The Cost of Preventing Blackouts

How to Check the Health of the UK Electricity Supply Sector

John Constable

Summary

Concern about blackouts in the United Kingdom is misplaced. Government has allowed National Grid use of costly system management tools, ultimately paid for by consumers, that reduce to tolerable levels the probability of a failure in electricity supply. However, the cost is very high, and comes with obvious economic penalties, including the inhibition of further electrification of the UK economy, which is now using less electricity than it did in the early 1990s. These costs and consequences, not security of supply, which is a minimum requirement, are the fundamental test of government plans, and assessed by these criteria current energy and climate policies are mistaken and unlikely to be sustained.

Introduction

Government and National Grid are correctly undisturbed by articles in the press suggesting that policies, renewables policies for example, will result in blackouts. Indeed, to a degree government colludes in the language employed, for they know better than anyone that 'keeping the lights on', while politically crucial, is not the most demanding test of policy success, but only the minimum threshold. Indeed, this focus on system collapse is welcome since it distracts attention from more relevant symptoms of policy inadequacy, which are the costs and consequences of the system management practices required to keep the probability of loss of load below a reasonable level.

That is to say, even if electricity supplies are maintained, the expenditures required to deliver security may imply significant economic damage in addition to increased consumer prices. Indeed, I will argue here that policy-induced increases in the cost of electricity, and particularly the cost of maintaining secure supplies, are inhibiting, and probably reversing the long term trend towards the electrification of Final Energy Consumption (FEC) in the United Kingdom[1], a trend that is much to be desired from various perspectives, including that of climate change policy, and is probably a fundamental indicator of general societal progress and positive economic development.

---

[1] Final Energy Consumption is the energy used by consumers at the point of consumption, say in an electric light or in a vehicle. It is to be distinguished from Primary Energy, which is energy entering the economy for conversion, for instance coal being used in a power station to generate electricity, or unrefined oil entering a refinery.

Final Energy Consumption in the United Kingdom

There are two principal stories to be told about post-war Final Energy Consumption in the United Kingdom. The first is the surprising decline in this quantity since the turn of the millennium. After a long period of steady increase FEC peaked in about the year 2000, stalling at about 160 million tonnes of oil equivalent (mtoe) per year, and in 2005 began a decline that appears to be continuing, with consumption in 2014 of about 135 mtoe per year, a level last observed in the 1960s. While this might appear to be an indication of improvements in efficiency, or a shift towards a 'knowledge' economy, and therefore to be welcomed, the abrupt nature of the change, and the approximate coincidence with the economic downturn of 2008, all give cause for concern. Moreover, there are some theoretical reasons for thinking that a healthy economy will tend to consume increasingly larger quantities of energy even and in fact because of improvements in efficiency or a transition in character.[2] However, I will leave these questions to one side and merely note them as troubling background.

The second major story regarding FEC is the displacement of coal by petroleum, electricity and natural gas. In 1948 coal accounted for nearly 80% of FEC, yet by 2008 this proportion had fallen to less than 2%.

