Project Discovery
Energy Market Scenarios Update

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Overview:

This document updates and extends the scenario analysis and stress testing that we described in our October publication for Project Discovery. It is an accompanying document to Project Discovery: Options for delivering secure and sustainable energy supplies. The purpose of Project Discovery is to examine the prospects for secure and sustainable energy supplies over the next 10-15 years. We have made changes to reflect new information and feedback received through the consultation responses.

Gas demand has reduced across the scenarios to account for the impacts of higher fuel prices, higher domestic energy efficiency and slower economic growth than expected. Electricity demand has increased in the non-Green scenarios to allow for some electrification of heat and transport in these scenarios. These changes have resulted in reductions for our estimates of CO_2 emissions and consumer bills, especially in the Dash for Energy scenario, in which consumer bills now increase by 52% by 2016 instead of 60% previously. In addition, our revised results for stress tests suggest that shocks to the energy system might lead to slightly more demand curtailment in the non-Green scenarios. The overall impact of these changes does not materially affect the conclusions presented in the October document. Each scenario shows that energy supplies can be maintained but the analysis continues to expose real risks to supplies, potential price rises and varying carbon impacts over the medium term.

In response to feedback, we have extended the model to include estimates for the impact on industrial and commercial customers, consumer surplus, generator profitability and cost of capital variation. We have also included three additional stress tests - for gas quality issues, investment delays and oil price shocks.

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Associated Documents

- Project Discovery – Options for delivering secure and sustainable energy supplies. February 2010. Reference number 16/10

http://www.ofgem.gov.uk/Markets/WhlMkts/Discovery/Documents1/Project_Discovery_FebConDoc_FINAL.pdf

- Project Discovery - Energy Market Scenarios. October 2009. Reference number 122/09

http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?file=Discovery_Scenarios_ConDoc_FINAL.pdf&refer=Markets/WhlMkts/Discovery

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Summary

Our key conclusions presented in the October consultation document were that under each of our scenarios energy supplies can be maintained over the next decade and beyond, but there are real risks to supplies, potential price rises and varying carbon impacts. We do not believe that the overall impact of the updates and extensions provided in this document materially changes these conclusions.

The main changes that we have made relate to revisions to gas and electricity demand. Gas demand is now lower across the scenarios while electricity demand is higher in the non-Green scenarios. Further information about these changes, and the reasons for them, are provided below. The principal impacts have been to reduce our estimated increase in consumer bills and CO_2 emissions in the scenario analysis, while there is now greater risk of demand curtailment in the non-Green scenarios for the electricity stress tests. Updates to our Gross Domestic Product (GDP) and storage assumptions have also had a slight impact on our results.

The changes that we have made to the assumptions since our October Energy Market Scenarios publication are summarised in Table 1 below. These changes have been made to reflect new information and responses to our consultation document, 'Project Discovery: Energy Market Scenarios' published on 9 October 2009[1].

Table 1: Revisions to Discovery model input assumptions

Variable	Source of revision		Impact of change
Gas storage	Stag Energy response and Exemptions data	↓	Investment
Russian gas production	Gazprom response and IEA	↓	EU gas pipeline flows
LNG liquefication	National Grid 10 Year Statement	↑	LNG liquefaction capacity
LNG regas capacity	National Grid 10 Year Statement	↑	LNG regas capacity
Annual gas demand	National Grid 10 Year Statement	↓	Annual gas demand
Peak gas demand	National Grid 10 Year Statement	↓	Peak demand
Electrification	UKERC response and Element Energy 2009	↑	Electricity demand in Non-green
Renewables generation	Various responses	↑	'Green' generation
LCPD oil plants	Energy Markets Outlook	↑	LCPD oil capacity
CCGT build	ATCO Power	↓	Investment
GDP	HM Treasury forecasts	↔	↓ 2009 and ↑ in 2010-12
Commodity prices	Bloomberg	↑	Oil prices

[1] Ofgem 2009, Project Discovery: Energy Market Scenarios, Ref: 122/09.

We have revised our gas demand assumptions downwards across all scenarios to account for higher fuel prices, higher domestic energy efficiency and slower economic growth. In the near term, this reduction is due to the greater than expected impact of the recession and reflects National Grid's latest Ten Year Statement (TYS) published in December 2009. In the medium term, this reduction increases in the Green scenarios to allow for the effects of electrification of heat and a stronger link to renewable technology, which means energy for heat is increasingly drawn from sources other than gas. In contrast, for the non-Green scenarios this reduced gas demand moves back our previous estimates in the medium term through the impact of higher electricity demand due to greater heat and transport electrification that increases gas consumed in the power sector.

For electricity, we have included demand from heat and transport electrification in the non-Green scenarios, which creates a 12.4 TWh annual increase by 2025 in the non-Green scenarios. In contrast, new information about the electricity consumption of heat pumps and electric vehicles has reduced annual electricity demand in the Green Scenarios by 19.3 TWh by 2025.

Our GDP assumptions are based on Treasury forecasts, which since October have been revised downwards for 2009 and upwards for 2010-2012. Updated assumptions on projects under construction have reduced storage capacity in all scenarios by around 0.3 bcm by 2014. In the Dash for Energy scenario we have pushed back some of the 4.5 bcm of further storage assumed built by 1-2 years to reflect the lower demand. We have also pushed back 0.5bcm of the additional storage projects in the Green Transition scenario for the same reason.

Scenario analysis

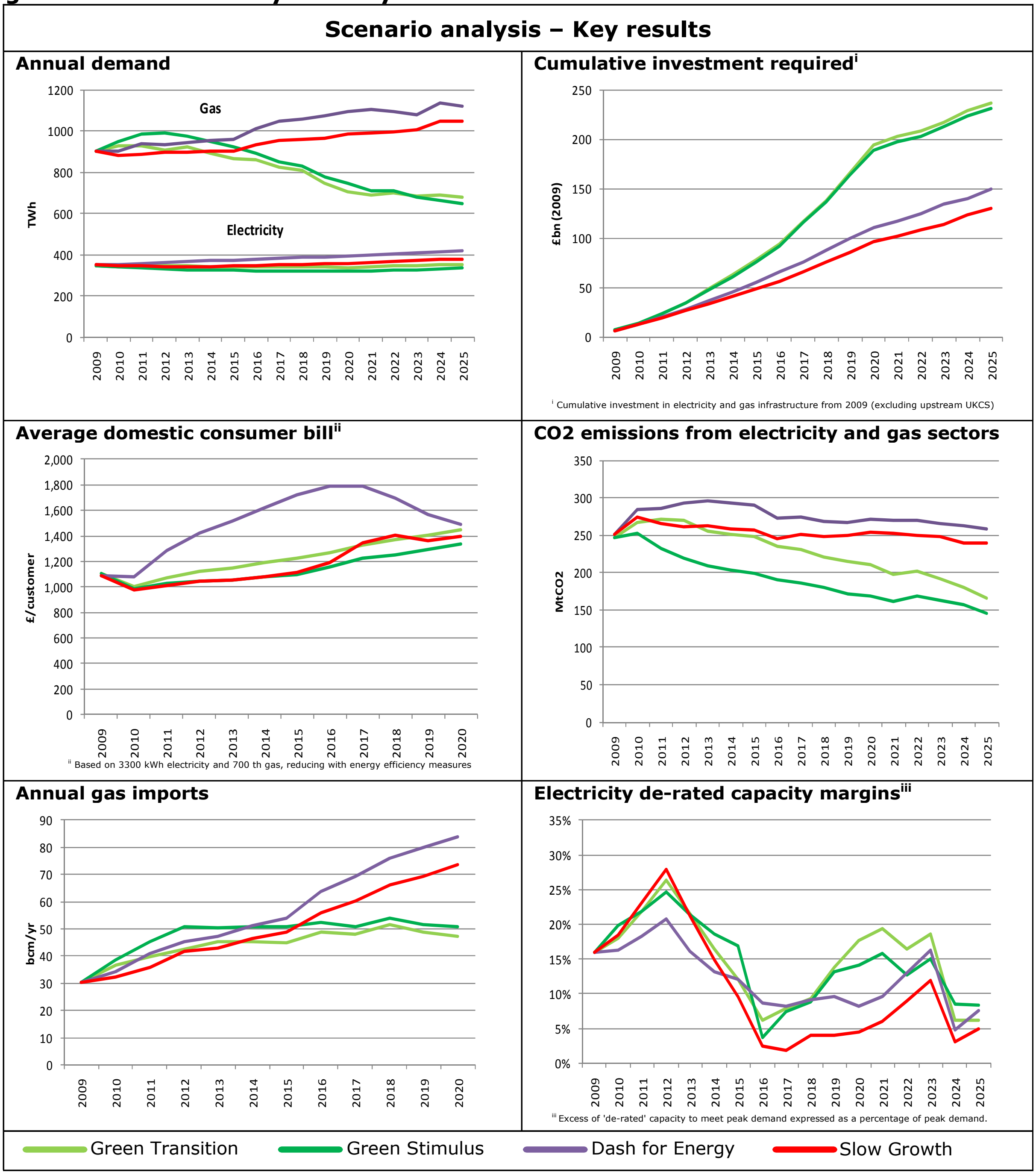
The Discovery scenarios represent a series of diverse, but plausible and internally consistent futures for testing current arrangements and future policy measures. They do not represent forecasts, and many other plausible outcomes can be envisaged. This section provides a short summary of the scenarios and key changes in our current results compared to what we presented in October.

The main driver of the lower CO_2 emissions and consumer bills compared to our previous results is the reduction in gas demand forecasts. In Dash for Energy, this change to gas demand means that the increase in domestic consumer bills is estimated at about 52% by 2016 (as opposed to the previous estimate of about 60%), which is equivalent to £100 less each year in absolute terms.

Figure 1: Scenario overview and key revisions

<table>
<tr><th colspan="2">Scenario Overview</th></tr>
<tr><th>Green Transition – a recap</th><th>Green Stimulus – a recap</th></tr>
<tr><td>In this scenario…
• There is a rapid economic recovery and significant new investment globally
• A global agreement on tackling climate change is reached
• Energy efficiency measures are effective
• New nuclear and CCS demonstration projects come on-line before 2020
• Gas prices are moderate, carbon prices are high, and coal prices are relatively low as demand is suppressed by the high carbon prices
• GB gas demand falls but electricity demand grows on the back of wider deployment of heat pumps and electric vehicles</td><td>In this scenario…
• There is a slow recovery from recession and restricted availability of finance
• A global agreement on tackling climate change is reached and governments implement ‘green stimulus’ measures
• Energy demand falls globally in the near term
• Fuel prices are relatively low
• The combination of relatively high carbon prices and direct government support to nuclear, CCS and large scale renewables promote rapid decarbonisation of the generation sector</td></tr>
<tr><td>Key revisions
• Total investment costs between 2009-2020 have reduced to £194bn instead of the £200bn reported in October.</td><td>Key revisions
• Carbon dioxide emissions from the electricity and gas sectors: down 46% from 2005 levels as opposed to 43% previously reported in October.
• Domestic consumer bills: increase by 13% by 2020 as opposed to 14% previously reported in October.</td></tr>
<tr><th>Dash for Energy – a recap</th><th>Slow Growth – a recap</th></tr>
<tr><td>In this scenario…
• Global economies bounce back strongly
• Security of supply concerns prevail over environmental concerns: there is no global agreement on tackling climate change
• Gas supply is tight and fuel prices are high
• Investment is forthcoming but not always timely
• Significant expansion of CCGT generation capacity
• Planning and supply chain constraints prevent new nuclear plant becoming operational before 2020
• Planning delays push back storage investment</td><td>In this scenario…
• Impact of recession and credit crisis continues
• Low levels of investment
• Low commodity and carbon prices, reducing incentives for renewables, nuclear and CCS
• Generation build is dominated by CCGTs
• Energy efficiency measures have limited impact but demand is low initially due to slow economic growth</td></tr>
<tr><td>Key revisions
• Carbon dioxide emissions from the electricity and gas sector: down 14% from 2005 levels. This is higher decrease than the 12% previously reported. This is still insufficient to meet targets.
• Domestic consumer bills: rise with high and volatile commodity prices, increasing by nearly 52% by 2016 before falling back. In October this increase was at 60%.</td><td>Key revisions
• Carbon dioxide emissions from the electricity and gas sector: down 19% from 2005 levels. This is higher than the 18% reported in October. This is still insufficient to meet carbon budgets.
• Domestic consumer bills: relatively low in early years but increase by 19% by 2020 as market tightens. This is a reduction from the 22% reported in October.</td></tr>
</table>

Figure 2: Scenario analysis – key revised results



Stress tests

We have captured those risks that could best be described as shocks (such as major infrastructure failures), and which could occur in any scenario in any year, through stress tests. They are designed to test the resilience of the market over time and between scenarios. While the results show some sensitivity to changes in the input assumptions, the overall message remains the same — the security of Great Britain's energy supply faces real risks over the next 10-15 years. The colour of the traffic lights broadly reflects the risk of demand curtailment.

Table 2: Stress tests – summary of updated results

Stress test	Period	Today	Green Transition	Green Stimulus	Dash for Energy	Slow Growth
Re-direction of LNG supplies	1-in-20 severe winter	🟢	🟡	🟡	🔴	🔴
Russia-Ukraine dispute	1-in-20 severe winter	🟢	🟡	🟡	🔴	🔴
Bacton outage	1-in-20 peak day	🟡	🟢	🟡	🟡	🟡
No wind output	1-in-20 peak day	🟢	🟡	🟡	🟡	🟡
Electricity interconnectors fully exporting	1-in-20 peak day	🟢	🔴	🔴	🔴	🔴

Low impact 🟢 Moderate impact 🟡 High impact 🔴

In summary, the gas stress tests show a similar picture to that reported in October while the impacts seem to have become higher across the electricity stress tests. This change is primarily due to the differences in our gas and electricity demand assumptions that are described above.

We have also carried out a number of additional stress tests, which have been suggested by respondents to our October publication:

- Gas quality: the specification of continental gas preventing gas imports through IUK over a severe winter;
- Oil price shocks: an increase of $80/bbl in oil prices in 2010, 2015 and 2020; and
- Investment delays: impact of two-year delay to all new electricity generation investment over a severe winter.

The oil price shocks affect prices and do not result in an increased risk of demand curtailment under our modelling approach. The price effects are discussed in Section 2. The impacts of the gas quality stress test (via loss of IUK imports) and the (generation) investment delay stress test upon demand curtailment are summarised below.

Table 3: Additional stress tests — summary of results

Stress test	Period	Today	Green Transition	Green Stimulus	Dash for Energy	Slow Growth
Gas quality	1-in-20 severe winter	🟢	🟢	🟢	🟡	🟡
Investment delay	1-in-20 severe winter	🟢	🔴	🟡	🔴	🔴

Low impact 🟢 Moderate impact 🟡 High impact 🔴

Model extensions

To reflect feedback from respondents, we have extended the model to include additional functionality relating to:

- Cost of capital: allowing variation across different types of technology;
- Profitability: producing more detailed results on the profitability of different plant types; and
- Industrial and Commercial (I&C) customers: reporting impacts on I&C customers specifically.

We have used the cost of capital and profitability extensions as part of our assessment of policy packages where possible. We also calculate the potential cost increases faced by I&C customers, which are described in Section 3.

1. Scenario analysis

1.1. This chapter shows changes to the scenario analysis. Further information about our scenario analysis approach is provided in Chapters 2 and 3 of Project Discovery: Energy Market Scenarios[2]. We present the charts that have changed since the October consultation. The charts below appeared in Chapter 3 of the previous document and we note their former figure label in the labels here for reference purposes. In the text, we highlight the key differences in the results as well as the broad reasons for them.

1.2. A summary of the changes that we have made to our assumptions is provided in Table 1.1. The key changes are a decrease in gas demand across all scenarios and an increase in electricity demand in the non-Green scenarios.

