# AIOIJS Artificial Intelligence + Aeolus

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### The Growth is Astonishing



IMAGE CREDIT: © PERFECT SENSE ENERGY

## Key Challenges Hindering Wind Energy's Full Potential

- Tech gaps across wind asset lifecycle— particularly in operational efficiency.
- Traditional methods struggle with the surging system complexity.







## Key Challenges Hindering Wind Energy's Full Potential

- Many elements in the full management system to improve performance.
- For example: Wake effects can significantly cut annual energy production (AEP)



### AIOLUS – To reshape wind energy via cutting-edge AI



#### 5% increase in AEP (annual power production)



Equivalent to 1,600MW of 'free / virtual' wind farms for the UK, based on its current 32GW fleet.



A value-add of **£3.2B** (assuming **£2m/MW**), **£9B** by 2030



Annual reduction of 2 million tons of CO<sub>2</sub> emissions based on current energy capacity.

## Intelligent wind farm control

Al-based, data-powered
Improved efficiency
More resilient and reliable

#### Next-Gen Wind Farm Modelling & Sim Tools • AI + CFD

Ultra fast and accurate

#### Intelligent wind farm control

AI-based, data-powered
Improved efficiency
More resilient and reliable

#### Al-Powered

Control enhancement Perception and awareness Physics + Al

#### Validations

High-fidelity simulations Wind tunnel experiments

Field tests

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### **Control – Core of AIOLUS**

- Europe's first AI-driven wind farm control.
- Reinforcement learning + advanced controls (robust, adaptive), graph theory, explainable AI.
- It is like a Sports Coach to teach the turbines how to play the wind farm game better.



• Reinforcement Learning (RL) learns to make decisions without needing a full model of the environment — shifting from white-box control to black-box learning.



• It enables agents to learn optimal behavior through trial and error in dynamic environments.



# Advancements of Deep Reinforcement Learning (DRL). AlphaGo and AlphaGo Zero







## Advancements of Deep Reinforcement Learning (DRL). ChatGPT



• Intelligent Wind Farm Control via Deep Reinforcement Learning.







## **Some Results**

- AI-powered, data-driven
- >10% in power generation increase
- Strong scalability, adaptability and robustness



H Dong and X Zhao, Reinforcement Learning-Based Wind Farm Control: Towards Large Farm Applications via Automatic Grouping and Transfer Learning, IEEE Transactions on Industrial Informatics, 2023.

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J Xie, H Dong, X Zhao, A Karcanias, Wind Farm Power Generation Control Via Double-Network-Based Deep Reinforcement Learning, IEEE Transactions on Industrial Informatics, 18, 2022. H Dong, J Xie and X Zhao, Wind Farm Control Technologies: From classical control to reinforcement learning. Progress in Energy, 4, 2022.

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Field test scheduled at C-Power Wind Farm. A working prototype has been demonstrated in our simulator.

