Global Wind Atlas calibration to Elexon power

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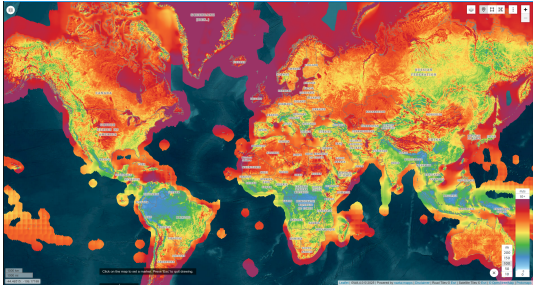
Calibration to power

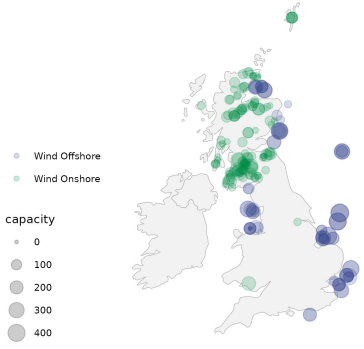
Global Wind Atlas (GWA) vs Elexon generation

Calibrate a GWA driven estimate to actual observed output

Global Wind Atlas



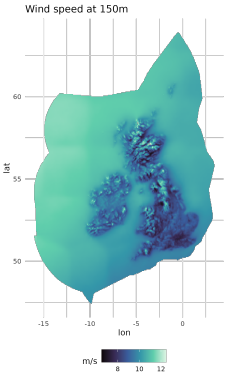
Elexon wind farms map (2025)



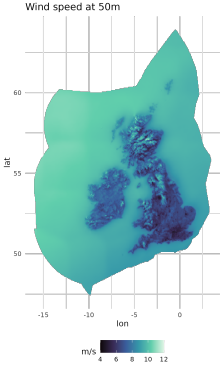
Global Wind Atlas

Characteristics

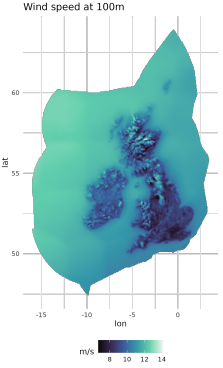
- Using DTU's Wind WAsP methodology
- Downscaled from ERA 5 to a 250m grid
- Models land and 200km from shorelines
- Long term average wind speed
- Heights: 10m, 50m, 100m, 150m, 200m
- Scale and shape parameters Weibull



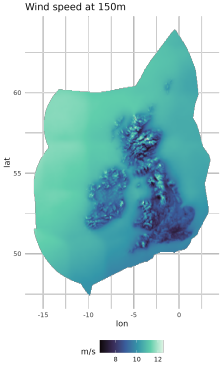
Mean wind speed



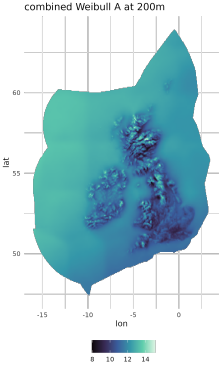
50m



100m

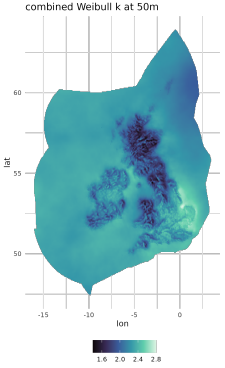


150m

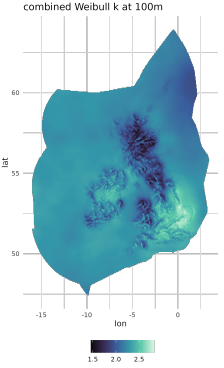


200m

Weibull shape parameter k



50m



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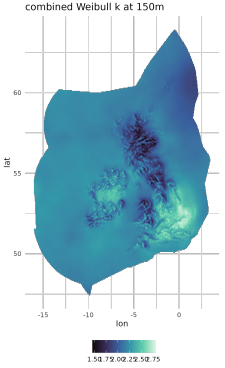
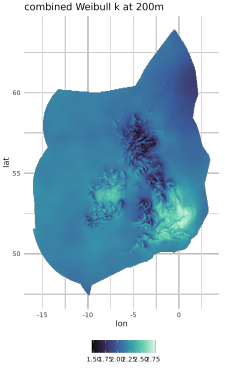
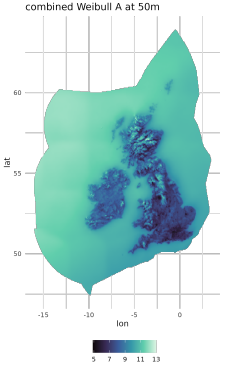


