Using publicly available power time series for re-analysis of offshore wind park energy yield

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Experienced professionals:

- **15 realised offshore wind farms** in DK, UK, DE, and numerous ongoing projects in these countries as well as CN, BE, NL, TW, USA.
- 14 years of experience in offshore wind from world leading offshore wind players.

Holistic perspective:

- Site conditions (Wind, Waves, Currents, Sea-Ice) and design basis certification.
- Wind resources, wind farm layout development, LCoE mapping.
- Turbine and foundation loads.
- Structural design and fabrication.

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Areas of Expertise

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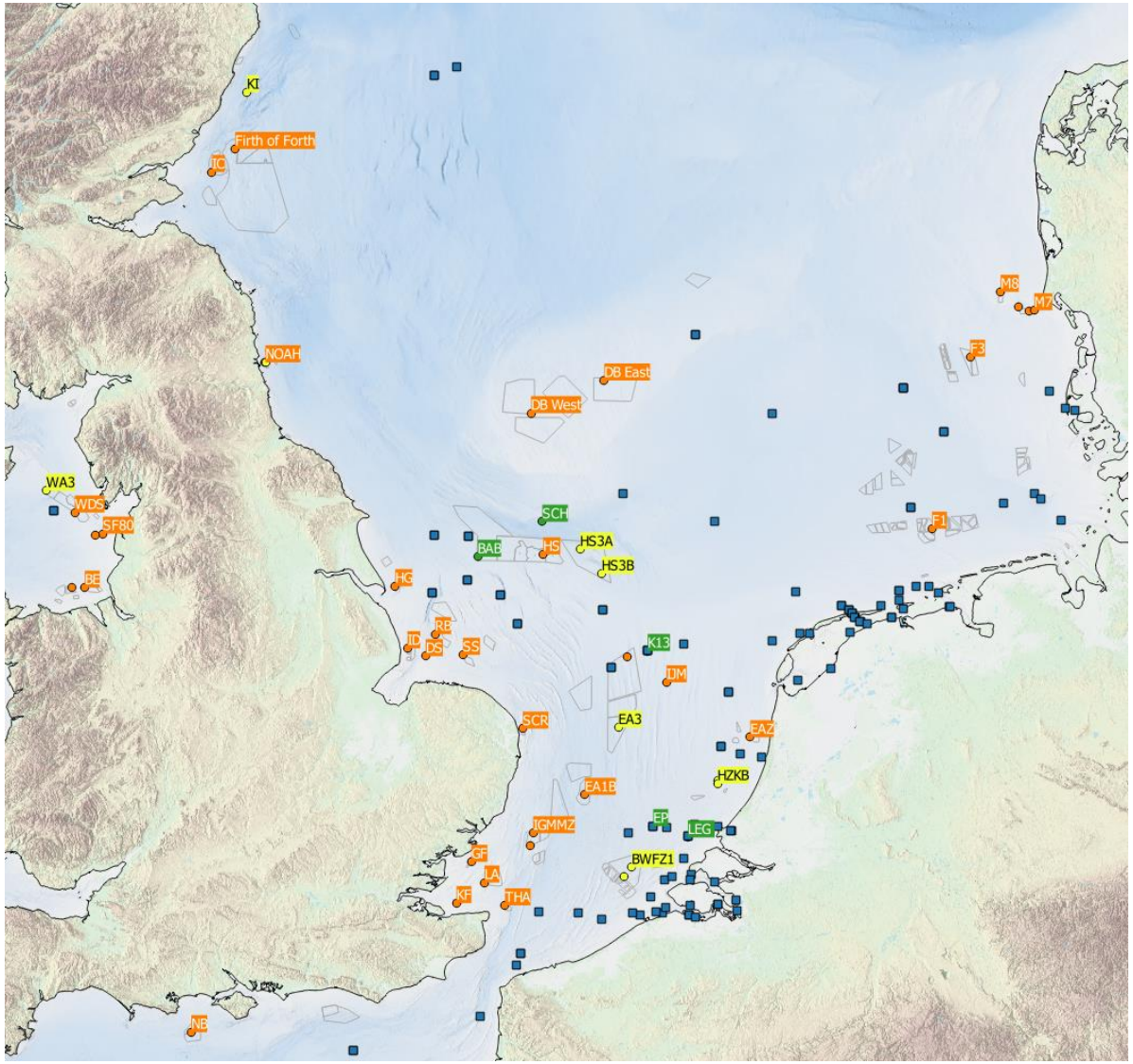
Wind measurements (used as primary basis for EPAs)



Legend: met masts (orange), floating LiDARs (yellow), weather stations (blue).
Where to find those locations (and not necessarily the data): Marine Data Exchange, Wind op Zee, Copernicus Marine Services, KNMI, FINO1-3, SEAFISH.

