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UKERC response to the Ofgem consultation 'Project Discovery: Future Energy Markets'.

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UKERC Response

The UK Energy Research Centre welcomes this opportunity to provide input to the Ofgem consultation 'Project Discovery: Future Energy Markets'. The UKERC response addresses a number of the questions posed in the consultation document.

Summary

- There are extremely ambitious technology deployment rates (for example for CCGT, heat pumps and electric vehicles) within some scenarios that could be challenging in reality and should therefore be subjected to stress testing.
- In addition to the need for appropriate investment signals, analysis should address the incorporation of a very active demand side and if the current arrangements can handle large amounts of intermittent generation supplying an elastic demand side.
- UKERC recommends that Ofgem consider a stress test that examines the loss of Norwegian gas supplies.

CHAPTER: Two

Question 1: Please provide comments on our approach of using scenarios and stress tests to explore future uncertainty, and as a basis for evaluating policy alternatives.

UKERC employed a scenario and stress testing approach during the Energy 2050 project and found that it was well understood and allowed exploration of a range of possible future outcomes and thus was ideal for evaluating policy impacts. The stress testing we performed allowed the impact of low probability events for different scenarios to be measured and possible mitigation responses to be evaluated [1].

There have been a range of UK energy scenarios that have relied on the approach of using high-level trends and subsequent modelling analysis; see the scenarios WP2 under the EON-EPSRC Transitions Pathways project for details [2]. In future stages of Project Discovery an approach would be to think through the actors and institutions that could drive/enable such transition - see the scenarios WP3 under the EON-EPSRC Transitions Pathways project for details [2].

Question 2: Are there other techniques for analysing uncertainty that we should consider?

There are a range of probabilistic modelling techniques that could be used to characterise and then propagate uncertainty in data. A significant issue is in assigning probability distributions to input assumptions.

For example stochastic modelling could be used to model uncertainly in data. This could be applied to wind generation modelling (wind speeds) and the effect it has on electricity prices.

Question 3: Do you agree with how we measure the impacts of our scenarios and stress tests?

We broadly agree with the approach to measurement of impact. However, we note the comments in paragraph 5.5 of the Next Steps section concerning future assessments of the adequacy of current market arrangements, the need for policy responses and the balance of risks and costs. For that reason, it might be helpful to take the stress test analysis one step further and identify the costs and welfare losses associated with demand curtailment. UKERC has adopted two different approaches to this. In the energy system MARKAL model, welfare losses are derived from demand elasticities. In our electricity/gas system models, we used value of lost load assumptions to monetise demand curtailment. This gave us a basis to compare the benefits of mitigating measures (e.g. storage investment) with their cost. If Project Discovery advances to the next stage and different market arrangements that provide different incentives for infrastructure investment are assessed, it will surely be necessary to monetise the impacts of demand curtailment, perhaps in combination with the probabilistic approaches discussed in Chapter 4.

Question 4: Do you agree with our key scenario drivers and choice of scenarios?

Broadly, the OFGEM approach seems both sensible and defensible. The main aspect that seems to be missing from the scenarios is how energy service demands might develop. It could be argued that in the Green scenarios, consumers might be more willing to adjust their energy service demands for environmental reasons. You do not seem to envisage this, and it might be worth spelling that out. Similarly the possibility of demand-supply interactions, e.g. through smart meters, do not appear to be explored. Again, you might wish to be explicit that you have chosen not to consider for, e.g. simplicity reasons, rather than that you have not considered it at all.

Additionally, it is not clear as to whether the scenario assumptions apply largely to the UK, the EU, the OECD, or the global economy.

Question 5: Do you believe our scenarios sufficiently cover the range of uncertainty facing the market, and hence cover the areas where future policy responses may be required?

No. Specifically some key assumptions appear to be in a narrow range. These include commodity prices and carbon marginal values. For example in 2020, oil prices are only from $80 to $90/bbl. Is this realistic if the scenarios are applied to the wider economy (see earlier comment on question 4, Chapter 2)?

