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Offshore Renewable Energy

VALUE OF LINE PACKING HYDROGEN FOR OFFSHORE WIND ENERGY TRANSPORT AND STORAGE

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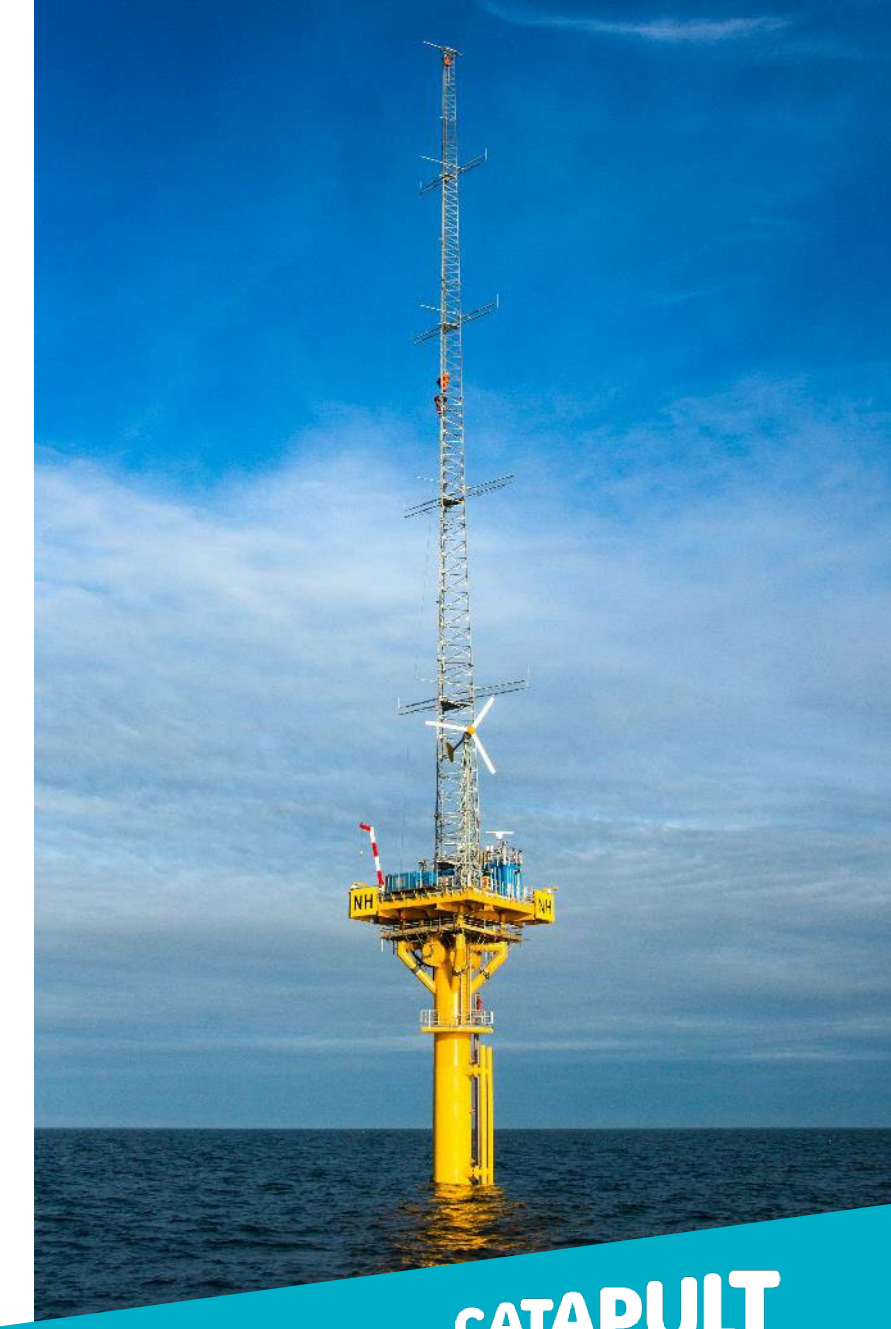
Credit: Equinor Hywind Floating Offshore Wind Farm

THE OFFSHORE RENEWABLE ENERGY CATAPULT

The UK's leading technology innovation and research centre for offshore renewable energy

Mission: to accelerate the creation and growth of UK companies in the offshore renewable energy sector.