1.3. We have revised our gas demand assumptions downwards across all scenarios to account for higher fuel prices, higher domestic energy efficiency and slower economic growth. In the near term this reduction is due to the greater than expected impact of the recession and reflects National Grid's latest Ten Year Statement (TYS) published in December 2009, and creates a difference of between 1% and 3% compared to our previous assumptions. In the medium term, this reduction increases in the Green scenarios, reaching a 4.2% fall in Green Stimulus by 2025 compared to our previous results, to allow for the effects of electrification of heat and a stronger link to renewable technology, which means energy for heat is increasingly drawn from sources other than gas. In contrast, for the non-Green scenarios this reduced gas demand moves back towards our previous estimates in the medium term. This difference reduces to 1% by 2025 through the impact of higher electricity demand due to greater heat and transport electrification that increases gas consumed in the power sector.

1.4. Electricity demand is somewhat higher in our non-Green scenarios, due to changes in our assumptions about heat and transport electrification and a slight upwards revision in our GDP growth assumptions, based on latest Treasury forecasts. Our heat pump electrification assumptions now reflect information in the Low Carbon Transition Plan about the electricity consumption of heat pumps and are explicitly linked to renewable heat in the model. We have revised our electrification assumptions to take account of electric vehicle projections published by Element Energy and reflect that some electrification is likely to take place in the non-Green scenarios (30 per cent of that in the Green Scenarios)[3]. Overall, electricity demand is

[2] Ofgem 2009, Project Discovery: Energy Market Scenarios, Ref: 122/09.
[3] Element Energy 2009, Strategies for the uptake of electric vehicles and associated infrastructure implications, Final Report for Committee on Climate Change, http://hmccc.s3.amazonaws.com/Element_Energy_-_EV_infrastructure_report_for_CCC_2009_final.pdf.

12.4 TWh higher by 2025 in the non-Green scenarios due to the changes we have made to our assumptions about heat and transport electrification, which is equivalent to around 1% of total power demand. In contrast, new information about the electricity consumption of heat pumps and electric vehicles has reduced annual electricity demand in the Green Scenarios by 19.3 TWh by 2025.

1.5. In addition we have revised our storage capacity assumptions to reflect new information about likely completion dates for investment that was provided through Stag Energy's response, as well as internal Ofgem data. We have also taken account of the revised gas demand in the model deferring some of the new storage assumptions in our model. We have reduced storage capacity in all scenarios by around 0.3 bcm by 2014. In the Dash for Energy scenario we have pushed back some of the 4.5 bcm of further storage assumed built by 1-2 years to reflect the lower demand. We have also pushed back 0.5 bcm of the additional storage projects in the Green Transition scenario for the same reason.

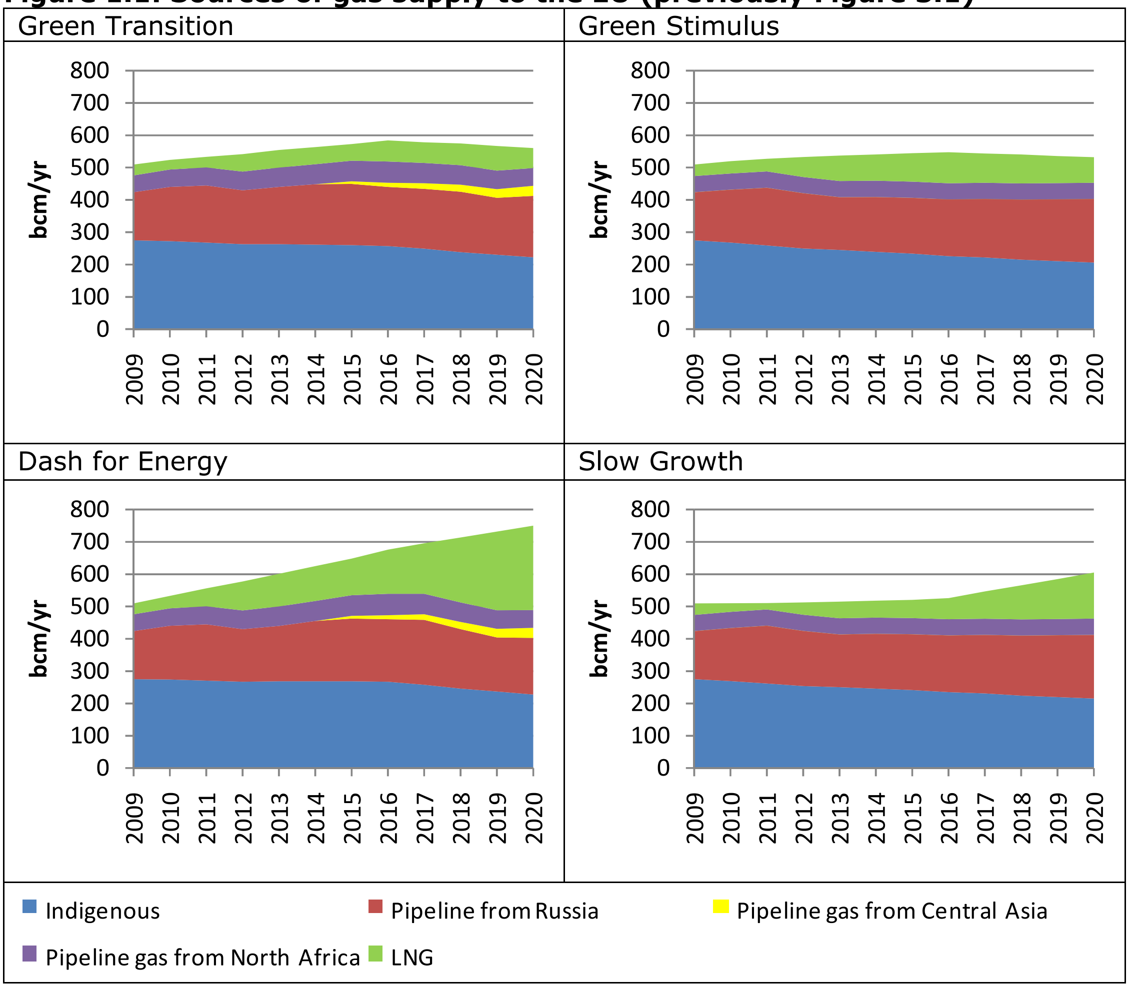
Table 1.1: Revisions to Discovery model input assumptions

Variable	Source of revision		Impact of change
Gas storage	Stag Energy response and Exemptions data	↓	Investment
Russian gas production	Gazprom response and IEA	↓	EU gas pipeline flows
LNG liquefication	National Grid 10 Year Statement	↑	LNG liquefaction capacity
LNG regas capacity	National Grid 10 Year Statement	↑	LNG regas capacity
Annual gas demand	National Grid 10 Year Statement	↓	Annual gas demand
Peak gas demand	National Grid 10 Year Statement	↓	Peak demand
Electrification	UKERC response and Element Energy 2009	↑	Electricity demand in Non-green
Renewables generation	Various responses	↑	'Green' generation
LCPD oil plants	Energy Markets Outlook	↑	LCPD oil capacity
CCGT build	ATCO Power	↓	Investment
GDP	HM Treasury forecasts	↔	↓ 2009 and ↑ in 2010-12
Commodity prices	Bloomberg	↑	Oil prices

Security of supply - gas

1.6. The charts in Figure 1.1 below show the sources of gas supply for the EU under the four scenarios. We have reduced the assumed level of gas supply from Russian pipelines into the EU in the later years for the Green Transition and Dash for Energy scenarios to reflect more recent information about the timing of the Shtokman field. The difference in demand is met by LNG because we assume that this is the swing source of supply over the medium to long term.

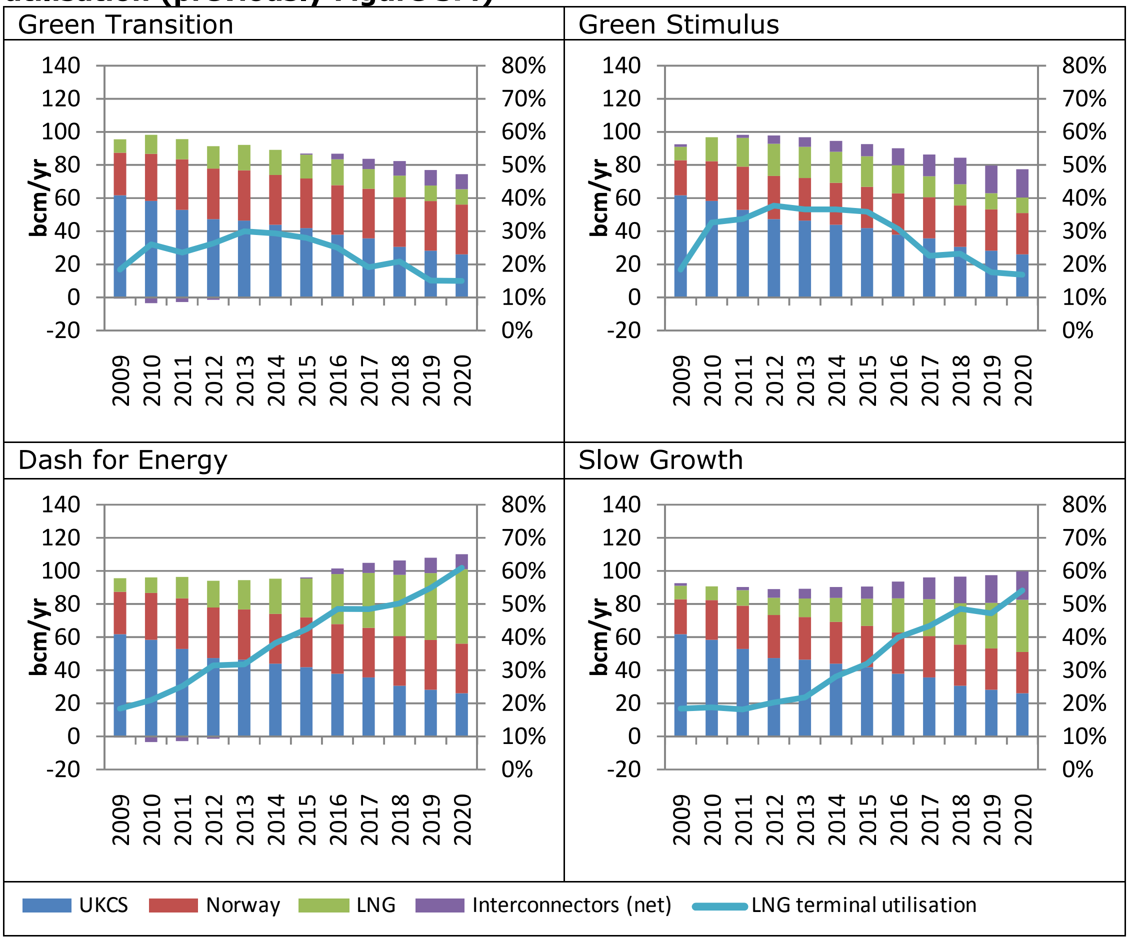
Figure 1.1: Sources of gas supply to the EU (previously Figure 3.1)



1.7. The bars in Figure 1.2 show the volumes of gas from different supply sources expected to meet GB demand on an annual basis. The blue lines represent LNG terminal annual capacity utilisation rates.

1.8. The charts have changed to reflect National Grid's lower demand forecasts from the latest TYS, which have been used as the basis for our starting assumptions, which lowers total supply in all scenarios. As LNG is assumed to be the swing supply source over the medium to long term, the volume of LNG imports is now lower.

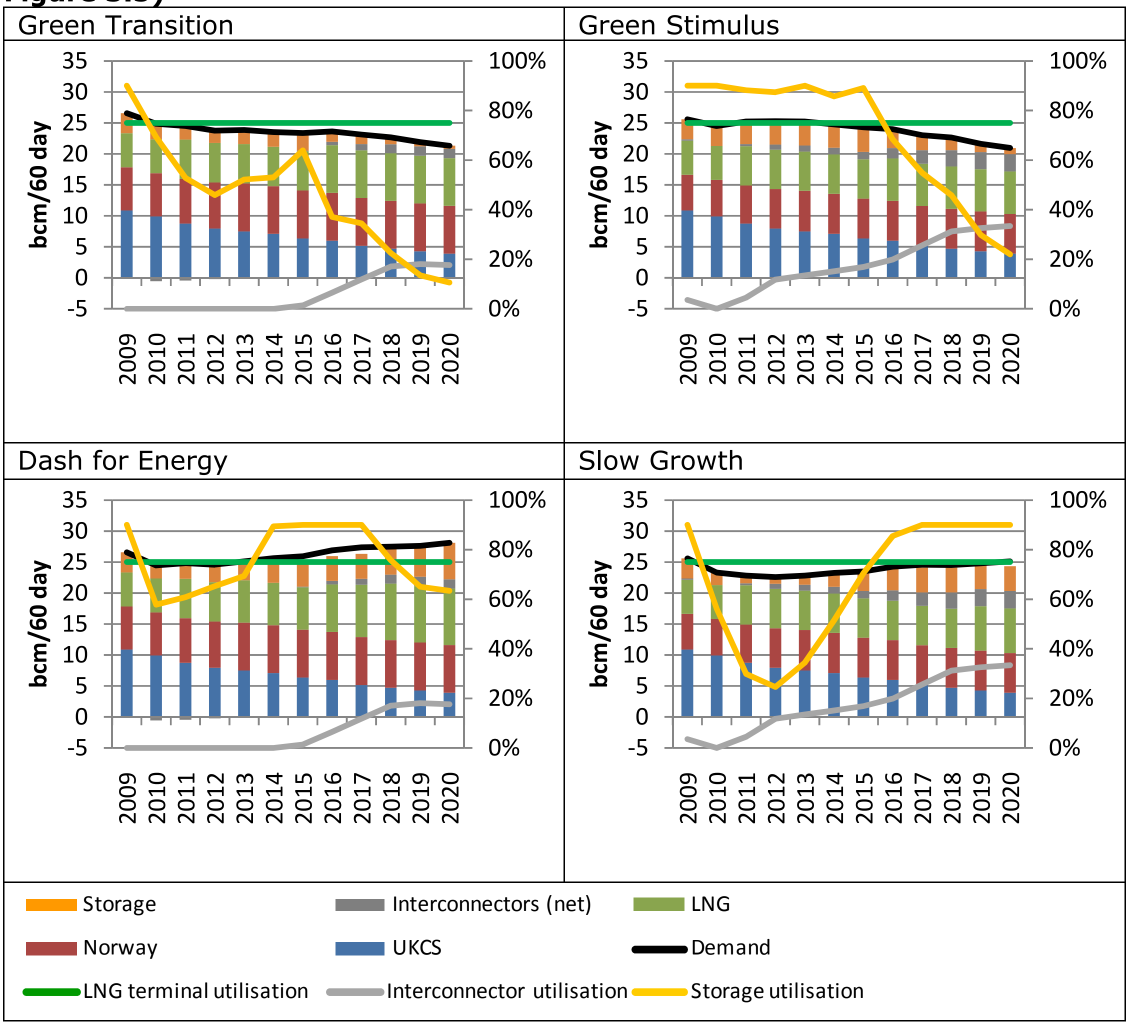
Figure 1.2: Annual GB gas supplies and LNG regasification terminal utilisation (previously Figure 3.4)



1.9. Figure 1.3 below shows gas demand and supply sources for a one in twenty (1-in-20) severe winter. The most significant change is the reduction in gas demand, which has resulted in lower demand in all scenarios. As storage is assumed to be the swing supply source during a severe winter, storage utilisation is lower in the Green Transition, Green Stimulus and Slow Growth scenarios as a result of the reduction in demand.

