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Economic Impact Assessment of Hydrogen generated from Offshore Wind: A case study for Belgium

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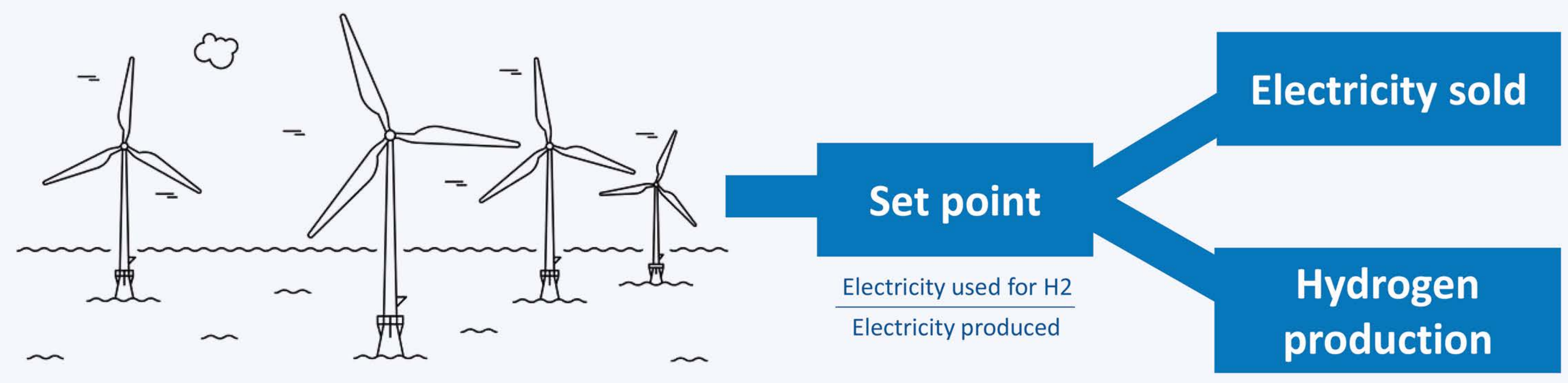
ABSTRACT

Green hydrogen is increasingly cited as a solution to the decarbonization of industry, however, large-scale production is in its infancy, and some uncertainties remain. This poster explains an **Economic Impact Assessment** (EIA) method. A versatile and flexible model was generated, which estimates the **LCoE** (Levelized Cost of Energy) of an offshore wind farm and **LCoH** (Levelized Cost of Hydrogen) of a hydrogen generation plant, either as a hybrid renewable energy system (HRES) or independent from each other. Costs are estimated for a study case using a **schedule-based approach** which takes into account the reliability, maintenance operations and production of both the offshore wind farm and the onshore hydrogen generation plant.

