Maximising Energy Yield from Floating Wind Farms through Asymmetric Mooring Design

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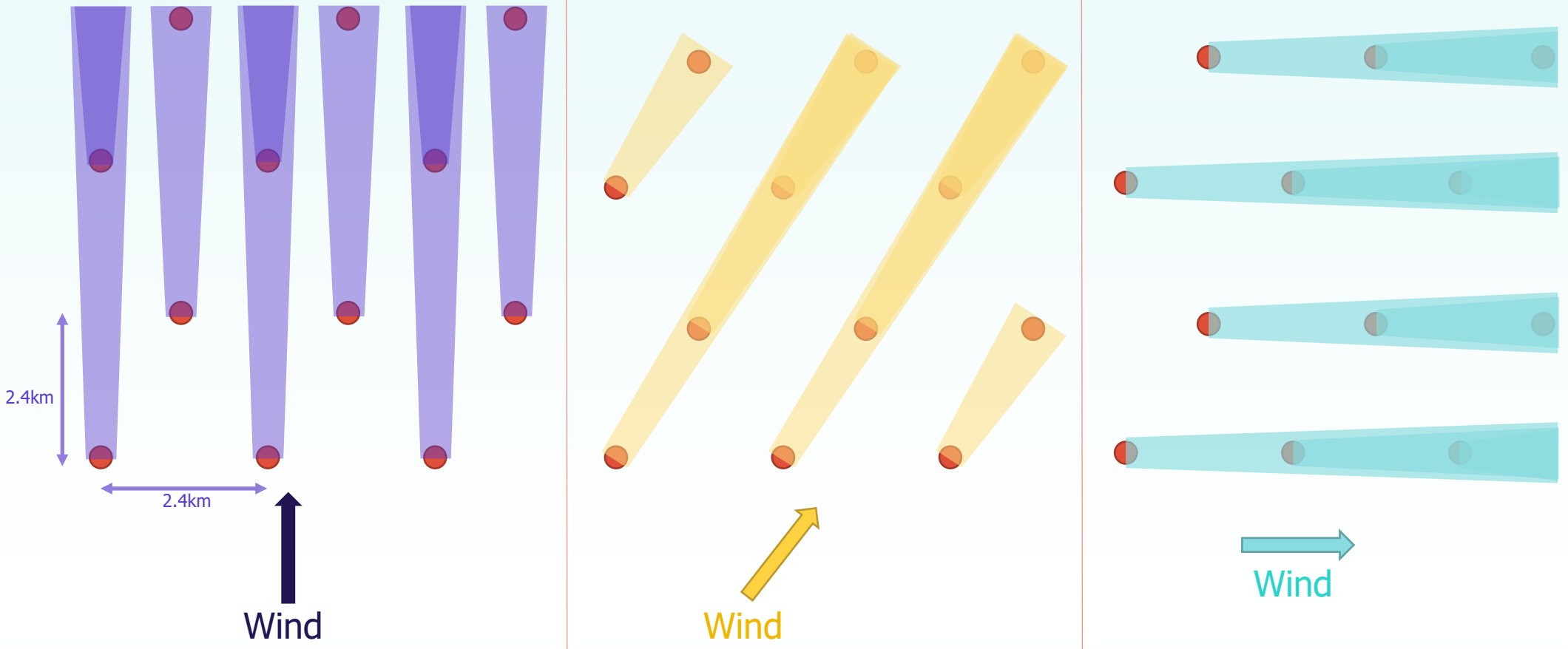
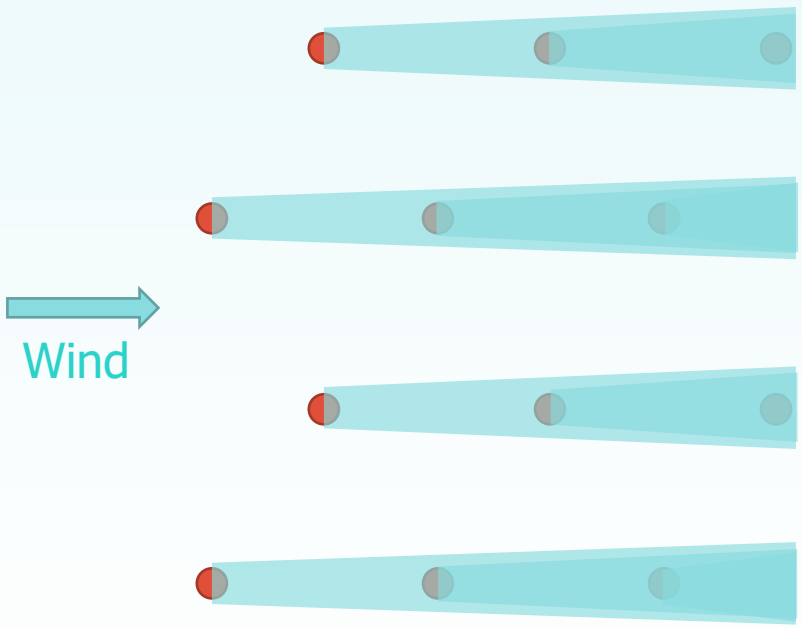
The Problem:
E.g. A fixed wind farm with a regular layout

