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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Title:**  IA No:  RPC Reference No:  **Lead department or agency:**  Health and Safety Executive (HSE)  Other departments or agencies:  Department for Business, Energy and Industrial Strategy (BEIS) | | | |  | | --- | | Impact Assessment (IA) | | Date: October 2021 | | Stage: Consultation stage | | Source of intervention: | | Type of measure: Secondary Legislation | | Contact for enquiries: | |  | |  | |  | |  | |  | |  | | | |
| Summary: Intervention and Options | | | **RPC Opinion:** Pending | | |
|  | | | | | |
| Cost of Preferred (or more likely) Option (in 2019 prices & 2020 present value) | | | | | |
| Total Net Present Social Value | Business Net Present Value | Net cost to business per year | | Business Impact Target Status  Qualifying Regulatory Provision  BIT Score: £17.5m |
| -£53.4m | -£53.4m | £3.5m | |
| **What is the problem under consideration? Why is government action or intervention necessary?**  Over the past 15 to 20 years, gas supplies from the UK Continental Shelf (UKCS) have been declining, increasing reliance on imported supplies, via pipelines, interconnectors and Liquefied Natural Gas (LNG) shipments. However, gas quality standards specified in the Gas Safety (Management) Regulations 1996 (GSMR) constrain the supply of gas from alternative sources and result in significant gas processing costs. As such, the Health and Safety Executive (HSE) and the Department for Business, Energy and Industrial Strategy (BEIS) are working closely with the Institution of Gas Engineers and Managers (IGEM) to develop safe options for revising GSMR to broaden the range of viable gas sources, reduce costs and open up the Regulations to facilitate any potential future changes needed to address Net Zero. | | | | |

**ANNEX 1**

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| What are the policy objectives of the action or intervention and the intended effects?  HSE is currently in the process of evaluating options around the possible inclusion of gas with a higher or lower Wobbe Number (WN) (or Wobbe Index (WI)) into the transmission and distribution networks. These changes would enable:   * The adaptation of prescriptive GB regulation for gas composition contained in GSMR Schedule 3 that is restricting the sources of gas sitting outside of current specifications into the transmission and distribution network * A greater diversity of gas resources to be accessed from across the North Sea including both the United Kingdom Continental Shelf (UKCS) and the Norwegian sector, contributing greater security of GB’s energy supply * Reduced gas processing, potentially making gas supplies easier to secure, and the potential for fewer greenhouse gas (GHG) emissions being produced by the processing of gas to comply with the current gas composition specifications * The changes must maintain or improve the safety standards that have been achieved to date by the Gas Safety (Management) Regulations 1996 (GSMR) |

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| --- |
| What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)   * **Option 1: Business as usual:** Retain Great Britain’s (GB’s) gas quality specification within GSMR with industry seeking exemptions to the gas quality specifications outside the requirements of Schedule 3. * **Option 2 (preferred option):** Retain GB’s safe gas quality specification within GSMR, Schedule 3 and amend the values to those proposed and consulted upon by IGEM (IGEM/GL/10) and those assessed to be safe by HSE: * decrease the lower WN limit from ≥47.2 MJ/m³ to ≥46.5 MJ/m³ (the existing lower emergency limit) * extend the current GSMR class exemptions for oxygen in biomethane to a general 1 mol% oxygen limit at ≤38 barg for all gas sources * remove the Incomplete Combustion Factor (ICF) and Soot Index (SI) limits and to introduce a relative density of ≤0.7 for gas interchangeability * to also update the regulations to account for changes to the industry that have occurred since 1996   This is the governments preferred option as it will result in a greater diversity of domestic gas resources to be used for GB energy consumption by adapting the prescriptive GB regulation for gas composition that is currently restricting sources of gas which lie out with the current specifications. This option will reduce gas processing and will potentially reduce the carbon footprint of GB’s gas supply. The evidence supporting these changes has been independently reviewed by experts within the HSE and assessed as maintaining and in some areas, improving safety standards. This preferred option supports a number of government objectives; greater security of energy supply, maximising economic recovery of the UKCS, maintaining an effective regulatory framework ensuring health, safety and welfare standards and will have a role in levelling up and in the transition to decarbonisation of the energy network. |

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| |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Does implementation go beyond minimum EU requirements? | | N/A | | | | | Is this measure likely to impact on international trade and investment? | | Yes | | | | | Are any of these organisations in scope? | **Micro**  Yes | **Small**  Yes | **Medium**  Yes | | **Large**  Yes | | What is the CO2 equivalent change in greenhouse gas emissions?  (Million tonnes CO2 equivalent) | | Traded: | | Non-traded: | |   Will the policy be reviewed? It will be reviewed. If applicable, set review date:  TBC |

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

|  |  |  |  |
| --- | --- | --- | --- |
| Signed by the responsible : |  | Date: |  |

# Summary: Analysis & Evidence Policy Option 1

Description: Business-as-usual baseline

FULL ECONOMIC ASSESSMENT

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Price Base Year | PV Base Year | Time Period Years N/A | Net Benefit (Present Value (PV)) (£m) | | |
| Low: N/A | High: N/A | Best Estimate: N/A |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| COSTS (£m) | Total Transition   (Constant Price) Years | | Average Annual  (excl. Transition) (Constant Price) | Total Cost  (Present Value) | |
| Low | N/A |  | N/A | N/A | |
| High | N/A | N/A | N/A | |
| Best Estimate | N/A | N/A | N/A | |
| Description and scale of key monetised costs by ‘main affected groups’  Being the business-as-usual baseline, there are no additional costs or benefits. However, maintaining the current gas quality standards will see gas producers continue to spend between £3.8m and £5.1m per annum on gas processing. | | | | | |
| Other key non-monetised costs by ‘main affected groups’  Being the business-as-usual baseline, there are no additional costs or benefits. However, there would be the potential that GB gas supply from LNG sources would carry a higher carbon footprint than alternative sources from the Southern North Sea or biogas that would face a regulatory barrier to being introduced to the network. GB gas supplies from low-WN sources would also continue to be restricted, with consequences for diversity and security of supply. In addition, GSMR would remain unmodernised with respect to industry changes since 1996 so that safety standards continue to be applied inconsistently across areas where risk is present. | | | | | |
| BENEFITS (£m) | Total Transition   (Constant Price) Years | | Average Annual  (excl. Transition) (Constant Price) | Total Benefit  (Present Value) | |
| Low | N/A |  | N/A | N/A | |
| High | N/A | N/A | N/A | |
| Best Estimate | N/A | N/A | N/A | |
| Description and scale of key monetised benefits by ‘main affected groups’  Being the business-as-usual baseline, there are no additional costs or benefits. However, gas producers, distributors and power generators would not need to adapt their operation to account for the changes to gas supply, estimated to cost between around £63m and £360m in present values. | | | | | |
| Other key non-monetised benefits by ‘main affected groups’  Being the business-as-usual baseline, there are no additional costs or benefits. However, further as-yet un monetised adaptation costs would be avoided by gas distributors and industrial end-users. In addition, dutyholders would not need to adapt their operations to account for the modernisation changes to GSMR. | | | | | |
| **Key assumptions/sensitivities/risks** Discount rate (%) | | | | |  |
|  | | | | | |

BUSINESS ASSESSMENT (Option 1)

|  |  |  |  |
| --- | --- | --- | --- |
| Direct impact on business (Equivalent Annual) £m: | | | Score for Business Impact Target (qualifying provisions only) £m: N/A |
| Costs:       N/A | Benefits: N/A | Net:       N/A |  |
|  |  |  |  |

# Summary: Analysis & Evidence Policy Option 2

Description: Retain GB’s safe gas quality specification within GSMR, Schedule 3 and amend the values to those proposed and consulted upon by IGEM (IGEM/GL/10) and those assessed to be safe by HSE.

FULL ECONOMIC ASSESSMENT

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Price Base Year 2021 | PV Base Year 2022 | Time Period Years 21 | Net Benefit (Present Value (PV)) (£m) | | |
| Low: -£282.9m | High: £11.2m | Best Estimate: -£61.1m |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| COSTS (£m) | Total Transition   (Constant Price) Years | | Average Annual  (excl. Transition) (Constant Price) | Total Cost  (Present Value) | |
| Low | £18.3m | 1 | £2.6m | £60.9m | |
| High | £36.7m | £19.7m | £339.1m | |
| Best Estimate | £23.7m | £6.5m | £125.7m | |
| Description and scale of key monetised costs by ‘main affected groups’  Estimated costs are driven by the modification and maintenance of power generating gas-powered turbines. There are additional smaller estimated costs for gas producers to make adjustments to their gas supply arrangements under Option 2 and determining what they will have to do to respond. | | | | | |
| Other key non-monetised costs by ‘main affected groups’  Adaptation costs for industrial users are anticipated, but not estimated at this stage. Costs for the gas National Transmission System, independent gas transporters and smaller gas distribution networks also remain un-estimated at this stage. HSE also proposes to make a number of modernisations to GSMR, which could generate some costs or savings – these will be estimated in the final stage IA. Several gas users may also need to undertake familiarisation with the changes and potentially with gas quality itself. | | | | | |
| BENEFITS (£m) | Total Transition   (Constant Price) Years | | Average Annual  (excl. Transition) (Constant Price) | Total Benefit  (Present Value) | |
| Low | N/A | N/A | £3.5m | £56.2m | |
| High | N/A | £4.7m | £72.1m | |
| Best Estimate | N/A | £4.1m | £64.6m | |
| Description and scale of key monetised benefits by ‘main affected groups’  Averted gas-processing for low-Wobbe gas produced from the UK continental shelf (UKCS) accounts for the estimated savings. | | | | | |
| Other key non-monetised benefits by ‘main affected groups’  Gas producers in the Southern North Sea estimate around 2.6bn therms of low-WN gas could be made viable for extraction should GSMR be amended; the value of this gas would be substantial and will be estimated for the final stage IA. The potential greenhouse gas emissions savings should increased UKCS production displace higher-emissions gas such as liquified natural gas will be estimated in the final stage IA. The proposed changes under Option 2 are also anticipated to strengthen the UK’s energy diversity and so security of supply. Allowing lower-Wobbe gas into the network also enables the more economical adaptation of lower-emissions gases such as biogas. | | | | | |
| **Key assumptions/sensitivities/risks** Discount rate (%) | | | | | 3.5% |
| Long-terms trends in gas use are uncertain, driven by changes in technology, economic activity and Government policy, such as the Net Zero target. The changes discussed in this IA are permissive – they give businesses the freedom to introduce lower-Wobbe gas to the network, but it is not clear what the effect on gas composition will be in practice. | | | | | |

BUSINESS ASSESSMENT (Option 2)

|  |  |  |  |
| --- | --- | --- | --- |
| Direct impact on business (Equivalent Annual) £m: | | | Score for Business Impact Target (qualifying provisions only) £m: £17.5m |
| Costs: £8.3m | Benefits: £4.2m | Net: -£4.0m |
|

# Evidence Base

## Problem under consideration and rationale for intervention

1. Twenty-five years has passed since these regulations came into force. In that time Great Britain’s (GB) gas market has been liberalised, new producers have entered the market, the supply mix for GB gas demand has shifted from domestic production to imports and there is new emphasis on making our energy consumption greener. This has meant the gas network, as defined by the 1996 regulations, no longer encapsulates the current breadth of gas conveyance occurring in GB and the regulations need to be updated and modernised in order to ensure safety standards are consistently applied across the network. Dutyholders also need to be clarified in order to achieve this policy objective so amendments to the regulations are necessary.
2. Today, UK Continental Shelf (UKCS) supplies meet around 50% of gas demand in GB. Additional volumes of gas in the UKCS are outside the gas quality specification set out in Schedule 3 of the Gas Safety (Management) Regulation 1996 (GSMR), which means this gas must be processed to comply with the safe gas composition specifications, or not recovered at all. The regulations are constraining further volume and further development of gas from the UKCS. As easily accessible indigenous natural gas reserves have been depleted, sources such as imported liquefied natural gas (LNG) have provided an alternative means of meeting GB’s gas supply using the established pipeline infrastructure. Currently, much of the gas from these sources must be processed to comply with the specifications set out in GSMR. As such, given that GSMR safe gas composition specifications create significant processing costs and act as a potential barrier to future diversification of GB gas sources to support the UK Government’s 2050 Net Zero commitments and the security of the UK’s gas supplies, it is reasonable to review the specification to establish whether the regulations reflect safety or commercial constraints and to determine whether the costs of tight control of gas quality are justified by the benefits.
3. The safe gas composition specification set out in Schedule 3 of GSMR originates from the early days of UKCS production and the current limits reflect the composition of the majority of gas produced at that time. Gas networks and appliances were designed for the safe transportation and use of that gas. The Regulations apply to the conveyance of natural gas (methane) through pipes to domestic and other consumers and define the gas transmission and distribution network. A key part of the specification is the Wobbe Number (WN) or Wobbe Index (WI), an indicator of the interchangeability of fuel gases such as natural gas. Gases are said to be interchangeable when they may be substituted for one another without affecting the operation of gas burning appliances and equipment; and reflect the degree to which they give similar heat input to the appliance, ignite reliably, have a stable flame and completely combust.
4. The safe gas composition specification aims to correct the potential negative externality of upstream gas producers and suppliers inserting gas into the network that could adversely affect the safe operation of downstream gas equipment; and the asymmetry of information and resources that mean upstream producers and suppliers are more aware of gas specification and capable of adjusting it than downstream users.
5. The future network will need to reflect current safe gas composition and the changing needs and sources of gas supply to the UK market. UKCS reserves exist to supply a significant proportion of GB demand for many decades to come.[[1]](#footnote-2) Gas composition varies between reservoirs and the relatively narrow band of acceptable Wobbe range in the UK specification adversely impacts the ability to maximise economic extraction of these reserves.[[2]](#footnote-3) Furthermore, many world-traded LNGs have WN values above the current GSMR specification. Before these sources of gas can be injected into the GB gas network the GSMR safe gas composition specification requires that:

* high-Wobbe LNG be ballasted with nitrogen to meet the upper end of the WN range;
* some imported pipeline gas be processed to meet the current incomplete combustion factor (ICF);
* low WN gas from, for example, the southern and central North Sea be blended with gas streams consisting of higher WN gas;
* low-Wobbe biomethane to be mixed with propane (‘propanation’) to meet the lower end of the WN range.

1. This means that unless the GSMR gas composition specification is changed to safely accommodate this greater variety of sources, increasing quantities of gas will require processing before they can be conveyed and used in GB.
2. Understanding and evidence of gas composition impacts have advanced significantly through the ‘Opening up the Gas Market’ (OGM) Oban project[[3]](#footnote-4) after its demonstration of higher WN gas usage in the community in Oban, Scotland, which has its own independent gas network, known as a Scottish Independent Undertaking (SIU). The project has produced an evidence base in relation to domestic and commercial appliance safety and performance using a higher WN than currently permitted by the regulations.
3. IGEM’s Gas Quality Working Group (GQWG) has collectively agreed that the gas composition specification can be widened and has been submitting evidence to HSE in support of these changes. Evidence has been received on outcomes and demonstrations from the OGM Oban project and the higher WN, research on industrial and commercial appliances, gas interchangeability, oxygen content, oxygen depletion sensors, the lower WN, transmission assets and pipeline fracture propagation and the governance process for a proposed IGEM Gas Quality Standard.
4. The OGM report concluded that domestic and small commercial appliances correctly installed, serviced and operated can safely burn gas with a WN up to 54.76MJ/m³; that there was no evidence of deterioration in appliance performance after one year operating on gas outside of GSMR limits; and as a statistical representation of GB, it estimated that 4% of appliances in GB would be at risk against the Unsafe Situations Procedures and 2% would be immediately dangerous due to their existing condition (rather than the receipt of a wider gas range). Appliances within households in Oban that were found to have pre-existing faults or were in poor condition upon arrival were serviced and/or fixed, or where appropriate, replaced for free by the Oban project. During the field trial period, regular testing of appliance performance was undertaken. All the appliance checks were deemed satisfactory and there were no identifiable or material changes recorded in the burning characteristics and performance of appliances on the high WI gases.
5. These early demonstrations have shown that safe gas composition specifications, as currently set out, do serve as a barrier to the deployment of additional gas sources, including cleaner sources that could contribute to the government’s Net Zero commitment. As a result, continuing savings related to gas processing could potentially be realised by some producers; and GB could benefit further from access to a wider range of gas sources, with benefits for diversity of supply and Net Zero. This impact assessment aims to provide a robust analysis of these benefits and the potential costs and broader impacts to the gas network and gas-users to inform policy and decision-making.