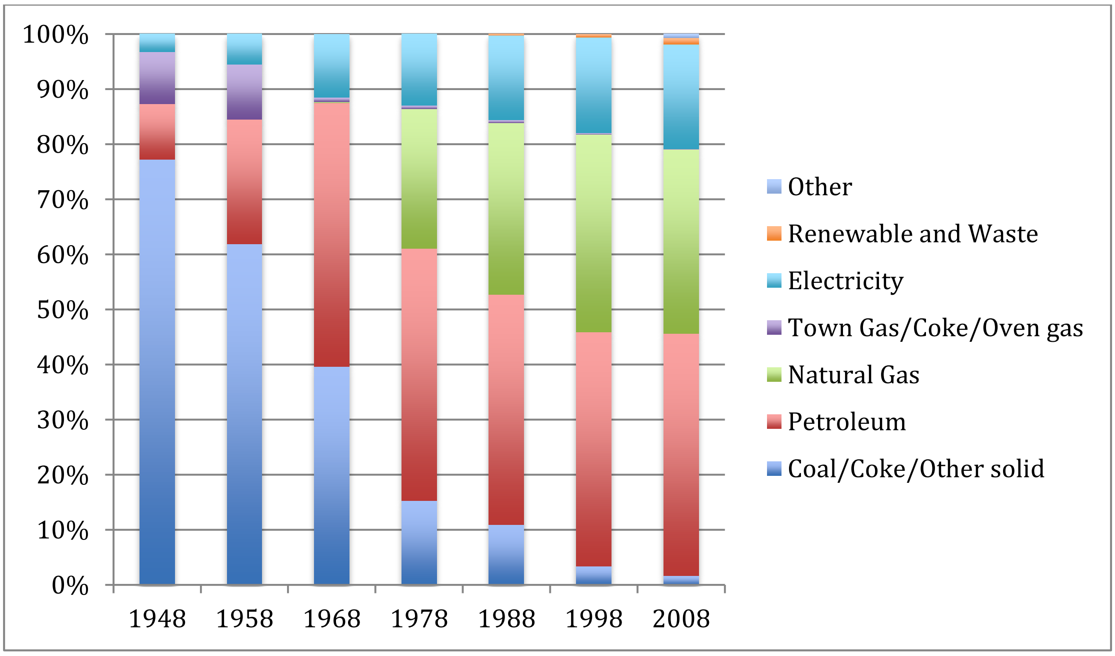

Figure 1: Final Energy Consumption in the United Kingdom, 1948 to 2008, by fuel type. Redrawn by the author from data in DECC, *60th Anniversary: Digest of United Kingdom Energy Statistics* (2008), 8.

[2] "Thermo-Economics: Energy, Entropy and Wealth", *Britain and Overseas*: *The journal of the Economics Research Council* 44/2 (Summer 2014), 3–14.

This reduction is not merely proportional: in 1948 about 1,180 Terawatt hours (TWh[3]) of coal was being used, but in 2008 this had fallen to about 30 TWh. (It is worth recalling that at the primary consumption level, the reduction in coal's share is less marked, declining from 90% (1,489 TWh) to 16% (441 TWh), a level largely accounted for by the continuing importance of coal in the electricity generation sector.)

Of the displacing fuels, the transition towards electricity is perhaps the most interesting and important in the longer term, as well as being the most unproblematically positive in character. Electricity is not a fuel in the same sense as gas or petroleum, but a very high grade *carrier* of energy, offering extremely high power density, low entropy, cheap and rapid transmission over long distances, and ready transformation into a wide range of forms at the point of consumption, heat, light, and mechanical energy, to say nothing of its importance in energizing informational systems. And of course all this is accomplished with remarkably little environmental pollution at the point of use. Further electrification of final energy consumption, then, seems straightforwardly desirable, and likely to occur spontaneously since it improves human facility and wellbeing. Electrification is also widely considered to be central to any viable long term decarbonisation of global energy supplies, and therefore a key component in policies intended to address climate change.[4]

However, and in spite of all these manifest advantages, the trend towards electrification appears to have faltered and to be going into reverse in the United Kingdom. Instantaneous load on the transmission network of Great Britain peaked at roughly 60 gigawatts (GW) in about 2002, and after a short period of flat-lining, is now falling, with the peak currently at about 54 GW, a level last seen in the mid-1990s. Such a fact could be accounted for by a combination of general efficiency improvements in conversion devices, such as the use of low wattage Compact Fluorescent Lights (CFLs) and Light Emitting Diodes (LEDs), and also a substantial rise in embedded generation, so is not necessarily troubling in itself, though as with the fall in Final Energy Consumption discussed above, the timing and abrupt nature of the change, and various other theoretical considerations, suggest that this explanation is not entirely satisfactory.

---

[3] 1 TWh = 1 billion kWh. An average UK household uses between 4,000 and 5,000 kWh of electrical energy per year.

[4] See Sugiyama, T, and A. Trembarth, "High Electricity Prices caused by Renewable Energy kills low carbon society". See also IPCC, WG3, AR5, Chapter 6. http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter6.pdf.

These concerns can be confirmed by reference to final consumption of electrical energy (MWh), which includes embedded generation, as represented in the following figure between 1965 and 2014:

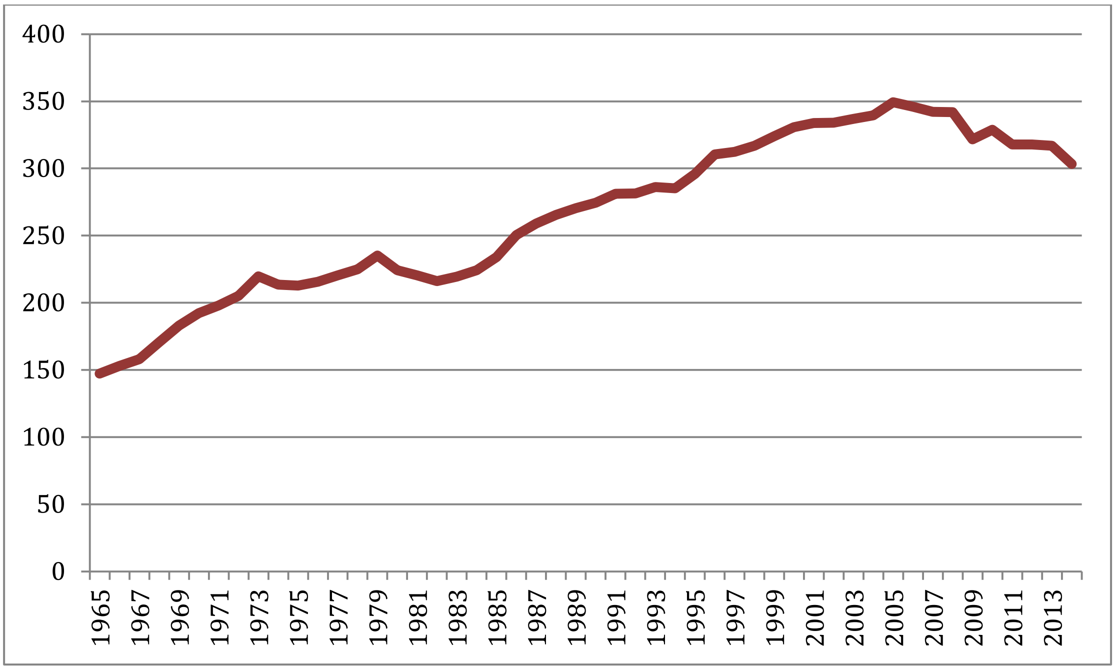

Figure 1: Final Electricity Consumption (TWh), 1965 to 2014. Source: DECC ("Historical Electricity Data", 1920 to 2014", 2015). Chart by the author.

Other data related to major power producers and in the same DECC set reveals a more or less smooth increasing trend from 1920 to the early 1960s, where this chart begins, after which clear perturbations appear, and from the late 1960s and early 1970s the pace of electrification appears to slacken, before going into decline, having peaked in 2005, at 349 TWh. The increasingly widespread use of gas for domestic heating and cooking is doubtless a key factor in the shift of the early 1970s. In later years, efficiency improvements should also be taken into account. However, the downturn must remain a matter for concern because a fall of this scale, a little over 45 TWh in under a decade, is clearly inconsistent with the UK's rising population, up from 59m in 2000 to 64m in 2013, a 9% increase (Office of National Statistics 2014). Remarkably, the United Kingdom is now using less electricity than it was in the mid-1990s, a fall which is in fact found in all sectors, industrial, domestic, commercial, and even the public sector.

Whether government policies alone are responsible for this remarkable shift is debatable; but it is beyond doubt that cost increases imposed by energy and climate policies, for example renewable electricity subsidies of £4 billion a year, will be inhibiting further electrification. I will further argue that the high costs of restraining the probability of system failure, which has risen as a byproduct of those renewables policies, threatens to exacerbate this problem, and adds a further argument in favour of a far-reaching revision of policy.

Is there Sufficient Electricity Generation Capacity to meet UK Load?

All casual discussions of the 'electricity crisis' begin with the question of 'keeping the lights' on, in other words a doubt as to whether there is sufficient generation capacity to meet instantaneous load, a question that is all the more exciting and novel since system reliability in the UK in the last forty years has been, industrial action aside, generally excellent. However, this has not always been the case, and as Hannah observed in his standard history, in the years immediately post-war "[…] demand sometimes exceeded the capacity available to meet it, with very slender margins of capacity over potential load. As a consequence both power cuts and voltage reductions were essential".[5] Indeed, as he observed, "given the incidence of breakdowns and repairs, even a positive spare capacity margin of less than 10 per cent was sometimes insufficient to maintain supplies." Hannah's data indicates a "spare capacity margin", i.e. the margin of capacity over theoretical potential load, not maximum load actually met, that exceeded 5% in only eight years between 1948 and 1963, and exceeded 10% in only three of those years. In 1950 and in 1962 negative results of -2.4% and -2.1% were recorded.[6] It was against this background, and in the knowledge that other systems in the world operated with larger margins, that, as Hannah reports, "since 1968 the supply industry in Britain has also increased its planned margins". Consequently, margins during the Central Electricity Generating Board (CEGB) period were uniformly generous, around 30% and sometimes much higher. This arguably too conservative margin was gradually reduced, as can be seen in the following chart, with the process beginning well before the privatization often identified as the cause. Indeed, if anything, the Dash for Gas of the 1980s seems to have bolstered the capacity margin.

[5] Leslie Hannah, *Engineers, Managers and Politicians: The First Fifteen Years of Nationalised Electricity Supply in Britain* (Macmillan: London, 1982).
[6] Leslie Hannah, *Engineers, Managers and Politicians: The First Fifteen Years of Nationalised Electricity Supply in Britain* (Macmillan: London, 1982).