As per the answer to question 4, Chapter 2, the scenarios are overwhelmingly concerned with supply meeting largely given energy service demands (consistent with Ofgem's remit). Again, it might be worth being clear that this is your chosen focus.

Question 6: Do you have any specific comments on scenario assumptions, and their internal consistency?
The assumptions for Green Transition and Green Stimulus scenarios listed on page 88 "Increase in Demand Due to Heat Pumps and Electric Vehicles" are somewhat at variance with the UKERC scenarios derived for our own Energy 2050 project [1]. While recent policy has pointed in the direction of incentives for both electric vehicles and domestic heating from heat pumps, the magnitude of increase suggested in the OFGEM modelling seems challenging.

Under current driving patterns, and using conservative efficiency figures, electric vehicles use around 2 MWh each per annum. This implies that 1.7 million vehicles (as recommended in the recent CCC progress report) would consume approximately 3.4 TWh per year. It is also worth looking at page 43 in BERR & DfT [3] to check your assumptions against the electric vehicle scenarios and electricity demand.

Also, it is not always clear if assumptions are inputs or model outputs. A specific example is the CO_2 price - i.e. is the modest price of €30-50/tCO_2 an input or output?

Question 7: Do you agree with our methodology for modelling gas and electricity supply/demand balances?
Annual, seasonal and daily balancing is sufficient for realistic interpretation of supply/demand patterns in scenarios where wind generation capacity is limited.

In scenarios where wind dominates the generation capacity mix greater granularity (within day, hourly) is required to determine operational supply/demand balancing.

Question 8: Do you agree that LNG is the likely medium-long term source of "swing gas" for the European market
This will depend on the relative price of LNG and pipeline gas imports (continental /Russian). Additionally, the capacity of import infrastructure will determine if LNG acts as “swing” gas supplies.

In the UKERC scenarios (UKERC Energy 2050 project [1]) LNG capacity by 2025 is comparable with pipeline imports (including Norwegian supply capacity). As a consequence of this increase in capacity combined with competitive LNG prices and a decline in domestic gas reserves, LNG supplies command the largest share of total gas supplies by 2025.

CHAPTER: Three

Question 1: Do you have any observations or comments on the scenario results?

The scenario results are driven by the assumptions and the model type - see earlier answer to question 7, Chapter 2.

Specific comments:

- The electrical energy demand in the green transition scenario (which takes into account the electrification of the heat and transport sectors to be expected by 2025) is more or less flat across all years. Energy demand decreases with energy efficiency gains until 2015 then increases, but we would have expected a more pronounced increase in the later years.
- The electricity demand for all 4 scenarios seems remarkably similar. At the very least it might be appropriate to consider increased electrical energy demand in the stress tests.
- The CCGT load factor in the green stimulus/transition scenario is expected to drop quite sharply (~75% to 25%) from 2009 to 2025. It remains to be seen if this reduction in energy revenues will allow CCGT owners to recoup their investment costs or if additional “capacity” related incentives are required.
- It appears that the timing of high fuel prices and investment requirements are correlated (with highest peaks in 2015 - 2020). This suggests severe upward pressure on UK electricity and gas prices - i.e. a direct contradiction between meeting carbon and security goals versus keeping prices low.
- Figure 3.8 on page 39 of the consultation document shows the change in GB generation capacity for the four scenarios at three points in time, 2009, 2020, and 2025. In both Dash for Energy and Slow Growth scenario, gas generation increases from approximately 27 GW to 54 and 48 GW respectively. Both of these scenarios envisage a second dash to gas, with resultant generation output greater than 50% of 2025 electricity demand. Is it realistic to assume that it is possible to continue CCGT deployment at a rate near that of in the dash for gas of the 90s (on average 2.5 GW/annum)? UK MARKAL scenarios show gas generation making up no more that 30% of electricity demand in 2025. It is also worth noting that in carbon constrained scenarios, gas electricity generation halts

around 2030, with the capacity standing by for backup to renewable technologies only. In all UK MARKAL scenarios, primary gas demand reduces by at least 20% on 2000 level by 2025. Is it useful to include two scenarios in which gas makes up such a large proportion of the UK electricity generation sector?