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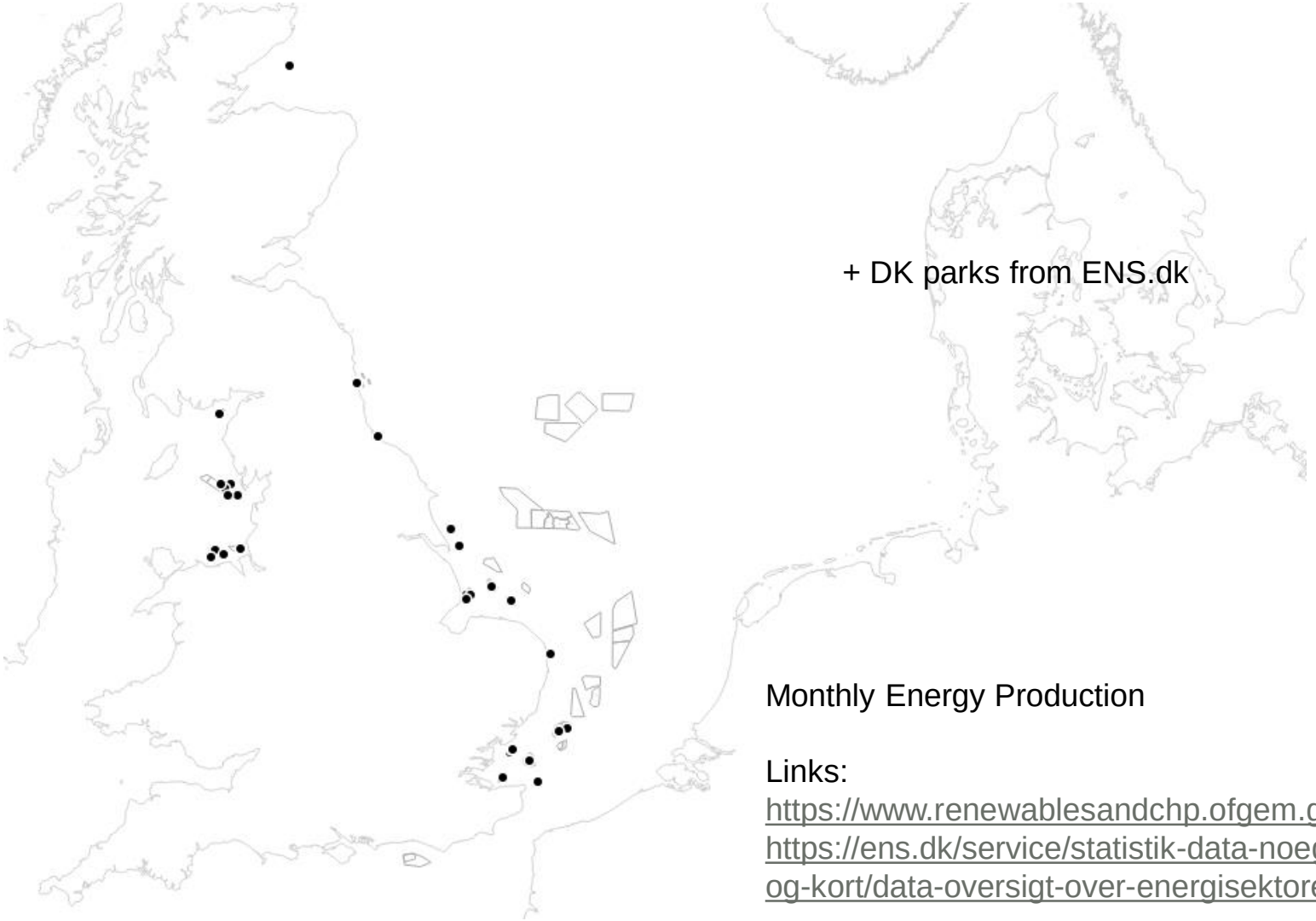
Office of Gas and Electricity Markets (OFGEM)



+ DK parks from ENS.dk

Monthly Energy Production

Links:
https://www.renewablesandchp.ofgem.gov.uk/
https://ens.dk/service/statistik-data-noegletal-og-kort/data-oversigt-over-energisektoren

