Assessing the relevance of trade-offs in optimising a honeycomb wind farm layout with shared anchors.

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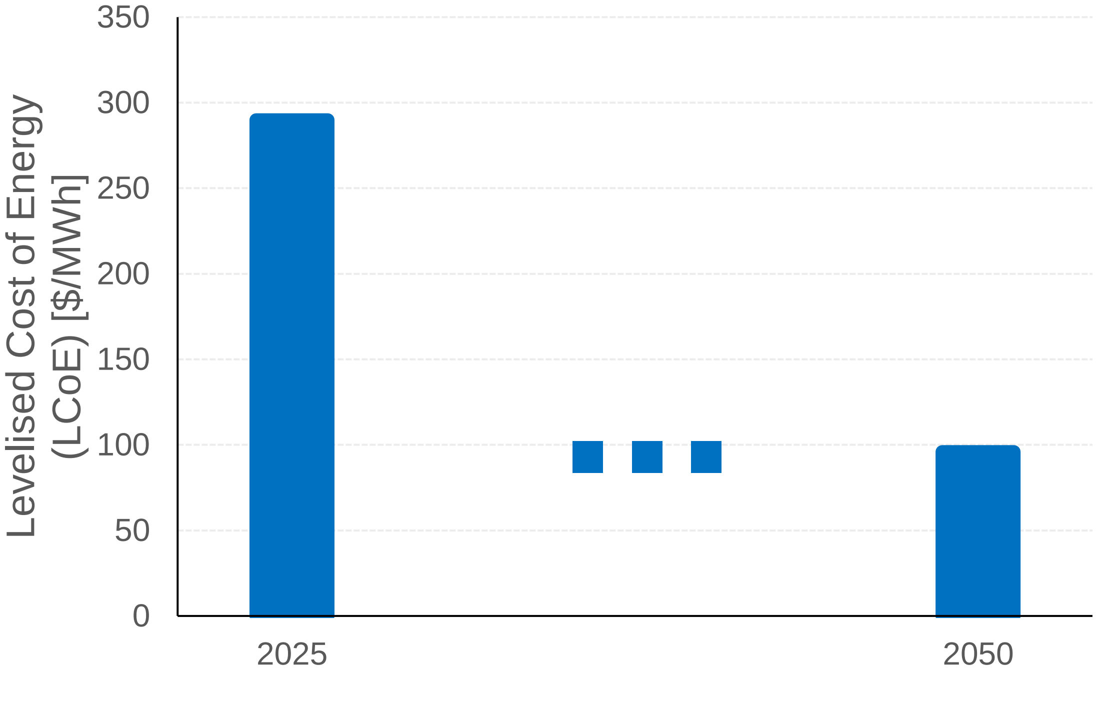
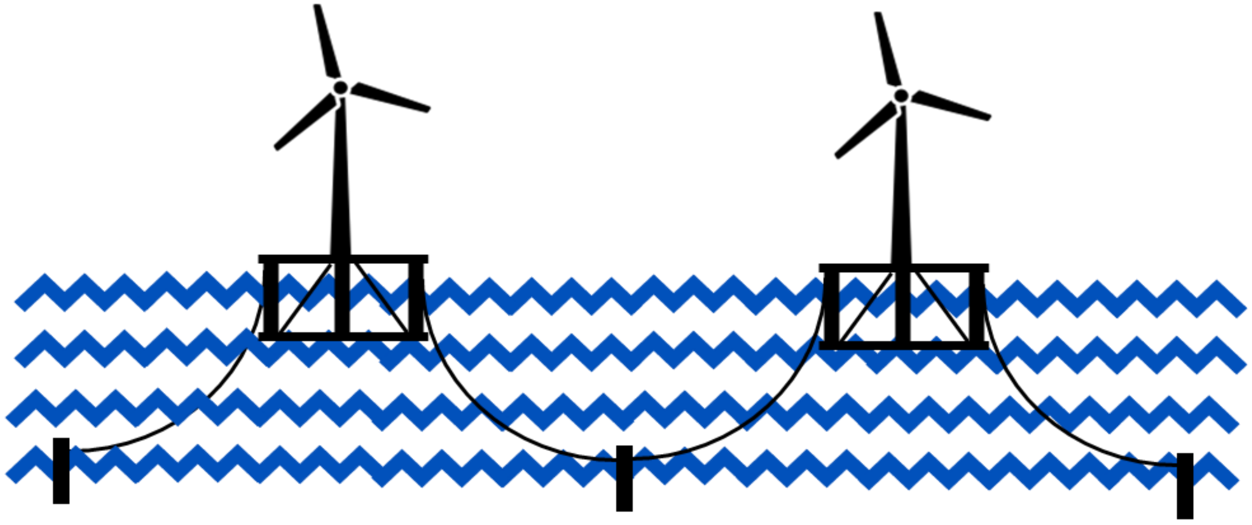
Floating wind LCoE reduction





