Modification proposal 049 "Optional Limits for Inert Gases at System Entry Points"

Impact assessment

November 2005

Summary

This document sets out, for consultation, Ofgem's Impact Assessment (IA) on National Grid National Transmission System's (NG NTS) proposed Uniform Network Code (UNC) modification proposal 049 'Optional Limits for Inert Gases at System Entry Points'. The proposal seeks to modify the current limits that apply to some aspects of the quality of gas injected onto the National Transmission System (NTS) so that:

- the limit on the level of **carbon dioxide** that is permitted to be included in injected gas is increased from 2.0% to 2.5% per mole of gas injected; and

- the limit on the **inerts content of gas** (including nitrogen) is removed, although inert components will continue to be restricted indirectly by other specifications of gas quality, such as the Wobbe Index.

The **main benefit of the proposal** is that, by relaxing the limit on the volume of carbon dioxide included within injected gas, it would allow more gas to flow into GB than might otherwise be the case[1]. Improved gas availability would improve the security of gas supply and tend to reduce the overall market price of gas, to the benefit of customers.

The **main cost of the proposal** is that more carbon dioxide will be released than would otherwise be the case, which is considered to be harmful to the environment through an enhancement of the natural greenhouse effect leading to changes in climatic conditions.

Ofgem has undertaken an assessment of these costs and benefits, by:

- estimating the benefits to customers of the value of the price effect of more gas being available to the market using two different methodologies:

  - under the first approach, Ofgem used an estimate of the elasticity of supply, to estimate the benefits to customers from this proposal. The benefits ranged from £40m to £65m per annum, depending on

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[1] Typically gas is blended offshore to ensure that it meets the specified quality limits. However, in circumstances where some gas fields with higher quality gas are under maintenance or unavailable for other reasons, it may not be possible for offshore operators to blend their gas to meet the current limits, with the result that the entirety of their gas production cannot be injected onto the NTS. Therefore, relaxing the limit on the level of carbon dioxide allowed in the gas injected onto the NTS will increase the overall volume of gas that can be made available to the market.

assumptions as to when the additional gas is made available to the market;

- under the second approach Ofgem uses a merit-order methodology, and estimates benefits to customers are between £8m and £47m per annum; and

- assessing the costs to customers of the proposed modification by estimating the additional volume of carbon dioxide that would be released into the environment and by valuing it based on prevailing prices in the emissions market. Using a number of "worst case scenarios", Ofgem calculates that the additional cost of the carbon emissions will be between £0.8m and £4.7m per annum, depending of the assumptions used for the price of carbon and the assumed volume of additional carbon dioxide flowing into the NTS.[2]

Given these estimates of the potential benefits and costs to customers, **Ofgem's initial view is that proposed modification 049 should be approved**. This initial view is without prejudice to Ofgem's final consideration of whether to approve modification proposal 049, which will need to include a consideration of whether the proposed modification better facilitates achievement of relevant objectives of the UNC[3] and is consistent with Ofgem's principal objective and general duties, taking into account, among other things, the responses received to this IA.

Way forward

Ofgem welcomes views on this IA, to be received by close of business on 13 December 2005. Once respondents' views on the IA have been carefully considered, Ofgem intends to make a decision on whether to accept or reject modification proposal 049 by 16 December 2005.

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[2] Ofgem has also given careful consideration to other aspects of the proposal, including the possibility of increased oxides of nitrogen formation and changes to gas compositions which could potentially increase customers' costs. While Ofgem acknowledges the theoretical possibility that modification proposal 049 could lead to increased costs, in practice it considers that the effect is likely to be negligible.

[3] Standard Special Condition A11 of the relevant transporters' licence.

Related issues

It is important to note that this IA only evaluates the costs and benefits directly associated with modification proposal 049. It does not attempt to address the potential costs and benefits which may be associated with other gas quality issues linked to GB's increased reliance on imports of gas, which would occur regardless of modification proposal 049. Such issues will be addressed in the DTI's forthcoming gas quality consultation document.

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1. Introduction

Purpose of this document

1.1. The purpose of this document is to consult upon Ofgem's Impact Assessment (IA) on Uniform Network Code (UNC) modification proposal 049 'Optional Limits for Inert Gases at System Entry Points', hereafter referred to as modification proposal 049.

Background

Gas Safety (Management) Regulations (GS(M)R)

1.2. The GS(M)R, which are part of health and safety legislation, set the legal parameters for gas entering into and leaving the GB gas network. These parameters are set to ensure the safe distribution and utilisation of gas. All gas entering the National Transmission System (NTS) at either sub-terminals or in some cases specified downstream blending points[4] must comply with these regulations.

Gas quality parameters

1.3. Natural gas contains hydrocarbons (methane, ethane, propane, and butane), small quantities of hydrogen, inert gases such as nitrogen and carbon dioxide, and contaminants such as hydrogen sulphide and oxygen. In GB, gas appliances are designed and tested to operate on methane. The appliances are tested with this reference gas (methane) and some tests are also performed with limit gases. The limit gases[5] are those which fall at the upper and lower ends of the Group H

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[4] Gas Safety (Management) Regulations 1996 Regulations 2(4) and 8.
[5] Limit gases relate to gas falling at the upper and lower end of the group H classification as determined by EN 437 Gas Category H. These limit gases have a Wobbe number of 54.7 MJ/m^3 at the higher end and 45.7 MJ/m^3 at the lower end. These gases are usually tested to confirm that they will operate safely, if temporary excursions up to these limits occur. It should be noted that it is accepted that "operate safely" can be achieved by controlling shutdown of the appliance in a manner that presents no hazard to the user or surrounding property.

Wobbe range. The Wobbe index is related to calorific value (CV) and density. The GS(M)R range for the Wobbe number is 47.2 MJ/m^3-51.41 MJ/m^3.

Network entry agreements / legacy contracts

1.4. In addition to the GS(M)R, National Grid National Transmission System (NG NTS, formerly known as Transco NTS) has its own individual gas quality specifications at each entry point, which it agrees with the relevant sub-terminal operator. At some sub-terminals, these specifications are contained in Network Entry Agreements (NEAs). NEAs are subsidiary documents governed by the UNC. However, at some of the sub-terminals, these specifications are contained in pre-network code agreements (so called "legacy" contracts). These legacy agreements were signed primarily by British Gas and the relevant producers at the entry points prior to the introduction of Transco's network code in 1996.

1.5. The gas quality specifications contained in these agreements are referenced in the UNC.[6] Under section I of the UNC, any changes to the Network Entry Provisions (NEPs), which include gas entry conditions, measurement provisions and the point or points of delivery, need the written consent of all users who are registered at such a date when the amendment is to take effect. Alternatively, changes to NEPs can be progressed via a modification proposal.

The modification proposal

1.6. Modification proposal 049, which seeks to remove the current direct limits for nitrogen and other inerts and raise the current limit for carbon dioxide from 2.0% to 2.5%, was raised by NG NTS. It is important to note that the Wobbe Index and other existing limits will continue to place indirect limits on the total inerts that gas entering the GB system could contain. In addition, modification proposal 049 would enable the new limits to be introduced at any existing entry point without the need to raise a further modification proposal.

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[6] Ofgem published gas quality specifications at individual sub-terminals in Annex 3 of its letter 'Establishing a gas quality Review Group', 20 September 2004. (available at www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/8705_21904.pdf?wtfrom=/ofgem/work/index.jsp&section=/areasofwork/wholesalemarketmonitoring

Sub-terminals affected by the modification proposal

1.7. Several major sub-terminals already apply limits for inerts and carbon dioxide above those proposed in modification proposal 049. For example, St Fergus (Exxon-Mobil and Total sub-terminals), Teesside and Burton Point allow carbon dioxide limits in excess of 2.5%. 12 of the existing sub-terminals have no direct limits on the level of nitrogen permitted into NG NTS's system. Accordingly, the modification would only affect a portion of gas currently entering the GB gas market. Based on current flows, the increase in the allowable carbon dioxide provided by the modification proposal would affect 65% of gas entering GB. The increase in the inerts level would affect 36% of gas volumes.

Previous relevant modification proposals

1.8. Ofgem has accepted a number of proposals to modify gas quality specifications at sub-terminals. Modifications to align primarily the Wobbe number but also other gas quality parameters with the GS(M)R were accepted at Theddlethorpe (ConocoPhillips), St Fergus (Total), Dimlington (BP), West Sole, Rough and Hornsea. Appendix 1 contains a summary of relevant modification proposals that have been accepted by Ofgem. Appendix 2 summarises Ofgem's and NG NTS's obligations with respect to gas quality.

Ongoing developments

DTI/Ofgem/HSE/DEFRA study

1.9. The Government committed in the Energy White Paper with respect to gas quality, to "keep developments here closely under review. In particular we will monitor the likely effects on gas quality"[7]. Subsequently, the Department of Trade and Industry (DTI) announced the launch of a three phase gas quality exercise. This is a joint study between the DTI, Ofgem, the Health and Safety Executive (HSE) and the Department of Environment Food and Rural Affairs (DEFRA).

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[7] Energy White Paper: Our energy future creating a low carbon economy, DTI, February 2003

1.10. The gas quality exercise assesses the gas quality implications for GB as it becomes more import-dependent over the coming years. The exercise also considers both the need to facilitate trade in the wholesale gas market and the need to ensure that customers' gas appliances function adequately. In phase one of the gas quality exercise, a study was commissioned by the DTI from Ilex Energy Consulting Ltd[8]. It concluded that GB's ability to meet gas demand could be impaired by the mismatch between the national gas specification requirements with respect to the quality of gas that could be imported and the quality of potential imported gas sources. This finding launched phase two of the study, which looked at the two high level policy options of no change versus changing the GS(M)R parameters. A number of research contracts were awarded during 2004 and 2005 to various technical consultancies to assess the costs, benefits and risks of these options, the results will be used to inform future policy decisions.

Increasing reliance on imports

1.11. As GB's gas production declines, gas imports from the continent and beyond will increase. New infrastructure projects such as the Bacton-Balgzand pipeline (BBL) from the Netherlands and the Langeled pipeline from Norway, as well as the existing Interconnector UK (IUK) pipeline from Belgium, will bring gas to GB from other European markets. Accordingly, differences in GB and European gas quality specifications could in future lead to operational problems, where gas meets the specifications of the exporting country but is not compliant with the GB gas quality specification.

1.12. Ofgem and the DTI are aware of the gas quality developments that are occurring in Continental Europe. These developments are mainly focusing on the work being achieved by EASEE-gas[9], which comprises representatives of gas transporters and other interested parties from Europe, working to agree on common gas quality standards to aid the harmonisation of the gas markets in

[8] Ilex Energy Consulting – Importing Gas into the UK – Gas Quality Issues, November 2003 – A report to the Department of Trade and Industry, Ofgem and the Health and Safety Executive.
[9] European Association for the Streamlining of Energy Exchange, for more information see www.easee-gas.org

Europe. At present, the results of this forum are voluntary and therefore EASEE-gas cannot currently compel member states to adopt the standards. Currently the Commission is pressing for more work to be done in this area, recognising the fact that implementation of the proposals could give rise to significant downstream issues and costs.

Structure of this document

1.13. This document is structured as follows:

- Chapter 2 describes the possible impacts of the modification proposal;
- Chapter 3 evaluates the costs and benefits associated with the modification proposal; and
- Chapter 4 sets out Ofgem's initial conclusions.

Views invited

1.14. The analysis presented in this document provides estimates of the costs and benefits based on high-level assumptions. Ofgem invites views on both the assumptions and estimates that have been made.

1.15. Ofgem would welcome views on this IA, to be received by close of business 13 December 2005. In accordance with its usual practice, Ofgem intends to make responses to this consultation available through the Ofgem library and website. Respondents may request that their response is kept confidential. Ofgem shall respect this subject to any obligations to disclose information e.g. under the Freedom of Information Act 2000 or the Environmental Information Regulations 2004. Respondents wishing their responses to remain confidential should clearly mark the documents to that effect and include the reasons for confidentiality.

1.16. Responses should be addressed to:

Sonia Brown

Director, Wholesale Markets,

Office of Gas and Electricity Markets

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London

SW1P 3GE

1.17. Electronic responses should be sent to fiona.lewis@ofgem.gov.uk

1.18. Ofgem has committed from January 2005 to aim to set a minimum consultation period of 6 weeks for IAs and where the period is shorter to explain why. With respect to this IA, Ofgem is unable to consult for longer than 28 days because a longer consultation could adversely affect the timetable for investment in new gas supplies to the GB gas market, and therefore risks undermining security of supply.

1.19. If you wish to discuss any aspect of this paper please contact Fiona Lewis (e-mail: fiona.lewis@ofgem.gov.uk telephone: 020 7901 7436).

Way forward

1.20. Ofgem will carefully consider responses received to this IA on modification proposal 049 to help inform the Authority's final decision. The initial view in this IA is without prejudice to Ofgem's final consideration of whether to accept the modification proposal, which will need to take into account, among other things, the responses received to this IA. Ofgem intends to make a decision on modification proposal 049 by 16 December 2005.

2. Potential impacts

2.1. This chapter outlines the main areas modification proposal 049 could affect. In compiling the list of areas possibly affected, Ofgem has considered responses to NG NTS's modification proposal. The possible impacts, which are considered in turn below, include:

- economy and efficiency;
- competition;
- impact on customers;
- security of supply; and
- impact on the environment.

Economy and efficiency

Transportation charges

2.2. A higher percentage of inerts in the GB gas system could raise the costs of NG NTS as System Operator (SO). Some or all of these costs would be passed through to customers, for example, NG NTS may have to transport a higher volume of gas to deliver the same quantity of energy. This could result in increased operating costs which would be reflected in the transportation charges and ultimately passed onto customers. In addition, higher levels of carbon dioxide could increase the energy required to compress a given volume of gas. In the longer term increased capital costs could result if the increased volume of inerts accelerated the need for new pipeline investments.