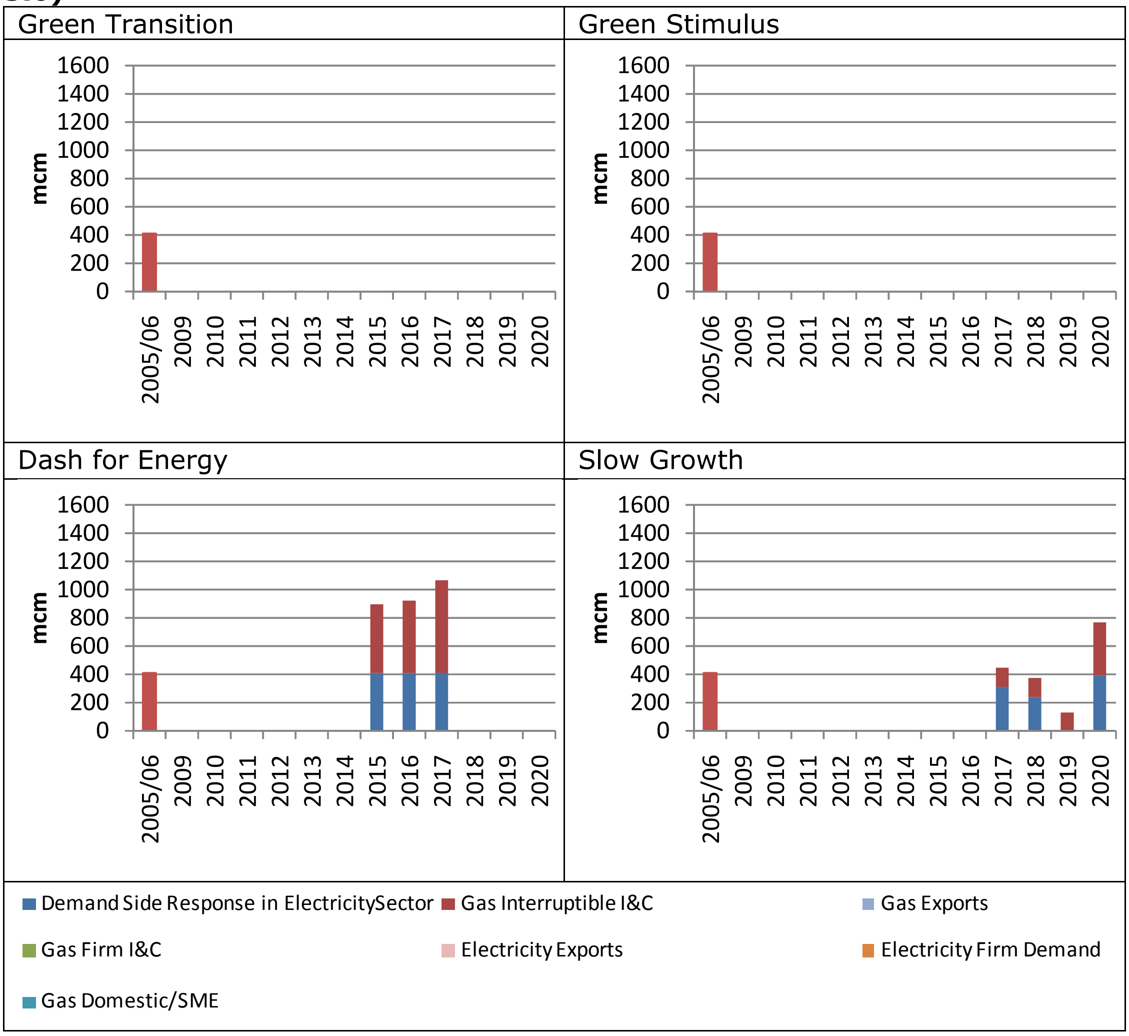
1.10. We have also reduced our assumptions on the amount of storage constructed in the Dash for Energy scenario. As described above, this downward revision reflects new information about likely completion dates for investment as well as our revised gas demand assumptions. The decrease in available storage is more than offset by the decrease in demand, so storage capacity utilisation in the Dash for Energy scenario is also lower.

Figure 1.3: GB gas supply and demand during a 1-in-20 winter (previously Figure 3.5)



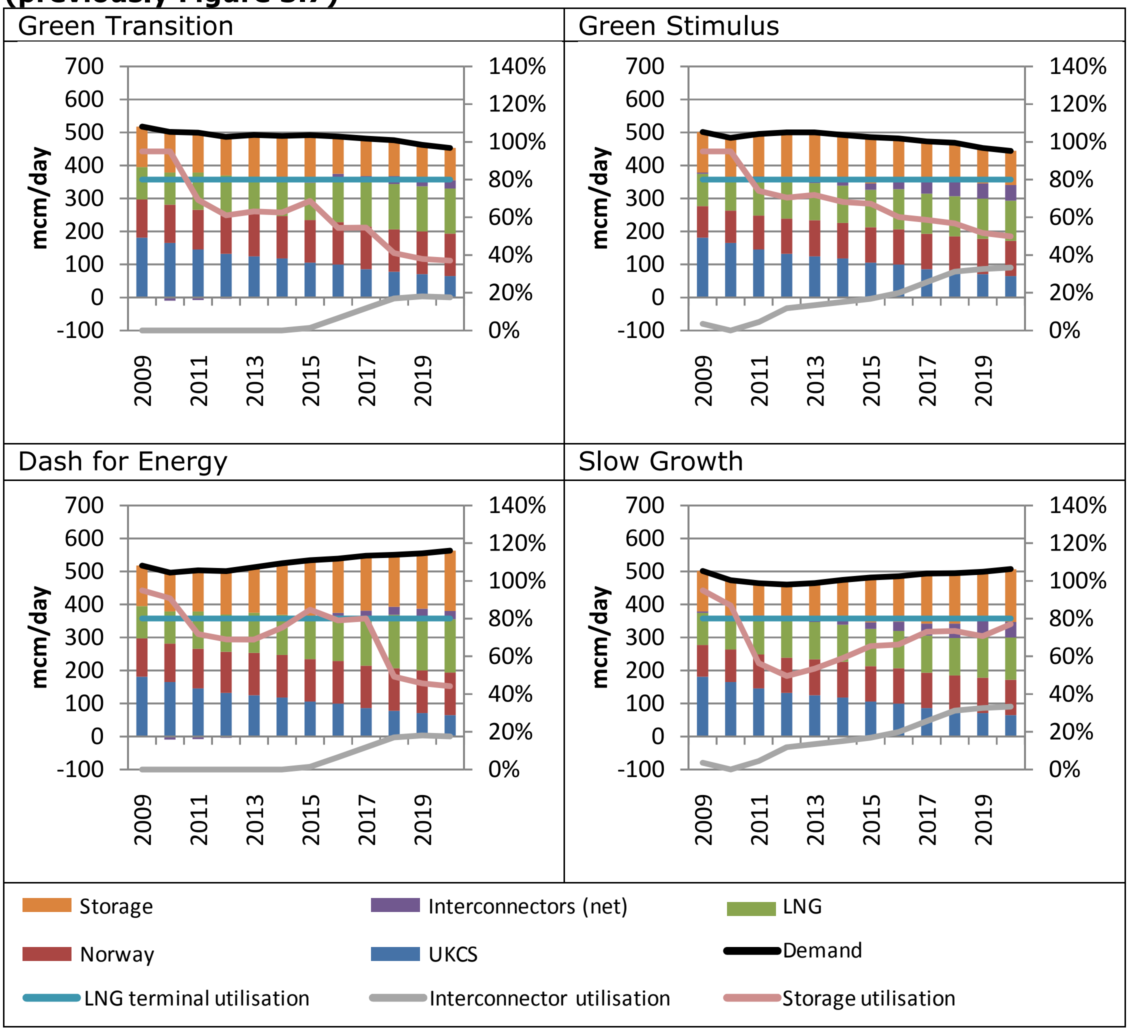
1.11. Figure 1.4 below relates to the shortfall in gas supply in Figure 1.3. The lower gas demand results in lower risk of demand curtailment in the Slow Growth scenario now compared to the October results. There is also less demand curtailment in the Dash for Energy scenario, which is focused on the earlier years.

Figure 1.4: Demand curtailment during a 1-in-20 winter (previously Figure 3.6)



1.12. Figure 1.5 shows the gas supply and demand balance for a 1-in-20 peak demand day. Again, the main change to the charts below is the lower gas demand. Similar to the October document, this results in no demand curtailment caused by a peak day event in any of the scenarios without a shock to the system (or in the absence of a stress test).

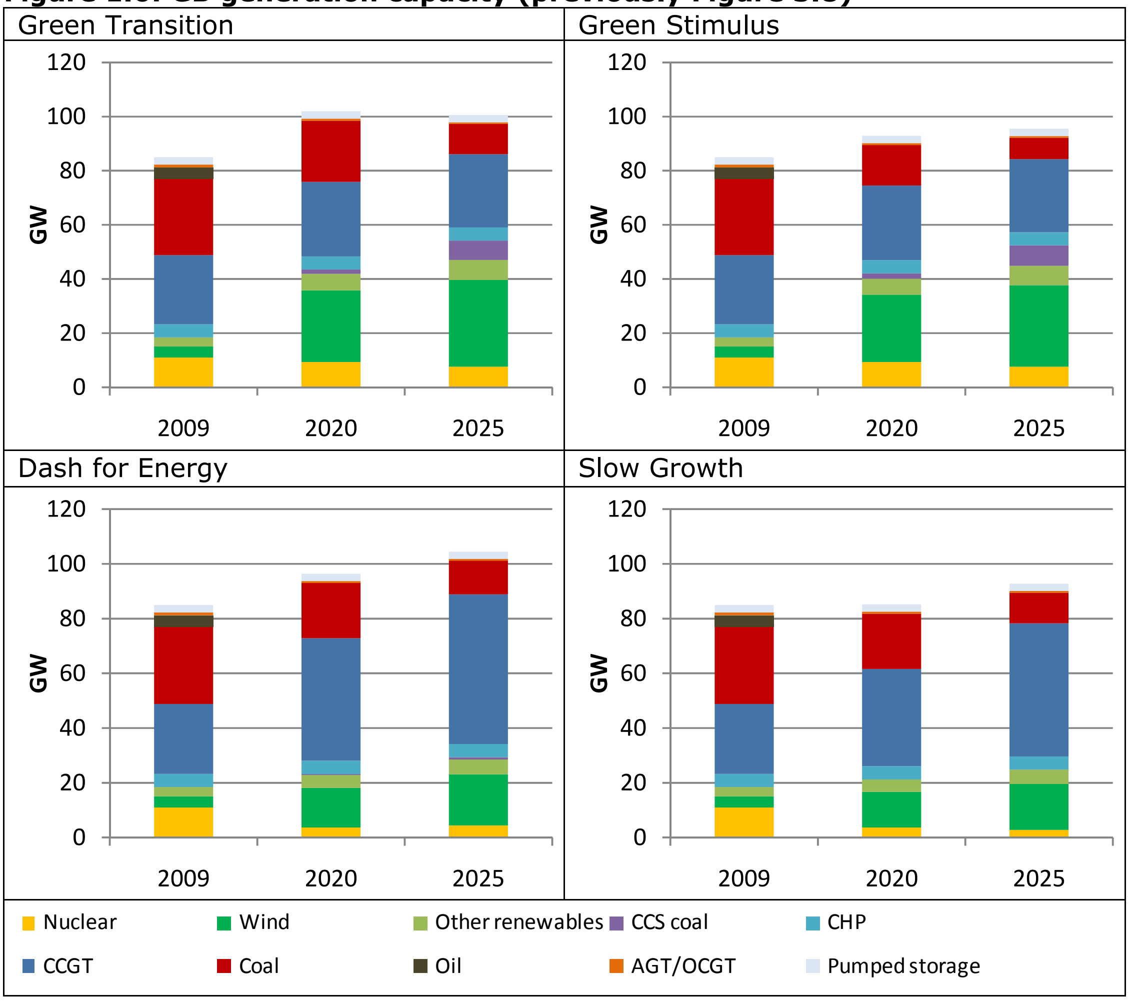
Figure 1.5: GB gas supply and demand during a 1-in-20 peak demand day (previously Figure 3.7)



Security of supply - electricity

1.13. Figure 1.6 below shows the generation mix in three selected years for each scenario. The amount of CCGT built is lower, reflecting changes to demand in the Slow Growth and Dash for Energy scenarios. We have also revised our assumptions on LCPD opt-out plant, to reflect information from National Grid's Seven Year Statement, which has increased availability of oil plant in Green Stimulus up to 2010 and in all other scenarios up to 2015.Less wind generation is constructed in both the Green Transition and Green Stimulus scenarios. This reflects the lower electricity demand in the Green scenarios due to revised assumptions about transport electrification, based on the information in Element Energy's 2009 report to the Committee on Climate Change and information on electricity consumption from heat pumps presented in the Low Carbon Transition Plan. In the Dash for Energy and Slow Growth scenarios, we assume greater investment in wind generation in the later years to reflect higher electricity demand in those scenarios.

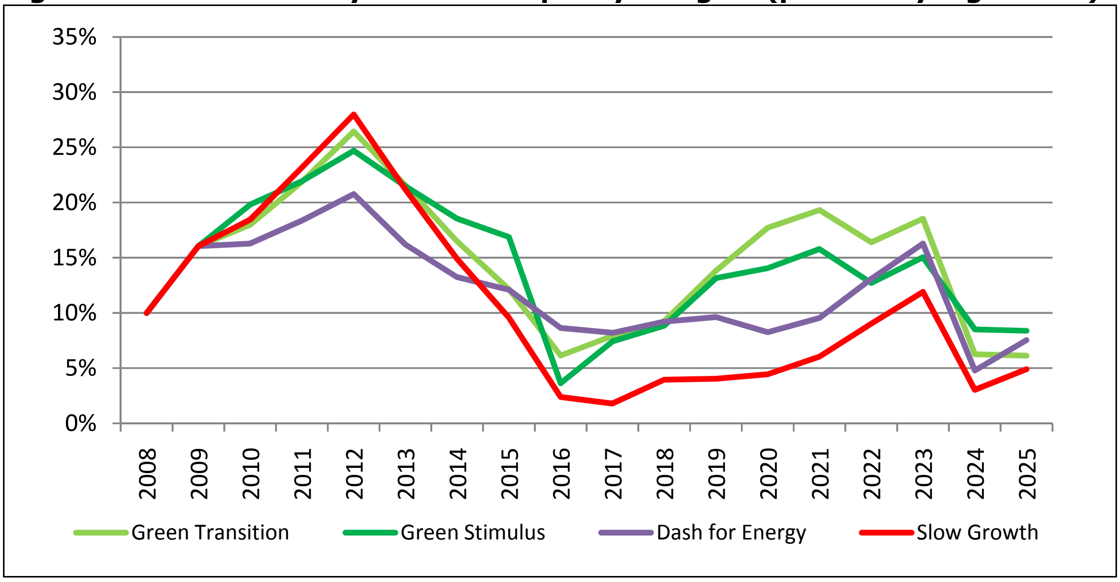
Figure 1.6: GB generation capacity (previously Figure 3.8)



1.14. Figure 1.7 shows the de-rated capacity margins in electricity. The capacity margin is the amount of generation capacity that is surplus relative to demand, as a percentage of peak demand. De-rated capacity refers to capacity adjusted for plant and resource availability.

1.15. The pattern shown in the chart below is similar to that in Figure 3.9 in the October document. The curves for all of the scenarios have moved slightly due to changes in our assumptions about electrification of heat and transport, as well as the amount of generation constructed and closed. There is also a slight impact from our upward revision in GDP forecasts based on latest Treasury forecasts.

