Renewables and Balancing Behaviour: Lessons from Germany

November 2013

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1. Executive Summary

In Germany the generation mix is less flexible than the UK, which should be prone to higher balancing costs.

Variable generation (wind and PV) accounts for 12.2% of installed capacity in Germany, a much higher percentage than in the UK. In theory, this should also lead to higher balancing costs.

The German grid, whilst having greater interconnection than the UK, also has historical constraints and transmission problems which will exacerbate balancing challenges.

Despite these factors, there is evidence that balancing costs have declined since 2006, predating the latest reforms, and that they only seem to have increased in the last year.

Wind forecasting accuracy improved between 2001 and 2005 to reduce errors from 10% to 6.5%, irrespective of the reforms introduced.

The main concern in Germany has not been about incentivising good balancing behaviour, but how the market responds to negative price signals and whether these signals have an appropriate impact on plant dispatch decisions.

There is evidence that lignite plant have not been responding appropriately. This is not a problem that we should expect to see replicated in the UK.

Looking ahead, the important issue is to minimise the cost to the consumer by ensuring that incentives are most appropriately placed with actors who are able to respond to those signals. Incentives for helping balancing need to be available throughout the system, not just placed on individual generators, to encourage innovation throughout the market. In the UK, because of the structure of the current market, the Big Six enjoy a competitive advantage in managing balancing exposure compared to other actors. This creates a barrier for new entrants and innovation, undermining market plurality. If the incentives are placed correctly however, the market could be re-opened to innovation and challenge. This would improve the efficiency of the balancing system for the benefit of consumers.

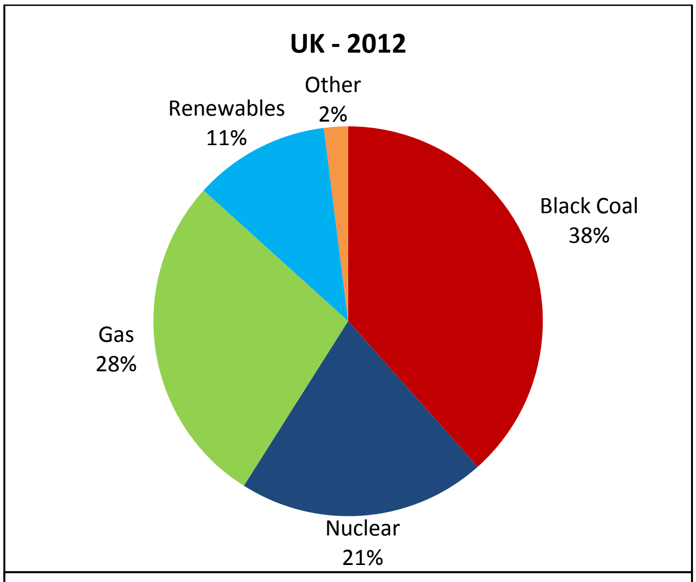
The German example is evidence that the cost of balancing renewables does not necessarily increase straightforwardly with renewable penetration. Other factors, particularly the impact of other actors, such as the balance of fossil fuel generation between inflexible lignite coal on the one hand and flexible gas on the other, can cause significant deviation from modeling predictions.

2. The German Electricity System

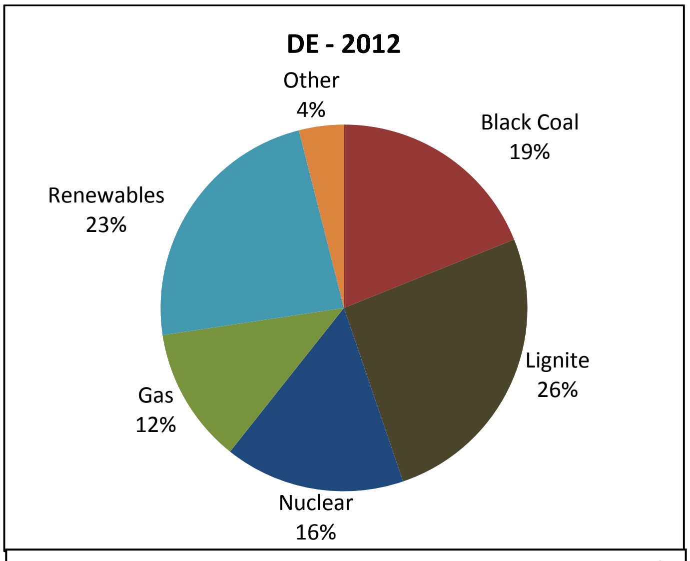
A comparison of balancing behavior in Germany and the UK must first take account of the differences between the two electricity systems.

