

A Response to National Grid on *Operating the Electricity Transmission Networks in 2020*

We welcome the opportunity to comment on National Grid's document on the requirements for flexible and backup capacity. We support National Grid's views on the issues arising from the integration of larger quantities of variable renewables to the "conventional" power.

In the situation where the fairly "static" power business is not converting to integrate large quantities of renewables and to thereby reduce CO₂, new technologies may be needed and developed by the technology providers. Such technologies are already in the market, successfully balancing power systems with 20% and more of their capacity coming from intermittent renewables. As appendix to our response, we offer you a white paper on one such flexible and dynamic technology option.

Modern flexible power plants are capable of delivering power to the grid in just 30 seconds from start command, and reach full power in 5 minutes, with no impact on maintenance schedule. These capabilities are undoubtedly beyond the reach of any other thermal power generation technology, e.g., gas turbines. We hope that such capabilities could prove useful and valuable to National Grid in the future.

Sincerely,



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Appendix 1: "White Paper – Combustion engine power plants"

RESPONSES

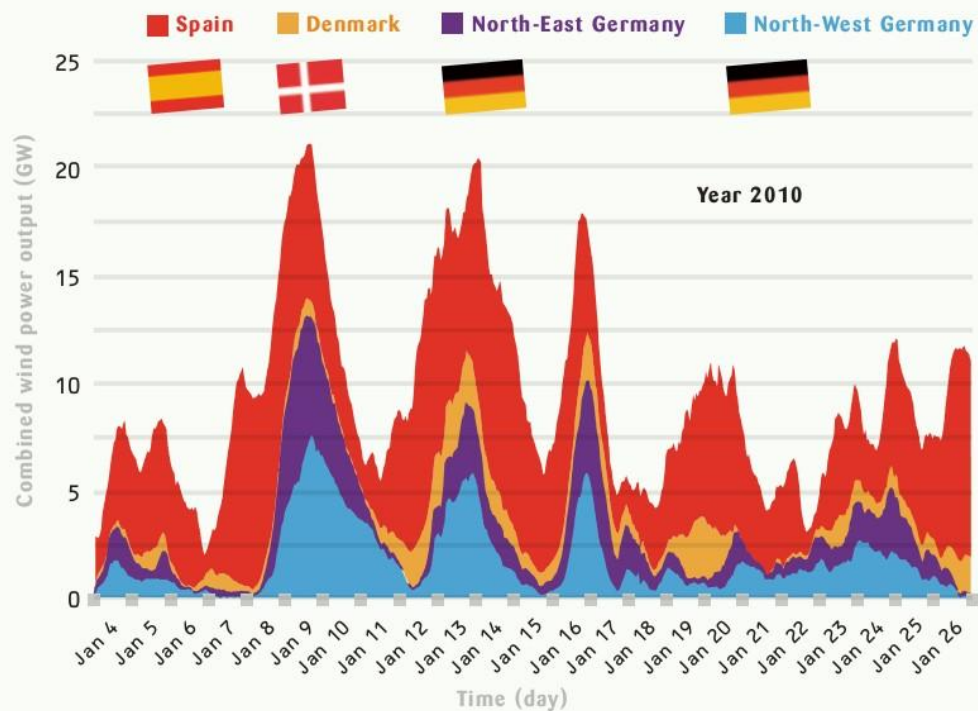
Question number	1 (p29)
Stated in the document	<i>Do you agree that cut out will be an issue for GB or will wind (onshore and offshore) turbine technology compensate for the GB wind resource density?</i>
Wärtsilä's response	<p>It is the view of Wärtsilä that wind cut out will be an issue for the GB grid. When discussing such eventualities, it is important to acknowledge that the relative frequency or probability of such events is only of secondary importance. Of primary importance are (a) the probable magnitude of the event, i.e. how many GWs of output will be lost in how many minutes, and (b) the understanding that sooner or later a cut out event will occur. In other words, regardless of whether a system-threatening event is forecast to occur once every year or every six years, the same level of contingency and back up will need to be implemented.</p> <p>Drawing from the experience in Scotland (p. 26 of <i>Operating the Electricity Transmission Networks in 2020</i>¹), where wind cut out has resulted in a 50% decrease in wind output within one hour, we can estimate that a possible similar event in GB grid in 2020 with 26.8 GW of wind capacity (p. 20, <i>OETN2020</i>) would create a sudden need for over 13 GW of despatchable output.</p> <p>Further, although future technological advances might be able to mitigate the issue of cut out to a certain extent, it is unlikely that the issue could ever be completely nullified. For the foreseeable future, then, and especially with respect to the amount of wind power to be added to the GB system in the coming decades, wind cut out will impose a constant and increasing threat to the grid.</p>

