Planning an offshore energy infrastructure that supports the decarbonization of the European energy system.

How can technologically and spatially explicit energy modeling contribute?

Modeler's Exchange Workshop

Jann Launer

Brussels, 25.04.2024

JUST WiND 4 ALL

TU Delft

Funded by the European Union

Planning offshore energy infrastructure

Goal: Rapidly decrease GHG-emissions and reduce dependency on fossil fuels.

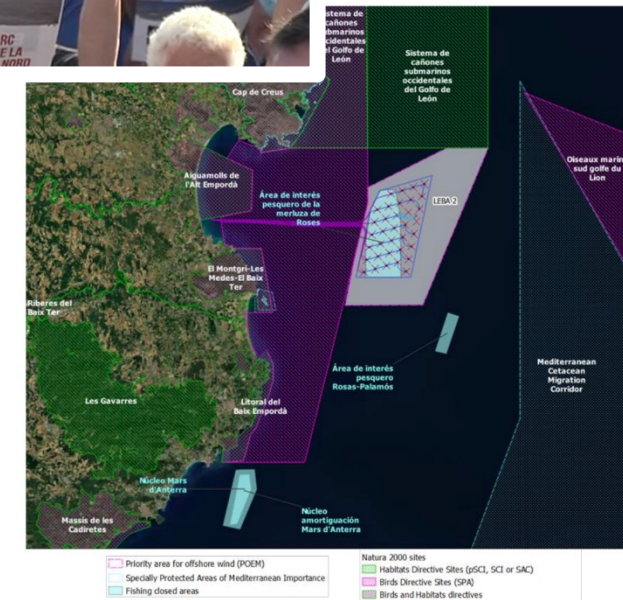Large-scale offshore wind energy capacity expansion

Challenges

- Grid integration and system design

- Environmental and landscape impact

- Many stakeholders with different interests

How to do effective planning in such a situation?

How can we find feasible system designs that offer benefits to all stakeholders?
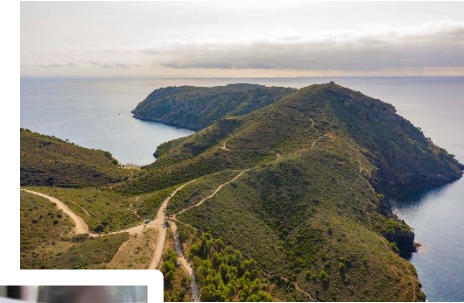
Diez-Caballero et al. "Environmental Compatibility of the Parc Tramuntana Offshore Wind Project in Relation to Marine Ecosystems." *Journal of Marine Science and Engineering* 10, no. 7 (June 29, 2022): 898.

How to do effective planning?

- Many actors

- Incomplete, contradictory, changing requirements

- No agreement on system boundary, data, method.

A wicked problem [1]?

[1] Rittel, Horst W J. 1973. "Dilemmas in a General Theory of Planning," Policy Sciences, 4: 155–69.
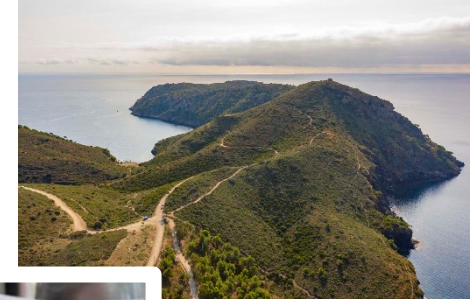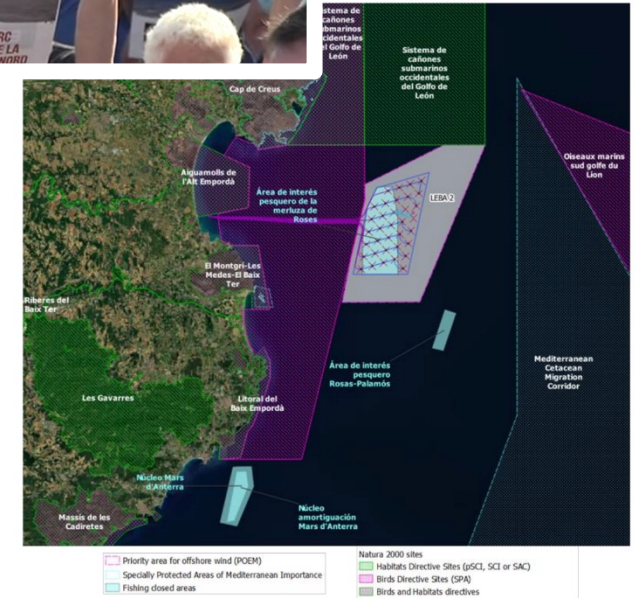
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Planning processes