Competition

2.3. The introduction of modification proposal 049 could increase the volume of gas that could reach the GB market, and therefore this would increase competition in the supply of gas. For example, at present there may be gas fields that exceed the current limits on carbon dioxide and inerts, and these fields cannot be exploited economically by blending or removing inert gases. Adoption of modification proposal 049 would allow such gas to reach the GB market, potentially lowering gas prices. Similarly, modification proposal 049 may allow some types of Liquefied Natural Gas (LNG), which cannot meet current gas quality specifications, to serve the GB gas market. Allowing a wider range of LNG to serve the GB market could increase competition, and lower gas prices.

Impact on customers

2.4. When assessing options for reforming the UNC arrangements, it is important to consider its impact on customers. In addition to the SO costs identified above, which customers are likely to face ultimately, customers could also face the direct costs outlined below.

CV Shrinkage

2.5. Calorific Value (CV) shrinkage refers to energy that is not billed because of the way charges are calculated. The Gas (Calculation of Thermal Energy) Regulations allow gas transporters to set up charging zones in which customers' bills are based on the flow weighted average CV (FWACV) of all gas entering the zone, subject to a cap. However, if the minimum CV of gas entering a zone is over 1 MJ/m^3 less than the FWACV in the zone, then customers' bills are based on an energy content equal to the minimum CV plus 1 MJ/m^3. The difference between the energy content billed and the FWACV is the cause of CV shrinkage. For example, if the FWACV in a zone was 42 MJ/m^3, and the minimum CV in the zone was 40.5 MJ/m^3, then customers would be charged on the basis of 41.5 MJ/m^3. The CV shrinkage would be 0.5 MJ/m^3, multiplied by the gas flows billed.

2.6. If modification proposal 049 increased the percentage of heavy hydrocarbons in some zones, the FWACV could increase while the minimum CV remained the same. This would increase CV shrinkage, and the amount of unbilled energy.

Effects on customers' processes

2.7. Some customers use natural gas as a feedstock for chemical processes and as an input into other processes. In the case of the former, it could be the case that changes in the composition of the feed gas could adversely affect production processes, which could constrain output and potentially reduce revenues.

Effects on customers' capital and operating costs

2.8. An increase in the amount of inerts in GB gas could increase the capital and operating cost of storage sites. Sites that liquefy and store natural gas for use at times of peak demand must remove carbon dioxide and nitrogen from the feed gas. NG LNG has claimed that an increase in the percentage of nitrogen in the feed gas could increase the capital and operating costs of producing LNG from gas in the GB system that is stored in these sites. Storage sites which inject gas into underground reservoirs may experience increased costs of compression, if the composition of the injected gas changes.

2.9. Conceivably, a change in the GB gas composition could change the Lower Explosive Limit (LEL). The LEL is the minimum percentage of natural gas which, when mixed with air, could sustain an explosion. The LEL is used to determine safe distances between equipment that could ignite a gas/air mixture and potential sources of gas leaks. The introduction of a higher fraction of heavier hydrocarbons in the gas could reduce the LEL, and this could necessitate remedial action (e.g. re-location of equipment).

Carbon costs

2.10. Under the EU-wide Emissions Trading Scheme (EU ETS), installations (sites) carrying out activities in sectors covered by the scheme must pay for carbon emissions in excess of their allowances. Sites covered in the scheme include combustion installations (including power plants), iron, steel, glass cement, brick and tile manufacturing. Sites' carbon emissions are calculated on the basis of fuel-specific Carbon Emissions Factors (CEFs), which specify the amount of carbon emissions per unit of energy used ($kgCO_2/kWh$).

2.11. By relaxing the maximum carbon dioxide and nitrogen content of gas at some sub-terminals, modification proposal 049 could raise CEFs (all CEF's quoted are based on net CVs), and therefore increase the cost of carbon emissions per unit of energy used. This could occur in two possible ways. First, the amount of carbon dioxide in the un-burnt gas will increase. Second, the absence of a limit on nitrogen could allow producers to put an increased percentage of heavier hydrocarbons (propane, butane etc.) in their gas, and respect the Wobbe limit by 'ballasting' the gas with increased amounts of inerts (nitrogen). A higher fraction of heavier hydrocarbons in the gas would increase the CEF, because heavier hydrocarbons produce more carbon dioxide for every MJ of energy released. Similarly, modification proposal 049 could allow the importation of LNG that requires an inert gas content higher than the current limit to meet the Wobbe specification. The result would be an increase in the average level of heavier hydrocarbons in the system, and an increase in the CEF.

Security of supply

2.12. Many customers (particularly small domestic, small industrial and commercial customers) place value on being able to consume gas and electricity without interruption and at reasonable price.

2.13. As domestic GB gas production declines, imports of piped gas and LNG are forecast to increase. Pipeline gas will come via the existing IUK line from Zeebrugge in Belgium, and from future pipelines such as the BBL line from the Netherlands and the Langeled pipeline from Norway. Gas from these sources is allowed a higher contractual level of carbon dioxide and inerts than is currently acceptable in GB. For example, gas from the Norwegian Continental Shelf is allowed to contain 2.5% carbon dioxide and no limit is placed on total inerts. Similarly, Transmission System Operators in much of Europe, including Belgium and the Netherlands, have higher limits for carbon dioxide content than that stated in NG NTS's 10 year statement.

2.14. Accordingly, operators of interconnecting pipelines to GB must ensure that the levels of carbon dioxide in the pipelines meet the lower GB specification for carbon dioxide and inerts, even though much of the source gas may contain higher levels of carbon dioxide than would be allowed in GB. Pipeline operators achieve this by blending different gas sources.

2.15. Blending raises at least two issues with respect to security of supply. First, the need to blend gas may constrain the total amount of gas that is available to the GB market. For example, production from a field with higher carbon dioxide content may be limited by the level of production available from a field with lower carbon dioxide content. If the upper carbon dioxide limit was raised, production could be increased. Similarly, some types of LNG may not be able to serve the GB gas market, because they cannot reduce the Wobbe specification to meet the current GB gas specification without breaching the limit on total inerts. Adopting modification proposal 049 would allow such sources of LNG to serve the GB market. In the event that a shipment of LNG is disrupted, there would be a wider choice of alternative sources of LNG, thus increasing security of supply.

2.16. Second, for technical reasons blending could fail temporarily, for example, if the blend gas stream is unavailable for reasons such as unplanned maintenance, causing the imported gas to breach the maximum allowed inert or carbon dioxide limits. The extent to which blending could be possible would primarily be dependent upon the quantity of gas delivered in any blend gas stream and could therefore be unreliable. These could cause the source of importing gas to be cut off suddenly, whilst the problem is resolved. The result would be a temporary reduction in gas supply and an increased probability of supply disruption. This would lead to an increase in the wholesale gas price and, if available, substitution of the off-specification gas supplies with more expensive sources of gas.

2.17. Adoption of the modification proposal would avoid the need for interconnector operators to blend gas, and reduce the possibility of supply disruptions due to differences in carbon dioxide and nitrogen specifications between continental and GB gas. This would increase security and diversity of supply.

Environmental Impact

2.18. In carrying out its functions under the Gas Act, Ofgem is required "to have regard to the effect on the environment of activities connected with the conveyance of gas through pipes." The Sustainable Energy Act 2003 requires IAs to be carried out on important proposals which includes one which has significant effects on the environment. All IAs must include an assessment of the likely effects on the environment of implementing the proposal.

Carbon emissions

2.19. Carbon emissions from GB may increase, as a result of this modification proposal for the reasons set out above.

NOx emissions

2.20. Emissions of Nitrous Oxides (NOx) could potentially increase as a result of this modification proposal, for two reasons. First, increased amounts of nitrogen in GB gas could potentially contribute to the formation of NOx. Second, changes in the gas composition, such as an increase in heavier hydrocarbons, could increase flame temperatures and the formation of NOx.

Fugitive emissions

2.21. Inevitably, every year about 0.6% of gas transported leaks from the NTS and Local Distribution Zones (LDZs). These emissions cause environmental harm, because the methane in natural gas is a greenhouse gas, and the hydrocarbons also contribute to local pollution e.g. low-level ozone formation, amongst other things. The net change in the amount of environmental harm that would result from changes in gas composition resulting from the proposed modification is complex because:

- direct emissions of CO2 in the gas would increase as a result of the greater concentration in fugitive gas;

- to the extent that methane in the gas was replaced by heavier hydrocarbons (which are not greenhouse gases), the climate change impacts of fugitive gas may be reduced; and
- local air quality may be reduced, as a result of the higher proportion of heavier hydrocarbons in fugitive gas, as the heavier the hydrocarbons, the more local air quality damage is done per volume of gas leaked.

Summary

2.22. This chapter has outlined the main areas that modification proposal 049 could affect. The next chapter assesses the costs and benefits associated with modification proposal 049 in relation to the areas identified.

3. Costs and benefits

Introduction

3.1. This chapter attempts to evaluate the costs and benefits of modification proposal 049. It is important to note that this IA only evaluates the costs and benefits directly associated with the modification proposal. It does not attempt to address the potential costs and benefits which may be associated with other gas quality issues linked to GB's increased reliance on imports of gas, which would occur regardless of modification proposal 049.

3.2. Ofgem does not employ a 'present value' (PV) approach in this IA. A PV approach is appropriate when the timing of the costs and benefits differ. As Ofgem expects the costs and benefits of modification proposal 049 to occur simultaneously, it simply compares costs and benefits for a typical year.

3.3. Modification proposal 049 would clearly lead to some increase in levels of carbon dioxide in GB gas; allowing higher levels of carbon dioxide is the source of the main benefit of the proposal. Therefore, Ofgem has asked NG NTS to quantify the levels of carbon dioxide that might result from modification proposal 049. It is less clear that modification proposal 049 would result in increased levels of inerts in GB gas including nitrogen. Accordingly, with respect to NOx and other issues, Ofgem has investigated whether modification proposal 049 is expected to result in an increase in levels of nitrogen in GB gas, before pursuing a quantitative analysis.

Costs

Carbon allowance costs

3.4. In this IA Ofgem differentiates between the allowance or 'cash-costs' of carbon which are incurred from the cost of buying emissions allowances, and the environmental cost of carbon. For example, many carbon emitters are not covered under the EU ETS. Hence, increased carbon emissions from such sites will have no allowance cost, but will still have an environmental impact. This section of the IA deals only with the allowance costs of carbon. The Environmental Impact section of the IA discusses the environmental impact of carbon emissions.

3.5. Ofgem has estimated the additional allowance cost of carbon potentially caused by this modification proposal using three inputs: the estimated increase in CEFs as a result of modification proposal 049; projected levels of carbon emissions from burning natural gas in installations covered under the Emissions Trading Scheme; and finally the future cost of carbon allowances. Multiplying these three inputs together gives the increased allowance cost of carbon emissions as a result of this modification proposal.

3.6. Ofgem has adopted a scenario approach to capture both the expectation and extremes of the allowance costs associated with higher levels of carbon dioxide in GB gas. In the low case scenario, only the Langeled line and the BBL line exceed the current 2% carbon dioxide limit. The medium scenario assumes that the IUK line also exceeds the current 2% carbon dioxide limit, while the high scenario takes the case that Langeled, BBL, IUK and all GB sub-terminals that currently have a 2% limit use the new 2.5% carbon dioxide limit fully.

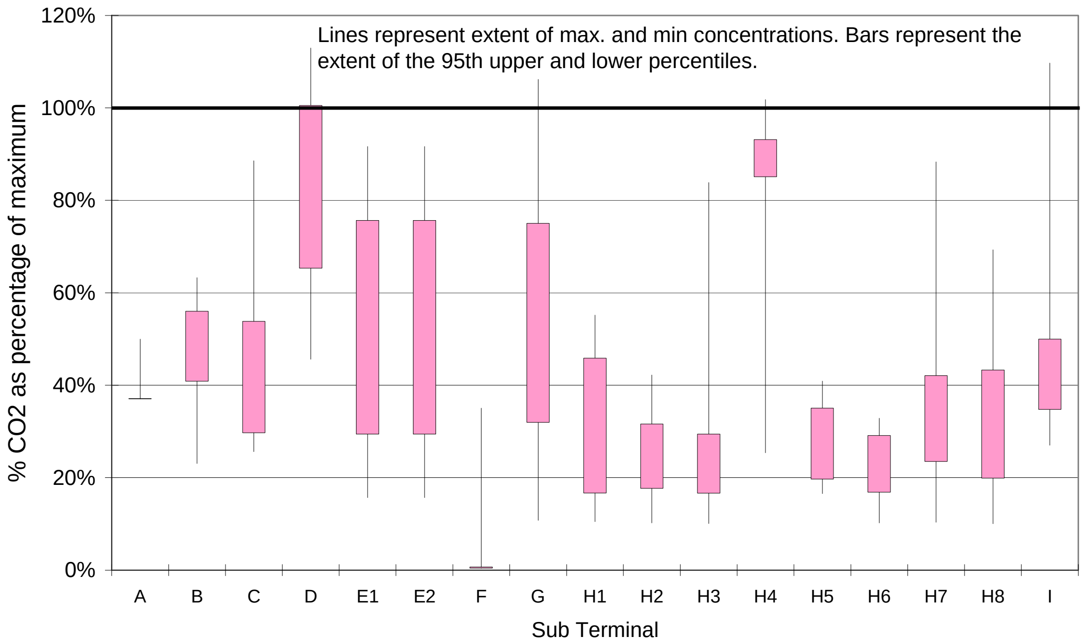
3.7. Table 1 summarises the scenarios. All flows are consistent with the 'Global LNG' scenario used in NG's 10 year statement.