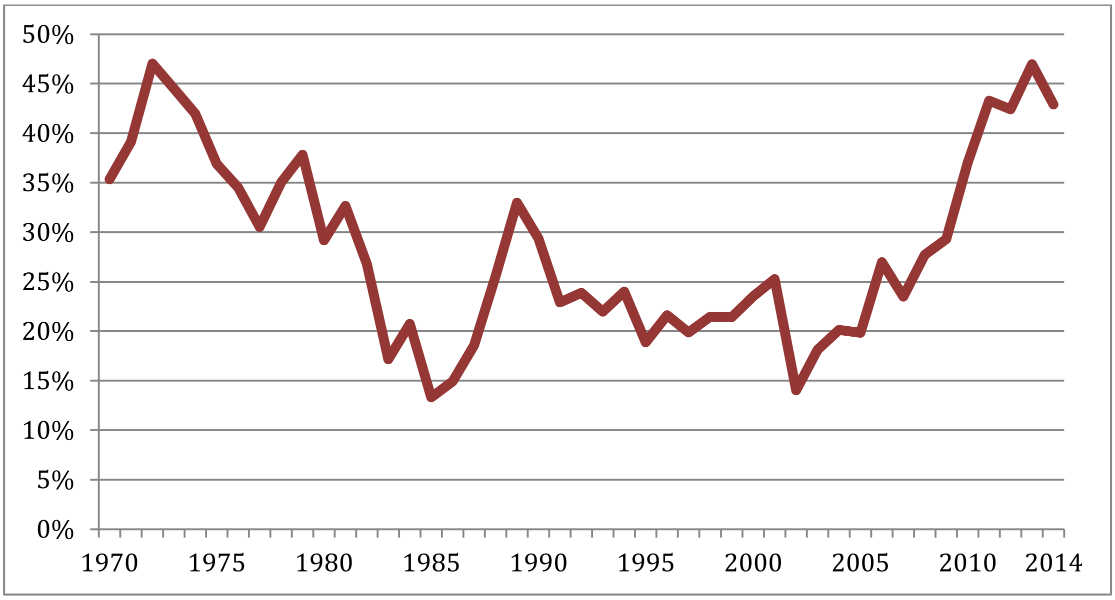

Figure 3: Capacity margin (%) in the United Kingdom, 1970 to 2014. Calculated as the margin Total Declared Net Capacity (DNC) over the simultaneous maximum load met on the system in that year. DECC, "Historical Electricity Data".[7] Chart by the author.

However, a casual glance at this chart might suggest that there is no particular problem at the present, since the capacity margin seems to have been growing steadily since 2002, with current levels comparable to the early 1970s, partly as a result of falling peak load and partly as a result of new power plant construction. To be specific, in 2014 there were power stations with a Declared Net Capacity (DNC) of some 77 GW, against a peak load of about 55 GW (down from 60 GW in 2005). In fact there is no puzzle here. Current concerns arise from the fact that much of the new capacity is wind and solar generation and so variable and uncontrollable and consequently not firm, by which is meant that it is has a low probability of generating at a specified output at any specified time, peak load on a dark cold windless winter's afternoon for example. In the jargon of the electricity industry, wind and solar are non-dispatchable, which is a crucial consideration in a system where supply is adjusted to meet demand on a practically instantaneous basis.

At the time of writing (December 2015) the UK has a total operational renewable electricity fleet of about 23 GW, of which 80% is not firm (5 GW of solar; 13 GW of wind, on- and offshore). A further 31.5 GW of capacity is under or awaiting construction, of

[7] https://www.gov.uk/government/statistical-data-sets/historical-electricity-data-1920-to-2011

which, again, 80% is not firm (4 GW of solar; and 21.7 GW of wind, on- and offshore).[8] In other words, of the 54 GW of renewable electricity capacity granted planning permission by the relevant governmental authority since 2002, over 80% (44 GW) contributes little or nothing towards the capacity margin. Thus, in spite of quite remarkable rates of construction, and vast capital investment (ca. £40bn), the renewables explosion has done little to address the need for new firm capacity required to replace conventional oil, coal, and nuclear power stations as they retire.

This problem has been well understood for some time, and analysts have been remarking on the matter since the rapid development of renewables first began as a response to the introduction of subsidies under the Renewables Obligation in 2002. EdF was amongst the first in the field, providing crucial data in evidence submitted to the government's "Energy Review" of 2006, data that predicted a rapid decline in conventional generation:[9]

> The UK is facing an electricity generation capacity shortage during the next decade as coal- and oil-fired power stations close, largely in response to new environmental controls imposed by the Large Combustion Plants Directive (LCPD), and as gas cooled nuclear power stations reach the end of their useful lives. […] Between now and 2016, 13 GW of coal and oil plant that have "opted out" of the LCPD will close. "Opted in" coal plant may also be closed by 2016 depending on the economics of fitting further equipment to reduce emissions of nitrogen oxides – for which new limits are to be introduced after 2015. 7.5GW of nuclear closures are scheduled by 2015. […] The UK will have a generation gap of 32 GW in 2016, assuming moderate demand growth and expected growth in renewables in line with the Renewables Obligation (RO). Even under very optimistic scenarios regarding grid electricity demand reduction the generation gap will still be 25 GW in 2016.[10]

These concerns quickly became mainstream, and in 2009 Ofgem initiated 'Project Discovery', a "year-long study of whether the current arrangements in GB are adequate for delivering secure and sustainable electricity and gas supplies over the next 10-15

---

[8] Calculated from data collected by DECC for the Renewable Energy Planning Database, and reprocessed by Renewable Energy Foundation at http://www.ref.org.uk/planning/index.php

[9] EdF's work, and that of others is reported and analysed in Sharman, H., and John Constable, "Going Black or Breaking the Rules?", Petroleum Review (Jan. 2009), 1-4. See also Sharman, H., and John Constable, *Electricity Prices in the UK: Fundamental Drivers and Future Trends* (Renewable Energy Foundation: London, 2008). Downloadable from www.ref.org.uk.

