2050 Pathways Call for Evidence Co-ordinator
Department of Energy and Climate Change
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2050 Pathways Analysis Call for Evidence

EDF Energy is one of the UK's largest energy companies with activities throughout the energy chain. Our interests include nuclear, renewables, coal and gas-fired electricity generation, carbon capture and storage (CCS), combined heat and power, and energy supply to end users. We have over five million electricity and gas customer accounts in the UK, including both residential and business users.

EDF Energy welcomes the 2050 Pathways Analysis, in that it sets out the long-term policy context for making the transition to a low carbon economy by making an explicit reference to the UK's legally binding target to deliver an 80% reduction in carbon emissions, and helps demonstrate the scale of the challenge ahead. We believe that, as well as concerted efforts to improve energy efficiency, large scale investment in electricity infrastructure is urgently required to replace existing plants and meet the UK's climate change targets.

It is important that the transition to a low carbon economy is progressed efficiently, to ensure that the competitiveness of UK energy supplies is maintained while also ensuring the stability and affordability of energy prices. While we believe it is important to incorporate a diverse energy mix, including nuclear, renewables and CCS technologies that could be applied to fossil fired generation plant, it is essential that the right decisions are made now and that mechanisms to secure investment in the most mature and most affordable technologies are progressed as a matter of urgency. The 2050 pathways that have been developed could help inform these priorities for policy development and accelerate the delivery of this investment.

This represents a major challenge for the electricity sector and it is important to take action now. The current market arrangements have served us well up until now, but these need to adapt to deliver the UK's revised energy policy objectives. We welcome the planned consultation by DECC on electricity market reform in the autumn, as well as the work that is being taken forward by HM Treasury to underpin the carbon price to ensure that we get a robust signal on the future carbon price. We hope these elements provide sufficient clarity to continue with our plans to invest in low carbon electricity generation.

We believe that the 2050 Pathways calculator is an important first step in demonstrating the different combinations of developments by which the 80% reduction in greenhouse gases by 2050 may be met, while ensuring that energy supply meets demand. We welcome the recognition that nuclear new build has a clear role to play in the decarbonisation effort and this is evident in five out of the six illustrative pathways. The only pathway that does not include new nuclear (Pathway Gamma) is deemed the most

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difficult (with a score of 81) and is the only occasion in the analysis that a 'Level 4' measure is needed within a pathway to meet the objective, requiring a substantial increase in storage, demand shifting and interconnection. Conversely, Pathway Delta (with the most new nuclear build), is deemed the least difficult (with a score of 71), and requires a minimum level of effort from almost all other low carbon technologies.

EDF Energy believes that energy policy must address the three overarching issues of decarbonisation of the economy, security of supply and affordability. While the 2050 analysis considers the first two elements in depth, we believe that the results would be greatly enhanced if complemented by cost analysis. We therefore welcome and support DECC's intention to explore the cost of the different illustrative pathways in more detail, and would strongly recommend the publication of a timetable for this. We believe this is an important piece of work and will be essential in getting consumer buy-in into Government policy decisions. It is also critical that DECC considers the risks associated with the practical delivery of the pathways because this will clearly have an impact on costs, and will in turn influence both the feasibility and attractiveness of the different options.

We believe that new nuclear will be a vital component of any pathway compatible with the 2050 objective, since it is the most internationally competitive and lowest cost option for firm low carbon electricity supplies, and can make a significant contribution to providing safe, secure and affordable low carbon energy in the UK. This is demonstrated in the analysis on page 43, which shows that Pathway Gamma, which has no nuclear new build, has the highest average gross per megawatt-hour cost of all the pathways under all fossil fuel price scenarios, whereas Pathway Delta, which has the most nuclear new build, has the lowest cost.

Nevertheless, we believe that all low carbon technologies will be required in order to achieve a diverse generation mix that will allow the country to meet both its climate change and security of supply objectives. We believe that low and zero carbon electricity will make a significant contribution to the decarbonisation of other sectors, such as heat and transport, and agree with the analysis that highlights the importance of the role of heat pumps and electric vehicles in the decarbonisation effort.