Table 1: Assumed carbon dioxide concentrations from different gas sources in the three scenarios used to estimate costs

Gas source	Low cost scenario	Medium cost scenario	High cost scenario
Langeled, BBL	2.5% CO2	2.5% CO2	2.5% CO2
IUK	Current level	2.5% CO2	2.5% CO2
GB sub-terminals	Current level	Current level	2.5% CO2

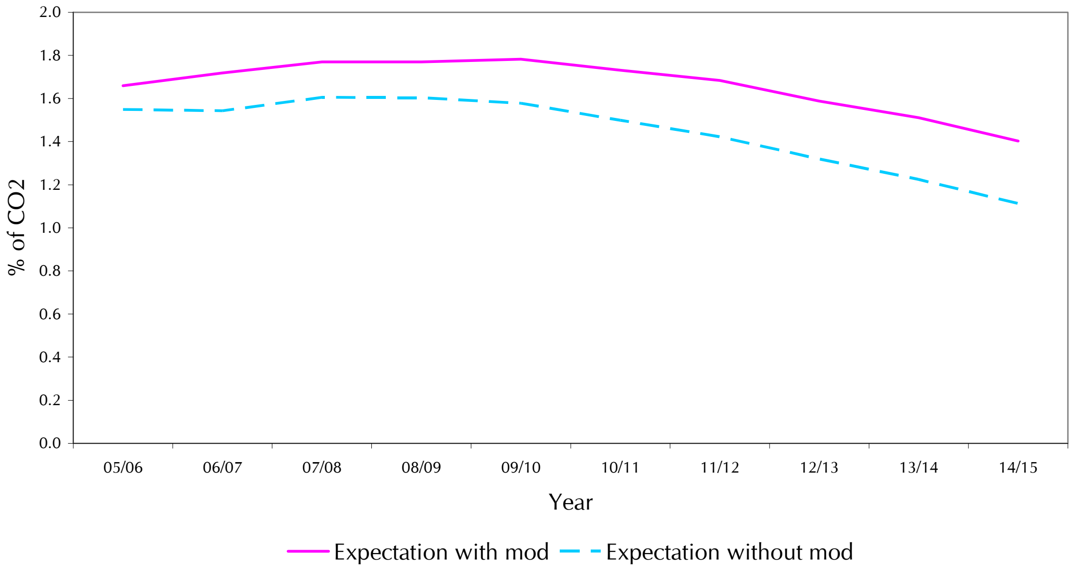
3.8. The evidence suggests that the high scenario – where all GB sub-terminals produce at the new 2.5% limit – is highly unlikely to materialise. Figure 1 illustrates that the level of carbon dioxide observed at most sub-terminals with a 2% limit is usually below the contractual limit. Therefore, it seems unlikely that an increase in the maximum level of carbon dioxide allowed would result in an increase in the average level of carbon dioxide produced. If gas producers wished to produce 2.5% carbon dioxide, then presumably they would produce close to the 2% limit already. To do otherwise would defer gas production (by shutting in or limiting flow from high carbon dioxide fields) or increase processing costs. The fact that gas producers do not produce close to the 2% limit currently allowed suggests that there would be little if any increase in average carbon dioxide levels if modification proposal 049 were approved. Therefore, Ofgem regards the high scenario – where all GB sub-terminals experience 2.5% carbon dioxide levels – as extremely unlikely.

Figure 1: Range of concentrations of carbon dioxide at GB sub-terminals with a current 2% limit as a percentage of the maximum concentration allowed



3.9. Moreover, NG NTS project that if the modification proposal is approved, the average carbon dioxide content of GB gas will continue to fall, albeit at a somewhat lower rate than without the modification proposal (see Figure 2).

Figure 2: Expected average CO2 levels with and without modification proposal 049[10]



3.10. Also with respect to the high scenario, Ofgem asked NG NTS to report the change in carbon dioxide levels relative to existing limits of 2%. In other words, NG NTS estimated the difference in carbon dioxide production between:

- a comparison case where GB sub-terminals produced at their current carbon dioxide limit; and
- a case where GB sub-terminals with a carbon dioxide limit of less than 2.5% increased carbon dioxide production to a 2.5% limit.

3.11. To report the difference between current carbon dioxide production at GB sub-terminals and carbon dioxide production at a 2.5% limit would exaggerate the effect of modification proposal 049. As Figure 1 illustrates, most GB terminals which currently have a 2% limit produce well below this limit, and so a substantial increase in carbon dioxide (from current levels to 2%) would be possible even without modification proposal 049. The correct approach is to report only the incremental effect that modification proposal 049 could have on carbon dioxide levels, rather than report what increases are already possible even without modification proposal 049.

[10] Illustrates carbon dioxide levels in the medium cost case and the no modification case.

Change in CEFs

3.12. Ofgem has asked NG NTS to study the increase in CEFs that may result if modification proposal 049 is approved, relative to a base case where modification proposal 049 is not approved, for the three scenarios for the gas years 2005/06 to 2014/15. For every year between 2005 and 2015, NG NTS has calculated the CEF for each year and each LDZ without modification proposal 049 and the CEF for each year and in each LDZ with the proposal. NG NTS has then calculated the percentage difference for each year and in each LDZ. For the benefit of larger gas users, NG NTS has also prepared estimates of the CEFs at GB terminals, with and without modification proposal 049. These numbers are reported in Appendix 3.

3.13. NG NTS has estimated that, even in the worst case scenario, the introduction of modification proposal 049 would increase the average CEF (i.e. averaged over all years studied and all LDZs) by less than 0.5%. Ofgem also notes that the methodology adopted exaggerates the change in CEFs. Even in the low scenario, the methodology assumes that, for example, Langeled would have an average carbon dioxide level of 2.5%. In reality, Langeled and other pipelines will only experience infrequent peaks up to 2.5% carbon dioxide. Average carbon dioxide levels will be almost unchanged. Hence, Ofgem expects that, for all scenarios, the changes in CEFs that NG NTS predicts will be far higher than will occur in practice.

3.14. The figures below give a summary of the changes in average GB gas CEFs, while Appendix 3 presents more detailed results.

Figure 3: Forecast average percentage change in regional CEF's 2006-2015 - low cost scenario

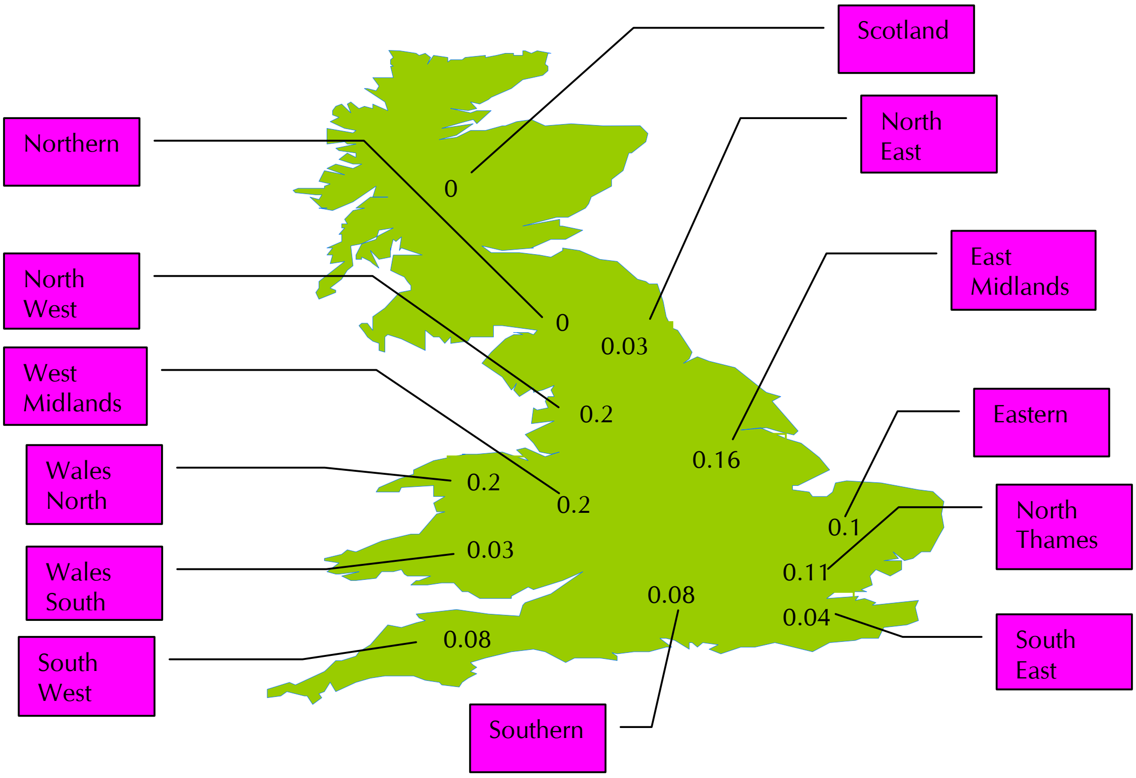


Figure 4: Forecast average percentage change in regional CEF's 2006-2015 - medium cost scenario

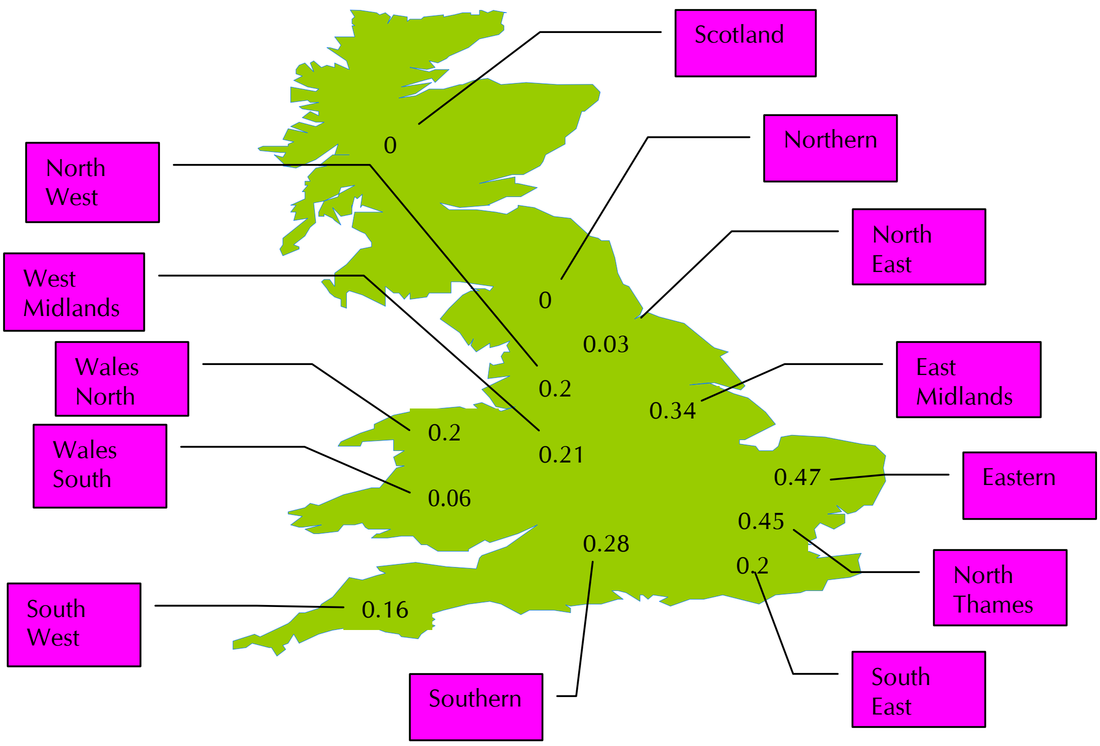
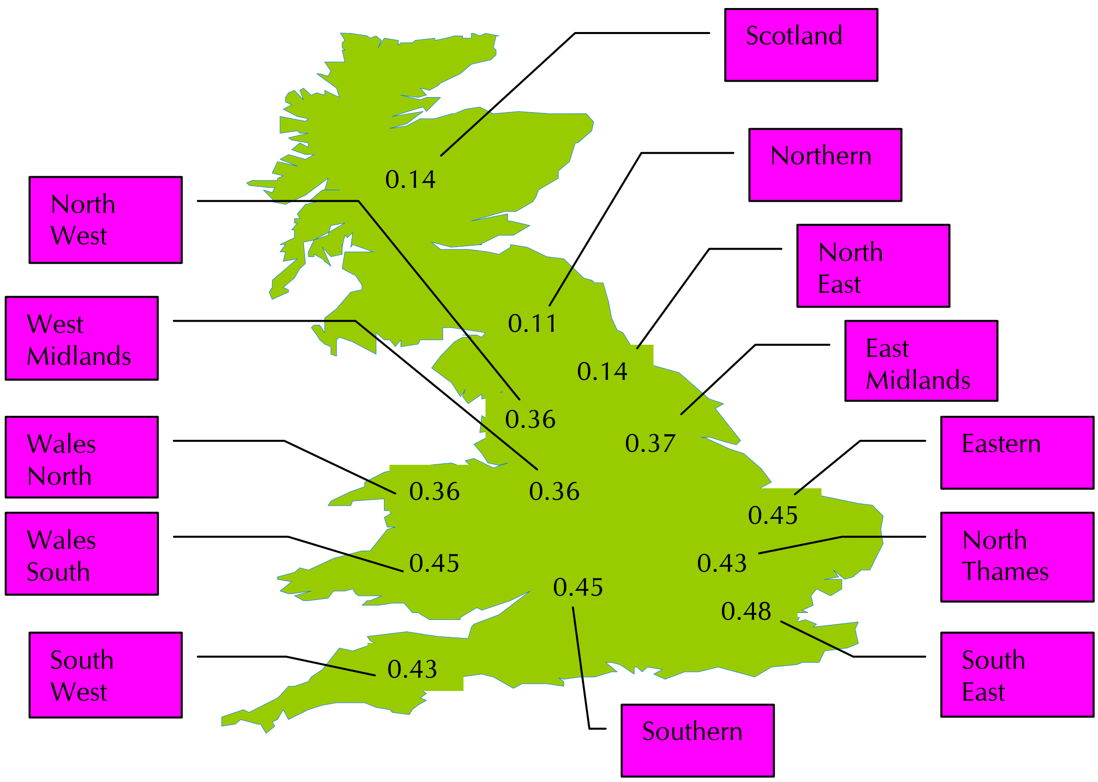


Figure 5: Forecast average percentage change in regional CEF's 2006-2015 - high cost scenario



Projected carbon emissions covered by EU ETS

3.15. Ofgem has used the DTI's November 2004 estimates of carbon emissions from burning natural gas in installations covered under the Emissions Trading Scheme.[11] The DTI will shortly update its estimates of carbon emissions. However, Ofgem considers that, in the interests of this IA being as transparent as possible, it is better to use carbon emissions underlying the public November 2004 projections, rather than rely on slightly more recent data that Ofgem would be unable to publish. Moreover, the DTI estimates that there will not be a material difference between the November 2004 forecasts and its forthcoming update.