2.1 German generation mix

The principal difference between the UK and German electricity systems is in the mix of generating sources.



UK electricity generation by source in 2012[1]



German electricity generation by source in 2012[2]

[1] DECC, 1.8.13, https://www.gov.uk/government/publications/fuel-mix-disclosure-data-table

Germany is more reliant on coal, particularly lignite, which is a very inflexible source of generation. Lignite generation is based close to lignite mines in western Germany as it is uneconomical to transport lignite. Together, black coal and lignite made up 45% of German electricity generation in 2012 and 52% in 2013[3], compared to a stable 35-38% of UK generation. UK coal generation uses only black coal, which is both cleaner and more flexible than lignite.

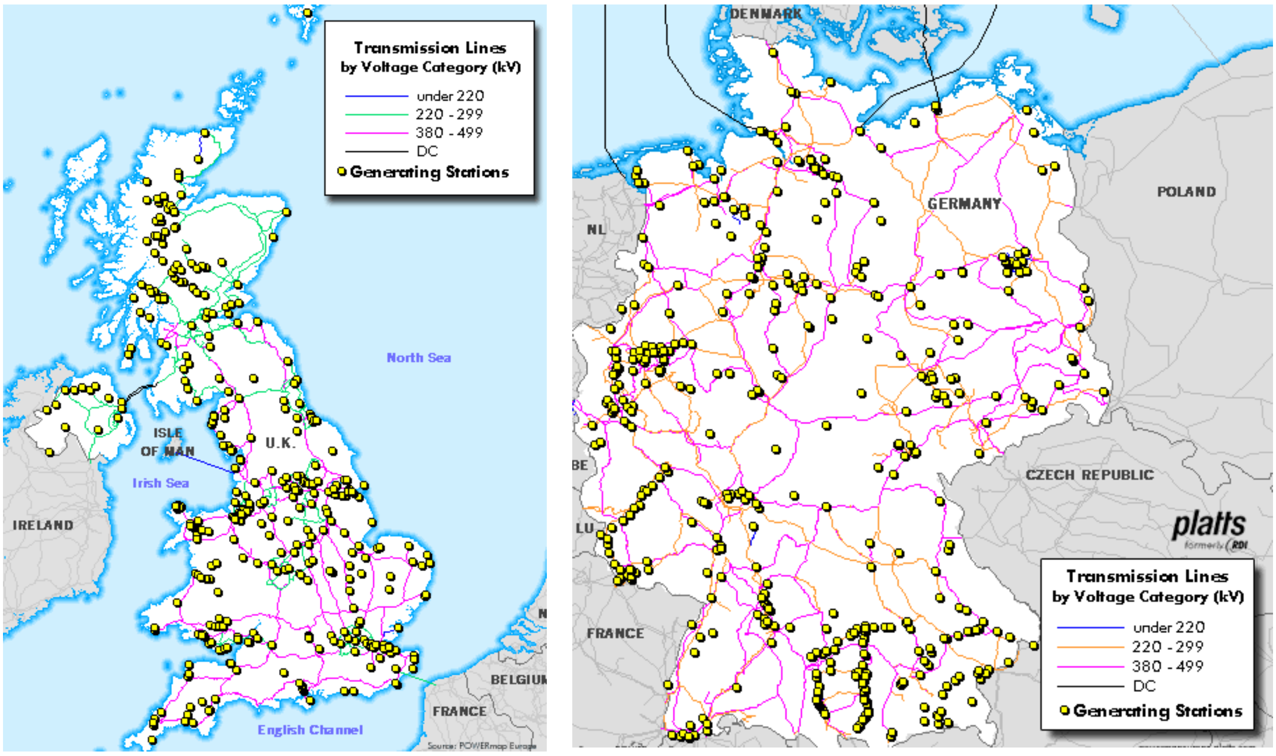
Germany has fewer natural gas generation assets than the UK (gas generation in Germany accounted for 12% of total electricity generation in 2012, 7% in 20133; as against a stable 28-30% in the UK), largely because of Germany's historic reluctance to increase dependency on Russian imports and the UK's exploitation of its North Sea reserves. Natural gas is a useful resource to balance intermittent generation, and although the German Government is now encouraging the construction of more flexible fossil fuel plants[4], its level of intermittent generation (wind and PV, 12.3%) is currently higher than its short-term flexible generation (gas, 7%). In the UK natural gas currently generates four times as much electricity as intermittent sources[5] (wind and PV, 7%; gas 30%). Germany's grid is not considered flexible enough in its current state to incorporate large quantities of intermittent renewable energy[6].