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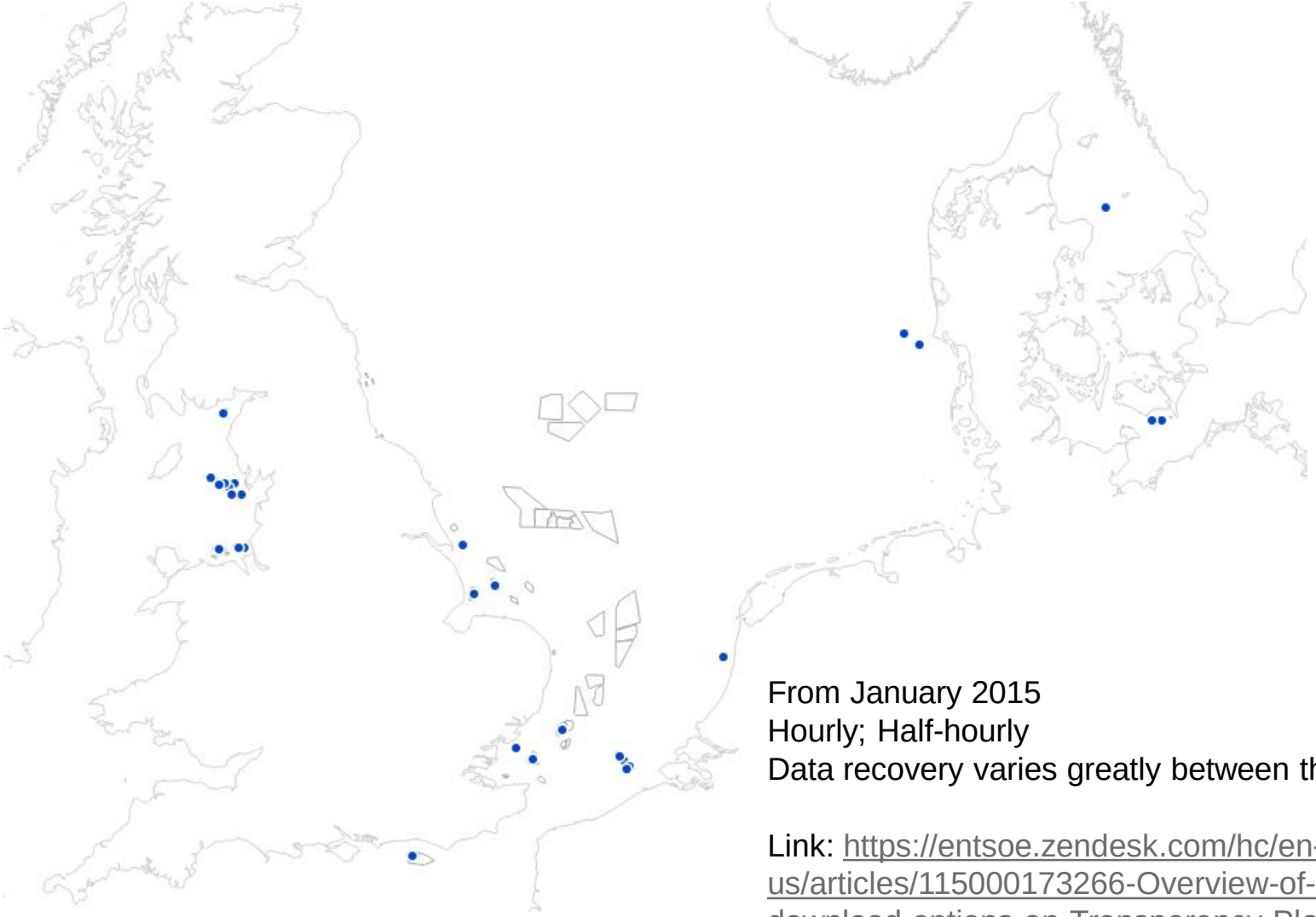
European Network of Transmission System Operators (ENTSO-E) wind farm production data



From January 2015
Hourly; Half-hourly
Data recovery varies greatly between the parks.

Link: https://entsoe.zendesk.com/hc/en-us/articles/115000173266-Overview-of-data-download-options-on-Transparency-Platform

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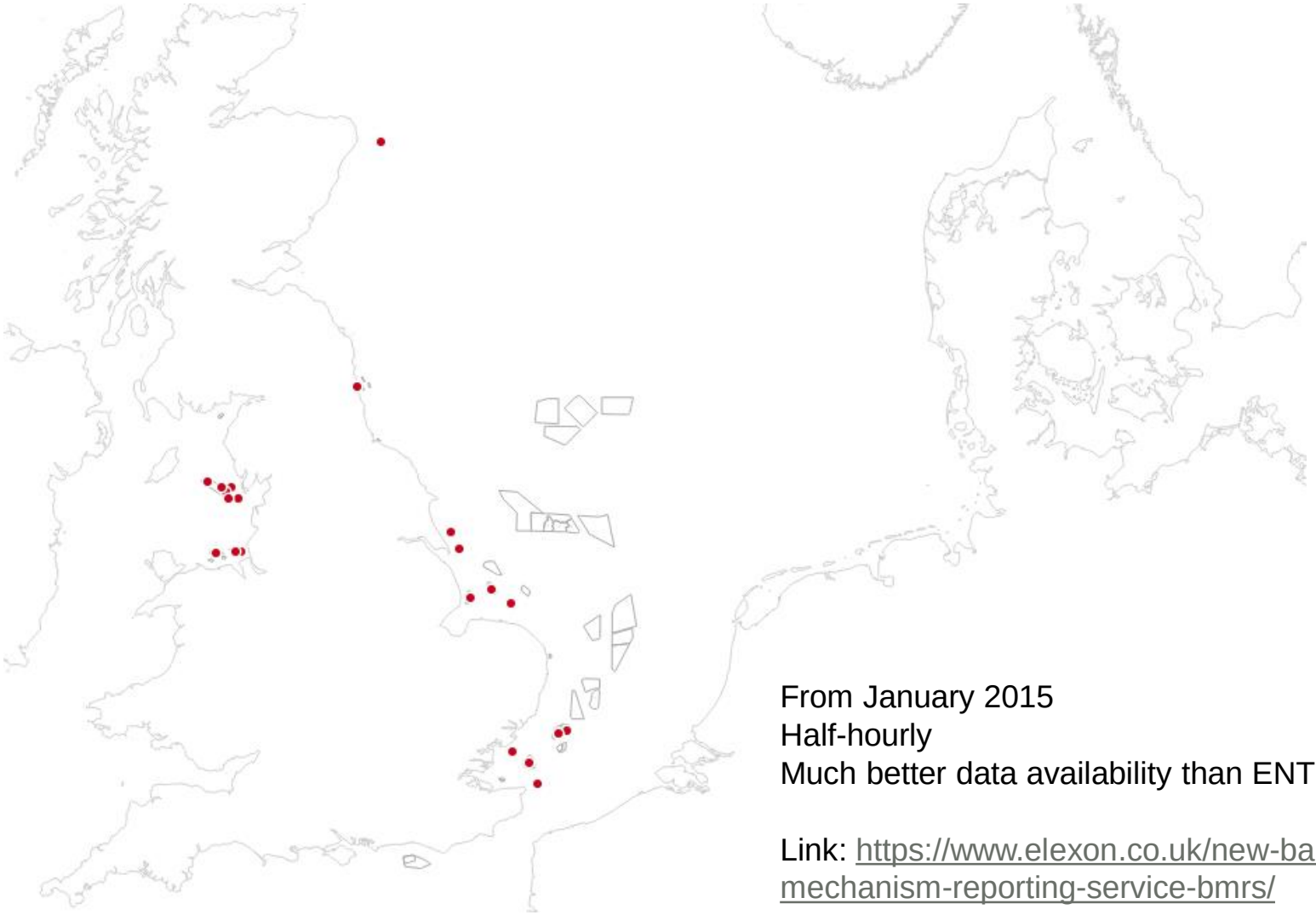
Balancing Mechanism Reporting Service (BMRS)



