
OPERABILITY ESTIMATION TOOL

For offshore wind marine operations

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SINTEF Ocean

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Photo: Vegar Johansen/SINTEF

WHAT IS OPERABILITY?

The ability to safely and efficiently carry out a mission or an operation within the constraints of environmental conditions

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WindRise

*An integrated value chain for sustainable and up-scaled
production, transport and installation of offshore wind substructures*


WindRise

MOTIVATION

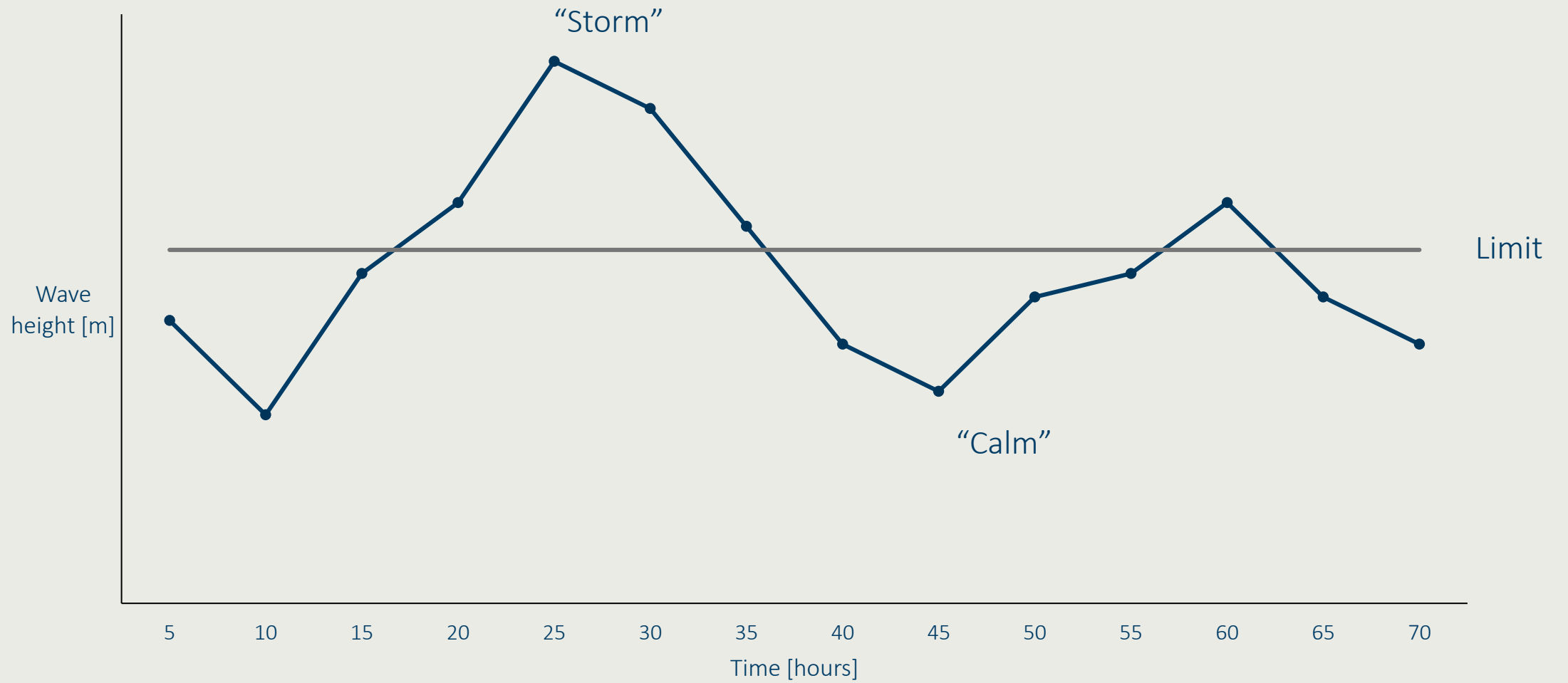
Enable comparison of:

- Operation limits

- Operation durations

- Seasonal variations

BASIC CONCEPT



HOW CAN WE ESTIMATE OPERABILITY?