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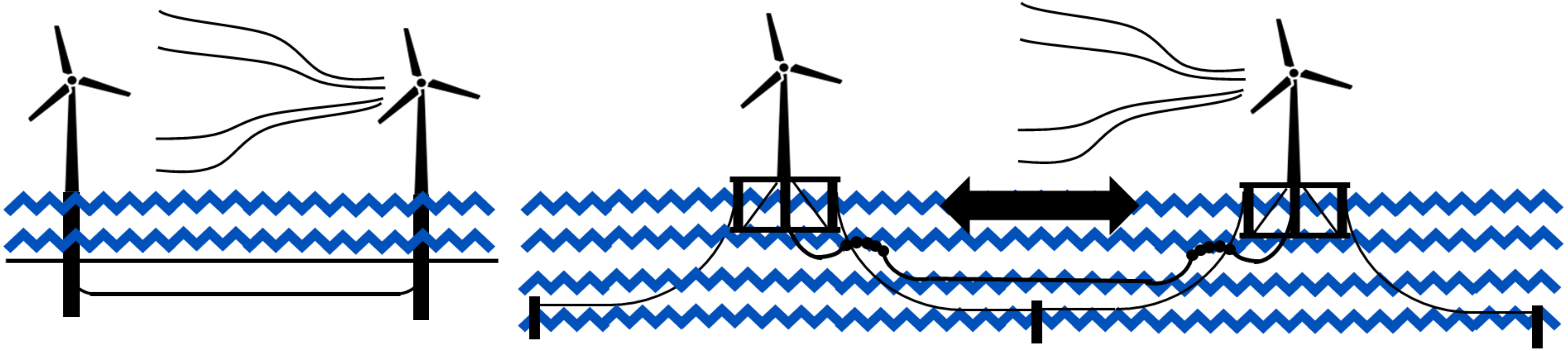
The research objective



How relevant is accounting for this trade-off for LCoE reduction?

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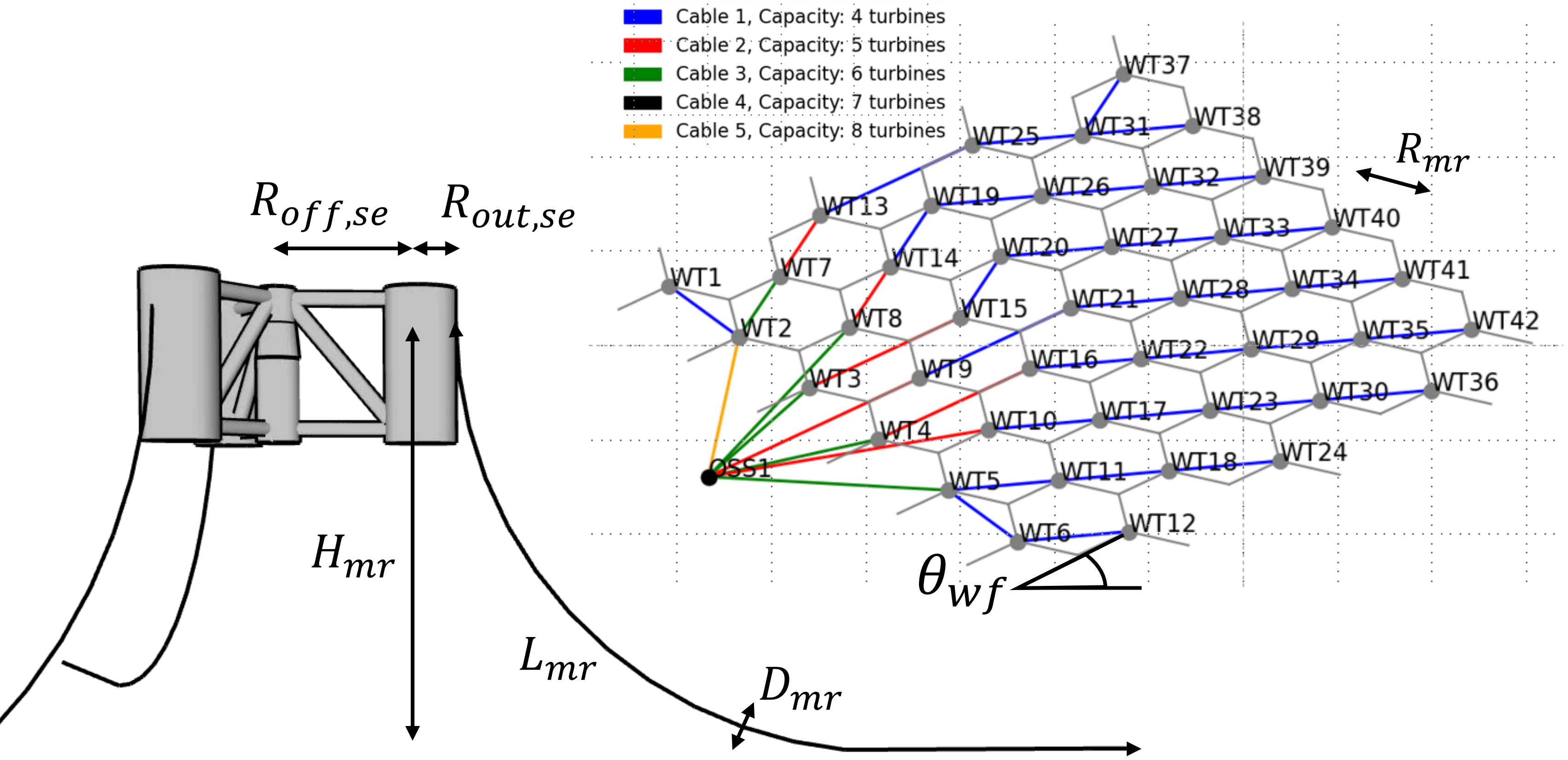
Design variables