2.2 German grid

The structure of the German grid is very different from the UK. Germany has far greater interconnection with neighbouring countries, which allows it to draw on the resources of others to balance its grid to a certain extent. This has the unintended consequence that the energy price signals Germany sends to regulate its energy supply are often picked up by its neighbours, which can disrupt their energy systems.[7] It also dilutes the effect of price signals in the domestic energy market.

Germany's transmission and distribution grids also present challenges, in part because of the legacy of the Cold War where East and West German grids evolved in isolation. In particular, Germany has a North-South distribution issue, requiring it to route some of its power through neighbouring countries[8], which the Government is attempting to remedy through an ambitious expansion of the high-voltage distribution grid[9]. Unfortunately planning constraints make this a slow process, and some municipalities have accused the grid operators of not pushing ahead with grid reforms fast enough. Hamburg has bought out its electricity grid in response, and a referendum in Berlin on the issue just failed to reach quorum.[10] The need for lignite generation to be based close to the open-cast lignite mines in western Germany also militates against an even geographical distribution of generation assets and exacerbates the problem of low grid integration.

[2] BMU via Unendlich Viel Energie, retrieved November 2013, http://www.unendlich-viel-energie.de/de/detailansicht/article/226/strommix-in-deutschland-2012.html
[3] Platts, 10.7.13, http://www.platts.com/latest-news/electric-power/london/german-coal-fired-power-rises-above-50-in-first-26089429
[4] BMU, retrieved November 2013, http://www.bmu.de/en/topics/climate-energy/transformation-of-the-energy-system/resolutions-and-measures/
[5] DECC, 14.11.13, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244726/renewables.pdf
[6] Quintel Intelligence research report, "Load Management", June 2013
[7] Inter Press Service, 28.8.13, http://www.trust.org/item/20130828055035-f12r8/?source=hppartner
[8] Bundesnetzagentur, 2012, http://www.netzausbau.de/SharedDocs/Downloads/DE/I/NEP/ZFStromnetzausbau2012.pdf?__blob=publicationFile
[9] See footnotes 4 and 8.
[10] BBC, 4.11.13, http://www.bbc.co.uk/news/world-europe-24800129



Transmission and generation assets in UK and Germany[11]. Note the concentrations of generation assets in western Germany.

2.3 German transmission systems operators

Modifying and modernising the German grid must take account of the Transmission Systems Operators (TSOs). Unlike in the UK, where the entire English and Welsh transmission system is owned and operated by the National Grid, who takes responsibility for balancing, the German transmission and distribution systems are split between four TSOs in different regions, who each take responsibility for balancing the grid in their areas. As of 2010 the TSOs now cooperate on secondary and minute reserves to reduce overall balancing risk, but continue to maintain separate primary balancing reserves. The regional separation of balancing risks and competition between the TSOs make whole-grid balancing incentives less effective and further complicates the balancing process[12].

The German electricity market is dominated by 4 large energy firms. E.On and RWE generated 56% of German power between them in 2008. Vattenfall and EnBW generated just over 16% and 12% respectively, the remaining 15% coming from other sources[13]. E.On and RWE generate 9%[14] and 2%[15] of their electricity from renewables respectively and Vattenfall still generates "over 90%" from fossil fuels[16]. The renewable energy market in Germany is largely populated by small and local players.