- Unique facilities, research and engineering capabilities
- Bringing together innovators, industry and academia
- Accelerating creation and growth of UK companies
- Reducing cost and risk in renewable technologies
- Growing UK economic value
- Enabling the transition to a low carbon economy



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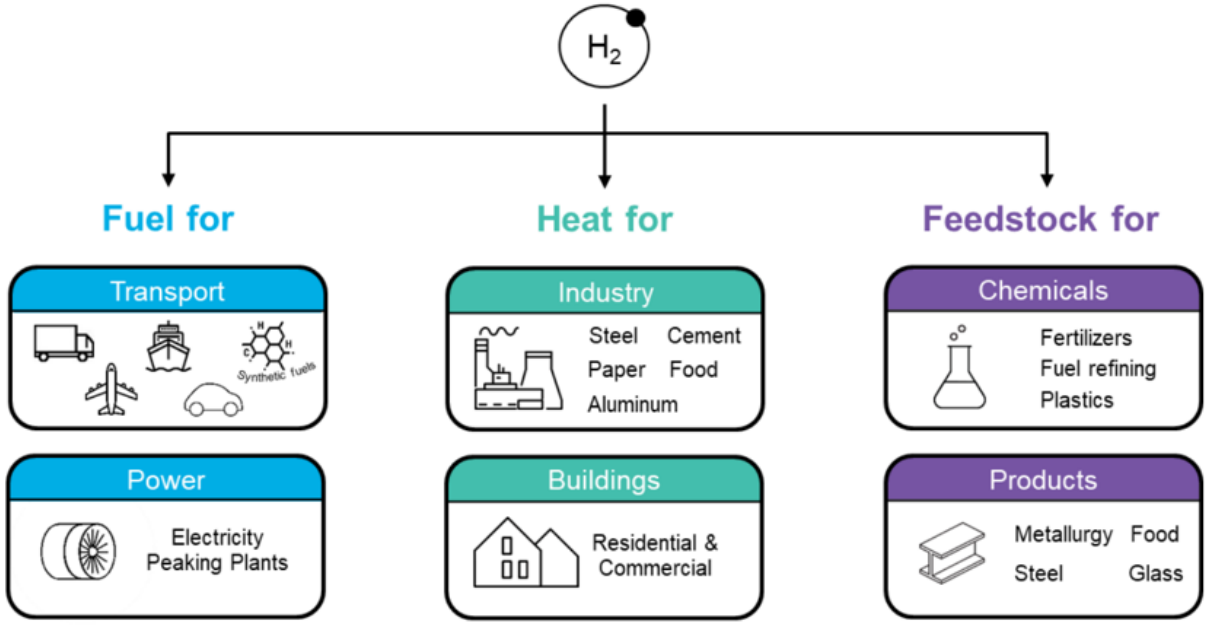
WHY IS HYDROGEN IMPORTANT?

- Electrical grid integration of wind turbines are forecast to become more difficult as we approach net-zero.
- Energy system modelling from the IEA, IRENA, DNV, BloombergNEF predict hydrogen supplying 12 – 22% of final energy demand in Net Zero 2050 scenarios.
- In 2020, ORE Catapult estimated the UK energy system will need 130 – 200 TWh of hydrogen in 2050, to integrate 75 GW+ of offshore wind.