Figure 1.7: GB electricity de-rated capacity margins (previously Figure 3.9)



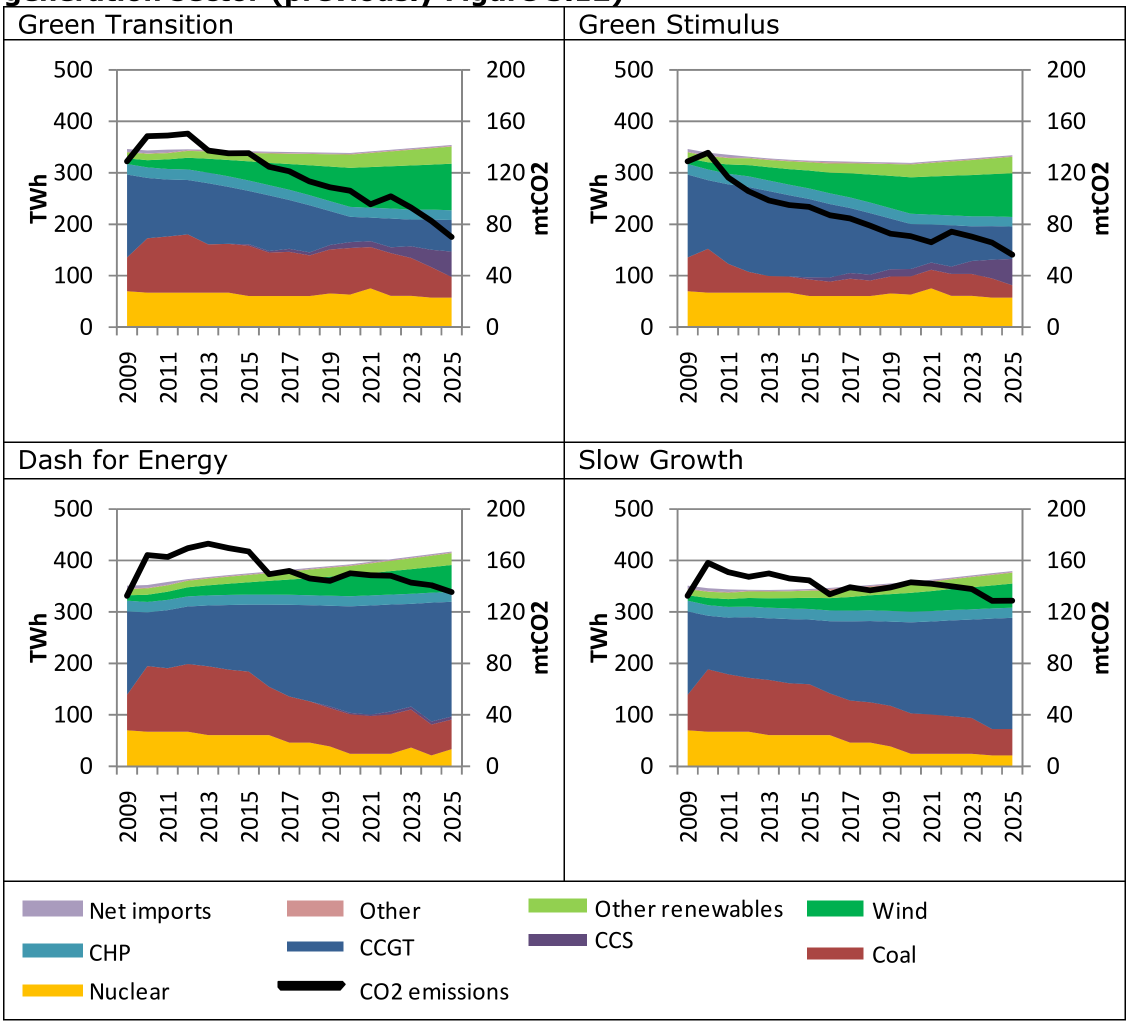
Environmental impact

1.16. Figure 1.8 shows the volume of electricity generated by technology type across the four scenarios, while the black lines show the carbon dioxide emissions resulting from electricity generation.

1.17. The main change to the non-Green scenarios in these charts is the increase in electricity demand due to the increase in assumed electricity demand from the electrification of heat and transport.

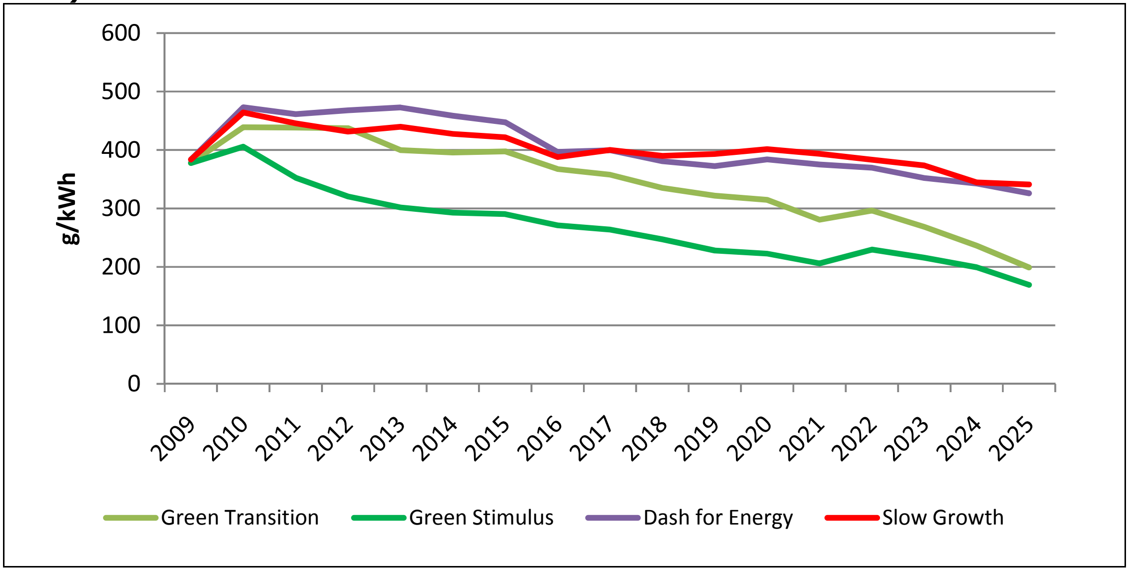
1.18. In the Green scenarios demand is lower, which leads to a reduction in the amount of generation output from coal in the later years, resulting in lower emissions of carbon dioxide in the latter years. In Green Stimulus, CO_2 emissions from the electricity and gas sectors will be down 46% from 2005 levels, instead of the 43% we reported in October. In Dash for Energy, CO_2 emissions are down 14%, instead of the 12% previously reported. In Slow Growth, CO2 emissions are down 19%, instead of the 18%.

Figure 1.8: GB generation output and carbon dioxide emissions from the generation sector (previously Figure 3.12)



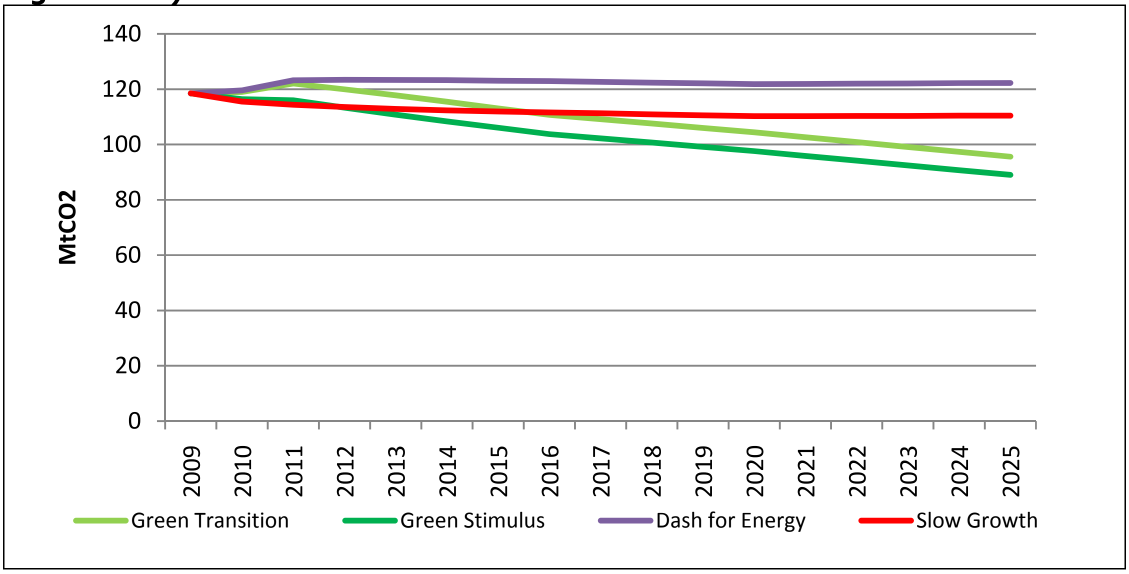
1.19. Figure 1.9 shows the carbon intensity of generation in the four scenarios over time. There is little change to this from the October document, apart from for 2009, which is lower than previously projected due to greater use of gas versus coal because of lower gas prices.

Figure 1.9: Carbon intensity in the GB generation sector (previously Figure 3.13)



1.20. Figure 1.10 below shows the total carbon dioxide emissions from the gas sector due to a lower gas demand effect.

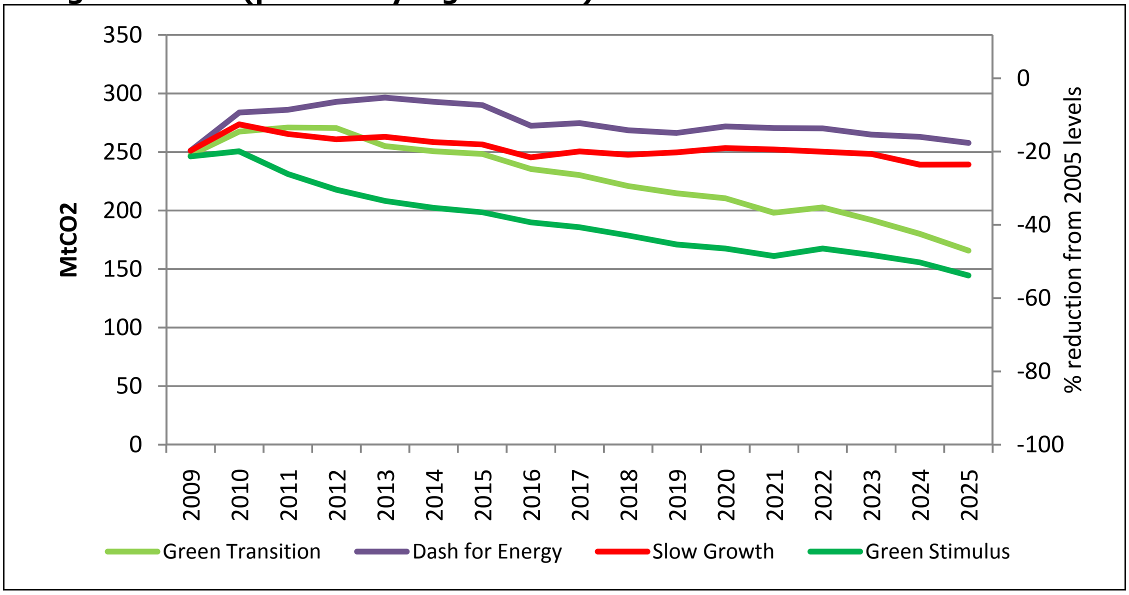
Figure 1.10: Carbon dioxide emissions from the GB gas sector (previously Figure 3.14)



1.21. Figure 1.11 shows the total combined carbon dioxide emissions from the GB generation and gas heating sectors. As electricity and gas demand are now assumed to be lower in the Green scenarios, emissions are lower in both of these scenarios.

1.22. In the non-Green scenarios, the reduction in emissions from the lower gas demand is partially offset by the increase in electricity demand from the electrification of heat and transport. For this reason, the level of emissions is lower over most of the period, but is at a similar level to that shown in the October document by 2025.

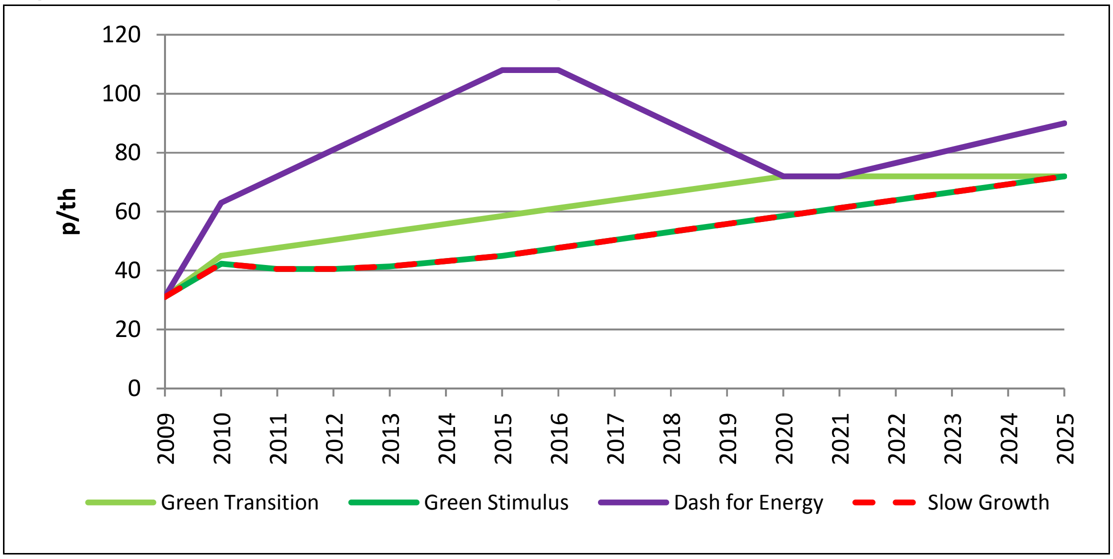
Figure 1.11: Combined carbon dioxide emissions from the GB generation and gas sectors (previously Figure 3.15)



Investment, prices and consumer costs

1.23. Figure 1.12 shows the assumed gas price in the four scenarios. The only change relative to Figure 3.18 in the October document is due to the inclusion of actual data for the year 2009. The actual gas price in 2009 was lower for all scenarios than was assumed. This wholesale price is assumed to feed into consumer bills, together with assumptions about hedging strategy, seasonal demand weighting factors and partial pass-through of winter price spikes where these occur in our scenarios and stress tests.

Figure 1.12: Gas prices (previously Figure 3.18)

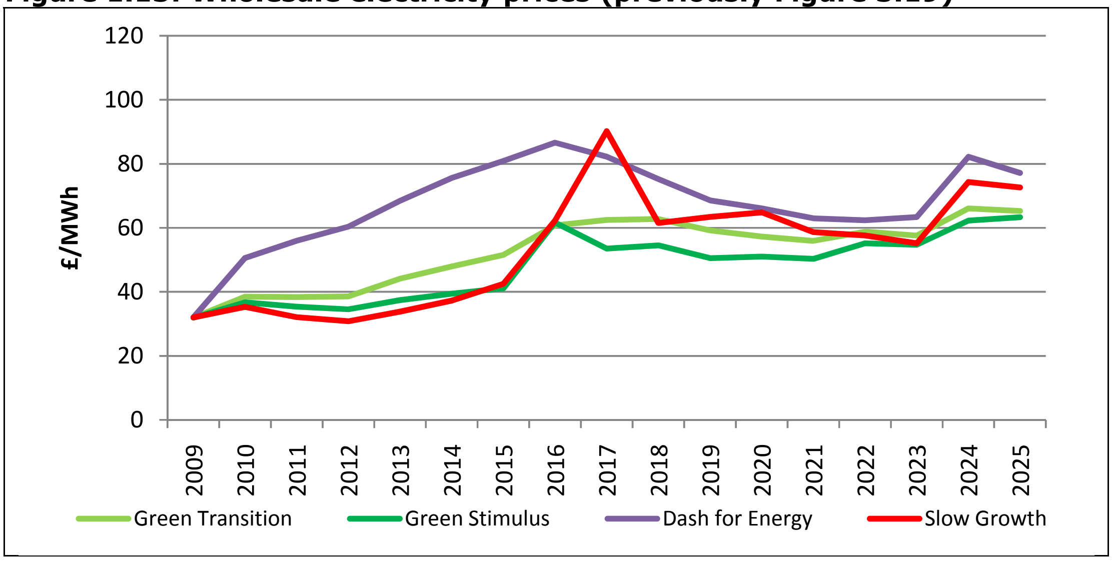


1.24. Chart 1.13 shows the wholesale electricity price in the four scenarios. The electricity price has changed in all of the scenarios, reflecting increased demand in the non-Green scenarios, reduced demand in the Green scenarios, and the changes to the assumed construction of new generation plant.