Question number	2 (p29)
Stated in the document	<i>Will wind turbines within a comparatively small geographical area behave in a consistent manner?</i>
Wärtsilä's response	As can be seen on pages 28 and 29 of <i>OETN2020</i> , the density of the wind resource is very uniform throughout the GB area. Consequently, it is only logical that wind turbines within a comparatively small geographical area should behave in a consistent manner. Fluctuations in wind speed can cause rapid divergences in frequency. In order to safeguard frequency, a very fast,

¹ Henceforth referred to as OETN2020

flexible, and local, i.e. distributed reserve could be deployed.

Equally interesting to the behaviour of wind turbines in a small geographical area is the behaviour of wind turbines in a large geographical area.



In the above picture² are overlaid the wind power outputs of Spain, Germany and Denmark between January 4 and January 26 of 2010. What’s striking about the picture is how well the major wind peaks – as well as troughs – coincide in all the three countries. In other words, it would seem that wider patterns of wind affect the whole of Western Europe rather than individual countries.

The picture puts the concept of balancing wind throughout Europe into question. Instead of balancing across regions, increasing wind penetration could very well exacerbate the problem of intermittency: at one end, the whole of Western Europe is experiencing a still week and electricity prices are spiking in every market; at the other, several countries are experiencing excess wind output, even base load plants are being shut down, while electricity prices are plummeting and even negative in some areas.

Question number	6 (p49)
Stated in the document	<i>Do you agree that there has been a permanent loss of demand as a result of the recession?</i>

² From Jacob Klimstra & Markus Hotakainen: *Smart Power Generation*, published in 2010, available as ebook from www.smartpowergeneration.com

Wärtsilä's response	<p>In July 2011, the UK Department of Energy & Climate Change (DECC) released the document <i>Planning our electric future: a White Paper for secure, affordable and low-carbon electricity</i>. On page 6 of said document, DECC states that “despite the improvements in household and non-domestic energy efficiency which will be generated through the introduction of the Green Deal and the roll-out of Smart Meters across the country, overall demand for electricity may double by 2050 due to the electrification of the transport, heat and other carbon-intensive sectors”.</p> <p>While it is difficult to ascertain the future electricity demand in the GB grid, based on the above it is our view that any shortfall resulting from the recent recession will eventually be made up.</p>
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Question number	7 (p60)
Stated in the document	<i>How significant would a 25% increase in [number of] starts be to the operation and maintenance of a CCGT?</i>
Wärtsilä's response	<p>Optimizing a CCGT plant is a very complex task of multivariable optimization. In order to maximize output and minimize fuel consumption, CCGT plants are typically optimized for base load operation – i.e. 8,000+ hours per year at 90+% of max output – in a relatively steady state. Most of the capacity existing today might not be suited for daily starts and stops and continuous ramp-ups and ramp-downs (also known as <i>cyclic operation</i>).</p> <p>Regarding the estimate of a 25% increase in number of starts for CCGTs, we can compare with some of the results from our own modelling³ regarding future power grids and specifically the operation of grids with considerable amounts of intermittent renewable power. By increasing the wind capacity in a system, we have seen dramatic increases in the number of starts and stops for CCGT plants, much more than 25%. We've also discovered that the number of starts and stops visible in the modelling depends on the granularity of the model, i.e. whether the model runs on a 10 minute or 60 minute interval. The more accurate the model is, i.e. the shorter the interval, the more starts thermal power plants experience, as the system has to take into account shifts in wind and solar output every 10 minutes, not just hourly deviations.</p> <p>When attempting to estimate the effect of cyclic operation on the operating and maintenance (O&M) costs of a CCGT plant, it is important to understand that said costs arise from many aspects of operation simultaneously. Areas of interest include at least the following:</p> <ul style="list-style-type: none"> • Actual operation mode • Gas turbine • Heat recovery steam generator (HRSG), steam turbine and

³ Should National Grid deem it of interest, we are eager to share and discuss our models and findings.