From January 2015
Half-hourly
Much better data availability than ENTSO-E

Link: https://www.elexon.co.uk/new-balancing-mechanism-reporting-service-bmrs/

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Measurement location: OSP(s) for every park ?

Example: London Array, two substations, 4 export cables.

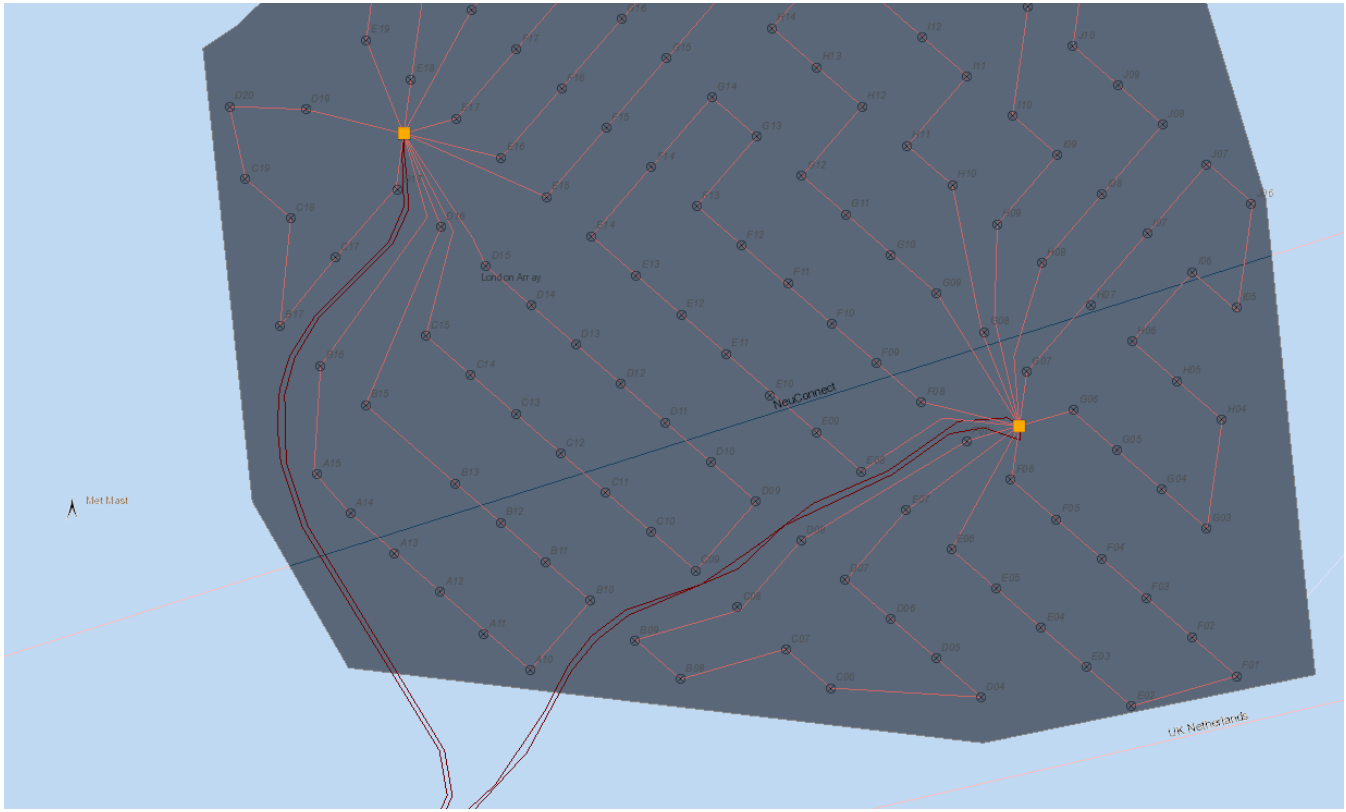
ENTSO-E

Wind Offshore	LARYO-1
Wind Offshore	LARYO-2
Wind Offshore	LARYO-3
Wind Offshore	LARYO-4