## Policy objective

1. The policy objectives are to:

* To adapt the prescriptive GB regulation for gas composition contained in GSMR Schedule 3 that is restricting the sources of gas sitting outside of current specifications that can be used in the transmission and distribution networks.
* Enable a greater diversity of gas resources to be accessed from across the North Sea including both the UKCS and the Norwegian sector, contributing to greater security of GB’s energy supply
* Reduce gas processing, potentially making gas supplies easier to secure, and the potential for fewer greenhouse gas (GHG) emissions being produced by the processing of gas to comply with the current gas composition specifications.
* Maintain or improve upon current safety standards in those areas subject to GSMR.

1. Also, making these changes will provide an opportunity to modernise GSMR in parallel to take account of significant changes to the industry since 1996, by updating, expanding or removing definitions related to electricity generating stations, biogas pipelines and LNG import terminals and changing the duty to provide an emergency call handling service to industry rather than British Gas.

**B1. Description of options considered**

1. HSE has been working closely with IGEM, BEIS, Office of Gas and Electricity Markets (Ofgem), the Oil and Gas Authority (OGA), Energy Networks Association (ENA) and the wider gas industry to ensure that the latest safe gas composition evidence is brought together and reviewed to remove potential investment barriers and secure wider access to gas supplies. This leads to two options for regulatory reform:

### B.2.Option 1 – business as usual

1. Retain GB’s safe gas composition specification within GSMR, Schedule 3, with industry seeking exemptions where necessary. Exemptions are timebound and can only be granted if there is evidence that 'the health and safety of persons who are likely to be affected by the exemption will not be prejudiced'.
2. This is the baseline against which the other options will be assessed. While Option 1 includes the potential for HSE to issue exemptions from the regulations, it is not proposed to model these exemptions in the baseline of this analysis, which would serve to lessen the costs and benefits assessed. HSE could under Option 1 issue a class exemption to practically achieve the changes to WN, ICF and is. A class exemption would not require dutyholders to apply for individual exemptions to HSE, and therefore the exemption process itself would not create any costs for dutyholders. Such a baseline would render the additional costs and benefits of regulatory change related to gas quality change under Option 2 nil. This would not be a useful baseline against which to assess the impacts of regulatory change. Therefore, this IA will assume a business-as-usual baseline without the issuing of a class exemption.

### B.3.Option 2 – preferred option

1. The preferred option is to retain GB’s safe gas quality specification within GSMR, Schedule 3 and amend the values to those proposed and consulted upon by IGEM (IGEM/GL/10) and those assessed to be safe by HSE:

* decrease the lower WN limit from ≥47.2 MJ/m³ to ≥46.5 MJ/m³ (the existing lower emergency limit)
* extend the current GSMR class exemptions for oxygen in biomethane to a general 1 mol% oxygen limit at ≤38 barg for all gas sources
* remove the Incomplete Combustion Factor (ICF) and Soot Index (SI) limits and to introduce a relative density of ≤0.7 for gas interchangeability
* Alongside these changes, to also modernise GSMR to account for significant changes to the industry occurring since 1996, as previously discussed

**B.4. Options considered but not taken forwards**

1. The primary strategic objectives of the policy proposals discussed in this IA are safety and improving energy security. The Gas Quality Working Group have developed evidence to inform proposals to revoke GSMR Schedule 3, transfer the specifications to an IGEM Gas Quality Standard (IGEM/GL/10) and amend the gas quality specification values to those proposed and consulted upon by IGEM (IGEM/GL/10) through its earlier work:

* decrease lower WN limit from ≥47.2 MJ/m³ to ≥46.5 MJ/m³ (the existing lower emergency limit)
* increase upper WN limit from ≤51.41 MJ/m³ to ≤52.85 MJ/m³ (the existing upper emergency limit)
* include a new WN upper emergency limit of ≤53.25 MJ/m³
* extend the current GSMR class exemptions for oxygen in biomethane to a general 1 mol%
* oxygen limit at ≤38 barg for all gas sources
* remove the Incomplete Combustion Factor (ICF) and Soot Index (SI) limits and to introduce a relative density of ≤0.7 for gas interchangeability

1. This option has not been taken forward due to outstanding concerns about safety associated with a higher WN limit and therefore the corresponding safety reduction of an IGEM Gas Quality Standard that did increase the upper WN limit.
2. Whilst the OGM report provided an excellent foundation for a review of GSMR, further evidence submissions from the GQWG have further developed understanding of the risks involved.
3. The Quantified Risk Assessment of the OGM report showed that increasing the WI to 53.25 MJ/m3 has a small increase in risk, with appliance installation condition the most significant contributor to risk. This issue is most acutely felt when different gas quality ranges are supplied to an appliance that is faulty, in poor condition, has not been regularly serviced, or has been adjusted from its factory setting. The report identified a safe operational range of gas quality of 5-6 MJ/m³. The proposals to increase the upper WN and decrease the lower WN would extend the range beyond this OGM parameter and could potentially lead to a scenario where extreme adjustment of an appliance to either a low or high WN setting fed with the extreme opposite WI gas (either high or low) could lead to substantial increases of CO emissions.
4. To exacerbate this problem, it is not known how many appliances within the GB population have been field adjusted.
5. The GQWG acknowledged this issue and undertook further consideration of the risk, its potential and subsequent impact on CO poisoning risk, as well as consideration of how to manage this risk.
6. The Oban SIU and three other SIU’s have continued to operate on WN gas up to ≤53.25 MJ/m³, acting as a further demonstration of safety. They have received an exemption from HSE from the gas composition specifications set out in GSMR Schedule 3 in order to do this. The exemption has several conditions which are helping to manage the risk of CO emissions in unsafe or adjusted appliances and the problem associated with a wider range of gas quality to such appliances:

* Additional testing is undertaken on the long-term effect on appliances with gases of a higher WN and of longer durations than previously undertaken
* A copy of the monthly Excursion Report (excursions are predominantly short spells where the WN may rise to ≤55.00 MJ/m³ as a result of switching supply between storage vessels) and supporting data is sent to HSE
* Random appliance monitoring tests are conducted and the results of these tests sent to HSE. These consist of continuous monitoring at one property in each of the 4 SIUs and 200 random spot tests at selected premises over the exemption duration at each of the 4 SIUs.

1. The subsequent evidence submission on the impact of widening the WI range on CO poisoning risk[[4]](#footnote-5) has calculated the potential for CO poisoning risk on boilers whose air-fuel ratio had been adjusted, when supplied with the proposed lower WI, the proposed higher WI and the extended range of WI gas were both the higher and lower WN’s amended. The proportion of field adjusted boilers was assumed to be 5%. These parameters were weighted against the scenario where appliances have been factory set with G20 test gas and supplied with the same potential varying distributions of gas quality.
2. Industry submissions on this matter estimate that the risk of fatality from CO poisoning associated with the proposed higher WN increases by a degree of between 0.24 and 2.8 additional fatalities per annum.
3. This increased risk is not tolerable within law. GSMR’s parent act, the Health and Safety at Work etc Act 1974 (HSWA) section 1(2) outlines that regulations shall be designed to maintain or improve standards of health, safety and welfare established by or under those enactments. Based on the evidence submission increasing the higher WN limit, or increasing both higher and lower WN limits would not maintain or improve standards.
4. Mitigation of risk is discussed within the evidence submission on CO poisoning risk. The most beneficial mitigation is argued to be increased prevalence of appliance servicing and inspection. This would mirror the mitigations used in Oban and the three other SIU’s. Aside from this, the industry evidence submission recommends that field adjustment is prevented in order to manage the risk; and the submission discusses various means to do this.
5. Increased servicing and inspection are inherently problematic to replicate for the entire gas network and upscale to the greater GB population. Regulations do not impose requirements for domestic end-users of gas to service gas appliances and mandating this practice would be entirely cost-prohibitive, potentially leading to fuel poverty for some consumers. Presently, there is no mechanism for ensuring appliances are regularly serviced. Inspection of appliances is also cost-prohibitive and practically very challenging – requiring significant levels of skilled resource, infrastructure and end-user compliance. Prevention of field adjustment is somewhat easier to accomplish but the evidence submission indicates this would have only a minor impact and HSE would prefer to see further demonstration of the effectiveness of such a mitigation and wider discussion with delivery partners before making legislative changes.
6. HSE has undertaken some research and analysis on the potential impacts of pursuing this option, and those methods are summarised in the next section. This analysis has shown that pursuing changes at both ends of the WN range has the potential for high adaptation costs for some downstream gas users, including domestic, commercial, industrial and power-generators. These are driven by the need to replace, maintain or service some equipment to ready it for a wider gas quality range. Initial estimates compiled in consideration of this option were subject to a high degree of uncertainty due to lack of definite information on the current state and condition of gas appliances and equipment, but pointed to possible present value adaptation costs in the high hundreds of £millions and possibly £billions over the twenty-one year appraisal period, driven chiefly by the effect of higher WN gas on equipment.
7. In terms of benefits and savings, reduced nitrogen-ballasting of gas supplies associated with a higher WN was estimated to generate savings of a similar order of magnitude to the potential costs.
8. The proposed IGEM Gas Quality Standard may well be the most effective and efficient means of changing GB gas quality in order to transition to a low carbon gas network, removing the legislative process and moving to a more goal-setting regulatory framework, but there has not been opportunity to demonstrate this yet and the evidence-gathering and formulation of this proposal has taken a long time.
9. The proposed governance process does not currently include a workable mechanism for HSE to guarantee that safety standards are not reduced. There are also concerns on the ability of government to introduce changes or influence the timing of changes. This presents a risk of not being able to deliver government objectives such as hydrogen blending and decarbonising energy.
10. With ambitious timescales to meet government commitments on hydrogen blending, and decarbonising the energy system, which involve large-scale impacts and adaptations for the energy sector, it is felt that retention of the gas composition specification is the best method at this time to deliver these government policies, with its consultation and impact assessment model, collective responsibility and Parliamentary scrutiny principles, statutory reviews and independence from the sector. Such projects will also require some degree of resourcing and financing, which the government is well placed to meet.
11. Based on the evidence that has been presented, the policy objectives are best served by changing the lower WN limit (Option 2) only at this time.
12. An alternative means of achieving the policy objectives would be to use the exemption route. Regulation 11 allows the Health and Safety Executive to exempt a person or persons from any part of the regulations and so this route could be used to permit lower WN gas to be supplied at certain points and under certain conditions. This would mean that lower WN gas is not conveyed throughout the gas network but only at locations the Health and Safety Executive exempt, and so the policy objectives are only partially delivered. This method is available under the Option 1 notional baseline in this IA. However, this IA uses a ‘business as usual’ baseline to capture the full effects of Option 2, as including exemption in the baseline would effectively render the costs of Option 2 nil. This is discussed further in paragraphs 14 and 15.
13. Non-legislative options to achieve these ends would involve financial incentives. Either financial incentives for alternative sources of gas from the North Sea and gas producers operating there meaning they could develop new gas fields and still make it economically viable to process this gas in order for it to meet the gas quality specification. Financial incentives for biomethane production could also deliver the policy intent although the capacity for additional biomethane production is limited. Ideally, any financial incentives for biomethane production would also need to be accompanied by billing reform due to The Gas (Calculation of Thermal Energy) Regulations 1996, and that would be a legislative change. Billing reform would complement financial incentives well as it could mean less gas processing for biomethane producers. Alternative sources of gas could also be obtained through financial incentives for LNG import facilities as this could counteract the cost of processing alternative sources of LNG. This however, would not meet the policy objectives of greater diversity of supply from the North Sea or reduced gas processing.
14. HSE recognise that hydrogen is likely to play a significant role in the decarbonisation of the gas network. However, at this stage, until the evidence of hydrogen usage as an energy component is finalised, we are not proposing to include changes to current hydrogen limits in the safe gas composition specification. The proposed changes will enable the government to facilitate any potential future changes needed to address Net Zero.

## Research and consultation to inform this impact assessment

1. HSE has undertaken a considerable amount of research and consultation to inform the development of policy options and assess the potential impacts. In addition, HSE has fed into and drawn from an extensive industry consultation, led by IGEM. Much of this evidence-gathering concerned impacts of raising the top and lowering the bottom of the WN range in GSMR. The main evidence-gathering activities are summarised below.

* IGEM consultation/ meetings: IGEM is the professional engineering institution for the gas industry. The Institution writes and publishes technical standards by working with stakeholders and experts to inform and influence current and future gas and energy policy. The Gas Quality Working Group (with 23 members) was formed in 2016 to propose a standard covering the UK gas quality specification and carried out an extensive evidence-gathering exercise over three years and undertook a consultation on the proposed standard.
* Interviews with stakeholder groups: HSE held semi-structured, qualitative interviews with 13 trade associations, professional bodies and businesses representing the groups expected to be affected by the proposals. Interviewees were asked about the likely main impacts on their area of expertise and the rest of the market; whether evidence gathered through earlier consultation omitted any important impacts; and an indication of the potential magnitude of impacts. This information was used to inform further evidence gathering and specify the quantitative survey below.
* Stakeholder survey: HSE developed a comprehensive survey aimed at eliciting quantitative and qualitative business-level data about the impacts of the proposed change on all potentially affected constituents, from gas suppliers to end users. The survey was distributed to relevant trade associations, professional bodies, dutyholders and others HSE received 81 responses to the survey. The survey evidence is assessed in further detail in the relevant sections of the IA below.
* Interviews with appliance and equipment manufacturers: HSE conducted nine further semi-structured interviews with manufacturers and manufacturers’ associations to explore the likely impact of the proposed changes on equipment in the field and whether new equipment could be pre-adapted. This was to provide additional evidence to support survey responses from users who were unsure of the impact on their own equipment.
* Interviews with key affected stakeholders and their associations in upstream gas production to explore likely costs and savings arising from changes to gas processing; and the availability of further gas reserves that could be made economical by changes to GSMR

1. HSE will use the public consultation, targeted follow-up interviews and gas market analysis to gather further evidence and develop interim findings presented in the following sections to produce the final impact assessment.

## Monetised and non-monetised costs and benefits of each option (including administrative burden)

### Option 1 – Business as Usual (BAU)

1. This option would not deliver any improvement to the out-of-date legislative landscape that regulates the gas industry and would fail to reflect the currently available gas composition and the changing needs and sources of gas supply to the UK market. Maintaining the BAU would not enhance energy supply, reduce regulatory burdens or help enable the transition to Net Zero. It therefore does not meet the policy objectives. However, the business-as-usual case is the notional baseline against which other impacts are assessed.
2. It should be noted that if GSMR were not changed in the manner proposed, HSE has the option to issue a non-legislative exemption to the current WN range, provided that HSE is satisfied as to the safety of such a measure. This means that it is possible that the changes and impacts that this IA discusses could happen in a notional ‘do not change the regulations’ baseline. However, it would be perverse to assess the impacts of changing GSMR against a baseline where the same effect is brought about through non-legislative means – with the result that the costs and benefits of changing GSMR are effectively nil. As such, a ‘business as usual’ baseline is adopted with respect to the regulatory position.