Source: BloombergNEF

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ENERGY VECTOR COMPARISON

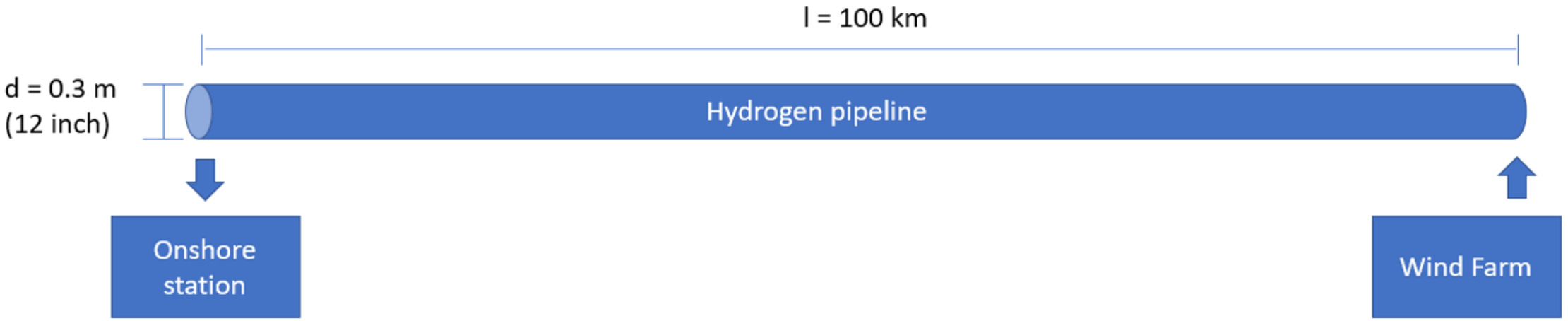
		Distance from shore		
		< 120 km	120 – 245 km	> 250 km
Water Depth	< 50 m	Alternating current	High voltage direct current	High voltage direct current with offshore substation
	50 – 150 m	Offshore substation	Offshore substation or hydrogen	High voltage direct current with offshore substation or hydrogen
	> 150 m	Offshore substation or hydrogen	Offshore substation or hydrogen	Hydrogen

LINE PACKING SCENARIO

Line packing is where the pressure of the pipeline is varied, allowing it to act as an energy storage device: increasing the pressure is like “charging” the pipeline, while decreasing the pressure is like “discharging” the pipeline.