Our detailed response is set out in the attachment to this letter. Should you wish to discuss any of the issues raised in our response or have any queries please contact my colleague [redacted], or myself.

Yours sincerely,

[redacted]

[redacted]

Corporate Policy and Regulation Director

Attachment

Pathways Analysis 2050 Call for Evidence

EDF Energy's response to your questions

1 (a) Are there any low carbon technologies or processes or major demand-side options which are not currently included within the scope of the model but that you consider should be in the future?

EDF Energy believes that the model captures the main low carbon technologies (i.e. fossil fuel with carbon capture and storage, renewables and nuclear) that will make the greatest contribution to the decarbonisation of the UK economy. We welcome the fact that all six illustrative pathways assume an almost complete penetration of heat pumps by 2050 (~32 million) as we believe that the wide-scale deployment of heat pumps using decarbonised electricity can provide cost effective scalable heating solutions in contribution to the UK's renewable energy target, and in turn the longer-term 2050 objective. We also note the important role that electric vehicles will have to play in achieving the target, as all the pathways assume a 60-80% penetration of electricity in passenger kilometres travelled by car by 2050.

We believe that the transition to a low carbon economy should incorporate a diverse energy mix as this will help ameliorate any security of supply concerns. Of course, these technologies only reflect current technical know-how, and we would fully expect, given the long time-frame under consideration, that other emerging technologies will contribute to achieving enduring and sustainable emissions reduction across the economy with potential innovations in technologies such as hydrogen fuel cells that are not currently included in the model.

2 (a) Does the range of alternative levels of ambition presented for each sector cover the full range of credible futures? If not, what evidence suggests that the range of scenarios should be broader than those presented?

We note that the levels of ambition for each sector have been presented as four levels of potential roll-out, representing increasing levels of effort. However, we feel it is important to recognize that the 'Level 4' ambitions are indeed, as described, ones that test the very edge of plausibility. We would be concerned if their inclusion in this work was interpreted as lending credibility to these ambitions in the absence of more specific evidence to support them.

What appears to be missing at present is due consideration of the relative delivery risk embodied in the technology options being assessed. For example, as of today, nuclear is a far more proven and established technology than CCS technologies that could be applied to fossil fired generation plant; the latter represents a significantly higher risk when considering the possibility of capacity additions on any scale. It is crucial that the relative degree of difficulty between technologies is reflected in policy choices and that perverse situations do not arise where, for example, a 'Level 3' in one unproven technology is chosen ahead of a proven technology that was also at 'Level 3' (or even where the same result could be achieved using a lower level of effort using the proven technology).

2 (b) Do the intermediate levels of ambition (levels 2 and 3) provided for each sector illustrate a useful set of choices, or should they be moved up or down?

We believe that the two intermediate levels of ambition for nuclear are reasonable in choice given that it is a relatively mature technology and provides a cost effective means of decarbonising electricity. This further reinforces the pressing need for the Government to carry out the facilitative actions required in line with its indicative timeline. However, it is critical that other key constraints such as skills scarcity and supply chain bottlenecks are addressed at an early stage to prevent any slippage from this target.

The Government has previously published analysis[1] showing that there is a need for non-renewable generation to help fill a generation 'gap' in 2025, and that new nuclear power should be free to contribute to this. We believe that new nuclear will, subject to adequate implementation of the necessary facilitative actions, be well placed to meet a large proportion of this. As is mentioned in the analysis, there is already a clear precedent over what nuclear build rates can potentially be achieved by looking at the rates that France achieved during the country's major programme of nuclear build over 1979 and 1988, and this comparison provides a degree of robustness to the levels used in the model.

However, we have concerns over the level of consistency across the different sectors, in terms of comparability of effort. For example, the current operational capacity of offshore wind is 1GW and yet a 'Level 2' effort is equivalent to a total capacity of 60GW by 2050. This would require a globally unprecedented rate of growth of offshore wind, a strong assumption that potential planning delays would be minimal in nature and most likely relies on the assumption that the current subsidies mechanism (i.e. the Renewables Obligation) will be extended beyond 2037 and perhaps even be enhanced. Some of these points have been highlighted in a recent report by UKERC[2], which finds that the costs involved in offshore wind generation have escalated markedly, especially against early predictions. As the paper states, while 'there are grounds to be optimistic about offshore wind', this has 'to be tempered with *realism* about the challenges associated with its development'[3]. Even if the practical aspects of supply chain management and project delivery can be overcome, we do not believe that a 'Level 2' description is an accurate reflection of the difficulties that will be encountered in funding such an expansion through the significant subsidies that will be required from domestic and industrial consumers alike.