EU targets
- Periodical updates
- Scope: Emission reduction, capacity targets

TYNDP
- Every 2 years
- Scope: Next 10-20 years of transmission grid extension
- Stakeholder input
- Result: Report, scenarios, system needs, cost-benefit analysis of every project, projects of common interest

ONDP
- 1st release 2024
- Scope: Offshore electricity grid needs
- Input
- Result: Reports

NGO-led recommendations and scenarios

Energy modeling in academia
- Publications/project cycle
- Scope: Variety of scopes, integration of technologies, sectors and non-technical perspectives.
- Input: Academic literature, reports, policy documents, open data
- Result: Papers/reports, modeling tools, data

National energy scenarios and targets
- Periodical updates
- Emission reduction, capacity targets, coal phase-out etc.
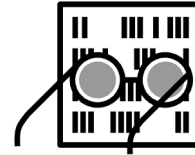
MSP processes (national)
- Periodical updates
- Scope: Space use of EEZ
- Stakeholder input
- Result: MSP
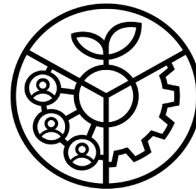
Diversity of **focus** and **scale**

4

How can energy system modeling contribute?

Large scale ESOM lack local detail, regional ESOM lack context and diversity.

Limited resolution of heterogeneity

Societal and environmental aspects are underrepresented
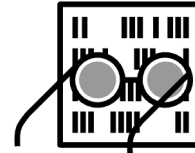
Research gaps

How can energy system modeling contribute?

Energy modeling in academia (my PhD project)

Resolve energy system design at local scale.

Reveal impacts and benefits of alternative techno-economically feasible system designs.

Broaden the scope: Integrate or couple to socio-environmental research.

Large scale ESOM lack local detail, regional ESOM lack context and diversity.

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JustWind4All

Need for and viability of current and novel wind power technologies in Europe, given the evolution of the overall energy system.

✓ Increase technical and spatial detail

❑ Method to compare system-cost optimizing and local benefit maximizing system designs

❑ European wind deployment scenarios and maps

JustWind4All

Revisit offshore area potential,

Distinguish areas for conventional and floating offshore.