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[11] Global Energy Network Institute, http://www.geni.org/globalenergy/library/energy-issues/index.shtml

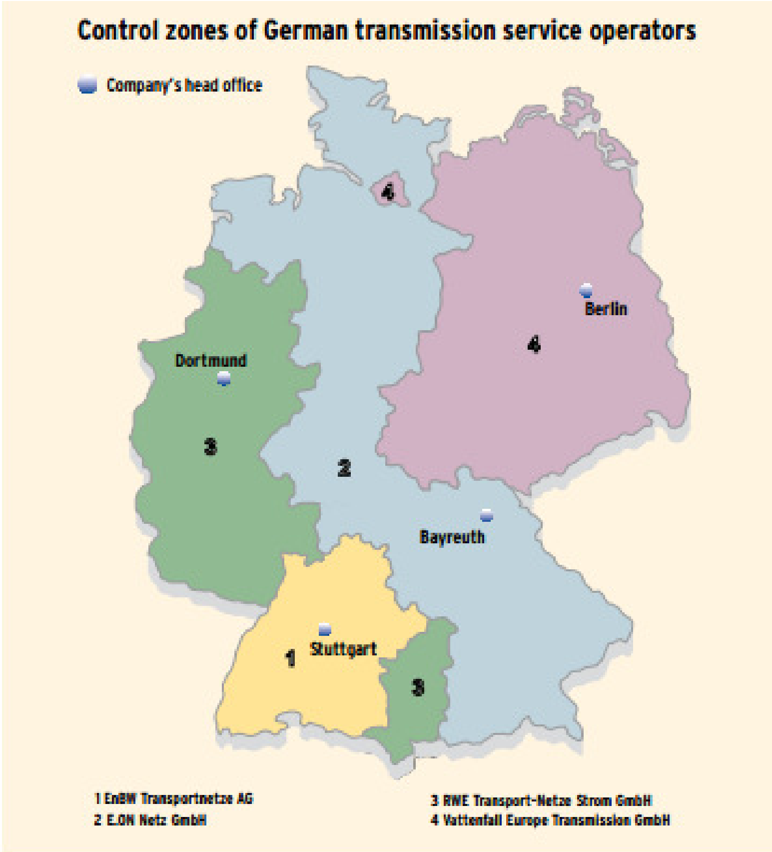
[12] Bundesnetzagentur, 5.2.13, http://www.bundesnetzagentur.de/SharedDocs/Downloads/EN/BNetzA/PressSection/ReportsPublications/2012/MonitoringReport2012.pdf?__blob=publicationFile&v=4

[13] Bundeskartellamt, 2011, http://www.bundeskartellamt.de/wEnglisch/download/pdf/2011-05-05_SU_Strom_Executive_Summary_EN_final-2.pdf

[14] E.ON, retrieved November 2013, http://www.eon.com/en/sustainability/regional-activities/germany.html

[15] RWE, September 2012, http://www.rwe.com/web/cms/mediablob/en/108808/data/114404/42/rwe/investor-relations/factbook/Facts-Figures-2012.pdf

[16] Vattenfall, retrieved November 2013, http://www.vattenfall.com/en/germany.htm



Source: Federal Association of the Energy and Water Industries (BDEW)

The four TSOs are subsidiaries of these four large energy companies. This adds another layer to the incentives acting on the TSOs, as alterations to transmission systems which help the efficient integration of decentralised intermittent generation will also help undermine the competitiveness of traditional generation sources[17]. The growth of renewables in Germany has led to a drop in wholesale energy prices[18]. If the grid becomes better able to incorporate intermittent renewable generation, there will be even less demand for non-balancing traditional generation such as lignite and coal. The four big energy companies have a significant interest in these forms of generation, which has led some campaigners to call for the renationalisation of the German grid to defuse this conflict of interest.[19]

