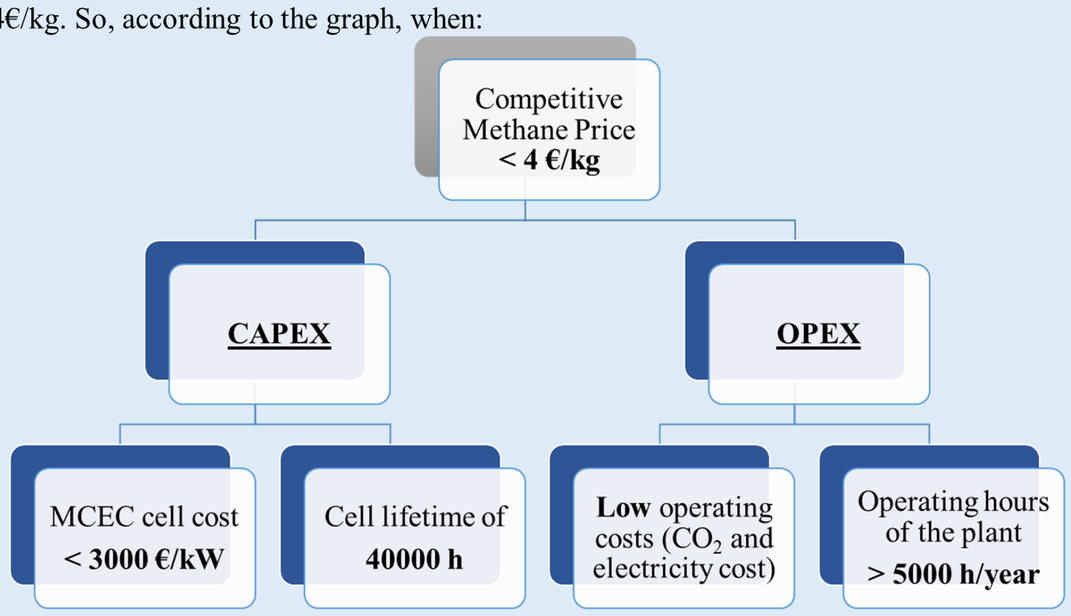
- **45000 h** cell lifetime, and **1000 €/kW** cell cost (CAPEX)
- **30 €/MWh** electricity cost, and **20 €/tonne** CO_2 cost (OPEX)

Based on the fact that the cell has reached 40000 h lifetime, the impact of both CAPEX (cell cost) and OPEX (CO_2 and electricity cost) together on the methane selling price is simultaneously examined assuming that the plant operates for 8000 h per year.

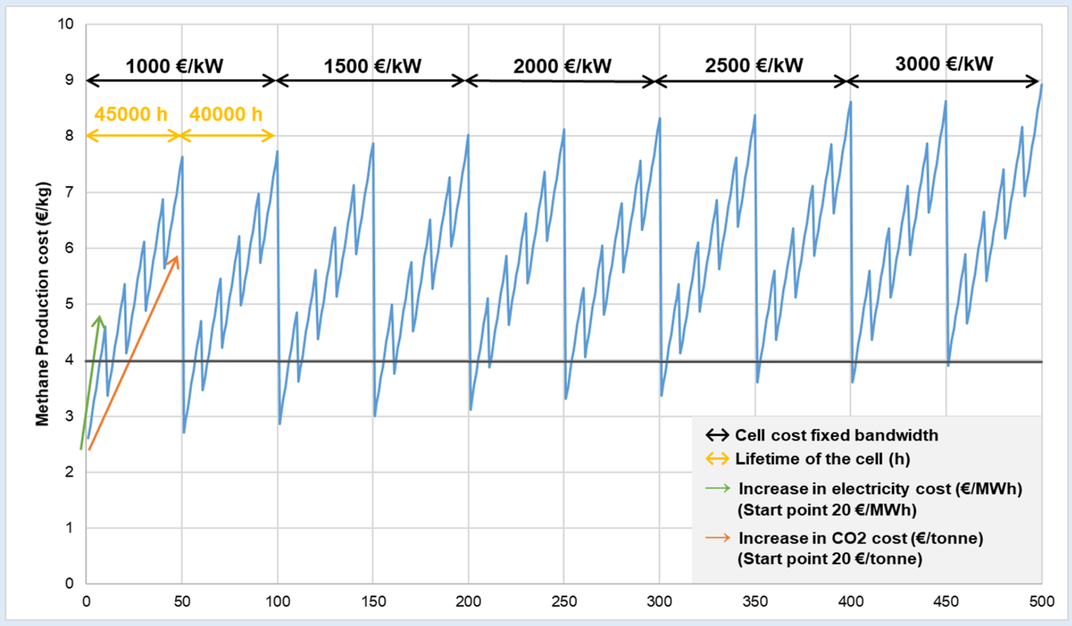
1. Principal Results:

- The methane production cost decreases with the decrease in cell cost.
- The additional improvement in lifetime of the cell after reaching 40000 h has no significant impact on the methane selling price
- Although the methane cost is highly affected by the cell capital cost, it can't reach a competitive price with the conventional ones without reducing the operating cost.

To have a competitive methane price, the methane production cost must drop below 4€/kg. So, according to the graph, when:



Therefore, it can be deduced that the operating cost combined with the cell cost considerably influence the final methane selling price.



2. Future Perspectives:

The parametric study outcomes encourage profound research on the operating and capital costs situation.

Parameters	Perspectives
Electricity cost: Driven by the cost of the renewable energy source since MCEC is the most electric energy consumer.	International Renewable Energy Agency (IRENA) in 2020: reported a cost of • Onshore wind turbine electricity of 36 €/MWh • PV electricity of 53 €/MWh. These costs are expected to reach below 40 €/MWh in the coming years.
CO_2 cost	Depends on the carbon capture technology used.
Cell Lifetime	MCFC has reached 40000 h lifetime, no certitude about the lifetime in the reverse mode
MCEC cost	Determined by the technology improvements and the manufacturing capacity. There is still no public available information on the current status of the MCEC cost and its roadmap

Conclusion

The power-to-gas system based on Molten carbonate electrolyzer is an intriguing concept of storing energy and reusing CO_2. However, significant advances in terms of cost feasibility are required. Based on our economic study, this process might be economically competitive with other technologies if the operating costs are low, the cell cost is below 3000 €/kW, and the operating hours of the plant are higher than 5000 hours per year. The vision for the future on these targets appears optimistic in terms of operating cost; nevertheless, there are still some challenges due to a lack of the cell cost forecast in the upcoming years.

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