[11] DTI Updated Emissions Projections, Final projections to inform the National Allocation Plan (NAP) 11 November 2004.

3.16. Unfortunately, the DTI only identifies carbon emissions by industry type, and not by fuel type. The DTI does however make projections for carbon emissions from gas-fired power generators, and these represent the majority of carbon emissions from natural gas. Therefore, Ofgem assumes that total carbon emissions from natural gas covered under the Emissions Trading Scheme is equal to emissions from gas-fired power stations plus gas-fired emissions from industry. This is a conservative estimate (in that it is likely to overestimate Emissions Trading Scheme emissions from natural gas) because not all of the installations Ofgem includes under industrial emissions are covered under the Emissions Trading Scheme. Using this definition, DTI forecast that (in the absence of modification proposal 049) carbon emissions from natural gas from Emissions Trading Scheme installations will be 24.4 MtC in 2005 and 24.8 MtC in 2010.

3.17. As the DTI does not prepare carbon emissions forecasts by LDZ, Ofgem applies the increase in the national average CEF to calculate the carbon costs of modification proposal 049. This methodology should not introduce a large inaccuracy, because Ofgem expects carbon emissions to be relatively uniform between the LDZs.

The allowance cost of carbon

3.18. The costs of this modification proposal will be highly sensitive to the cost of carbon assumed. In 2002, a joint Department for Environment Food and Rural Affairs (DEFRA)/Her Majesty's Treasury (HMT) paper recommended a central figure of £70/tC for policy analysis, and £35/tC and £140/tC for sensitivity analysis.[12] Since publication, the figure of £70/tC has been widely criticised and DEFRA has set-up a cross-departmental group, which Ofgem participates in, to review this recommendation. While this figure is under review, Ofgem will use an illustrative carbon price of £35/tC (£10/tCO2) for this IA. However, Ofgem also recognises that since the 2002 study cited above, traded carbon markets have become much more liquid and the prices they produce more reliable.

[12] 'Estimating the Social Cost of Carbon Emissions' Richard Clarkson & Kathryn Deyes Environment Protection Economics Division Department of Environment, Food and Rural Affairs: London, January 2002.

Accordingly, it is also appropriate to use recent market prices of carbon for this IA.

3.19. At the time of writing, market prices for carbon were around £55/tC (£15/tCO2), a historically high price. For example, in January 2005 carbon prices averaged just over £18/tC (£5/tCO2).

3.20. The forward curve for carbon is relatively flat, with prices not differing significantly from £55/tC up to 2008. Therefore, Ofgem calculates the cost of extra carbon emissions taking a price of £55/tC as our base case, but Ofgem performs a sensitivity using a carbon price of £35/tC.

3.21. **Estimated increase in carbon allowance costs** .

3.22. Table 2 summarises the estimated increase in carbon allowance costs for the three scenarios considered. The costs range from £0.8 million per year to £4.7 million per year.

Table 2: Increase in average annual EU ETS allowance costs

Scenario	Change in CEF,%	Additional carbon emissions 2005-2010, tC/year	Cost @ £55/tC, £ million	Cost @ £35/tC, £ million
High	0.34%	84,530	4.7	3.0
Medium	0.21%	52,095	2.9	1.8
Low	0.10%	23,770	1.3	0.8

Impact on the environment

Carbon dioxide emissions

3.23. The previous section described the effect of modification proposal 049 on carbon allowance costs. This section of the IA deals with the environmental impact of increased carbon emissions as a result of modification proposal 049.

3.24. Modification proposal 049 will lead to increased carbon emissions from GB, both from emitters covered under the EU ETS scheme and other sites (generally household emissions and those from smaller industrial and commercial installations). For emitters covered under the EU ETS scheme, there will be no increase in carbon emissions on an EU basis as a result of modification proposal 049, because carbon emissions are capped by the scheme. If GB sites emitted more carbon, they would need to buy allowances from other sites in Europe which would have to reduce their emissions.

3.25. However, modification proposal 049 could result in increased carbon emissions in GB from sites not covered under the EU ETS. Ofgem has estimated the size of this impact based on likely annual emissions for each of the scenarios (see table 2).

Table 3: Increase in annual emissions from the non-EU-ETS sectors

Scenario	Change in CEF,%	Average increase in Non EU ETS carbon emissions 2005-2010, tC/year
High	0.34%	95,000
Medium	0.21%	58,000
Low	0.10%	27,000

3.26. Increased carbon emissions from sites not covered under the EU ETS will not automatically be offset by reductions in emissions elsewhere. However, shippers have advised Ofgem that without modification proposal 049, gas with a range of carbon dioxide between 2.0% and 2.5% would flow to European gas markets, rather than flowing to the GB market. Therefore, the higher carbon dioxide gas will be burnt (and the carbon released) either in continental Europe or the GB market.

3.27. Hence, it seems likely that this modification proposal does not lead to a significant increase in carbon emissions on a European basis, but rather transfers carbon emissions from the continent to GB. Therefore, modification proposal

049 has little net environmental effect with respect to carbon emissions. Moreover, Ofgem's assumptions with respect to the amount of carbon emitted by sites covered under the EU ETS exaggerate the actual carbon emissions. Therefore, it is likely that any incremental carbon emissions from non-EU ETS sites are already captured in Ofgem's analysis. It could also be the case that an increase in gas prices, due to repeated interruptions of supply, could cause power generators to switch to a cheaper, but environmentally more harmful fuel such as coal and oil.

3.28. The exception to the above arguments is if the modification proposal allowed producers to exploit gas containing between 2.0% and 2.5% carbon dioxide, which in the absence of the modification proposal they would not have exploited. This would lead to a net increase in carbon dioxide emissions on a European basis (and also offsetting benefits in the form of increased competition and possibly lower gas prices). However, Ofgem is not aware of any fields that fit the above description, and so has not included any costs or offsetting benefits to this effect.

NOx Emissions

3.29. LNG cargoes typically require ballasting with inerts (usually nitrogen) to meet GB gas specifications. If there are some LNG sources that require more than the current maximum level of inerts to enter the GB system, then theoretically the level of heavier hydrocarbons in the GB gas system could increase. This could raise the average Wobbe number (within the allowed range), flame temperature and hence NOx emissions.

3.30. However, work carried out by Advantica (a technical consultancy)[13], suggests that in practice this problem will not materialise. Advantica estimates that the current limit of 7% inerts would allow the import of LNG with an (un-ballasted) Wobbe Index of 55 MJ/m^3. In a recent report, Ilex reported the Wobbe indices of LNG produced from 17 different plants. This study did not identify any existing LNG cargoes that would require more than the current maximum level

[13] http://www.advantica.biz/

of inerts to reach the GB gas specification[14]. This implies that all LNG currently produced could be imported into the GB gas market with the existing 7% limits on inerts.

3.31. As the production of nitrogen to ballast LNG creates costs, logically LNG importers would only add the minimum nitrogen required to meet the upper end of the GS(M)R gas specifications. This remains true even if nitrogen costs are only a small fraction of the total costs of delivered LNG. Accordingly, Ofgem would not expect to see nitrogen levels above 7% even if modification proposal 049 was approved, because LNG importers would not need or wish to add more than 7% nitrogen. Hence, approval of modification proposal 049 would not lead to an increase in the amounts of heavy hydrocarbons in the GB gas system.

3.32. Moreover, even if LNG with a Wobbe Index above 55 MJ/m^3 were produced in future, these cargoes would likely be sent to markets such as Spain or Belgium. These countries both import LNG and allow higher Wobbe gas than the GB market, so LNG ballasting costs for the producers would be reduced relative to shipping LNG to the GB market.

3.33. In theory, modification proposal 049 might allow GB gas producers to include a higher concentration of heavy hydrocarbons in the gas, and still meet the Wobbe requirements by adding more inerts. Ofgem notes that in practice, the majority of GB sub-terminals do not place a limit on the total inerts allowed. Based on current flows, 65% of gas volumes flow into terminals which place no limit on inerts. Moreover, in an argument analogous to that described for carbon dioxide, Ofgem notes that if GB gas producers wished to add more heavy hydrocarbons to their gas, then they would already produce at the maximum nitrogen level allowed at those sub-terminal that apply a limit. In four of the five sub-terminals which do place a limit on nitrogen, Figure 6 illustrates that observed nitrogen levels are well below the maximum level allowed. This indicates that nitrogen production from offshore GB gas is unlikely to increase if the modification proposal is approved.

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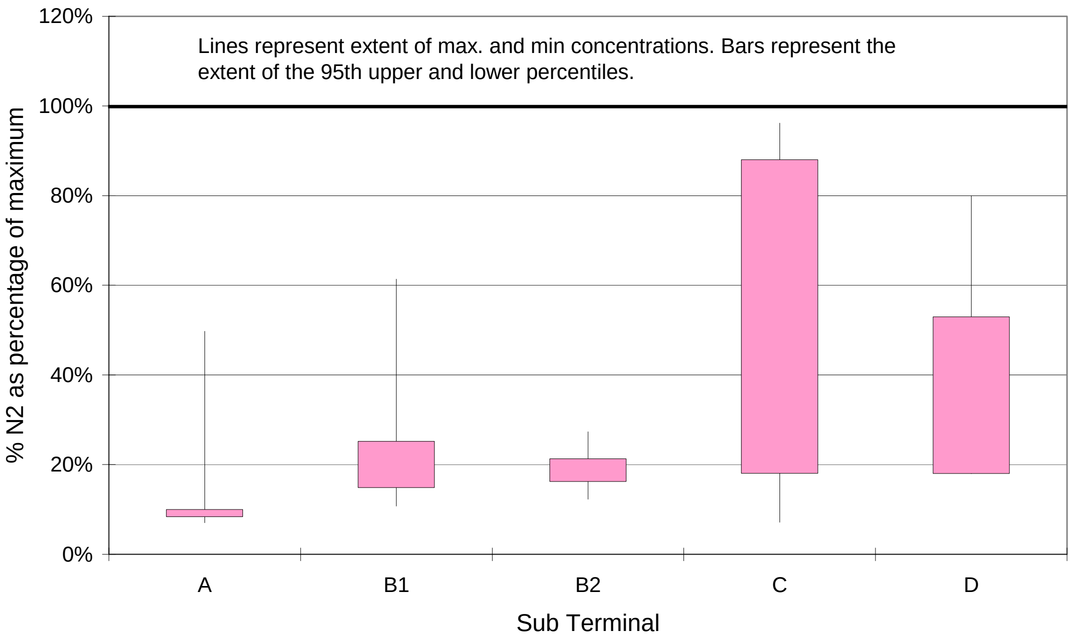
[14] Ilex Energy Consulting – Importing Gas into the UK – Gas Quality Issues, November 2003 – A report to the Department of Trade and Industry, Ofgem and the Health and Safety Executive.

Figure 6: Range of concentrations of nitrogen at GB sub-terminals which apply a limit, as a percentage of the maximum concentration allowed



3.34. Ofgem understands from Advantica that, even if the average nitrogen content of GB gas were to increase, this would not lead to an increase in NOx emissions. The principal modes of NOx formation involve reactions with nitrogen in air, which is about 80% nitrogen. In contrast, fuel is only around 10% of the combustion mixture, and nitrogen is only a small fraction of this 10%. Hence, a small increase in nitrogen in the gas being combusted would not increase NOx emissions.

3.35. Finally, even if modification proposal 049 were to result in increased levels of heavier hydrocarbons in GB gas, it seems unlikely that this would have a material effect on NOx emissions. Advantica notes that with respect to NOx formation the increased level of inerts would offset the effect of increased levels of heavier hydrocarbons. Flame temperatures (which influence NOx formation) are a function of Wobbe number. Therefore, if the maximum Wobbe limit has not increased then NOx formed by high flame temperatures would not be increased.

3.36. Advantica also states that for constant Wobbe gases, the NOx emissions level is relatively constant for inert gas levels up to at least 10%. No naturally occurring gas currently produced in GB could achieve such a high level of inerts while meeting all other relevant specifications.

3.37. In summary, while Ofgem acknowledges the theoretical possibility that the modification proposal could lead to increased NOx emissions, in practice the effect is likely to be negligible. This modification proposal is highly unlikely to lead to increased ballasting of LNG cargoes or increased nitrogen production from offshore fields or the interconnectors. Even in the unlikely event that higher levels of higher hydrocarbons did materialise, the increased amount of inerts would mitigate any increase in NOx emissions.

Fugitive emissions

3.38. As discussed above, there would be no significant change in gas compositions as a result of modification proposal 049, other than a small increase in average carbon dioxide levels. Hence, modification proposal 049 would not increase the ozone-depletion potential of fugitive emissions. There may be a small increase in the levels of carbon dioxide released to atmosphere. However, as noted in paragraph 3.23, in the absence of modification proposal 049 the higher levels of carbon dioxide would be sent to continental gas markets, where the level of fugitive emissions is similar to those in the GB market. Therefore, modification proposal 049 will not increase the environmental impact of fugitive emissions on a European wide level.

Economy and efficiency

Transportation charges

3.39. NG NTS has not identified any increases in compression costs as a result of modification proposal 049. As a result, Ofgem does not expect the transportation charges to increase.