- Electricity demand in UK MARKAL scenarios generally agrees with that presented in the four Project Discovery Scenarios. Nuclear build rates are also in agreement with the UK MARKAL scenarios.

Question 2: Do you agree with our assessment of what the key messages of the scenario analysis are?

It is very important to stress the point made in 3.64 - that the future benefits of low-carbon electricity system mixes are not represented. An exclusive focus on costs of low-carbon gives the impression that there is the possibility of a low-cost, high-carbon scenario. This is most unlikely to be the case, as is made clear in some of the later discussion.

Question 3: Are there other issues relating to secure and sustainable energy supplies that our scenarios are not showing?

Electrification of the heat and transport sectors could maintain load factors of conventional generation thus easing concerns about how to justify investment but at the same time raising issues about carbon emissions and the decarbonisation of the electricity sector.

There has been some recent discussion about the larger availability that previously expected of supplies of unconventional gas. While more expensive that conventional gas if it both plentiful and geographically dispersed, this may serve to put a cap on the gas price and limit volatility. Is it worth mentioning this anywhere?

Question 4: To what extent do you believe that innovations on the demand side could increase the scope for voluntary demand side response in the future?

The role of smart meters in the development and operation of the electric power system should be investigated. Demand side participation could contribute to radically lower CO_2 emissions and reduced requirements for investment in assets.

CHAPTER: Four

Question 1: Do you agree that our stress tests are representative of the types of risks facing the GB energy sector over the next decade?
In the UKERC 2050 report (Chapter 3: A resilient energy system) [1], we analysed the following energy shocks using the CGEN (Combined Gas and Electricity Network) optimisation model [4]:

- Milford Haven (LNG) terminal: This shock resulted in the loss of all LNG supplies form Milford Haven.
- Bacton terminal: All continental imports (BBL and IUK pipelines) to the UK would be affected if there was an outage at the Bacton terminal. This shock is equivalent to a disruption of continental/Russian gas supplies.
- Easington terminal: Norwegian supplies would be affected through the loss of utilisation of the Langeled pipeline. The Rough gas storage facility would also no longer be available.
- Scottish and English electrical interconnector: An outage at of the Scottish-English interconnector (assumes total loss of interconnector, this would imply multiple substation failures).

The duration of shock was simulated over days (5 days); weeks (40 days) and months (90 days). Additionally, all simulations assumed a 1 in 50 severe winter demand.

Stress tests 1 and 2 (Re-direction of LNG supplies; Russia-Ukraine dispute) are in practice quite extreme. UKERC analysis of past events of this type have shown a shorter duration. Exploring the sensitivity of the outcome to the duration of prolonged disruptions would be useful.

Question 2: Are there further stress tests that you think should be considered?
Norwegian gas supplies to the UK are significant and over the next 10-15 years will still command a reasonable market share, therefore the potential loss of Norwegian gas supplies should be investigated.

In section 4.4, alternative stress tests not covered in the main document are mentioned. The risks of delays to infrastructure and commissioning of new capacity are two aspects that the UCL Energy Institute is also looking at using UK MARKAL Elastic Demand.

In UK MARKAL, delays in specific technologies or supporting infrastructure results in a shift from one technology mix to another as the model seeks to meet energy service demands.

MARKAL maximises the discounted net surplus of the whole UK energy system and so if one technology fails or is delayed in any five-year period it is replaced by the next most viable technology. Our scenarios run over a much longer time scale than those in Project Discovery. However, the scenarios show that between 2020 and 2035, more than 70 GW of new electricity generation capacity is commissioned, even in the base case (no carbon reduction targets). The majority of investment occurs in the period before 2035 indicating that this is a critical period as the electricity system is reconfigured. Key technologies identified in low carbon scenarios include the now familiar trio of coal CCS, nuclear and wind.