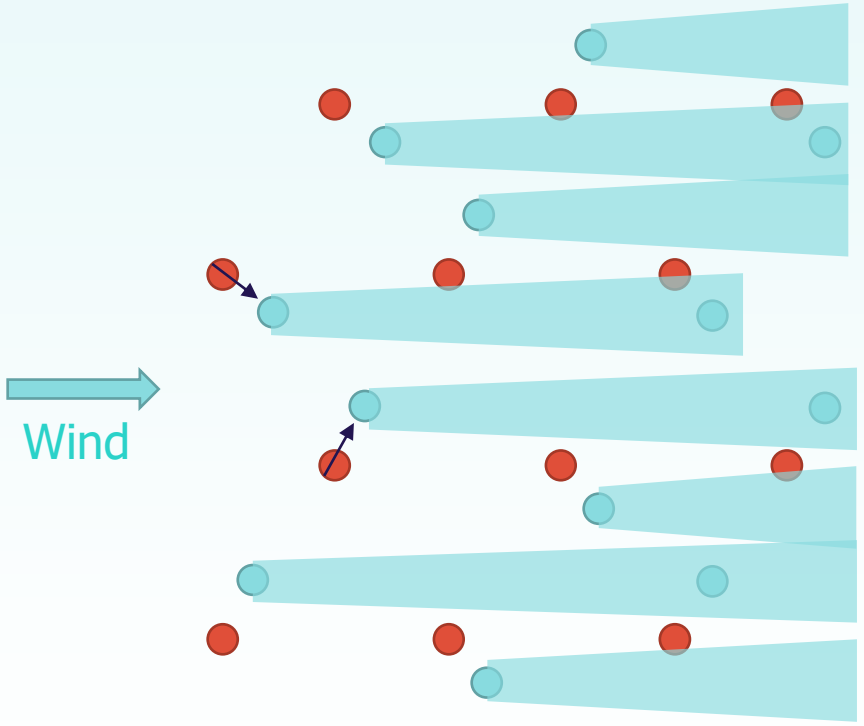


The Solution:
Asymmetric mooring concept for floating farms

Fixed Farm



Floating Farm



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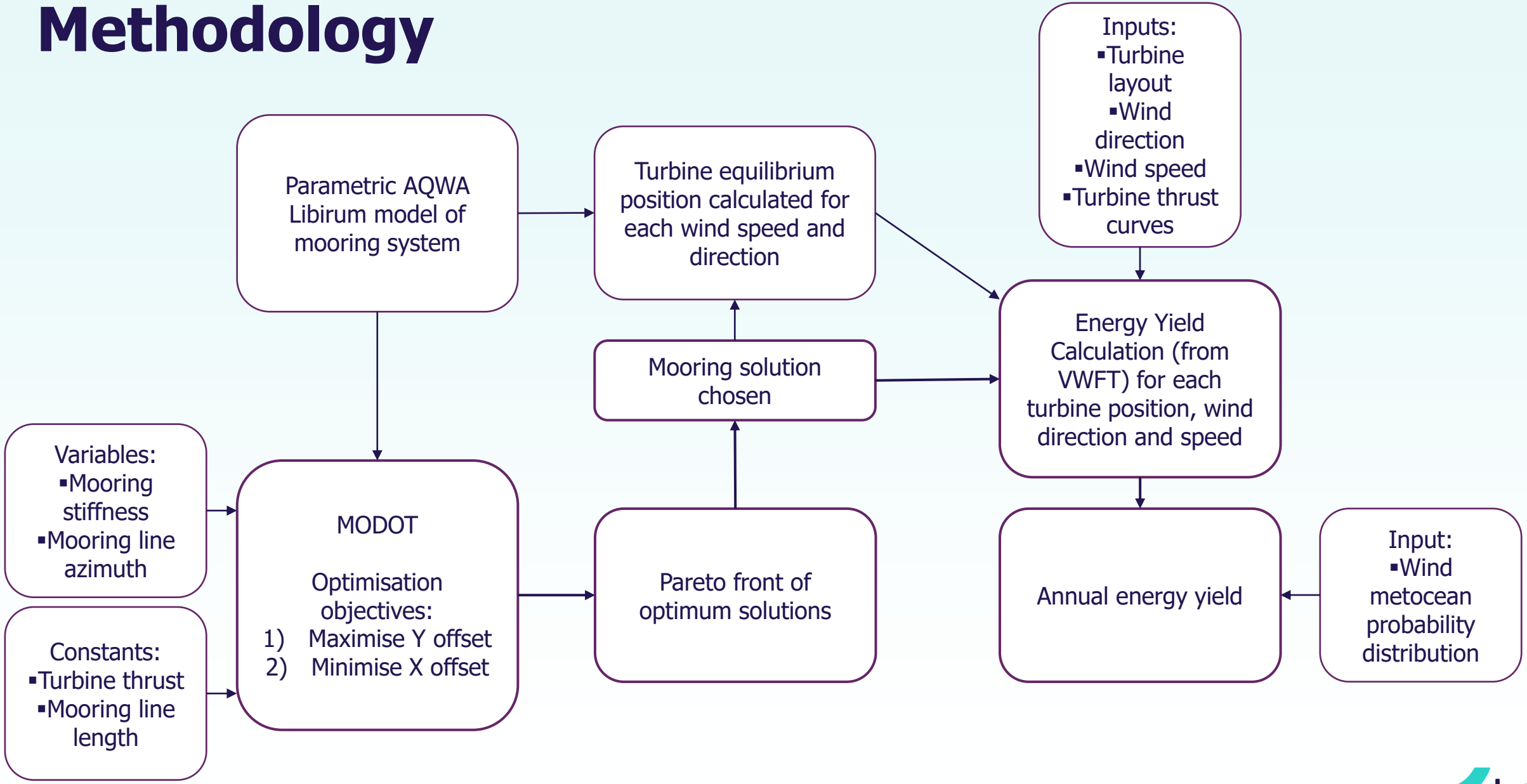
Methodology



About the solution

- Uses well proven existing mooring systems
- Allows asymmetry of mooring lines, unlike traditional systems
- Makes use of different line stiffnesses, lengths and azimuth angles
- Jensen Park Wake Model
- Kent’s in-house MODOT and VWFT
- Passive system based on setting each mooring line tension individually