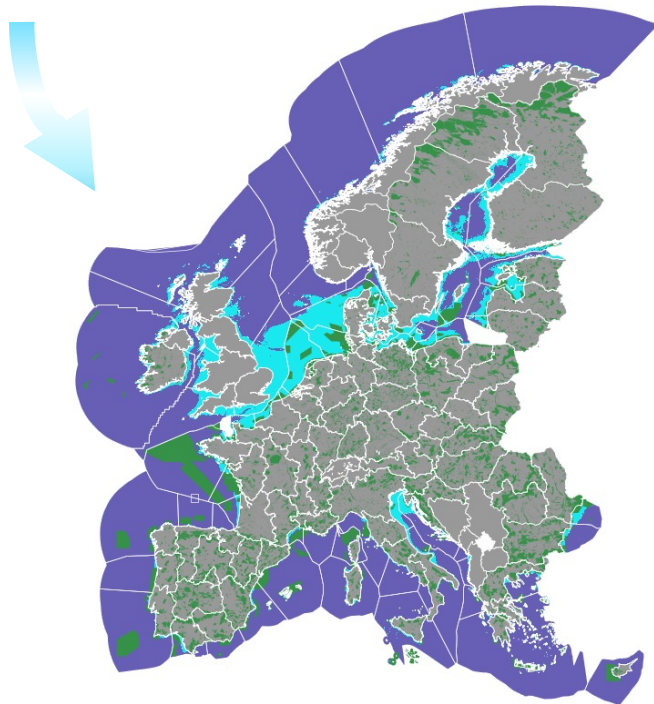Wind resource assessment: Capacity factors for Airborne wind energy.
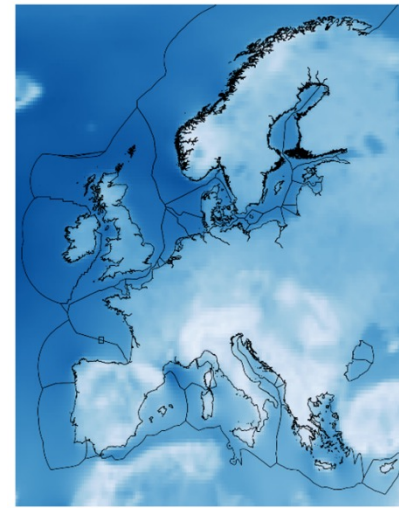
Conventional wind energy: Average wind speed at 100m height.
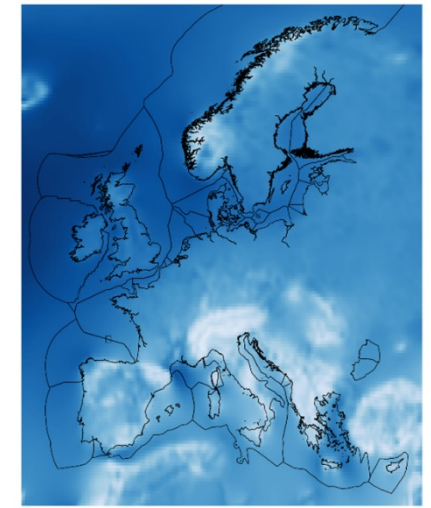
Airborne wind energy: Average wind speed at 334m height.

First diagnostic model runs

JustWind4All project deliverable: Europe-wide energy system scenarios for wind deployment areas

https://justwind4all.eu/
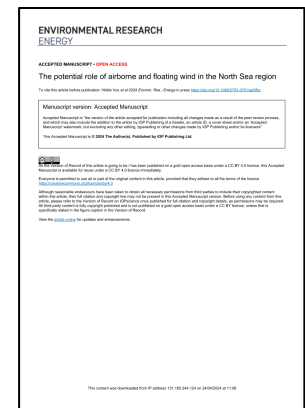
Vos, Hidde, Francesco Lombardi, Rishikesh Joshi, Roland Schmehl, and Stefan Pfenninger. 2024. "The Potential Role of Airborne and Floating Wind in the North Sea Region." *Environmental Research: Energy*, April. https://doi.org/10.1088/2753-3751/ad3fbc.

Next steps: Downscaling methods

How can energy system model scenarios be meaningfully downscaled to assess local benefits?

Goals

- Present methods to increase spatial resolution of energy system models despite computational limits [2,3,4] towards the scale relevant for local actors.

- Compare cost-optimal with designs that optimize local benefits.

[2] Bogdanov, Dmitrii, Ayobami Solomon Oyewo, and Christian Breyer. 2023. "Hierarchical Approach to Energy System Modelling: Complexity Reduction with Minor Changes in Results." *Energy* 273 (June): 127213.

[3] Frysztacki, Martha Maria, Veit Hagenmeyer, and Tom Brown. 2023. "Inverse Methods: How Feasible Are Spatially Low-Resolved Capacity Expansion Modelling Results When Disaggregated at High Spatial Resolution?" *Energy* 281 (October): 128133.