150m

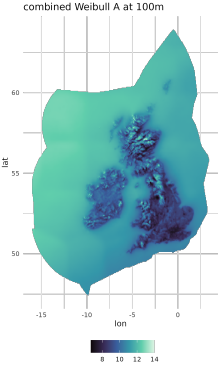


200m

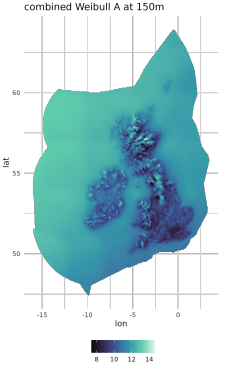
Weibull scale parameter A



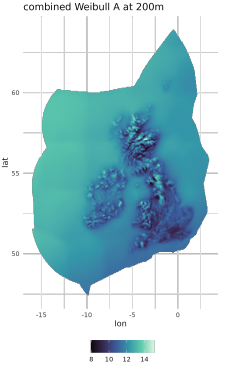
50m



100m



150m

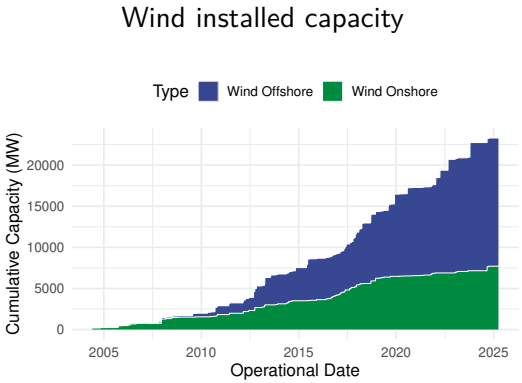


200m

Elexon data

BMU wind data

- 150 wind farms split in over 216 units
- Total capacity: 27 GW
- Half hourly resolution
- Records starting in 2019
- Curtailment (pending)
- Location / turbine data unavailable



BMU wind data

BMU wind generation data in 2025 (up to 29 September)

Type	Generation (GWh)	Capacity (MW)	Number of BMUs	Capacity Factor
Wind Offshore	33,230.5	18,100	87	0.21
Wind Onshore	11,151.0	8,996	129	0.14
Total	44,381.5	27,096	216	0.19

Renewable energy planning database (REPD)

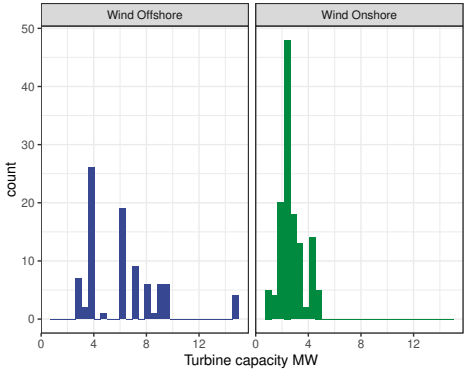
- Official UK government renewable data
- Over 800 wind farms listed as operational
- Coordinates available
- Also available:
  - Development status
  - Number of turbines
  - Turbine capacity
  - Turbine height (for some only)

REPD wind farms

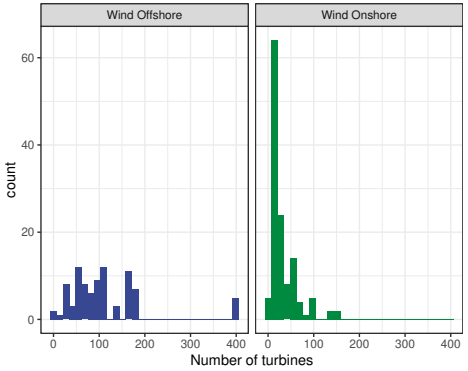
Type	Development Status	Count	Capacity MW
Wind Offshore	Operational	47	14,679
Wind Offshore	Under Construction	7	7,742
Wind Onshore	Operational	770	14,738
Wind Onshore	Under Construction	37	1,779
Total	-	861	38,938

