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Development of a Risk Analysis Model for the Installation of Offshore Wind Farms

Nico Garcia Munoz

Introduction

Motivation, research questions and objective

Motivation

- Expanding renewable energy generation by constructing new offshore wind farms
- Installation phase represents major cost and risk driver
- Significant cost reduction potential in identifying and controlling installation risks

Research questions

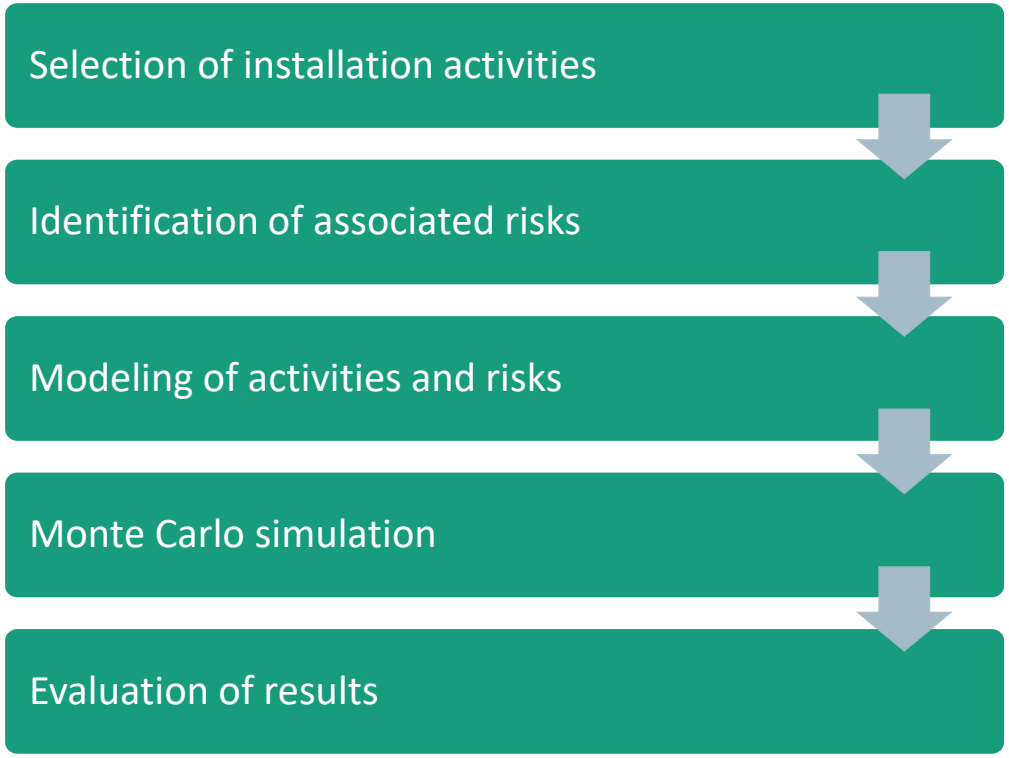
- Which are the most relevant risks associated with the installation of an offshore wind farm?
- How can activity-related installation risks be appropriately modeled and considered in project planning?

Research objective

Develop a simulation-based quantitative risk analysis model to assess the impact of identified risks on the overall project schedule

