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# Assessment of the GB Electricity System

## Introduction

Government decisions are being made about the GB electricity system on the basis of information that has not been properly tested. For example, statements are being made that the cost of wind energy is coming down and that it will soon become competitive with other forms of generation. In this document we provide a cost estimate that indicates that this is not the case and an explanation, based on measurements of wind power output, that shows why it cannot be so.

Only by making assessments based on the most advanced methods available can a fit-for-purpose electricity system be delivered. Some of these methods are noted in the document.

It is recommended that a Total System Analysis approach be adopted.[1]

## Estimate of cost for the GB electricity system

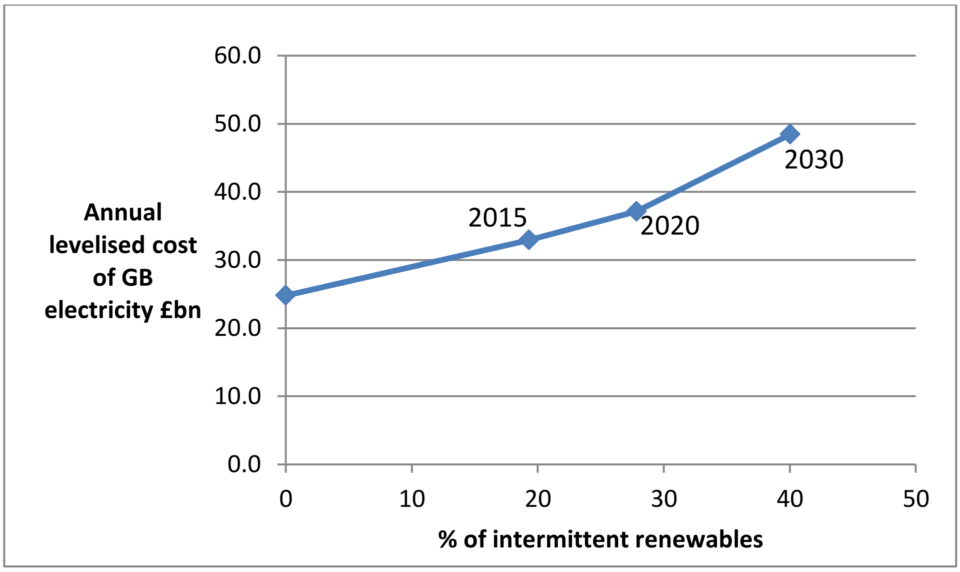


Figure 1 Cost of production for GB electricity system[2]

Figure 1 shows an estimate of cost of electricity as the percentage of renewables in the system increases.

This graph is based on the following:

- The mix of generation was taken as the average of the scenarios in the National Grid Future Energy Scenarios[3]

[1] http://library.iesis.org/2014/IESIS-trans154-paper1668.pdf

[2] The spreadsheet used for this estimate is available here. It was written by Mr Colin Gibson, formerly Power Network Director, National Grid Company

- Gas generation was added to the NG scenarios to meet a risk to security of supply standard of 8% i.e. that failure may be expected in 8 years in every 100. This is double the probability of failure used pre-privatisation.
- The levelised cost method was used taking account of system integration costs.[4]
- Wind generation was assumed to have an 'equivalent installed thermal capacity' of 10%

Note that by 2030 the estimate indicates that the cost will be almost double the present level.

Figure 1 represents the most accurate estimate that we can make using the limited resources available to us. It provides strong evidence for the need to create the equivalent of Figure 1 using the most advanced methods. This should involve:

- Using the total system cost method rather than levelised cost. Total system cost works from a detailed digital model of the system.
- The estimates for security of supply should be based on the combined probability of wind and thermal generation based on performance data.