Scenario A: Steady state flow, no line packing

Scenario B: Line packing, trying to maximise revenue

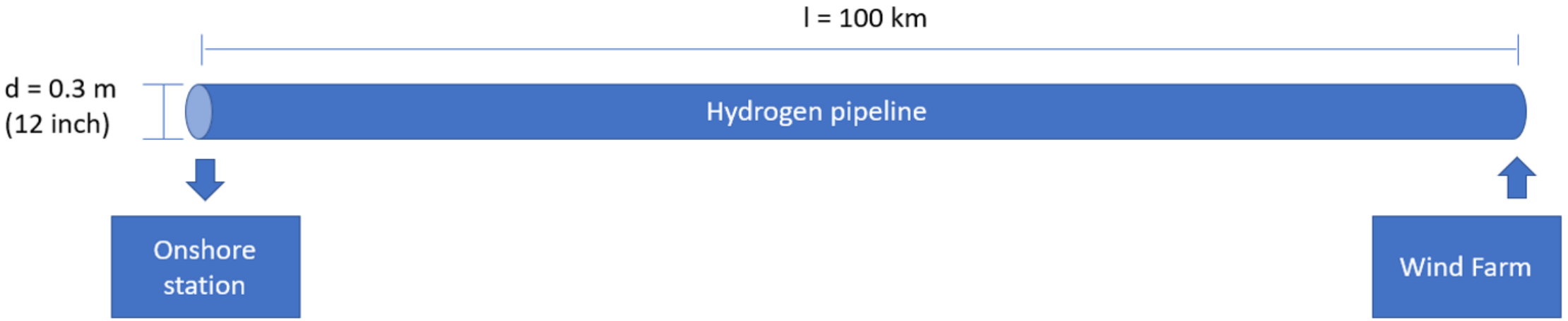


LINE PACKING SCENARIO

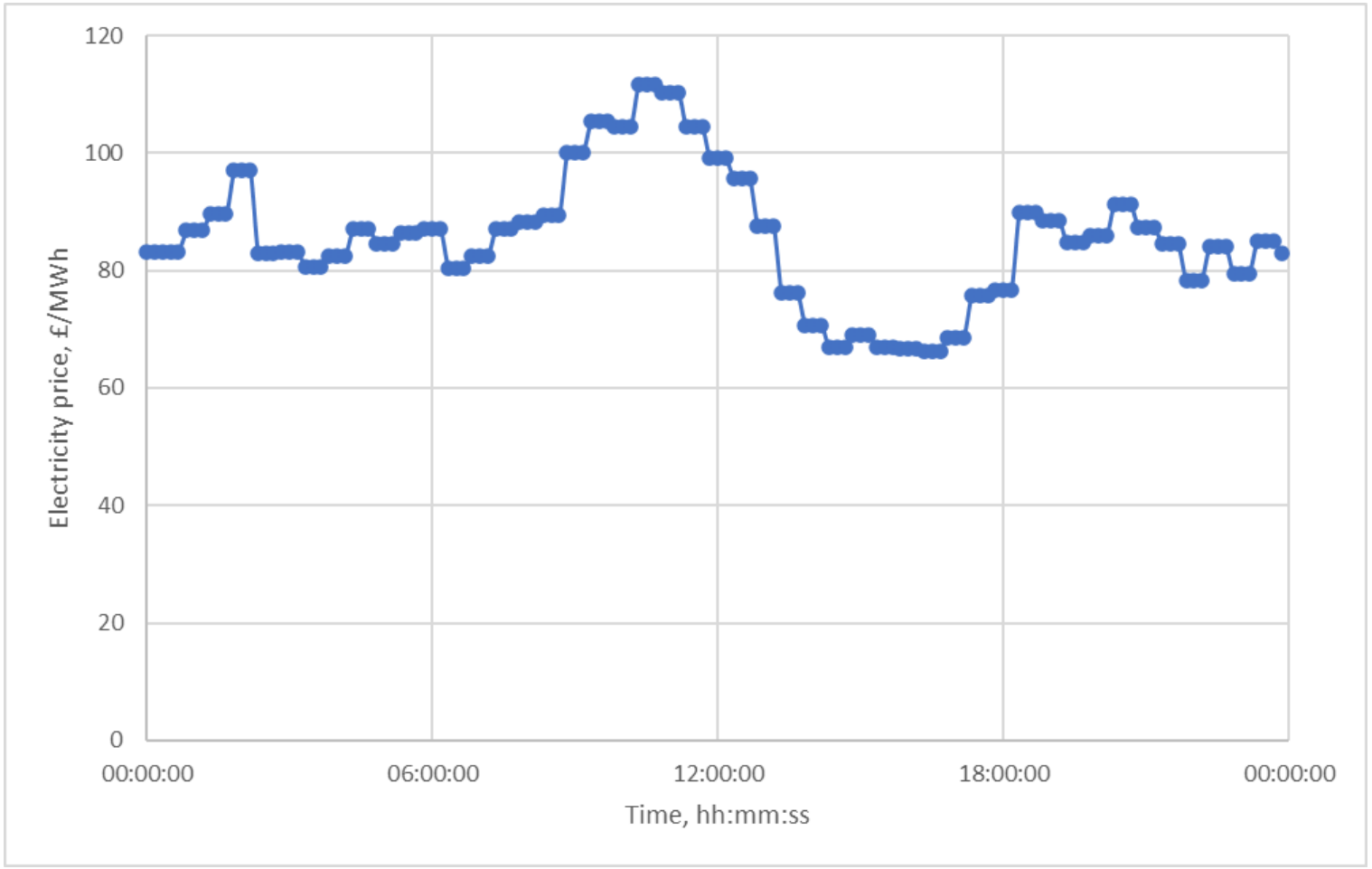
Lower pressure threshold: 70 bar (@10°C ~ 41,000kg of H^2)

Upper pressure threshold: 94 bar (@10°C ~ 54,000kg of H^2)

Energy differential between lower and upper threshold: 436 MWh (LHV, 33.3 kWh/kg)