Methodology

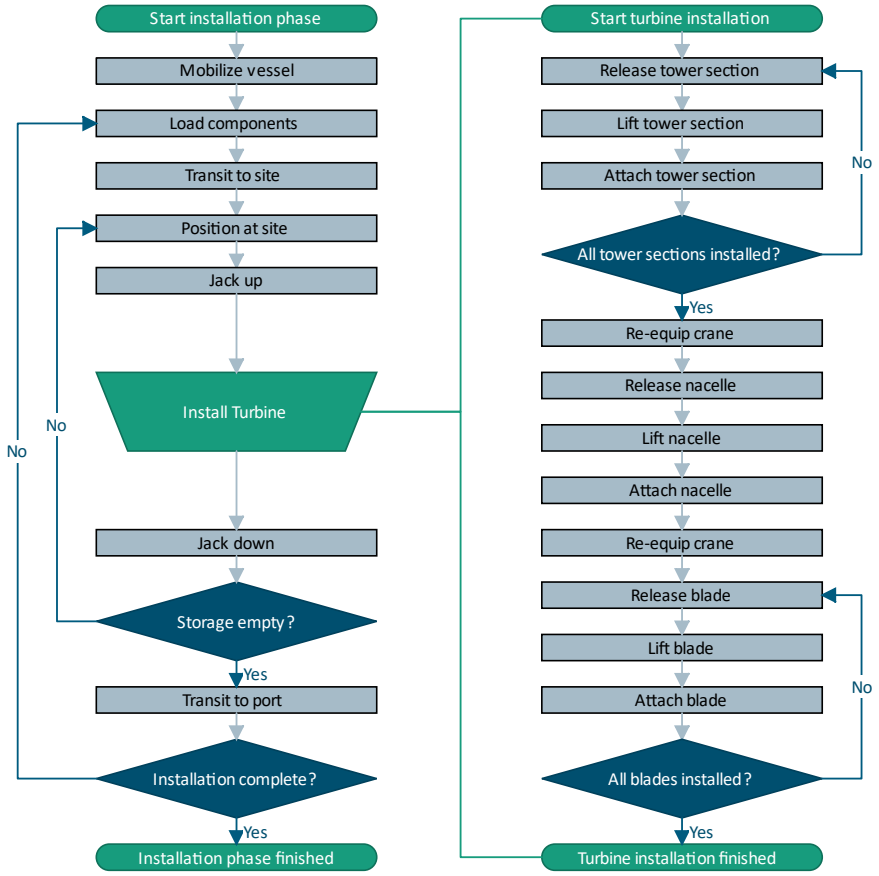
Five-step approach to developing the risk analysis model



- Activity durations and requirements from an industry benchmarking project representing existing wind farm
- Systematic literature review and expert interviews to identify and validate most relevant risks
- Risk register with qualitative description and quantitative values for risk probabilities and consequences
- Risk impacts simulated from inputs with defined probability distributions according to level of uncertainty
- Range of total project duration and its sensitivity to each risk, practical and theoretical implications of the model

Development of the risk analysis model

Selection of activities and identification of associated risks



Risk name	Conside-rations	Probability	Consequence in hours Min	Most likely	Max
Vessel availability	1	0.02	168	720	8760
Equipment availability	1	0.02	168	336	2160
Personnel availability	1	0.01	24	72	720
Port availability	14	0.05	12	24	168
Supply chain failure	13	0.06	24	72	4320
Defect components	300	0.0001	24	168	4320
Handling failure	700	0.001	3	12	336
Dropped object	600	0.00003	168	336	8760
Vessel machinery breakdown	13	0.00085	48	336	8760
Vessel collision	13	0.000059	48	336	8760
Contact with foundation	13	0.000067	48	336	8760
Jacking failure	100	0.01	2	6	8760
Tower attachment failure	100	0.01	3	5	4320
Nacelle attachment failure	50	0.02	3	10	4320
Blade attachment failure	150	0.04	3	19	4320
Systematic uncertainty	20	1	-10%	±0	+50%