BMRS

- London_Array_BMU1
- London_Array_BMU2
- London_Array_BMU3
- London_Array_BMU4

https://www.elexon.co.uk/wp-content/uploads/2017/09/metering_offshore_wind_farms_v2.0.pdf



Source: 4C Offshore

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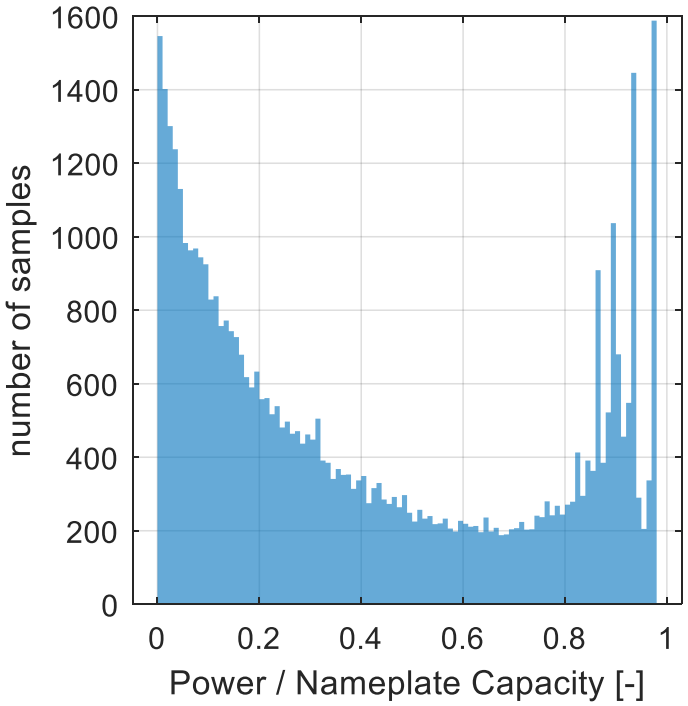
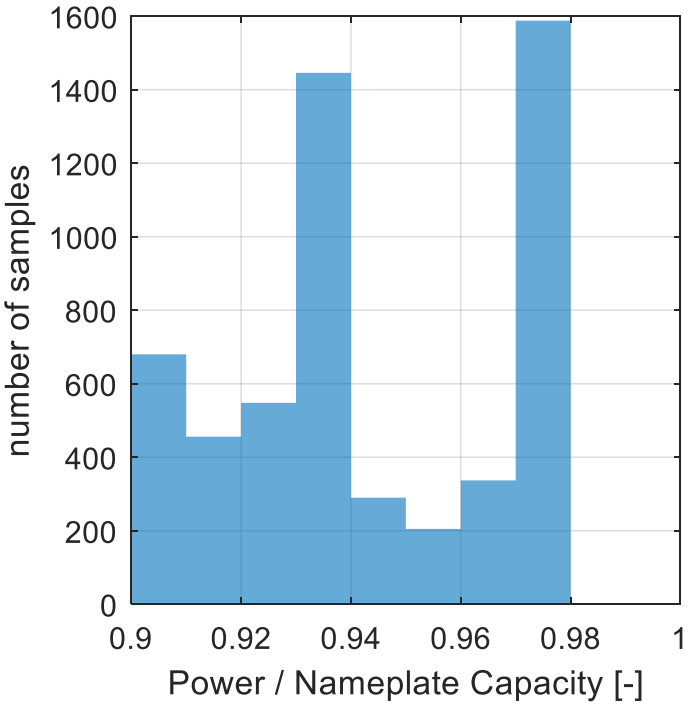
Electrical Losses and Curtailment

#BMRS #WhatToDoWithIt

Example: for this wind farm, many occurrences of curtailment that can be identified from the power values distribution. The electrical losses up to the metering point (at LV side of OSP ?) are about 2-3% at rated power.