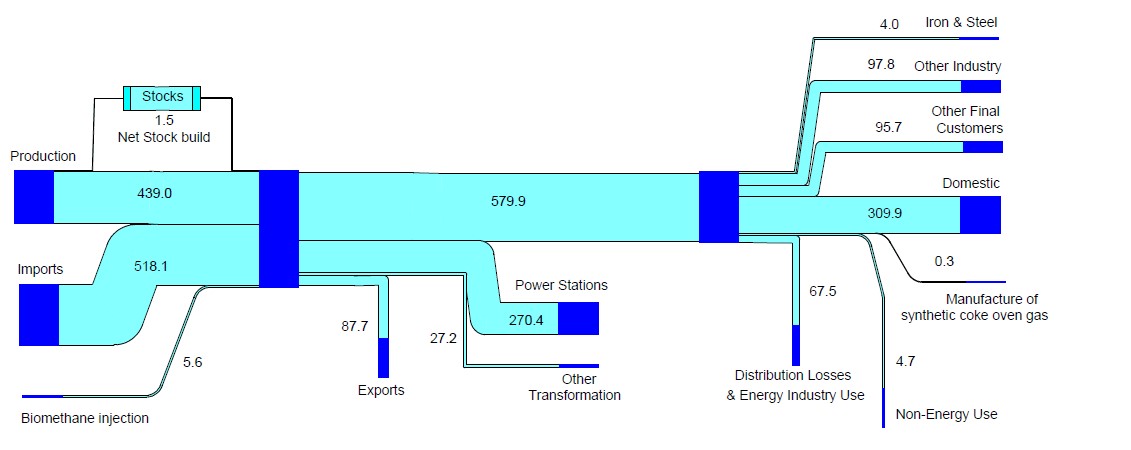
### D.2. Option 2 – Amend GB’s safe gas composition specification but retain within GSMR, Schedule 3, plus other changes to modernise GSMR.

1. The preferred option is to continue to specify the safe gas composition within GSMR and retain HSE’s ownership and control of GB’s gas quality specification. The bottom of the WN range would be lowered and future changes would continue to require HSE’s assessment and changes to GSMR.
2. The shorter-term impact of Option 2 is driven by the proposed widening of the Wobbe Index (WI) range, which will allow gases with a lower gas quality into the GB gas network. This has the potential to reduce gas processing costs for some producers but to also increase costs to users from ensuring that equipment is compatible with a wider range and managing potentially greater fluctuations and variability in gas quality.
3. Also, making these changes will provide an opportunity to modernise GSMR in parallel to take account of significant changes to the industry since 1996, by updating, expanding or removing definitions related to electricity generating stations, biogas sites and LNG import terminals and changing the duty to provide an emergency call handling service to industry rather than British Gas in order to ensure all risk occurring within the current gas network is subject to regulation, and applying safety standards consistently in all areas where risk is present.

### D.3. Summary of affected sectors

1. The basic ‘lifecycle’ of gas in the UK starts with it entering the national transmission system (NTS) from the North Sea, via a pipeline or as Liquified Natural Gas (LNG), travelling through the NTS and ultimately coming out of a pipe for use by an end-user. The proposed changes of widening the WN range under Option 2 have the potential to affect all operators involved in this lifecycle. The flow of gas in TWh terms is summarised in Figure 1.

Figure 1: Natural gas flow, 2019 (TWh)[[5]](#footnote-6)



1. BEIS produce estimates of gas demand by sector, summarised below in Table 1. The domestic, commercial and public administration etc. sector is the largest consumer, followed by transformation, general industry and the energy industry.

**Table 1**: Summary of gas demand by sector, 2020 (GWh)[[6]](#footnote-7)

|  |  |
| --- | --- |
| **Sector** | **Total gas demand (GWh)** |
| Domestic, commercial, public administration etc. | 390,000 |
| Transformation (e.g., electricity generation) | 260,000 |
| Industry | 95,000 |
| Energy industry (e.g., oil and gas extraction; refineries etc.) | 60,000 |
| Non energy use total | 4,500 |
| Losses\* | 2,700 |
| Road transport | 310 |
| **Total demand** | **810,000** |

**Note:** figures rounded to two sig. fig., so may appear not to sum. \*Refers to downstream losses. For an explanation of what is included under these losses, see Downstream Gas methodology on BEIS website at: <https://www.gov.uk/government/publications/downstream-gas-statistics-data-sources-and-methodologies>

1. For the purposes of evidence gathering and analysis, HSE has defined the groups in Table 2. These groups were suggested by initial research and engagement with industry and IGEM as the most appropriate and suitable for the IA research. The potential impact of the proposed changes under Option 2 on these groups is assessed below.

Table 2: Definition of groups affected by proposed changes

|  |  |
| --- | --- |
| **Group** | **Description** |
| Gas producers/ importers | Those bringing gas to shore via pipelines and via imports of LNG, and processing this gas to enter the NTS |
| National Transmission System (NTS), Gas Distribution Networks (GDNs) and Independent Gas Transporters (IGTs) | Britain’s gas transmission network, the National Transmission System (NTS), is the high-pressure gas network which transports gas from the entry terminals to Gas Distribution Networks, or directly to power stations and other large industrial users.  Regional Gas Distribution Networks (GDNs) and Independent Gas Transporters (IGTs) transport gas to other end-users across GB. |
| Domestic end-users | Households that use gas primarily for central heating (e.g., boilers) or cooking |
| Commercial end-users | Organisations and businesses using gas in a similar manner to domestic users (i.e., for heating and cooking), but on a larger scale – e.g., hotels, conference centres etc. |
| Industrial end-users | Organisations and businesses that do not use gas to heat water or use gas for cooking, but use gas in a more directed way (e.g., glass making, oil and gas extraction) or as a constituent of a chemical process (e.g., producing hydrogen; pharmaceuticals) |
| Power generators | Large-scale organisations using gas to drive sizeable engines and turbines generating electricity for businesses and consumers, e.g., EDF, Centrica (British Gas), E.ON, RWE npower, Scottish Power and Southern & Scottish Energy. Smaller power generators use gas to drive turbines and/or engines to generate electricity for their own needs rather than to sell. |

### General assumptions in this analysis

##### **D.2.1.1. Appraisal period and discounting**

1. Decision-making on changes to GSMR will need to consider business costs and investments in gas-fuelled domestic, industrial and commercial equipment. The lifecycle for many of these types of equipment will extend beyond the typical ten-year appraisal period of an IA. Evidence gathered for this IA indicates that that period can be between 15 to 30 years, depending on the type of equipment in question. As such, this IA follows the approach of the 2005 BERR impact assessment[[7]](#footnote-8) of proposed changes to the Wobbe range in assessing costs over a longer appraisal period, comprising one year of transition and a further twenty years of costs and benefits.
2. The first year of the appraisal period (Year 0) is 2022. After this initial year of transition, the remaining appraisal period runs from 2023 (Year 1) to 2042 (Year 20).
3. We welcome the RPC’s comments on the appropriateness of the appraisal period in their assessment of this IA at consultation stage.
4. The analysis adopts a discount rate for future values of 3.5%, in line with Green Book guidance.

##### **D.2.1.2. Assumptions about trends in gas use**

1. As part of the government’s commitment that the UK should be a net-zero carbon emitter by 2050, the National Grid produced the Future Energy Scenarios (FES)[[8]](#footnote-9) research on how natural gas usage might change over that period. The FES 2021 estimates used in the analysis use the Leading the Way scenario to model low gas usage (i.e. rapid decline in gas use) over the appraisal period; and the System Transformation scenario for high gas usage.
2. The FES expect gas demand to fall from around 81 billion cubic metres (bcm) in 2020 to between around 2 bcm and 47 bcm by 2050, depending on the usage scenarios. By the end of the appraisal period (2042), gas demand is expected to fall to between around 14 bcm and 49 bcm.
3. As summarised in Table 3, the estimated percentage decline is applied to ongoing costs to model declining gas usage where appropriate in the analysis. Note that this attempt to account for long-term trends in gas demand – in the short-term, demand (particularly for certain types of gas, e.g. LNG or low-Wobbe Southern North Sea gas) could change due to short-term price volatility or competing gas types – it has not been possible to control for this in the consultation stage IA.

Table 3: Estimates of national gas usage 2020-2050

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Calendar year** | **Year of appraisal period** | **Gas usage (bcm)** | | | **Gas usage as percentage of Year 0** | | |
| **Low** | **Central estimate** | **High** | **Low** | **Central estimate** | **High** |
| 2020 |  | 81 | 81 | 81 |  |  |  |
| 2021 |  | 72 | 75 | 78 |  |  |  |
| 2022 | Year 0 | 69 | 72 | 76 | 100% | 100% | 100% |
| 2023 | Year 1 | 67 | 71 | 75 | 98% | 99% | 100% |
| 2024 | Year 2 | 64 | 70 | 75 | 93% | 96% | 99% |
| 2025 | Year 3 | 61 | 67 | 72 | 89% | 92% | 95% |
| 2026 | Year 4 | 58 | 64 | 70 | 85% | 89% | 93% |
| 2027 | Year 5 | 56 | 61 | 67 | 81% | 85% | 88% |
| 2028 | Year 6 | 55 | 61 | 67 | 79% | 84% | 89% |
| 2029 | Year 7 | 52 | 59 | 66 | 76% | 82% | 87% |
| 2030 | Year 8 | 50 | 57 | 65 | 72% | 79% | 86% |
| 2031 | Year 9 | 46 | 54 | 63 | 67% | 75% | 83% |
| 2032 | Year 10 | 43 | 52 | 61 | 63% | 72% | 80% |
| 2033 | Year 11 | 40 | 49 | 58 | 58% | 68% | 77% |
| 2034 | Year 12 | 37 | 47 | 57 | 54% | 65% | 75% |
| 2035 | Year 13 | 34 | 44 | 55 | 49% | 61% | 72% |
| 2036 | Year 14 | 30 | 42 | 54 | 44% | 58% | 72% |
| 2037 | Year 15 | 27 | 40 | 52 | 39% | 55% | 69% |
| 2038 | Year 16 | 24 | 38 | 51 | 35% | 52% | 68% |
| 2039 | Year 17 | 22 | 36 | 50 | 31% | 50% | 66% |
| 2040 | Year 18 | 19 | 34 | 49 | 28% | 47% | 65% |
| 2041 | Year 19 | 16 | 33 | 49 | 24% | 45% | 65% |
| 2042 | Year 20 | 14 | 31 | 49 | 21% | 43% | 64% |
| 2043 | Year 21 | 12 | 30 | 48 | 17% | 41% | 63% |
| 2044 | Year 22 | 10 | 29 | 48 | 14% | 40% | 63% |
| 2045 | Year 23 | 6.1 | 26 | 47 | 8.8% | 37% | 62% |
| 2046 | Year 24 | 5.0 | 26 | 47 | 7.3% | 36% | 61% |
| 2047 | Year 25 | 3.9 | 25 | 47 | 5.7% | 35% | 61% |
| 2048 | Year 26 | 3.2 | 25 | 46 | 4.7% | 34% | 61% |
| 2049 | Year 27 | 2.5 | 24 | 46 | 3.6% | 34% | 61% |
| 2050 | Year 28 | 1.7 | 24 | 47 | 2.5% | 33% | 61% |

**Note:** figures may appear not to sum due to rounding

### Gas producers and importers

1. Gas producers are likely to be among the main direct beneficiaries of the proposed changes under Option 2. Operators that were previously required to process gas to bring it within the existing GB gas specification may now avoid some processing costs, where the gas is within the proposed wider WN range. Additionally, a wider WN range could increase the volume of gas that can be exploited profitably, with or without processing.

#### Data on gas producers and importers

1. According to the BEIS 2020 DUKES report[[9]](#footnote-10), total gas supply to the UK before exports was 961 GWh, of which UK production accounted for 439 GWh (46%) and imports 518 GWh (54%). Pipeline imports from Norway and the Continent accounted for 61% of imports, with LNG accounting for 39% (up from 15% in 2018 due to a fall in wholesale LNG prices).
2. Available data on the number of gas producers and importers indicates that there are around 53 companies operating around 213 installations on the UKCS; three LNG import terminals, with almost half of LNG sourced from Qatar; three interconnectors connecting GB with Norway and Belgium; around 100 suppliers of biomethane to the NTS; and around 60 onshore gas well pads, which produced around 0.85 billion cubic meters in 2018[[10]](#footnote-11), with three pads currently supplying into the local or the national grid.

**D.3.2. Evidence on potential change in volume of production and import to GB market**

1. Reduction in processing costs would, all else equal, be expected to stimulate supply to the market of the previously processed gas. While the HSE survey focused on the policy option of widening the WN range at both the top and the bottom (the option of which is no longer being considered), two respondents to that survey that currently undertake processing exclusively to raise the WN of their gas did report that they might expect to increase their supply to the market as a result by between around 6% and 8%. These suppliers currently produce around 4.3 billion cubic metres (bcm) per annum; and both source their gas from the UKCS.
2. We assume that the supply of gas onto the NTS will still need to balance with demand, which we assume to be finite and unaltered by the options proposed. We believe this is appropriate as the gas pipeline infrastructure has to maintain specified operational tolerances around pressure in the system. Therefore, our modelling assumes that any increases in supply from a source such as the UKCS will be offset by reduced supply through pipeline interconnectors to mainland Europe or from reduced imports of liquified natural gas (LNG).
3. A lower WN limit would bring into specification gas sources previously outside the WN range. It may also make it profitable to process some sources of gas outside the new wider WN range so they can be supplied to the UK gas network. These sources could include low-WN gas from the southern North Sea (SNS) and biomethane. As above, it should be noted that any additional supplies will likely displace other gas sources, rather than raising supply overall.
4. There are considerable uncertainties around the potential volume of gas that could be developed if the WN lower limit is reduced, but estimates produced by the OGA suggest that around 30 billion therms of gas is present in total in leads and prospects in the SNS.[[11]](#footnote-12)
5. Evidence from interviews and research undertaken by gas producers indicates that enabling lower-WN gas from the SNS to enter the system without propanation or blending could lead to more gas being economically viable for extraction. However, we would expect that this will be subject to wholesale price volatility and competition from other gas sources. Gas producers have estimated that perhaps 2.6 billion therms could potentially be extractable from the SNS. It might take 3-4 years before it began to be extracted; and take perhaps 10 years to fully extract. The value of this gas could be substantial; the benefits of this will be estimated for the final stage IA.
6. This native gas could also offset more carbon-intensive LNG imports, generating carbon-savings – more evidence on this will be sought during consultation.
7. Lowering the WN range could lead to increased investment in the development of biomethane.￼[[12]](#footnote-13)could reduce the cost of processing biomethane and could improve market access of this gas, encouraging investment in its infrastructure. Biomethane is a newer energy supplier and globally biomethane is underutilised with opportunities to provide a greater proportion of gas supply. Biomethane’s WN range is around 45.9MJ/m3 to 48.2MJ/m3; the proposed changes to the WN in GSMR would encompass most of this range and could increase investment in biomethane and encourage growth in this energy supply, meeting government strategies for energy security and Net Zero.
8. However, evidence from the survey and from the interviews indicates that conditioning outlined in The Gas (Calculation of Thermal Energy Regulations) 1996 around the flow-weighted average calorific value (FWACV) of gas – which requires that the calorific value of gas used for billing within a local distribution zone (LDZ) cannot be higher than 1MJ/m3 above the lowest-calorie gas supplied to that LDZ – might lead to a continued demand for propanated biomethane in order to raise the calorific value of that gas to the FWACV. This could mean that gas producers in the biomethane sector may not realise the benefit of reduced gas processing as a result of the proposed decrease in the lower WN. We will explore this further with industry and with Ofgem during consultation.
9. Evidence from interviews indicates that that the main effect in the short term could be a reduction in processing costs and that any change in supply composition might happen over a longer period. But, further work on the market effects of changes to the gas quality specification must also bear in mind the possible decline in gas demand, which is likely to be accelerated by Net Zero.
10. Across Europe there is a wider range of WN across the different countries of both the lower and upper end of the UK specification ranging from 46.44MJ/m3 to 52.85 MJ/m3. Further work will be needed during consultation to explore the compatibility of the proposed GSMR WN with those in countries that GB is connected to through interconnectors, including Northern Ireland, the Republic of Ireland and Belgium.