[17] RWE, as reported in Financial Times, 14.11.13, http://www.ft.com/cms/s/0/b769e958-4d06-11e3-9f40-00144feabdc0.html#axzz2kQwWT7Ip
[18] European Commission Eurostat, retrieved November 2013 http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=ten00114
[19] BBC, 4.11.13, http://www.bbc.co.uk/news/world-europe-24800129

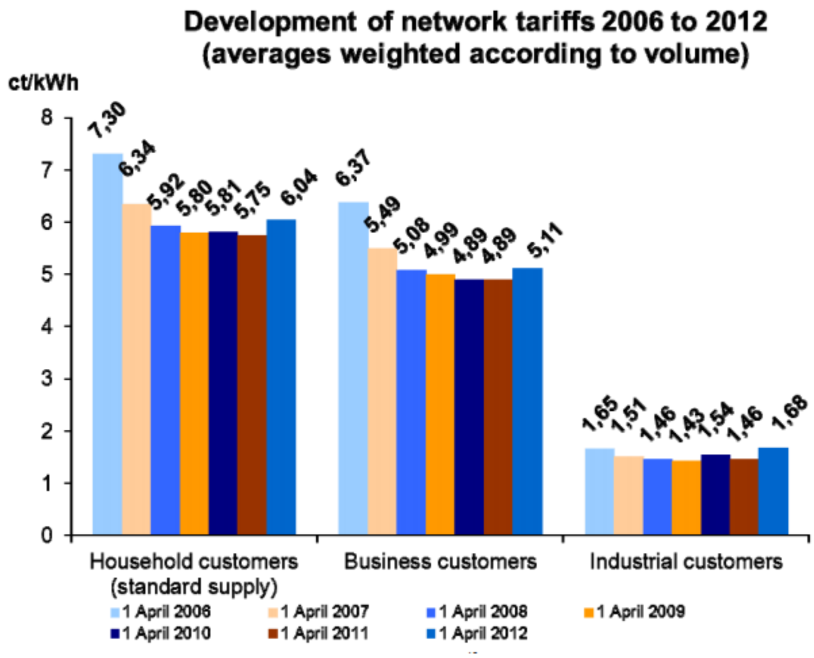
3. German balancing

Turning to the German balancing system, there is evidence to suggest that the balancing situation has been gradually improving since 2006.

3.1 Costs to the consumer

The fee that covers balancing costs has been steadily decreasing since 2006 due to improvements in German network regulation[20], although it rose slightly in 2012[21]. The decrease was largely due to increasing cooperation between TSOs in managing reserves.[20]

Balancing, transmission and grid management costs are subsumed in a non-transparent "network tariff," charged by the TSOs, which has gradually decreased since 2006. However, although the network tariff has dropped the TSOs maintain that balancing costs are rising[22]. The network tariff is itself subsumed in the wholesale price of electricity, which has been dropping since 2009[18]. The details of the network tariff are treated as commercially sensitive by the TSOs[22], making the true costs of balancing very hard to identify due to poor publically available information, a similar situation to the UK.



Evolution of German network tariffs which include the cost of balancing, 2006-12[20]

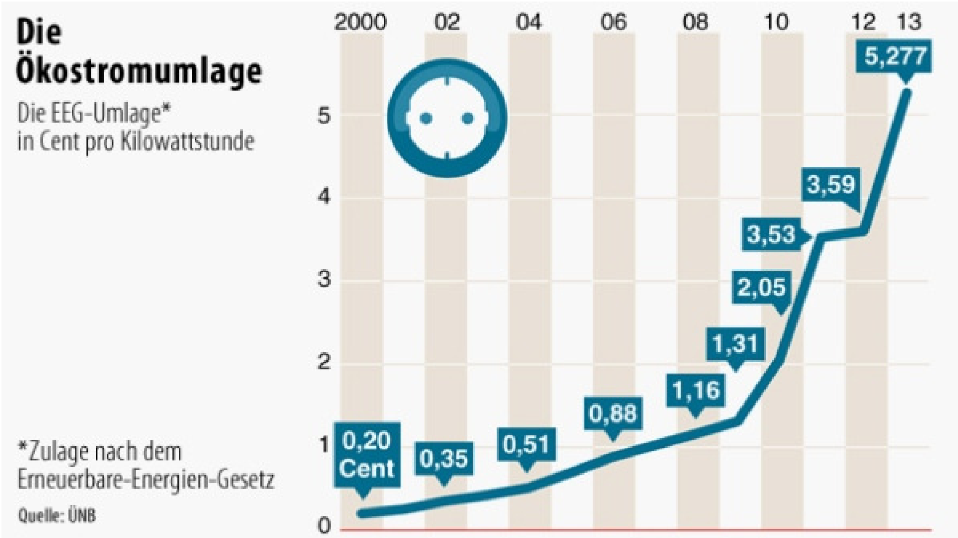
Household energy prices continue to rise due to the increase in renewable energy but this is due to the mandatory EEG surcharge, which rose from 0.2 cents per KWh in 2000 to 5.28 cents per KWh in 2013. This