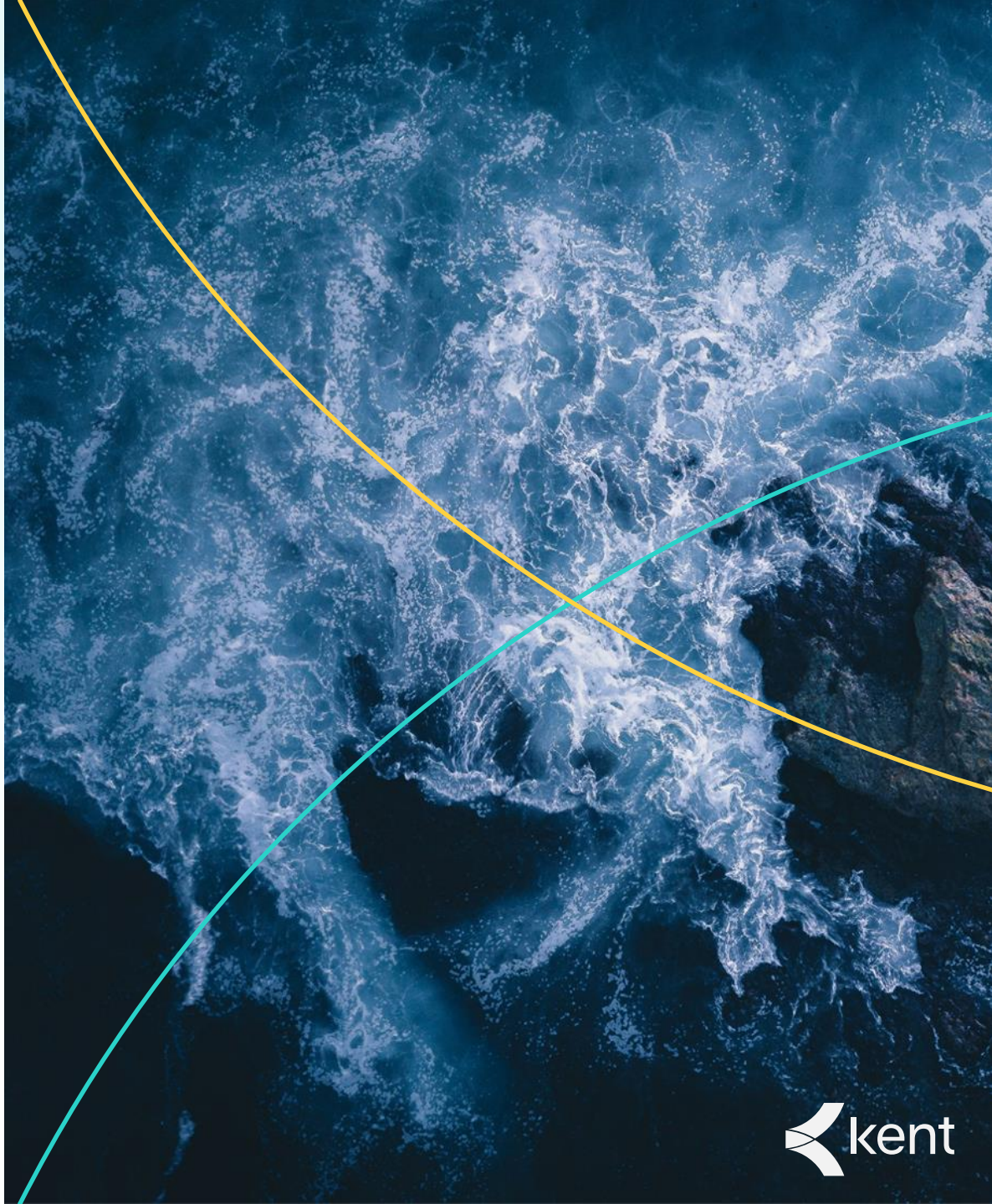


Photo By: Bel Air Aviation – Helicopter Services

Jensen Wake Model

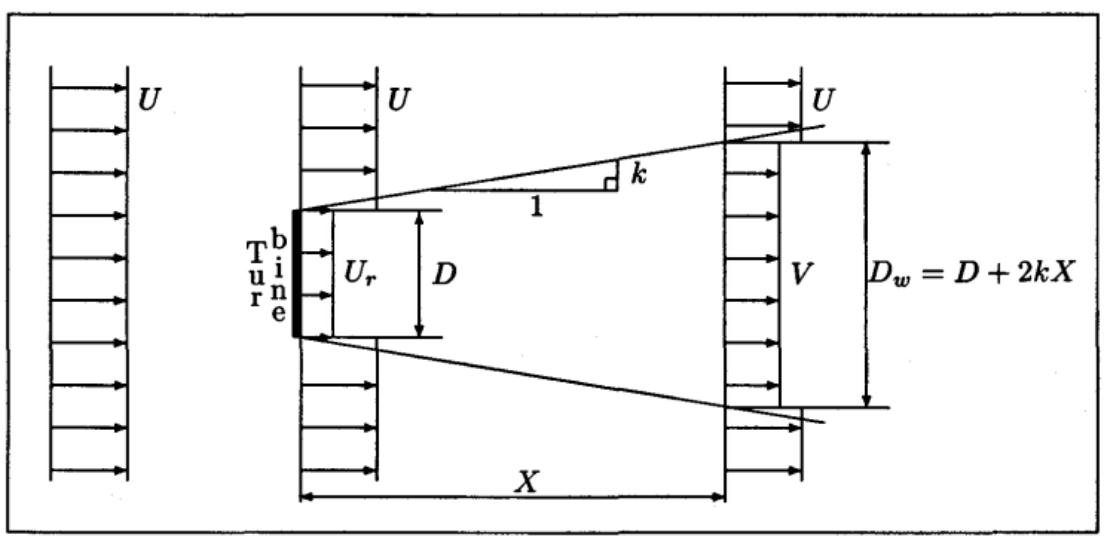


Figure 1. Flow field used by the program to calculate wind turbine output.

The reduced wind speed is calculated by the formula:

$$V = U\left[1 - \left(1 - \sqrt{1 - C_t}\right)\left(\frac{D}{D + 2kX}\right)^2\right]$$

where $\sqrt{1 - C_t} = U_r/U$, V is the wind speed in the wake, U the undisturbed wind speed, C_t the turbine thrust coefficient, D the rotor diameter, X the axial distance from the rotor to the point for the calculation, and k is the wake decay constant.

Ref: PARK- User's Guide. A PC-program for calculation of wind turbine park performance, Peter Sanderhoff

