Department for
Energy Security
& Net Zero

Enabling Industrial Electrification

Call for evidence on fuel-switching to electricity

Summary of responses

September 2024

Any enquiries regarding this publication should be sent to us at:
industrialelectrification@energysecurity.gov.uk

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Executive summary

Electricity is already used as an energy source across industrial sites[1] and, as we accelerate towards a clean power grid by 2030 and net zero by 2050, it will provide an increasingly attractive low carbon energy source. Our 2023 Call for Evidence has returned valuable evidence on the barriers faced by industrial sites regarding electrification. It also provides clarity from respondents that further electrification-specific intervention is needed to bring parity with other low carbon fuels, therefore allowing sites to choose the right decarbonisation option for their business. This summary document sets out the key insights we have drawn from responses by chapter, as well as a detailed, question by question view in the appendices. We thank all 74 respondents to this Call for Evidence for their considered and invaluable input.

Key themes from responses

Electricity costs are high relative to natural gas

Respondents to this call for evidence were clear that electrification is the preferred option for decarbonisation across a significant proportion of industrial sites. Responses, however, also confirmed that the high cost of electricity relative to natural gas is the primary barrier to widespread industrial electrification. 48 out of 60 respondents rated financial barriers as severe or extremely severe. With electricity costs four times greater than gas[2], it is challenging for industrial users to make a strong business case in favour of fuel switching to electricity. Work is already underway to develop options to decrease the price of electricity relative to gas. This is a critical policy priority.

Grid connection delays are lengthy

Respondents told us the average delay industrial sites face for an upgraded connection is 5 years. Such delays are the second most cited barrier to electrification. Demand for connections will continue to rise as we push towards our net zero ambition to replace around 50 TWh of fossil fuels used by industrial sites annually by 2035 with low carbon alternatives, of which electrification is expected to play a significant role.

The newly announced Mission Control for clean power by 2030, alongside planning reforms to speed up infrastructure development, will play a vital role in unblocking issues on grid connection delays. Working with Ofgem, this will support efforts to overhaul the way new projects access the grid by improving the connections process and releasing network capacity so that viable projects can connect faster. These reforms to grid connections will drastically reduce the time it takes for viable projects to connect to the grid. Through these reforms, we

[1] Electricity comprised 32% of total industrial energy consumption in 2021. Digest of UK Energy Statistics DUKES) (2022)
[2] Electricity costs are 4x greater than gas for non-domestic users outside of the Energy Intensive Industries (EII) Scheme (https://www.gov.uk/government/statistical-data-sets/gas-and-electricity-prices-in-the-non-domestic-sector)

aim to enable the vast majority of projects to connect in line with their realistic project requirements. Accelerating connection dates is also dependent on increasing network capacity and the Department for Energy Security and Net Zero is working at pace with Ofgem and the network companies to accelerate investment and halve the delivery time of new transmission infrastructure.

Together with Ofgem, we are also working closely with the network companies to monitor the impacts of actions underway and assess whether more will be required to accelerate connections. We will not hesitate to go further and have identified areas where we can take stronger action, if required. We will work with Ofgem, network companies and the new National Energy Systems Operator (NESO) to understand where investment in grid infrastructure ahead of need may be required to match expected demand from electrifying sectors such as industrial electrification projects.

Some technology gaps exist, particularly for high-heat processes

Heat pumps and electric boilers are already on the market, especially at lower temperatures, however electric alternatives for more complex and higher heat, high power processes are not yet available either at the right scale or at an economical cost for industry. Findings from research on electrification opportunities in industry, commissioned by the Department for Energy Security and Net Zero (as yet unpublished), examined seven major industrial heating processes. This work identified that there are viable and/or developing options for electrification of emission-intensive heating processes in the cement, glass, paper, olefins, refining and food & drinks sectors. The report highlights the need for further innovation to develop and demonstrate electrification technologies at a commercially relevant scale, overcome remaining technical design challenges, and accelerate site integration.

Respondents confirmed our understanding that high temperature processes should be the focus for further technological innovation. Responses also suggest that this will need to focus on mid-range Technology Readiness Level (TRL) equipment, where proof of concept has been achieved but further investment is needed to scale up. To date the Government has committed £17.3m to industrial demonstrations of electrification technologies across a range of industries, via the Industrial Fuel Switching Competition (phase 2). We will consider how we can further enable technology development for high-heat processes.

Increased confidence in novel electrification equipment is needed

Respondents highlighted that there is a need to demonstrate novel electrification technologies at scale in order to increase confidence in their use, in particular for high heat processes which are currently most reliant on fossil fuel use. Increasing confidence in new technologies, particularly for specific processes, will be key for industrial sites making the switch away from fossil fuels. To date, the Industrial Energy Transformation Fund has been the Government’s key vehicle for funding electrification projects, committing £28.2m of funds to electrification demonstration projects. We will consider how best to enable demonstration of electrification technologies in the future.

Further clarity on the availability and relative support for hydrogen and electrification is needed.

Electricity, low carbon hydrogen and bioenergy all have an important role to play in decarbonising industry, and the exact mix of low carbon fuels in the future is still uncertain. Respondents highlighted that whilst they observe progress in the development of a hydrogen economy, there remains uncertainty as to exactly where and when hydrogen will become available, particularly for industrial users outside of the main clusters. This uncertainty, in combination with favourable support for hydrogen production and off-taking, is affecting industry's decision-making regarding electrification. Some respondents stressed that to meet the principle of technology neutrality, electrification specific support would be needed.

