Havvindmøller: Planlægning fra rummet

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Offshore Wind Farm Planning from Space

Satellite ocean wind products are used to assess the wind resource and estimate the potential electricity production worldwide for sustainable energy transition.

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A: Department of Wind Energy

The challenge

Offshore wind energy gives consumers green electricity. The challenge is to plan in an optimal way wind farms offshore in Europe, Asia and North America.

Offshore wind data is very limited. Satellites have global coverage. Radars on board satellites view the Earth in all weather conditions, day and night, and can provide maps of wind speed and wind direction.

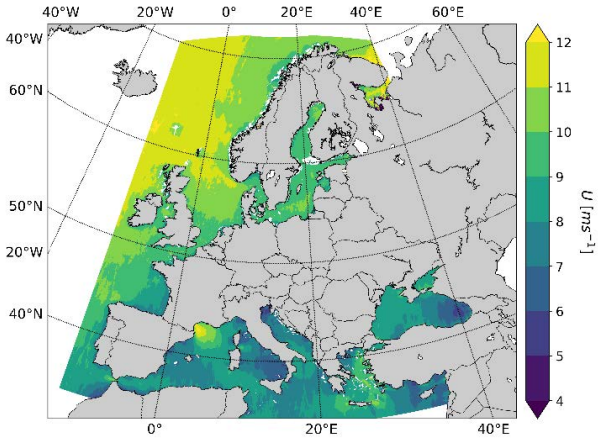
Satellite wind maps are treated in software to produce wind resource statistics. Wind resource data is key input in the planning phase of offshore wind farms to identify windy places suitable for wind turbines.

The expected energy production depends on the wind speed to the third power. In other words, it is necessary to know the wind as accurately as possible.

The space-based solution

The Copernicus Sentinel-1 satellites with Synthetic Aperture Radars on board are uniquely suited for very detailed wind speed mapping. It is possible to map the ocean winds at 1 km by 1 km resolution.

Offshore wind farms typically cover from 30 km^2 to more than 100 km^2. The land influences the winds offshore, and therefore the wind resource varies across each wind farm area. It is important to include such detail in the planning to estimate the production of each wind turbine.



European offshore wind atlas from Envisat ASAR and Sentinel-1 entire archives from 2002 to 2018. Mean wind speed at 100 m height. Source: DTU Wind Energy.

> **Satellite wind maps are giving us important insights into how much the wind speed varies over large areas and how the wind farms influence each other through wakes.**
>
> *Nicolai Gayle Nygaard, Ørsted*

Wind farm wake at Horns Rev 1 offshore wind farm in the Danish North Sea. Source: Vattenfall.

Radar images for Europe and selected other sites globally are received daily at DTU Wind Energy. The radar images are calibrated, and a wind retrieval algorithm is applied. The near-real-time wind maps are produced and offered free of charge. More than 200,000 scenes are available at the database https://satwinds.windenergy.dtu.dk/.

Benefits to citizens

The benefits to citizens of clean energy include:

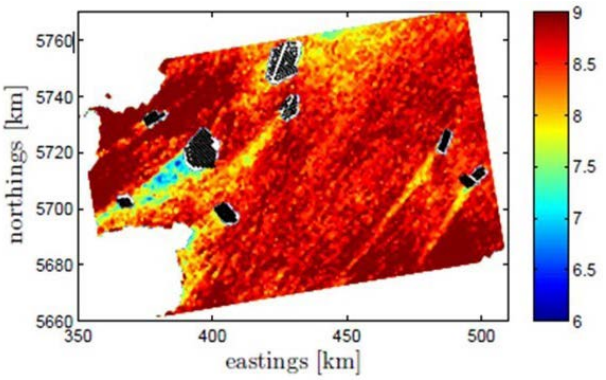
1. Firstly, offshore wind is an abundant resource.
2. Secondly, wind energy is sustainable energy with great potential to support United Nations Development Goal on Energy.
3. Thirdly, offshore wind energy is cost competitive.
4. Fourthly, high- and low-tech jobs are available within the offshore wind industry in coming years, often in less favorable regions giving better life conditions.

The benefit of clean energy from offshore wind turbines is a key driver for modern societies with need for electricity. Electricity at cost-competitive price and its secure delivery, from local to regional areas, are part of the green solution.

European world-leading knowledge is expected to introduce cost-competitive solutions worldwide based on Copernicus data within offshore wind energy.

Outlook to the future

Offshore wind energy is expected to deliver clean energy in the future energy system across the world. Satellite remote sensing will be used for planning and operations to optimize siting, production, operation and maintenance. Sentinel-1 of the Copernicus programme will be essential in coming years.



Wind farm wakes observed by satellite radar in Belgium and UK North Sea. The black colour indicates wind farms. Lower winds southwest of each wind farm are the wake (lee effect). The wind is blowing from the northeast. Wind speed in m/s.
Source: DTU Wind Energy.

Acknowledgements

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