[20] BMU, April 2009, http://www.bmu.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/brochure_electricity_costs_bf.pdf; and Bundesnetzagentur presentation, July 2010, http://www.eprg.group.cam.ac.uk/wp-content/uploads/2010/08/Kurth.pdf

[21] Bundesnetzagentur, 5.2.13, http://www.bundesnetzagentur.de/SharedDocs/Downloads/EN/BNetzA/PressSection/ReportsPublications/2012/MonitoringReport2012.pdf?__blob=publicationFile&v=4

[22] BMU, April 2009, http://www.bmu.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/brochure_electricity_costs_bf.pdf

surcharge is the mechanism through which TSOs recoup the difference between the FiT and the market price. It is a reflection of the rapid build-out of subsidised renewable technology and is exacerbated by the widespread exemptions awarded to energy-intensive industries, which leave the domestic sector with a much higher burden than would otherwise be the case.



The EEG surcharge 2000-13 in cent/KWh

The current worries in Germany about the increasing costs of renewables are focused on the increase in the EEG surcharge, which has had a large effect on household energy bills – a crucial political issue in any country. The cost of balancing renewables has never been part of that equation.

3.2 Oversupply

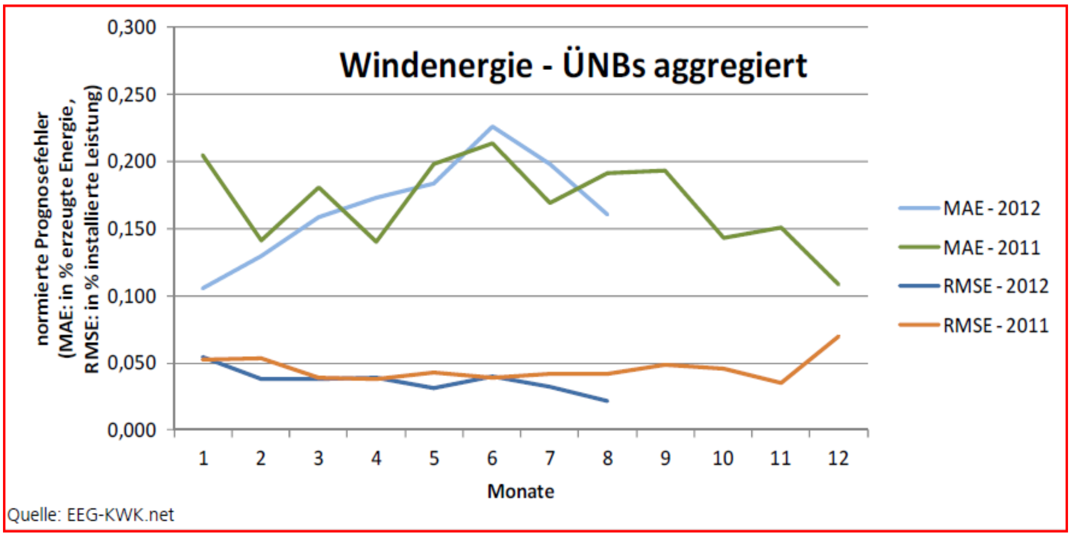
The main problem with the German electricity market is over-supply: traditional generators have been unwilling or unable to scale back production as input from renewables has increased[23], contributing to increasing periods of negative prices when the grid has been flooded with power[24]. Although these periods are always caused by spikes in renewable production, Germany's vulnerability to them is a direct result of consistent and inflexible oversupply – which is due to a high level of baseline generation from non-balancing sources such as lignite plants. If the four big energy companies were incentivised to scale back the input from these energy sources over the long-term in favour of more controllable plants, the issue would be better addressed. The German Government is seeking to achieve this as a matter of priority, but planning constraints and a historical reluctance to increase reliance on imported Russian gas have slowed progress.