Turbine data available

Turbine capacity histogram



Number of turbines histogram

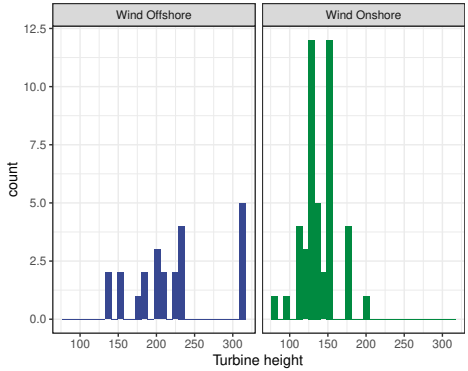


Turbine data available

Turbine Height availability

Type	Height available	Average height (m)	count
Wind Offshore	FALSE	222.0	23
Wind Offshore	TRUE	NaN	64
Wind Onshore	FALSE	137.7	45
Wind Onshore	TRUE	NaN	84

Turbine height histogram



Power conversion

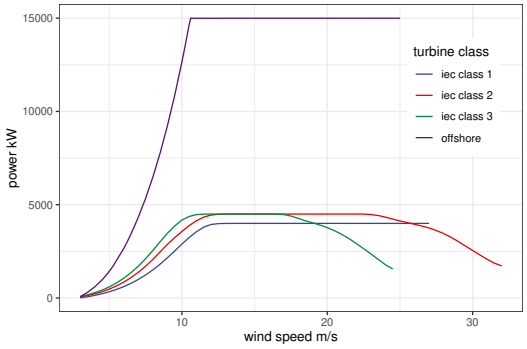
Generic power curves

- Using 3 generic power curves
- Offshore plus the IEC 3 classes
- Assigning class based on GWA mean wind speed at location
- Rescaling rated power to turbine capacity

IEC classification

Class	Mean wind speed at hub height (m/s)	Extreme 10-min gust (m/s)	Typical sites
I	10	70	Very windy / exposed sites
II	8.5	59.5	Moderate wind sites
III	7.5	52.5	Low-wind / inland sites

Generic power curves (PC_k)



Power estimate based on generic power curves

For each location i we have: observed power p_i, number of turbines n_i, turbine capacity c_i, turbine height v_i, and mean wind speed μ_i.

- Map location to a rescaled power curve $\widetilde{\mathsf{PC}}_k$
- Estimate wind farm power in GWh

$$\widetilde{p}_i = \widetilde{\mathsf{PC}}_k(\mu_i) \times n_i \times h_i$$

where h_i are the number of hours in the year (8,760 full year, 6,527 in 2025).

Power estimate based on generic power curves

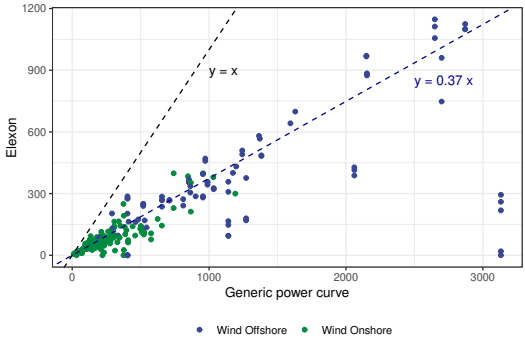
GWA also offers access to the Weibull parameters at each grid point. Due to the heavy tail of the Weibull distribution applying $\widetilde{\mathsf{PC}}_k(\mu_i)$ overestimates power.

$$\widehat{p}_i = n_i \times h_i \times \mathrm{E}\left(\widetilde{\mathsf{PC}}_k(w_i)\right)$$

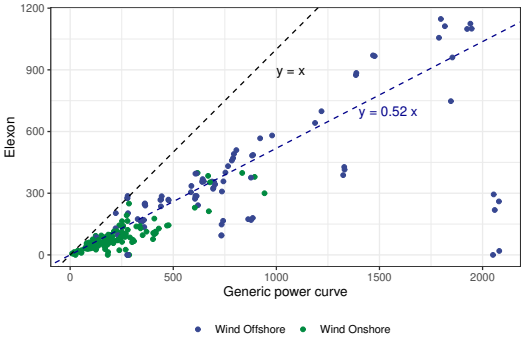
where w_i are random replicates of $W_i \sim \mathsf{Weibull}(A_i, k_i)$, and A_i, k_i are the scale and shape parameters, respectively.

GWA based estimates vs Elexon 2025

PC on GWA mean wind speed $\widetilde{p}_i$



Estimate using Weibull distribution $\widehat{p}_i$



Next Steps

- Compare other years: 2019-2024
- Estimate loss factors based on history
- Refine power curve conversion
- Quantile mapping calibration