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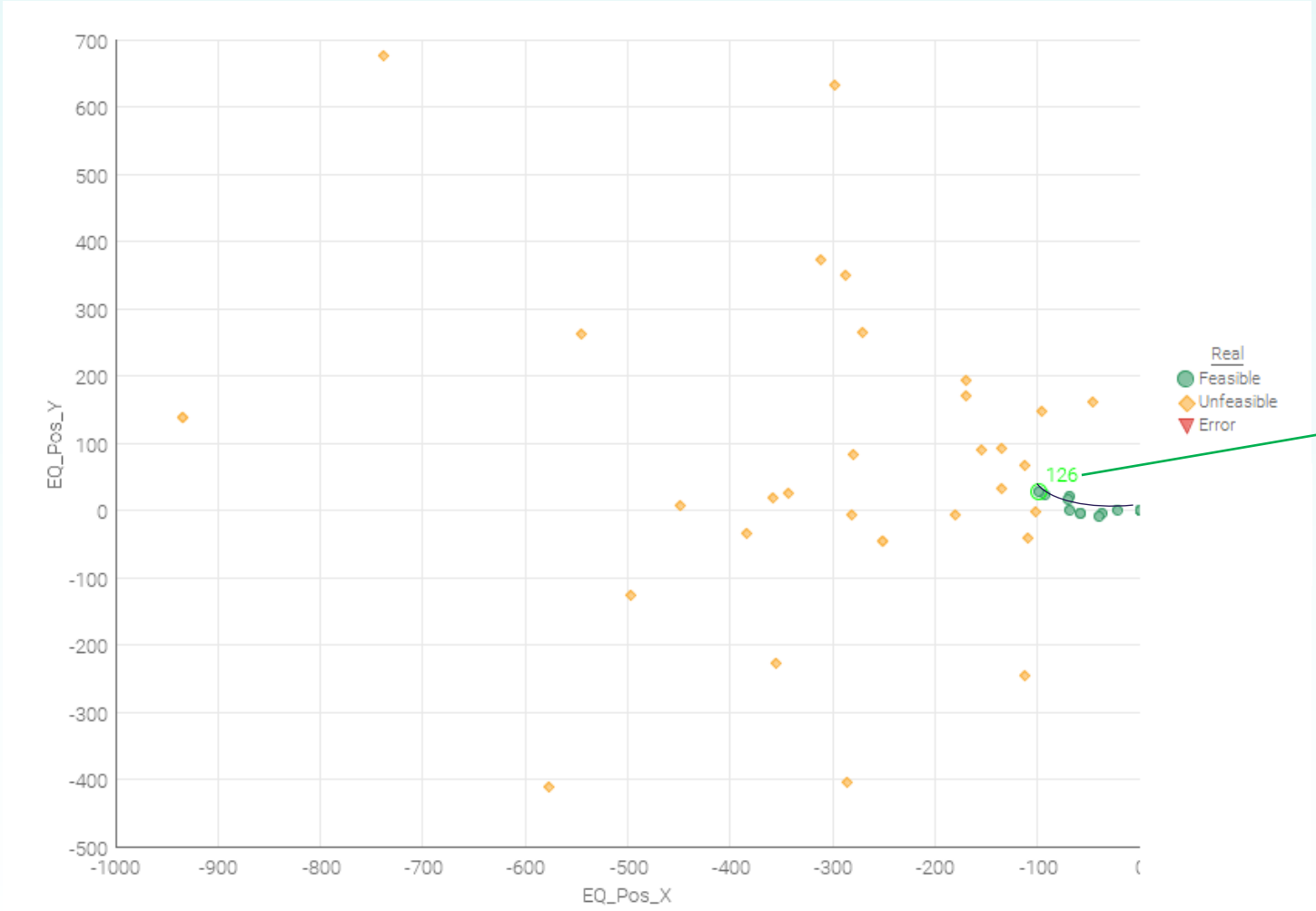