## Why does cost increase with increased intermittent renewables?

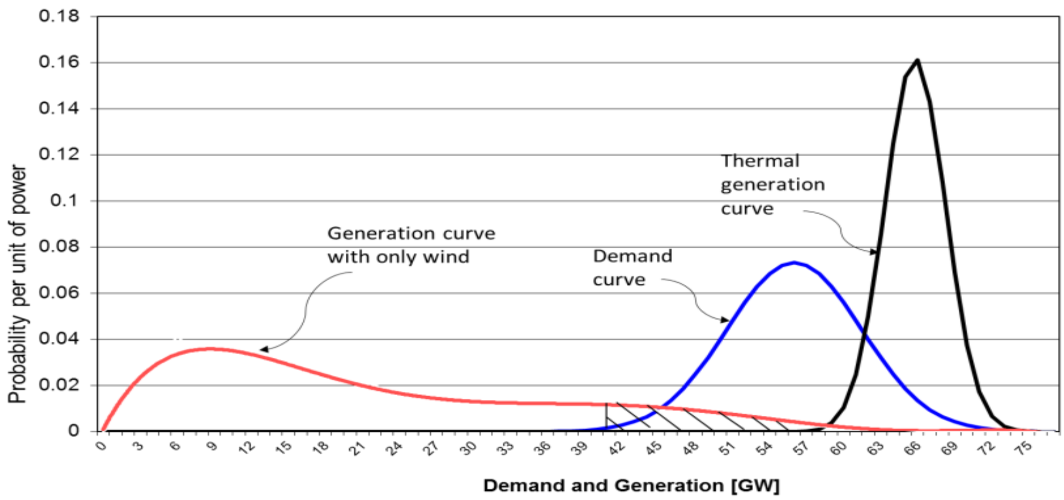


Figure 2 probability density functions for electricity generation and demand

The horizontal axis of Figure 2 represents electrical power up to 77 GW which is an estimate of the thermal generation needed to meet a typical security of supply criterion. The vertical axis represents values of probability density function (pdf).

The blue curve is the pdf for demand assumed to be a normal distribution with a maximum value of the function at about 56 GW.

The black curve is that for thermal generation, also assumed to be a normal distribution, with a maximum value of the function at about 68GW.

The red curve is for 77 GW of wind generation only. It has a maximum value at about 9GW.

To meet a security of supply standard, the generation pdf must lie to the *right* of the demand curve in the diagram. Overlap of peak demand and minimum generation indicates a risk that peak demand may not be met.

The wind curve lies almost wholly to the *left* of the highest demand value. With 77 GW of wind in the system there would be a negligible chance of meeting peak demand. The probability of meeting even the lowest demand of 40 GW with only wind is about 1 in 5.

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[3] http://fes.nationalgrid.com/

[4] The spreadsheet used for the levelised cost calculations is here

The wind curve shown on Figure 2 is an average from different parts of GB. Even in the windiest areas, e.g. the Western Isles and the Northern Isles, the curves are only marginally more favourable.

Interpretation of Figure 2 shows beyond doubt that any replacement of thermal generation by wind generation will cause a reduction in security of supply. Therefore as the wind fleet builds up, very little reduction in thermal capacity can be accepted. Two sets of generation are provided when only one is needed. This results in:

1. Extra transmission costs
2. Extra costs for backup for the wind generation
3. Extra costs because the thermal generators need to operate inefficiently when operating as subsidiary to wind generation.

These are 'integration costs' that will make a major contribution to increases in system cost as the proportion of intermittent renewables increases.

## $CO_2$ Savings

This section discusses another area where untested information is being used.

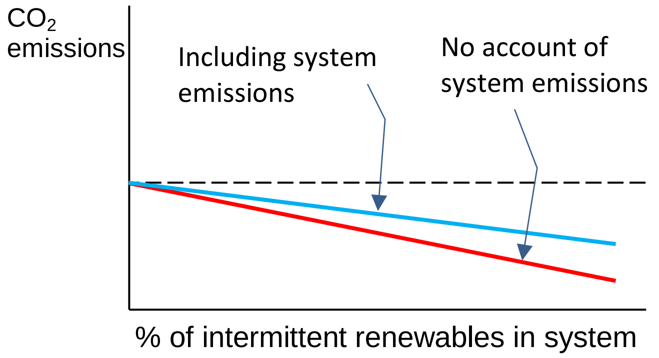


Figure 3 $CO_2$ emissions

In an electricity system comprising intermittent and thermal generators, coal and gas generators are used to control the system for demand and stability. Due to the high level of wind power fluctuation, the coal and gas generators need to be 'cycled' to cope with the much greater than normal variation in the power levels that they are required to deliver. They cannot work efficiently in such a mode and therefore produce more emissions than in the absence of wind generation. These are 'system emissions'.

Figure 3 indicates trends in reduction of emissions. The red line would be based on the assumption that, for example one megawatt hour of wind energy displaces this amount of gas or goal generation. The blue line indicates the emissions to be expected if system emissions are included in the calculation. That there would be system emissions is not in question. Analysis of generation from other countries shows that this effect can be significant.

What reduction in emissions can be expected from the GB system as the proportion of intermittent renewables increases? As far as we know, no attempt has been made to answer this question. The need to answer it as part of a Total System Analysis is manifest.

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