Impact on customers

CV Shrinkage

3.40. Based on the points outlined earlier, Ofgem finds it unlikely that modification proposal 049 will increase the percentage of heavy hydrocarbons. Therefore, Ofgem does not expect modification proposal 049 to increase either the FWACV or CV shrinkage. Even if a change in CV shrinkage costs were to occur, this would simply result in transfers of charges between consumers, and there would be no net increase in aggregate customer costs.[15] Accordingly, Ofgem does not attribute any costs to this issue with respect to modification proposal 049.

Effects on customers' processes

3.41. As discussed earlier, modification proposal 049 is highly unlikely to lead to increased levels of either higher hydrocarbons or total inerts. Shippers can ballast existing LNG cargoes with the current limits on inerts, and offshore gas producers and importers do not take full advantage of their inerts limits where they exist, suggesting that they have no more inerts to add to the system. Therefore, the increased costs of liquefying natural gas claimed by NG LNG are highly unlikely to materialise. The predicted increase in carbon dioxide levels will also be extremely modest, so gas storage and other sites should not experience increased corrosion as a result of the proposal.

3.42. Therefore, Ofgem concludes that modification proposal 049 will not result in material costs (with the exception of the carbon allowances discussed elsewhere) for customers who use gas as a feedstock to a chemical process, liquefy or store natural gas or use natural gas for generating power.

Lower Explosion Limit (LEL)

3.43. As discussed earlier, it is unlikely that modification proposal 049 will result in an increased level of heavier hydrocarbons which could affect the LEL. In the unlikely event that this does occur, Advantica has advised Ofgem that, although

[15] For example, if some customers paid less as a result of modification proposal 049, NG NTS would have to recover the increased CV shrinkage costs from all network users. Hence, there would simply be a re-allocation of costs between customers.

an increase in the heavier hydrocarbons in GB pipeline gas could lower the LEL, the increased level of inerts would counter-balance the effect. Hence, there would be no material change in the LEL as a result of modification proposal 049.

Benefits

3.44. The principal benefit of modification proposal 049 is that it will avoid sudden interruptions of gas supply due to gas temporarily breaching carbon dioxide, nitrogen and total inert specifications. Such supply interruptions would in turn be expected to lead to sharp short-term price increases and reliance on other, more expensive sources of gas. By changing the gas quality specification, this modification proposal would avoid these occasional gas supply interruptions and associated price spikes, to the benefit of consumers. Gas which temporarily fails to meet current GB carbon dioxide and nitrogen specifications is most likely to come from continental Europe, via the Langeled pipeline, the BBL line or the existing IUK line. Accordingly, Ofgem's benefits assessment focuses on these three pipelines.

3.45. In addition, modification proposal 049 may conceivably reduce carbon emissions, if more carbon intensive fuels (oil, coal) were to replace interrupted gas supplies. By reducing the frequency of interruptions, the proposal would reduce the burning of more carbon intensive fuels and reduce carbon emissions. However, as it is difficult to say with any certainty which fuels would replace interrupted gas supplies, Ofgem has not attempted to quantify this benefit further.

3.46. Ofgem has calculated the benefits of modification proposal 049 in two steps. First, Ofgem estimated the frequency and magnitude of supply interruptions that would be caused by gas failing to meet current specifications. Second, Ofgem estimated the increase in gas prices that would result from the interruption. Avoiding these price increases would be the main benefit of the modification proposal.

Security of supply

3.47. There is some uncertainty associated with both the frequency and magnitude of supply interruptions and the effect they have on market prices. With respect to the first issue, Ofgem adopted a number of scenarios which cover the likely range of interruptions. With respect to the second issue, Ofgem uses two methodologies: a demand-elasticity methodology, which is more suitable to estimate the effect of relative short unplanned supply interruptions of one day or less; and a merit-order methodology which is more suitable to measure the price effect of a supply interruption of duration greater than one day.

Frequency and duration of supply interruptions

3.48. Precise details relating to the expected frequency and durations of gas quality excursions for specific pipelines are confidential and commercially sensitive. However, after consultation with relevant parties, Ofgem developed three interruption scenarios for each methodology which it considers are realistic and will reflect any benefits of the modification proposal. Ofgem has assumed that excursions in gas quality would lead to 40 mcm/d (444 GWh/d) being interrupted. 40 mcm/d is 90% of the lowest capacity pipeline of Langeled, BBL and IUK, and represents a likely volume of gas supply that would be interrupted. For the demand elasticity methodology, Ofgem assumes that the interruption would occur for a period of 24 hours during one of three different periods of the year; the top 10th percentile of demand ('winter'), the average demand in the year ('spring/autumn') and the bottom 10th percentile of demand ('summer').

3.49. For the merit order methodology, Ofgem assumes that the interruptions would occur at the same periods of the year but that they last five days in the 'winter' and 'spring/autumn', and three days during the 'summer' period. Ofgem considers a shorter interruption is more appropriate for the summer because the volumes of gas flowing during this period are likely to be smaller relative to other times of year. Given that there are three pipelines which could be affected by carbon dioxide issues, Ofgem estimates that the assumed interruption durations are realistic if modification proposal 049 is not approved. Ofgem notes that the scenarios chosen are likely to underestimate the benefits, as actual interruptions could last for longer than assumed in this IA.

Effect of a supply interruption on prices

Elasticity methodology

3.50. The own-price elasticity of gas supply measures how gas supply responds to changes in gas prices. Ofgem has examined historical data on gas prices, supply and demand in the GB gas market, and estimated that prices would have to increase by 6.7% to produce a 1% increase in supply. For the purposes of this IA, Ofgem assumes that demand is relatively inelastic, so that there is no decrease in demand as a result of the post-interruption price increase. Ofgem recognises that this is a simplification and therefore would likely increase the estimated benefits, and that in reality demand response would be expected.

3.51. Ofgem derived the level of demand for the average and upper and lower 10th percentiles of demand based on the 2004/05 gas year, and derived pre-interruption prices from the average of quarterly forward prices between 2006 and 2008.[16] Table 3 summarises the supply interruption scenarios.

Table 3: Supply interruption scenarios studied for the elasticity methodology

	Scenario 1	Scenario 2	Scenario 3

[16] Based on forward prices as of 1/11/05. Scenario 1 price is the average Q1 price between 2006-2008; scenario 2 is the average of Q2/Q3 prices between 2006-2008, and the scenario 3 price is based on the average Q4 price for 2006 and 2007.

Season	'Winter'	'Summer'	'Spring/Autumn'
Demand, mcm/d	365	185	280
Price p/therm	65	40	55

3.52. Based on this estimate of supply-elasticity, Ofgem estimates that if gas supplies reduced suddenly by 40 mcm/d, prices would need to increase by 48 p/therm in winter, 58 p/therm in summer and 53 p/therm in a 'spring/autumn' period to bring supply and demand into balance. The costs of these prices increases to the market would be £66 million, £41 million and £56 million respectively. Table 4 summarises our calculations.

Table 4: Estimated costs of a supply interruption using the price elasticity methodology

	'Winter'	'Summer'	'Spring/autumn'
Demand, mcm/day	365	185	280
Interupted flow, mcm/day	40	40	40
Change in supply, %	11%	22%	14%
1/price elasticity	6.7%	6.7%	6.7%
Pre- int. price, p/therm	65	40	55
Price increase, %	73%	145%	96%
Price increase, p/therm	48	58	53
Post int. price, p/therm	113	98	108
Cost, £ mln	66	41	56

3.53. Note that, somewhat counter intuitively, the methodology predicts larger price increases in summer than winter. This is because 40 mcm/d is a larger fraction of total supply in summer, so its sudden removal has a larger effect on the market. Whilst currently the UKCS could meet a 40 mcm fall in supply during summer, we would still expect a price response to encourage more marginal UKCS fields to meet the shortfall (of course summer is a traditional period for offshore maintenance). As the UKCS continues to decline, the price impact is likely to be larger.

3.54. Ofgem acknowledges that the elasticity methodology makes a number of simplifications which will introduce errors. For example, the elasticity of supply is unlikely to be identical in winter and summer, and may well differ at higher price levels. Nevertheless, the methodology is likely to give results which are sufficiently accurate for the purposes of this IA.

Observed price increases following an interruption

3.55. In the IA for UNC modification proposal 006, Ofgem observed from On-the-day-Commodity Market (OCM) data that an unexpected loss of offshore supplies caused on-the-day price increases of between 1.3 p/therm to 7.3 p/therm, i.e. an average of 4.3 p/therm.[17] These price increases are lower than those Ofgem predicts above for an outage of one of the interconnectors, for two reasons. First, the new pipelines (Langeled and BBL) are large relative to the average GB sub-terminal, hence the loss of an interconnector (the scenario which Ofgem studied in this IA) will have a larger effect on the GB gas market than the loss of the average GB sub-terminal. Second, gas prices have risen significantly since Ofgem measured the price rises cited above. Higher prices means that the price increases following an unplanned outage will be larger in absolute terms than the price increase seen during a period of lower prices.

3.56. Ofgem has tested the price elasticity methodology to see if it would have given accurate estimates of the price increases cited above for the IA of UNC modification proposal 006. At the time of the observations, gas prices were around 30 p/therm, and demand was of the order of 405 mcm/d. Assuming an average outage of 10 mcm/d (approximately the average flow rate through each sub-terminal), the elasticity estimate predicts a price increase of 5 p/therm (see Table 5), very close to the 4.3 p/therm observed. This indicates that the estimate of supply elasticity is realistic, and likely to yield accurate predictions of the benefits of modification proposal 049.

Table 5: Predicted price increase corresponding to Ofgem observations

[17] 3rd Party Proposal : Publication of Near Real Time Data at UK sub-terminals modification Reference Number UNC 006 (0727) Impact assessment, May 2005, Appendix 5, ¶5.4 p.103.

Demand, mcm/day	405
Interrupted flow, mcm/day	10
Gas CV, MJ/m3	40
Interrupted flow, GWh/day	111
Change in supply, %	2%
1/price elasticity	6.7%
Pre- int. price, p/therm	30
Price increase, %	17%
Price increase, p/therm	5

3.57. Some respondents might note that Ofgem's estimated costs of an interruption may be larger than the cost of reducing the carbon dioxide content of gas from 2.5% to 2.0%. In other words, it might be cheaper to remove carbon dioxide from imported gas rather than bear the cost of supply interruptions. Therefore, some respondents may feel that the avoided cost of carbon dioxide removal is the relevant benefit for this IA.

3.58. However, Ofgem does not believe that the cost of carbon dioxide removal is the relevant benefit. Shippers importing gas to the GB market would have no incentive to install carbon dioxide removal plant, if gas only exceeds the 2.0% carbon dioxide limit as infrequently as Ofgem assumes in this IA. The profit from selling extra gas (in this example 53 mcm/day for one day per year) would not offset the costs of the carbon dioxide removal plant. In theory, it would be worth GB gas customers paying for the carbon dioxide removal plant to avoid infrequent (but expensive) interruptions. In practice, there is no co-ordinating mechanism for GB gas customers to organise such a transfer. Therefore, in the absence of modification proposal 049, the most likely scenario would be occasional supply interruptions, rather than importers installing carbon dioxide removal plant. The avoided cost of the latter is not a relevant benefit for this IA.

Merit order methodology

3.59. Ofgem believes that the elasticity methodology described above is appropriate for modelling the price response to relatively short-term, unexpected gas supply interruptions. However, after some time, in an idealised market, the gas price will settle at the cost of the new marginal source of supply. Accordingly, a merit order methodology (explained in more detail below) is more suitable to model the price response of an interruption longer than about one day, especially if the market had some warning of the interruption, so 'panic buying' of gas is reduced.

3.60. Ofgem has developed a merit order of gas supplies to GB, which ranks gas supplies in terms of cost, and assumes that gas from lower cost sources will flow in preference to more expensive gas. The merit order also takes into account pipeline capacity constraints and the maximum volume which storages can produce. As the most expensive source of gas required to satisfy market demand will set the market price of gas, the merit order can be used to predict likely gas prices for given levels of demand. Appendix 4 provides more details of Ofgem's merit order assumptions and methodology.

3.61. If one of Langeled, BBL or IUK were interrupted, the merit order model assumes that another more expensive source of gas sets the market price. Therefore, the effect that an outage of Langeled, BBL or IUK has on the market price depends on the cost of the gas which replaces the lost supplies. If the cost of the replacement gas is similar to the cost of the interrupted gas, the price effect will be small, and conversely if the cost of the replacement gas is much higher than the cost of the interrupted gas the market price could rise significantly. Accordingly, the predicted price effect will vary from year to year, depending on what replacement sources of gas are available and the place of Langeled, BBL or IUK in the merit order. Ofgem has calculated the average price increase caused by an interruption for the years 2006 to 2010 inclusive. Table 6 summarises the results.

Table 6: Average annual costs of interruptions predicted by merit order analysis

	'winter'	'summer'	'spring autumn'
Price increase, p/therm	6.5	3.3	6.4
Demand, GWh	21,576	7,113	17,102
Cost, £ mln	47	8	37

3.62. Table 6 illustrates that on average a five day interruption in winter and spring/autumn would cost £47 million and £37 million respectively, per year. A three day interruption would cost £8 million in summer, per year.

