Identifying the best wind datasets for local energy models in IRELAND



Supporting

Energy

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- ★ Renewable and local energy communities are a key component to the success of the energy transition [Bloomfield et al., 2021]. We estimate wind power potential for such communities.
- \star The quality and accuracy of six reference datasets are validated against Met Éireann hourly wind speed "ground truth" data.
- \star Four stations are selected for the quality assessment based on the availability of



Seasonal variation of wind speed



• The reference datasets are able to ≅80% capture variation of observed wind speeds. • Highest correlations and IOA values are seen in ERA-5 data. •Winter and Autumn

DUBLIN

5-10% higher have correlation values compared to Spring and Summer.

wind records [Dublin Airport, Valentia Observatory, Belmullet, and Mountdillon].

 \bigstar We then analyze the wind potential at a sample of 13 locations in Ireland (5 inland, 8 coastal).

Methods

- Four skill metrics are used for the [correlation quality assessment coefficient (R), mean error (ME), rootmean-square error (RMSE), and index of agreement (IOA)].
- Transform wind speed records of different heights [10 m and 100 m] in to wind speed at hub height [110 m] through "logarithm profile law".
- Generate the wind energy at 1 hour resolution using a sample power curve for a Vestas V110 2.0 MW IEC IIIA turbine.
- Figure 2 shows the cut in speed $[v_{c}=3.0 \text{ m/s}]$, rated speed $[v_{r}=11.5]$ m/s], and furling speed [v_f =20 m/s].



Figure 4: Diurnal variation of 10 m wind speed at Dublin Airport as a function of season.

Seasonal variation of wind energy



Figure 5: Diurnal variation of wind energy capacity factor and wind speed at 110 m

• No clear diurnal variability wind of capacity energy factor.

• A small dip in the wind energy capacity factor [16-18 IST] is noticed during the summer season.

• Higher capacity [≅10-15%] factors are recorded during the winter and autumn compared to the spring and summer.

•ERA-5 is the best wind data source at Dublin Airport.

Figure 2: Representative wind power curve for a Vestas V110 2.0 MW IEC IIIA turbine.

Quality Assessment



the • All stations significant exhibit diurnal variation of wind speed.

• Relatively higher wind speeds are noticed over coastal stations (Figure 3a-c) compared to inland station (Figure 3d).

•At Mountdillon, the reference datasets have a 1 hour early peak with higher (lower) wind speeds in NEWA, MERRA-2 (ERA5, PVGIS) data relative sets to observations.

Figure 3: Diurnal variation of 10 m wind speed records at (a) Dublin Airport, (b) Valentia Observatory, (c) Belmullet, and (d) Mountdillon stations. Biases and RMSE values are in the colour boxes.

Corr.	Bias	RMSE	ΙΟΑ
0.89	0.23	1.47	0.92
0.87	1.28	2.06	0.88
0.84	1.89	2.76	0.82
0.89	-0.19	1.63	0.89
0.89	-0.19	1.63	0.89
0.89	-0.19	1.63	0.89
	Corr. 0.89 0.87 0.84 0.89 0.89 0.89 0.89	Corr.Bias0.890.230.871.280.841.890.89-0.190.89-0.190.89-0.19	Corr.BiasRMSE0.890.231.470.871.282.060.841.892.760.89-0.191.630.89-0.191.63

height at Dublin Airport during (a) winter (DJF), (b) spring (MAM), (c) summer (JJA), and (d) autumn (SON) seasons.

Conclusions

- \star This paper presents results of assessing the wind speed obtained from various publicly available datasets [two reanalysis datasets [ERA-5 and MERA-2], one mesoscale wind atlas [NEWA], and three PVGIS datasets [SARAH, SARAH2, ERA5]] in comparison to observations [Met Éireann].
- \star All the six reference datasets are able to capture the observed wind variations [80-90%] at the selected four locations in Ireland [Dublin Airport, Valentia Observatory, Belmullet, and Mountdillon].
- \star The average statistical metrics suggest that for wind speed, ERA-5 outperforms other datasets. It has the highest correlation and IOA, and the lowest RMSE values. Hence, ERA-5 is recommended for estimating the wind energy.
- ★A total of 43 years [1979 to 2021 at 1-hour temporal resolution] of ERA-5 wind energy [capacity] factor, and power] values are computed using the Vestas V110 2MW IEC IIIA power curve at 13 locations over Ireland.
- ★The highest capacity factors are estimated in Belmullet (coastal), and the lowest at Kilkenny (inland) stations.
- The inland stations [Kilkenny, Cork, Birr, Clones, and Mountdillon] yielded approximately 10-20% less capacity factor compared to the coastal stations.
- \star In future investigations, we are exploring more potential wind datasets available over the European region. This will allow us to design more accurate and appropriate input (energy scenarios) for the weather dependent local energy models.

More Information

1. Bloomfield, et al., (2021). The Importance of Weather and Climate to Energy Systems: A Workshop on Next

• All correlations are ≥ 0.84 .

- Lowest values of bias in PVGIS. ERA-5 has slightly higher and positive biases.
- Lowest RMSE and highest IOA values in ERA-5.
- Overall, ERA-5 exhibits the highest skill scores on average.
- Overall, NEWA exhibits the lowest scores.

for the wind speed at 10 m height. The mean is taken over four stations.

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2. Staffell, I. and Pfenninger, S. (2016). Using bias-corrected reanalysis to simulate current and future wind power output. *Energy*, 114(1), 1224–1239, https://doi.org/10.1016/j.energy.2016.08.068

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