#### Quantified cost estimates for gas producers and importers

##### **D.3.2.1. Initial adjustments to operations**

1. As part of the HSE survey, we asked gas producers and importers what they would have to do to determine how they would be affected and what, if anything, they would have to change. The survey asked about widening the WN range at the top and bottom, so reported costs may be an overestimate for lowering the bottom only.
2. More than half of respondents reported that they would not have to do anything or that they did not know or could not quantify.
3. No LNG importers or interconnector operators quantified any such costs.
4. Two gas producers sourcing their gas from the UKCS and from Norway reported costs of between around £30,000 to £100,000 to agree new procedures with National Grid, with a central estimate of around £65,000. These costs covered actions including assessing what further gas sources could be received and processed, implementing changes to National Grid entry specifications and updating interface procedures with National Grid. This gives a total one-off estimated cost of between around £60,000 and £200,000, with a central estimate of around £130,000.
5. Of the four biogas respondents, two reported costs would be ‘none’; and another that they would need to engage with operators to determine. One biogas producer estimated costs of around £2,000 for the establishment of new set-points for pressure-regulating devices. If we apply this estimate to between 25% and 50% of the roughly 100 biogas producers injecting into the grid (according to the Renewable Energy Association), this would generate a cost of between around £50,000 and £100,000, with a central estimate of around £75,000.
6. This gives a **total estimated cost of initial adjustments** of between around £110,000 and £300,000, with a **central estimate of around £210,000**.

##### **D.3.2.2. Processing to increase Wobbe Number**

1. Discussions with the biogas industry and Ofgem have revealed that, while biogas is propanated at virtually all of the 100 sites injecting biogas into the grid, this is done principally to fulfil the requirements of the Gas (Calculation of Thermal Energy) Regulations 1996. These regulations stipulate that the calorific value of gas charged to consumers cannot be more than 1MJ/m3 greater than weakest gas supplied into a charging zone. As such, suppliers of biogas, which tends to have a lower calorific value, are often required to propanate their gas to comply with the flow-weighted average calorific value for a given zone.
2. As such, the Renewable Energy Association (REA) have estimated that the proposed changes to the Wobbe range in GSMR would not lead to reduced propanation by biogas producers.
3. Respondents to the quantified survey reported that they anticipated savings from processing UKCS gas to increase its Wobbe Number of around £6.2 million per annum from Year 1 to Year 21. Adjusting for the gas use projections in Table 3, this would give annual average savings of between around £3.5 million and £4.7 million, with a central estimate of around £4.1 million. This would give a **present value saving of** between around £56 million and £72 million, with a **central estimate of around £65 million**.

##### **D.3.2.3. Summary of Wobbe processing costs**

1. Total net present value processing savings are estimated to be between around £56 million and £72 million, with a central estimate of around £64 million, as summarised in Table 4.

Table 4: Summary of present value Wobbe processing costs and savings (£millions)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Low** | **Central estimate** | | **High** | |
| Savings from processing to increase Wobbe number | £56 | £65 | | £72 | |
| Costs to determine changes | £0.1 | £0.2 | | £0.3 | |
| **Total net savings** | **£56** | **£64** | | **£72** | |
|  | | | **Low** | | **Central estimate** | | **High** |
| Savings from processing to increase Wobbe number | | | £56 | | £65 | | £72 |
| Costs to determine changes | | | £0.1 | | £0.2 | | £0.3 |
| **Total net savings** | | | **£56** | | **£64** | | **£72** |

**Note:** figures rounded to two sig. fig., so may appear not to sum

#### Priorities for further analysis for gas producers and importers

1. During consultation, further analysis will be sought to fill evidence gaps and provide quantifiable costs and benefits, where possible and proportionate to do so. These gaps are summarised in Table 5.

Table 5: Priorities for further research with gas producers and importers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Impact area** | **Cost or saving/ benefit?** | **Expected magnitude** | **Proposed further research** | **See paragraph…** |
| Costs of initial adjustments | Cost | Currently estimated one-off cost around £0.1m-£0.3m | Testing at consultation | 68 to 73 |
| Averted processing to increase Wobbe number | Saving | Currently estimated around £3.5m-£4.7m per annum | Testing at consultation | 76 |
| Additional sources of gas made economically viable, both to import of from UKCS | Benefit | 2.6bn therms of gas – expected to be a substantial benefit | Estimate benefit for final stage IA | 58 to 62 |
| Arrangements for operation of interconnectors | Costs | Unknown | Engagement with affected suppliers | 67 |

### National Transmission System (NTS), Gas Distribution Networks (GDNs) and Independent Gas Transporters (IGTs)

1. The NTS, GDNs and IGTs in broad terms comprise the network, storage facilities and related apparatus that transports gas to a wide range of end-users. These comprise: the National Transmission System (NTS), which supplies gas to power stations and large industrial users; four Gas Distribution Network (GDN) operators, that transport gas from the NTS to commercial and domestic users; and twelve independent gas transporters (IGTs), who operate smaller, local networks.
2. Potential effects of the proposed change on the NTS, GDNs and IGTs could include:
   1. Increased maintenance costs or replacement of equipment due to changes in gas composition or increased impurities from low-WN gas (e.g. biomethane)
   2. Increased monitoring of gas quality, including in real-time, to inform customers and to manage the network
   3. Increased compressor[[13]](#footnote-14) costs
   4. Increased insurance and warranty costs for equipment operating out of expected gas quality ranges
   5. Changes to blending costs to mix gases of different qualities together
   6. Costs from billing and calorific value shrinkage, which could be due to:
      1. Gas used as fuel for compressors
      2. Calorific value shrinkage in terms of what can be billed for under the Gas (Calculation of Thermal Energy) Regulations 1996 (amended 1997)
      3. Unaccounted for losses
3. The HSE survey asked about raising the top and lowering the bottom of the Wobbe range, but responses give an indication of some of the impacts around lowering the bottom only (Option 2 in this IA). Respondents to the survey indicated that they would bear these costs in some cases, but did not give conclusive evidence of what those potential costs would be in the aggregate – but the estimates indicated that costs for any one of these impacts could be in the hundreds of £thousands or low £millions. Further evidence will be sought during consultation.
4. We also asked in the survey whether there would be any costs associated with gas storage and leaks, but there was no indication in the responses that this would be the case.

#### Evidence on potential costs and benefits to the NTS, GDNs and IGTs

1. Interviews with key stakeholders prior to the survey indicated that the extent of shrinkage costs would depend on changes in pressure, with lower WN gas being higher pressure and therefore greater shrinkage costs would be expected. The overall effect of this on the system will be hard to predict and it will be unlikely that this could be modelled quantitatively in the cost model.
2. The interviews also indicated that the extent of variability and fluctuation of gas quality would vary in different parts of the country. Areas close to onshoring points experiencing fairly consistent gas quality; while areas in the middle of the country in the ‘zone of confluence’ between several gas sources would experience more variability and fluctuation. This will also be difficult to predict and quantify in the cost model.
3. Interview respondents felt that the current operation of the network and the day-to-day act of conveying gas through the transmission and distribution pipelines would not be signiﬁcantly aﬀected by the change in WN range.
4. Evidence in the interviews and survey indicated that suitable equipment for the real-time monitoring of gas quality may not be available yet and would have to be developed.

#### D.4.2. Quantified impact for NTS, GDNs and IGTs

##### **D.2.1. Determining impact and what needs to change**

1. Responses to the HSE survey indicated potential costs to determine what would have to change of between around £50,000 and £150,000 per network operator, with a central estimate of around £100,000. These costs were accounted for by testing or surveying of equipment and changes to equipment controls.
2. If we assume these costs are broadly representative for the NTS, four GDNs and twelve IGTs, this would give an **estimated total one-off cost** of between around £850,000 and £2.6 million, with a **central estimate of around £1.7 million**.
3. These costs may be an overestimate in respect of IGTs, whom we might expect to have lower costs. We will explore this further during consultation.

**D.4.3. Priorities for further analysis for NTS, GDNs and IGTs**

1. During consultation, further analysis will be sought to fill evidence gaps and provide quantifiable costs and benefits, where possible and proportionate to do so. These gaps are summarised in Table 5.

Table 6: Priorities for further research with NTS, GDNs and IGTs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Impact area** | **Cost or saving/ benefit?** | **Expected magnitude** | **Proposed further research** | **See paragraph…** |
| Maintenance | Cost | Unknown | Engagement with networks and BEIS | 80 |
| Equipment replacement | Cost | Unknown | Engagement with networks and BEIS | 80 |
| Monitoring of gas quality | Cost | Unknown | Engagement with networks and BEIS | 80 and 84 |
| Compressor operation | Cost | Perhaps hundreds of £thousands | Engagement with networks and BEIS | 80 |
| Gas supply arrangements | Cost or saving | Unknown | Engagement with networks, Ofgem and BEIS | 80 |
| Warranties | Cost | Unknown | Engagement with networks and BEIS | 80 |
| Insurance | Cost | Unknown | Engagement with networks and BEIS | 80 |
| Blending of gases | Cost or saving | One cost estimate in the low £millions | Engagement with networks and BEIS | 80 |
| Billing and shrinkage | Cost | Possibly in the hundreds of £millions | Engagement with networks, Ofgem and BEIS | 80 and 83 |
| Costs of determining changes | Cost | Currently estimated at between around £0.9m-£2.6m | Engagement with networks and BEIS | 87 to 90 |

**D.5. Power generators**

#### D.5.1. Background on power generators

1. Gas’s share of power generation was 39.5% in 2018. Power generators are the greatest end-user of gas by volume in the UK.[[14]](#footnote-15)
2. There are four main categories of natural gas fuel power generators used in GB production: reciprocating engines, Open Cycle Gas Turbines (OCGTs), Combined Cycle Gas Turbines (CCGTs), and Combined Heat and Power systems (CHP). Most of the gas-fuelled power generating capacity comes from CCGTs.
3. Reciprocating engines are a common technology similar to motor vehicles. These are piston engines that produce electricity and can be tuned to many fuel sources.
4. OCGTstations use a gas turbine that produces electricity. These turbines are in decline and many are either being decommissioned or converted into CCGTs.
5. CCGT stations combine in the same plant gas turbines and steam turbines connected to one or more electrical generators. This enables electricity to be produced at higher efficiencies than is otherwise possible when either gas or steam turbines are used in isolation. The gas turbine produces mechanical power (to drive the generator) and hot exhaust gases (waste heat). The waste heat is fed to a boiler, where steam is raised at pressure to drive a conventional steam turbine that is also connected to an electrical generator.[[15]](#footnote-16)
6. CHP stations produce energy and capture heat for use other than electricity generation. In GB, natural gas-fuelled CHPs utilise any of the above generating systems with the addition of a gas steam engine. CHPs are most likely to be found in the industrial and commercial sectors.
7. According to BEIS Dukes energy report[[16]](#footnote-17) there are 17 major power plant companies using a variety of turbine technology.
8. Power generators were asked in the survey about how their equipment would respond to both the potential range of the proposed new WN (i.e. the potential to receive higher and lower Wobbe gas than currently); and the potential fluctuation (the rate of change that could occur between higher and lower Wobbe gas). Fluctuation can be exacerbated by ‘slugging’, whereby the quality of gas coming from the supply can change instantly if gas of different qualities has not been sufficiently mixed.
9. The survey asked about widening the WN range at both the top and the bottom, which option is no longer considered viable by HSE. The responses revealed a high level of uncertainty: respondents were unsure if existing equipment could safely deal with the potential range and variability. Some responded that they expected that they would have to invest in new monitoring and control systems in order to manage the changes.
10. For range (variability) and fluctuation (rate of change), the interviews and survey results seem to agree somewhat. Some facilities will need upgrading to manage WN changes. Most survey respondents were uncertain if equipment could manage the proposed range. Where equipment is not able to manage the proposed changes, possible costs of equipment damage or interruptions to energy supply from shut-downs were discussed. Most thought that their facilities’ control and monitoring system would not be able to manage fluctuations. For those who thought their facilities could manage the WN change, they reference manufacturers still needing surveys to review; however, in a subsequent follow-up interview, a turbine manufacturer was able to make some estimates of impact and mitigation costs. The takeaway from the survey responses is that equipment, and control and monitoring systems will need engineering surveys to determine if they can safely manage the proposed WN changes regardless of the age of the facility.

#### D.5.2. Quantified cost estimates for power generators

##### **D.5.2.1. Number of gas turbines in scope**

1. BEIS produce figures of the numbers of CCGTs and OCGTs in operation and those being built or planned. Evidence from interviews with manufacturers of such equipment indicates that turbines from before the mid-1990s would probably not require modification – although this might seem counterintuitive, the argument is that older equipment is less finely tuned and so less sensitive to Wobbe range changes. These interviews were based around the initial policy of widening the WN range at both the top and the bottom, rather than just lowering the bottom, and so costs discussed with manufacturers may serve to overestimate the costs of Option 2.
2. The total numbers of turbines used in this analysis are summarised below in Table 7. The lower estimate for turbines is based on the number built; the mid estimate on the number built and under construction; and the high on the number built, under construction and consented by BEIS. This reflects different scenarios wherein new turbines might or might not be able to be adapted to the Wobbe range as part of construction – evidence from interviews was not conclusive on whether engineering solutions could be adopted during initial construction without additional cost.

Table 7: Estimated power-generating gas turbines

|  |  |  |  |
| --- | --- | --- | --- |
| **Appliance type** | **Low** | **Mid** | **High** |
| CCGTs | 45 | 46 | 57 |
| OCGTs | 12 | 13 | 18 |
| **Total** | **57** | **59** | **75** |
|  |  |  |  |
| *Minus, number of turbines pre-1996* |  |  |  |
| CCGTs | 7 | 7 | 7 |
| OCGTs | 3 | 3 | 3 |
| **Total** | **10** | **10** | **10** |
|  |  |  |  |
| **Net total** |  |  |  |
| CCGTs | 38 | 39 | 50 |
| OCGTs | 9 | 10 | 15 |
| **Total** | **47** | **49** | **65** |

1. In addition, reciprocating engines are used to generate power. Evidence from interviews indicates that there could be around 60,000 in operation; and that perhaps 10% are gas-powered, giving around 6,000 in total.
2. Combined Heat and Power (CHP) units produce energy and capture heat for use other than electricity generation. In GB, natural gas-fuelled CHPs utilise any of the above generating systems with the addition of a gas steam engine. CHPs are most likely to be found in the industrial and commercial sectors.
3. There are no definitive estimates for the numbers of CHPs in GB. The DUKES report[[17]](#footnote-18) estimates that there are around 2,500 CHP schemes – it is likely that many schemes will comprise more than one CHP, so this would likely be an underestimate of the number of CHPs. During interviews, one manufacturer estimated that there might be around 6,000 CHPs in operation. DUKES also estimates that 69% of CHPs are in the commercial sector.
4. Manufacturers estimated during interviews that they do not expect the ‘vast majority’ of reciprocating engines and CHPs to be replaced or need modification due to the Wobbe changes at the top and bottom of the range as they are not particularly sensitively tuned; and it is often not economical to adapt them, but rather to let them reach the end of their usual operational life and then simply replace them with a new engine that is calibrated as needed. Based on evidence received from manufacturers and HSE expert assessment, we do not anticipate that reciprocating engines or CHPs would experience significant costs under Option 2, where only the bottom of the range is proposed to be lowered.