In relation to hydrogen, the Government is developing a strategic planning process for the rollout of hydrogen infrastructure, which will be informed by further evidence on future hydrogen production, demand, and storage as it becomes available. The Government's ambition is for the NESO to then formally take on responsibilities for strategic planning of hydrogen transport and storage infrastructure from 2026. The Government is also designing business models to support and incentivise private investment in the UK's hydrogen economy and has already selected the first electrolytic hydrogen production projects to be awarded contracts under the Hydrogen Allocation Round 1 scheme (subject to signing of contracts)[3]. This will allow for analysis of the best ways in which to support bringing forward the development of the UK's hydrogen economy, and further clarity for business and industry on the access to hydrogen infrastructure that is likely to be available in coming years.

Different 'archetypes' of industrial sites face different hurdles to electrification

To unpack the role of electrification in decarbonising industry further, we divided industrial sites into four "archetypes" in the call for evidence:

- Archetype 1: Low temperature processes on dispersed sites
- Archetype 2: Low temperature processes on sites in clusters
- Archetype 3: High temperature (particularly direct fired) processes on dispersed sites
- Archetype 4: High temperature (particularly direct fired) processes on sites in clusters

Whilst respondents highlighted nuances, broadly Archetype 2 sites would appear to have the clearest pathway to electrification. Many low temperature electrification technologies are commercially available already, and sites benefit from access to infrastructure and economies of scale in a cluster. The key overall barriers of energy costs and network access notwithstanding, they will be able to electrify more quickly than other site archetypes and achieve significant emissions savings.

[3] https://www.gov.uk/government/publications/hydrogen-production-business-model-net-zero-hydrogen-fund-shortlisted-projects/hydrogen-production-business-model-net-zero-hydrogen-fund-har1-successful-projects

Respondents confirmed our understanding that Archetype 3 sites face the most barriers to electrification. These high temperature industrial processes have not yet been electrified at scale with many technologies still in the research and development phase. Additionally, adoption will take longer to make economic sense when this is compounded by the obstacles faced in dispersed sites which may have more complicated access to essential infrastructure.

Conclusion and next steps

Respondents sent a clear message that electrification offers significant technical potential for industry to replace fossil fuel use. The 2024 Climate Change Committee report also references the essential role of industrial fuel switching, with accelerated electrification of industrial heat flagged as a priority action[4]. Given its many benefits including well-established existing infrastructure, a strong knowledge base, improved efficiency and secondary environmental benefits such as reduced noise and particulate pollution, many respondents indicated a preference for electrification as the technically optimal fuel switching solution for their site. If barriers of cost and grid connection can be overcome, including through the Clean Power Mission, then this potential could be realised in the 2020s helping us to meet our near-term carbon budget commitments. Targeted intervention is urgently needed to address these barriers and ensure electrification is on a level playing field with other decarbonisation options. We will further develop the next steps outlined in this summary and return to stakeholders for further consultation and evidence gathering in due course.

[4] https://www.theccc.org.uk/publication/progress-in-reducing-emissions-2024-report-to-parliament/

Introduction

About the Call for Evidence

On 19 July 2023, the Department for Energy Security and Net Zero launched a call for evidence to understand how to enable industry to switch away from fossil fuels to electricity. Its aim was to gather evidence to build our understanding of the role of electrification in industry, the challenges industry faces when considering electrification options, and to test early-stage policy thinking. The call for evidence was open for 12 weeks, closing on 20 October 2023.

The call for evidence was divided into two parts. Part I was for all stakeholders to complete and covered broader questions on electrification. Part II was only to be completed by industrial sites and asked detailed questions about electrification.

Part I covered the benefits of industrial electrification, the technologies available to electrify, the barriers and enablers of industrial electrification, and if existing and upcoming policies are enough to enable electrification or whether further targeted support might be needed. Respondents were asked to support their answers with evidence relating to their business, product, sector, published literature studies, or to their broader expertise, wherever possible.

Part II asked for more granular information from industrial sites, to further explore the opportunities and challenges of switching from fossil fuels to electrification in industrial sites across the UK. Part II responses are treated as commercially sensitive and will not be published.

To raise awareness of the call for evidence with potential respondents, the Department for Energy Security and Net Zero officials held ten online discussions. The sessions engaged representatives from across industrial sectors (including electrical and mechanical engineering, food and drink, glass, ceramics, chemicals, construction, iron & steel, and paper), energy and technology suppliers, as well as academia and the devolved administrations.

About the respondents

In total, 74 distinct respondents provided evidence across Part I and Part II.

This document summarises responses from the 68 respondents that submitted an answer to at least one of questions 19-48 in Chapters 1, 2 and 3 of Part I, or provided a response relevant to those questions through correspondence. 47 respondents only provided responses to Part I. 21 respondents provided responses to both Part I and Part II, and their Part I responses are represented in this document.

We received 27 responses to Part II, which will feed into further policy development, but are not included in this summary of responses due to their commercially sensitive nature.

6 respondents only responded to Part II and did not provide answers to Part I beyond the ‘About you’ and ‘About your site’ sections. Therefore, they are omitted from this document, including the ‘Respondent Demographics’ section of the Annex.

Table 1: Summary of total respondents

Section	Total Respondents across Part I and Part II	Part I Total Respondents (beyond ‘About you’ section)	Part II Total Respondents
Count	74	68	27

Table 2: Breakdown of total respondents across Part I and Part II

Section	Respondents who answered both Part I and Part II	Respondents who answered only Part I	Respondents who answered only Part II
Count	21	47	6

The respondents to Part I largely came from industrial sites (30) followed by trade associations/industry bodies (20) and energy suppliers (7), among a few other organisation types. The ‘respondent demographics’ section in the Annex provides a more detailed breakdown on respondents based on their answers to the ‘About you’ and ‘About your site’ sections of the call for evidence. This includes type of organisation, the sectors they represent, the region, and the types of technology they represent.