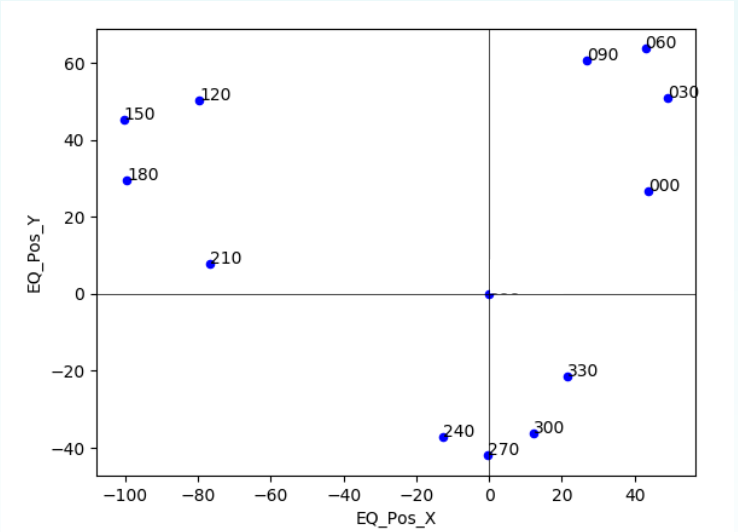
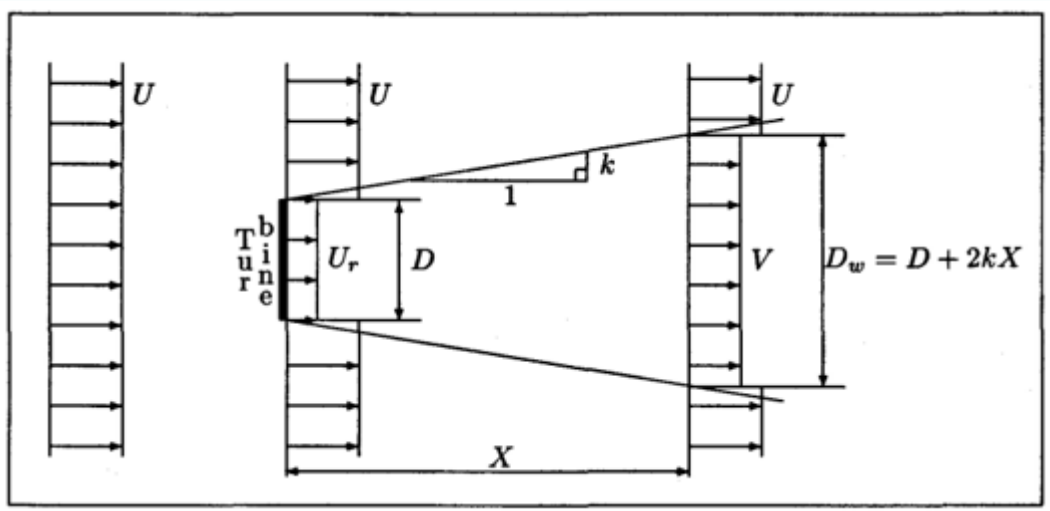
The Solution