##### **D.5.2.2. Costs of modification for power generators**

1. For turbines, interviews with manufacturers indicated that modification for the Wobbe range might cost between around £360,000 and £440,000 for control systems upgrades, with a central estimate of around £400,000.
2. In addition, analysis by a turbine operator indicates that each turbine might require tuning at a cost of between around £8,000 to £80,000, with a central estimate of around £44,000.
3. This would give a total cost of turbine modification and tuning of between around £17 million and £34 million, with a central estimate of around £22 million. As noted in paragraph 101, these costs could be an overestimate for Option 2.
4. For reciprocating engines, interviews and responses to the quantified survey indicate a number of modifications could be required for those reciprocating engines where actions would be taken:
   1. A control panel costing between around £50,000 and £100,000, with a central estimate of around £75,000
   2. Internal monitoring system costing around £15,000
   3. Tuning costing between around £1,200 and £4,000, with a central estimate of around £2,600
5. For CHPs, the evidence suggested that their adaptation could incur the costs under (a) and (b), where any action needed to be taken.
6. These estimates of costs for reciprocating engines and CHPs were made as part of discussions around raising the top of the WN range, as well as lowering the bottom, which is no longer considered a viable option. As discussed in paragraph 106, we do not expect any of these costs to be incurred for reciprocating engines or CHPs under Option 2.
7. This gives a **total one-off cost of power generator modification** for turbines only of between around £17 million and £34 million, with a **central estimate of around £22 million**.

##### **D.5.2.3. Increased maintenance costs**

1. For turbines, manufacturer interviews indicate that under the baseline, each might undergo a partial engine refurbishment, costing around £4 million, after every year of operational time. Depending on how often the turbine is in operation, each turbine might undergo this partial refurbishment between every four to two calendar years or so, giving an annual average cost of between around £1 million and £2 million, with a central estimate of around £1.3 million.
2. Interviews with manufacturers indicate that they expect that each turbine might need to undergo one or two additional partial refurbishments each decade, due to both the change in the Wobbe range and possible additional impurities in the gas from lower Wobbe sources (i.e., biogas). We have interpreted this as being equivalent to an additional 10% to 20% of annualised maintenance cost per turbine: between around £100,000 and £400,000, with a central estimate of around £200,000. This estimate was made during discussions around raising the top and lowering the bottom of the WN range, so may prove an overestimate of costs under Option 2.
3. This would give an initial annual estimate of increased maintenance costs for turbines of between around £4.7 million and £26 million, with a central estimate of around £9.8 million. This cost would be borne from Year 1 to Year 21. Applying the model of declining gas demand in Table 3 and discounting this annual cost over the appraisal period generates a **present value cost** of between around £43 million and £300 million, with a **central estimate of around £100 million**.
4. We do not anticipate increased maintenance costs for reciprocating engines and CHPs under Option 2– we will explore this further during consultation.

##### **D.5.2.4. Total estimated costs for power generators**

1. As summarised in Table 8, the **total estimated present value cost to power generators** is between around £60 million and £340 million, with a **central estimate of around £120 million**.

Table 8: Total estimated present value costs to power generators (£m)

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Low** | **Central estimate** | **High** |
| Modifying equipment | £17 | £22 | £34 |
| Maintaining turbines | £43 | £100 | £300 |
| **Total** | **£60** | **£120** | **£340** |

**Note: figures rounded to two sig. fig., so may appear not to sum.**

#### Priorities for further analysis for power generators

1. During consultation, further analysis will be sought to fill evidence gaps and provide quantifiable costs and benefits, where possible and proportionate to do so. These gaps are summarised in Table 9.

**Table 9:** Priorities for further research with power generators

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Impact area** | **Cost or saving/ benefit?** | **Expected magnitude** | **Proposed further research** | **See paragraph…** |
| Possible temporary shut-downs to electricity supply | Cost | Unknown | Engagement with power generators and BEIS; desk research of potential costs | 100 |
| Adjustment to turbine costs, which may be overestimated currently | Cost | Unknown | Test during consultation | 101 |
| Any costs to reciprocating engines or CHPs from reducing the lower bound of the WN range | Cost | Unknown | Engagement with equipment manufacturers | 106 |

### D.7. Domestic end-users

#### D.7.1. Background on domestic users

1. Domestic end-users (i.e. households) use gas via domestic appliances primarily for heating (e.g. boilers) and cooking. The proportion of GB homes connected to the gas grid has remained consistent between 2016 and 2018 at around 85.6% overall[[18]](#footnote-19). The demand for domestic gas has declined 16% since 2000.[[19]](#footnote-20)
2. Lower WN gas is already used in some parts of Europe e.g. Poland, Netherlands and Germany, with similar appliances to the UK. Evidence suggests that there is no diminution in safety; and gas with a WN of 46.5 MJ/m3, and below, could be utilised by appliances and equipment without adverse impact.
3. The initial interviews and pre-IA engagement with industry on both raising the top and lowering the bottom of the WN range suggested that there would be no signiﬁcant costs or beneﬁts in relation to domestic customers (any reduction in wholesale gas prices, and thereby how much domestic consumers pay, due to cost savings elsewhere in the process, is discussed in section 0).
4. However, survey responses from domestic equipment manufacturers indicated the potential for significant costs from raising both the top and bottom of the WN range. These were anticipated for equipment warranty (such as increased call outs related to poor performance or failures due to over-firing), insurance cost increases, maintenance, carbon monoxide (CO) monitoring, replacement, and efficiency. However, no quantified costs were estimated in responses to the survey.
5. Further qualitative costs described in the survey include increased field engineer time during commissioning and maintenance of appliances. This is because the WN at a local level will be unknown. Manufacturers anticipate a need for portable WN measurement for onsite use, so gas engineers can correctly setup an appliance, where required. If WN gas quality changes result in an increase in CO2 outside of tolerance, increased training of field engineers and call handlers could be needed to be reviewed to match call volume.
6. Concerns were also raised over domestic hot water performance. It was speculated that appliances receiving lower WN gas would lower water temperatures up to 10%, but no evidence has been provided for this. HSE experts acknowledge this problem and anticipate that this could be overcome by using more gas to reach current temperatures.

#### D.7.1.1. Number of households connected to the gas grid in GB

1. BEIS estimate that there are around 24 million households connected to the gas grid out of a total of 28 million households in 2019/20. This gives around 14% of households not connected to the gird.[[20]](#footnote-21)
2. Owner-occupiers have no legal duty to maintain their home gas equipment in good order. We would anticipate that owner-occupiers would have limited awareness of the proposed Wobbe changes or what the implications could be for their equipment, if any. In addition, many may struggle to meet any necessary costs: perhaps a third of households would be unable to afford a new boiler.[[21]](#footnote-22)
3. For rented accommodation, landlords (whether social or private) will have duties under the Gas (Safety) Installation and Use Regulations 1998 (GSIUR) to ensure gas equipment is safe and annually checked. The Department for Levelling Up, Housing and Communities estimate that in England in 2020 approximately 4.8 million households were privately rented; around 2.5 million rented from Housing Associations; and around 1.6 million rented from Local Authorities.[[22]](#footnote-23)
4. Around half of domestic boilers are under warranty.[[23]](#footnote-24) We would anticipate that the manufacturers that hold these warranties would have an awareness of the Wobbe changes and the need for changes to appliances (if any). However, it is unclear from manufacturer interviews undertaken for this IA whether such changes (if any were required) would be covered by existing warranties.

##### **D.7.1.2. Number of potentially affected domestic appliances in GB**

1. The Oban study found that each household had on average two gas appliances; this is in agreement with the BERIAIA. Assuming that Oban is broadly representative of the GB domestic and commercial gas-user population (which is what SGN and DNV GL, the Oban report’s authors, estimate), this would imply that there are around 49 million GB domestic gas appliances connected to the grid.
2. The Oban study also provided figures on the distribution of appliance types surveyed. Applying these to the approximate 49 million GB domestic appliances gives the distribution shown in Table 10.

Table 10: Oban study-derived estimates of domestic appliances by appliance type

|  |  |  |
| --- | --- | --- |
| **Domestic appliance type** | **Oban percentages** | **Implied GB population** |
| Central heating boilers | 47% | 23,000,000 |
| Space heating | 17% | 8,400,000 |
| Domestic cooking | 30% | 15,000,000 |
| Other | 5% | 2,400,000 |
| Water heating | 1% | 390,000 |
| **Total** | **100%** | **49,000,000** |

**Note:** figures rounded to two sig. fig., so may appear not to sum

1. Further studies provide estimates to challenge and triangulate these estimates – particularly central heating boilers and domestic cooking, which in Oban accounted for around 77% of appliances:
   1. For **boilers**, the 2018-19 MHCLG English Housing Survey[[24]](#footnote-25) found that around 85% of dwellings in England have gas central heating. Applying this to GB households gives around 24 million gas boilers
   2. For **domestic cooking**, the 2011 DECC (as was) Energy Follow-Up Survey[[25]](#footnote-26) found that around 61% of households in England have a gas hob. Applying this to GB households gives around 17 million as domestic cooking appliances[[26]](#footnote-27)
2. Adding these additional estimates in to provide ranges for boilers and domestic cooking gives the figures in Table 11, which will be used in this analysis: a total of between around 49 million and 52 million, with a central estimate of around 51 million.

Table 11: Estimates of GB domestic gas appliances

|  |  |  |  |
| --- | --- | --- | --- |
| **Domestic appliance type** | **Low** | **Central estimate** | **High** |
| Central heating boilers | 23,000,000 | 23,000,000 | 24,000,000 |
| Space heating | 8,400,000 | 8,400,000 | 8,400,000 |
| Domestic cooking | 15,000,000 | 16,000,000 | 17,000,000 |
| Other | 2,400,000 | 2,400,000 | 2,400,000 |
| Water heating | 390,000 | 390,000 | 390,000 |
| **Total** | **49,000,000** | **51,000,000** | **52,000,000** |

**Note:** figures rounded to two sig. fig., so may appear not to sum

##### **D.7.1.3. Potential costs**

1. As part of initial research with appliance manufacturers and testers exploring both raising the top and lowering the bottom of the WN range, we learned that stakeholders expected a number of potential impacts for domestic users.
2. Where domestic appliances are older (say, older than fifteen years) or not properly maintained and serviced, some stakeholders reported that a small proportion would need to be replaced due to safety concerns. The SGN Oban study found that around 2% of appliances were ‘immediately dangerous’; and another 4% ‘at risk’ of becoming so. HSE understand from the SGN research that these appliances posed a risk before any change in the WN range was applied (and so needed to be replaced or made safe anyway.
3. Although we do not anticipate these costs to be borne under Option 2, as part of options development we sought estimates of replacement costs from the previous BIAR IA, input from key stakeholders and from published BEIS analysis.[[27]](#footnote-28) Estimates of replacement costs are summarised below in Table 12 in 2020 prices. Stakeholders also estimated that the time required to replace a boiler would be around a full working day.

Table 12: Estimated replacement costs for domestic appliances

|  |  |  |  |
| --- | --- | --- | --- |
| **Domestic appliance type** | **Low** | **Central estimate** | **High** |
| Central heating boilers | £2,100 | £3,000 | £4,000 |
| Space heating | £420 | £420 | £420 |
| Domestic cooking | £380 | £380 | £380 |
| Other\* | £380 | £400 | £420 |
| Water heating | £350 | £400 | £450 |

**Note:** figures rounded to two sig. fig. \*The cost for ‘other’ appliances is found by averaging the costs of identified appliances, excluding boilers, which risk skewing the estimate

1. Some stakeholders also discussed the possibility of modifying or adjusting domestic appliances to cope with a widening of the Wobbe range at both the top and bottom. Having considered the policy options, HSE does not believe that field adjustment of domestic appliances would be a safe or suitable approach.
2. An appliance tester that we interviewed thought that the majority of any issues could be resolved through servicing. Interview estimates indicate that a thorough boiler servicing might cost between around £150 and £170. Benchmark[[28]](#footnote-29) estimate that around 56% of households have their boiler serviced every year.
3. Appliance manufacturers also discussed the possibility that widening the range at both the top and the bottom could lead to a reduction in the life expectancy of appliances, leading to them being replaced earlier than they otherwise would. We understand from interviews with manufacturers and reviews of our estimates by key stakeholders that the life expectancy of a domestic appliance might be around twelve to fifteen years if properly maintained (although many appliances will be replaced earlier than that due to home remodelling, for example). Estimates from manufacturer interviews indicates that widening the WN range at both the top and the bottom might reduce this by around 10% to 15%, although there is great uncertainty around this.
4. Manufacturers also estimated that widening the WN range at the top and the bottom could lead to increased time to set up and install new appliances as the prevailing local gas quality would need to be assessed. HSE experts question whether this would be the case as combustion analysis would already be carried out and it is not apparent what further effective testing could be done; in any case, domestic appliances will be factory-set.
5. Lastly, some manufacturers expected that changes to the WN range could lead to an increase in households calling out engineers where they notice domestic appliances operating differently and are concerned. However, other manufacturers did not expect increased call-outs. We will explore during consultation whether it is likely that additional call-outs could be necessary; and who would pay for them in cases where appliances are under warranty.

##### **D.7.2. Estimated costs under Option 2**

1. Reviewing this evidence in light of the proposal of Option 2 to lower only the bottom of the WN range and keep the top of the WN unchanged, HSE experts assess that no replacement or extraordinary servicing of domestic appliances should be necessary; nor should appliances suffer a reduced life expectancy. While burning higher WN gas might adversely affect the safety performance or wear of domestic appliances, burning lower WN gas should not.
2. In addition, HSE experts do not anticipate that additional set-up and installation time will be required under Option 2.
3. We will seek further comment on this assessment of zero cost to domestic users under Option 2 as part of consultation.
4. **D.8. Commercial end-users**

#### D.8.1. Background on commercial users

1. Commercial end-users are much like domestic appliance users with appliances that are used for space-heating, water-heating or cooking, but on a larger scale. Stakeholders in this group include hospitals, hotels, conference centre, leisure centres, schools, retail, and offices.
2. They are a numerous and varied stakeholder group, including, as measured by property value in 2016: [[29]](#footnote-30)
   1. Retail, including shopping centres, retail warehouses, supermarkets and others: £337 billion
   2. Offices: £273 billion
   3. Hotels: £32 billion
   4. Leisure: £17 billion
   5. Other: £30 billion
3. Engaging with these stakeholders directly was not expected to be productive as they do not manage the technical specification and operability of gas appliances. Initial interviews met with few respondents who had knowledge of the implications of the WN change on commercial gas appliances. Only two respondents – a trade association and energy producer – had substantive feedback; they did not believe that available safety evidence around widening both the top and bottom of the WN range was sufficient as it did not involve appropriate equipment tests.
4. Contradicting views on the impact of lowering the bottom of the WN range on water-heating were raised where one respondent thought large boilers would be unable to heat water for surge use in hotel settings. Another respondent thought the impact on hot water heat was negligible and would result in a 0.6°C decrease in water temperatures.
5. Insurance coverage was raised as a potential issue but there was little detail or evidence provided for this view.
6. Evidence from the survey came from three equipment manufactures. Commercial sector sentiments indicated that respondents either did not know what the impacts of widening both the top and bottom of the WN range would be; or expected them to be negative.
7. Survey responses somewhat agreed with the initial interviews in that they either were unsure or did not agree that equipment or control and monitoring equipment would be able to manage the variability or fluctuations proposed by widening both the top and bottom of the WN range. There was strong agreement that additional safety evidence was needed to determine the impacts and the safety of the WN change. All three detailed survey responses called for testing. Tests would need to assess the limits of the WN range and the rate of change. Respondents thought that all equipment would need to be re-tested and recertified for the new range; as well as replacement, increased maintenance, and emissions tests.
8. Field testing of older equipment will require the deployment of handheld WN devices. One of the respondents saw older and existing equipment as the biggest challenge of the proposed WN change; but all three of the detailed survey responses indicated that existing equipment would be a challenge to assess.
9. Respondents thought control systems were not effective for managing the effects of widening both the top and bottom of the WN range. Most equipment lacks control systems as they are considered too expensive. Of those that are used, electronic control systems designed for safety and efficiency would be most detrimentally affected. Deployment of new control systems would be limited to newly designed equipment and retrofitting might not be possible.
10. Monitoring systems to measure gas quality changes are not typically used on this type of gas equipment, but new equipment could deploy them. One respondent was uncertain if existing equipment could be upgraded with monitoring equipment. The unit cost of monitoring equipment was put at £500-£2000 by one respondent.
11. Efficiency impacts were raised by the one respondent, who answered that they thought the efficiency impact of widening the WN range at both the top and the bottom could be negative or positive depending on the overall average gas quality changes (i.e., higher or lower Wobbe gas on average).