About this summary of responses

This document summarises the responses to Part I of the call for evidence. The question order in this document varies from the original call for evidence as the responses and outputs for several questions have been combined where they are answering the same high-level thematic questions. The count for the number of respondents to a question does not always equal 68 as some respondents did not answer every question. Furthermore, the total count of respondents in each question may not always equal the sum of count of themes/options due to multiple themes being raised in the same answer or multiple options being selected by respondents.

Whilst officials sought to ensure analysis was as systematic and robust as possible, there are several key limitations to note:

- There is inherently a degree of subjective judgement in using qualitative coding, therefore, the creation and application of the coding framework may have varied slightly across the different officials reviewing the responses. We sought to minimise this through reviewing and refining our approach with a social researcher. A lead official also quality assured all the questions after they were coded to ensure a consistent and robust approach had been applied.
- The 68 responses to Part I of this call for evidence may not form a representative picture of those impacted by electrification of industry as a whole. The number of responses to each question, as well as the extent to which respondents elaborated on their answers, varied significantly. Some organisations aligned their responses to the call for evidence, leading to duplications. These were counted as distinct responses.

Summary of responses to Chapter 1 – the role of electrification in decarbonising industry

Chapter overview

To support industrial electrification, we need to understand and agree on the role of electrification across industry. This chapter covered:

- The advantages of industrial electrification.
- The technologies needed to electrify.
- The possible role of electrification across different industrial sites.

The advantages of industrial electrification

The advantages of electrification provided in the call for evidence included electricity having an established role as a fuel source with existing transmission and distribution infrastructure; improved efficiency compared to gas and other alternatives; and secondary environmental benefits (i.e. reduced noise). These were widely supported by respondents.

Respondents noted several additional advantages of electrification beyond those outlined in the call for evidence. Respondents most commonly cited the role electrification can play in enhancing process operation and control, improving occupational health and safety, reducing compliance and pollution abatement equipment costs. It was also noted that electrification can help to reduce demand for hydrogen and bioenergy, allowing those options to be better targeted where they are most needed.

The technologies needed to electrify

Electrification is technically possible for a wide range of applications, however technologies for many high heat processes are generally still in the research and development stage. In the next questions we asked for views on how we continue to address technology innovation and demonstration barriers.

We presented Technology Readiness Levels (TRL) and specifications of different electrification technologies for review and comment. Respondents were broadly in agreement with the specifications (including the TRL) of different technologies needed to electrify. However, respondents also highlighted some omissions and further evidence which should be included to support policy development and understanding of applications in the real world. This included specific examples of technology which ought to be added to the existing group, new TRL information, and a few other corrections.

Respondents ranked the importance of the key areas for innovation and confirmed that '*reducing the cost of commercially ready electrification technologies',* '*demonstration of electrification technologies on sites*' and '*scaling up technologies to meet commercial production requirements'* are particularly important factors to focus on.

'*Research and development of high temperature electrification equipment*' was also ranked as important. Respondents thought that targeted innovation to overcome sector and process-specific challenges for high temperature processes should be the focus for innovation. Respondents had the opportunity to express additional areas of focus for innovation of electrification and some felt there needed to be further evidence on the flexibility of electrification technologies, and another mentioned that the risk involved in investing in and developing electrification technologies is high.

Respondents to these questions confirmed our understanding that high temperature processes should be the focus for technological innovation. We recognise the need to target research and development to overcome sector or process-specific challenges in high temperature industries, as well as the need to reduce the cost of new electrification technologies for them to be adopted at scale.

The possible role of electrification across different industrial sites

To further unpack the role electrification can play in the decarbonisation of industry, we divided industrial sites into four "archetypes". The two main factors defining these archetypes are process temperature (i.e. low or high) and geography (i.e. clustered or dispersed). The approach of site archetypes was largely supported by respondents, but additional considerations were also highlighted, including comments on high temperature processes which vary widely, the definition of clusters used being too broad, and temperature cut-off for low vs. high temperature being too low.

The next questions asked if respondents agreed with the role electrification plays across these site archetypes as presented. Overall respondents were broadly in agreement with the list of advantages and specifications (including TRL) of different electrification technologies.

Respondents mostly agreed with the role of electrification presented for each of the archetypes. The most cited consideration was that electrification is the preferred option for the glass sector, followed by comments that some high temperature electrification technologies are already commercially available.

Subsequently we have updated the technologies table and refined our site archetypes based on respondent feedback. Broadly respondents confirmed that industrial sites with low temperature processes in clusters (Archetype 2) have the lowest barriers, and high temperature processes in dispersed sites (Archetype 3) are more challenging to electrify as they face higher barriers to electrification. Our increased understanding of how barriers impact archetypes will inform our approach to targeted policy design.

Summary of responses to Chapter 2 – Industrial electrification barriers and enablers

Chapter overview

We understand that industrial sites looking to electrify face several challenges, including technical, financial, infrastructure, organisational and regulatory/policy barriers. High electricity costs and limited grid access and capacity are particularly significant. This chapter sought to:

- Test our understanding of the barriers to industrial electrification, including gaining a complete list of the barriers, order of severity, and how the barriers affect different site archetypes.
- Understand whether private renewable generation could act as an enabler to industrial electrification, and if there are any barriers to private renewable generation.
- Understand whether demand side response (DSR) could act as an enabler to industrial electrification, and if there are any barriers to DSR.

Barriers to industrial electrification

Respondents confirmed that the list of barriers presented in the call for evidence is representative, and they supported our initial views that financial and infrastructure & supply barriers are the most severe. Taken together, we can now consider these to be the most significant barriers to electrification.