We need two things:

1. Probability of weather being below operational limits
2. Probability of weather window being large enough

DATASETS

Metocean data from Sørilige Nordsjø II¹ and Utsira Nord²

Hourly data from 1982 to 2022

Includes:

- Time and location

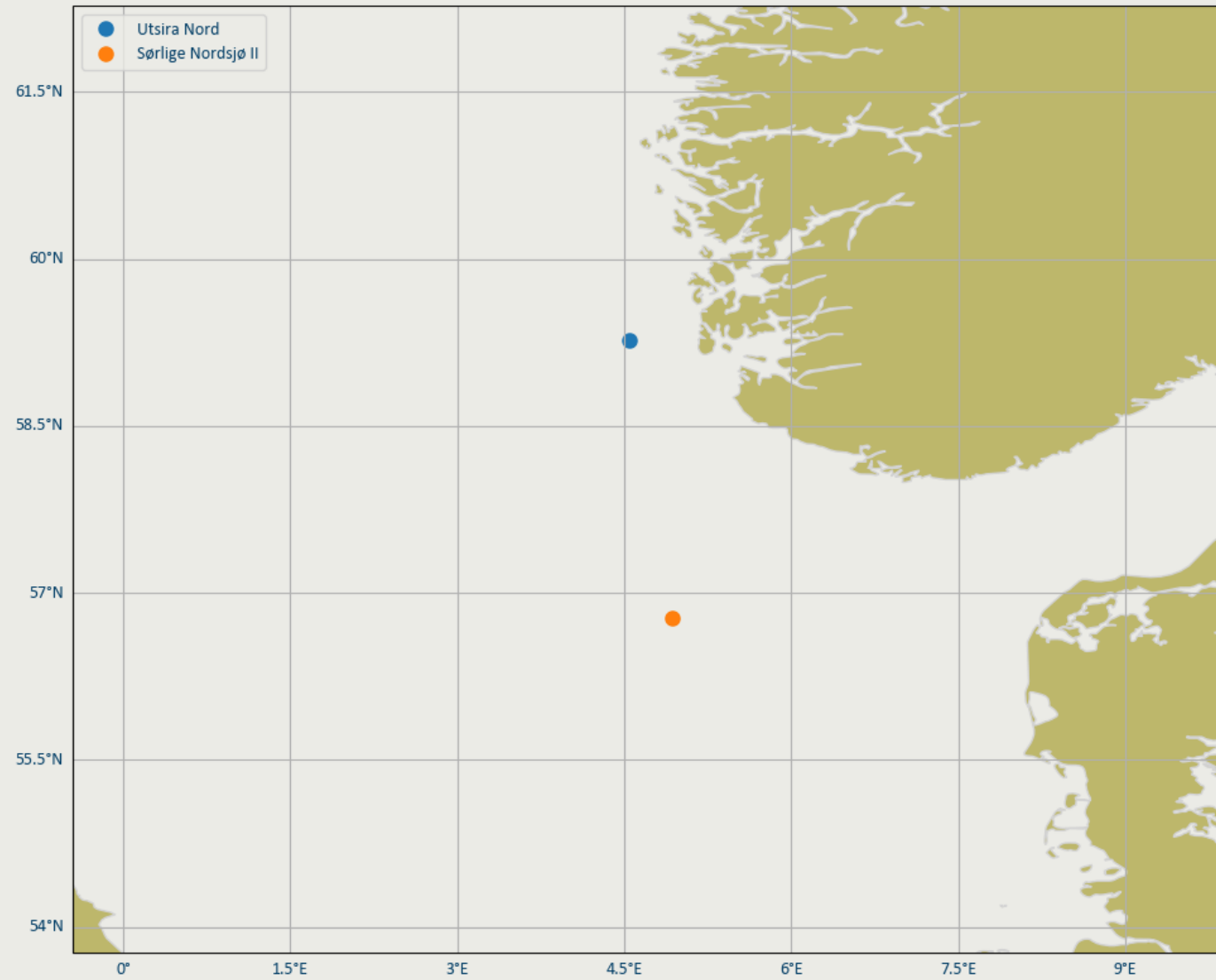
- Significant wave height

- Wave peak period

¹ Cheynet E., Li L., Jiang Z. Metocean Conditions at Sørilige Nordsjø II with NORA3 (1982-2022). Zenodo; 2022.

² Cheynet E., Li L., Jiang Z. Metocean Conditions at Utsira Nord with NORA3 (1982-2022). Zenodo; 2023.