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[1] Draft Overarching National Policy Statement for Energy (EN-1), DECC, November 2009

[2] Great Expectations: The cost of offshore wind in UK waters – understanding the past and projecting the future, UKERC, September 2010

[3] Ibid, p97

More specifically, we would like to be reassured that, in developing the assumptions on offshore wind potential, the full challenges of re-blading are being taken into account. From 2030 onwards it is likely that, in addition to the requirement for new build, significant re-blading of existing turbines will be required. In other words, far more construction effort is needed to ensure that a given level of offshore wind capacity is operational in 2050 than for other generation technologies. This additional effort needs to be factored into consideration when assessing the viability of the installation rates assumed for offshore wind under different scenarios.

We appreciate that choosing the levels within a sector is a subjective process but we believe there is a need to take greater account of the difference between mature technologies and emerging technologies in assessing the level of effort required. For example, while EDF Energy acknowledges the potential contribution of CCS in decarbonising the power sector, and welcomes the Government's involvement in promoting the demonstration of CCS technologies, it has to remembered that this technology is currently still immature and has not been deployed in a commercial or technical capacity in the UK or elsewhere, and so by its nature contains an inherent degree of risk not found in other alternative low carbon technologies. Therefore, we believe that, as far as possible, DECC should ensure that the challenges of future investment in all technologies are treated fairly and consistently in the development of the relevant input assumptions and that the assessment of difficulty should include an assessment of the ability to secure the funding required to deliver the assumed outcomes and corresponding impacts on the affordability and the competitiveness of UK energy supplies.

Given the subjective nature of the process, we broadly support the judgements that DECC has made in determining the levels of ambition for each technology but would urge it not to revise upwards the levels of ambitions for specific technologies, unless this is based on firm evidence as opposed solely to optimistic forecasts, as this may have a significant impact on the presentation of the results.

2 (c) The 2050 Pathways Calculator currently describes alternative directions of travel rather than different levels for some sectors where changes reflect a choice rather than a scale. Is this a suitable approach and clear to users?

We understand the rationale behind some sectors being better suited to reflect a choice rather than a scale. However, we have found that, due to the structure of the model, some combinations lead to outcomes that are at first view, counter-intuitive. In our opinion, the heating module can provide some misleading and unexpected results, unless one reads the accompanying report in detail. This defeats the purpose of such an open tool aimed as much at the general public as at industry and policy makers. In particular, we find it misleading that two categories, namely 'electrification level' and the 'non-electric heating fuel' scenarios (confusingly referred to as 'primary non-electric source' in table D10), are presented as two distinct elements, when in fact both levers work together to create a set of 16 very different 'heating and cooling technology pathways'. In our opinion, this leads to some misleading results. For example:

- Starting from the Reference Pathway (all 'Level 1s') and simply changing the 'Home heating electrification' choice from 'A' to 'B', has a radical impact on the UK electricity carbon intensity (going from 403gCO_2/kWhe to 82gCO_2/kWhe in 2050), and initially this does not make much sense. However, on closer inspection this is due to a change in the heating pathway chosen, which implies a radical change in the heating technology assumed. In fact, going from 'A' to 'B' in the 'electrification level', while remaining on scenario 'A' for 'non-electric fuel' equates to changing from heating pathway 9, where gas boilers still dominate (80%), to heating pathway 11, where 90% of heating technologies are fuel cell micro-CHP, fuelled by biogas.
- Choosing a 'Medium' electrification level ('3') and 'Biogas' as the 'primary non-electric source' ('A') leads to heating pathway 10, which only has a 30% dependence on electricity. However, choosing a 'Low' electrification level ('2') and 'Power station heat' as the 'primary non-electric source' ('C') leads to heating pathway 14, which has a 34% dependence on electricity, and this is more than heating pathway 10, despite having a lower level of electrification.