[10] EdF, *Energy Review* Submission (2006), 12.

years".[11] Ofgem reported on this work in February 2010, and "identified a number of concerns with the current arrangements and have concluded that significant action will be called for given the unprecedented challenges facing the electricity and gas industries".[12] One of the principal concerns identified was the lack of capacity:

> Short-term price signals at times of system stress do not fully reflect the value that customers place on supply security which may mean that the incentives to make additional peak energy supplies available and to invest in peaking capacity are not strong enough.[13]

From 2012 to 2014 Ofgem was obliged to produce an "Electricity Capacity Assessment Report", but this requirement was removed in 2015, ostensibly because the newly introduced Capacity Mechanism (CM), discussed below, has created an obligation on National Grid to produce a similar report. However, clearly realizing that the consumer would not necessarily be well-served by such a development, with the lack of independence that it entails, Ofgem has sensibly persisted in generating an equivalent report, focusing on National Grid's 'Future Energy Scenarios'.

In its latest report Ofgem, expects there to be some 71.6 to 75.3 GW of capacity, depending on scenario, in 2017/18, only 58 GW to 61 GW will be conventional, that is firm capacity. Consequently, the capacity margin will range from −1.9% to 5.1% depending on scenario, which is clearly low.[14]

Anyone unfamiliar with the electricity sector over the last decade might find this surprising, partly because the problem has been clearly identified for nearly a decade, and partly because it seems reasonable to presume that incomes could be gained from supplying this need. Why has so little conventional capacity with planning permission reached the Final Investment Decision that would initiate construction? The answer lies partly in the opportunity cost of so much renewables development, which has absorbed a very large part of the capital available for power sector investment. But the overwhelming cause is that the presence of so much subsidized renewable generation has in the UK market destroyed investment signals for otherwise fundamentally economic technologies. Ofgem itself notes:

---

[11] Ofgem, *Project Discovery: Options for delivering secure and sustainable energy supplies* (Feb. 2010).
[12] *Project Discovery* (2010), 1.
[13] *Project Discovery* (2010), 5.
[14] Ofgem, *Electricity Security of Supply* (2015), 14.

> Capacity in the market has continued to drop since last year's assessment. National Grid now expects a net reduction of around 4 GW of installed capacity between winter 2014/15 and 2015/16. This is a 2 GW net reduction compared to the expectations in Future Energy Scenarios 2014. National Grid projects this reduction is mainly caused by gas-fired plants leaving the market either permanently or through mothballing, due to poor plant economics.[15]

Why should gas plant be uneconomic? Because the electricity market has been coerced into accepting a large a share, some 20% in fact, of subsidized renewables and consequently gas-fuelled generators are now faced with load factors that are below their break-even level. In fact, Combined Cycle Gas Turbines (CCGT), which are technically capable of a 90% load factor, have in the last few years been compelled to run at a level that DECC itself concedes is about 30%.[16] Load factors this low inevitably make investment in new and even the operation of existing CCGTs deeply unattractive. Furthermore, with renewables poised to take still larger shares of the market because of continuing subsidies and targets, investment becomes extremely unlikely. If all the currently renewable electricity capacity with planning permission is built it will generate about 150 TWh of electrical energy, some 35% in excess of the target quantity for the EU 2020 Renewables Directive, and over 50% of the final consumption of electricity in the UK. In this context nothing else can compete.[17]

The present Secretary of State for Energy and Climate Change, the Rt Hon Amber Rudd MP, recognizes this, and in her major speech of 18 November admitted that:

> We now have an electricity system where no form of power generation, not even gas-fired power stations, can be built without government intervention.[18]

In effect, by distorting the markets so extensively with subsidies to uncontrollable and uncompetitive renewables the government has driven firm generation from the market, and so reduced the capacity margin to uncomfortable levels. Since government is reluctant to admit a mistake on renewables or backtrack on those commitments it has thus been obliged to introduce expensive system management tools to guarantee security of supply. In effect, having destroyed the market with subsidies to renewables it

---

[15] Ofgem, *Electricity Security of Supply* (2015), 14.
[16] DECC, Digest of United Kingdom Energy Statistics (2015), 122.
[17] See the calculations on http://www.ref.org.uk/planning/index.php
[18] https://www.gov.uk/government/speeches/amber-rudds-speech-on-a-new-direction-for-uk-energy-policy

is now compelled to introduce a Capacity Mechanism, discussed below, to subsidise conventional generators that in an undistorted market would be fundamentally economic and spontaneously attractive. This is an absurd situation.