#### D.8.2. Quantified cost estimates for commercial users

##### **D.8.2.1. Number of pieces of commercial gas equipment in GB**

1. The 2020 Hy4Heat WP5[[30]](#footnote-31) report estimated the number of pieces of commercial gas equipment using a combination of sales data, FOI requests and gas consumption data. The Hy4Heat estimates are made for the UK, so this analysis has adjusted them for GB using regional GDP estimates.[[31]](#footnote-32) These number between around 1.1 million and 1.9 million, with a central estimate of around 1.5 million as summarised in Table 13.
2. As with domestic users, we would not expect universal understanding among commercial gas users of the WN range or of the effects of changes to gas quality; evidence gathered through research conducted thus far appears to bear this out. However, certain commercial users might be more likely to be aware of the WN through the sensitivity of their work to changes in gas quality, for instance.
3. Unlike domestic end-users (see paragraphs 127 to 128), commercial end-users do have a regulatory duty under GSIUR to ensure that their gas equipment is safe. However, they do not have a specific prescriptive duty to perform annual checks, as domestic landlords do.

Table 13: Estimates of commercial gas appliances in GB

|  |  |  |  |
| --- | --- | --- | --- |
| **Appliance type** | **Low** | **Central estimate** | **High** |
| Boilers (pre-mix) | 390,000 | 480,000 | 540,000 |
| Boilers (package) | 9,100 | 11,000 | 12,000 |
| Air heaters | 180,000 | 290,000 | 350,000 |
| Radiant heaters | 120,000 | 230,000 | 290,000 |
| Water heaters | 160,000 | 200,000 | 220,000 |
| Tumble dryers | 49,000 | 65,000 | 78,000 |
| Ovens (combination) | 2,000 | 3,900 | 5,900 |
| Ovens (bakery deck/ rack) | 5,900 | 9,800 | 16,000 |
| Ovens (pizza and convection) | 2,000 | 2,900 | 4,900 |
| Ovens (steam) | 3,900 | 5,900 | 9,800 |
| Ranges | 41,000 | 68,000 | 110,000 |
| Hobs | 6,800 | 12,000 | 19,000 |
| Grills | 18,000 | 29,000 | 47,000 |
| Chargrills and griddles | 21,000 | 34,000 | 55,000 |
| Fryers | 29,000 | 49,000 | 78,000 |
| Boiling units and bratt pans[[32]](#footnote-33) | 5,900 | 9,800 | 16,000 |
| Others (kebab, rotisserie, tandoor) | 12,000 | 20,000 | 31,000 |
| **Total** | **1,100,000** | **1,500,000** | **1,900,000** |

**Note:** figures rounded to two sig. fig., so may appear not to sum.

##### **D.8.3. Potential costs**

1. As part of initial research with appliance manufacturers and testers exploring both raising the top and lowering the bottom of the WN range, we learned that stakeholders expected a number of potential impacts for commercial users.
2. As with domestic gas appliances, older or not properly maintained commercial gas equipment might require replacement due to safety concerns. The SGN Oban study, which looked at both domestic and small commercial appliances, estimated that around 2% of appliances were ‘immediately dangerous’; and another 4% ‘at risk’ of becoming so. HSE understand from the SGN research that these appliances posed a risk before any change in the WN range was applied (and so needed to be replaced or made safe anyway).
3. The Hy4Heat report estimates the costs of appliance replacement, weighted by appliance capacity. These estimates are summarised below in Table 14.

Table 14: Estimated replacement costs for commercial gas equipment

|  |  |
| --- | --- |
| **Commercial appliance type** | **Replacement cost (£)** |
|
| Boilers (pre-mix) | £15,000 |
| Boilers (package) | £72,000 |
| Air heaters | £14,000 |
| Radiant heaters | £7,700 |
| Water heaters | £18,000 |
| Tumble dryers | £44,000 |
| Ovens (combination) | £38,000 |
| Ovens (bakery deck/ rack) | £96,000 |
| Ovens (pizza and convection) | £14,000 |
| Ovens (steam) | £12,000 |
| Ranges | £19,000 |
| Hobs | £8,700 |
| Grills | £11,000 |
| Chargrills and griddles | £9,500 |
| Fryers | £12,000 |
| Boiling units and bratt pans | £7,600 |
| Others (kebab, rotisserie, tandoor) | £11,000 |

**Note:** figures rounded to two sig. fig.

1. Unlike domestic appliances, commercial appliances are more regularly subject to field adjustment of their burners during set-up or as part of servicing. Interview respondents thought that such adjustments might be an appropriate measure to adapt commercial appliances if the WN range were widened at both the top and the bottom. Research participants were unable to give any cost estimates for such modification. However, the Hy4Heat report makes estimates for the modification of in situ commercial equipment for hydrogen. HSE put these to key stakeholders to ask what proportion of the hydrogen cost might reasonably represent a rough cost for adjustment for a wider WN range at both the top and bottom. While an imperfect method and estimate, we hope that this provides an initial benchmark for further refinement through consultation, if necessary. Key stakeholders reported that HSE’s initial suggestion of 50% of the hydrogen conversion cost was too high and that a more appropriate figure would be around 10%, given that adjustment for a wider WN range was expected to be significantly simpler than hydrogen conversion. These estimates based on 10% of the hydrogen conversion cost are summarised below in Table 15.

Table 15: Estimated wider WN adjustment costs for commercial equipment

|  |  |  |  |
| --- | --- | --- | --- |
| **Commercial appliance type** | **Estimated modification cost** | | |
| **Low** | **Central estimate** | **High** |
| Boilers (pre-mix) | £330 | £490 | £820 |
| Boilers (package) | £340 | £510 | £900 |
| Air heaters | £330 | £480 | £680 |
| Radiant heaters | £290 | £360 | £450 |
| Water heaters | £380 | £730 | £1,400 |
| Tumble dryers | £330 | £500 | £1,100 |
| Ovens (combination) | £330 | £490 | £780 |
| Ovens (bakery deck/ rack) | £350 | £610 | £1,100 |
| Ovens (pizza and convection) | £280 | £330 | £410 |
| Ovens (steam) | £290 | £340 | £400 |
| Ranges | £280 | £340 | £450 |
| Hobs | £280 | £320 | £370 |
| Grills | £280 | £330 | £380 |
| Chargrills and griddles | £280 | £310 | £370 |
| Fryers | £280 | £320 | £390 |
| Boiling units and bratt pans | £280 | £310 | £360 |
| Others (kebab, rotisserie, tandoor) | £280 | £320 | £380 |

**Note:** figures rounded to two sig. fig.

1. An appliance tester that we interviewed thought that the majority of any issues could be resolved through servicing. It is not clear what proportion of commercial gas equipment is regularly serviced currently. While commercial gas users have duties under GSIUR to keep their equipment safe, they are not required to do this through prescriptive measures, such as annual servicing.
2. As with domestic appliances, commercial equipment manufacturers also discussed the possibility that widening the range at both the top and the bottom could lead to a reduction in the life expectancy of commercial equipment, leading to them being replaced earlier than they otherwise would. We understand from interviews with manufacturers and reviews of our estimates by key stakeholders that the life expectancy of a domestic appliance might be around twelve to fifteen years if properly maintained. Estimates from manufacturer interviews indicates that widening the WN range at both the top and the bottom might reduce this by around 10% to 15%, although there is great uncertainty around this.
3. Lastly, manufacturers also estimated that widening the WN range at the top and the bottom could lead to increased time to set up and install new commercial appliances as the prevailing local gas quality would need to be assessed. HSE experts question whether this would be the case as combustion analysis would already be carried out and it is not apparent what further effective testing could be carried out.

##### **D.8.3.1. Estimated costs under Option 2**

1. Reviewing this evidence in light of the proposal of Option 2 to lower only the bottom of the WN range and keep the top of the WN unchanged, HSE expect that no replacement, adjustment or extraordinary servicing of commercial equipment should be necessary; nor should equipment suffer a reduced life expectancy. While burning higher WN gas might adversely affect the safety, performance or wear of domestic appliances, burning lower WN gas should not.
2. In addition, HSE experts do not anticipate that additional set-up and installation time will be required under Option 2.
3. We will seek further comment on this assessment of zero cost to commercial users under Option 2 as part of consultation.

### D.9. Industrial end-users

#### D.9.1. Background on industrial users

1. Industrial end-users are those organisations and businesses that do not use gas to heat water or use gas for conventional cooking; rather they use gas in a more directed way (e.g. glassmaking) or as a constituent of a chemical process (e.g. producing hydrogen).
2. Industry groups include chemicals, pharmaceuticals, paper, iron & steel, glass manufacturers, petrochemical plants, non-ferrous metals, mineral production, mechanical engineering, electrical engineering, vehicles production, textiles, paper, and construction.
3. Views from the industrial interviews indicated an expectation that the gas systems should mostly be able to manage a widening of the WN range at the top and bottom, but that some systems would require upgrading. Comments from stakeholders suggest that a wider WN range of gas would increase both variability and ﬂuctuations, but this increase can largely be managed within the parameters of: a) existing equipment (e.g. burners); and b) existing systems (e.g. control and monitoring systems).
4. Some interview responses indicated that upgrading could be done with new equipment or simply retuning to manage a new WN range; the WN range was not perceived as an issue since the current emergency WN range is occasionally exceeded without incident.
5. However, other interview responses expressed some uncertainty around how these systems would be impacted by a wider WN range at the top and bottom as industry users are unfamiliar with the quality of the gas they receive, and they will need to learn about the supply to implement interventions. Familiarisation costs will need to be considered.
6. Engineer equipment tuning may not be effective after only a single visit and equipment could require several visits to run effectively. During this tuning process, heat and NOx emissions would be expected to be issues. Heat changes could break equipment and result in unplanned shutdowns and replacement. Respondents expect automatic shutdowns with engineers needing to be called out to diagnose equipment and effect repairs. A concern that was raised was a perceived lack of handheld WN devices to assist with trouble shooting and tuning equipment. Follow up research has demonstrated that these devices do exist.
7. Some stakeholders thought they would need to complete additional monitoring to manage wider swings in gas quality if the WN range were widened at the top and bottom. New control systems should be able to manage the WN range; the challenge would be managing rapid quality changes over the course of the day. Challenges in managing rapid gas quality changes might result in operators fitting new controls and monitoring equipment. The greater the variability the more likely monitoring and control systems would be required.
8. Rapid changes in gas quality are known as ‘slugging’ and results in additional wear and tear; and equipment shutdowns in extreme cases. Due to diﬀering sources of gas entering the network, there is already a certain amount of variability and ﬂuctuation in gas quality coming ‘out of the pipe’ to end-users. According to evidence from IGEM, “*Current variations and rates of change in gas quality are already much greater than is widely recognised by many users*”.[[33]](#footnote-34) This is mitigated via the use of monitoring equipment (which automatically monitors the quality of gas) and control systems (which make the necessary changes to equipment settings to maintain performance), often with both working in tandem.
9. Emissions changes around oxygen trim and NOx were flagged; one respondent was uncertain how CO levels would be affected. There is a tight range for pollution and large burners must comply with emissions and efficiency legislation. It is possible that new emissions abatement equipment could be needed to manage the proposed change.
10. Industrial gas processes that are extremely sensitive to gas quality, such as glassmaking, already exercise high levels of control over their gas quality. These industrial users should experience limited impacts from the WN change. Equipment used includes gas chromatography for monitoring quality changes in real time; and active and passive control systems. Other sensitive industries could be those who use gas as a chemical feedstock – a members association suggest that this is small group which could incur a cost of £1 million to adjust.
11. OEM insurance impacts were mentioned as an area of concern but again there was little detail in the interviews describing potential costs.
12. We received only a handful of responses to our survey from industrial users. The one detailed response from a paper and paperboard manufacturer expected that the overall impact of widening the WN range at the top and bottom would be negative. This end-user operates a combed heat power (CHP) facility for electricity and heating. They expected cost increases for monitoring gas quality through gas chromatography at £15,000. Otherwise, the respondent thought the WN change would be manageable with current equipment.
13. Industry sector sentiment on the overall impact of widening the WN range at both the top and bottom indicates a split between those who believe the impact will be negative; and those who think there will be no impact. However, three of the respondents who said there would be ‘no impact’ went on to describe potential negative impacts for other gas users or for wider society, including safety concerns and a reduction in public faith in the gas industry.
14. An appliance manufacture association believed that equipment impacts are unknown, so safety is a “grave” concern for existing and new equipment. They thought that thorough testing of range (variability) and fluctuation is needed for existing equipment and believed that no costs can be estimated without testing.
15. The association also expects challenges in that gas quality monitoring equipment is not widely used and existing control systems are not suitable for WN gas quality change. Some equipment could be upgraded while others will need to be replaced, but testing would be required to determine this. To complete maintenance on gas equipment, engineers would need additional training and deployment of handheld WN devices which are not currently used.
16. For the other equipment manufacturers, there is uncertainty about the impacts. Research into the impacts of widening the WN range at the top and bottom on one respondent’s equipment is expected to cost £250,000. This research will assess appliances at the proposed extremes of WN range to determine the extent of efficiency, NOx emissions, heat exchanger temperatures, thermostat compliance, and ensure safe combustion. The other manufacturer expressed concerns about equipment safety and performance, but does not state any specific cost.
17. Comparing the evidence from the initial interviews and the survey, there are somewhat contradicting responses as to the extent of the impact of widening the top and bottom of the WN range and the extent to which existing systems can cope with the changes. Many of the costs that were identified in the interviews are repeated in the survey responses, but the latter suggest a large impact where interviews suggest a smaller one..

#### D.9.2. Quantified cost estimates for industrial users

##### **D.9.2.1. Number of pieces of industrial gas equipment in GB**

1. The 2020 Hy4Heat WP6[[34]](#footnote-35) report estimated the number of pieces of industrial gas equipment. The Hy4Heat estimates comprise only those pieces of equipment with thermal capacity greater than 1 MW, to avoid overlap with smaller pieces of equipment captured under the ‘Commercial’ heading; and that is connected to the <7 bar network, which Hy4Heat estimate captures around 70% of gas use in the industrial sector. As a rough correction for the 7+ bar network, the numbers of pieces of industrial gas equipment below have been uprated by 1/0.7 to make up the gap – this probably has the effect of overestimating the total as the missing equipment on the 7+ bar network is likely to use more gas per piece of equipment than on the <7 bar network. We will seek to refine these estimates through consultation. As summarised in Table 16, we estimate there to be around 5,900 pieces of equipment.