These are just two examples of a number of other anomalous-looking outcomes, and we are finding it difficult to determine the actual relationship between the electrification levels and the non-electric heating fuel chosen and the resulting heating pathways. We believe it would be beneficial if the calculator interface was changed so that users were able to choose one of the 16 heating pathways for commercial and domestic heating/cooling, and believe that this would make the calculator more user-friendly.

3 (a) For each sector, are the input assumptions and the methodologies applied to those input assumptions reasonable?

We have the following comments on the nuclear assumptions:

- Load factor: The DECC 2050 analysis assumes a load factor of 80% for new nuclear plants out to 2050, albeit allowing for some flexible usage of nuclear plants. We believe this is low and undermines the full likely potential of 3rd generation nuclear power in the future UK energy mix. We would aim to achieve a load factor closer to around 90% for any new nuclear plant. This is justified based on the best performing plants in operation today around the world: in Finland, the Unit Capacity Factor is 94.7% over the last three years, and in the US it is 91.1%[4]. As the penetration of nuclear increases significantly, we expect that it will be technically possible for nuclear plants to operate more flexibly to help balance the system but this may not be the most economic way to operate the system.

- The DECC 2050 analysis assumes an own-use requirement of 10%. DUKES table 5.6[5], suggests that historical nuclear own use requirements have been slightly lower than that, at around 9%. However, we expect new nuclear plants to be more efficient. We

[4] http://www.iaea.org/cgi-bin/db.page.pl/pris.factors3y.htm?faccve=UCF&facname=Unit%20Capability%20Factor&group=Country
[5] http://www.decc.gov.uk/en/content/cms/statistics/source/electricity/electricity.aspx

would like to point out that the EPR's load factor of around 90% takes into account planned and unplanned outages, and that the capacity of 1630MWe is net of the plant's own use.

3 (b) Are the bioenergy conversion routes used in the model accurate, or are there more efficient routes for converting raw biomass into fuels?

While we do not have any specific views on the bioenergy conversion routes used in the model, we believe that as an overarching principle that the full life cycle analysis of CO_2 emissions should be considered, and that the appropriate standards and regulations are in place to limit unintended consequences or actions that undermine the wider intent of policy.

3 (c) Can the model's assumptions on wave resource be improved, for example regarding the length of wave farms, their distance from shore, the efficiency of devices, constraints from other ocean users, and other assumptions?

We do not have any specific views on this issue but given that this is an immature and emerging technology, we believe that visibility of the cost assumptions and the potential trajectories for cost reductions would be helpful in assessing the relative difficulty of this option.

3 (d) Can the model's assumptions on tidal stream resource be improved, for example regarding the method for assessing the resource at specific locations, and the scaling up of individual devices into an array?

Please see our response to 3(c).

3 (e) Is there any evidence that would help build an understanding of the potential impact of long term spatial development on transport demand, and how could this be accounted for in the model?

We do not have any views on this issue.

3 (f) Due to uncertainties in the evidence base on energy demand and associated emissions, the model currently sets out only one level of ambition for the future UK share of international shipping. Is there any evidence you could contribute to help build a greater understanding of the potential shipping trajectories?

We do not have any views on this issue.

3 (g) Could the relative roles of coal and gas out to 2050 vary from the assumptions shown in this work, and if so, how?

We note that the model assumes that all CCS generation is primarily to be coal-fired. However, we believe that there is scope for CCS to be fitted to gas-fired plant and it is for this reason we agree with the recommendation of the Committee on Climate Change (CCC) to fund at least one gas CCS demonstration project as part of the four CCS projects committed to by the Government. This would further support the UK's objective of securing the decarbonisation of the power sector. One of the primary benefits described by the CCC of having gas with CCS on the system is the better economics of the plant when running at lower load factors. This will be an important consideration as more intermittent wind comes on to the system. We therefore believe that an explicit objective of any gas with CCS demonstration project should be to prove that this type of plant is technically capable of operating flexibly in this way and is able to contribute to system balancing. However, as with other demonstration projects any subsidy to gas with CCS should be limited to the demonstration programme. After this the pace of implementation of CCS across gas generation should be driven by the carbon price and the electricity market - just as it should be for the implementation of all forms of low-carbon technology.