Stress tests that focus on the implications of specific technology failure should be included in the Project Discovery study. According to previous studies, using UK MARKAL, failure of an individual key technology will have little long-term effect on the optimisation of the objective function, maximising net discounted surplus, whereas failure of two or more of the key technologies results in a significant increase in cost [5]. However, it would be interesting to identify the short to medium term response to technology failure of gas and electricity prices and operation of the UK energy markets.

Question 3: Do you agree with the assumptions behind our stress tests?

In looking at gas interruptions, UKERC found that the level of investment in storage (and other infrastructure, including new interconnectors) had a very material impact on demand not met. We modelled an event similar to stress test 3 (Bacton outage) but needed to run our models over an extended period of time (not just one day) to explore the implications of investment in storage for mitigating impacts.

Question 4: Do you have any views on the probabilities of these stress tests occurring?

We do not have any insight on probabilities. UKERC looked at the historic incidence of events such as those covered by the stress tests as part of its UKERC Energy 2050 report. From these it was able to identify the nature and magnitude of relevant events but there was not enough information to form a robust basis for assigning probabilities. It was notable that the majority of the events we identified resulted from technical failures/weather/accidents rather than political action or market disturbances. We believe that these are still the most likely cause of stress to the system.

Given the technical causes of many stress events, it may be possible to start to assign, using subjective judgment or insights from the insurance sector, the probabilities associated with events with different magnitudes and duration. But having done so, the computational burden of running Monte Carlo simulations using bespoke system models that were designed for other purposes is considerable. UKERC is exploring the development of “reduced” versions of its models that could be run in Monte Carlo mode.

Question 5: Do you agree with how we have modelled demand curtailment in response to constrained supply?

UKERC employed a similar approach to demand curtailment in the Energy 2050 report [2]. VOLL (value of lost load) was used to value the impact of energy unserved. Our modelling approach explicitly modelled the interaction between the gas and electricity networks with gas fired power plants providing the link between these two sectors. Therefore gas fired generation would dynamically respond to price spikes due to supply shocks.

Question 6: Do you have any other comments on our stress tests?

In the UKERC Energy 2050 report we measured the impact of resilience measures (such as additional gas storage) would have on mitigating energy shocks. This provided analysis into the efficacy of different resilience measures and the possible policy related implementation issues.

Other issues

In addition to the need for appropriate investment signals, analysis should address the incorporation of a very active demand side and if the current arrangements can handle large amounts of intermittent generation supplying an elastic demand side.

Concerns include:

- The lack of liquidity in the electricity markets and their ability to accommodate the growth in short-term trading that will occur in matching large amounts of intermittent generation to a more dynamic demand base.
- How intermittent generation will fare given the still penal nature of the settlement process.
- To what extent self dispatch and self supply within a vertically integrated electricity sector leads to inefficient generation scheduling and unnecessary carbon emissions.
- The penal nature of the settlement process and how this will impact on the system with adequate demand side response.
- The inappropriate signals for transmission investment given by BETTA, possibly leading to unnecessary investment ands costs which will ultimately be borne by customers.

The report is restricted to whether the current GB arrangements are likely to give the right incentives for investment in generation. By taking a more holistic view in combining the scenario investment related approach with the appropriateness of market arrangements would lead to a deeper understanding of the challenges we face given the need to transition to a decarbonised and sustainable energy sector.

References

[1] UKERC Energy 2050 report, UKERC, 2009. http://www.ukerc.ac.uk/Downloads/PDF/09/0904Energy2050report.pdf

[2] http://www.lowcarbonpathways.org.uk/lowcarbon/publications/index.html

[3] BERR & DFT 2008. Investigation into the Scope for the Transport Sector to Switch to Electric Vehicles and Plug-in Hybrid Vehicles. London: BERR & DfT.

[4] M. Chaudry, N. Jenkins and G. Strbac, Multi-time Period Combined Gas and Electricity Optimisation, Elec. Power Syst. Res. 78 (2008) 1265-1279.

[5] PYE, S., HILL, N., PALMER, T. & OZKAN, N. 2008. MARKAL-MED model runs of long term carbon reduction targets in the UK (1). AEA.