3.3 Wind energy forecasting

A stated objective by some players in the German market was to ensure that all players are appropriately incentivised to contribute to improving forecasting. There was a concern that the dual market mechanism existing in Germany prior to 2009 (FiT combined with direct marketing) disincentivised renewable generators from improving forecasting, and that the change in market mechanism improved the situation. The evidence suggests that this was not the case.

[23] Business Spectator, 17.9.13, http://www.businessspectator.com.au/news/2013/9/17/renewable-energy/renewables-and-efficiency-depress-german-power-prices
[24] Fraunhofer Institute, August 2013, http://www.ise.fraunhofer.de/de/downloads/pdf-files/aktuelles/kohleverstromung-zu-zeiten-niedriger-boersenstrompreise.pdf

The accuracy of renewables forecasting depends on two variables: the quality of the input data and the model used to produce the forecast. Forecasting takes place at a grid level before being translated back to a site-by-site level. Each market participant has a different role to play in forecasting. The responsibility of generators extends to ensuring the data they provide regarding the availability and performance of their plant is of the best possible quality. This data is then combined with weather forecasts and other data to produce the most effective forecast.



Forecast accuracy at TSO level in 2011-12[25]

Recent quantitative analysis suggests that forecasting steadily improved throughout the period in question. In Germany the site-by-site forecasting error had decreased from 10% in 2001 to 6.5% in 2005[26] as data-gathering improved and models were adjusted incrementally. What might suggest that the change in market mechanism in 2009 increased the incentives for generators to improve their forecasting (ie the quality of data they passed to the forecaster) is that since 2009 a new shortest-term forecasting system was developed in Germany and has improved accuracy by 62%[27]. But this is a change in model not a change in data and has nothing to do with generators or the incentives placed upon them.

More recently, forecasting accuracy has remained stable at TSO-level since 2011 despite an increase in intermittent renewable energy sources – that is, TSOs' portfolios have included more and more renewable generators without negatively impacting their forecasting. A logical conclusion from this is that the accuracy of forecasting has increased in line with the increase in renewable generation.
Forecasting accuracy has never been a major concern in Germany. The Fraunhofer Institute, the Institute for Climate Protection, Energy and Mobility and BeckerBüttnerHeld have published Working Papers monitoring the effects of direct marketing. They examine the issues of oversupply and improving forecast accuracy but devote far more time to the issue of oversupply, which is linked to the inability of lignite generators not turning down their plants during periods of peak production.

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[25] From a presentation by Dr. Marian Klobasa from the Fraunhofer Institute for Systems and Innovation Research (ISI), 23.11.12
[26] Fraunhofer Institute, 2009, http://www.iwes.fraunhofer.de/de/publikationen/uebersicht/2009/role_of_wind_powerforecastsingridintegration/_jcr_content/pressrelease/linklistPar/download/file.res/1.pdf
[27] Fraunhofer Institute, 2009, http://www.iwes.fraunhofer.de/de/publikationen/uebersicht/2009/wind_power_predictionerrorsofashortest-termforecastofthetotalger/_jcr_content/pressrelease/linklistPar/download/file.res/Wind%20power%20prediction%20errors%20of%20a%20shortest-term%20forecast%20of%20the%20total%20German%20wind%20power%20generation.pdf