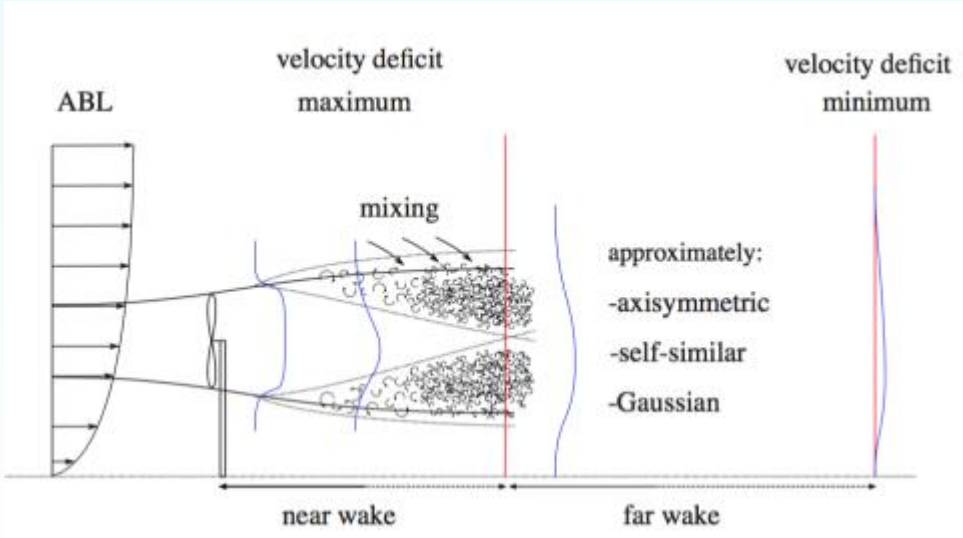




Energy Yield: Addressing the Limitations



Jensen Wake Model



Wake Case Schematic. Source: Sanderse 2009

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Conclusions

1. MODOT effectively and quickly identified asymmetric mooring solutions
2. In 200m of water depth, the simple model could cause 30m of offset
3. Jensen Wake Model would require turbines to move more than ~1 x diameter apart. In 200m of water depth, this is unfeasible
4. To see benefit from this study, a more complex wake model is required

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Future Work

01

Current calculation optimises only for the rated wind speed. Include all wind speeds in optimisation.