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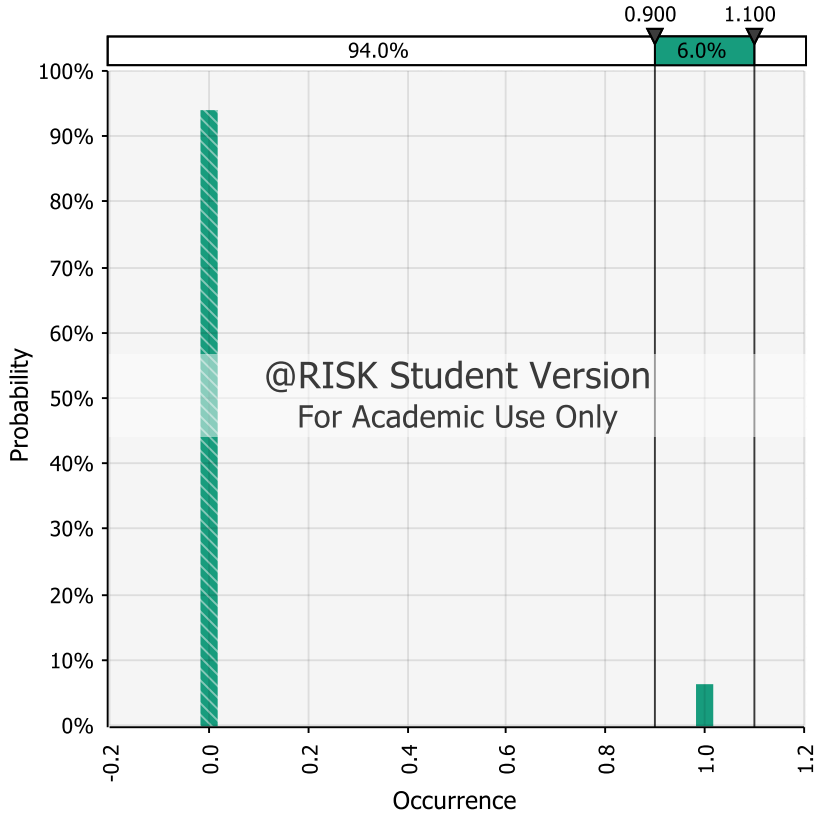
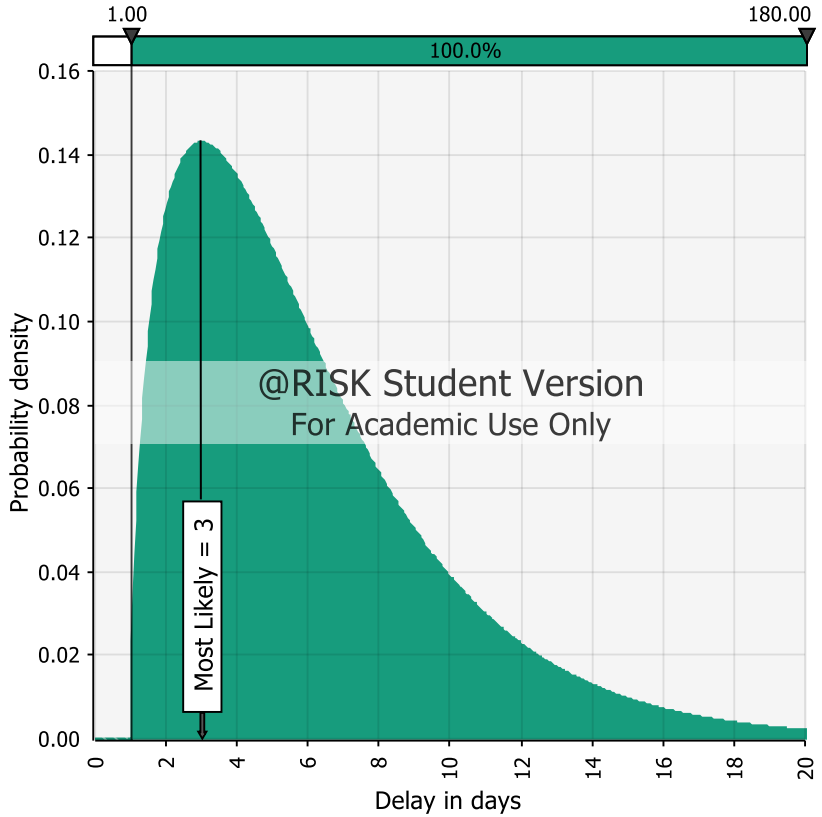
Development of the risk analysis model