1.25. In the Dash for Energy scenario, the highest electricity price in 2016 is now about £5/MWh higher than in the October document, at £86/MWh. This reflects the increase in electricity demand and our reduction in the assumed amount of new CCGT build. In the Slow Growth scenario, the very high price levels seen in 2016-17 now only occur in 2017.

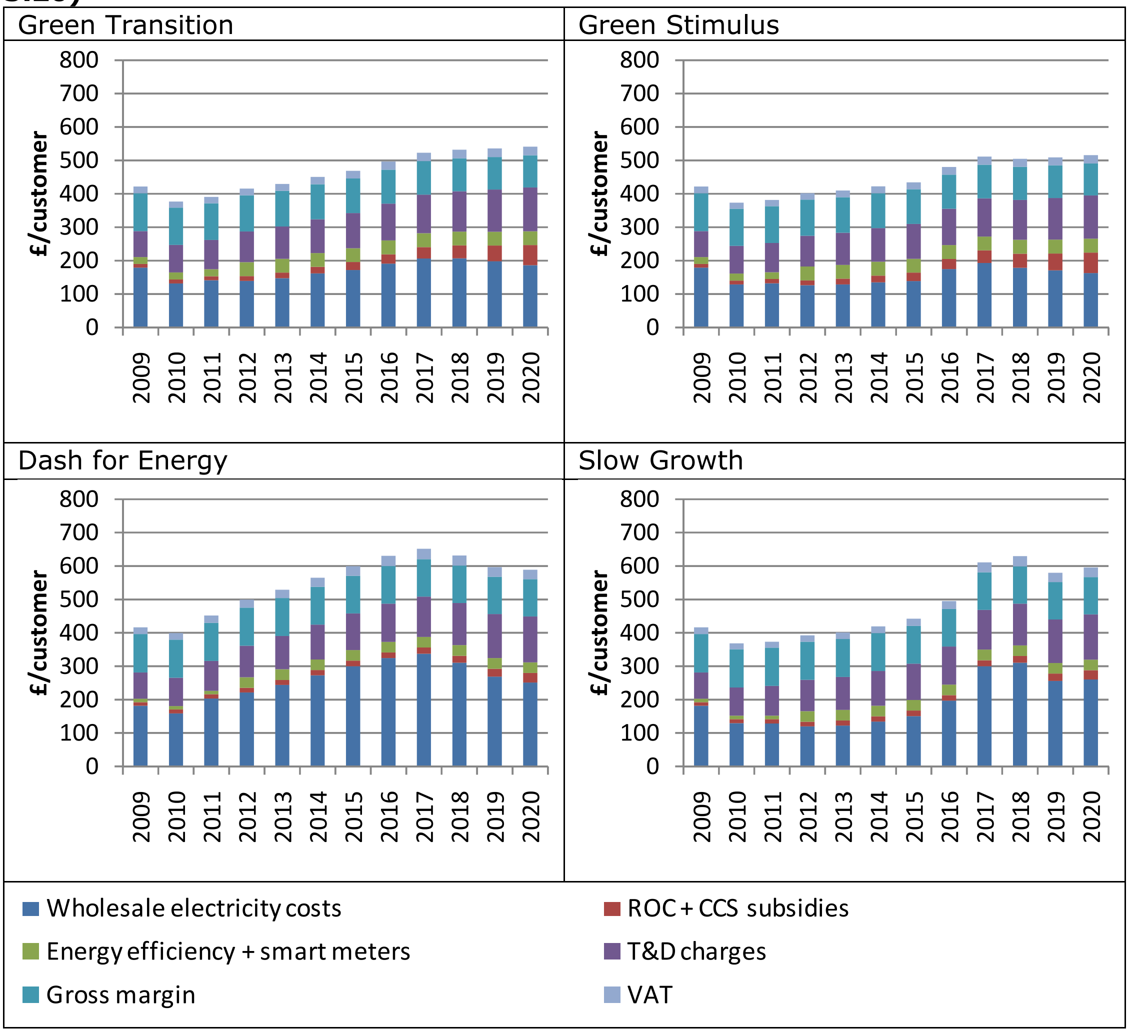
1.26. In the two Green scenarios, the electricity price rises less than was previously shown because of the reduction in the assumed level of demand.

Figure 1.13: Wholesale electricity prices (previously Figure 3.19)



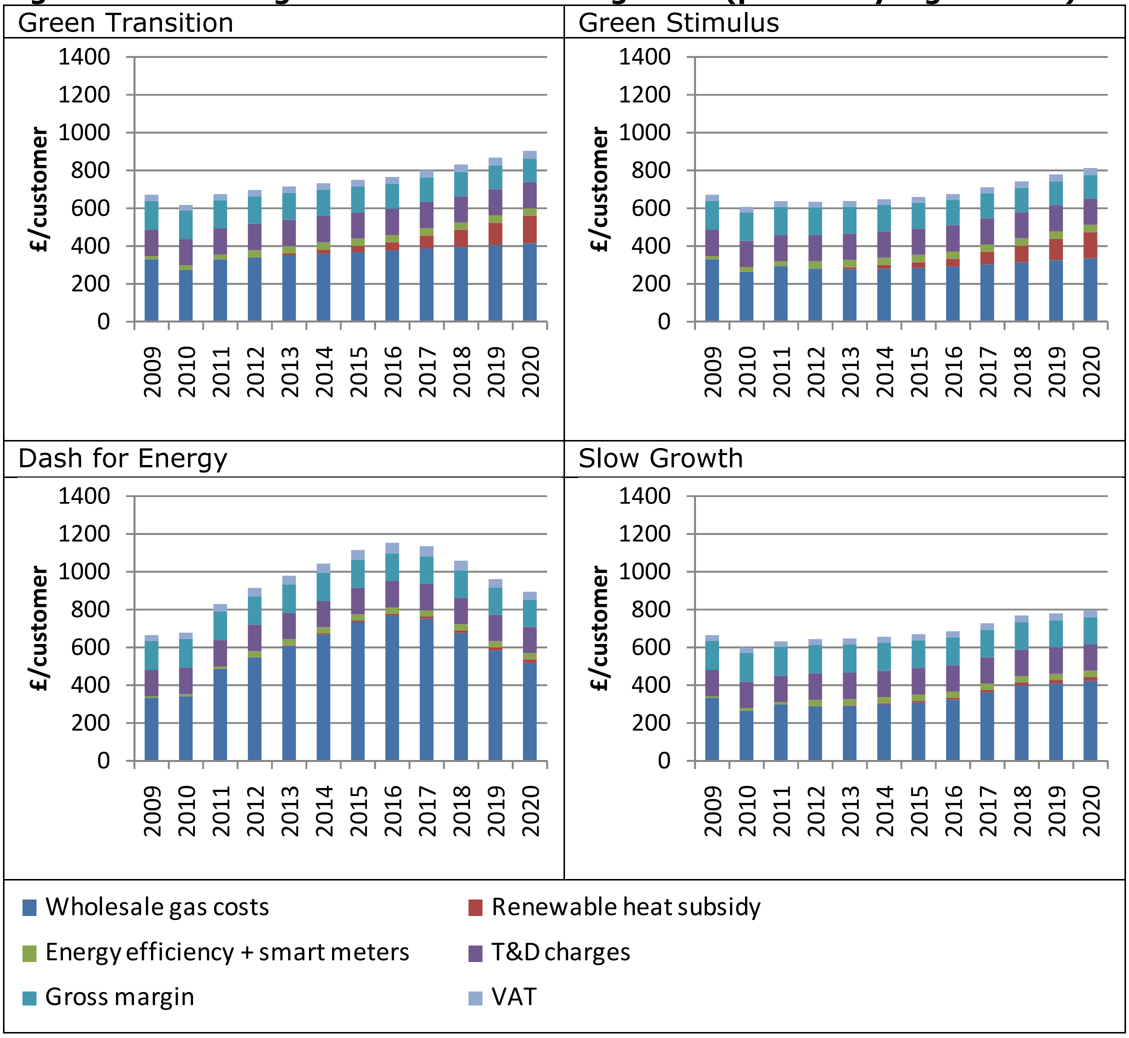
1.27. Domestic consumer electricity bills, shown below in Figure 1.14, differ slightly from those shown in the October document. The only element of the consumer bills that has changed is the wholesale cost of energy. This has decreased in the two Green scenarios and increased in the non-Green scenarios. Domestic consumer bills are calculated based on a two year hedging strategy and so the reduced duration of the peak wholesale prices shown in Figure 1.13 feed through to a lower increase in domestic consumer bills in 2018 in the Slow Growth scenario. In the Dash for Energy scenario, bills are slightly higher in 2020 than previously because of the increase in demand.

Figure 1.14: Average domestic consumer electricity bill (previously Figure 3.20)



1.28. As shown in Figure 1.15, consumer gas bills are lower in some years relative to the October document. This is because of a reduction in the frequency of gas price spikes in the winter due to the lower level of assumed demand.

Figure 1.15: Average domestic consumer gas bill (previously Figure 3.21)



2. Stress tests

2.1. By applying stress tests to the scenarios, we can demonstrate the impact and risk arising from selected extreme events and test how the ability of the market to deal with such shocks may differ between scenarios and may change over time.

2.2. We have identified a number of potential stress tests, with varying degrees of materiality and probability of occurring. Table 2.1 below outlines the stress tests.

Table 2.1: Summary description of stress tests

Title	Description	Period over which issue persists
Re-direction of LNG supplies	Re-direction of LNG supplies away from GB market due to higher prices in other global markets	1-in-20 severe winter
Russia-Ukraine dispute	Reverse gas interconnector flows resulting from a Russia-Ukraine gas dispute	1-in-20 severe winter
Bacton outage	Outage at GB gas import facility (Bacton)	1-in-20 peak demand day
No wind output	No output from GB wind generation fleet	1-in-20 peak demand day
Electricity interconnectors fully exporting	Reverse electricity interconnector flows due to sharper price signals in European countries	1-in-20 peak demand day
Gas quality	Continental gas does not meet Great Britain (GB) gas specifications and so imports are prevented through IUK during winter	1-in-20 severe winter
Oil price shocks	A $80/bbl increase in oil prices in 2010, 2015 and 2020	Annual
Investment delay	Two year delay to all new investment in electricity generation plant	1-in-20 severe winter

2.3. In this section, we provide revised stress test results for the shocks we assessed in our October publication. We do not provide them for the redirection of LNG supplies because the results have not changed. However we do present a number of additional stress tests that were suggested by respondents, as follows:

- Gas quality;
- Oil price shocks; and
- Investment delays.

2.4. The results from the new stress tests depend upon the scenario and their impact ranges from no risk of interruption to possible interruption of firm contracts.

Russia-Ukraine dispute

2.5. This stress test examines the impact of a reversal in the gas interconnector flows as a result of gas shortages on the continent, caused by a Russia-Ukraine dispute. We assume that the interconnectors are net exporting to the Continent (BBL at zero, IUK at 50% export) over the winter months, as witnessed in January 2009. Further details are provided in Section 4 of our October publication. Figures 2.1 and 2.2 below generally show less risk of demand curtailment in the updated results compared to those from October.

Figure 2.1: Demand curtailment for Russia-Ukraine style dispute during a 1-in-20 winter, Green scenarios

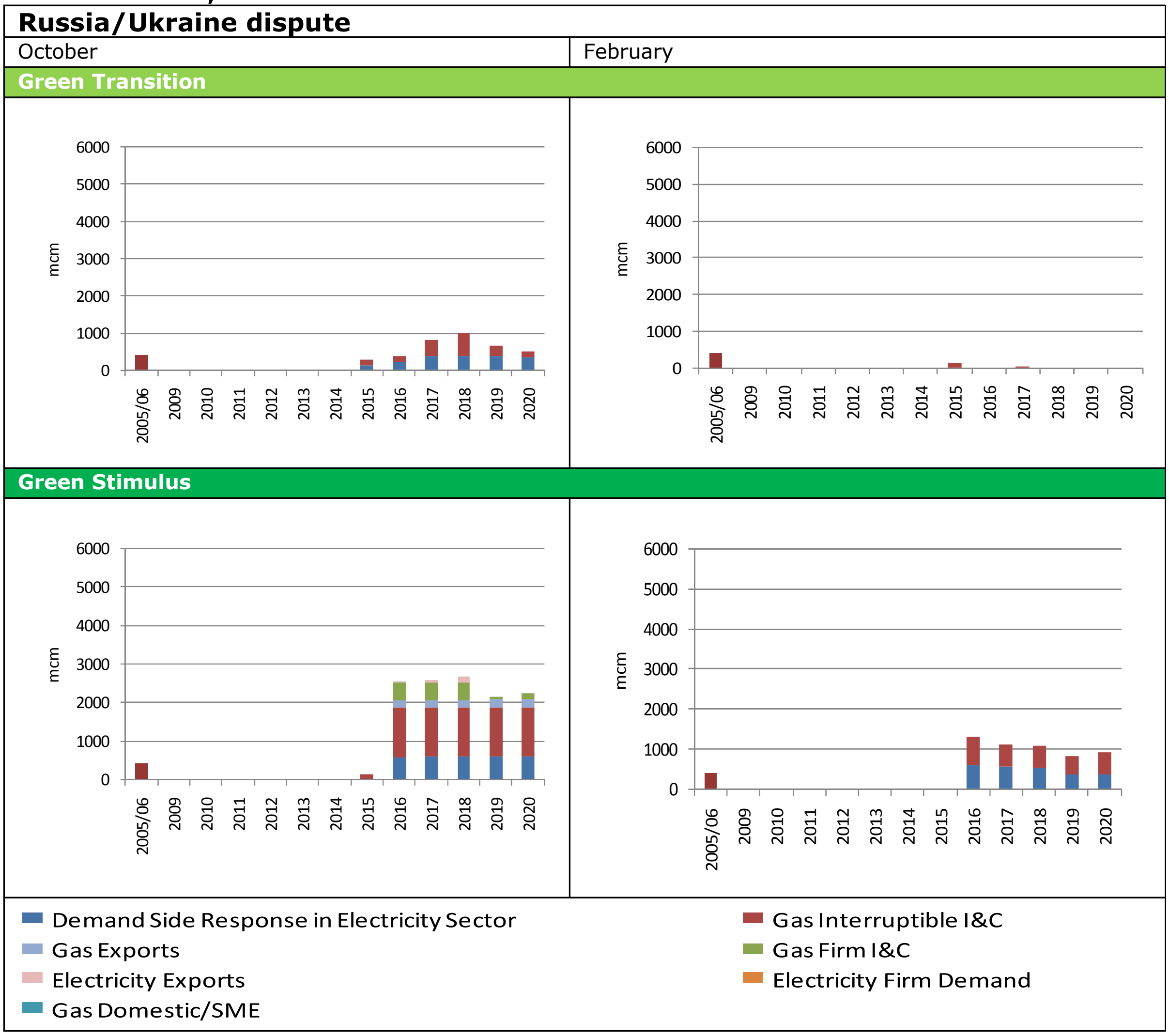
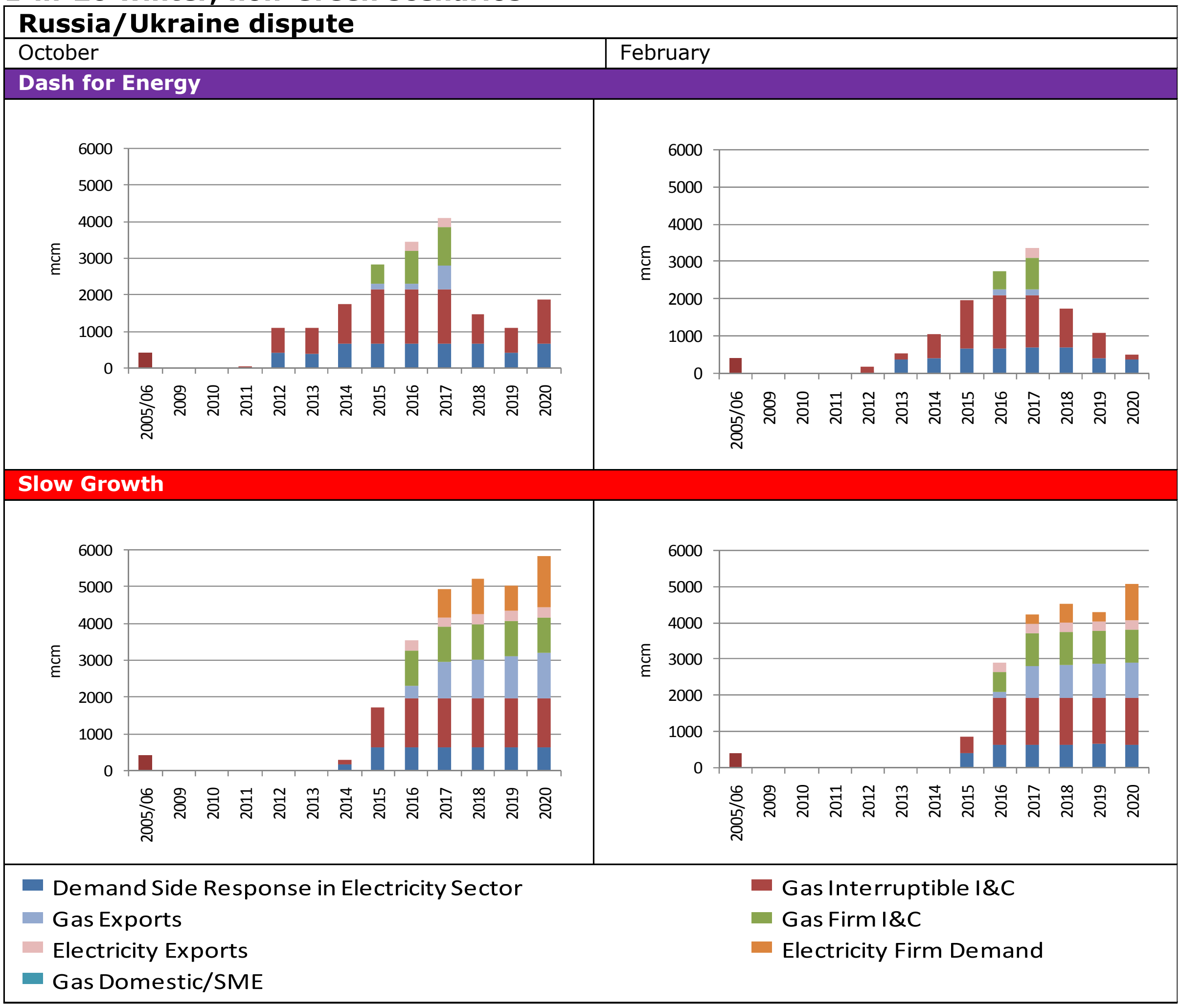