Respondents also confirmed the underlying reasons behind the key barriers. For fuel costs, the high electricity price relative to gas was cited as most important. For electricity grid access, lengthy timescales and delays were cited as the most important. For capital costs, Capex being high relative to natural gas technology and the cost of retiring incumbent technology early were most important.

Respondents mentioned several sub-barriers which were not listed in the call for evidence.The most cited one was concerns around the uncertain supply of sufficient renewable electricity, followed by uncertainty over future electricity and carbon costs.

The impact of the different barriers on each site archetype was fairly consistent: infrastructure and supply, as well as economic/financial barriers being the two main barriers for archetypes 1, 2 and 3[5]. Technology availability and scalability are two additional barriers highlighted for archetype 4[6].

Sites with low temperature processes in clusters (Archetype 2) have the fewest barriers to electrification. Many low temperature electrification technologies are commercially available, and sites benefit from infrastructure and economies of scale in a cluster. High temperature processes in dispersed sites (Archetype 3) are more challenging to electrify as they face the most barriers to electrification.

Using responses to these questions and taking into consideration the new sub-barriers raised we have a greater understanding of how barriers impact site archetypes which will inform our approach to targeted intervention design.

Private renewable generation as an enabler of electrification

Questions then turned to enablers for electrification and asked specifically about the role of private renewable generation and demand side response.

Most respondents stated that private renewable generation can be an enabler to electrification as it can provide certainty on a portion of electricity costs and reduce fuel costs.

Respondents were also asked to provide barriers to private renewable generation. The most cited were technical issues, including generation capacity being too small for an industrial site and any intermittent generation profile providing challenges. Infrastructure and supply barriers were the next most cited, including challenges with grid connection applications and network security standards regarding electricity export.

While respondents agreed there is potential for private renewable generation to act as an enabler to electrification, this requires further consideration to fully understand the potential and overcome the barriers.

Demand side response as an enabler of electrification

We also sought to gather views on whether demand side response (DSR) could act as an enabler for industrial electrification and whether there are any barriers to DSR for industry.

Respondents were split on whether demand side response can act as an enabler to electrification. The most cited enabler was the financial and economic benefits, including the potential for revenue generation from exported electricity, reduced network charges and reduced fuel costs. The most cited barrier was technical challenges, including intermittent and large-scale industrial energy use, and installation and integration with existing equipment.

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[5] Archetype 1 – Low temperature, dispersed; Archetype 2 – Low temperature, clustered; Archetype 3 – High temperature, dispersed.
[6] Archetype 4 – High temperature, clustered.

As respondents were split on DSR as an enabler, we will interrogate this further in future engagement with stakeholders. As with private renewable generation, DSR also requires further consideration to fully understand the potential and overcome the barriers.

Summary of responses to Chapter 3 – Exploring policy options

Chapter overview

Industrial decarbonisation, including electrification and adjacent policies, is a complex policy space. This chapter sought to understand:

- The impact of the current policy landscape on industrial electrification.
- Whether further intervention is required, and if so, which principles and types of interventions should be considered to help create an enabling environment for electrification.
- Any policy options or international options that should be considered.

Response summary

Current policy landscape

There are existing policies, and some in development, that look to address the main barriers to electrification identified in Chapter 2. The call for evidence asked if they positively or negatively impacted on industry's ability to switch away from fossil fuels to electricity. Respondents largely agreed that our list of adjacent policies was representative of the landscape. However, they also provided details of other policies that could impact industry's ability to electrify. The two most cited were the Carbon Border Adjustment Mechanism (CBAM) and the hydrogen business model. The government has now committed to delivering a CBAM by 2027, with a consultation on its delivery published earlier this year. Other commitments by HMG, made subsequent to publication of the call for evidence, include the new national Wealth Fund that will directly invest in industrial clusters across the UK.

Respondents thought the current policy landscape was not sufficient and were heavily in favour of further intervention to specifically support electrification of industry in the 2020s and 2030s. These responses have shaped our policy priorities for intervention.

Possible approaches

Questions in this section tested possible approaches for further government intervention to enable electrification. An initial set of principles that would guide future policy was provided for comment. There was support for the suggested policy principles, including value for money, simplicity, effectiveness, and consistency. However, respondents also highlighted that further consideration should be given to the maintenance of UK industrial competitiveness and policy should allow the most appropriate technology to be deployed.

Respondents were largely against further regulation to support electrification, although they did note that regulations to facilitate grid upgrades have some potential. Respondents also emphasised the need for consistent policies and long-term signals (into the 2040s), along with information sharing and industry co-ordination. We will carefully consider these as part of our policy making process.

Facilitating an enabling environment for electrification

Responses to questions of how government can facilitate an enabling environment for electrification have been grouped together as there were recurring themes within these responses. Resolving grid issues and addressing high electricity prices were again the most common themes. On a regulatory level, efforts to improve lead times for connection upgrades was the most common response. A significant proportion of answers also referred to deregulation or incentivisation, alongside calls for regulatory stability.

Most respondents supported a broader fuel switching approach rather than electrification-specific frameworks and the common reason given for supporting the broader approach related to site specific requirements which would need flexibility to choose the best option.

Those supporting electrification specific intervention had a wide variety of reasons, with the most common being to avoid locking-in fossil fuel use. Further delays in implementing electrification will result in more fossil fuel equipment being installed which, due to long investment cycles and machinery lifespans, would enable emissions to continue. Additional explanations included hydrogen and CCUS business model development reducing the feasibility of technology-neutral policy.