Modeling of risk occurrence and consequence

Risk name	Conside-rations	Probability	Consequence in days Min	Most likely	Max
Supply chain failure	13	0.06	1	3	180





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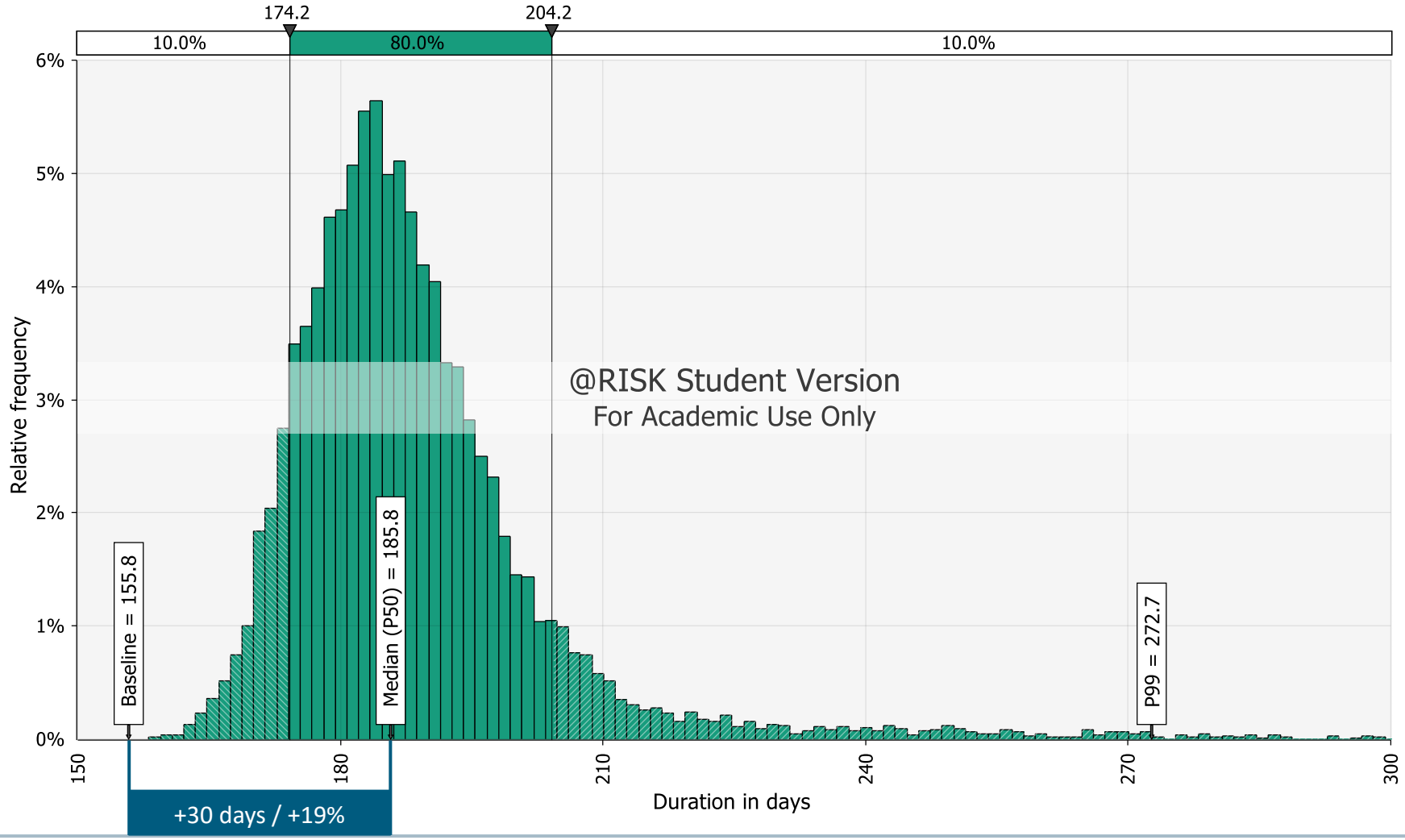
Discussion and evaluation of results