LOCATION



ASSUMPTIONS AND SIMPLIFICATIONS

Hindcast data can be used to “predict” future weather

Wave directions disregarded

Probabilities calculated based on relative frequency

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SCATTER DIAGRAM

		Wave periods [s]			
		0-5	5-10	10-15	15-20
Wave Heights [m]	0 - 0.5	1	3	6	2
	0.5-1.0	0	2	5	3
	1.0-1.5	0	4	9	5
	1.5-2.0	0	0	7	4

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$$P[H_s \leq 0.5 \cap T_p \leq 10] = \frac{1 + 3}{1 + 3 + 6 + 2 + 2 + 5 + 3 + 4 + 9 + 5 + 7 + 4} = \frac{4}{51} \approx 0.078$$

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WEATHER WINDOW DURATION

Probability estimation

Define inputs (max wave height/period, operation duration)

For each input:

- Find all lengths of calm periods

- Find all lengths of calm periods longer than operation duration

- Calculate relative frequency

OPERABILITY FORMULA

$$P[H_s \leq H_{s,max} \cap T_p \leq T_{p,max}] \cdot P[T_c > T_{op} | H_s \leq H_{s,max} \cap T_p \leq T_{p,max}]$$

OUTPUT VARIABLE

Available operation time (hours and percent):

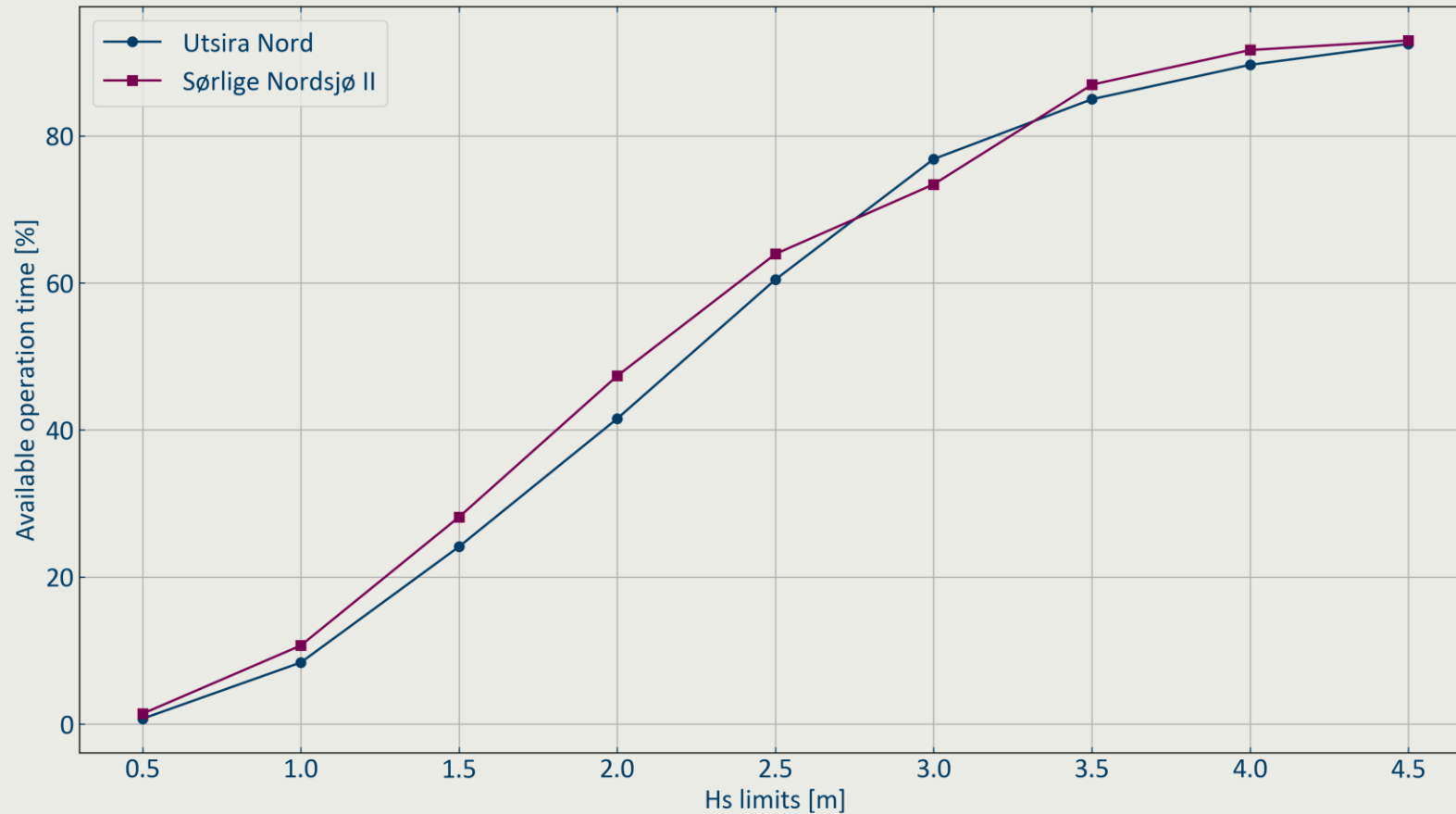
$$T = \textit{Operability} \cdot T_{tot}$$