Figure 2.2: Demand curtailment for Russia-Ukraine style dispute during a 1-in-20 winter, non-Green scenarios



Bacton outage

2.6. This stress test examines the impact of an outage at a GB gas import facility such as Bacton on a 1-in-20 peak demand day. We assume that the entire Bacton import facility is affected, which prevents beaching of all related flows from UKCS and interconnectors. Further details are provided in Section 4 of our October publication. Figure 2.4 below shows more risk of demand curtailment in updated results for the non-Green scenarios compared to those from October.

Figure 2.3: Demand curtailment for an outage at Bacton on a 1-in-20 peak day, Green scenarios

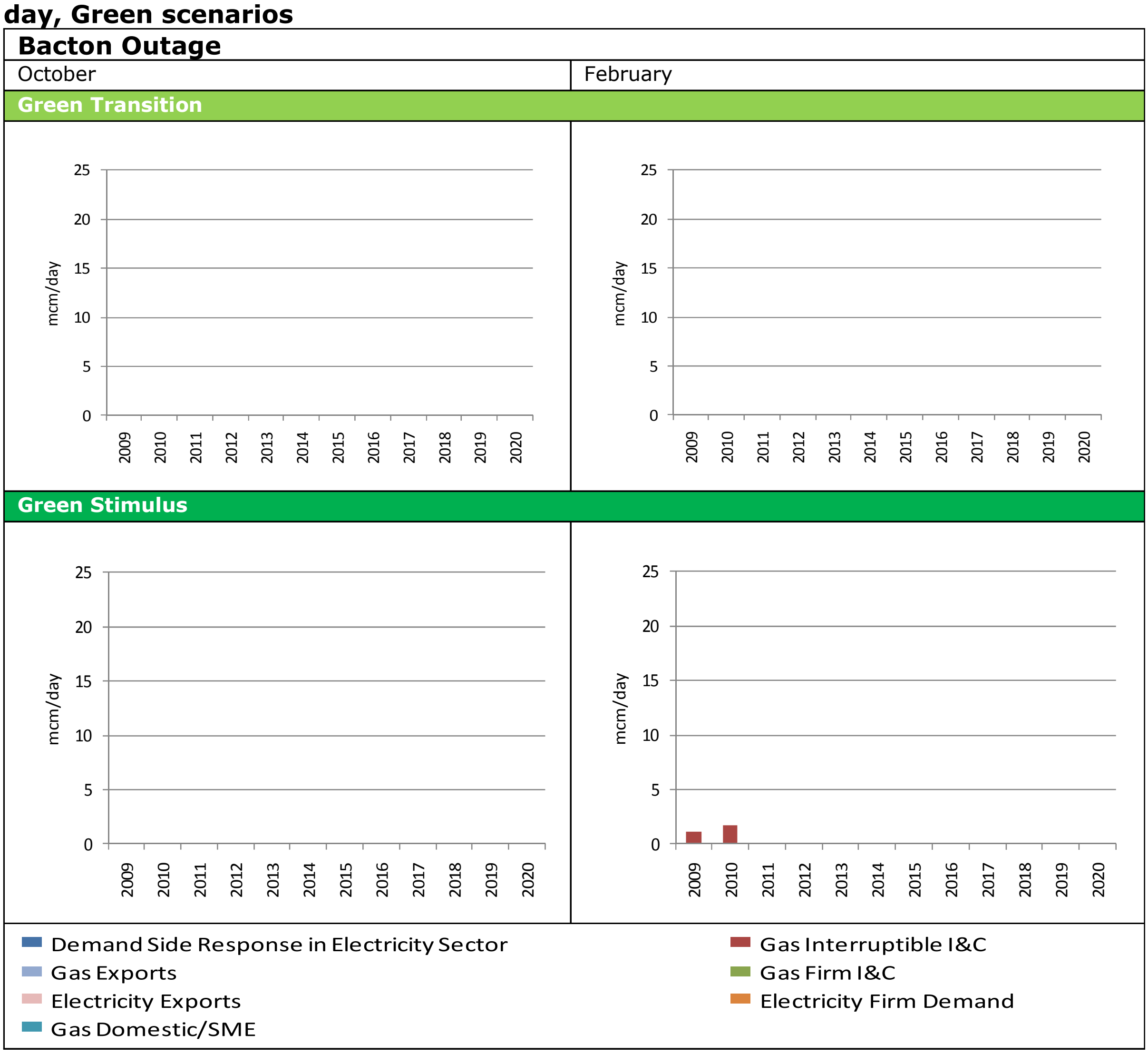
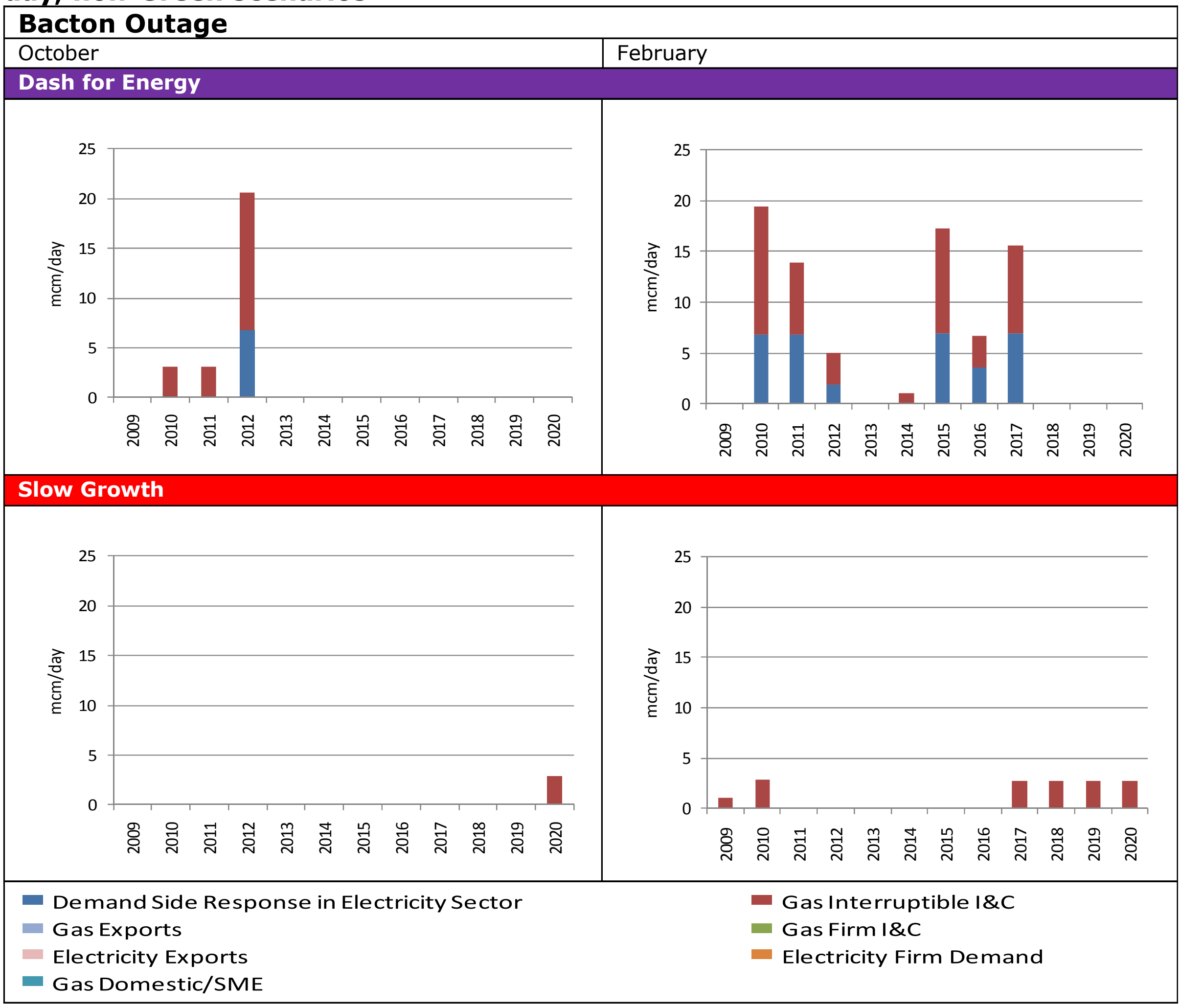


Figure 2.4: Demand curtailment for an outage at Bacton on a 1-in-20 peak day, non-Green scenarios



Low availability of wind capacity

2.7. In this stress test, we examine the impact of no wind blowing across the whole of GB during a 1-in-20 peak demand day, compared to our baseline assumption of 15% output. Further details are provided in Section 4 of our October publication. In Figure 2.5 below, the risk of demand curtailment is lower in the updated results compared to those from October due to our assumed lower demand. In Figure 2.6 below, the risk of demand curtailment is greater in the updated results compared to those from October due to our assumed higher demand. Our slight upward revision in GDP forecasts also contributes slightly to a greater risk of demand curtailment.

Figure 2.5: Demand curtailment for low availability of wind capacity on a 1-in-20 peak day, Green scenarios

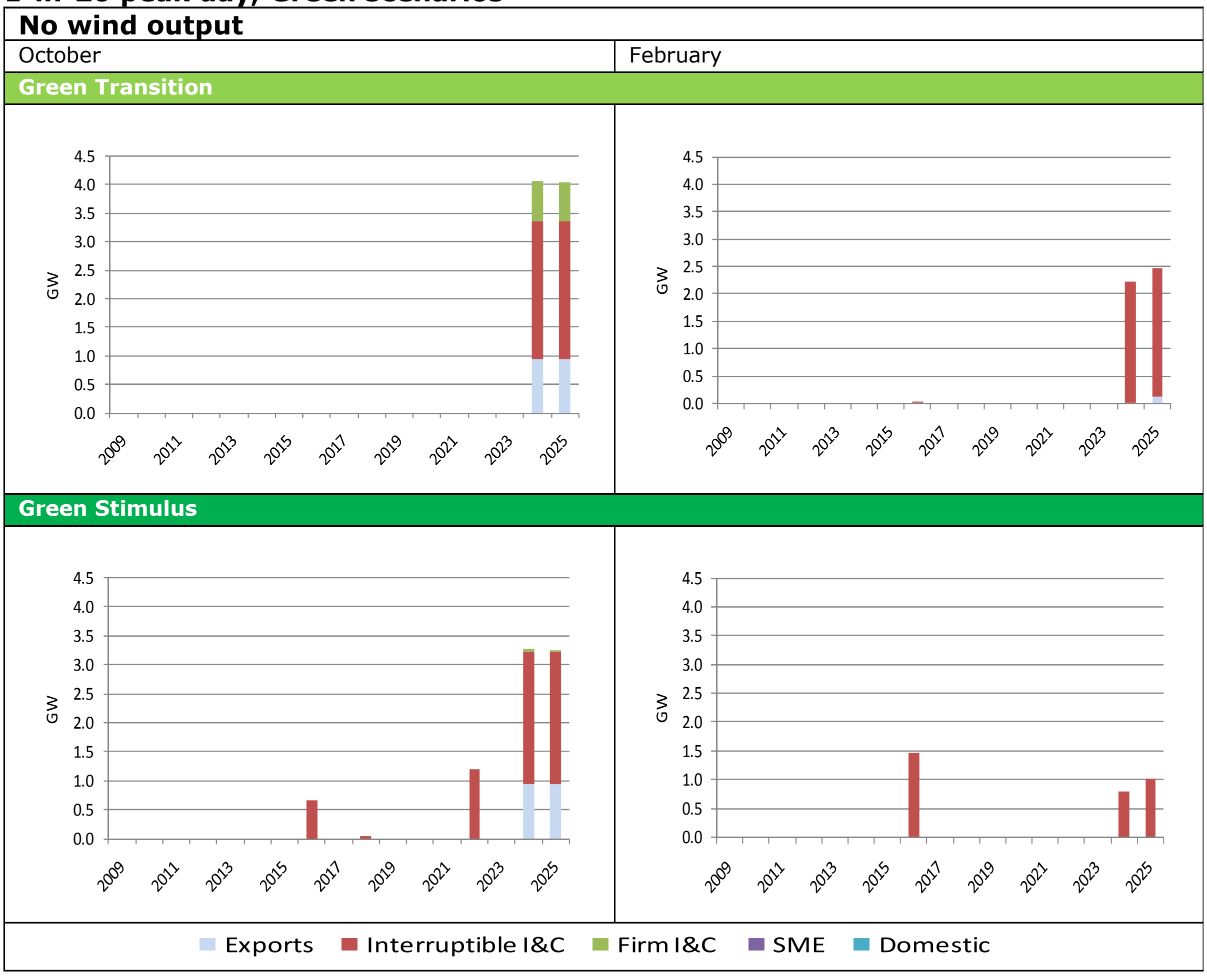
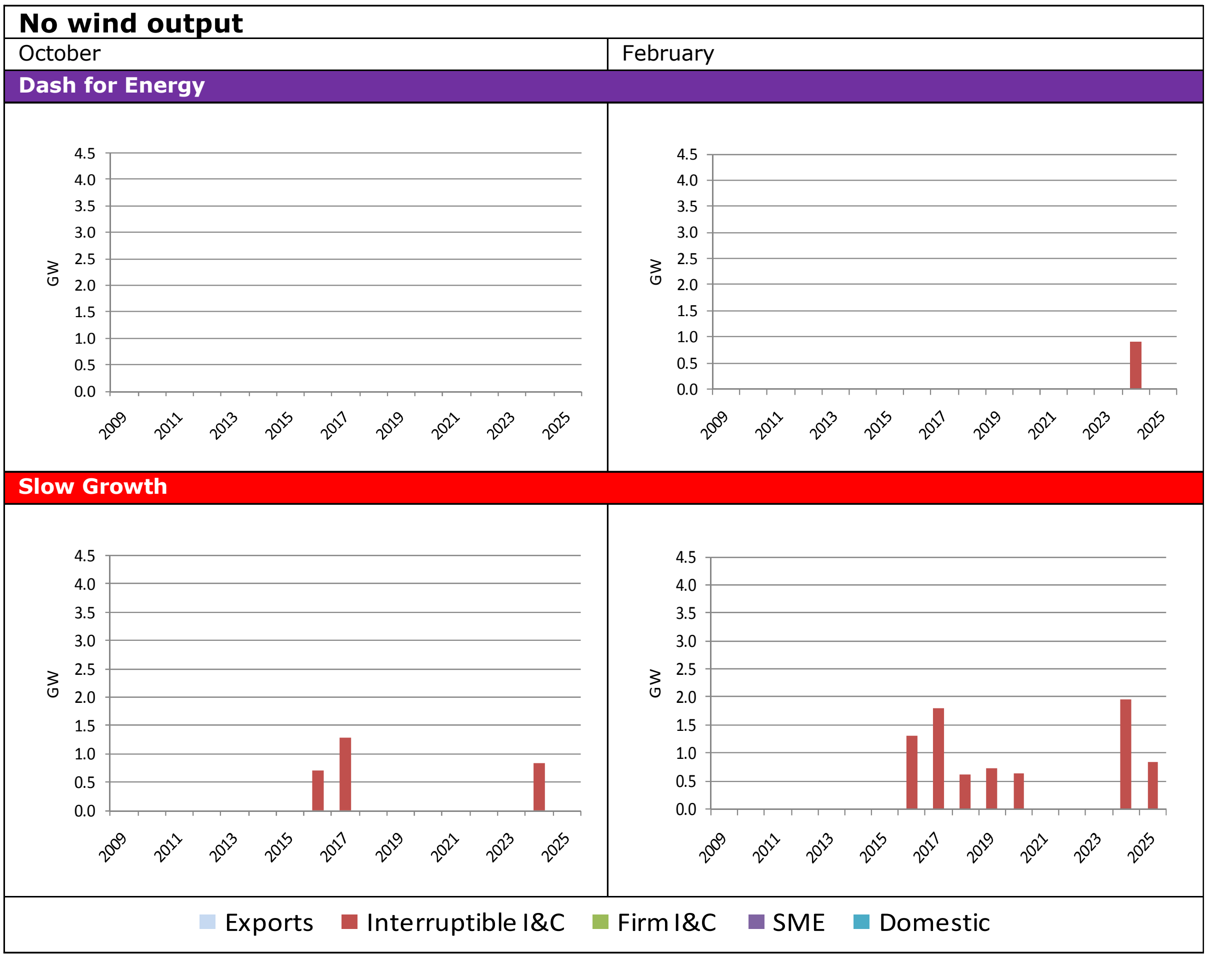