Future policy approach

We tested our understanding of any implications, positive or negative, of government intervention, including regulation and funding approaches. We asked for views on how a future funding policy could be structured, what risks there are and whether there were any other indirect policies to enable electrification. As previously mentioned, respondents were largely against further regulation to support electrification and in favour of a broader fuel switching approach to future policy.

Without a broader framework in place for fuel switching, respondents identified the highest risk to new electrification policy being that it could promote an unsuitable solution or technology through perverse incentives. The primary mitigation for this risk is to provide balanced support for different decarbonisation measures.

The second most cited risk identified that grid issues may be exacerbated due to increased demand if a new electrification policy is introduced. However, the view from respondents was that this risk could be mitigated through grid reform.

We acknowledge and understand the risk around unsuitable solutions being promoted through perverse incentives without a joined-up approach. As a result, we recognise the need for close coordination with hydrogen schemes, and to send a clear signal to industry on where we expect electrification to be the default solution.

Finally, respondents were asked to provide examples of international policy to enable or incentivise electrification that we should be considering. These are fully listed in the Annex. Key examples highlighted the significant financial and policy support available in the US and EU through the Inflation Reduction Act (IRA) and Fit for 55 pledge respectively. Carbon contracts for difference such as those seen in Germany were also cited as a possible blueprint for further support.

Overall, respondents were heavily in favour of further interventions to support electrification, but largely against further regulation. However, they did note that regulation to facilitate grid upgrades may have some potential. Respondents also emphasised the need for a broader fuel switching policy and long-term signals, along with information sharing and industry co-ordination.

We will use evidence provided in this chapter to shape our approach to driving industrial electrification.

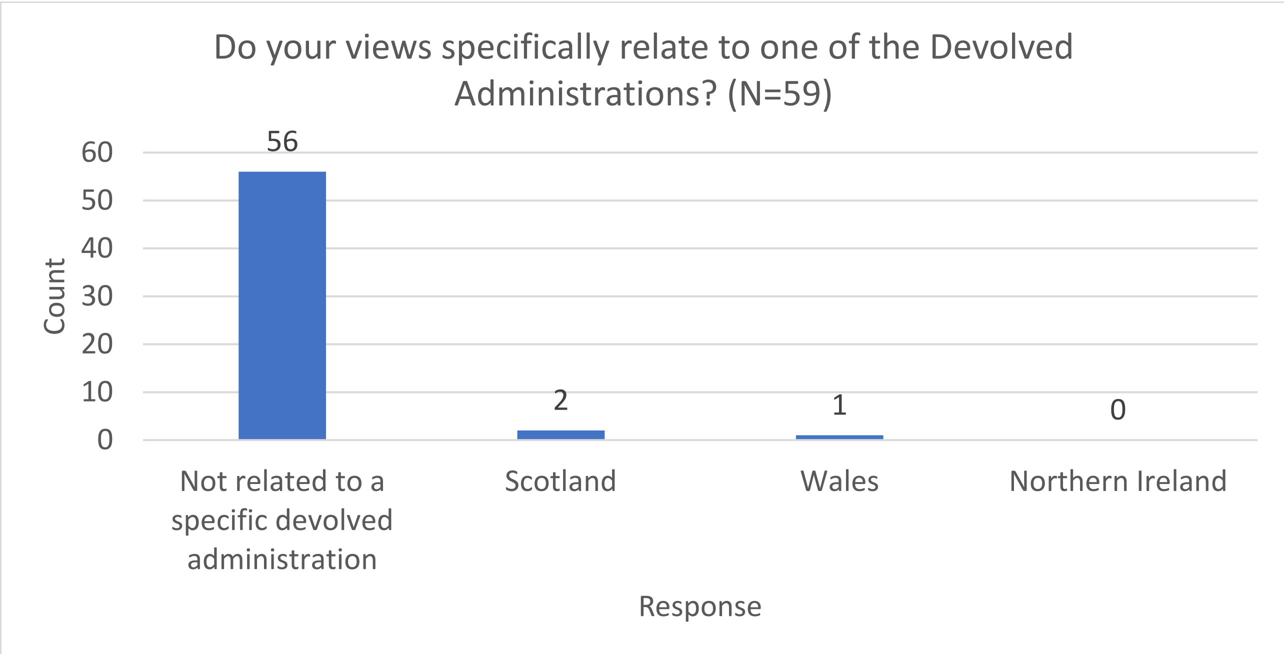
Annex

Annex A - Respondent demographics

This section provides an overview of responses to questions in the ‘About you’ section (questions 1 to 9) and ‘About your site’ section (question 10 to 18) of Chapter 1 of the call for evidence.