02

Optimise mooring orientations of each turbine individually. Then, optimise turbine array layout and mooring orientation simultaneously.

03

Integrate wake steering methodologies with the asymmetric mooring optimisation for maximum benefit.

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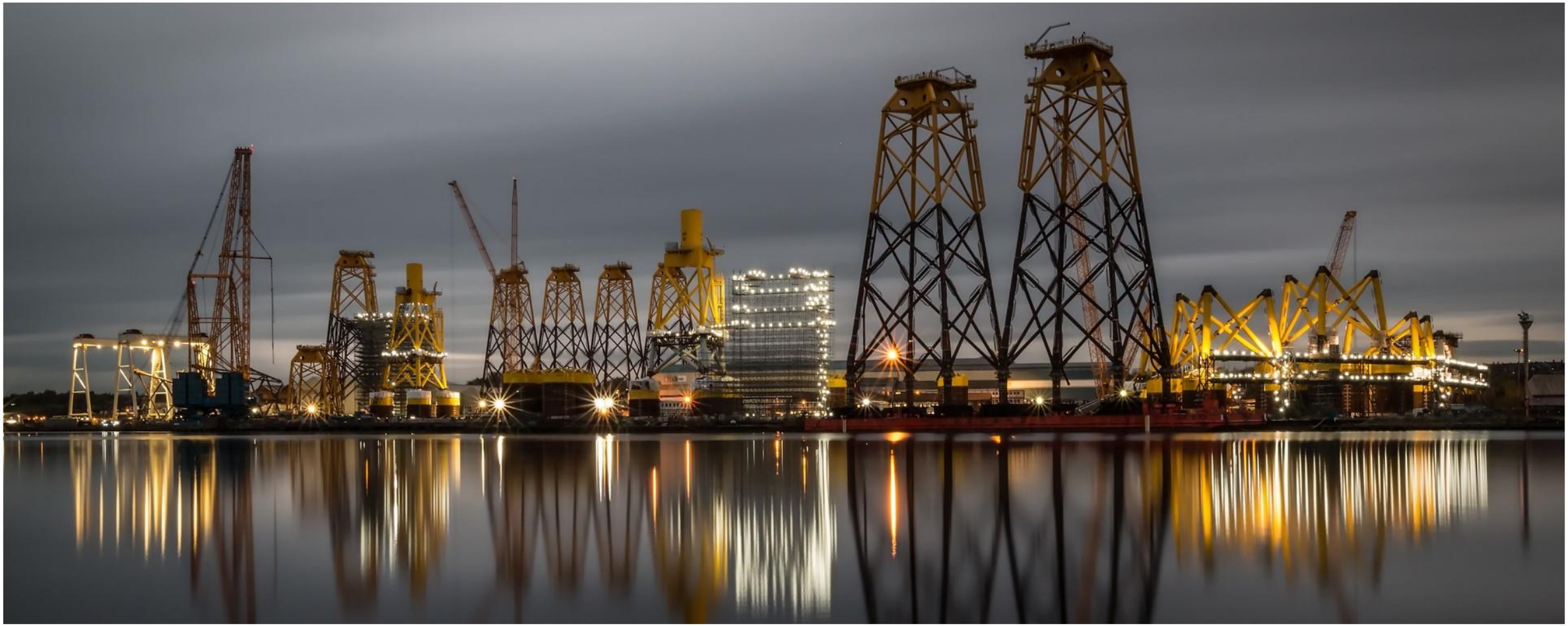
Thank you



Q&A

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If you’d like to find out more visit: www.kentplc.com