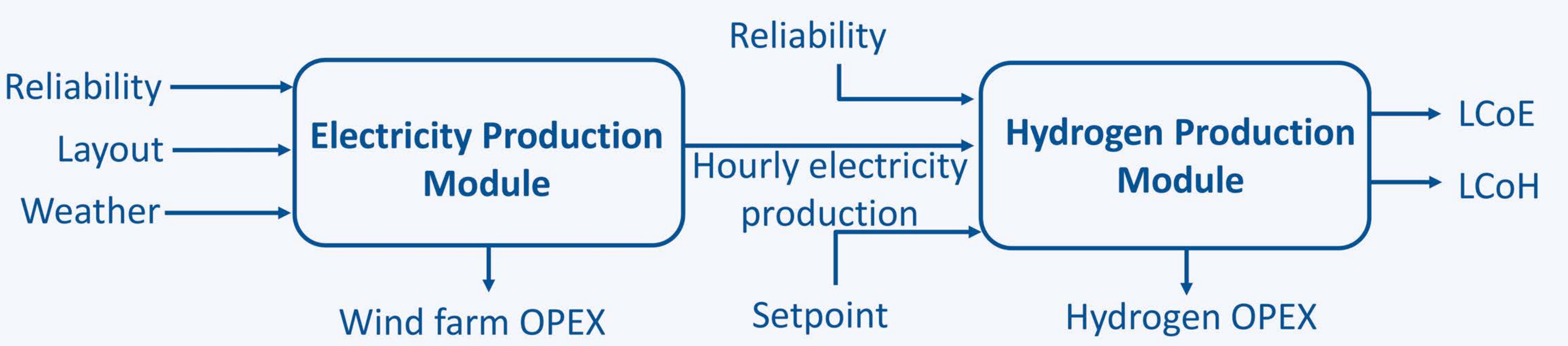
STUDY CASE

Mermaid Wind farm	
Capacity	235 MW
Turbines	28
Distance to Shore	54 km
Hub height	107.5 m

Hydrogen production plant	
Location	Zeebrugge
Capacity	235 MW
Electrolysis	PEM
Compression	700 kW



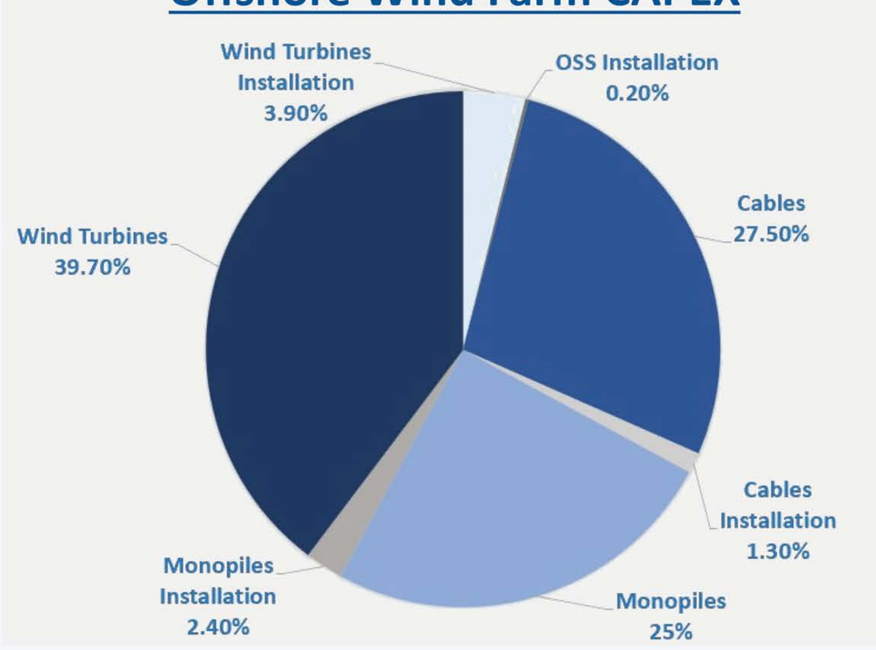
COST MODEL



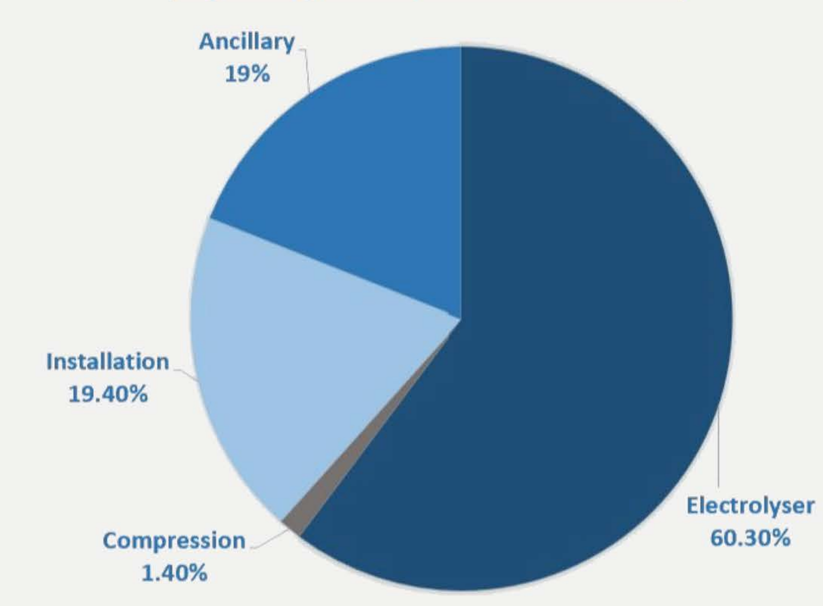
Two main modules are developed in this schedule-based model to represent the hybrid renewable energy system. The electricity production module considers the **wind farm layout, historical wind distribution and system reliability** to estimate availability as well as hourly electricity production. Based on a **Monte Carlo loop**, failures with different degrees of severity are modeled, and the OPEX of the wind farm is calculated. A part of this electricity production is sent to the hydrogen production plant based on a set point between 0 and 100%. A similar Monte Carlo loop is used in the hydrogen production module to assess the reliability, and a linear degradation of the stack efficiency is implemented. A stack replacement every 85,000 operating hours is used, and the hourly hydrogen production is computed. Using the CAPEX of both systems, calculated in a different model, the **LCoE** and the **LCoH** are evaluated and vary depending on the set point.