Future Electricity Demand

Of course, the question of whether there is sufficient plant in the system to meet load relies crucially on projections of that load. Obviously, if electrification had continued to grow in the trend established before 1960, or at least between 1960 and 2000, then there would have had to be a major expansion of generating capacity to meet that demand, probably not dissimilar to that predicted by Bending and Eden, whose classic 1984 study, *UK Energy*, foresaw consumption of about 452–666 TWh per year in 2020 and a fleet of between 113 and 166 GW.[19] Even in 2006, as noted earlier, EdF expected moderate demand growth. But load and demand has not grown, indeed, after a period of flat-lining, it has started to fall sharply, leaving analysts with a puzzle, and the uncomfortable necessity of hedging bets. As Ofgem wrote in its recent *Security of Supply Report* (2015) of the approaching winter of 2016/17, "our assessment is that there is potential for the risks to be managed by either a strong market response or a continued reduction in demand."[20] In other words, if load and demand return to growth there would have to be a strong market response if the government's security of supply standard, a Loss of Load Expectation (LOLE) for three hours per year (i.e. 0.03%) is to be satisfied, but if the trend is towards further reductions in demand, then no additional market response will be called for.

One might think it reasonable to infer that the costs of climate and energy policies are making it all but inevitable that demand will not return to growth; in other words that the as a result of price rationing demand will continue to decline, and the problem is not blackouts but economic contraction. Indeed, in the short run, but perhaps only in the short run, economic contraction might assist with reducing the risk of supply interruptions. However, electricity demand forecasting is notoriously difficult over anything longer than a few years, and reference to earlier projections, such as those of Bending and Eden, which are impeccably reasoned, should be fair warning.

With this sort of background, familiar to all in the field, no current public decision maker can afford to gamble on future demand staying low, even though the current downward trend seems strong, and since 2013 three mechanisms have been introduced to allow National Grid to address the increasing risks to security of electricity supply:

---

[19] Richard Bending, Richard Eden, *UK Energy: Structure, prospects and policies* (Cambridge University Press: Cambridge, 1984), 186–187.

[20] Ofgem, *Electricity Security of Supply: A commentary on National Grid's Future Energy Scenarios for the next three winters* (17 July 2015), 4.

1. Supplemental Balancing Reserve (SBR), which is a scheme in which power stations that would otherwise close or be mothballed contract to be available at a specified time (at present described as weekdays in winter between 18.00 and 20.00).[21]
2. Demand Side Balancing Reserve (DSBR) is a scheme in which large energy users can contract to reduce their energy demand in return for payments from the consumer, via National Grid.[22]
3. The Capacity Mechanism (CM) is a scheme under which a power station, new or old, receives a guaranteed income, in effect a retainer, irrespective of the energy (MWh) it generates, and in return undertakes an obligation to supply capacity (MW) on request.[23]

SBR and DSBR are already active, and have been employed in winters 14/15 and 15/16, while the CM will become active in 2018/19. In passing it is worth noting that while all three are implemented in such a way that they retain elements of competition, via auctions, they have the general consequence of reducing competition in the electricity markets, and accelerating the trend towards administrative pricing. While arguably necessary in the short term, it is doubtful whether this is in the longer term interests of the consumer.

However, no one should be in any doubt about these mechanisms; they are powerful, and can address the difficulties insofar as they can be foreseen, restraining the LOLE to within the government's specified level (3 hours per year). Indeed, it is a tribute to the strength of the measures that one of Ofgem's principal findings in its most recent review is that without the SBR and DSBR, LOLE will fail to meet the government's Reliability Standard in 2015/16, potentially reaching levels of as many as 20 hours of interrupted supply, with a capacity margin of around 4% or less, and with the possibility of it running into negative numbers. However, with the special measures now available the LOLE falls to around 4 hours, or less, and the margin to around 6%, and no less than 3%.[24]

Briefly, these measures should work. Nevertheless, it is worth noting that they are not resulting in comfortably high margins, and indeed the situation in 2016/17 deteriorates,

---

[21] http://www.nationalgridconnecting.com/balancing-act/
[22] http://www.nationalgridconnecting.com/balancing-act/
[23] http://www.nationalgridconnecting.com/keeping-the-lights-on/
[24] Ofgem, *Electricity Security of Supply: A commentary on National Grid's Future Energy Scenarios for the next three winters* (17 July 2015), 12.

and margins are predicted to vary between 0% and 4% in spite of the available measures, though in 2017/18 the outlook improves as the Capacity Mechanism brings mothballed firm generation plant back into service. Even so, margins are still hardly impressive, with Ofgem only feeling able to predict a margin of about 3% to 7%, and LOLE “broadly […] within the government’s reliability standard”. This qualified result is disappointing given the costs of the mechanisms, to which I will now turn, putting them into the context of current and earlier Balancing Services Use of System Costs (BSUoS).