Design variable	Symbol	Bounds
Offset central-outer columns	$R_{off,se}$	40m-70m
Radius outer column	$R_{out,se}$	2.8m-5.5m
Nominal chain diameter	D_{mr}	3cm-22cm
Reative fairlead height	H_{mr}	0-1*
Anchor-fairlead radial distance	R_{mr}	350-800m**
Chain length	L_{mr}	$f(H_{mr}, R_{mr})$
Wind farm rows orientation	θ_{wf}	0°-180°

*0 at free surface, 1 at kee
**Min. water-depth-dependent, Max. ~12 RD inter-turbine spacing

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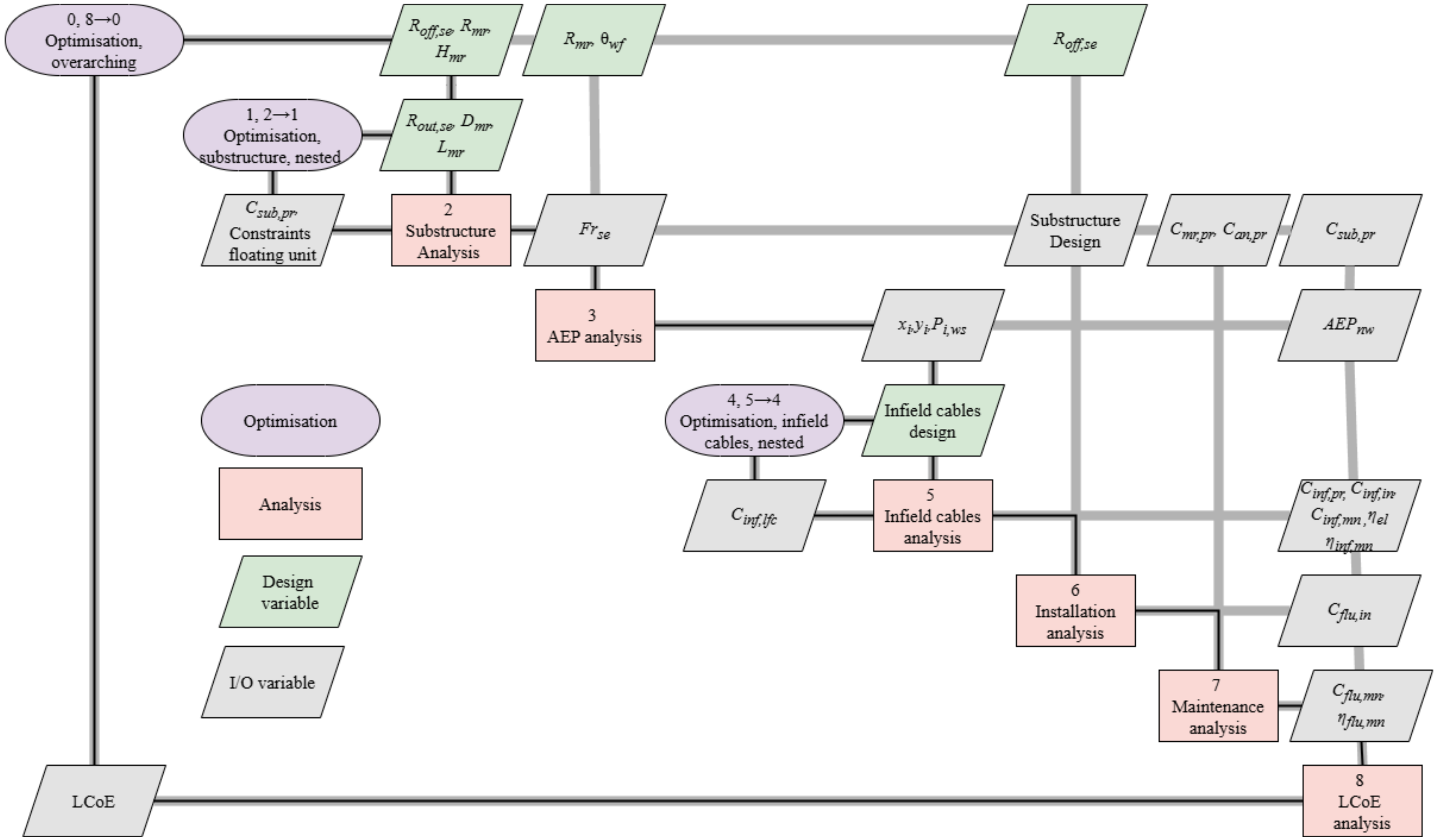
MDAO workflow



- Substructure analysis: RAFT
  - θ_{max}, α_{max}
  - x_{max}
  - T_{max}, $T_{V,max}$
  - F_{mr}
- AEP analysis: PyWake
- Infield cables optimization: Esau-Williams