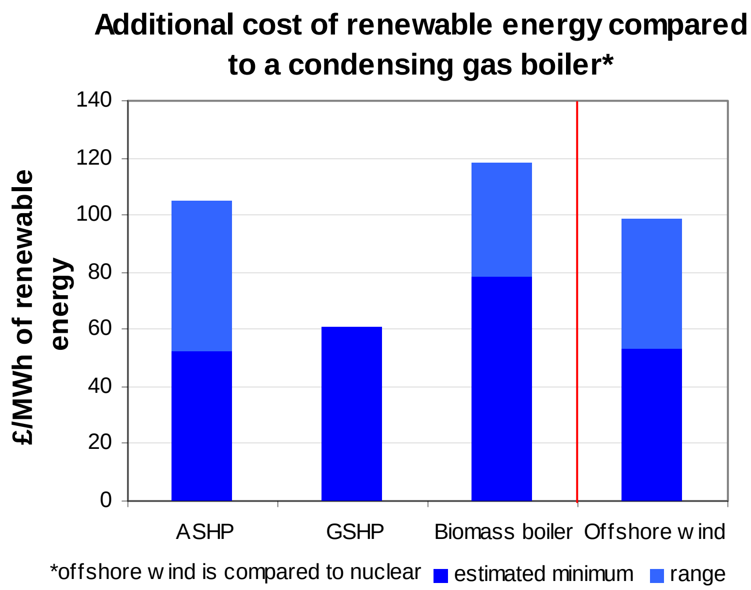
We also note that the model uses a standard load factor for each technology and so this does not allow for changes in assumptions on load-following or even degradation as plants age, and this will have an impact on the realism of the model.

4 (a) The introduction to the report sets out some of the implications and uncertainties common to the illustrative pathways. Does this list cover the key commonalities? If not, please identify other common implications and uncertainties and provide evidence as to why these are key conclusions from the analysis.

- We agree with all of the common implications and uncertainties listed across the six illustrative pathways, and in particular welcome recognition that low carbon electricity generation is expected to be a key driver in the decarbonisation of the heat and transport sectors. As is referred to, even though energy demand decreases in all but one scenario (Pathway Zeta: low behaviour change), electricity demand actually increases in each one, more than doubling in each pathway compared to 2010 levels. This is mainly driven by a very large penetration of electric technologies in the heat and transport sectors, namely heat pumps and electric vehicles (up to 90%), combined with a shift away from fossil fuels to electricity in the industry sector.

- While the decarbonisation of the UK electricity mix is a crucial step towards meeting our 2050 CO_2 emissions reduction target, it is not sufficient by itself. According to the DECC 2050 calculator, the maximum potential of supply-side measures is to reduce CO_2 emissions by only 40% compared to the 1990 baseline. This is achieved with nuclear, onshore and offshore wind at 'Level 2', and all other supply and demand measures at 'Level 1'. EDF Energy strongly supports the development of policy to decarbonise heat and the introduction of incentives to bring forward the commercial development of low carbon heating solutions. Not only will decarbonising heat play an important role in meeting the UK's 2020 renewable energy target, and the longer term 2050 objective, it is also likely to bring benefits in terms of security of supply, by reducing the reliance on fossil fuels to produce heat, and replacing them with low carbon alternatives.

EDF Energy believes that an increased emphasis on renewable heat with a corresponding reduction in the emphasis on renewable electricity provides an opportunity to deliver the UK's renewable energy target more cost effectively. Our analysis has shown that technologies such as heat pumps can compete on a £/MWh of renewable energy cost with offshore wind farms. We also believe that the opportunities to reduce the costs of renewable and low carbon heat technologies through wide-spread deployment of scalable technologies such as heat pumps are much greater than those that exist for offshore wind. We believe this sets an important benchmark in harnessing our efforts and implementing policy to deliver the UK renewable energy targets; and the potential for renewable heat should not be underestimated.