Competition

Increased competition

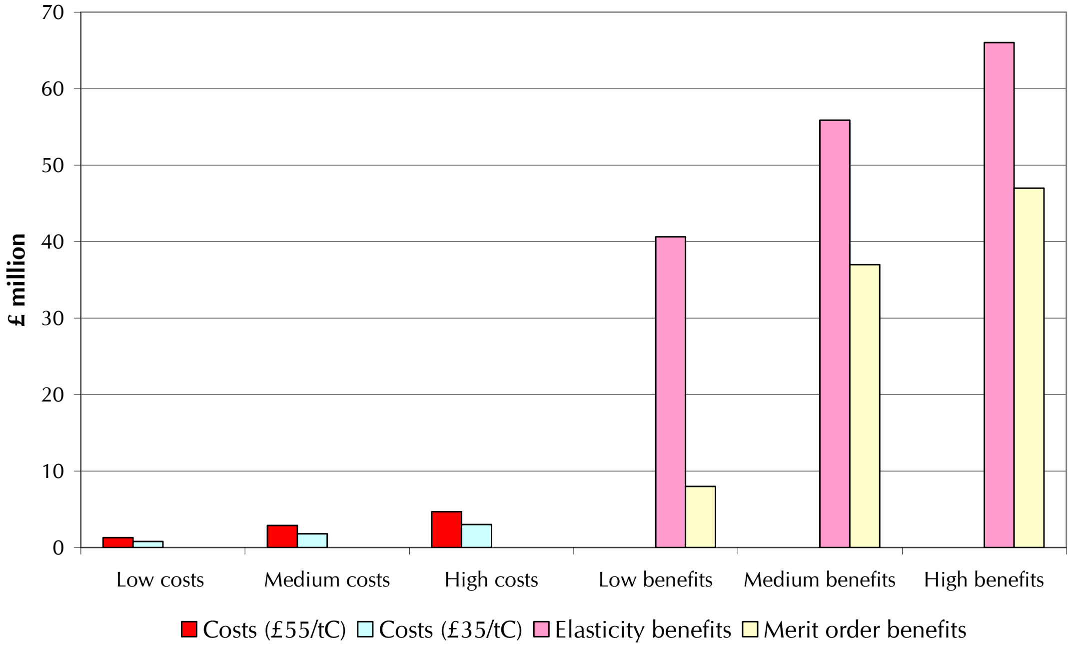
3.63. Increasing the maximum allowed level of carbon dioxide to 2.5% will increase competition in the GB gas market during periods where, in the absence of modification proposal 049, gas supply from continental Europe would have been interrupted. However, Ofgem considers that the previous section has adequately quantified these benefits.

3.64. More generally, modification proposal 049 will make it easier for the GB gas market to import gas from continental European gas markets, giving GB gas customers a wider range of gas sources to chose from, and increasing competition in the GB market.

3.65. In principal, modification proposal 049 may also allow GB gas producers to exploit gas containing between 2.0% and 2.5% carbon dioxide, which in the absence of the modification proposal they would not have exploited. This would lead to increased competition in the GB gas market. However, Ofgem is unaware of any such fields, and so does not attribute any quantified benefits to this possibility.

Summary of costs and benefits

Figure 7: Evaluation of the costs and benefits


70
60
50
40
30
20
10
0
£ million
Low costs
Medium costs
High costs
Low benefits
Medium benefits
High benefits
Costs (£55/tC)
Costs (£35/tC)
Elasticity benefits
Merit order benefits

Evaluation of costs and benefits

3.66. Table 7 illustrates Ofgem's estimates of the costs and benefits associated with modification proposal 049.

Table 7: Summary of Ofgem's estimated costs and benefits of modification proposal 049 compared to the baseline of no modification

	The proposal
Benefits	
♦ Security of supply:	
♦ Elasticity method	£ 40 - £65 mln
♦ Merit order methodology	£ 8 - £ 47 mln
♦ Reduced average gas prices	✓✓✓
♦ Increased competition	✓✓✓
Costs	
♦ Increased cost of carbon allowances	£0.8 - 4.7 mln
♦ Environmental impact	✘
Risks	
♦ Increased NOx emissions	No change
♦ Change in LEL	No change
♦ Increased system charges	No change
♦ Effect on customer's processes	✘

3.67. Ofgem notes that the methodology employed in this IA is likely to exaggerate the costs of the proposal and underestimate the benefits. The costs will be exaggerated, because NG NTS have (at Ofgem's request) assumed that producers will, to varying degrees, increase their average carbon dioxide levels to the new limits, whereas in practise the new limits are likely only to be used occasionally. The benefits are underestimated because Ofgem has assumed an interruption of at most five days per year of either of BBL, IUK or Langeled. Conversations with relevant shippers have indicated that actual interruptions are likely to be longer than assumed. Despite these assumptions, Ofgem's analysis indicates that the benefits far outweigh the costs.

4. Initial conclusions

4.1. Ofgem estimates that, in the worst case, the costs of carbon allowances could increase by between £0.8 million and £4.7 million per year as a result of the modification. However, Ofgem regards the scenario resulting in the highest of these estimates as highly unlikely. Moreover, all these scenarios exaggerate the increased cost of carbon, because they assume that some or all pipelines delivering gas will increase their carbon dioxide levels to the new maximum every day. In reality, the pipelines expect to see only the occasional peak to the new maximum. Therefore, average carbon dioxide levels (and hence CEFs) will not change appreciably even if modification proposal 049 is approved. Therefore, even the low estimate of £0.8 million per year probably overestimates the actual costs of modification proposal 049.

4.2. The modification would reduce unexpected interruptions of gas imports from the continent, and the potentially sharp gas price increases associated with such interruptions. As a result, even under a set of assumptions likely to underestimate the true benefits, Ofgem estimates that the modification would save consumers between £40 million and £65 million per year based on the elasticity method and between £8 million and £47 million per year, based on the merit order methodology.

4.3. Ofgem has given careful consideration to other effects of the proposal, including the possibility of NOx formation and changes to gas compositions which could increase customers' costs. While Ofgem acknowledges the theoretical possibility that modification proposal 049 could lead to increased NOx emissions, in practice the effect is likely to be negligible. Modification proposal 049 is highly unlikely to lead to increased ballasting of LNG cargoes or increased nitrogen production from offshore or interconnectors. Even in the unlikely event that higher levels of higher hydrocarbons did materialise, the increased amount of inerts would mitigate any increase in NOx emissions. Similarly, the effect of this modification proposal on gas compositions would not be significant.

4.4. Given the relative magnitude of the costs and benefits identified, Ofgem's initial conclusion is that approval of modification proposal 049 would provide benefits for security of supply and reduce average gas prices for consumers. On balance, Ofgem considers that the benefits of the modification proposal outweigh the costs (or negative impacts) of its implementation, and that this conclusion is robust against any reasonable set of assumptions. Therefore the analysis set out in this document has led to Ofgem's initial view that modification proposal 049 should be approved. This initial view is without prejudice to Ofgem's final consideration of whether to approve modification proposal 049, which will need to include a consideration of whether the proposed amendment better facilitates achievement of relevant UNC objectives and is consistent with Ofgem's principle objective and general duties taking into account, among other things, the responses received to this IA.

Appendix 1 Summary of other relevant and recent network code modifications

Modification proposal 0681 "Amendment of Network Entry Provisions at ConocoPhillips sub terminal at Theddlethorpe"

1.1 Network code modification proposal 0681 sought to change some of the gas quality parameters currently in place at ConocoPhillips sub-terminal at Theddlethorpe. These parameters included extending the current Wobbe range from 48.3 – 51.3 MJ/m^3 to 47.36 – 51.41 MJ/m^3, increasing the lower limit of CV for the gas from 36.9 MJ/m^3 to 37.3 MJ/m^3 and aligning hydrogen, soot index and incomplete combustion with the GS(M)R limit. Ofgem accepted modification proposal 0681 on 16 July 2004 after assessing that there was no identified increase in direct costs as a result of the changes to the gas quality parameters at entry.

Modification proposal 0707 "Amendment of Network Entry Provisions at Total E&P UK sub-terminal at St Fergus"

1.2 Network code modification proposal 0707 sought to change the Wobbe number upper limit at Total E&P UK's sub-terminal at St Fergus from 51.0 MJ/m^3 to 51.41 MJ/m^3. Ofgem accepted modification proposal 0707 on 13 August 2004 after assessing that there was no identified increase in direct costs as a result of the changes to the gas quality parameters at entry.

Modification proposal 0711 "Amendment of Network Entry Provisions at BP sub terminal at Dimlington"

1.3 Network code modification proposal 0711 sought to extend the Wobbe range in place at BP Gas Marketing Ltd's sub-terminal at Dimlington from 48.2-51.2

MJ/m^3 to 47.2-51.41 MJ/m^3. The modification also sought to align hydrogen, soot index and incomplete combustion factor with the GS(M)R limits and to revise the water dewpoint specification from -10°C@69 barg to -10°C@70.33 barg. This modification proposal was approved by Ofgem on 29 October 2004.

Modification proposal 0720 "Amendment of Network Entry Provisions at Rough Entry Point"

1.4 Network code modification proposal 0720 sought to extend the Wobbe range in place at Rough Entry Point from 48.2-51.2 MJ/m^3 to 47.2-51.41 MJ/m^3. This modification proposal was approved by Ofgem on 29 October 2004

Modification proposal 0722 "Amendment of Network Entry Provisions at Hornsea Entry Point"

1.5 Network code modification proposal 0722 sought to lower the Wobbe limit in place at Hornsea Entry Point from 48.14 MJ/m^3 to 47.2 MJ/m^3. This modification proposal was approved by Ofgem on 11 November 2004.

Modification proposal 0732 "Amendment of Network Entry Provisions at BP sub terminal West Sole"

1.6 Network code modification proposal 0732 was raised by BP Gas Marketing Limited on 26 November 2004. This modification proposal sought to amend the NEPs at BP Gas Marketing Ltd's sub-terminal at West Sole Easington. Specifically it sought to extend the Wobbe range from 48.2-51.2 MJ/m^3 to 47.2-51.41 MJ/m^3. The modification also sought to align the hydrogen, soot index and incomplete combustion factor with the GS(M)R limits and to revise the water dewpoint specification from a variable winter/summer spread to -10°C@48.26 barg and the hydrocarbon dewpoint specification from a variable winter summer spread to -2°C@48.26 barg. Ofgem accepted modification proposal 0732 on 29 March 2005.

UNC modification proposal 019 "Amendment of Network Entry Provisions at ConocoPhillips sub-terminal at Theddlethorpe to align with Transco's 10 Year Statement"

1.7 It sought to align the lower Wobbe limit to the GS(M)R moving it from 47.36 MJ/m^3 to 47.2 MJ/m^3. It also sought to align the CV value with Transco's 10 Year statement, therefore moving the CV from 37.3 MJ/m^3 to 36.9 MJ/m^3.

Appendix 2 Ofgem and NG NTS gas quality obligations

NG NTS's obligations

2.1 NG NTS has a number of obligations within the GS(M)R, the Gas Act 1986 and its Gas Transporters (GT) licence that are relevant when considering changes to gas quality arrangements at entry terminals.

2.2 NG NTS must comply with the GS(M)R when allowing gases to enter its transportation system at either sub-terminals or in some cases specified downstream blending points.

2.3 Under section 9 of the Gas Act 1986, NG NTS must comply, so far as it is economical to do so, with any reasonable request for it to connect to the system and convey gas by means of that system to any premises. In doing so, NG NTS must avoid any undue preference or undue discrimination in the terms on which it undertakes the conveyance of gas.

2.4 Standard Special condition A6 of the Gas Transporters licence also states that:

"the licensee shall conduct its transportation business in the manner best calculated to secure that neither –

- the licensee or any affiliate or related undertaking of the licensee, nor
- any gas shipper or gas supplier,

obtains any unfair commercial advantage including, in particular, any such advantage from a preferential or discriminatory arrangement."

Ofgem's statutory duty with regards to gas quality

2.5 The principal objective of the Authority is to protect the interests of consumers[18]. Further, under the Gas Act 1986, "the Authority may with the consent of the Secretary of State, prescribe standards of pressure and purity to be complied with by gas transporters in conveying gas to premises or to pipe-line systems operated by other gas transporters" [19].

[18] Section 4AA (1) of the Gas Act 1986
[19] Section 16 (1) (a) of the Gas Act 1986.

Appendix 3 Details of forecast changes in net CEFs

Table 8: Predicted net CEFs (tCO2/TJ) without modification proposal 049

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
LDZ										
Scotland	57.34	57.29	57.34	57.40	57.30	57.14	57.09	57.07	57.05	56.95
Northern	57.43	57.39	57.42	57.47	57.38	57.25	57.21	57.18	57.16	57.06
North West	56.97	56.78	56.81	56.84	56.85	56.84	56.85	56.86	56.86	56.85
North East	57.42	57.37	57.38	57.42	57.35	57.22	57.17	57.11	57.05	56.94
East Midlands	56.94	56.87	56.89	56.95	56.91	56.84	56.73	56.69	56.67	56.67
West Midlands	56.94	56.78	56.81	56.85	56.86	56.85	56.85	56.86	56.78	56.85
Wales North	56.99	56.79	56.82	56.85	56.86	56.85	56.85	56.86	56.87	56.85
Wales South	56.81	56.75	56.81	55.63	55.74	55.69	55.68	55.67	55.66	55.66
Eastern	56.64	56.63	56.64	56.68	56.66	56.56	56.46	56.42	56.41	56.35
North Thames	56.72	56.67	56.69	56.75	56.72	56.63	56.50	56.46	56.46	56.44
South East	56.20	56.23	56.26	56.31	56.35	56.29	56.14	56.03	55.95	55.93
Southern	56.44	56.39	56.57	56.70	56.71	56.62	56.51	56.46	56.45	56.48
South West	56.65	56.60	56.70	56.61	56.44	56.44	56.13	56.12	55.87	55.90
National	56.91	56.84	56.87	56.86	56.83	56.76	56.68	56.62	56.57	56.52