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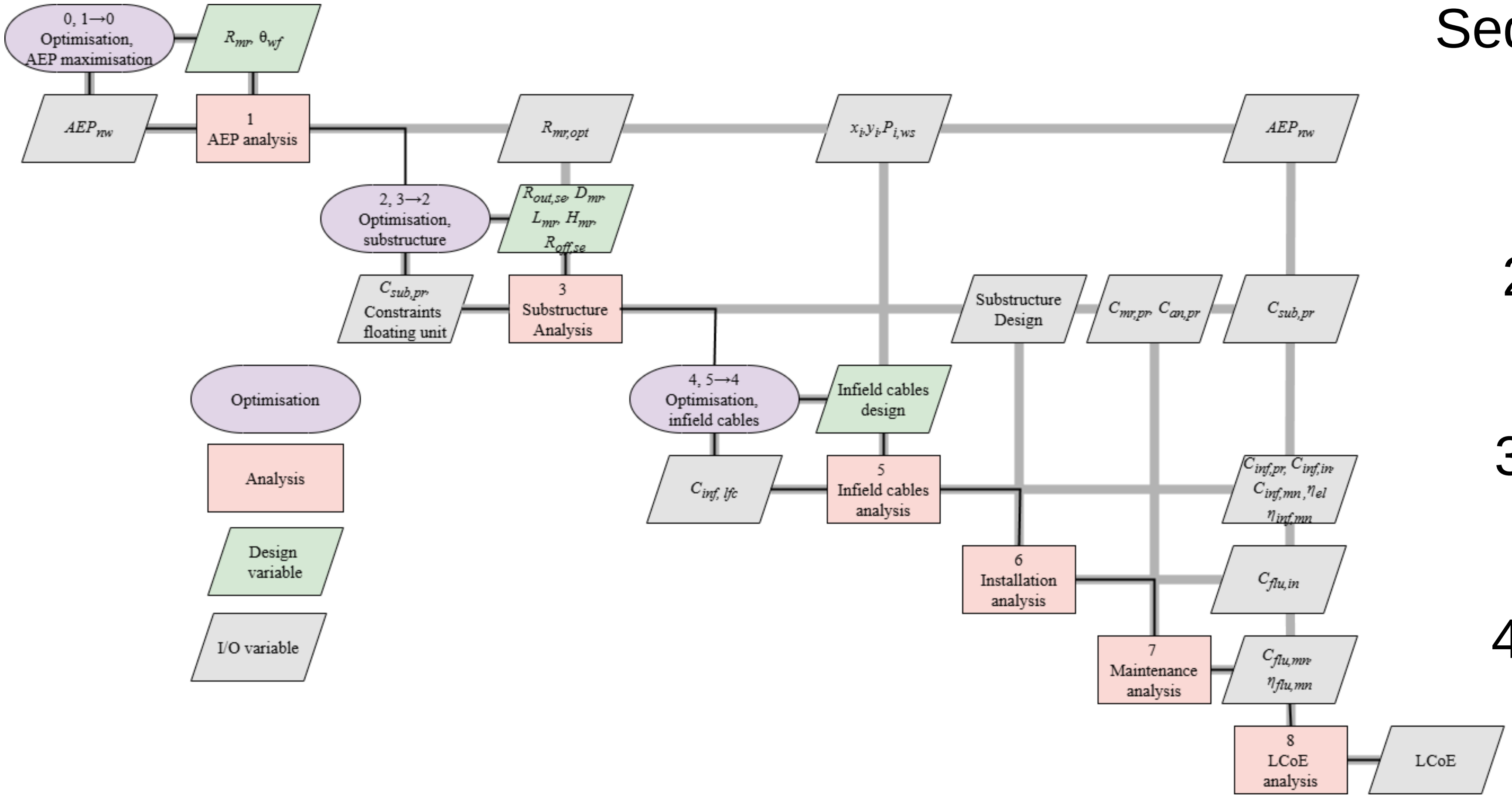
Sequential workflow



Sequential design workflow:

1. Maximise AEP
2. Minimise substructure capital cost
3. Minimise infield cables costs
4. Assess installation and maintenance costs

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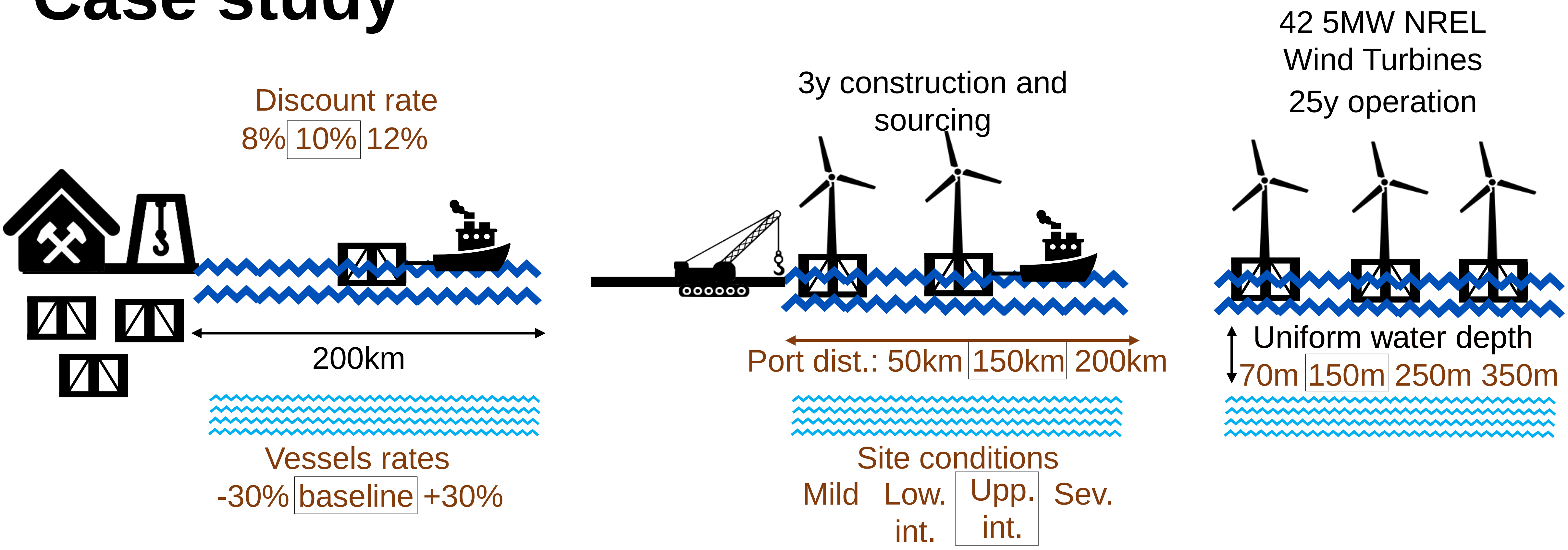
Case study