- The Committee on Climate Change (CCC), in providing its first report to Parliament in October 2009, confirmed that delivering the 2050 target is likely to require the power sector to be almost, if not completely, decarbonised by 2030, suggesting a carbon intensity of 70-110g CO_2/kWh by this date. It is worth noting that only one of the six pathways meets this milestone (Pathway Beta – Low CCS). However, this requires 100% of electricity reserves to be used and we note that the model assumes that anything above this would require the construction of OCGTs, which will have additional implications on affordability. We believe that the model would benefit by building in a number of checkpoints, particularly during the period 2025 and 2035, to ensure that the pathways are deliverable, and are not restricted by physical balancing constraints. It is important that any trajectory is realistic and does not solely focus on the 2050 end game.

- We also welcome the recognition (p36) over the uncertainty of the availability of sustainable bioenergy, given the likely global demand for sources from a wide range of sectors. While we believe that bioenergy can play a role in decarbonising heat, we believe that there should be caution over its use. Biomass will vary greatly in terms of energy and carbon content which could significantly impact on the costs of providing renewable heat solutions and the delivery of low carbon heat. It is not reasonable to assume that the majority of biomass supplies will provide a carbon neutral solution. In reality, the carbon savings achievable from biomass are wide-ranging, depending on the type and source. This variability is reflected, for example, by the sustainability criteria for bio fuels, as set out in the EU Renewable Energy Directive [Article 172(2)] which establishes a minimum greenhouse gas value of 35%, rising to 50% from 2017 and to 60% from 2018.

  Sustainable bioenergy resources are limited and this can affect the sustainability of a large-scale exploitation of bio-energy. As highlighted in the analysis, there are considerable uncertainties over land use impacts, fuel and transportation costs, emissions from transportation, storage and air quality issues, especially in urban areas. With these factors in mind, bio-energy should be used where it can gain maximum efficiencies. For heat, it is most suitable for use in industrial and commercial scale applications. For homes, due to air quality, transport and fuel storage and supply chain constraints, the potential for individual biomass boilers will be niche rather than a mass-market solution. For these reasons, we do not believe that the bioenergy requirements in Pathway Gamma (no new nuclear) or Pathway Delta (low renewables) are likely to be achievable, given that it requires the UK to import an amount of bioenergy equivalent to its entire projected market share by 2050.

5 (a) What criteria should be taken into account in understanding the impact and relative attractiveness of pathways?

EDF Energy believes that energy policy must deal with the three general overarching issues of decarbonisation of the economy, security of supply and affordability. We believe that fulfilling the first two objectives, at least-cost, should be the basis for assessing the relative attractiveness of different pathways. The analysis is incomplete without a consideration of costs, and this will make it more difficult to draw useful clear conclusions from the work. It is important that the transition to a low carbon economy is progressed efficiently to ensure that the competitiveness of UK energy supplies is maintained while also ensuring the stability and affordability of energy prices. We also believe it would be useful to take into account the risk associated with the practical delivery of the pathways. Although it would be interesting to have additional assessment criteria such as the degree of social change required or the level of involvement of UK industry etc, we believe that these would be difficult to quantify and would introduce an additional layer of complexity to the model, and would detract from the key issues stated above.

We therefore welcome and support the intention by DECC to explore the cost of the different illustrative pathways, and would strongly recommend the publication of a timetable for this. We believe that new nuclear will be a vital component of any pathway compatible with the 2050 objective and that it is the most internationally competitive and lowest cost option for low carbon electricity supplies, and can make a significant contribution to providing safe, secure and affordable low carbon energy in the UK. This is demonstrated in the analysis on page 43, which shows that Pathway Gamma, which has no nuclear new build, has the highest average gross per megawatt-hour cost of all the pathways under all fossil fuel price scenarios, whereas Pathway Delta, which has the most nuclear new build, has the lowest cost. It is also noted that under Pathway Delta, it is easier to balance the system and no additional back-up capacity is required beyond what already currently exists.