	<p>balance-of-plant components</p> <ul style="list-style-type: none"> • Emissions and fuel consumption <p>Firstly, the actual operation mode is what largely defines the extent of the cost impact. The number of starts and stops is arguably the most important variable, but it is essential to understand that every ramp up and ramp down also has an impact. In other words, merely fluctuating the output of the plant throughout the day to, for instance, accommodate fluctuations in wind output, is going to affect the long-term O&M costs of the plant. Also of importance are down times, i.e. how long the CCGT remains shut down before it is started up again. The longer the time between shut down and start up, the larger the impact of the start in terms of O&M cost.</p> <p>Secondly, the effect on the gas turbine itself can be estimated according to the guidelines provided by OEMs. Usually, these guidelines are based on what are known as 'equivalent operating hours' (EOH). According to this methodology, every action has a cost reflected in terms of operating hours. For instance, according to an industry rule of thumb, a single start with an industrial gas turbine equals 10 EOH – that is, one start causes as much wear and tear as 10 hours of normal operation at optimum conditions. As the maintenance schedule is laid out according to EOHs, it becomes apparent that operating a CCGT outside of its optimum parameters will lead to a shorter maintenance cycle, thus increasing costs.</p> <p>Thirdly, apart from the gas turbine, considerable damage is accrued elsewhere in the system. In fact, according to research by Intertek (cf. Power Magazine, August 2011, pp. 58-67), the majority of the damage caused by cyclic operation happens in the steam cycle, i.e. HRSG, steam turbine, and other related balance-of-plant components. As detailed by Intertek, the full effects and costs of cyclic operation usually surface months or even years after the beginning of cyclic operation.</p> <p>Finally, although often excluded from these kinds of calculations, it is very important to remember that when being operated at a non-optimal level, the efficiency of a CCGT plant always suffers, leading to higher fuel consumption and higher emissions per unit of electricity generated than in optimal i.e. base load operation. In fact, the impact on efficiency and the consequent effect on fuel and emission costs can easily be multitudes higher than the impact on maintenance cost.</p>
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Question number	18 (p81)
Stated in the document	<i>Do you agree that larger scale CHP such as district heating scheme developments are more probable or is there a larger role</i>

	<i>for domestic level or micro-CHP?</i>
Wärtsilä's response	We think that, in the future, distributed power generation will have an increasing role in the grid. Thus, CHP in the 10-50 MW scale could be something that the GB grid could deploy on a wider basis.

Question number	20 (p83)
Stated in the document	<i>What is a realistic view of the amount of PV installed capacity by 2020?</i>
Wärtsilä's response	<p>While we appreciate the role and importance of renewable in the future GB grid, we would like to point out that each additional MW will make the task of balancing the grid more difficult. Wind and solar are both intermittent in availability and difficult to forecast. Moreover, they don't correlate with each other, i.e. both have their own characteristic peaks and troughs. While it is true that by combining wind and solar might even out some troughs, it is equally true that sometimes the extremes of the two will coincide, creating even larger and steeper peaks and troughs into the system than either could produce on its own.</p> <p>Thus, the net effect of adding solar PV into the system could be to balance out benign fluctuation at the cost of making the low-probability, system-threatening events even more difficult to cope with.</p> <p>We would like to bring the recent experiences in Italy into National Grid's attention. During the first 7 months of 2011, more than 5 GW of new PV capacity was installed. This was in equal parts the result of a favourable regulatory regime and a speedy permitting process for new PV. Faced with an influx of new intermittent capacity, the main problem in Italy today seems to be ramping down thermal power plants quick enough in the morning to accommodate surging PV output.</p> <p>Thus, the addition of solar PV into the grid further increases the need for flexible, dynamic reserve capacity.</p>