MODEL INPUTS



Electricity price from day ahead market

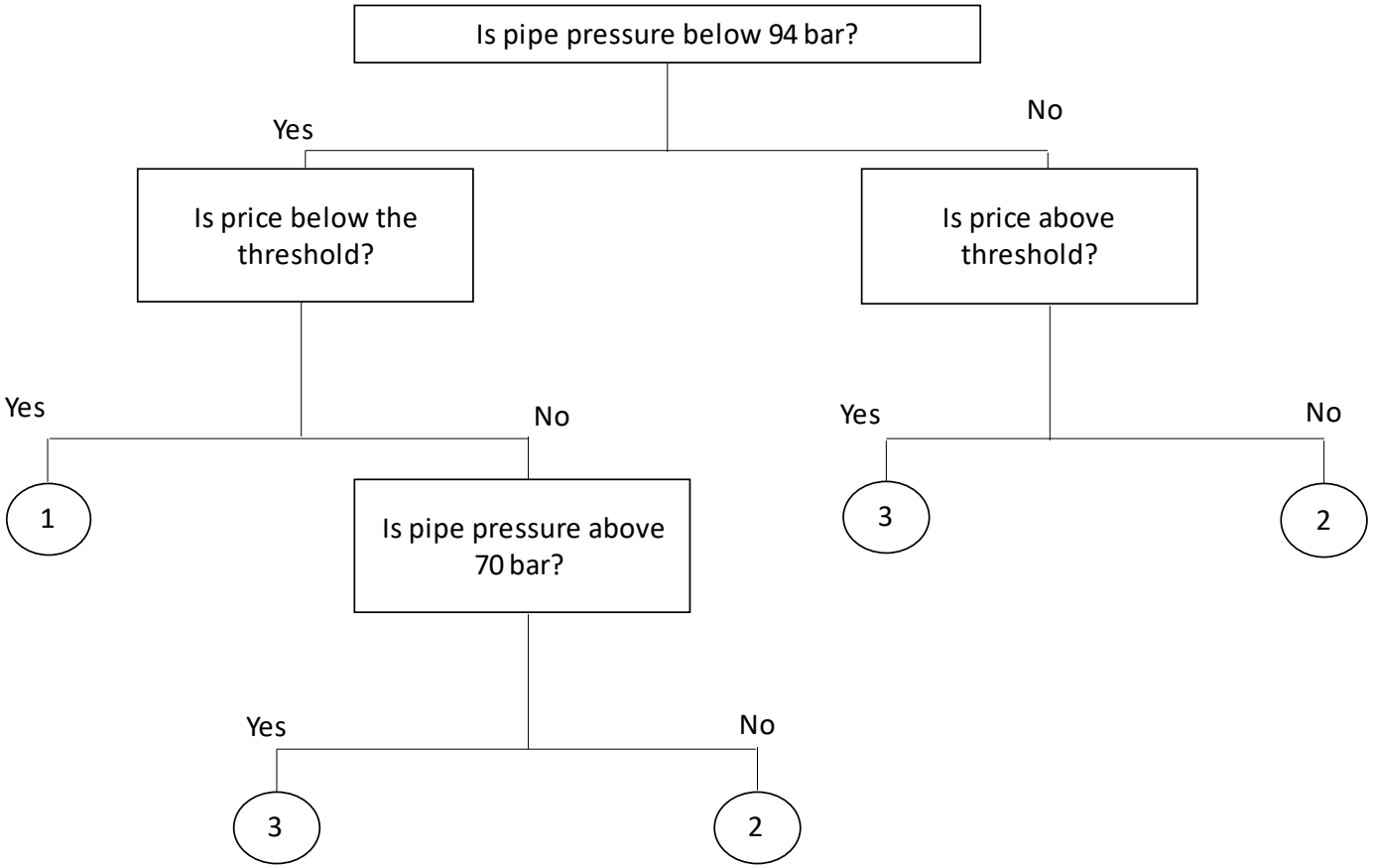
Electrolyser efficiency: 75%

Power station efficiency: 50%

Energy generated by

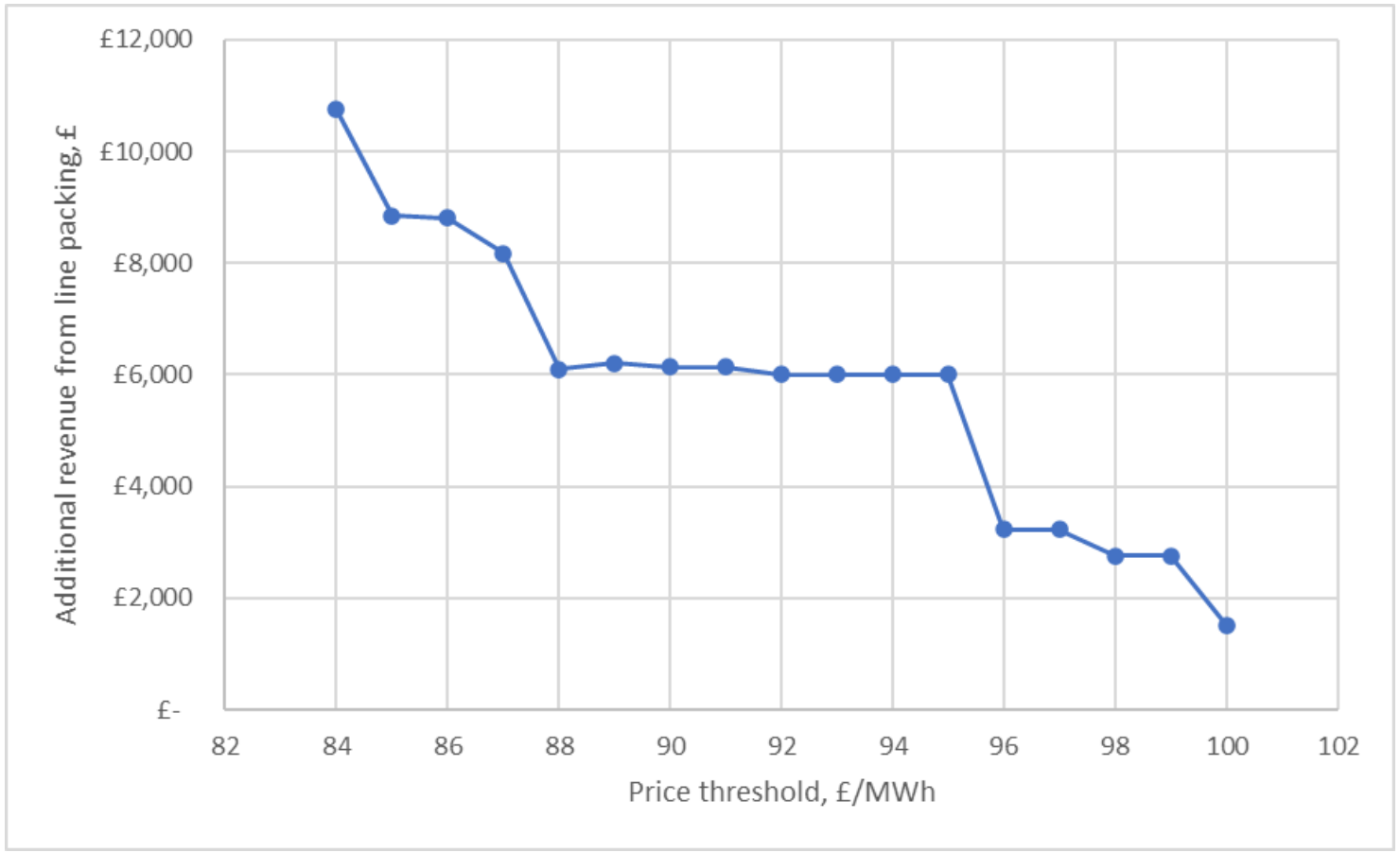
turbine every 10min: 150 MWh

MODEL CONTROL



1. Increase pipeline pressure
2. Keep pipeline pressure steady
3. Decrease pipeline pressure