[4] Reinert, C, T Söhler, N Baumgärtner, and A Bardow. 2020. "Optimization of Regionally Resolved Energy Systems by Spatial Aggregation and Disaggregation." In . Graz/Austria.
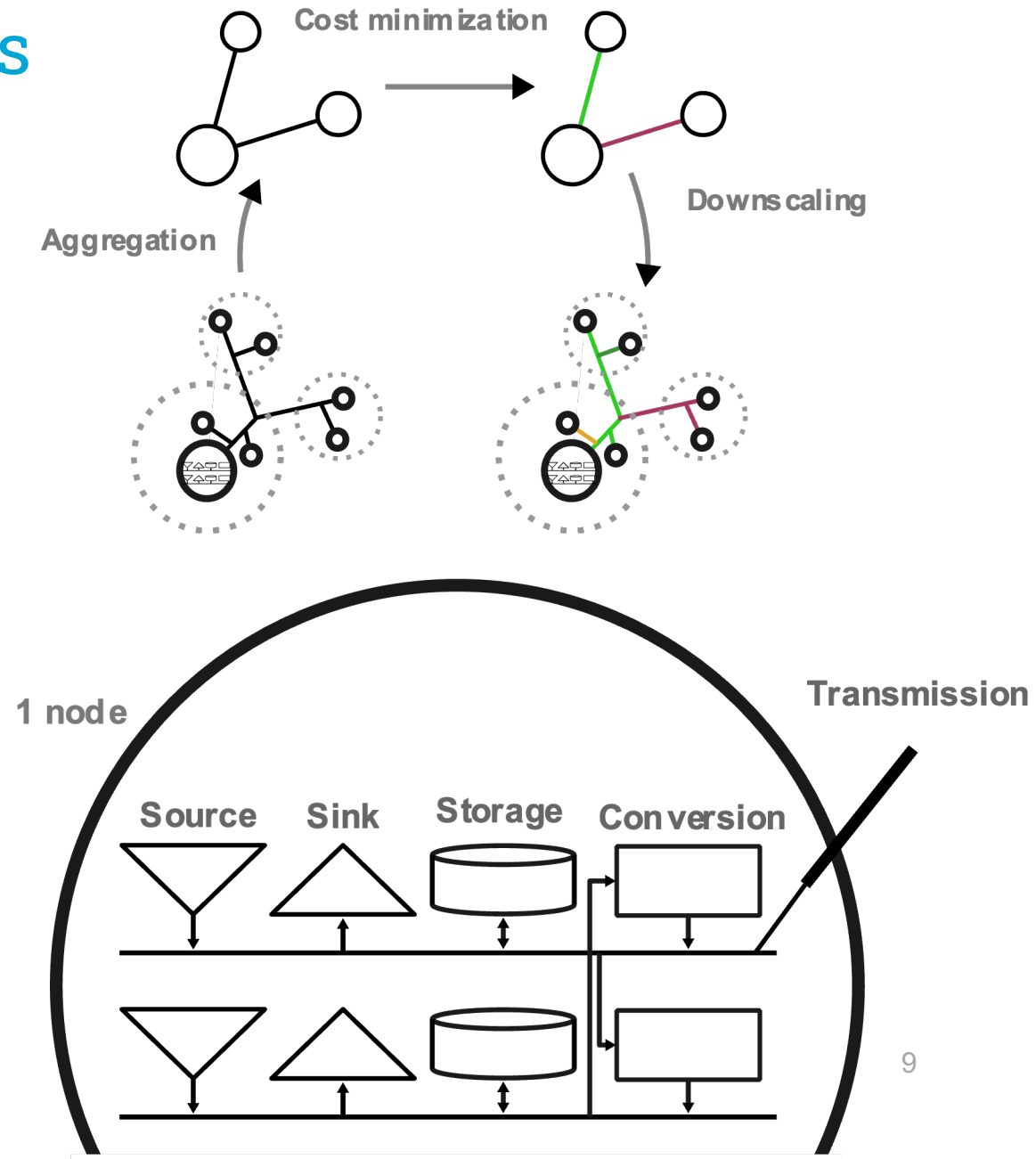
Interfaces to planning processes

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Research topics, assumptions

Assumptions & data

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Assumptions, data

Interfaces:
**Research topics
Assumptions
Data**

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Call to action

Modelers and planners, please

- **Report the requirements and assumptions of your design transparently.**
- **Publish high quality data (if possible, with an open license).**
- **Maintain clear data interfaces.**

Thank you!