RESULTS

Illustrative examples

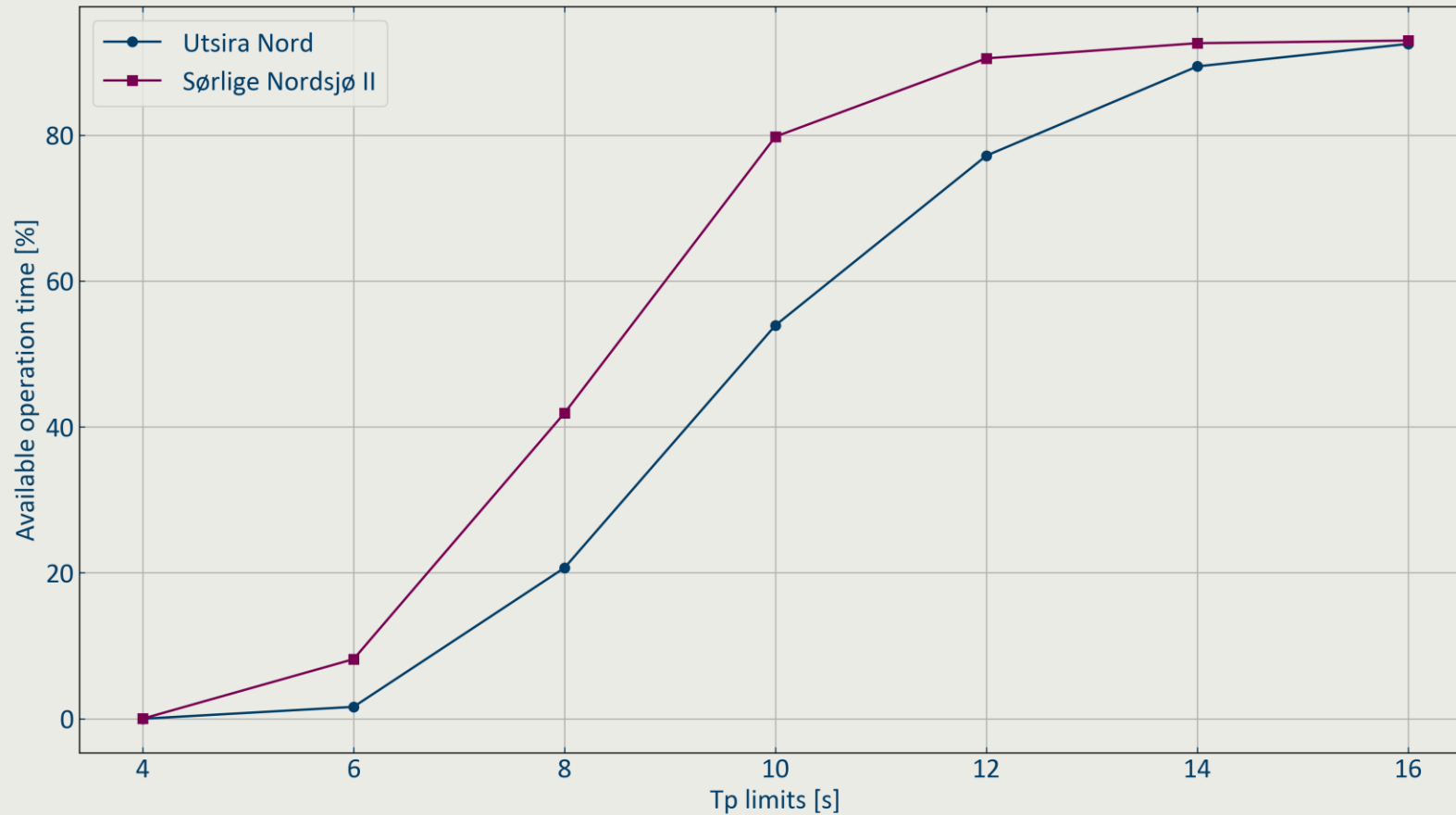
VARYING OPERATION LIMITS – H_s

Operation in summer – duration 48 hours – T_p limit 16 s



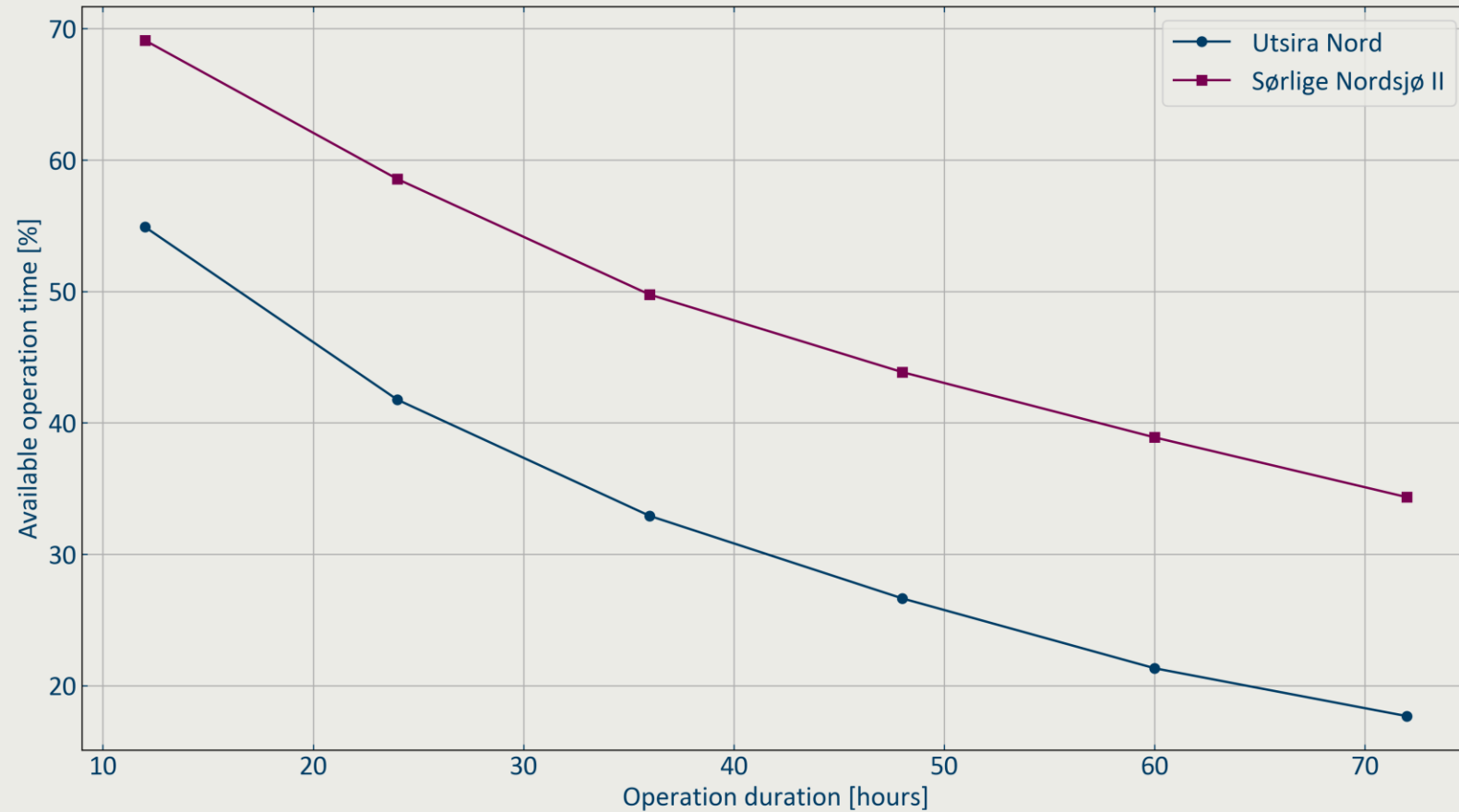
VARYING OPERATION LIMITS – T_p

Operation in summer – duration 48 hours – H_s limit 4.5 m



