

DTU Wind Energy

Nicolaos A. Cutululis Energy Islands – a Mars mission for the energy system



The Energy Islands

A Mars Mission for the Energy system

AALBORG UNIVERSITET ini

Contributors

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Energy islands – the concept



Energy islands are:

- hubs that connect *multiple* offshore wind power plants to the power grid...
- using *multiple* HVDC converters from *different* vendors.
- they may also host storage and power-to-gas conversion units.

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Why do we need energy islands?



The Energy Islands – A Mars mission for the Danish Energy system?

Let us look at the facts



Wind today



Cumulative installations



Zaporizhzhia nuclear power plant – 5.7 GW

Wind on energy islands



Offshore wind capacity



• Baltic Sea – on the existing island of Bornholm

North Sea – app. 80 km from the west coast of Denmark

North Sea Energy Island – 10 GW



An electron metropolis





An electron metropolis





Challenges

- How to design the electrical systems of offshore energy islands
 - Deliver stable & reliable power...and be resilient
 - Adequate simulation models
 - Topology & technology choices

The unknown unknowns...

• How to operate offshore energy islands

- Multi-terminal, multi-vendor HVDC (...and multi-owner construction) that will gradually expand over time
- Low probability high impact: low inertia system stability, weather, cybersecurity

Challenges

• How to expand offshore energy islands

built for 3 GW now, and expand to 10 GW or beyond

- Electrical infrastructure needs to be modular, scalable & robust
- Interoperability now and in the future
- Converter technology software & hardware technology likely to be different in 2030

• How to integrate operate offshore energy islands

- Coordination between markets including a market for electricity & hydrogen
- Balancing of supply-demand
- Electrification & power-to-X

Opportunities

- Discussion in the broader stakeholder community
- **Communicate** green transition to the public

- **Extreme** version of a de-carbonized power system:
 - Resilience & reliability
 - Interoperability & modularity





Opportunities

- Learn and build capacity!
- Education! Education! Engineers, technicians, regulators, and business people
- **Research** and **demonstration** both at lab scale and in demonstration projects





Opportunities

- Leadership in the green energy transition
- Lead the way and assist other countries leapfrog the **development**
- Danish competitiveness and exports







Energy islands offer a unique opportunity

For **companies** to develop **innovation** technologies and services

For **politicians**, **regulators** and **TSOs** to develop the **framework** required to run the energy islands

for **universities** and **research organizations** to **R&D** new solutions, **educate** the engineers to implement them and **share knowledge** with the world to advance the green transition around



Join the discussion!

1st Energy Islands – a Mars mission for the energy system

"The key challenge with the North Sea Energy Island is basically everything"

Mads Krogh from Danish Energy Agency

Download white paper:

- English
- Danish

Webinar Recording





#2 webinar: Energy islands as test infrastructure for tomorrows' energy system	#3 webinar: Global cooperation and potential for green growth
27. October 2021, 14:30-16:00	30. November, 13:00-14:30
Keynote speakers	
Christian Frank Flytkjær, Senior Manager, Grid Analysis, Energinet - Energy islands, the mission and its technical challenges	<u>Frede Blaabjerg, Professor AUU Energy</u> - International cooperation on transforming the power system
Jacob Østergaard, Professor, Head of Center for Electric Power and Energy, DTU Electrical Engineering Energy - Islands as production and test facility	Barbara O'Neill, Researcher, National Renewable energy Laboratory (NREL) - Global cooperation and G-PST
Discussion	
Moderator <i>: Kristine van het Erve Grunnet</i> , Managing Director Renewables, Danish Energy	Moderator: Birte Holst Jørgensen, DTU Wind Energy
Panel	
Troels Stybe Sørensen, Senior Director, Ørsted	Peter Marcussen, Director, Energinet
Adrian Timbus, Head of Portfolio, Hitachi ABB Power Grids	Anton Beck, Director Global Cooperation, Danish Energy Agency
Christian Frank Flytkjær, Senior Manager, Energinet	Susanne Pedersen, Director, UNEP DTU Partnership
Nicolaos A. Cutululis, Professor, DTU Wind Energy	Barbara O'Neill, Researcher, NREL
Registration	Registration