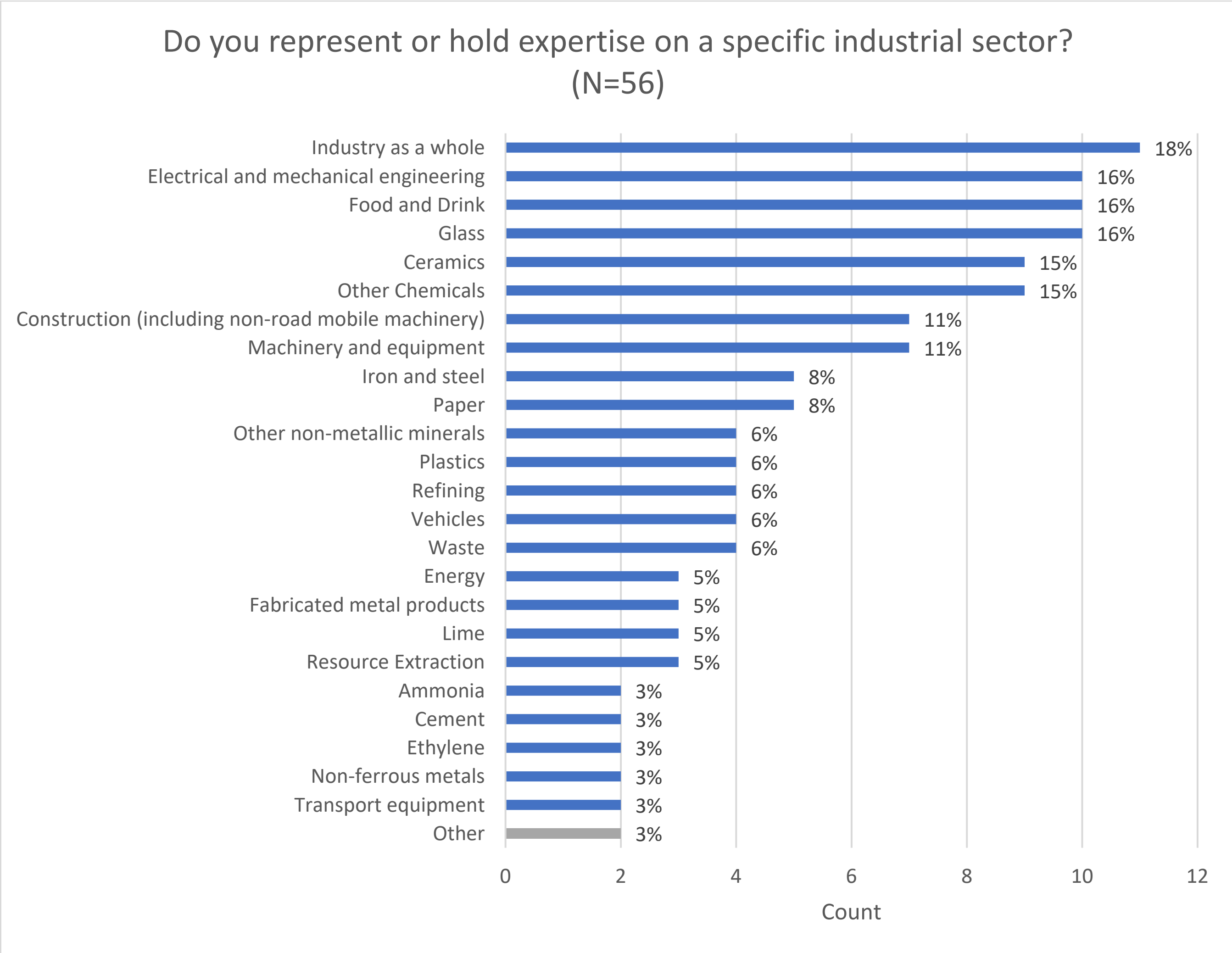
59 respondents confirmed whether their views specifically related to one of the Devolved Administrations (Figure 1). Of which, 56 responded that their views did not relate to a Devolved Administration; 2 related to Scotland; and 1 confirmed that their views related to Wales.

Figure 1: Respondents by Devolved Administration (N=59)



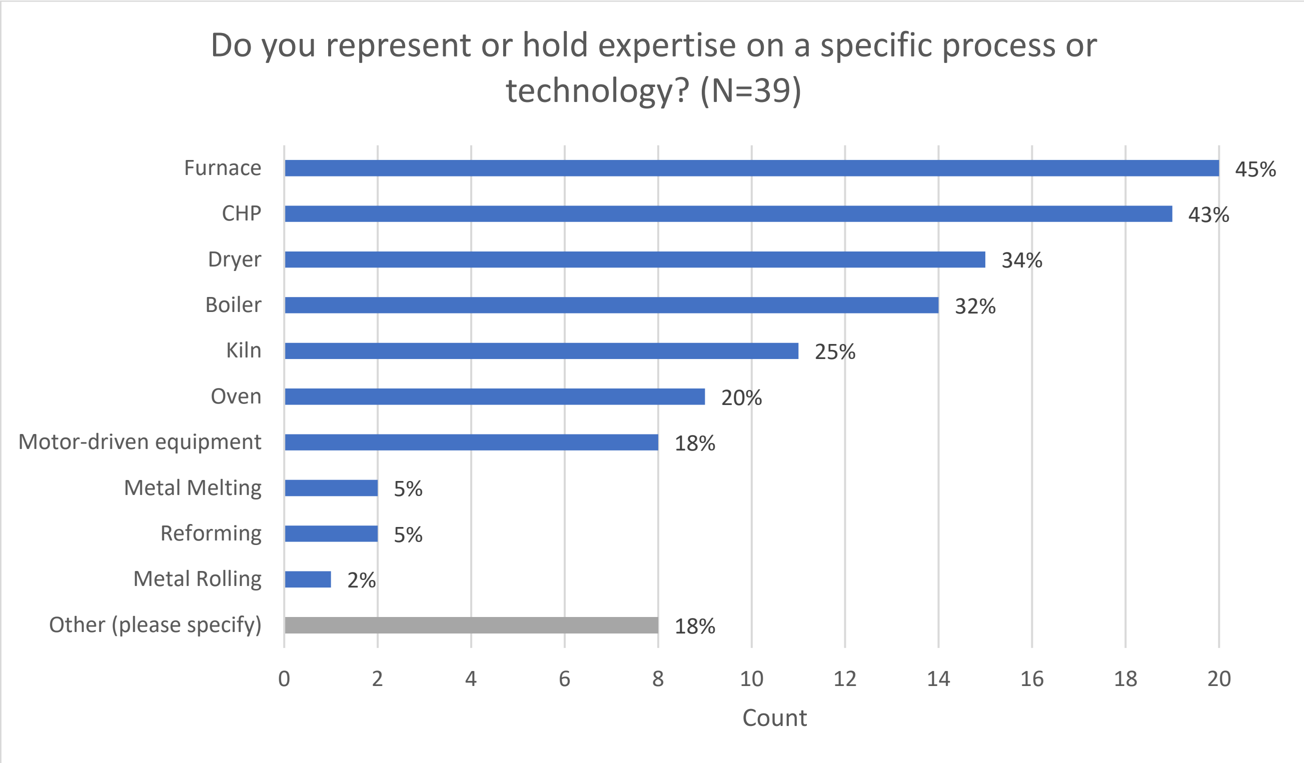
56 respondents stated the sectors they represent or hold expertise in (Figure 2). Respondents were given the option to state more than one sector. Seven sectors are represented by at least 10% of these responses: electrical and mechanical engineering; food & drink; glass; ceramics; other chemicals; construction; and machinery & equipment.