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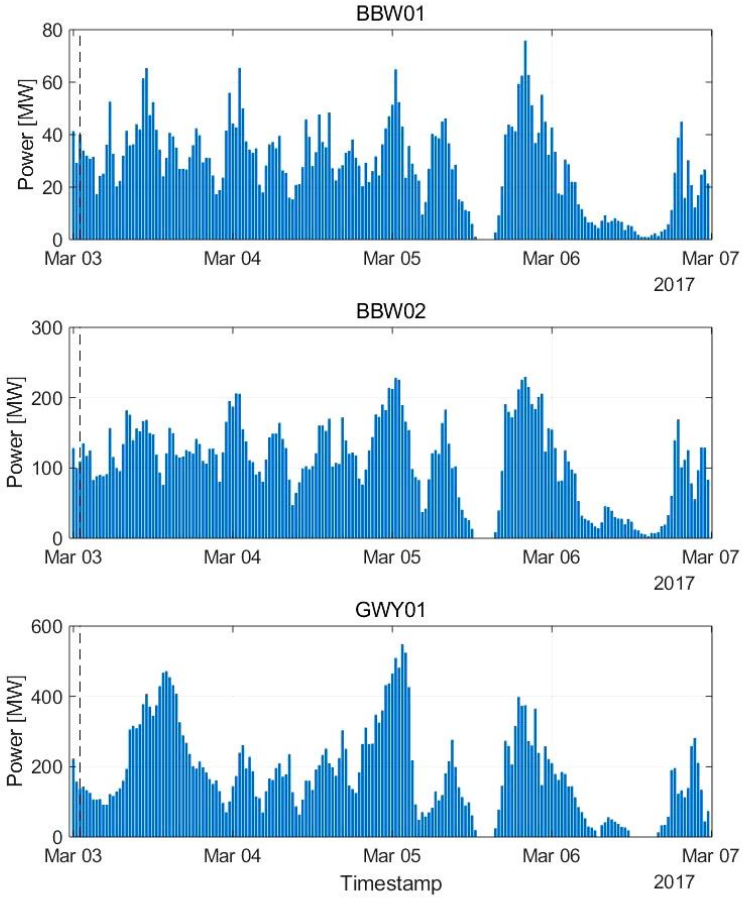
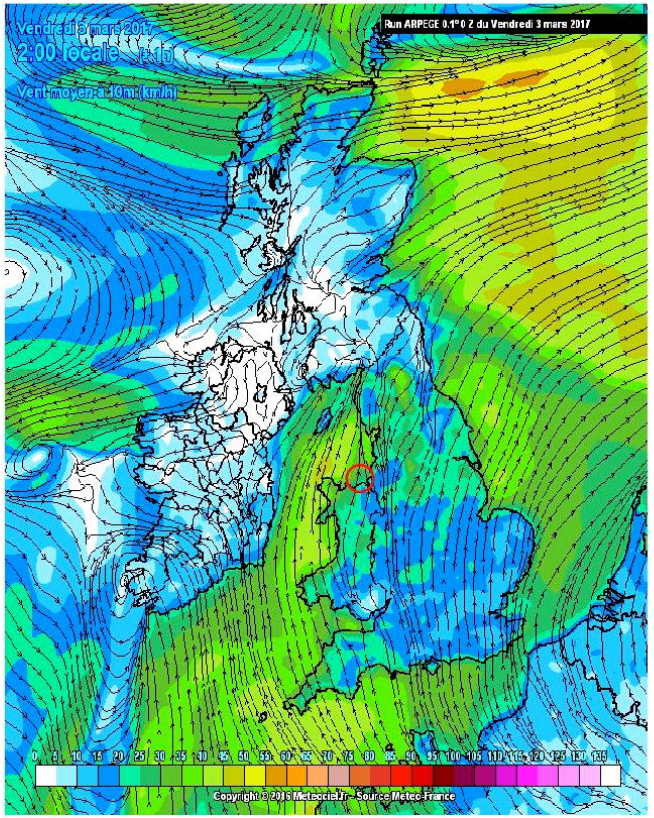
Variability

#BMRS #WhatToDoWithIt





Source: Meteociel ARPEGE

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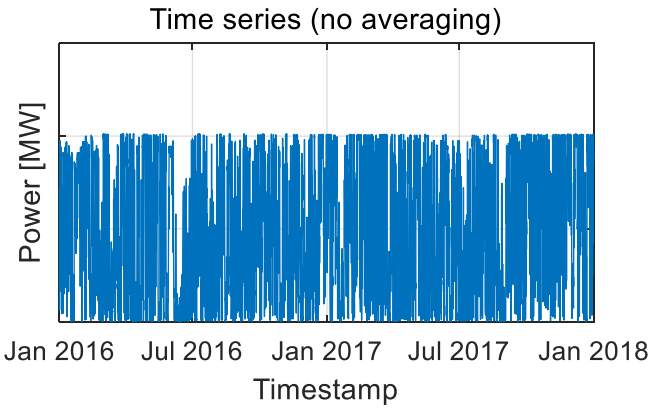
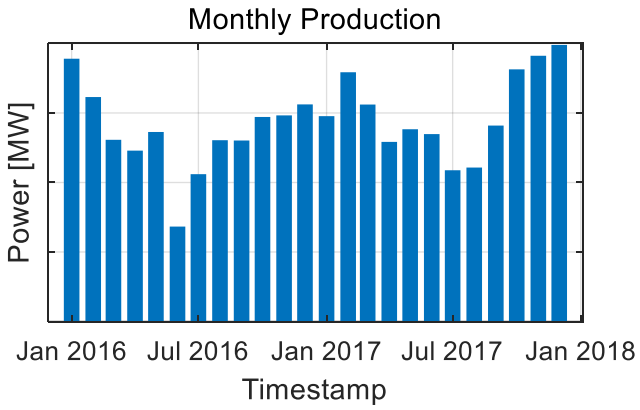
Production analysis

