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Spectra and cross-spectra of wind and wind power time series in view of smoothing fluctuations in wind power on the Faroe Islands

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The Faroe Islands is a small isolated mountainous island group 400 km off the Scottish North Coast, in the northern Atlantic stretching over an area of ∼100 * 80 km2. The closest adjacent land being the Shetlands, located around 300 km away. Thus, on the Faroe Islands an isolated power grid is operated, supplying electricity to ∼50.000 citizen. The islands show a complex topography governed by narrow Islands, reaching up to 880m a.s.l., separated by fjords.

The power supply is given by a combination of hydro power, wind power, and power from diesel generators. In 2018, 48.8% of the electrical energy was produced from renewable energy sources, where 18.1% was from wind power [1]. The political goal is to reach 100% renewable electricity energy by the year 2030. This will presumable be mainly achieved by implementing more wind power.

Considering the fact that wind power forms a significant part of the system, it is important to study the character of the wind field in the area with respect to magnitude and fluctuation characteristics. The focus of this study will be the characterization of the temporal and spatial structure of the wind field in this complex terrain in view of the resulting fluctuations imposed to the grid by the expected output windfarms. The characterization is given in the frequency domain by the spectra and cross-spectra of wind and wind power time series. This study is based on three data sets. Power data from the three wind farms currently in operation. This dataset consists of 1 min data from December 1st 2017 until now. Wind measurements stem, on one hand from three meteorological masts, taking measurements at 70-100m a.g.l. In addition, a set of wind data measured 10m a.g.l. at various locations on the islands, selected for the purpose of monitoring road conditions. These sets consist of 10 min data stretching over several years. Preliminarily results have shown that the correlation for both, the wind and power sets tend to be less with respect to intersite distance as compared to less complex terrain, i.e. Northern Germany. Currently the spectral and cross-spectral characteristics of the wind speed and power sets is analyzed. Results will be applied to estimate the relative smoothing of lumped series as compared to single station series (see e.g. [2,3]) on different time scales. The outcome is to be compared to respective studies referring to regions with less complex topography.

[1] http://www.sev.fo/Default.aspx?ID=8&Action=1&NewsId=3001&currentPage=3&PID=6, visited 12/4-2019.
[2] Beyer, H. G., Luther, J., and Steinberger-Willms, R., 1993, Power fluctuations in spatially dispersed wind turbine systems, Solar Energy, Vol. 50, No. 4, pp. 297-305.
[3] Katzenstein, W., Fertig, E., and Apt, J., 2010, The variability of interconnected wind plants, Energy Policy, Vol. 38, Issue 8, pp. 4400-4410.