Distribution of total project duration



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Discussion and evaluation of results

Ranking and evaluation of risks

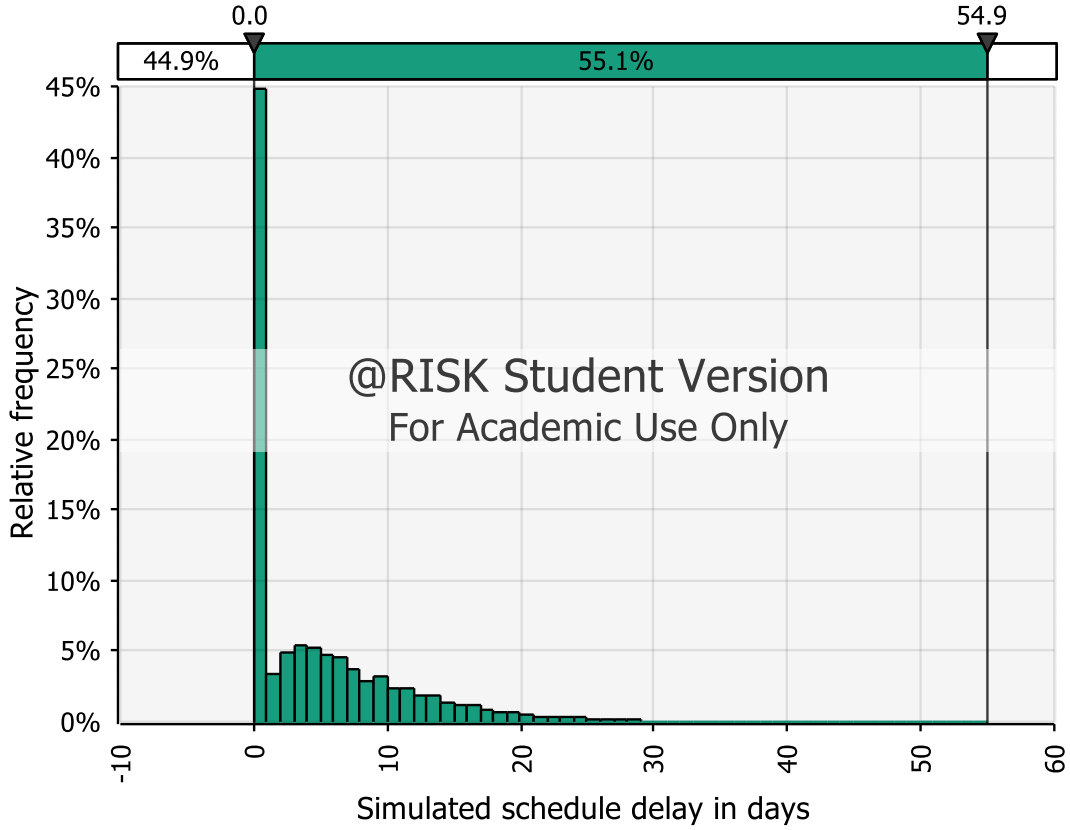
Most significant risks identified in sensitivity analysis

1. Supply chain failure
2. Blade attachment failure
3. Systematic uncertainty

Observations

- Individual risk events occur rarely
- Impacts are significant when associated with repetitive activities
- Underlying model assumptions have large influence on outcomes