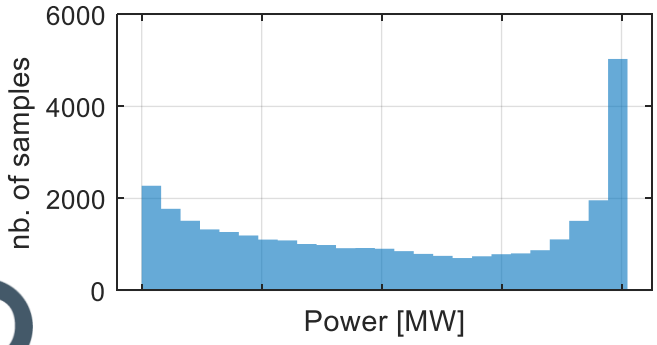
#BMRS #WhatToDoWithIt

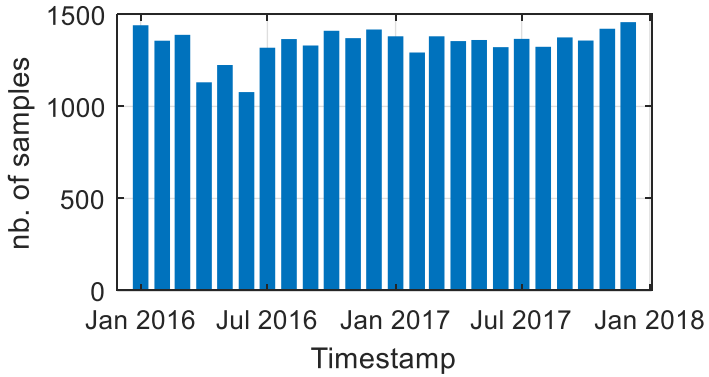
Since the BMRS database does not include all data points, the sum of all production values is not equal to the OFGEM values (plot not showed).

However, the time series are usually well populated (see year 2017 below). The value of this dataset resides in its granularity (30min), which allows to compare the pdf of the power time series with the “expected” one.









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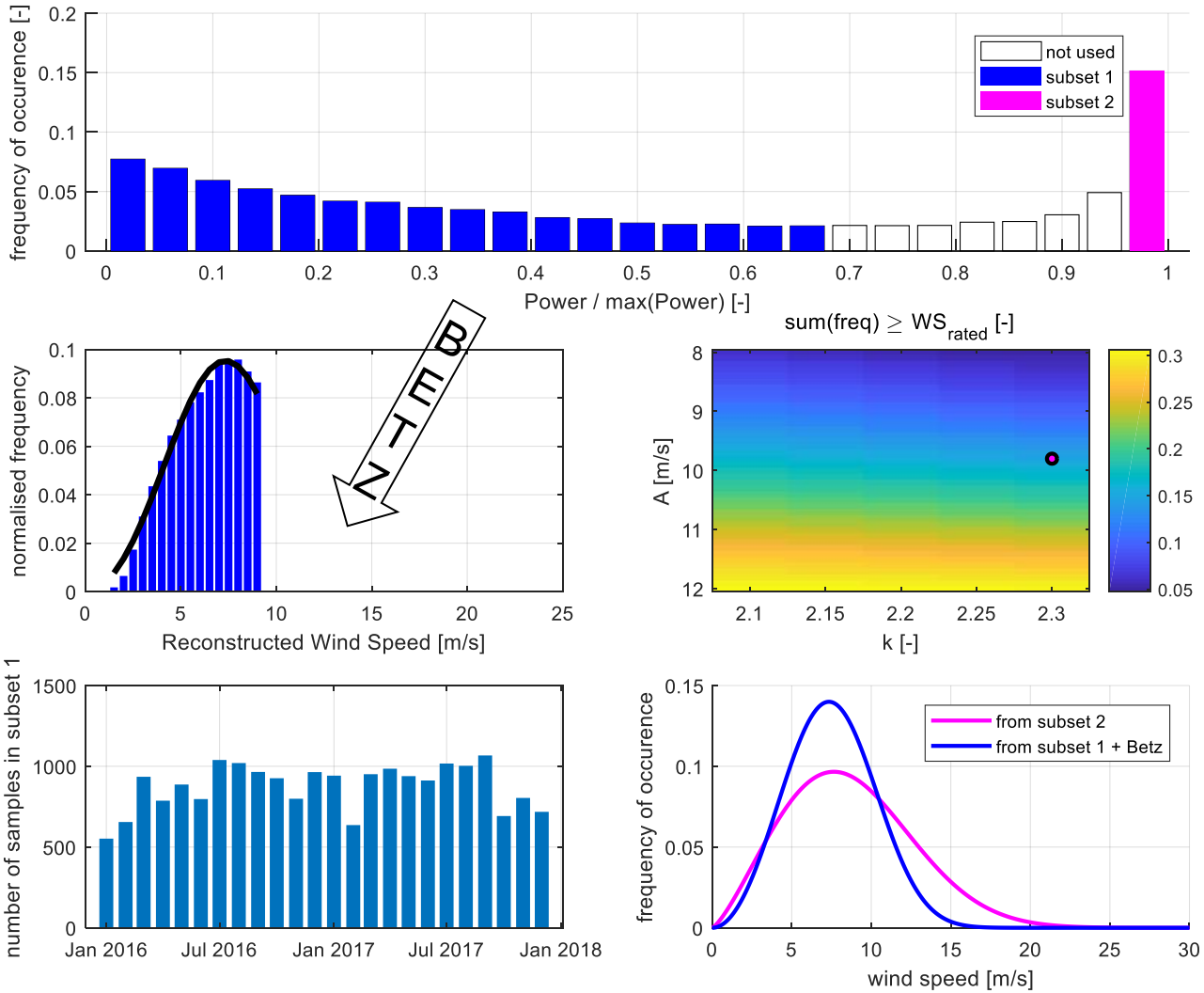
Production analysis