Table 16: Estimates of industrial gas equipment in GB

|  |  |
| --- | --- |
| **Appliance type** | **Best estimate** |
| Steam boilers | 2,000 |
| Ovens | 1,000 |
| Boilers (hot water) | 860 |
| Direct dryers | 860 |
| Furnaces (other) | 430 |
| Other | 390 |
| Kilns (ceramics) | 230 |
| Furnaces (metal melting) | 86 |
| Furnaces (glass) | 57 |
| Kilns (lime) | 21 |
| Kilns (other) | 14 |
| **Total** | **5,900** |

**Note:** figures rounded to two sig. fig., so may appear not to sum.

1. Also according to the Hy4Heat report, these pieces of industrial equipment are found across the following sectors in Table 17.

Table 17: Industrial gas use in TWh/year (2019)

|  |  |
| --- | --- |
| **Appliance type** | **TWh/year** |
| Food and drink | 15 |
| Chemicals | 11 |
| Electrical and mechanical engineering | 8 |
| Basic metals | 6 |
| Ceramics | 4 |
| Glass | 4 |
| Paper | 4 |
| Vehicle manufacture | 4 |
| Other non-metallic minerals | 3 |
| Lime | 1 |
| Refining | - |
| Other | 5 |
| **Total** | **65** |

##### **D.9.2.2. Potential costs**

1. The proportion of industrial gas equipment that could require modification is unclear, if any. Research with users indicates that certain industrial processes (such as ceramics and glass) are more sensitive to changes in the Wobbe range (e.g., changes in operating temperature) than others (such as cement manufacture). However, we would also anticipate that the more sensitive processes would already have control in place to protect them from current WN variability.
2. We have not been able to ascertain estimates with users or manufacturers of the proportions of industrial equipment that might require modification for the Wobbe range; or how much this could cost.
3. We will seek to gather further evidence on the proportions requiring modification during consultation.

#### D.9.3. Priorities for further analysis for industrial gas users

1. During consultation, further analysis will be sought to fill evidence gaps and provide quantifiable costs and benefits, where possible and proportionate to do so. These gaps are summarised in Table 18.

**Table 18: Priorities for further research with industrial gas users**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Impact area** | **Cost or saving/ benefit?** | **Expected magnitude** | **Proposed further research** | **See paragraph…** |
| Retuning of equipment | Cost | Unknown | Engagement with manufacturers | 174 |
| Cost of equipment shutdowns | Cost | Unknown | Engagement with manufacturers; estimation of output values | 174 |
| Increased maintenance and repair | Cost | Unknown | Engagement with manufacturers | 174 |
| Increased monitoring of gas quality | Cost | Unknown | Engagement with manufacturers | 175 |
| Emissions abatement | Cost | Unknown | Engagement with manufacturers and industrial users | 177 |
| Equipment insurance and warranties | Cost | Unknown | Engagement with manufacturers and industrial users | 179 |
| User testing of existing equipment | Cost | Unknown | Engagement with manufacturers | 182 |
| Replacement of equipment | Cost | Unknown | Engagement with manufacturers | 183 |

### D.10. Wider gas market impacts and emissions

1. For the final stage IA, we will attempt to make an assessment of the effects the lowering of the bottom end of the WN range could have on overall gas supply, import dependency, wholesale prices, consumer prices and emissions, where possible. This will be based on:
   1. Estimates of increased supplies of gas due to changes at the lower bound of the WN range from the HSE survey (see paragraph 58)
   2. Estimates of further gas reserves that could be made economical beyond the lower WN bound (see paragraphs 61 to 62)
   3. Any further evidence produced through consultation
2. In such analysis, we would assume that the supply of gas onto the NTS will still balance with demand, which we assume to be finite and unaltered by the options proposed. We believe this is appropriate as the gas pipeline infrastructure has to maintain specified operational tolerances around pressure in the system. Therefore, our modelling assumes that any increases in supply from a source such as the UKCS will be offset by reduced supply through pipeline interconnectors to mainland Europe or from reduced imports of liquified natural gas (LNG).
3. We do not possess evidence to verify which sources of supply will be displaced in the UK supply mix as a result of increases from an alternative source, such as the UKCS, for example. Therefore, we are only able to quantify the impact on UKCS and not on which sources of gas would be displaced.
4. To assess impacts over the future, we will use the National Grid Future Energy Scenarios (NG FES) projections for UK supply mix to provide representative low-high ranges for the net benefits on the wider market across the 21-year appraisal period. We considered a variety of projections to base our ranges on, including BEIS’s UKTM model[[35]](#footnote-36) and the BEIS Energy Emissions Projections (EEP).[[36]](#footnote-37) We were unable to use UKTM projections for gas demand as they were not sufficiently disaggregated. NG FES trajectories encompass a wide range of scenarios and also enable us to analyse gas supply by source as opposed to just total supply. In conclusion, FES had the advantage of providing primary gas demand projections which were also net zero compliant across the appraisal period.

#### D.10.1 Impact on Producers

1. Any increases in the quantity of gas supplied onto the NTS will only have the effect of shifting the amount of supply from different sources. Overall demand and supply are capped by the total user demand for gas at network offtake points. This cap means that the overall supply of gas onto the NTS has to remain proportionate to demand. Therefore, any increased supply from the specific UKCS or other producers would likely displace gas on the NTS that would have otherwise been supplied from other, higher cost gas producers.
2. This makes the net effect on overall producer welfare hard to predict as the marginal producer is hard to determine in the GB supply mix. Certain UKCS producers would benefit from reduced costs for processing gas. However, this may be partly offset by relative losses faced by other producers that may supply a lower quantity of gas, or face a reduced wholesale price for the gas that they sell. On balance, it is important to highlight that the gas supplied to the UK is procured from a global market. Even if we were to believe that specific gas importers would find it harder to access the UK market because of this regulatory change then we might expect there to be plenty of other potential markets to supply to, especially in the current environment of high demand to facilitate coal-gas switching for power generation and supply tightness.

#### D.10.2. Import Dependency

1. Any increased gas flows from UKCS producers incentivised by this regulatory change could reduce GB’s dependence on gas imports, relative to the counterfactual, if gas imports are the marginal source of gas. At this stage we are unable to verify the marginal source of the gas impacted by the WN changes. However, we know from DUKES Table 4.2 that UKCS provides a steady baseload and actually increased production even in years like 2020 when we witnessed a large fall in demand for gas as the pandemic took hold. During such periods imports into the UK for gas decreased significantly, suggesting that imports tend to be the source of gas that flexes in the UK market.

#### D.10.3. Impact on Wholesale Price

1. Current estimated processing cost savings of £6.2 million per annum (see paragraph 76) would have a negligible effect on wholesale prices, even assuming that they were passed on. The effect on wholesale prices of the potential 2.6 billion therms (around 0.25 tcf) of further (see paragraph 62) reserves remains to be analysed.

#### D.10.4. Impact on Consumers

1. The degree to which lower supply costs will be ‘passed-through’ the market as lower gas retail prices depends on the degree to which any producers which benefit are marginal. Marginal producers need to pass on changes in cost, but those producers not at the margin are likely to be able to retain the cost saving. Since we do not think that the gas producers which will benefit from this change are marginal, we do not think that there will be any benefits to consumers.

#### D.10.5. Potential Impact on Emissions

1. We consider that this stimulus to flows of UKCS gas could reduce the carbon footprint of gas in the UK supply mix. The average emissions intensity of UKCS production (22kgCO2e/boe\*)[[37]](#footnote-38) is considerably lower than that of LNG (59kg/CO2/boe) and if we assume that LNG sources will be the units displaced, then the changes to the WN number will yield a considerable carbon saving.
2. However, we do not possess conclusive evidence to know that LNG will be the only source to reduce to offset the reported increases in UKCS flows onto the NTS. Pipelined Norwegian and Netherlands imports have even lower associated average CO2 emissions than UKCS production, at 17 and 19kgCO2e/boe, respectively. If these units are displaced instead then the net impact on emissions will clearly be more nuanced, with a potential for higher emissions. The impact is therefore dependent on what is the marginal source of gas.
3. Different gas sources are associated with different emissions. We do not have conclusive evidence to show what will be displaced given the uncertainty on what the marginal source of gas will be.
4. The proposed changes would be expected to reduce greenhouse gas emissions (GHGs) from energy used in gas processing and allow less GHG-intensive gases such as biomethane.

### D.11. Other changes and modernisations to GSMR

1. The proposed changes to gas quality, which will require legislative amendments to GSMR, also provide the opportunity to update and modernise GSMR at the same time. These changes will largely be consequential or drafting corrections to account for and reflect the present-day operation of the gas network. We expect that these changes will mostly mean additional administration processes for some stakeholders, but we will seek further information about potential costs or benefits during consultation.
2. These changes and modernisations are summarised below.

#### D.11.1. Continuation of a call handling service

1. Regulation 7 requires British Gas plc to provide a continuously manned telephone service for gas users to be able to report a gas escape. This regulation exists to help manage the risk to safety that arises from gas escapes by coordinating an attendance and prevention response from the relevant gas conveyor. British Gas plc are no longer the dutyholders for this service and the reporting duties that come with it.
2. The proposal is for the service to continue without a named entity in the form of a general duty on the industry to provide an emergency call-handling service. All references to British Gas p.l.c. would be removed.
3. The Emergency Call Handling Service Provider will also have a duty to include a safety case; to provide a continuously manned telephone service (which together with other gas conveyors shall be contactable within Great Britain by the use of one telephone number); for enabling persons to report an escape of gas from the network of the gas conveyor or from a gas fitting supplied with gas from that gas conveyor.
4. The Emergency Call Handling Service Provider will be required to contact the relevant gas conveyor, or their emergency service provider (where different), immediately when an emergency arises from a gas escape or suspected emission of CO. The service provider needs to prepare and maintain efficient methods of collecting and recording up-to-date information on the geographical areas covered by each gas transporter and/or emergency service provider. It will also need to establish arrangements to demonstrate that notifications are passed on promptly.
5. This service is currently provided by Cadent and we do not anticipate any change of provider and so it follows that any costs should be minimal.

#### D.11.2. Inclusion of biomethane pipelines

1. Under GSMR, this is an issue for biomethane pipelines where the requirements of the regulations and the associated guidance have led to differing interpretations.
2. A safety case should be produced by the conveyor of gas to demonstrate safe operation of the pipeline including response to gas escapes and emergencies. This is an issue for biomethane pipelines where the requirements of the regulations and the associated guidance have led to differing interpretations.
3. Inconsistencies have arisen with the application of GSMR, with some pipelines connecting the biomethane production plants considered to be on the network and some to be out of the network. This results in some pipelines operated with a safety case, and some without, which does not comply with GSMR Regulation 3(1).
4. These inconsistencies have primarily arisen due to whether or not the operator of the pipeline has an existing safety case. Where the operator has an existing safety case (typically the downstream network operator) the new pipeline has become an extension of their network and incorporated into an existing safety case. In other cases, the new pipeline operator is standalone from the downstream system it connects in to and has no safety case.
5. The policy intention is to ensure that all parts of the network which are conveying gas periodically have a safety case in place which is helping to manage risk.
6. This would be a new duty on the operators of biomethane sites that do not have a safety case already in place and would mean an additional administrative cost to such operators of having to prepare and compile a safety case. We have not estimated these costs as part of the consultation stage IA, but will engage with dutyholders to do so for the final stage.

#### D.11.3. The proposal is for the inclusion of clear co-operation duties for operators of liquefied natural gas (LNG) import facilities

1. GSMR Regulation 6 places duties on several parties to co-operate with gas conveyors and the network emergency co-ordinator (NEC) to allow them to comply with their responsibilities under the regulations. Gas conveyors transport gas on behalf of shippers and suppliers and have duties to ensure that safe pressures are maintained in the network. They rely on other parties using the network to co-operate with them in discharging this duty.
2. The NEC co-ordinates the actions of the gas conveyors and these other parties if there is a widespread gas supply emergency. Currently, the co-operation duty covers gas production facilities, onshore processing terminals, and gas storage facilities but may not cover LNG import facilities (the legal view provided to HSE is that the current definition of a ‘gas production facility’ and a ‘gas processing facility’ cannot be applied to an LNG facility). It is important for the NEC to be able to ensure the co-operation of LNG terminals.
3. In practice coordination already happens due to shared understanding and mutual interest, but whilst there is an opportunity to amend GSMR, it is sensible to ensure that the co-operation duties apply to LNG import facilities. This will be done by either creating a new definition applicable to an LNG site, or amending existing definitions.
4. Again, costs or benefits have not been established but are expected to be minimal if any at all.

### D.12. Familiarisation costs

1. Evidence from the interviews and the survey indicate that, as well as the normal familiarisation with regulatory change that we would expect dutyholders to undertake, many might also have to take efforts to become familiar with the issue of gas quality itself and what it will mean for their business. We have not been able to estimate this for the consultation stage IA, but will explore what familiarisation would be required and what efforts it would take during consultation.

### D.13. Enforcement costs

1. Enforcement of the new Regulations would form part of HSE’s normal inspection work and reactive investigations. There would be no extra costs or additional time spent inspecting as a result of these new Regulations.

### Summary of potential costs and benefits

1. This consultation stage IA has achieved a partial estimation of the costs and benefits of Option 2, but gaps remain to be resolved in the final stage IA. In terms of further costs, these are expected to include costs to industrial users, the gas distribution system and the costs of familiarisation or all dutyholders. In terms of further benefits, the value of additional extractable gas reserves and potential for saved emissions will be explored in the final IA. All of these missing impacts could be significant and have the potential to shift the net position of the NPV.
2. As summarised in Table 19, total estimated present value costs are between around £61 million and £340 million, with a central estimate of around £130 million.
3. Estimated benefits total a present value of between around £56 million and £72 million with a central estimate of around £65 million.
4. This gives an **estimated net present benefit** of between around -£280 million and £11 million, with a **central estimate of around -£61 million**.
5. As discussed above, further steps will be taken to fill the gaps in our estimation; and to refine the estimates we do have during consultation.