RESULTS

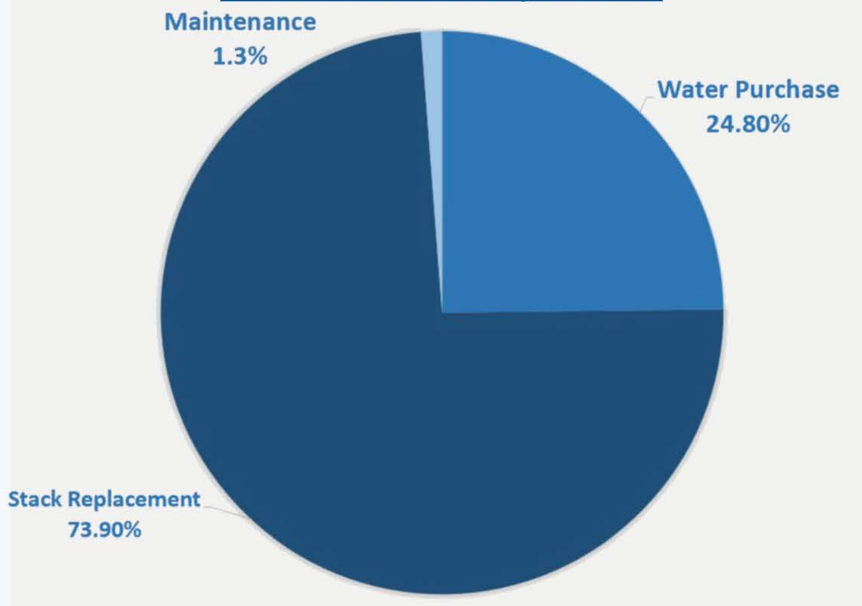
Offshore Wind Farm CAPEX



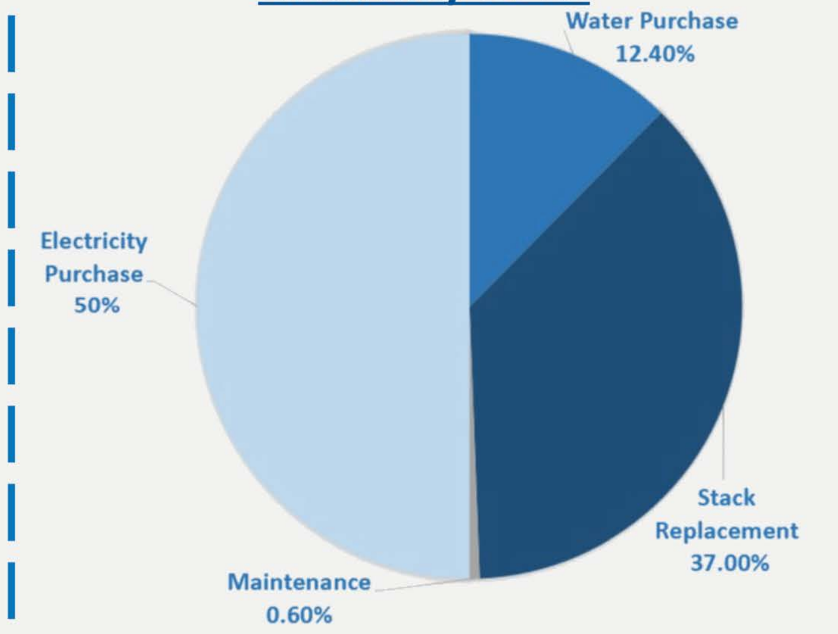
Hydrogen system CAPEX



Hydrogen system production from wind farm electricity OPEX

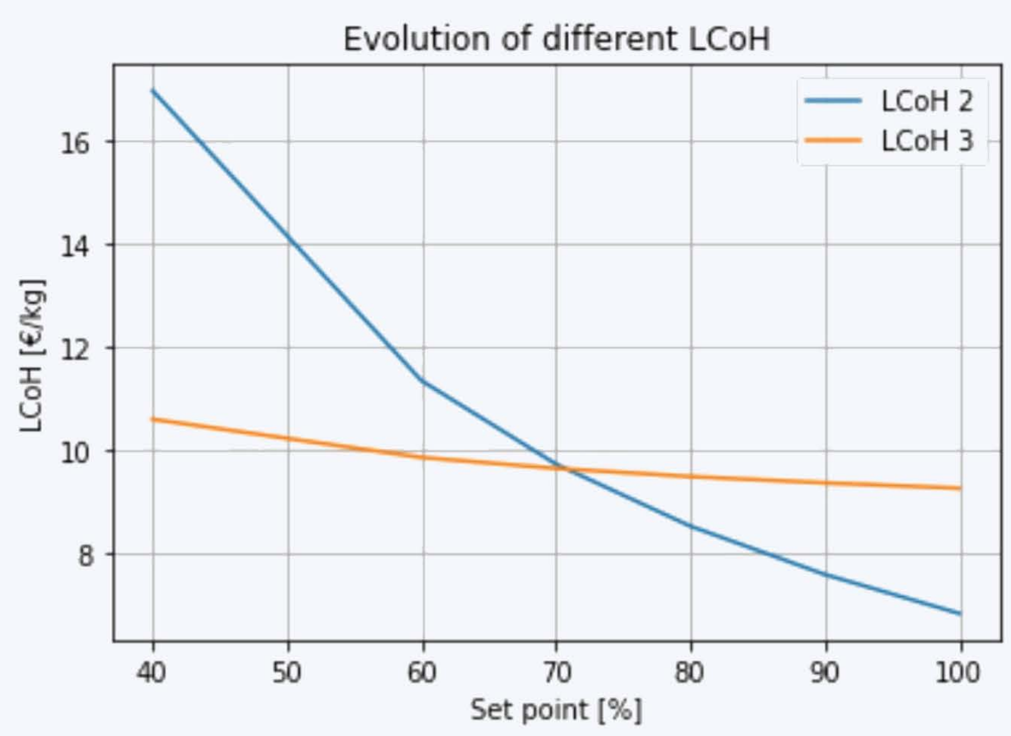


Hydrogen system production from grid electricity OPEX



LCoH 2 corresponds to the LCoH of the total system with electricity from the offshore wind farm production. LCoH 3 corresponds to electricity bought from the grid at market price with the same amount of hydrogen generated.

This graph shows that using more than **71%** of the wind farm electricity for hydrogen production is needed to produce **cheaper hydrogen** than with a grid electricity electrolysis.



CONCLUSION

Hydrogen generation strategies, coupled or decoupled with an offshore wind farm, require an Economic Impact Assessment to ensure the competitiveness of the production. The developed model shows that the stack replacement of the electrolyser is responsible for a **significant** part of the OPEX. The set point approach makes it possible to identify that producing hydrogen from an offshore wind farm is **only profitable if enough electricity is sent to the hydrogen plant.**

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