Table 9: Predicted net CEFs (tCO2/TJ) low cost scenario

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
LDZ										
Scotland	57.34	57.29	57.34	57.40	57.30	57.14	57.09	57.07	57.05	56.95
Northern	57.43	57.39	57.42	57.47	57.38	57.25	57.21	57.18	57.16	57.06
North West	56.97	56.85	56.91	56.97	56.98	56.97	56.98	57.00	57.01	57.00
North East	57.42	57.38	57.39	57.44	57.37	57.24	57.19	57.13	57.07	56.97
East Midlands	56.94	56.94	56.97	57.04	57.00	56.93	56.84	56.80	56.80	56.81
West Midlands	56.94	56.85	56.92	56.98	56.99	56.98	56.98	57.00	56.92	57.01
Wales North	56.99	56.86	56.93	56.98	56.99	56.98	56.98	57.00	57.01	57.01
Wales South	56.81	56.81	56.91	55.63	55.74	55.69	55.68	55.67	55.66	55.66
Eastern	56.64	56.67	56.68	56.73	56.72	56.62	56.52	56.49	56.49	56.43
North Thames	56.72	56.72	56.74	56.81	56.79	56.70	56.58	56.54	56.55	56.53
South East	56.20	56.25	56.28	56.33	56.38	56.32	56.17	56.05	55.97	55.94
Southern	56.44	56.41	56.59	56.74	56.75	56.67	56.56	56.52	56.52	56.56
South West	56.65	56.64	56.77	56.70	56.50	56.51	56.17	56.16	55.89	55.92
National	56.91	56.88	56.93	56.92	56.89	56.82	56.75	56.69	56.64	56.60

Table 10: Predicted net CEFs (tCO2/TJ) medium cost scenario

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
LDZ										
Scotland	57.34	57.29	57.34	57.40	57.30	57.14	57.09	57.07	57.05	56.95
Northern	57.43	57.39	57.42	57.47	57.38	57.25	57.21	57.18	57.16	57.06
North West	56.97	56.85	56.91	56.97	56.98	56.97	56.98	57.00	57.01	57.00
North East	57.42	57.38	57.39	57.44	57.37	57.24	57.19	57.13	57.07	56.97
East Midlands	57.01	57.01	57.02	57.08	57.07	57.02	56.96	56.95	56.96	56.99
West Midlands	56.97	56.87	56.93	56.98	56.99	56.98	56.98	57.00	56.92	57.01
Wales North	56.99	56.86	56.93	56.98	56.99	56.98	56.98	57.00	57.01	57.01
Wales South	56.92	56.88	56.92	55.63	55.74	55.69	55.68	55.67	55.66	55.66
Eastern	56.82	56.83	56.81	56.84	56.89	56.83	56.78	56.78	56.82	56.73
North Thames	56.87	56.87	56.85	56.90	56.93	56.87	56.81	56.80	56.85	56.83
South East	56.30	56.34	56.35	56.40	56.50	56.47	56.30	56.15	56.02	55.99
Southern	56.49	56.47	56.62	56.77	56.83	56.78	56.72	56.70	56.73	56.81
South West	56.74	56.71	56.79	56.71	56.52	56.54	56.21	56.21	55.94	55.98
National	56.97	56.93	56.96	56.95	56.94	56.88	56.82	56.78	56.74	56.70

Table 11: Predicted net CEFs (tCO2/TJ) if all GB sub-terminals produced at current limits without modification proposal 049

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
LDZ										
Scotland	58.14	58.08	58.13	58.20	58.09	58.00	58.02	58.13	58.25	58.38
Northern	58.09	58.05	58.09	58.13	58.05	57.98	57.99	58.07	58.16	58.29
North West	57.80	57.41	57.32	57.29	57.29	57.31	57.33	57.36	57.38	57.41
North East	58.06	57.97	57.99	58.00	57.94	57.88	57.90	57.99	58.10	58.20
East Midlands	57.55	57.31	57.31	57.35	57.31	57.27	57.14	57.12	57.11	57.13
West Midlands	57.70	57.36	57.30	57.28	57.28	57.30	57.32	57.35	57.33	57.41
Wales North	57.81	57.39	57.31	57.28	57.28	57.30	57.32	57.35	57.38	57.41
Wales South	57.41	57.27	57.29	56.71	56.75	56.73	56.72	56.72	56.72	56.72
Eastern	57.19	57.08	57.09	57.12	57.09	57.02	56.91	56.87	56.86	56.88
North Thames	57.28	57.12	57.13	57.18	57.14	57.08	56.95	56.91	56.91	56.93
South East	56.97	56.94	56.95	56.97	56.98	56.93	56.88	56.88	56.89	56.89
Southern	57.07	56.99	57.01	57.07	57.09	57.06	56.97	56.94	56.94	56.95
South West	57.26	57.15	57.17	57.13	57.05	57.07	56.91	56.91	56.78	56.79
National	57.59	57.42	57.41	57.40	57.36	57.33	57.29	57.28	57.28	57.29

Table 12: Predicted net CEFs (tCO2/TJ) high cost scenario

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
LDZ										
Scotland	58.19	58.14	58.19	58.24	58.15	58.07	58.09	58.22	58.37	58.56
Northern	58.13	58.10	58.13	58.16	58.09	58.03	58.04	58.15	58.26	58.44
North West	57.95	57.61	57.54	57.51	57.51	57.52	57.53	57.57	57.61	57.66
North East	58.11	58.03	58.05	58.05	58.00	57.96	57.98	58.09	58.23	58.39
East Midlands	57.70	57.51	57.51	57.54	57.51	57.47	57.37	57.36	57.36	57.39
West Midlands	57.85	57.57	57.52	57.49	57.50	57.50	57.52	57.57	57.56	57.65
Wales North	57.95	57.59	57.52	57.49	57.50	57.50	57.53	57.57	57.60	57.65
Wales South	57.60	57.49	57.50	56.99	57.02	57.01	57.00	57.00	57.00	57.00
Eastern	57.42	57.33	57.34	57.37	57.34	57.28	57.18	57.15	57.14	57.16
North Thames	57.49	57.36	57.38	57.41	57.38	57.32	57.21	57.18	57.19	57.20
South East	57.24	57.22	57.23	57.25	57.25	57.21	57.16	57.15	57.16	57.17
Southern	57.32	57.25	57.28	57.33	57.34	57.31	57.23	57.21	57.21	57.22
South West	57.48	57.39	57.41	57.37	57.30	57.31	57.17	57.17	57.06	57.07
National	57.74	57.60	57.60	57.59	57.56	57.52	57.48	57.49	57.50	57.53

Table 13: Percentage change in net CEFs in the low cost scenario

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	Average
LDZ											
Scotland	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Northern	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
North West	0.12%	0.18%	0.22%	0.22%	0.22%	0.23%	0.24%	0.25%	0.12%	0.18%	0.22%
North East	0.02%	0.03%	0.04%	0.04%	0.04%	0.04%	0.04%	0.05%	0.02%	0.03%	0.04%
East Midlands	0.12%	0.14%	0.16%	0.16%	0.16%	0.19%	0.20%	0.22%	0.12%	0.14%	0.16%
West Midlands	0.12%	0.19%	0.23%	0.23%	0.23%	0.23%	0.24%	0.24%	0.12%	0.19%	0.23%
Wales North	0.13%	0.19%	0.23%	0.23%	0.23%	0.23%	0.24%	0.26%	0.13%	0.19%	0.23%
Wales South	0.11%	0.18%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.11%	0.18%	0.00%
Eastern	0.08%	0.08%	0.09%	0.10%	0.11%	0.12%	0.13%	0.14%	0.08%	0.08%	0.09%
North Thames	0.09%	0.09%	0.11%	0.12%	0.12%	0.13%	0.14%	0.16%	0.09%	0.09%	0.11%
South East	0.04%	0.03%	0.04%	0.05%	0.06%	0.06%	0.04%	0.03%	0.04%	0.03%	0.04%
Southern	0.04%	0.04%	0.06%	0.08%	0.09%	0.10%	0.11%	0.13%	0.04%	0.04%	0.06%
South West	0.08%	0.12%	0.15%	0.11%	0.12%	0.07%	0.08%	0.03%	0.08%	0.12%	0.15%
National	0.07%	0.09%	0.10%	0.11%	0.11%	0.11%	0.12%	0.12%	0.07%	0.09%	0.10%

Table 14: Percentage change in net CEFs in the medium cost scenario

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	Average
LDZ											
Scotland	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Northern	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
North West	0.00%	0.12%	0.18%	0.22%	0.22%	0.22%	0.23%	0.24%	0.25%	0.27%	0.00%
North East	0.00%	0.02%	0.03%	0.04%	0.04%	0.04%	0.04%	0.04%	0.05%	0.05%	0.00%
East Midlands	0.13%	0.26%	0.23%	0.23%	0.28%	0.32%	0.41%	0.45%	0.50%	0.55%	0.13%
West Midlands	0.06%	0.16%	0.20%	0.23%	0.23%	0.23%	0.23%	0.24%	0.24%	0.27%	0.06%
Wales North	0.00%	0.13%	0.19%	0.23%	0.23%	0.23%	0.23%	0.24%	0.26%	0.27%	0.00%
Wales South	0.21%	0.23%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.21%
Eastern	0.32%	0.37%	0.29%	0.29%	0.39%	0.47%	0.57%	0.63%	0.72%	0.67%	0.32%
North Thames	0.27%	0.35%	0.28%	0.27%	0.37%	0.43%	0.54%	0.61%	0.68%	0.68%	0.27%
South East	0.18%	0.21%	0.15%	0.16%	0.26%	0.32%	0.29%	0.21%	0.13%	0.11%	0.18%
Southern	0.09%	0.14%	0.10%	0.13%	0.21%	0.27%	0.37%	0.43%	0.49%	0.58%	0.09%
South West	0.16%	0.19%	0.16%	0.16%	0.15%	0.17%	0.15%	0.16%	0.13%	0.15%	0.16%
National	0.10%	0.17%	0.16%	0.16%	0.20%	0.22%	0.25%	0.27%	0.29%	0.31%	0.10%

Table 15: Percentage change in net CEFs in the high cost scenario

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	Average
LDZ											
Scotland	0.09%	0.10%	0.09%	0.07%	0.10%	0.12%	0.12%	0.16%	0.21%	0.31%	0.09%
Northern	0.07%	0.08%	0.07%	0.05%	0.07%	0.09%	0.09%	0.12%	0.17%	0.25%	0.07%
North West	0.24%	0.35%	0.37%	0.38%	0.37%	0.37%	0.36%	0.37%	0.39%	0.43%	0.24%
North East	0.07%	0.10%	0.10%	0.09%	0.10%	0.12%	0.12%	0.17%	0.23%	0.33%	0.07%
East Midlands	0.26%	0.34%	0.35%	0.33%	0.34%	0.35%	0.39%	0.41%	0.43%	0.45%	0.26%
West Midlands	0.26%	0.36%	0.37%	0.38%	0.37%	0.36%	0.36%	0.37%	0.40%	0.43%	0.26%
Wales North	0.23%	0.35%	0.37%	0.38%	0.37%	0.36%	0.35%	0.37%	0.39%	0.43%	0.23%
Wales South	0.33%	0.38%	0.37%	0.49%	0.49%	0.49%	0.49%	0.49%	0.49%	0.49%	0.33%
Eastern	0.41%	0.44%	0.44%	0.43%	0.44%	0.45%	0.47%	0.48%	0.49%	0.48%	0.41%
North Thames	0.37%	0.43%	0.42%	0.41%	0.42%	0.43%	0.45%	0.47%	0.48%	0.48%	0.37%
South East	0.47%	0.48%	0.48%	0.48%	0.48%	0.48%	0.48%	0.48%	0.48%	0.48%	0.47%
Southern	0.43%	0.46%	0.46%	0.44%	0.44%	0.44%	0.46%	0.47%	0.48%	0.48%	0.43%
South West	0.37%	0.41%	0.41%	0.41%	0.43%	0.42%	0.45%	0.46%	0.48%	0.48%	0.37%
National	0.27%	0.32%	0.32%	0.32%	0.33%	0.34%	0.34%	0.37%	0.40%	0.43%	0.27%

Table 16: Maximum percentage change in net CEFs which could occur without modification proposal 049

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	Average
LDZ											
Scotland	1.37%	1.36%	1.37%	1.37%	1.36%	1.48%	1.60%	1.83%	2.05%	2.44%	1.37%
Northern	1.14%	1.13%	1.15%	1.15%	1.15%	1.25%	1.36%	1.54%	1.73%	2.11%	1.14%
North West	1.45%	1.09%	0.90%	0.79%	0.77%	0.81%	0.83%	0.87%	0.90%	0.98%	1.45%
North East	1.11%	1.04%	1.06%	1.00%	1.02%	1.14%	1.27%	1.51%	1.80%	2.16%	1.11%
East Midlands	1.06%	0.77%	0.74%	0.70%	0.69%	0.75%	0.72%	0.75%	0.77%	0.80%	1.06%
West Midlands	1.32%	1.01%	0.85%	0.74%	0.74%	0.78%	0.82%	0.85%	0.96%	0.97%	1.32%
Wales North	1.43%	1.05%	0.86%	0.74%	0.74%	0.78%	0.82%	0.85%	0.88%	0.97%	1.43%
Wales South	1.05%	0.91%	0.84%	1.91%	1.78%	1.83%	1.85%	1.86%	1.86%	1.87%	1.05%
Eastern	0.96%	0.79%	0.78%	0.77%	0.75%	0.80%	0.80%	0.80%	0.80%	0.92%	0.96%
North Thames	0.98%	0.79%	0.78%	0.75%	0.74%	0.79%	0.78%	0.80%	0.80%	0.86%	0.98%
South East	1.35%	1.26%	1.21%	1.17%	1.10%	1.14%	1.31%	1.49%	1.65%	1.70%	1.35%
Southern	1.10%	1.05%	0.78%	0.65%	0.67%	0.77%	0.81%	0.85%	0.86%	0.83%	1.10%
South West	1.07%	0.97%	0.82%	0.91%	1.07%	1.09%	1.37%	1.39%	1.60%	1.58%	1.07%
National	1.18%	1.01%	0.94%	0.93%	0.93%	1.00%	1.06%	1.15%	1.23%	1.33%	1.18%

Table 17: Predicted net CEFs (tCO2/TJ) at terminals without modification proposal 049