Figure 2.6: Demand curtailment for low availability of wind capacity on a 1-in-20 peak day, non-Green scenarios



Electricity interconnectors fully exporting

2.8. In this stress test we examine the impact of GB electricity interconnectors exporting at maximum during the peak period on a 1-in-20 peak demand day in response to higher continental prices. Further details are provided in Section 4 of our October publication. In Figure 2.8 below, there is a greater risk of demand curtailment in the Dash for Energy scenario in the updated results compared to those from October.

Figure 2.7: Demand curtailment for electricity interconnectors fully exporting on a 1-in-20 peak day, Green scenarios

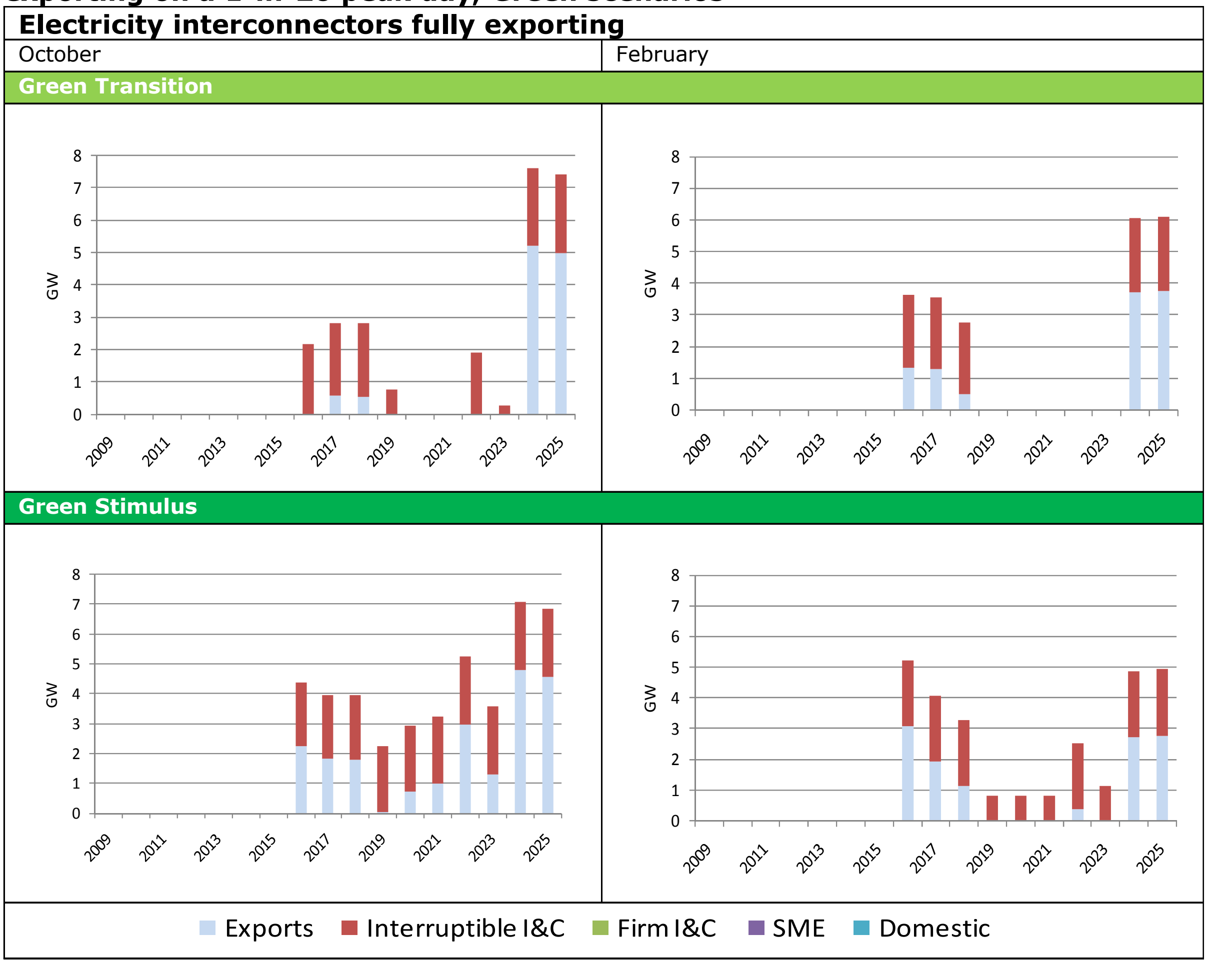
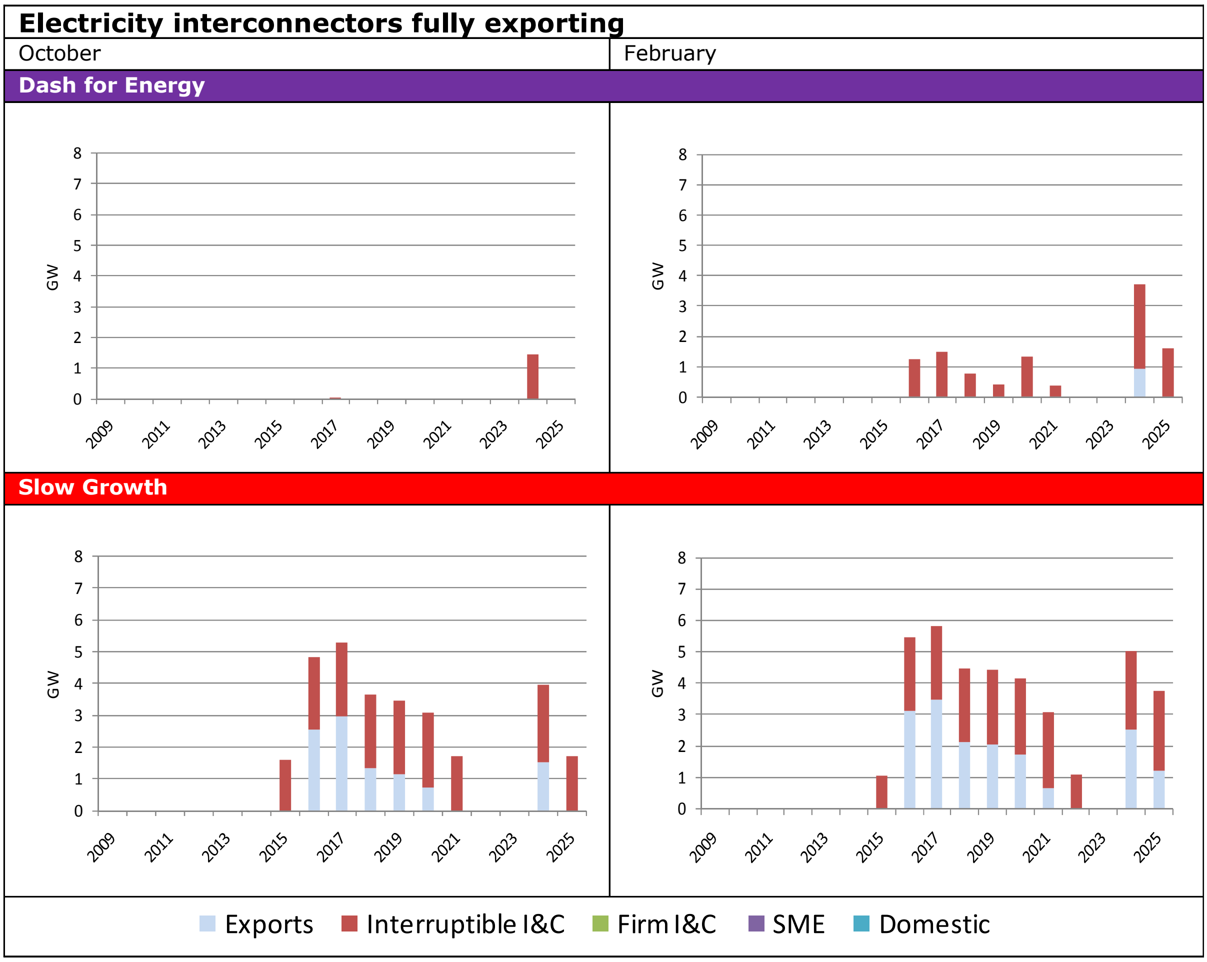


Figure 2.8: Demand curtailment for electricity interconnectors fully exporting on a 1-in-20 peak day, non-Green scenarios

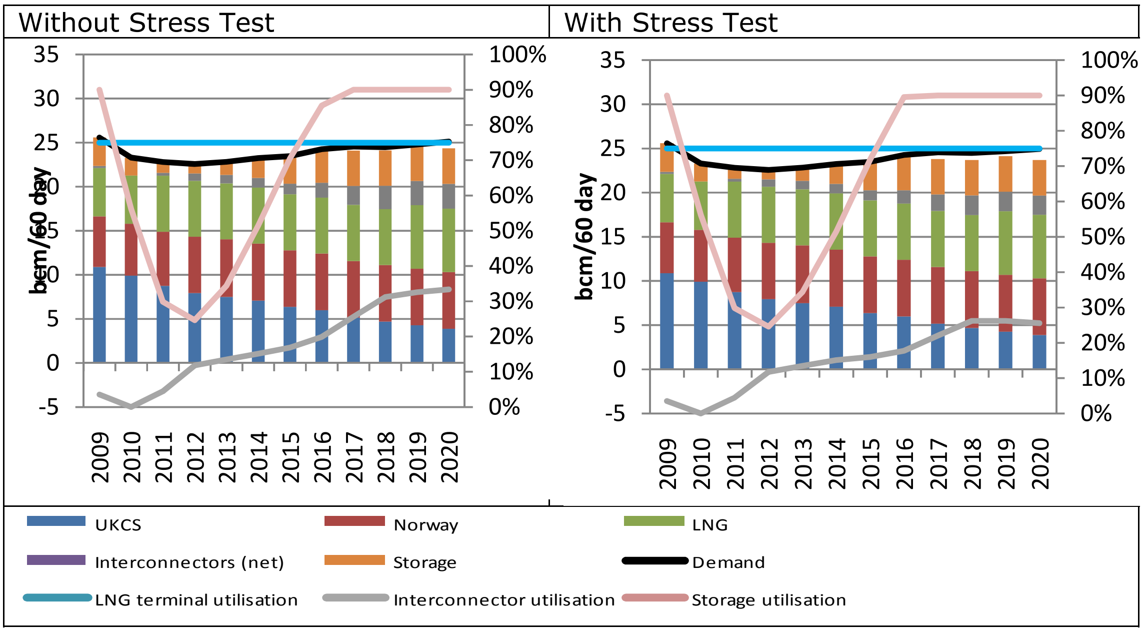


Gas quality

2.9. We have extended the model to include an additional gas quality stress test. For this stress test we assume that there are no imports through the IUK interconnector during the winter months due to the available gas being of the wrong specification to enter the GB system (we assume that gas is still flowing through the BBL interconnector under this stress test).

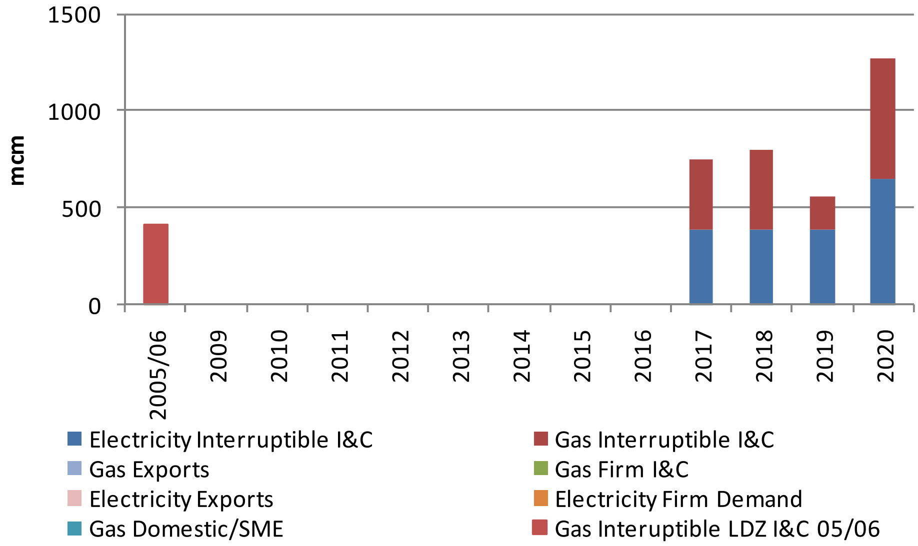
2.13. The scenario most affected by the stress test is Slow Growth. For Green Stimulus, gas demand is low and therefore this stress test does not have a substantial impact. For Green Transition and Dash for Energy, there is minimal impact because we do not assume large imports through the IUK during a severe winter in these scenarios. Figure 2.9 below shows the impact of this stress test on the Slow Growth scenario. The risk of gas shortfalls is highest between 2017 and 2020.