Balancing Services Use of System Costs

In an electricity system such as that in the UK, demand and supply must be balanced over short timescales, and the System Operator must take measures to correct for errors in the demand and generation forecast, as well as congestion in the transmission network. These include purchasing additional generation at short notice, as well several other ancillary services.[25] The cost of these services, including National Grid's own administration costs and profit, are initially charged to generators and to electricity suppliers, though, obviously, ultimately recovered from electricity consumers.[26]

The following chart tracks Balancing Services Use of System (BSUoS) charges, deriving them from the Settlement Final figures published by National Grid.

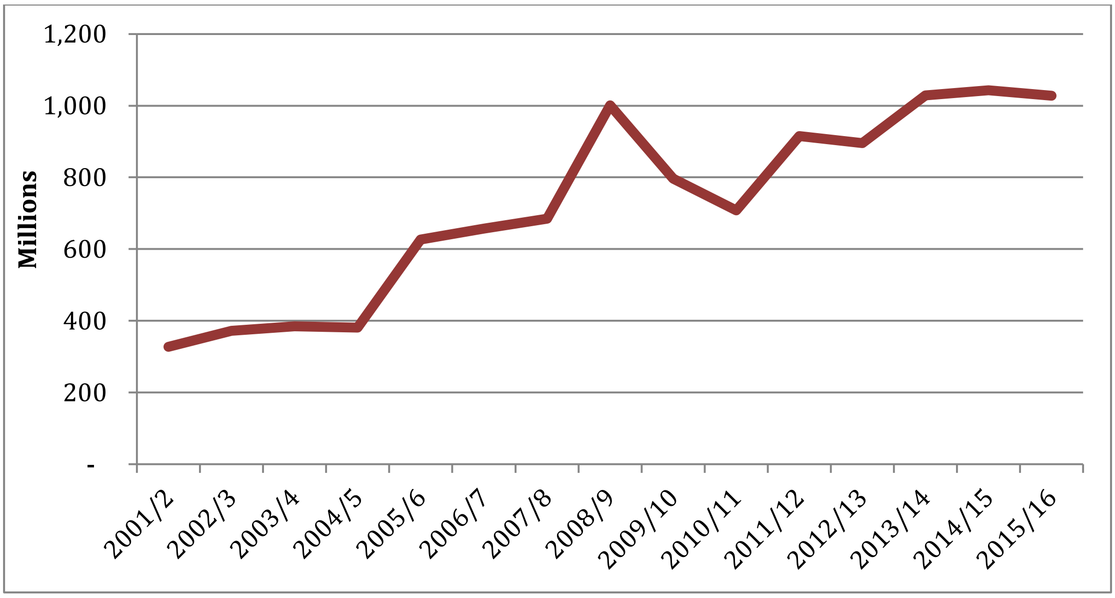

Figure 4: Balancing Services Use of System (BSUoS) costs 2001/2 to 2014/15. Data source, 2001/2–2014/15, current and historic datasets available at: http://www2.nationalgrid.com/bsuos/. Data for 2015/16, from National Grid estimates in *Monthly Balancing Services Summary* (Nov. 2015), 39. Chart by the author.

BSUoS costs have increased by a factor of three in the decade 2001–2012, a point that is all the more remarkable against the backdrop of falling demand, meaning that the BSUoS cost per unit of electricity carried through the system to consumers has increased by a factor well in excess three, and has now reached levels of about £3.5/MWh. This is in itself, and independent of other considerations, a severe criticism of policy.

[25] http://www2.nationalgrid.com/uk/services/balancing-services/
[26] http://www2.nationalgrid.com/bsuos/

While BSUoS may now fall, as constraint payments are eased by the construction of numerous grid reinforcements, including undersea High Voltage Direct Current (HVDC) cables on the eastern and western sides of Scotland,[27] overall costs to consumers will probably not fall, since the considerable capital cost of these reinforcements must be recovered from consumers at an annual rate of about 10% of the capital cost for the life of the assets, say 30 years, and this annual cost is unlikely to be less than hundreds of millions a year. Indeed, it is conceivable, perhaps likely, that the overall cost to consumer may exceed that of constraint payments. Under-utilised grid is almost certainly a less efficient way of dealing with the overbuild of Scottish wind power than paying wind farm owners to cease generating north of the main bottlenecks (currently £90m a year),[28] and then paying gas turbines to redress the consequent market imbalance south of the constraint (a cost known only unto National Grid). It would of course have been cheaper still not to overbuild wind in Scotland in the first place.