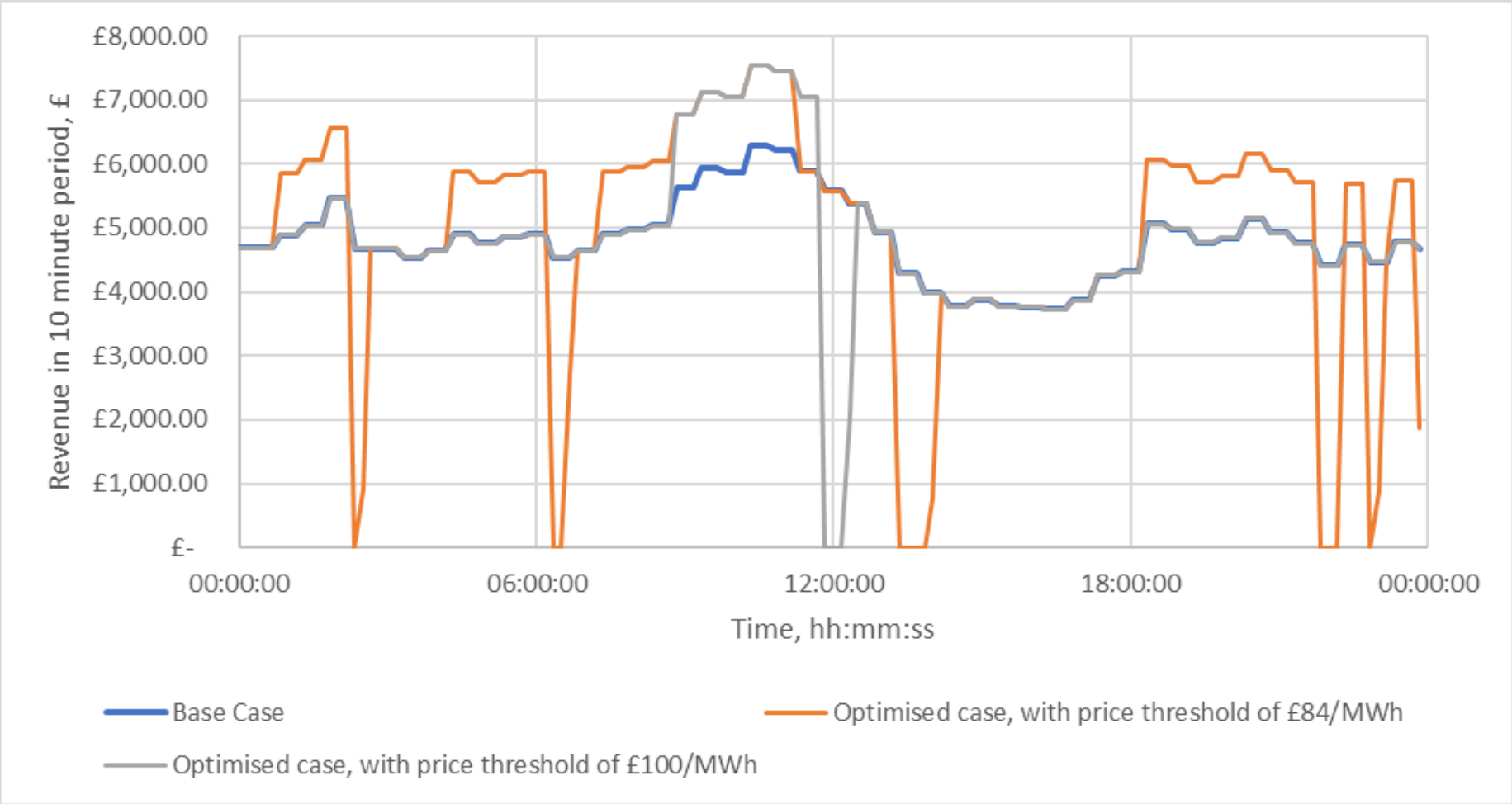
MODEL RESULTS



Maximum revenue increase: 1.55%.

Minimum revenue increase: 0.22%

MODEL RESULTS



POTENTIAL FUTURE WORK

- Develop model control system.
- Utilise a more sophisticated pipeline model.
- Quantify what additional costs line packing generates.
- Use more complex wind generation profiles that cover varying wind conditions, and over longer periods.
- Incorporate additional market data, potentially with some future scenarios in which renewables are the main contributor to the electrical grid.
- Potentially explore the impact of a given project on the overall energy system.

Q&A

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