For each case, results of the MDAO and sequential design workflow are compared

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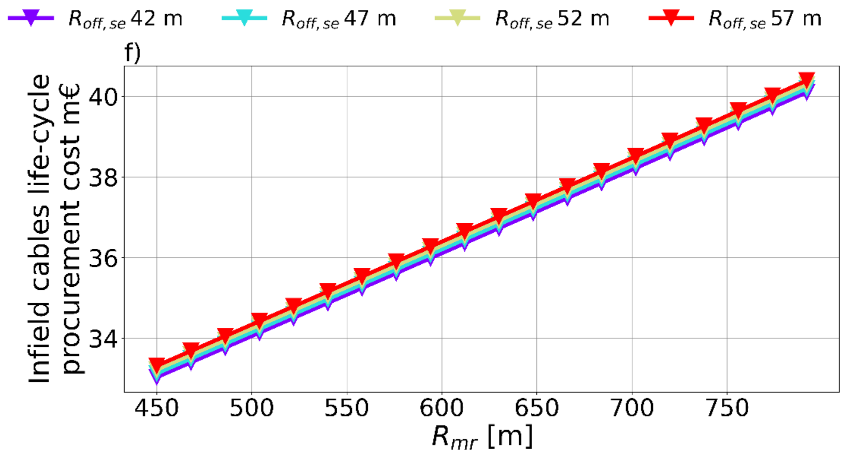
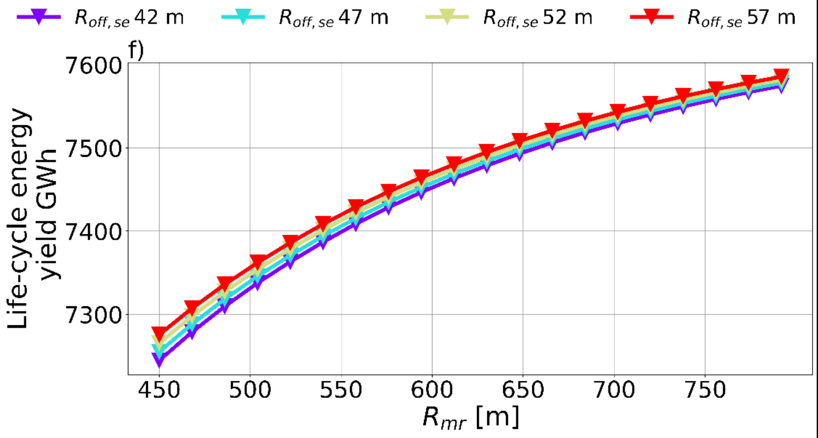
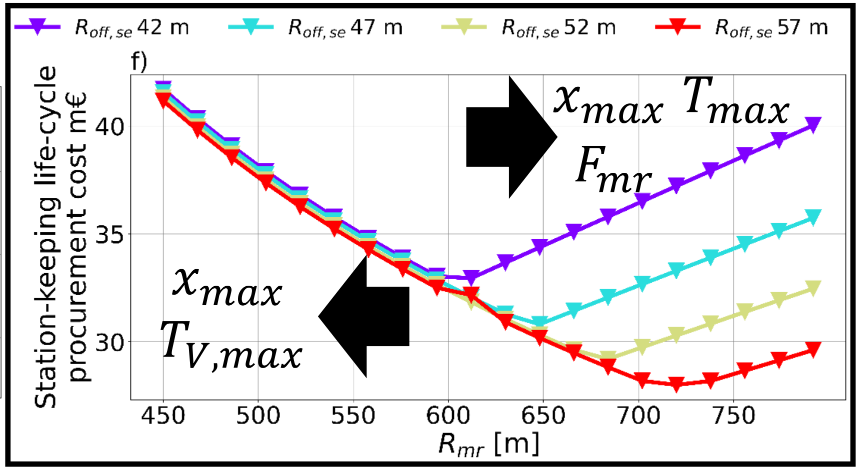
Mechanisms for the trade-offs