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
Terminal										
St Fergus	57.34	57.29	57.34	57.40	57.30	57.14	57.09	57.07	57.05	56.95
Teesside	57.69	57.70	57.69	57.66	57.62	57.60	57.59	57.57	57.53	57.58
Barrow	56.30	56.28	56.27	56.27	56.27	56.27	56.27	56.29	56.28	56.29
Easington	56.02	56.65	56.72	56.76	56.79	56.81	56.83	56.84	56.85	56.87
Theddlethorpe	56.22	56.15	56.47	56.60	56.60	56.50	56.41	56.34	56.30	56.28
Bacton	56.49	56.53	56.53	56.55	56.55	56.45	56.37	56.34	56.35	56.40
IOG	55.79	55.79	55.79	55.79	55.79	55.79	55.79	55.79	55.79	55.79
Milford Haven				55.63	55.74	55.69	55.68	55.67	55.66	55.66
Point of Ayr	56.56	56.56	56.56	56.56	56.56	56.56	56.56	56.56	56.56	56.56
National	56.91	56.84	56.87	56.86	56.83	56.76	56.68	56.62	56.57	56.52

Table 18: Predicted net CEFs (tCO2/TJ) at terminals, low cost scenario

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
Terminal										
St Fergus	57.34	57.29	57.34	57.40	57.30	57.14	57.09	57.07	57.05	56.95
Teesside	57.69	57.70	57.69	57.66	57.62	57.60	57.59	57.57	57.53	57.58
Barrow	56.30	56.28	56.27	56.27	56.27	56.27	56.27	56.29	56.28	56.29
Easington	56.02	56.85	56.94	57.00	57.03	57.06	57.09	57.11	57.12	57.13
Theddlethorpe	56.22	56.15	56.47	56.60	56.60	56.50	56.41	56.34	56.30	56.28
Bacton	56.49	56.57	56.56	56.57	56.59	56.50	56.43	56.41	56.42	56.48
IOG	55.79	55.79	55.79	55.79	55.79	55.79	55.79	55.79	55.79	55.79
Milford Haven				55.63	55.74	55.69	55.68	55.67	55.66	55.66
Point of Ayr	56.56	56.56	56.56	56.56	56.56	56.56	56.56	56.56	56.56	56.56
National	56.91	56.88	56.93	56.92	56.89	56.82	56.75	56.69	56.64	56.60

Table 19: Predicted net CEFs (tCO2/TJ) at terminals, medium cost scenario

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
Terminal										
St Fergus	57.34	57.29	57.34	57.40	57.30	57.14	57.09	57.07	57.05	56.95
Teesside	57.69	57.70	57.69	57.66	57.62	57.60	57.59	57.57	57.53	57.58
Barrow	56.30	56.28	56.27	56.27	56.27	56.27	56.27	56.29	56.28	56.29
Easington	56.02	56.85	56.94	57.00	57.03	57.06	57.09	57.11	57.12	57.13
Theddlethorpe	56.22	56.15	56.47	56.60	56.60	56.50	56.41	56.34	56.30	56.28
Bacton	56.72	56.76	56.71	56.72	56.80	56.75	56.73	56.73	56.79	56.89
IOG	55.79	55.79	55.79	55.79	55.79	55.79	55.79	55.79	55.79	55.79
Milford Haven				55.63	55.74	55.69	55.68	55.67	55.66	55.66
Point of Ayr	56.56	56.56	56.56	56.56	56.56	56.56	56.56	56.56	56.56	56.56
National	56.97	56.93	56.96	56.95	56.94	56.88	56.82	56.78	56.74	56.70

Table 20: Predicted net CEFs (tCO2/TJ) at terminals if all GB sub-terminals produced at current limits without modification proposal 049

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
Terminal										
St Fergus	58.14	58.08	58.13	58.20	58.09	58.00	58.02	58.13	58.25	58.38
Teesside	57.96	57.97	57.96	57.93	57.91	57.90	57.89	57.88	57.85	57.89
Barrow	57.19	57.18	57.19	57.19	57.19	57.19	57.19	57.19	57.19	57.19
Easington	56.73	56.84	56.85	56.85	56.86	56.86	56.86	56.87	56.87	56.87
Theddlethorpe	56.88	56.86	56.91	56.93	56.93	56.93	56.92	56.91	56.91	56.90
Bacton	57.01	56.98	56.99	57.00	56.99	56.92	56.84	56.81	56.81	56.81
IOG	56.88	56.88	56.88	56.88	56.88	56.88	56.88	56.88	56.88	56.88
Milford Haven				56.71	56.75	56.73	56.72	56.72	56.72	56.72
Point of Ayr	57.65	57.65	57.65	57.65	57.65	57.65	57.65	57.65	57.65	57.65
National	57.59	57.42	57.41	57.40	57.36	57.33	57.29	57.28	57.28	57.29

Table 21: Predicted net CEFs (tCO2/TJ) at terminals, high cost scenario

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
Terminal										
St Fergus	58.19	58.14	58.19	58.24	58.15	58.07	58.09	58.22	58.37	58.56
Teesside	57.96	57.97	57.96	57.93	57.91	57.90	57.89	57.88	57.85	57.89
Barrow	57.48	57.48	57.48	57.48	57.48	57.48	57.48	57.48	57.48	57.49
Easington	57.01	57.12	57.12	57.13	57.14	57.14	57.14	57.14	57.15	57.15
Theddlethorpe	57.16	57.14	57.20	57.21	57.21	57.21	57.21	57.20	57.19	57.18
Bacton	57.28	57.26	57.27	57.28	57.27	57.20	57.12	57.09	57.09	57.09
IOG	57.15	57.15	57.15	57.15	57.15	57.15	57.15	57.15	57.15	57.15
Milford Haven				56.99	57.02	57.01	57.00	57.00	57.00	57.00
Point of Ayr	57.93	57.93	57.93	57.93	57.93	57.93	57.93	57.93	57.93	57.93
National	57.74	57.60	57.60	57.59	57.56	57.52	57.48	57.49	57.50	57.53

Appendix 4 Details of Ofgem's merit order model

4.1 In undertaking the analysis, merit orders were constructed for each year up to 2010/11 by estimating the relative prices and deliverability of different sources of gas supply. For any day, each source of gas supply (beach / interconnector / LNG etc.) were assumed to be used in ascending order of relative (estimated) price until estimated demand was met. In other words, it was assumed that the cheapest source of gas would be nominated first with each subsequent nomination being sourced from the next cheapest source of gas (until supply equals demand). The price of the most expensive source of supply required to meet demand was then assumed to be the market price for gas on that day (this process is described in more detail below). In all years, demand levels were based on the assumption of an average winter.

4.2 Assumptions about the price, daily deliverability and annual deliverability of each source of supply have been made. Using these parameters, the marginal price for each day modelled can be determined by calculating the marginal source of gas on each day:

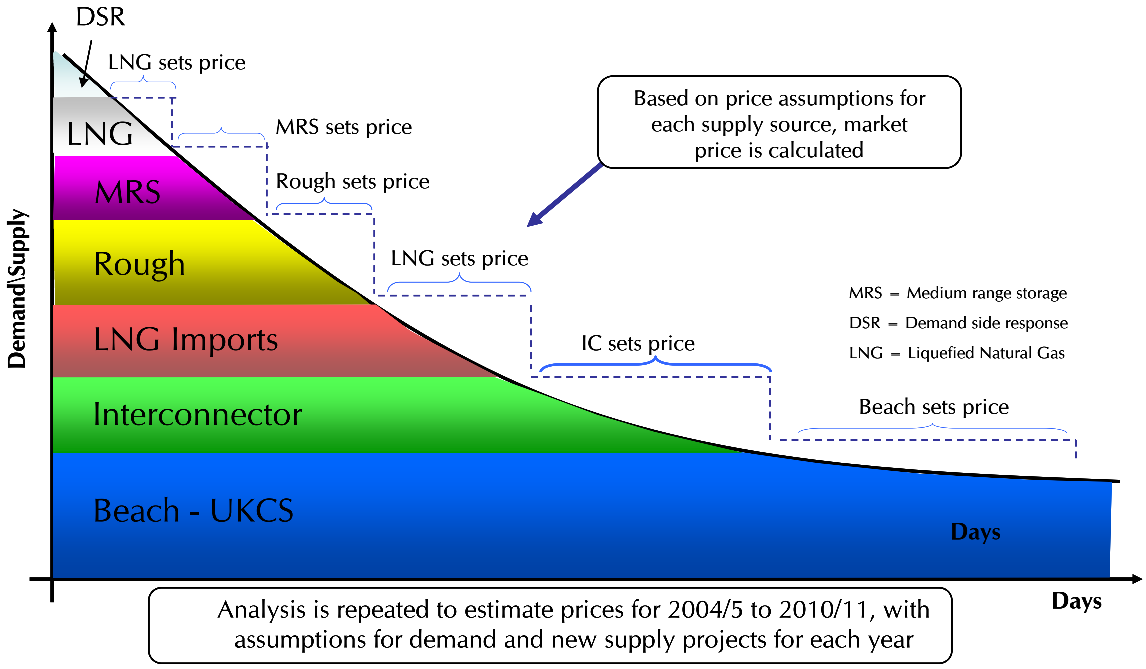
1. Beginning with the day with highest demand, the total demand was compared on that day with the daily deliverability of the cheapest source of supply.

2. If this source of supply was not enough to satisfy demand, then the shortfall was compared with the daily deliverability of the next cheapest source of supply, and so on up the supply curve until demand is satisfied.

3. Steps 1 and 2 were repeated for the day with the next highest demand – with the added condition that the total gas used from any particular source could not exceed the annual deliverability for that source – and so on down the demand curve until all days of the year had been calculated.

4. The highest price supply source used on each day set the price for all gas on that day.

4.3 Figure 1 shows a stylised example of the analysis showing the different sources of supply used to satisfy demand.



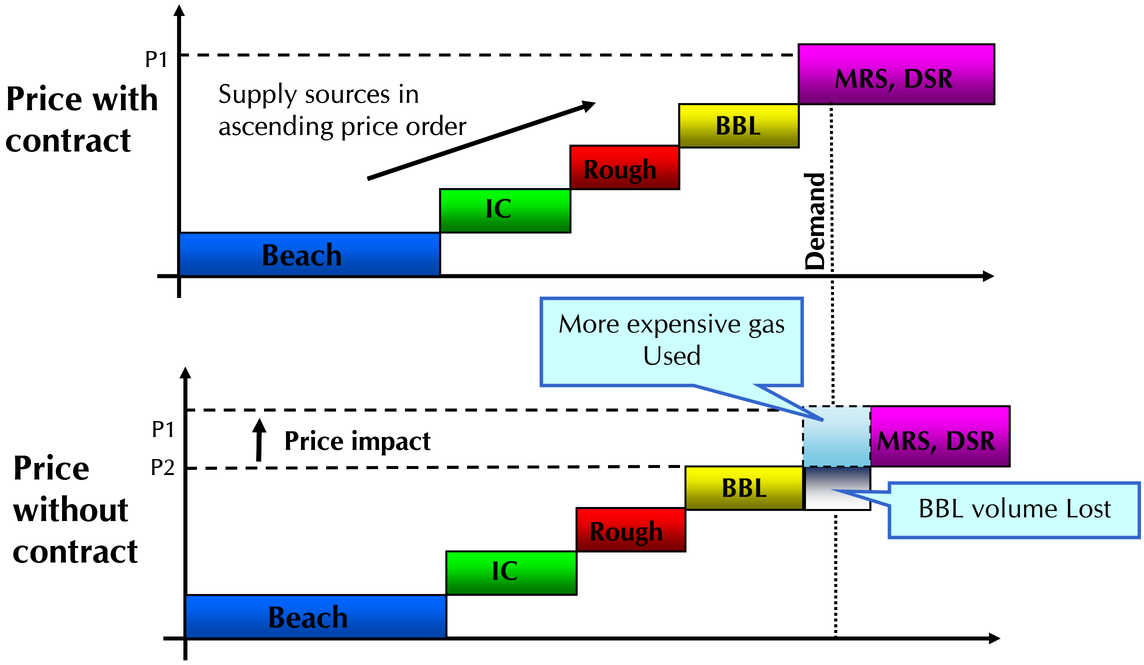
4.4 This analysis provided 'base' forward prices for each year from 2004/5 to 2010/11. The merit order for each year was then re-run to estimate the impact on forward prices for three different scenarios:

1. 433GWh/d of gas supply is lost due to the carbon dioxide levels in gas from BBL, Langeled or the Bacton-Zeebrugge interconnector exceeding the 2% carbon dioxide limit, on five days, during the 10^{th} percentile of demand

2. 433GWh/d of gas supply is lost due to the carbon dioxide levels in gas from BBL, Langeled or the Bacton-Zeebrugge interconnector exceeding the 2% carbon dioxide limit, on five days, during the average percentile of demand.

3. 433GWh/d of gas supply is lost due to the carbon dioxide levels in gas from BBL, Langeled or the Bacton-Zeebrugge interconnector exceeding the 2% carbon dioxide limit, on three days, during the lower 10^{th} percentile of demand.

4.5 The impact of the loss of supply, under each scenario, results in higher wholesale gas prices, since the shortfall in gas supply is made up from a more expensive source of supply[20]. This is shown in the diagram below.



4.6 The prices from the 'base' merit order analysis and the prices calculated for each of the three scenarios, described above, were used to estimate a total impact on the wholesale market for each scenario. This impact was calculated by multiplying the price difference for each scenario with price from the 'base' analysis by total demand for the each year.

4.7 The merit order analysis provided the following estimate of the impact on the wholesale market:

- Scenario 1: £47m per annum
- Scenario 2: £37m per annum
- Scenario 3: £8m per annum

[20] This was not true for all years, where, for certain scenarios, the loss of supply was not sufficient to result in a move to a higher source. This is because residual demand was satisfied by the remaining deliverability of the source less the lost volume therefore, not requiring gas from the next, more expensive, source.