Figure 2.9: Stress testing the impact of gas quality issues at the IUK during a 1-in-20 winter, Slow Growth scenario



2.10. Figure 2.10 below shows the potential reduction in demand required if this stress test were to occur in the Slow Growth scenario. Gas and electricity interruptible I&C customers would be affected but the risk of curtailment of firm demand is low.

Figure 2.10: Potential demand curtailment in response to gas quality issues at the IUK during a severe winter, Slow Growth scenario (2005/6 – 2020)

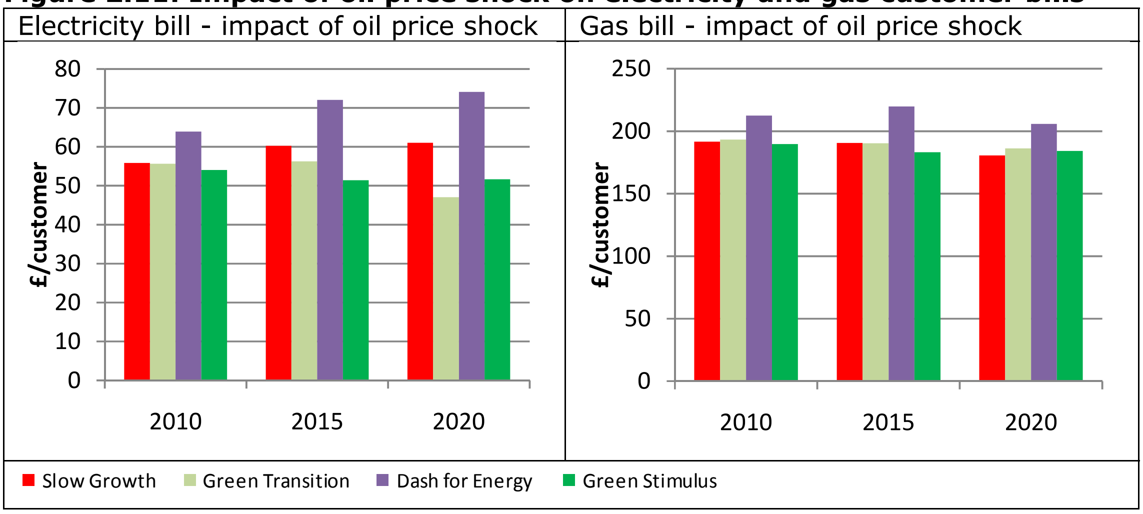


Oil price shocks

2.11. The focus of the impact of this stress test is on prices rather than physical security of supply. We look at a simple case of an $80/bbl increase in oil prices in spot years (2010, 2015 and 2020), with similar effects on other fuel prices. These price increases last for the whole of the year in question. For example, the oil price is assumed to increase under Dash for Energy to $220/bbl in 2015 with a $56/T and 62p/th increase in coal and gas prices respectively. This assumes an underlying linkage of 100% for oil and gas prices and 50% for oil and coal prices. In other words, there is assumed to be a 1-1 pass through for gas and 2-1 pass through for coal.

2.12. Figure 2.11 show the impact of an oil price shock on domestic electricity and domestic gas bills under the four scenarios. On average, such an oil price shock pushes annual domestic electricity bills up by around £60 and domestic gas bills up by around £190, taking total domestic consumer energy bills to between £1334 (Green Stimulus) and £2013 (Dash for Energy) in 2015. This assumes that the full impact of higher gas prices is passed onto consumers.

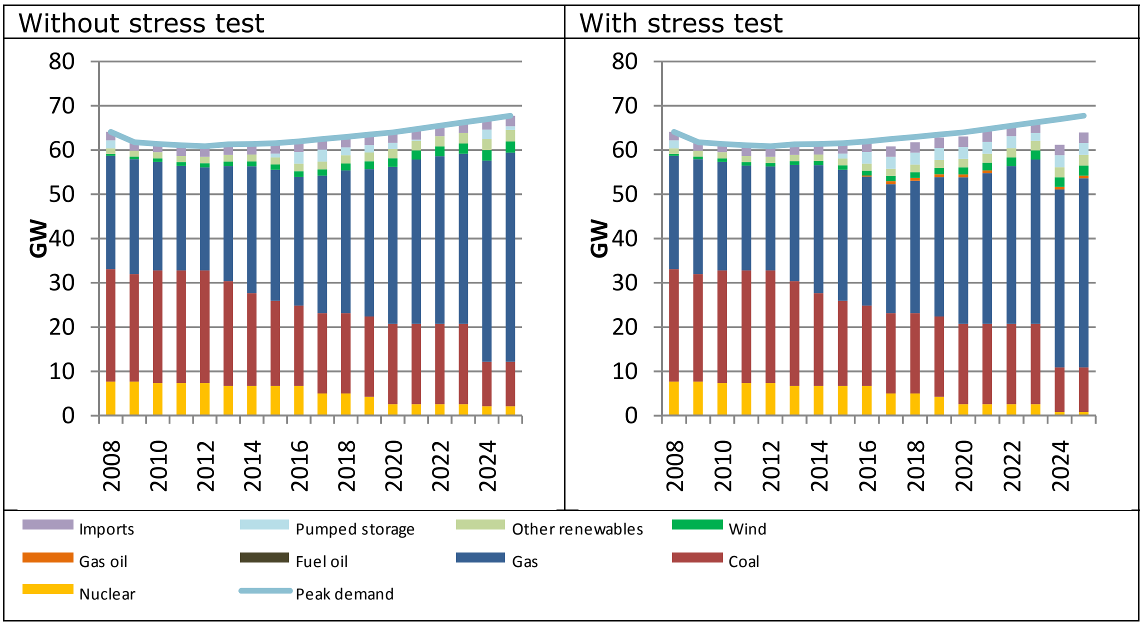
Figure 2.11: Impact of oil price shock on electricity and gas customer bills



Electricity investment delay

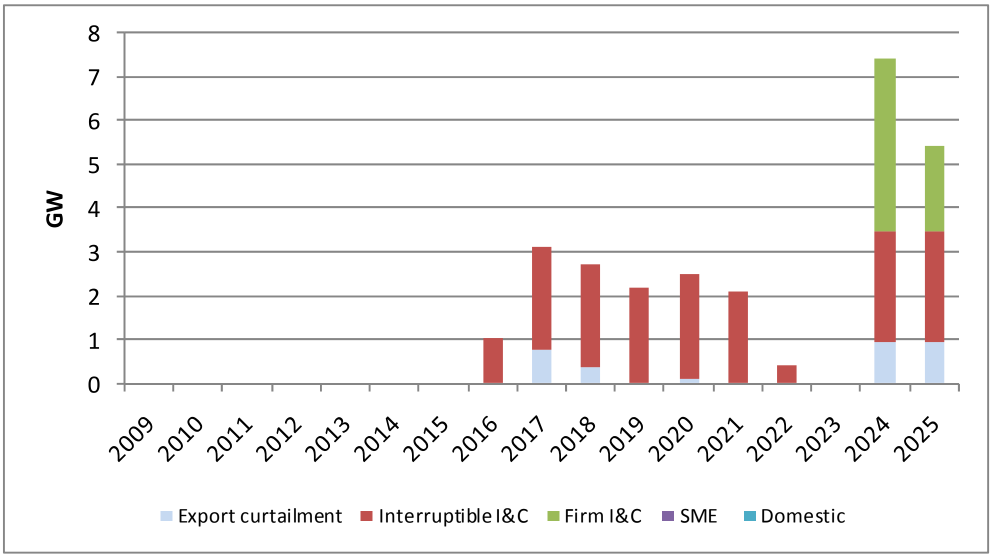
2.13. This stress test considers the impact of a two-year delay to all new investment in electricity generation plant. This delay could reflect financial or planning challenges that mean all plants come online two years later than our baseline scenario assumptions. The scenario most affected by this stress test is the Slow Growth scenario, followed by the Dash for Energy scenario. The impact is also felt in the two Green scenarios for security of supply. Figure 2.12 below shows the impact of this stress test on the Slow Growth scenario, with an increasing risk of supply shortfalls occurring from 2017 onwards, and in particular after 2024, since the impact of the investment delay is that new plant will not be online in time to replace that plant closing under the LCPD and IED respectively.

Figure 2.12 Stress testing the impact of delayed investment on the peak demand day for electricity, Slow Growth scenario



2.14. Figure 2.9 below shows the risk of demand curtailment in the Slow Growth scenario on a peak demand day under this stress test. Before 2024 only interruptible I&C customers and exports would be at risk of being curtailed as a result of this stress test. However, in 2024 and 2025 there is also a reduction in exports and risk of curtailment to firm I&C customers. The shortfall in capacity mainly reflects delayed CCGT investment, which needs to be very high in 2024/25 in the Discovery model to ensure security of supply following the closure of older plants under the IED. There are obvious uncertainties around this, for example investment could pick up later in the period to compensate in response to earlier delays.

Figure 2.9 Potential demand curtailment on peak demand day in response to delayed investment, Slow Growth scenario.



3. Model extensions

3.1. We have extended the Discovery model in response to consultation feedback to include additional functionality for the following:

- Cost of capital — this can now vary across different types of technology;
- Profitability — producing more detailed results on the profitability of different plant types; and
- Industrial and Commercial (I&C) customers — reporting impacts on I&C customers specifically.

Cost of capital

3.2. The consistency on capitalisation in the model has been extended to enable the adjustment of cost of capital (8 to 12 per cent) by each plant technology type (CCGT, nuclear, coal CCS and OCGT). We can use this functionality to test the impact of changes in the cost of capital upon security of supply and prices. Some results of this extension are used in Project Discovery: Options for Delivering Secure and Sustainable Energy Supplies.

Profitability

3.3. Our model was extended to better show the profitability of new plants by technology type in each year (2010 – 2025) across the four scenarios. This is useful for confirming the internal consistency of our scenarios. We have also developed the concept of an "economic capacity margin" in the model. This is the de-rated capacity margin at which the cheapest generation technology that can be built in relatively short timescales (in our examples, CCGT) could just cover its fuel, operating and capital costs (or "levelised costs"). If the de-rated capacity margin is higher than this, electricity prices would be too low to cover the levelised costs of a new CCGT. Whilst if the de-rated capacity margin was lower than this, prices would be higher and further investment should be attracted into the market.

3.4. The economic capacity margins can be adjusted to take account of different costs of capital (8 to 12 per cent) and expectations of load factors. The economic capacity margin can also be calculated under differing assumptions on how high peak prices can rise — £500/MWh, £1,000/MWh, £5,000/MWh and £10,000/MWh. We use this functionality to test the impact of short term price signals on the security of supply in Project Discovery: Options for Delivering Secure and Sustainable Energy Supplies.

Industrial and Commercial customers

3.5. We have also considered the impact of the four scenarios on I&C consumer bills, in addition to domestic consumers as previously. As with domestic bills, the impact on costs includes the effects of wholesale energy costs, environmental charges (ROCs, CCS subsidies and energy efficiency measures), as well as network costs and margins. The costs faced by firms from the Climate Change Levy and other taxes are also included. The I&C bills are calculated based upon annual wholesale prices instead of the two-year hedging strategy used for domestic bills.

3.6. The changes in I&C gas and electricity costs over the period to 2020 are shown in the charts below. These charts show an overall increase of between 94% and 115% in electricity costs, and 64% to 139% in gas costs by 2020. However, gas prices rise by more than this in the Dash for Energy scenario over the first half of this period, increasing 167% by 2016 before falling back again. Similarly electricity price increases peak at 141% in the Dash for Energy scenario, and 150% in the Slow Growth scenario in 2017. Wholesale price increases account for the overwhelming majority of the I&C price rises in the non-Green scenarios, whereas environmental charges (ROCs, renewable heat, CCS and energy efficiency) are broadly equal in impact to wholesale price increases in the Green scenarios. All I&C consumer bills information is presented in £/MWh rather than total annual bill, as the wide range of consumption levels between different I&C customers means that looking at an average bill is not meaningful.

Figure 3.2 I&C Gas Costs

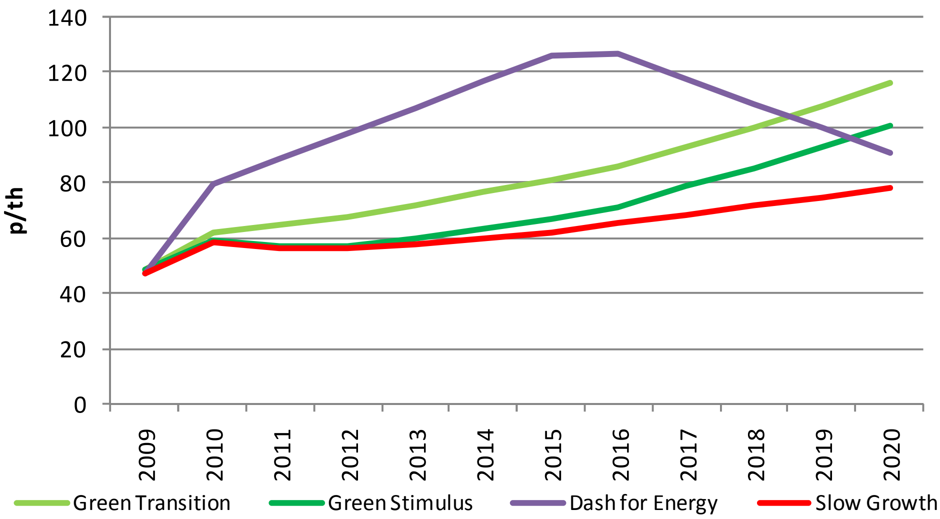
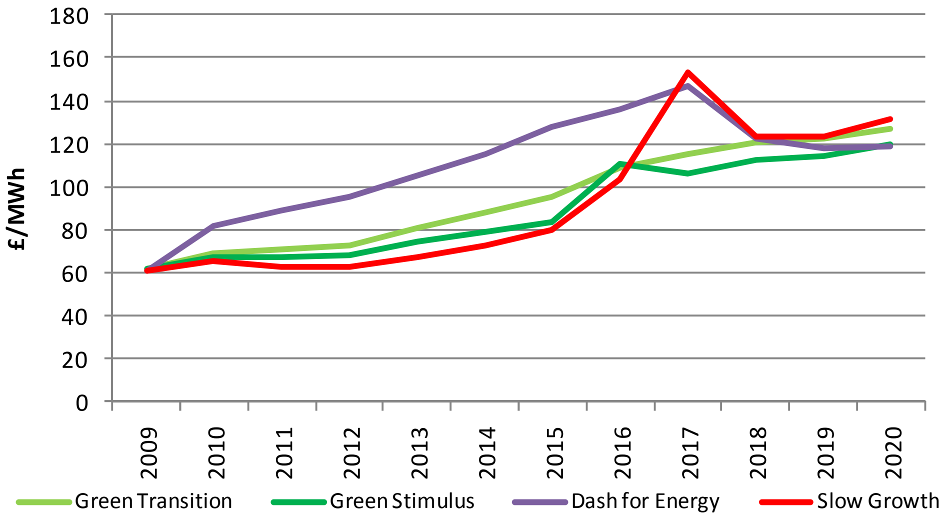


Figure 3.3 I&C Electricity Costs



3.7. However, these calculations of percentage increases are highly sensitive to the costs in the initial year that is used as a base for comparison or choice of baseline. The values for I&C prices in 2009 that we have used as a baseline for the calculations above reflect the relatively low outturn commodity prices seen last year. However with wholesale prices trending sharply downwards during 2009 from the highs of 2008, I&C costs have been highly volatile, which means customers will have paid a wide range of energy prices last year depending on how they have contracted their energy through purchasing and hedging strategies. We estimate that I&C customers locking in annual contract prices in the October 2008 contract round would have paid up to twice as much for their energy as customers following a prompt purchasing strategy. Using an alternative 2009 baseline of Q1 to Q3 average prices from DECC's quarterly survey of energy suppliers[4], the projected I&C costs under the Discovery scenarios in 2020 are much lower, with a range from 25% to 38% for electricity costs and 7% to 61% for gas.

[4] DECC Quarterly Energy Prices December 2009, Table 3.4.2.