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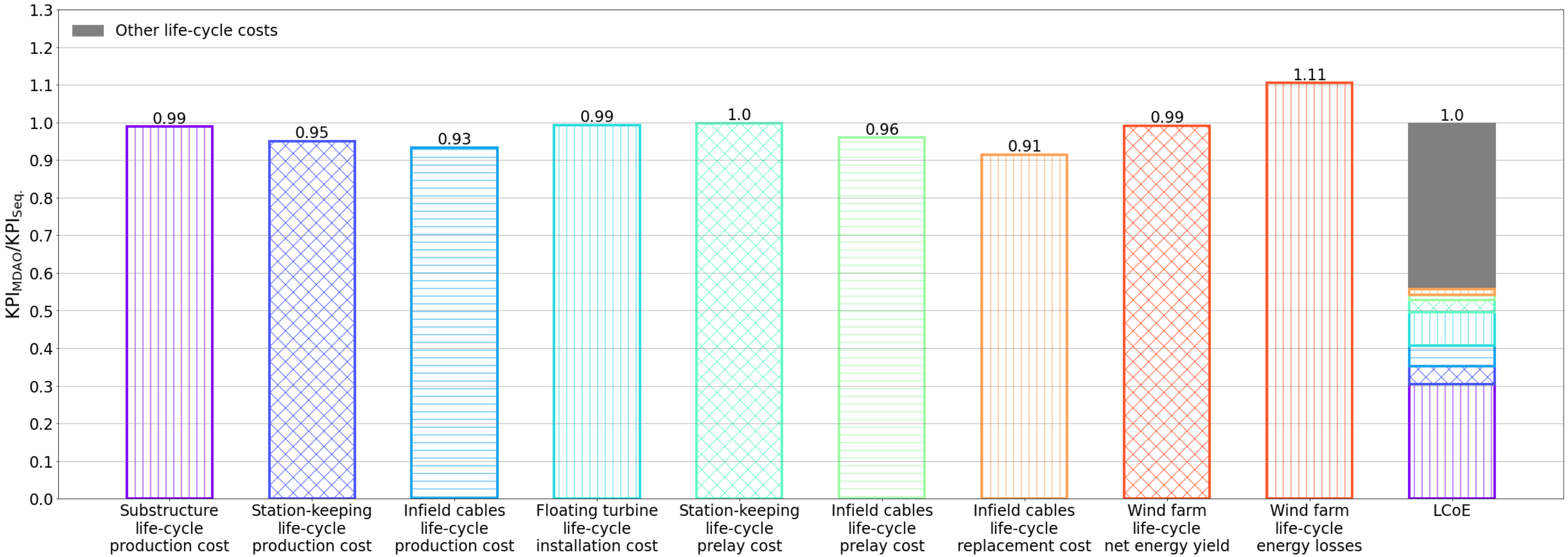
Base case – what is traded



-0.31 €/MWh

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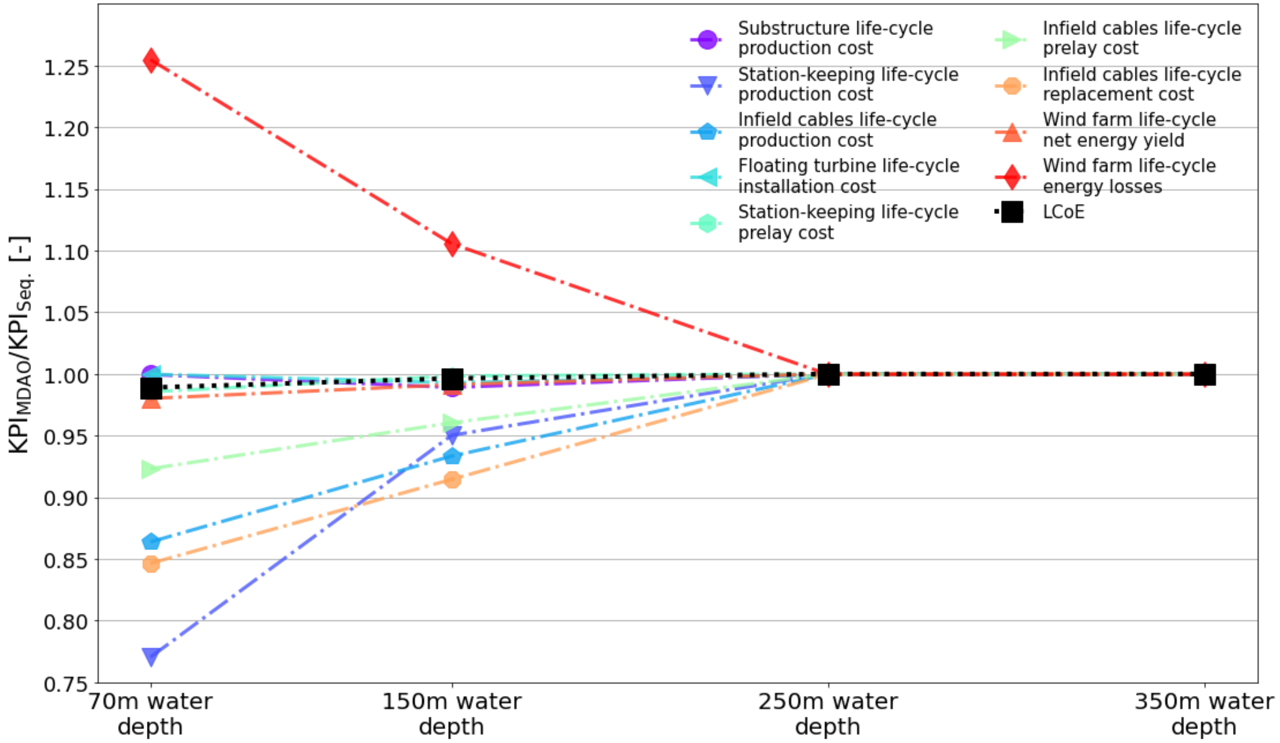
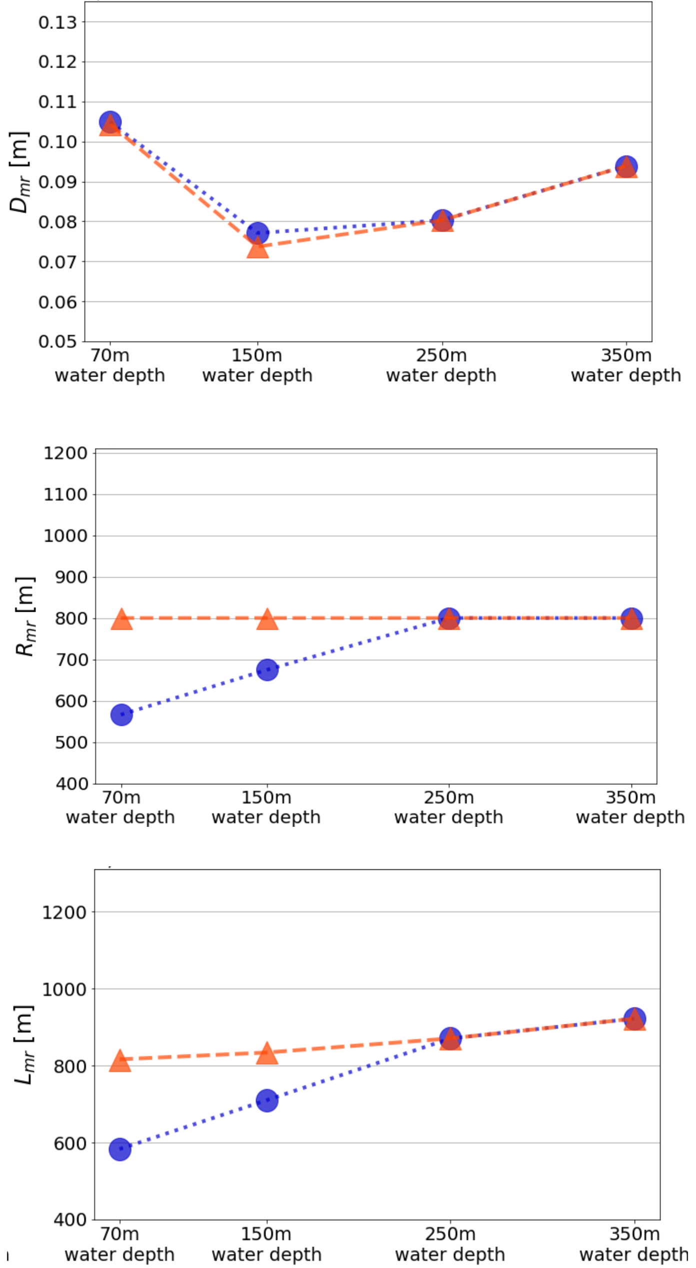
Water depth variation