Simulated risk impact



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Conclusion

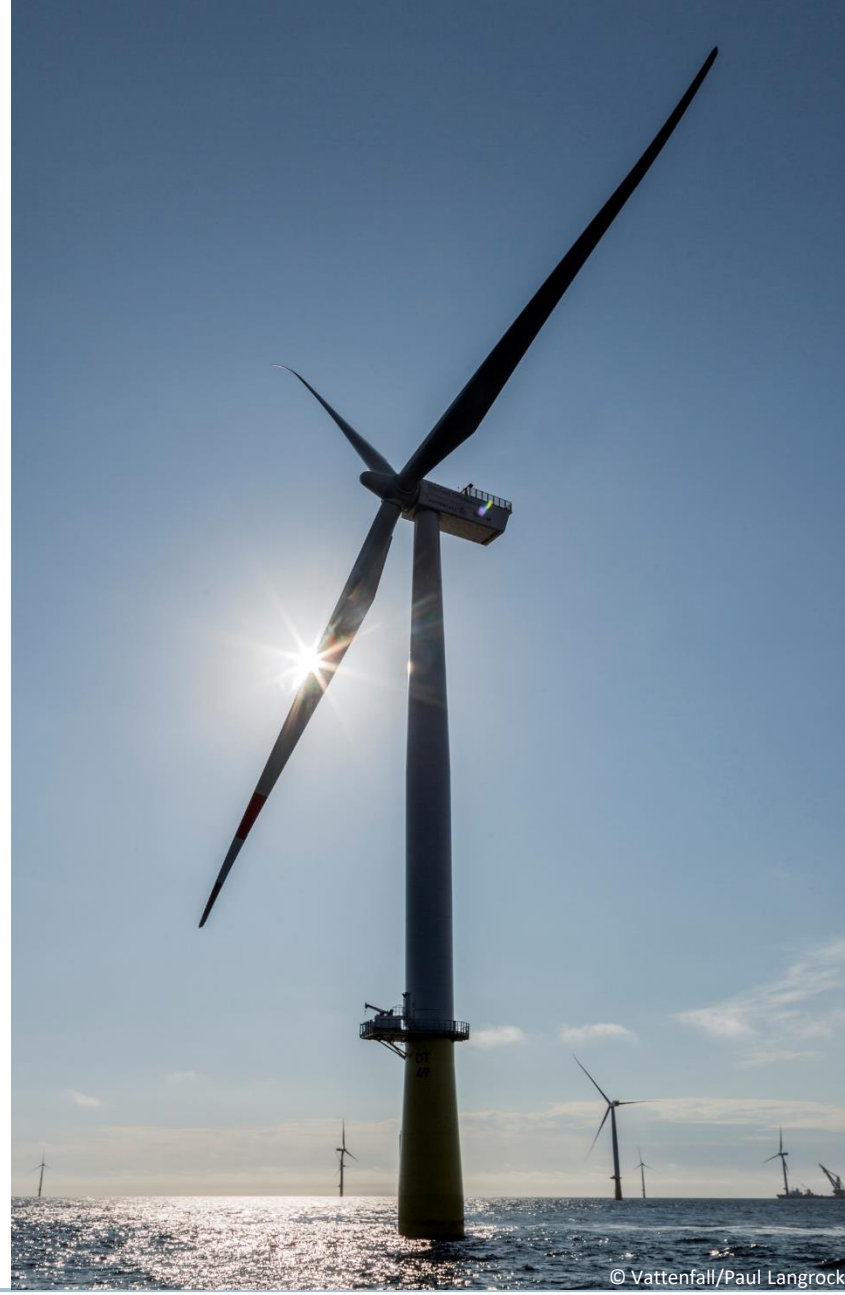
Summary and outlook

Summary

- Proof of concept of a method to identify, analyze and evaluate risks associated with offshore wind farm installation
- Basis for developing more reliable schedule estimations during project planning
- Contribution to minimizing installation delays and lowering the cost of offshore wind energy

Outlook

- More quantitative data and valid assumptions can increase accuracy and quality of model results
- Expansion to further installation phases and projects
- Combination with weather-related risks to achieve a holistic risk assessment model



Thank you!

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