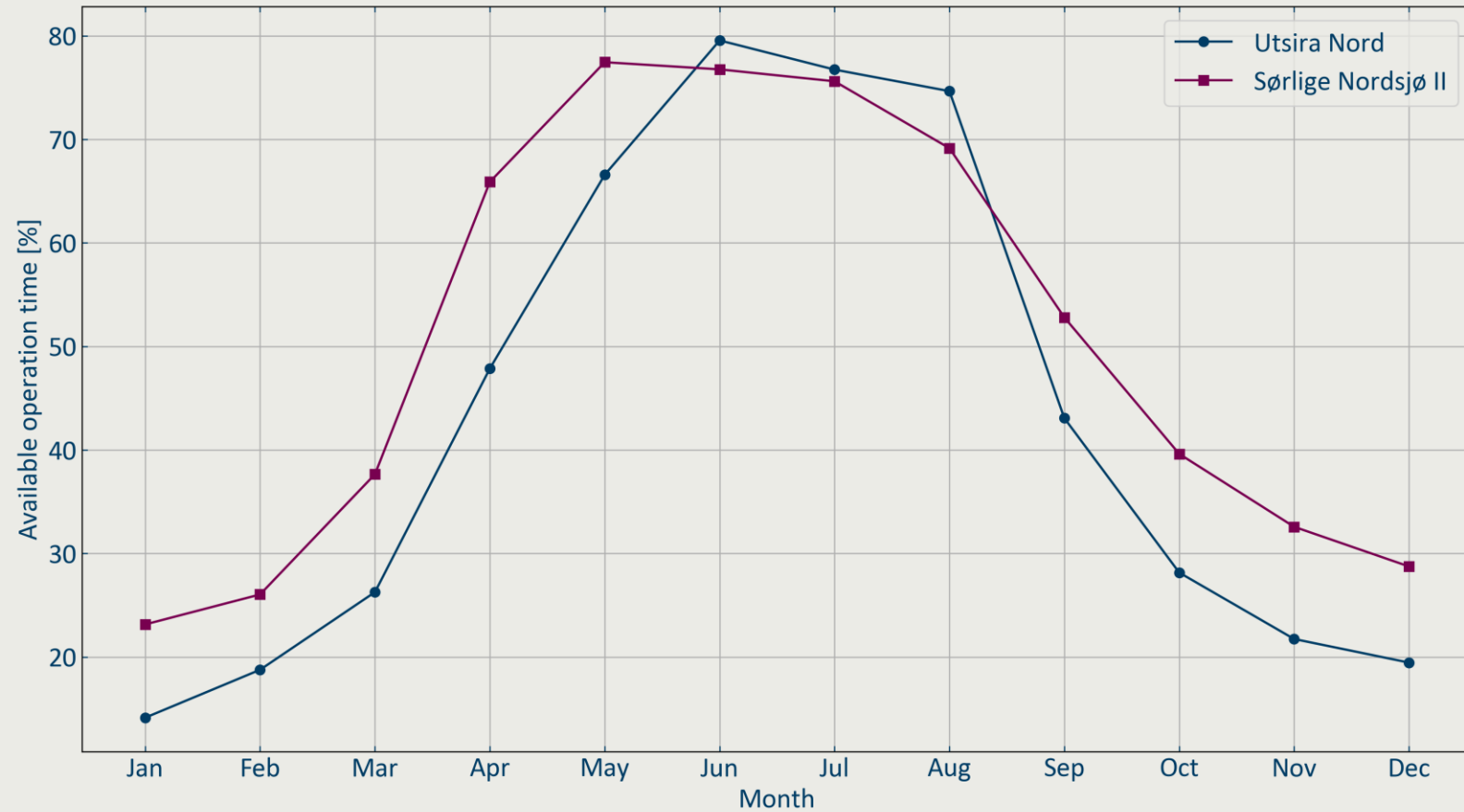
VARYING OPERATION DURATION

Operation in summer – Hs limit 2 m – Tp limit 10 s



VARYING MONTH

Duration 48 hours – Hs limit 3 m – Tp limit 16 s



CONCLUSION

Easy estimation of operability – Considering both wave height and wave period

Enables comparison of varying limits, durations and seasons

Future of the tool

REFERENCES

Cheyne E., Li L., Jiang Z. Metocean Conditions at Sørlige Nordsjø II with NORA3 (1982-2022). Zenodo; 2022.

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