Table 19: Summary of estimated costs and benefits of Option 2 (present values over twenty-one years, in 2021 prices)

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Low** | **Central estimate** | **High** |
| **Costs** |  |  |  |
| Gas producers |  |  |  |
| Determining change | £110,000 | £210,000 | £300,000 |
|  |  |  |  |
| NTS, GDNs IGTs |  |  |  |
| Determining change | £850,000 | £1,700,000 | £2,600,000 |
| Other costs | Unquantified | Unquantified | Unquantified |
|  |  |  |  |
| Power generators |  |  |  |
| Modification | £17,000,000 | £22,000,000 | £34,000,000 |
| Maintenance | £43,000,000 | £100,000,000 | £300,000,000 |
|  |  |  |  |
| Industrial end-users |  |  |  |
| Adaptation or replacement of equipment | Unquantified | Unquantified | Unquantified |
|  |  |  |  |
| Familiarisation | Unquantified | Unquantified | Unquantified |
| **Total costs** | **£61,000,000** | **£130,000,000** | **£340,000,000** |
|  |  |  |  |
| **Benefits** |  |  |  |
| Gas producers |  |  |  |
| Gas processing | £56,000,000 | £65,000,000 | £72,000,000 |
| Value of further extractable gas reserves | Unquantified | Unquantified | Unquantified |
|  |  |  |  |
| Wider impacts |  |  |  |
| Emissions | Unquantified | Unquantified | Unquantified |
| **Total benefits** | **£56,000,000** | **£65,000,000** | **£72,000,000** |
|  |  |  |  |
| **Net benefits** | **-£280,000,000** | **-£61,000,000** | **£11,000,000** |

**Note:** figures rounded to two sig. fig., so may appear not to sum.

## Impact on small and micro businesses

1. These Regulations govern the safety and management of gas inserted into GB networks. It would present serious physical and economic risk to allow businesses exemption from these requirements on the basis of anything other than risk. As such, no exemption for small or micro businesses is being considered.
2. Small and micro businesses are generally not dutyholders under these regulations and so would not be in scope for exemption from these requirements. There may be some biogas producers that would qualify as small or micro business and these producers would be dutyholders. However, the conveyance of gas is a major hazard regime. Physical hazards arising from the activity that these regulations apply to include the risk of exposure to harm, danger and death arising from hazards such as explosion and carbon monoxide poisoning, including to members of the public and to people in their homes. Given the level of harm that can occur, it is proportionate that all safety measures apply across the breadth of activity involved and that exemptions would increase risk. Businesses are also typically areas and locations in which people convene, and therefore are sites in which the potential for harm is greater than other centres of lower population density such as private dwellings.
3. The economic costs of major accidents occurring in gas pipelines or explosions at people’s homes can be substantial, including loss of life, injury, property damage, evacuation, shelter and emergency service response. For business, damage to equipment and premises or disruption to supply chains caused by major accidents can have substantial costs both locally and as a knock-on through the wider economy. Research by HSE*[[38]](#footnote-39)* into the costs of major accidents at onshore major hazard sites (which are not the same as pipelines, but which can provide illustrative examples) gives costs in the tens and hundreds of £millions.
4. We expect that the majority of impacts quantified thus far will fall to large businesses – natural gas producers and operators of gas-fuelled turbines. Further costs and benefits to be estimated in the final stage impact assessment could impact more on some small and micro businesses, such as industrial gas users. The final stage impact assessment will consider the impact of the changes on small and micro businesses in particular; and will attempt to estimate if they incur any disproportionate impacts, but this may not be possible to quantify in all cases.

## Rationale and evidence to justify the level of analysis used in the IA (proportionality approach)

1. This impact assessment is one that justifies a high level of effort: it has potentially large impacts; the balance between costs and benefits is initially unclear with trade-offs between different groups; and the impacts span several areas and groups of stakeholders, including gas producers, domestic users, market trends and GHGs.
2. We have undertaken extensive evidence gathering from several sources, as set out in summary of research/ consultation section. As a result, we have a strong qualitative understanding of impact in many areas, but gaps remain in our understanding, leaving us with only a partial estimate in this consultation stage IA.
3. To address these challenges, further research will take place focusing on equipment manufacturers and key dutyholders, who are expected to have a clear understanding of impacts of a wider WN range; and potentially experience of working with a wider WN range in other countries, particularly in Europe.

## Risks and assumptions

1. A key assumption in the analysis is that if the permissible WN range were widened, additional gas outside of the current range would be inserted into the network. While there is no requirement in the regulations that this must occur, the weight of evidence and the economic incentives would appear to make it likely. In the event that such wider-WN gas supplies are not inserted into the network, certain impacts around equipment efficiency and maintenance or the wider market impacts would not occur. However, we would anticipate that dutyholders would still make preparatory adjustments.
2. A further assumption is that the technology and expertise exist to facilitate and support the changes stakeholders would have to make to operate equipment with a wider WN range. This is a reasonable assumption as several European countries have wider WN ranges than GB and have technological solutions.
3. Baseline changes in the gas market will also have an effect on the extent of compliance costs resulting from any changes to the WN range. Any baseline increases or decreases in gas demand would affect the extent of costs over the appraisal period. In addition, any expected baseline increases in variability or gas supplied within the existing WN range could itself necessitate investment in new equipment or enhanced monitoring and control irrespective of the proposed changes to GSMR. We have attempted to account for long-term gas use changes using the Future Energy Scenarios estimates (see paragraph 52), but have not been able in this consultation stage IA to account for other, shorter-term variability. We will explore if this is possible in the final stage IA.

## Monitoring and Evaluation

1. These regulations have served public safety and the industry well since they were introduced in 1996. Gas transmission and distribution is critical to the nation’s energy consumption and thankfully few serious incidents have occurred when compared to the millions of transactions taking place every day.
2. Gas supply has remained stable and reliable and GB has never experienced a gas supply emergency. This has enabled millions of people to heat their homes and cook their food, and for business to operate their goods and services. Gas consumption plays a major part in power-generation too, providing electricity supply through gas turbines.
3. Official statistics[[39]](#footnote-40) relating to domestic gas safety indicate that piped natural gas can be regarded as a very safe fuel. Fatalities attributed to domestic gas are very low, and reported incidents have reduced significantly over the 25 years the current regulatory regime has been operating. The approach to gas escapes has been successful and the national gas emergency telephone number provides an appropriate forum for the general public to report incidents.
4. The regulations have enabled the North Sea oil and gas industry to flourish, placing itself at the heart of the UK’s energy and industrial strategy and has also enabled new sources of gas to come to market, such as biomethane and Liquified Natural Gas, diversifying our energy mix and providing resilience in our energy supply.
5. There will be a statutory requirement to review the GSMR every 5 years. The evaluation tool for this is the Post Implementation Review (PIR). The publication of the PIR report will be available to view on the legislation.gov.uk website.
6. The evidence gathered for the PIR from stakeholders will seek to establish if the Regulations remain fit for purpose and have achieved their original objectives. The PIR will also establish if Government intervention by regulation is still required and remains the most effective way to control the risks. Any unintended costs or impacts will be sought to test the assumptions made in the original impact assessment and if they remain relevant.
7. The amendments being proposed to Schedule 3 of GSMR will enable a wider range of gases to be used in the GB gas network and are anticipated to increase UKCS production and biomethane production. There are considerable uncertainties around the potential volume of gas that could be developed and as these are permissive changes there is no guarantee that the proposals will mean an increase in production. Decisions on additional development of gas resources are at the whim of gas producers and such decisions are subject to economic conditions such as investment power, extraction costs and price volatility. Additional production of biomethane is also linked to consumer billing arrangements set out in The Gas (Calculation of Thermal Energy) Regulations which dictate that gas must have the average calorific value of the charging zone it is injected into. This often means that biomethane must be propanated before it can be injected in distribution networks. Additional biomethane production and growth in the sector may be dependent on reform of billing arrangements as well as these changes.

## Summary and preferred option with description of implementation plan

1. Option 2: The preferred option is to retain GB’s safe gas quality specification within GSMR, Schedule 3 and amend the values to those proposed and consulted upon by IGEM (IGEM/GL/10) and those assessed to be safe by HSE:

* decrease the lower WN limit from ≥47.2 MJ/m³ to ≥46.5 MJ/m³ (the existing lower emergency limit)
* extend the current GSMR class exemptions for oxygen in biomethane to a general 1 mol% oxygen limit at ≤38 barg for all gas sources
* remove the Incomplete Combustion Factor (ICF) and Soot Index (SI) limits and to introduce a relative density of ≤0.7 for gas interchangeability
* alongside these changes to also modernise GSMR to account for significant changes to the industry occurring since 1996.

1. The changes to GSMR will be made via an amending secondary legislation statutory instrument (SI) with a coming into force date of 1st October 2022. HSE is considering what transitional arrangements will be required.
2. HSE has engaged with key stakeholders to ensure they are informed about the proposed Regulations and expect this to continue in the lead up to the Regulations coming into force and beyond. This has already involved participating in a number of meetings to discuss the proposals and to support dutyholders in understanding the transition to the new arrangements. The HSE website would be updated to provide an introduction to and overview of the new Regulations. L80 guidance on GSMR will also be updated.
3. It is unclear at this stage how many further meetings would be needed to ensure the required coverage. However, it is envisaged that the meetings would involve the range of trade unions and gas transporters and industrial and commercial users affected by the changes.

1. The Oil and Gas Authority estimates around 20 years, although this estimate was made before the Government’s Net Zero commitment: [Oil and Gas Authority: Reserves and resources - Data downloads and publications - Data centre (ogauthority.co.uk)](https://www.ogauthority.co.uk/data-centre/data-downloads-and-publications/reserves-and-resources/) [↑](#footnote-ref-2)
2. IGEM/TSP/19/363 - Neptune Lower WI interim report [↑](#footnote-ref-3)
3. <https://www.sgn.co.uk/sites/default/files/media-entities/documents/2019-07/SGN-Oban-Gas-Market-Report-Executive-Summary-2016.pdf> [↑](#footnote-ref-4)
4. IGEM-TSP-21-396 DLC189\_D – Impact of widening WI range on CO poisoning risk [↑](#footnote-ref-5)
5. [DUKES\_2020\_MASTER.pdf (publishing.service.gov.uk)](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/924591/DUKES_2020_MASTER.pdf) [↑](#footnote-ref-6)
6. <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904797/DUKES_4.2.xls> [↑](#footnote-ref-7)
7. Not currently published. [↑](#footnote-ref-8)
8. <https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.nationalgrideso.com%2Fdocument%2F199971%2Fdownload&data=04%7C01%7CKyran.Donald%40hse.gov.uk%7C7beffcb267d2400c354b08d9a466fae7%7C6b5953be6b1d4980b26b56ed8b0bf3dc%7C0%7C0%7C637721584486072364%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=MSCvifTMBqzo8TKFVH0PHdADaxbWM7uRrBBqGEQFSrs%3D&reserved=0> (tabs SV.7 and SV.8) [↑](#footnote-ref-9)
9. [Digest of UK Energy Statistics (DUKES) 2020 - GOV.UK (www.gov.uk)](https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2020) [↑](#footnote-ref-10)
10. [UKOOG 2018 Annual Report 2pg.pdf](https://www.ukoog.org.uk/images/ukoog/pdfs/UKOOG%202018%20Annual%20Report%202pg.pdf) [↑](#footnote-ref-11)
11. Oil and Gas Authority, (2021) “2020 UK Oil and Gas reserves report – 2021 – publications

    <https://www.ogauthority.co.uk/news-publications/publications/2021/2020-uk-oil-and-gas-reserves-and-resources-report/> [↑](#footnote-ref-12)
12. [Outlook for biogas and biomethane: Prospects for organic growth – Analysis - IEA](https://www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth) [↑](#footnote-ref-13)
13. Compressors are essentially jet engines in the NTS that increase gas pressure in the network [↑](#footnote-ref-14)
14. [\*DUKES\_2019\_MASTER\_COPY.pdf (publishing.service.gov.uk)](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/840015/DUKES_2019_MASTER_COPY.pdf) [↑](#footnote-ref-15)
15. [DUKES\_2020\_Chapter\_5.pdf (publishing.service.gov.uk)](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904805/DUKES_2020_Chapter_5.pdf) [↑](#footnote-ref-16)
16. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\_data/file/911906/DUKES\_5.11.xls [↑](#footnote-ref-17)
17. [DUKES 2021 Chapter 4 Natural gas (publishing.service.gov.uk)](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1006628/DUKES_2021_Chapter_4_Natural_gas.pdf) [↑](#footnote-ref-18)
18. [Sub-national Electricity and Gas Consumption: Regional and Local Authority, Great Britain, 2018 (publishing.service.gov.uk)](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/853760/sub-national-electricity-and-gas-consumption-summary-report-2018.pdf) [↑](#footnote-ref-19)
19. [DUKES 2021 Chapter 4 Natural gas (publishing.service.gov.uk)](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1006628/DUKES_2021_Chapter_4_Natural_gas.pdf) [↑](#footnote-ref-20)
20. [Sub national electricity and gas consumption summary report 2019 (publishing.service.gov.uk)](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/946968/sub-national-electricity-and-gas-consumption-summary-report-2019.pdf) [↑](#footnote-ref-21)
21. [1 in 3 Homeowners Can't Afford a New Boiler - iHeat](https://iheat.co.uk/boiler-help/homeowners-cant-afford-new-boilers) [↑](#footnote-ref-22)
22. [Live tables on dwelling stock (including vacants) - GOV.UK (www.gov.uk)](https://www.gov.uk/government/statistical-data-sets/live-tables-on-dwelling-stock-including-vacants), Table 104 [↑](#footnote-ref-23)
23. [Updated-6421-Fixing-Fit-and-Forget-Culture-Report.pdf (benchmark.org.uk)](https://www.benchmark.org.uk/media/f2d225aa34a53768b25792a9451b76c8/Updated-6421-Fixing-Fit-and-Forget-Culture-Report.pdf) [↑](#footnote-ref-24)
24. [Section 1 (publishing.service.gov.uk)](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/898344/Energy_Report.pdf) [↑](#footnote-ref-25)
25. [9\_Domestic appliances, cooking and cooling equipment.doc (publishing.service.gov.uk)](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/274778/9_Domestic_appliances__cooking_and_cooling_equipment.pdf) [↑](#footnote-ref-26)
26. Other sources estimate that between 30% and 38% of households have a gas oven. This analysis assumes that there is a total overlap between households with a gas hob and those with a gas oven such that the proportion with a gas hob encompasses those with gas hobs and gas ovens. [↑](#footnote-ref-27)
27. [The cost of installing heating measures in domestic properties (publishing.service.gov.uk)](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/913508/cost-of-installing-heating-measures-in-domestic-properties.pdf) [↑](#footnote-ref-28)
28. [Updated-6421-Fixing-Fit-and-Forget-Culture-Report.pdf (benchmark.org.uk)](https://www.benchmark.org.uk/media/f2d225aa34a53768b25792a9451b76c8/Updated-6421-Fixing-Fit-and-Forget-Culture-Report.pdf) [↑](#footnote-ref-29)
29. [bpf-pia-property-report-2017-final.pdf](https://bpf.org.uk/media/3278/bpf-pia-property-report-2017-final.pdf) [↑](#footnote-ref-30)
30. [Report (squarespace.com)](https://static1.squarespace.com/static/5b8eae345cfd799896a803f4/t/600b21507e57ed248ed0358b/1611342168875/ERM+FINAL+2020.pdf) [↑](#footnote-ref-31)
31. [Regional gross domestic product: all ITL regions - Office for National Statistics](https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/regionalgrossdomesticproductallnutslevelregions) [↑](#footnote-ref-32)
32. A bratt pan is a heavy-duty commercial cooking appliance which is able to perform up to eight cooking functions: braising, boiling, steaming, poaching, stewing, roasting, deep-fat frying and shallow frying. [↑](#footnote-ref-33)
33. A key step on the pathway to Net Zero emissions – EVIDENCE REPORT’ Institute of Gas Engineers & Managers (IGEM) (24/04/2020) (https://www.igem.org.uk/\_resources/assets/attachment/full/0/64268.pdf), paragraph 5.1, page 16 [↑](#footnote-ref-34)
34. [WP6 Understanding Industrial Appliances Report (squarespace.com)](https://static1.squarespace.com/static/5b8eae345cfd799896a803f4/t/5e287d78dc5c561cf1609b3d/1579711903964/WP6+Industrial+Heating+Equipment.pdf) [↑](#footnote-ref-35)
35. See <https://www.ucl.ac.uk/energy-models/models/uk-times> for more information [↑](#footnote-ref-36)
36. Available at <https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2019> [↑](#footnote-ref-37)
37. Boe refers to Barrel of Oil Equivalent. Data taken from the Oil and Gas Authority Emissions Intensity Comparison of UKCS Gas Production and Imported LNG and Pipelined Gas, available at: <https://www.ogauthority.co.uk/media/6522/emissions-intensity-comparison-of-ukcs-gas-production-and-imported-lng-and-pipelined-gas-v2.png> [↑](#footnote-ref-38)
38. Available at [rr1055.pdf (hse.gov.uk)](https://www.hse.gov.uk/research/rrpdf/rr1055.pdf) [↑](#footnote-ref-39)
39. HSE, 2021, Health and safety statistics, ridgas.xlsx.(live.com) [↑](#footnote-ref-40)