MDAO LCoE reduction, €/MWh

70m	150m	250m	350m
-0.96	-0.31	-0.01	-0.01

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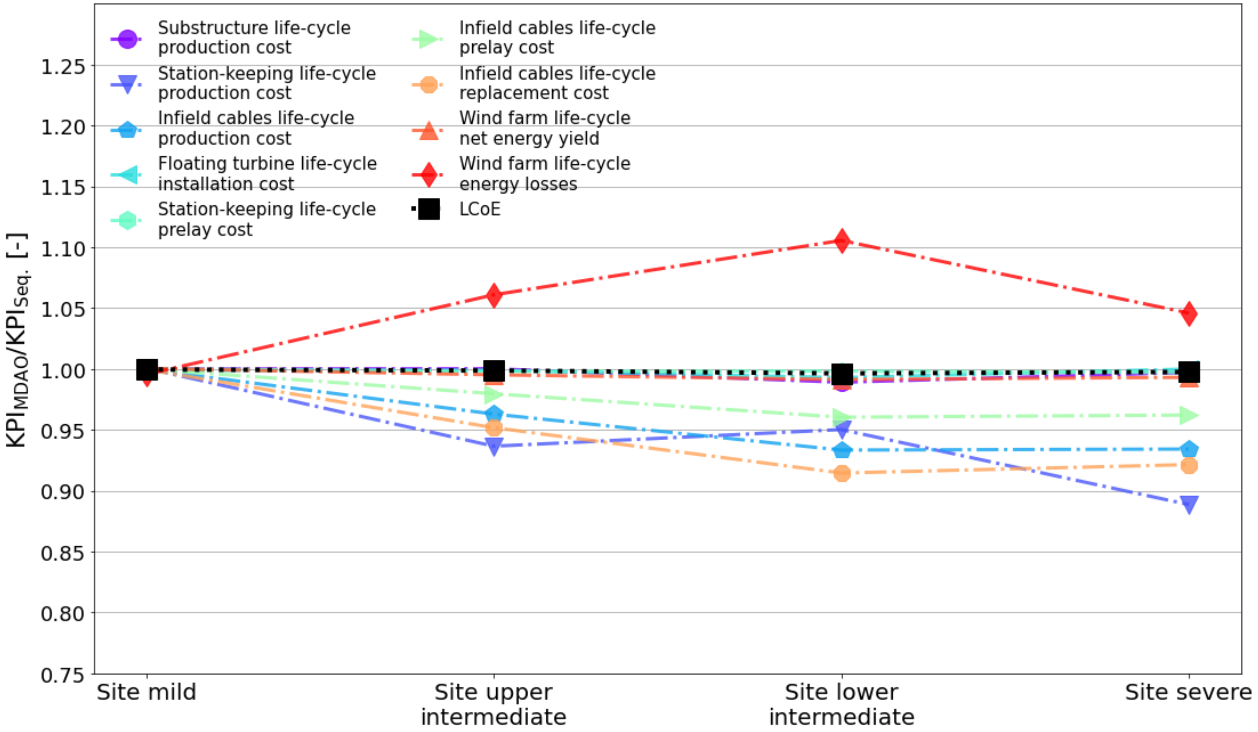
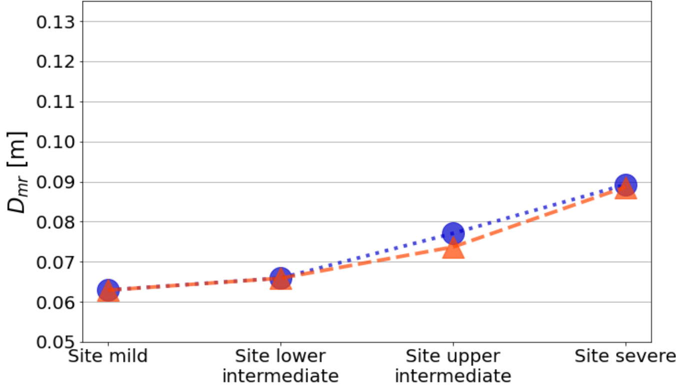
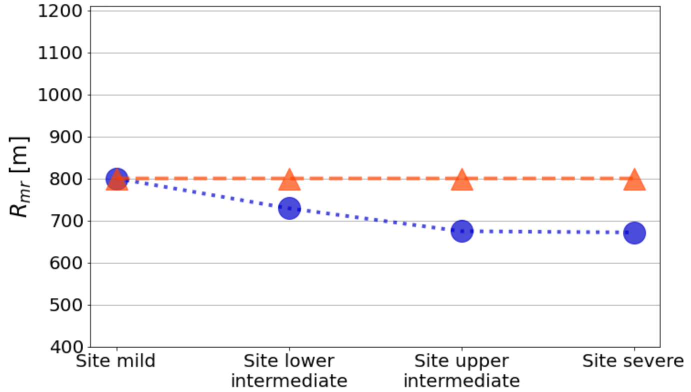
Site conditions variation







