REF
RENEWABLE ENERGY FOUNDATION

Information Note

31.03.11

Pöyry Study Confirms REF Research on Market Impacts of Intermittent Renewables

Pöyry's important report,[1] available to the public in summary form as *The Challenges of Intermittency in North West European Power Markets,* crystallizes the current state of discussion of the degree to which a geographically distributed wind fleet connected by a European Supergrid could resolve the impact of wind intermittency on the electricity system and its markets.

Starting in 2005, the Renewable Energy Foundation (REF) commissioned a series of reports which have played a key role in this debate. These include the 2005 Telford Gold Medal winning papers by Hugh Sharman on the Danish wind experience;[2] the work published between 2006 and 2008 by James Oswald and his co-authors, which models the output of a 25 GW wind fleet distributed across the UK;[3] and the work of Paul-Frederik Bach on the impact of wind power intermittency on electricity spot prices, which was published in 2009 and 2010.

Oswald showed that, contrary to previous statistical work by the Environmental Change Institute (Oxford), smoothing of wind-generated electricity output would be modest at best, with the entire wind fleet functioning effectively as one power station, with frequent power ramps of significant scale and rapidity, and extended periods of near zero output, indicating that even a 25 GW wind power fleet produced little or no firm, or reliable, capacity. The Pöyry study is consistent with these results.

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[1] http://www.poyry.com/media/media_2.html?Id=1301471113.html

[2] Hugh Sharman, "Why Wind Power works for Denmark", Civil Engineering, 158, May 2005, 66-72. http://www.ref.org.uk/images/PDFs/sharman.ice.pt1.pdf. Hugh Sharman, "Why UK Wind power should not exceed 10GW", Civil Engineering, 158, Nov 2005, 161-169. http://www.ref.org.uk/images/PDFs/sharman.ice.pt2.pdf

[3] Jim Oswald, "25GW of distributed wind on the UK Electricity system", 7 Dec 2006 http://www.ref.org.uk/images/PDFs/ref.wind.smoothing.08.12.06.pdf. Jim Oswald, et al., "Will British Weather Provide Reliable Electricity", *Energy Policy*, 36 (August, 2008), 3202-3215.

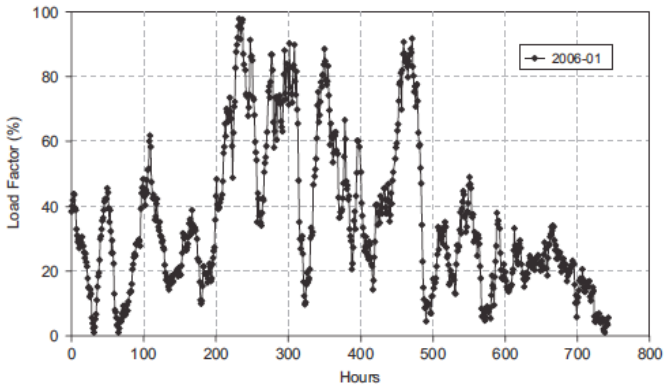

Figure 1: Modeled aggregate power for 25 GW of wind, January 2006. Source, James Oswald et al. (2008).[4]

In addition Oswald showed that the fluctuations of such a wind fleet would have the effect of transforming the residual market, served predominantly by conventional fossil-fuelled plant, from a varying but regular demand to a system exhibiting random variations. This would inevitably result in economic and operational difficulties for the conventional plant. Since this plant remains indispensable in guaranteeing security of supply, in spite of wind, such difficulties are a matter of real concern.

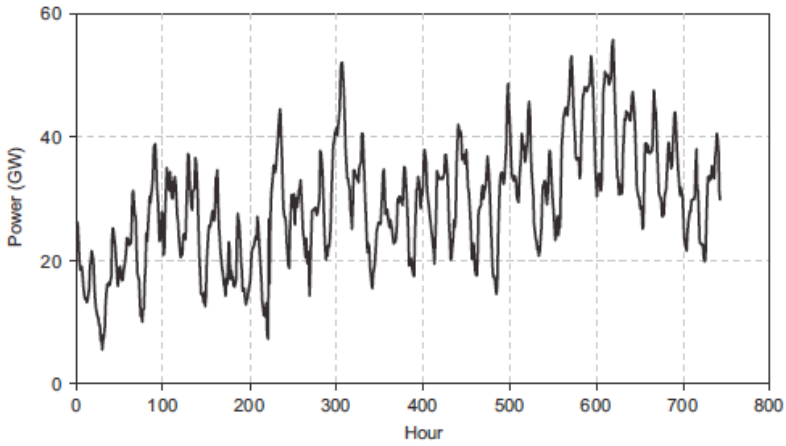

Figure 2: Modeled residual demand on conventional plant, January 2005. Source James Oswald et al. (2008).[4]

Further work funded by REF examined the relationship between the German and Danish electricity markets to shed light on the spot market price impacts of wind variability.

The first study, by the leading European engineer and former planning director of Eltra (the Danish grid operator), Paul-Frederik Bach, was published by REF in May 2009 under the title *Wind Power and Spot Prices: German and Danish Experience 2006-2008*. Mr Bach's work indicated that wind caused significantly increased levels of volatility in the spot markets, particularly at times of low wind, and that both wind power and spot market prices in Germany and Denmark showed periods of close correlation.