Figure 2: Respondents by sector (N=56)



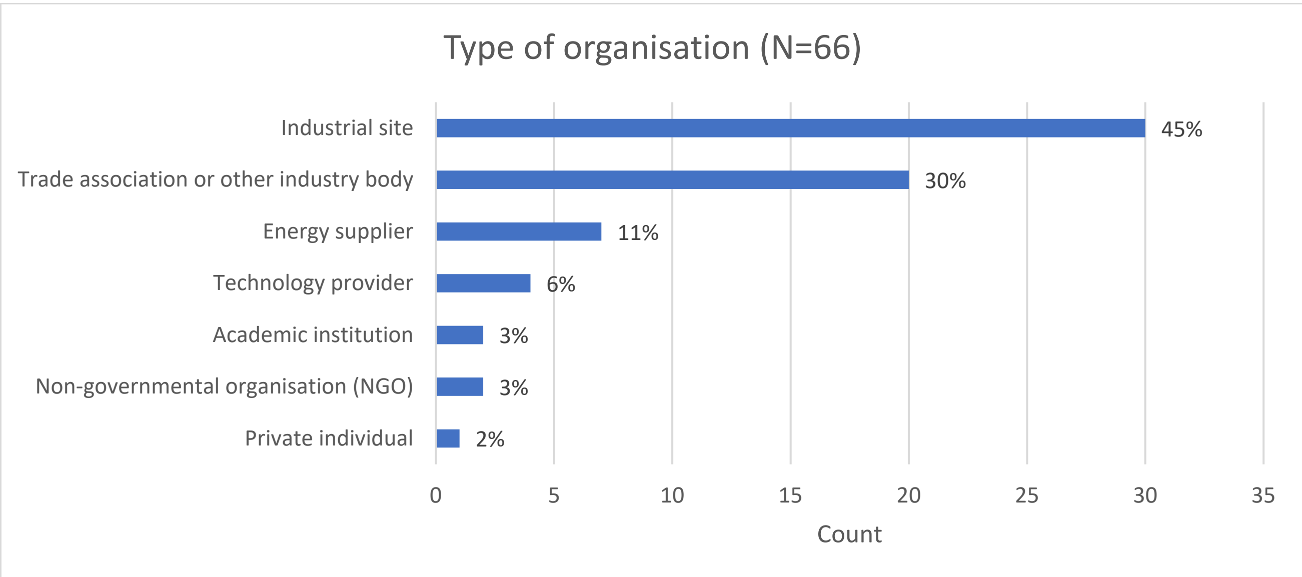
39 respondents stated they have expertise in at least one specific process or technology (Figure 3). More than a third of these respondents said they have expertise in furnaces, combined heat and power, and dryer processes/technologies.

Figure 3: Do you have expertise on a specific process or technology? (N=39)



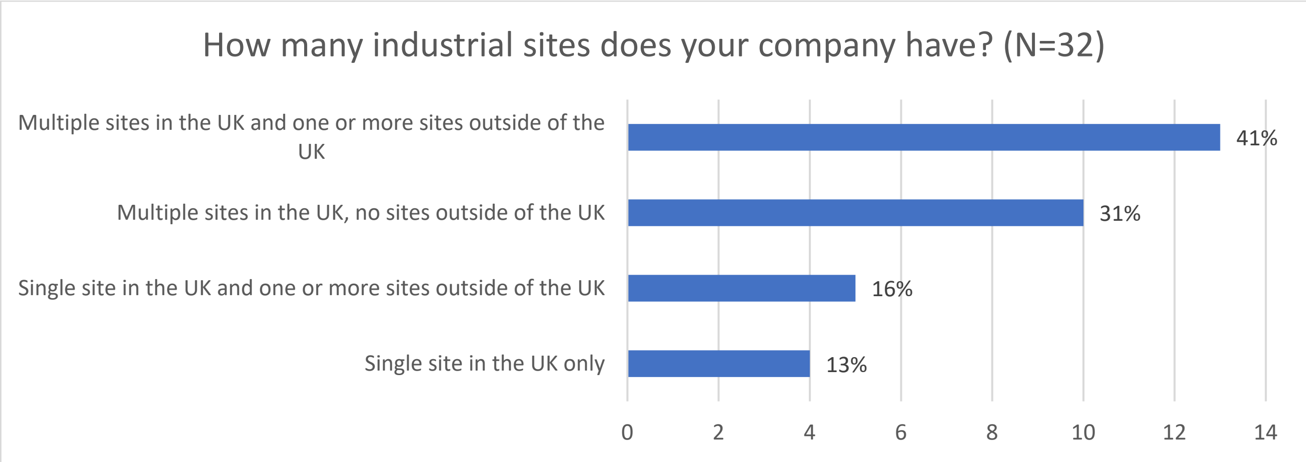
66 respondents stated the type of organisation they represented (Figure 4). 30 of these responses are from representatives of industrial sites, with trade associations or other industry bodies being the second most represented, followed by energy suppliers and technology providers.