#BMRS #WhatToDoWithIt #WorkInProgress



Production analysis

#ThereAreNoPerfectWindFarm

In order to derive a conservative estimate of the mean wind speed, are needed:

- A pretty “neat” time series (no significant abnormal behaviour)
- Little curtailment (in particular for subset 2)
- Many assumptions -> sensitivity analysis and threshold analysis.

However, the main idea is the following:

1. Without measurements at all for performing an EPA, the uncertainty of the mean wind speed (typically from a mesoscale model), is generally reported to be about 5-7%.
2. This corresponds to a p90/p50 ratio (on wind speed) of 0.936-0.913.
3. The BMRS dataset, possibly in combination with the method presented here, could help decrease this uncertainty in some situations, and could come up useful.

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Production analysis

#BMRS #WhatToDoWithIt #WorkInProgress

Other possible use of the data:

- Direct comparison with the (p50,uncertainty) distribution from the EPA.
- Review of wind farm production data during due diligence process.
- Wake effects (when there are more than one OSP, or neighbouring wind farms).

OVERALL: reducing the wind-related risk**, and increasing the focus for wind analysts on the non-wind related risks (cluster wakes, wtg and grid availability, curtailment).

*i.e. by providing a wind speed smaller than the free stream wind speed.

*over the North Sea :P

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Next steps

#BMRS #JustTheBeginning?

- Documentation and better of understanding of the datasets (so far, attempts to obtain detailed info have not worked out :/).
- Get hold of the German wind farms data.
- Better book-keeping and reporting (website ??)
- Support as much as possible any wind analyst interested in making use of this data as well ☺

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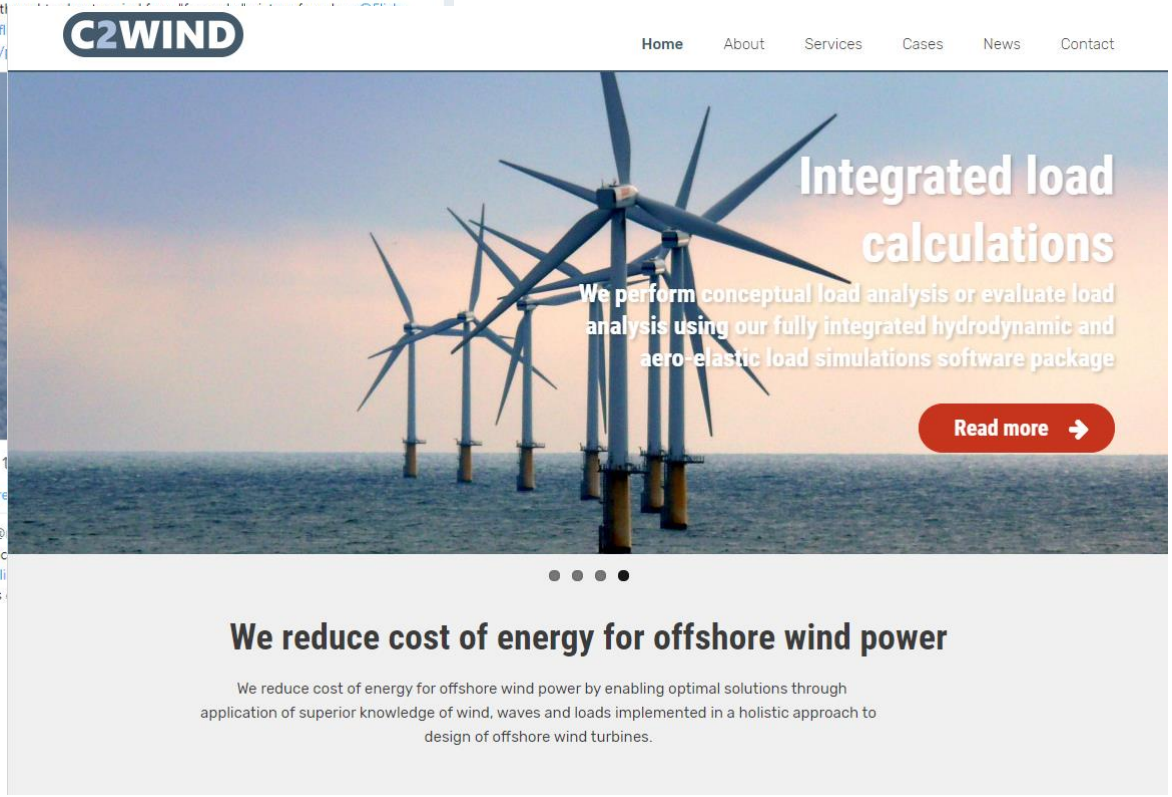
Thank you for your attention



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