4. The Role of Renewable Generators in Balancing

4.1 Incentivising good balancing behaviour from generators

Generators cannot balance themselves; balancing by definition is a management of the grid to match electricity supply to demand. The TSOs are therefore the only part of the system able to deal with the balancing risk of the system. While conventional generators can be incentivised by the TSOs to make the process easier by generating more at peak times and vice-versa, the idea of giving renewable generators an incentive to generate in response to market demands is academic. How wind and solar generators can respond to such incentives at all is unclear. If and when technology improvements allow efficient storage of green electricity (current estimates suggest that this will not be for another 20 years) this could become a useful mechanism, but as renewable generators cannot "save up" energy production for times of high demand (like a gas plant can, by burning more gas at peak times), as long as prices are positive there cannot be an incentive for renewable generators to self-regulate at source to match market trends. Any potential not fulfilled when the wind is blowing or the sun is shining is potential lost, so renewable generators will always be incentivised to maximise generation as long as prices are positive.

In Germany the introduction of the Market Premium Model in 2012 sought to improve the market and system integration of renewable energy generators by incentivising them to contribute to grid stability. Unfortunately it does not appear to be achieving this effectively[28]. It is, however, succeeding in diversifying the energy supply market by encouraging the growth of aggregators and direct marketers, who balance a portfolio of generation assets alongside the four large energy companies. Although the German Government attempted to alter the behaviour of generators, it succeeded only in altering the behaviour of the transmission and distribution parts of the market, where the greatest potential for meeting balancing challenges lies.[29]

4.2 Balancing costs versus penetration of renewables

On the basis of this evidence from Germany, it seems that the relationship between the balancing cost and the penetration of wind (or other intermittent technologies) may not be as strong as suggested by theoretical models such as the work completed for Ofgem's balancing review[30].

The reason for this is that models often fail to account for the marginal actions of individual actors responding to market events with sufficient granularity, rational real-time developments in balancing strategies, the effectiveness of forecasting and data management expertise, the more effective utilisation of otherwise redundant plant (such as diesel stand-by generators and uninterruptible power supply systems) and technological improvements (such as more responsive CCGTs, demand side management, and storage).

These innovations will occur and will reduce the strength of the correlation between wind penetration and balancing costs. However, they will occur across all aspects of the electricity network. To effectively capture and reward such innovation, the market for balancing services need to be taking place at a network level.

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[28] Helmholtz – Zentrum fur Umweltforschung, January 2013, http://www.ufz.de/export/data/global/46349_4%202013%20Gawel_Purkus_Case%20Study%20Renewable%20Energies_gesamt.pdf

[29] Baringa, 16.7.13, page 44 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/253175/Baringa_analysis_of_PPA_market_liquidity._Presentation_at_April_workshop___Report_published_July_2013_.pdf

[30] Baringa, via Ofgem, 18.7.13, https://www.ofgem.gov.uk/ofgem-publications/82296/baringa-ebscr-quantitative-analysis.pdf

By looking at the individual plant as the main point of responsibility for the provision of balancing services, the potential for innovation will be reduced, and the costs to the consumer for delivering an equivalent amount of low carbon generation will be higher (or the amount of low carbon generation delivered will be lower).

The theoretical modeling provided by Ofgem is based on broad, high-level assumptions which are likely to diverge from actual developments in the market over a significant period of time. Without the publication of the full range of sensitivities that underlie the result, it is very difficult to understand how changes in underlying assumptions impact the forecast cost of balancing. It is important to understand these sensitivities as they will demonstrate the potential improvement that can be brought about by innovation, the importance of keeping the market as open as possible to as many actors as possible, and the importance of offsetting these theoretical results by comparing them with relevant international examples.

5. About RES

RES is one of the world's leading renewable energy project developers

Drawing on decades of experience in the renewable energy and construction industries, RES has the expertise to develop, construct and operate utility-scale renewable energy projects that include wind, solar, biomass and marine energy. The company's headquarters are located in Kings Langley, and we have offices across the UK, Europe, North America, Africa and Asia Pacific.

RES has been at the forefront of the wind energy industry for over three decades. Our core activity is the development, design, construction, financing and operation of wind farms worldwide, both onshore and offshore. We have developed and/or built over 7.5GW of wind energy capacity and have several thousand megawatts under construction and in development. RES is also an independent power producer - we own and operate a growing portfolio of wind farms, currently totaling almost 700MW. Additionally, we operate a further 540MW for clients.

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