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[4] Jim Oswald, et al., "Will British Weather Provide Reliable Electricity", *Energy Policy*, 36 (August, 2008), 3202-3215.

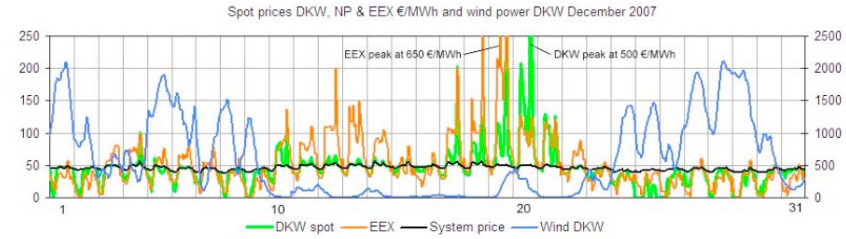

Figure 26: Wind power and spot prices (DKW) and spot prices (EEX) - December 2007

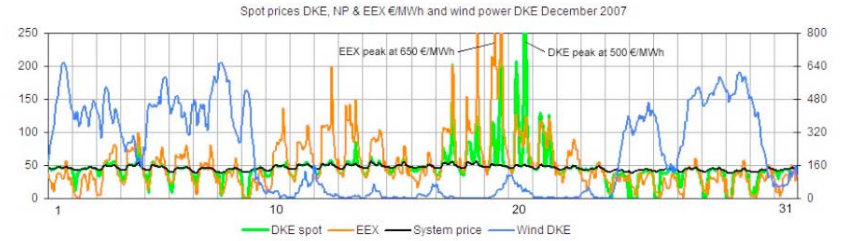

Figure 27: Wind power and spot prices (DKE) and spot prices (EEX) - December 2007

Figure 3: Wind power and spot prices in Denmark and Germany, December 2007. Source: Bach (2009).[5]

Both these REF studies have been widely influential in the further analysis of the impact of wind intermittency on the UK system, for example they are key references in Parsons Brinckerhoff's important review *Powering the Future: Mapping our low-carbon path to 2050* (December 2009), 67, 141-156[6].

In subsequent work for REF, published in July 2010, Mr Bach updated and extended his work in a book entitled, *The Variability of Wind Power: Collected Papers 2009-2010.* This work revealed the degree to which wind variability might be synchronized across Europe, with the implication for spot prices and the value of trans-continental interconnections. As Mr Bach wrote: "*The combination of wind power in Denmark, Germany, and Ireland produces a statistical smoothing effect […] however, the effect is not strong, and even assuming market interconnections which are perfect in a physical and regulatory sense there would still be extreme peaks and troughs in wind output*" (p. 47).

However, it became apparent during Mr Bach's work that it was difficult to fully investigate the matter in the United Kingdom due to poor market data. In his preface to the book Professor Laughton observed: "*this study's use of large publicly available databanks […] shows that there is a pressing need for similar data transparency in the United Kingdom. Bluntly, at present we could not attempt to replicate Mr Bach's work here; the data is simply not available*" (p. x).

Pöyry's study goes some way to addressing the questions raised by Oswald and Bach's work, and reiterates many of the conclusions previously drawn by REF in its research work on intermittent renewables, namely that:

(i) A geographical spread of wind (and, Pöyry argue, solar) supported by a supergrid would not resolve the problems of intermittency because similar weather patterns can extend across much of the continent of Europe and the UK and Ireland.

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[5] Paul-Frederik Bach, *Wind Power and Spot Prices: German and Danish Experience 2006-2008* (Renewable Energy Foundation: London, 2009), 23.

[6] http://www.pbpoweringthefuture.com/

(ii) A substantial deployment of intermittent renewables leads to increased price volatility.

(iii) Intermittent renewables force the remaining fossil-fuelled plants to run in an inefficient manner, which in turn increases consumer costs.

As recently as January 2011, REF published an Information note on "Low Wind Power Output in 2010", in which we noted that further data from Europe confirmed the view, grounded in the work of Oswald and Bach, that "*while widespread interconnection via the widely discussed European Supergrid, may assist in managing variability, its contribution will not on its own be sufficient to solve the problems, since wind output is approximately synchronised across very large geographical areas*".[7]

We therefore welcome Pöyry's major contribution to augmenting research in this area. However, we note that only extracts of Pöyry's work are in the public domain. REF believes that it is regrettable that such key research on a critically important issue, with significant economic implications for the subsidising consumer and the wider economy, is not being carried out by the Government, but instead is left to charities such as REF and to commercial consultancies such Pöyry. REF is also disappointed that the full report is not available for independent scrutiny, but recognizes that commercially-commissioned work cannot always be distributed and is grateful to Pöyry for making a summary available. In an ideal world government would buy this study and make it freely available.

REF is proud to note that, although a small charity subsisting on private donations, it has contributed so significantly to this debate, and that Pöyry's work confirms our major conclusions.

REF is delighted that the perspectives it has helped to pioneer are becoming mainstream. The findings demonstrate that the current target-driven UK and EU energy policy could result in a disproportionate cost burden on the consumer, with, arguably, little or no substantial contribution to climate change policy or security of supply.

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[7] http://www.ref.org.uk/publications/217-low-wind-power-output-2010