Independent scenario analysis carried out by Pöyry Energy Consulting for EDF Energy also clearly demonstrates that placing greater emphasis on nuclear power (the other two scenarios being a Renewables-emphasis and a CCS-emphasis) significantly reduces the cost of decarbonisation, an outcome that is clearly in the best interests of UK consumers and industry. The analysis shows that by 2030, the total cumulative investment requirement in the Renewables-emphasis scenario is £38 billion (24%) higher than the Nuclear Emphasis scenario, increasingly significantly to £115 billion (54%) by 2040, largely due to the requirements to re-power wind turbines after around 20 years of operating life. A similar pattern emerges with regards to annual system costs, with the Renewables Emphasis scenario again being the most expensive. In 2030, annual costs are £6 billion (18%) higher in the Renewables Emphasis than the Nuclear Emphasis scenario, rising to £18bn (43%) by 2040. Therefore, while there may be a number of different pathways by which the 2050 objective may be met, it is clear that a greater emphasis on nuclear significantly reduces the cost of carbon reductions.

6 (a) Can you suggest a methodology by which the wider cost implications of choosing one pathway over another could be accurately reflected, and any relevant findings from such an approach?

As stated above, we believe that an assessment of difficulty should include an assessment of the ability to secure the funding required to deliver the assumed outcomes and the corresponding impacts on the affordability and competitiveness of UK energy supplies. It is crucial that technology costs are backed up by firm evidence of costs (for example, by reference to costs internationally), as opposed to forecasts based on optimistic assumptions of future economies of scale and 'learning by doing'. While we would like to know, as a matter of urgency, the *total* cost of the various pathways in order to extract real value from the model, we believe that it would be beneficial if the cost of generation of the different pathways, on a £/MWh basis, was at least given, even as just an interim measure. This would be a useful starting point on costs.

7 (a) Do you have any further suggestions for refining the 2050 Pathways Calculator?

We have made the following observations:

- Industrial Processes - the industrial processes module is quite simplistic, and it would be beneficial to enable the user to choose more options. At the very least, it would make sense to split "size of the UK's industry" and "carbon intensity of the UK's industry" as they are two distinct categories.

- Economics of generation plants - it does not appear that the model takes into account the resulting economics of either the fossil or the low carbon plants on the system. The model enables the user to provide significant overcapacity of low carbon generation which makes no commercial or economic sense. Also, the load factor (and hence economics) of fossil fuel generation technologies, mainly CCGTs, are not taken into account.
- Waste module: we could not reconcile the waste module as described in the report (section F). Pathway E (Pathway C on waste arising, 1 on marine algae and agriculture and land use) shows that the amount of energy from Waste is 180.5TWh in 2050, including 46TWh from agriculture and land use. 'Level 1' on marine algae leads to no energy from algae by 2050, leaving 134TWh that has to come from waste. The report (Figure F4, p156) shows that the theoretical maximum energy production from waste is 100TWh. We would welcome clarification on this discrepancy.
- We have concerns over whether the model adequately answers the question of security of supply, which is based on National Grid's concern regarding a 5-day anti-cyclone blocking event. This is because the assumed contribution of wind during this period is 20%, which we believe is too generous compared to other work on this subject, and that the drop in the load factor from 30% to 20% is not sufficient.
- We also believe that the model should take into account the seasonality of wind, which is currently not considered and has implications on seasonal storage, and that it would benefit by using a load duration curve approach to take account of the reality of seasonal and daily load shapes. This would help avoid misleading conclusions over the feasibility of certain pathways.

7 (b) Could the 2050 Pathways Calculator be improved to reflect the fact that the level of ambition for some sectors will depend on local preferences? Could the Pathways Calculator be improved such that the inherent degree of individual and local choice in a chosen pathway were clear?

EDF Energy supports the idea of the greater community involvement in local projects through a collaborative process that promotes social engagement and participation. Local choice can help achieve consumer buy-in and this is a key factor in facilitating the social change that will be required in the transition to a low-carbon environment. However, we believe that for the purposes of this exercise that incorporating such local preferences is beyond the scope of this model which is primarily focused on a national problem (i.e. reducing greenhouse gas emissions) and the national need for vital infrastructure, and would introduce an additional layer of complexity to a model that is already facing a series of unknown variables.

EDF Energy
October 2010