Furthermore, the special instruments introduced by National Grid are themselves expensive. SBR and DSBR, which are holding the fort until the Capacity Mechanism is implemented, cost £31.3m in 2014/15, £34.7m in 2015/16, and National Grid has successfully requested that both schemes be extended to 2017/18.[29] While this cost will presumably diminish or lapse when the CM starts, the cost to consumers will not fall, since the CM is expensive in itself, and the problems it will be addressing will be still greater. The Office for Budget Responsibility has estimated that in its first year, 2018/19, the CM will cost some £600m. In 2019/20 this expected this to rise to £1.1bn and then to £1.3bn in 2020.[30] These estimates would appear to be approximately correct. The first auction, for the year 2018/19, secured 49,300 MW at a cost of £19,400/MW, giving a total cost of £956m.[31] The second auction, for the period 2019/20 secured 46,534 MW at a price of £18,000/MW, giving a total cost of £834m.[32] Thus the total cost is approximately £1.79bn for just one element of BSUoS for these two years, 2018/19 and 2019/20, almost exactly the OBR's estimate.

---

[27] https://www.ofgem.gov.uk/sites/default/files/docs/monitoring_the_connect_and_manage_electricity_grid_access_regime_sixth_report_from_ofgem_0.pdf

[28] See the constraint payments data page at the Renewable Energy Foundation: http://www.ref.org.uk/constraints/indextotals.php

[29] https://www.ofgem.gov.uk/sites/default/files/docs/2015/10/minded_to_decision_to_extend_sbr_and_dsbr_cost_recovery_arrangements_until_2017-18_v1.1_0.pdf

[30] See Office of Budget Responsibility, http://budgetresponsibility.org.uk/economic-fiscal-outlook-july-2015/. Data from Fiscal Supplementary Tables.

[31] https://www.gov.uk/government/publications/capacity-market-location-of-provisional-results

[32] https://www.gov.uk/government/news/securing-future-electricity-supply

These costs are all the more striking when it is recalled that before the current energy and climate policies began to bite, i.e. before 2002, BSUoS was in total costing £300m a year, and that the need for the services covered by that charge, for instance Frequency Response and Black Start, have not disappeared. The CM costs are additional to the earlier BSUoS costs and do not replace them.

None of this is really surprising, and government has little excuse for having blundered into this situation. Many analysts foresaw the problems. In 2011 work by the present author and his colleagues at the Renewable Energy Foundation used work written for the Institute of Engineers and Shipbuilders in Scotland (IESIS) by Mr Colin Gibson, former Power Networks Director (PND) at National Grid, to estimate that the systems costs of the renewables target alone would put an additional £5bn a year, on the national electricity bill, including additional rapid response plant to cover errors in the wind forecast, additional grid and grid reinforcements, and the additional cost of running at low load factor a conventional generation fleet equivalent to peak load (plus a margin) in order to guarantee security of supply.[33] This estimated figure, which amounts to nearly £200 a year per household in total cost of living impact was plausible then, but is now increasingly so as the costs of some of the elements covered in Gibson's estimates are revealed empirically.

[33] REF, *Electricity Policy and Consumer Hardship* (London, 2011).

Conclusion

It seems reasonable to conclude that Ofgem is correct in thinking that while capacity margins are likely to be tight in the near term, particularly in 2016/17, the mechanisms available to National Grid, namely the SBR and DSBR, will restrain LOLE to a level roughly consistent with the government's Security Standard. After 2018/19 the Capacity Mechanism will take over and provide similar remedial treatment, and the risks of interruptions to security of supply will be thereafter be contained within reasonable levels.

However, these special measures significantly reduce competition in the electricity market, with serious implications for the consumer in the longer term, and come at a very high cost in the short and medium term. The total additional cost of subsidies to renewables (which will be upwards of £7.6 billion a year in 2020), and the system costs, including the special measures discussed above (perhaps £5bn), plus VAT, will add about £14 billion a year to the UK electricity bill, equivalent to just under 1% of current GDP. Such costs will be damaging in themselves, but will also drive the UK further towards de-electrification, a phenomenon that is already observable in the data and which raises grave doubts about the fundamental health of the UK economy. Such policies are, therefore, forcing the British people to choose between, on the one hand, an insurance policy to address climate change, and, on the other, modern prosperity. They may dither over this for some time, but the ultimate decision cannot be in doubt: the people of the United Kingdom, like any other people, will prefer to flourish. This is a needless dilemma. A low-cost clean energy system can be delivered with current technologies, probably a mix of gas and nuclear, but the greatest obstacle to its implementation is now the tangled web of embarrassed state commitments, long-term subsidy entitlements and deeply-vested interests created by the failed renewables experiment of the last twenty years.

In summary: The British public do not need a blackout to see that the energy and particularly the electricity policies of the United Kingdom over the last two decades have been disastrous. The casualties and collateral damage arising from the costs of the remedial actions necessary to prevent system failures are sufficient indictment.