$$\frac{\partial LCoE}{\partial R_{mr}} = \frac{1}{E_{Y,lfc}} \frac{\partial C_{lfc}}{\partial R_{mr}} - \frac{C_{lfc}}{E_{Y,lfc}^2} \frac{\partial E_{Y,lfc}}{\partial R_{mr}}$$

$C_{flu,in}$ ↑ $C_{flu,mn}$ ↑ $C_{fl\,sub,prc}$ ↑

MDAO LCoE reduction, €/MWh

-0.08	-0.12	-0.31	-0.37

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Other design drivers variation

MDAO LCoE reduction, €/MWh

Site conditions: Mild, Low.-int., Upp.-int., Sev.	-0.08	-0.12	-0.31	-0.37
Water depth: 70m, 150m, 250m, 350m	-0.96	-0.31	-0.01	-0.01
Discount rate: 8%, 10%, 12%	-0.25	-0.31	-0.36	
Distance from port: 50km, 150km, 250km	-0.20	-0.31	-0.27	
Vessels rates: -30%, Baseline, +30%	-0.31	-0.31	-0.28	

Baseline

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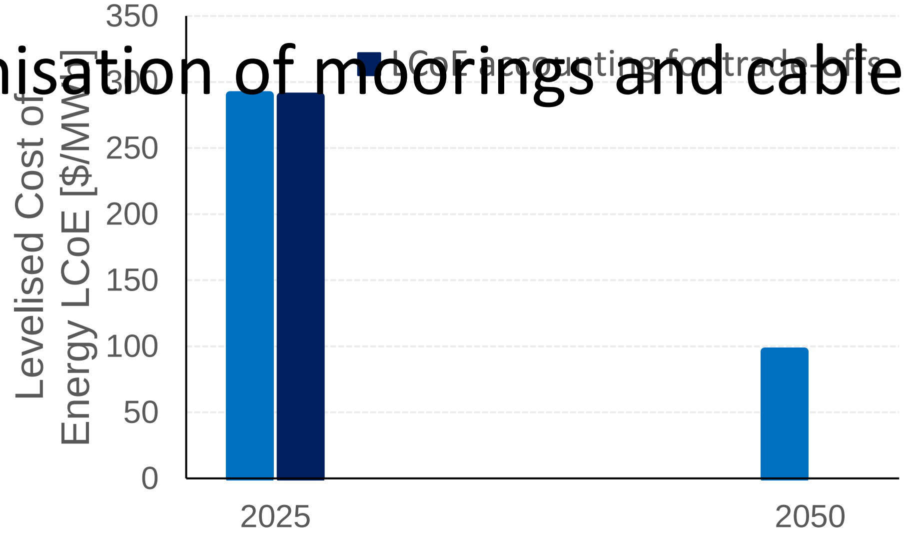
Conclusions and next steps

- ✓ Mooring system cost minimisation becomes a third ingredient of the trade-off in optimising wind farms with shared anchors
- ✓ Variation in water depth and site conditions showed the largest impact on the trade-off
- ✓ LCoE reduction achieved by accounting for the coupling is small

- ➢ Simultaneous optimisation of moorings and cables topology avoiding crossings



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Thank you!

Questions?

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Backup

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