Figure 4: Respondents by type of organisation (N=66)



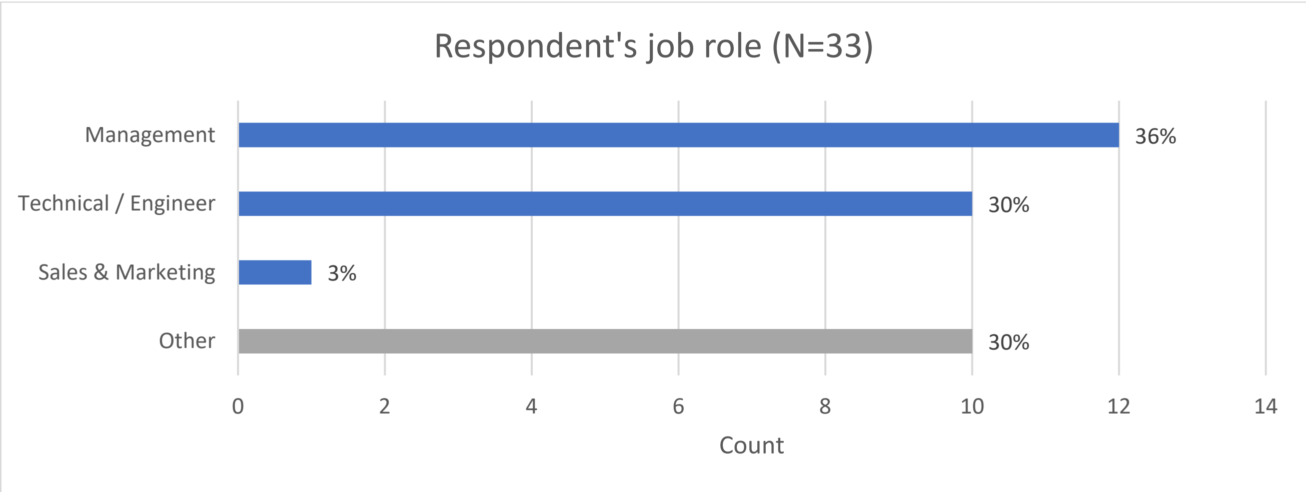
32 respondents stated whether the company had a single site in the UK or if they had multiple sites in the UK and abroad (Figure 5). Over two-fifths of these respondents stated they had multiple sites in the UK and one or more sites outside of the UK, and almost a third stated they had multiple sites in the UK with none outside.

Figure 5: Number of Industrial Sites by Company (N=32)



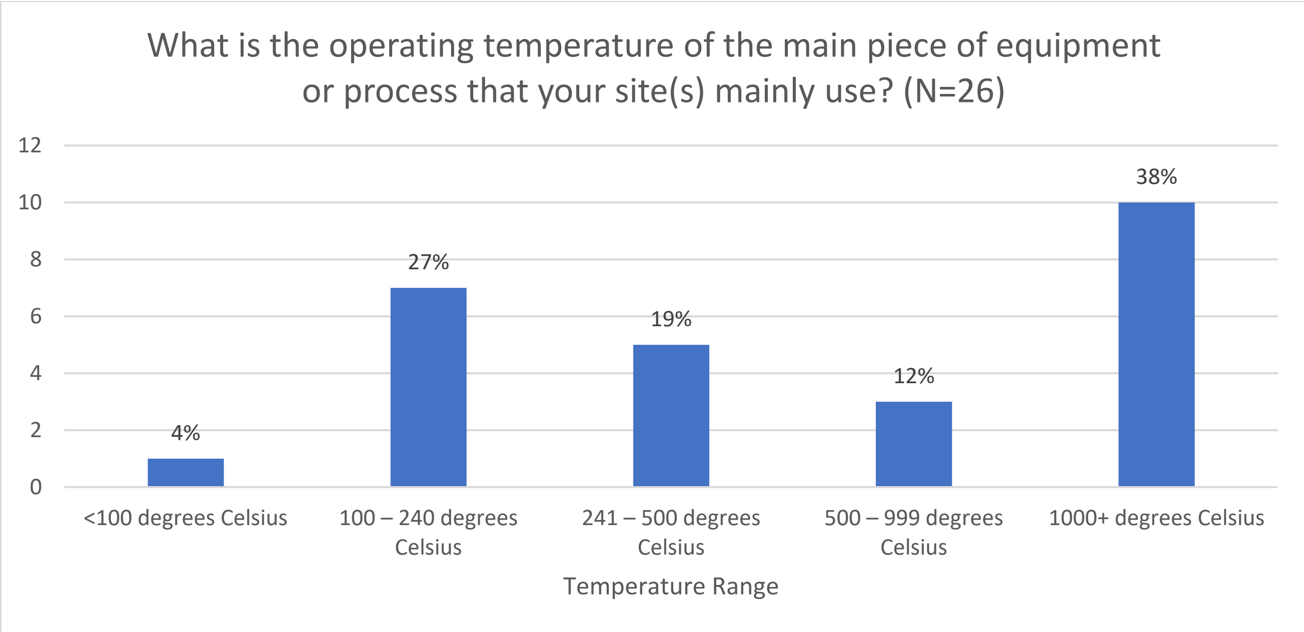
33 respondents provided an answer to the question asking about their job role. At least two-thirds of these are in a managerial or technical/engineering occupation (Figure 6). It is worth noting that respondents may have consulted others within their organisation when completing the call for evidence survey.

Figure 6: Respondent's Job Role (N=33)



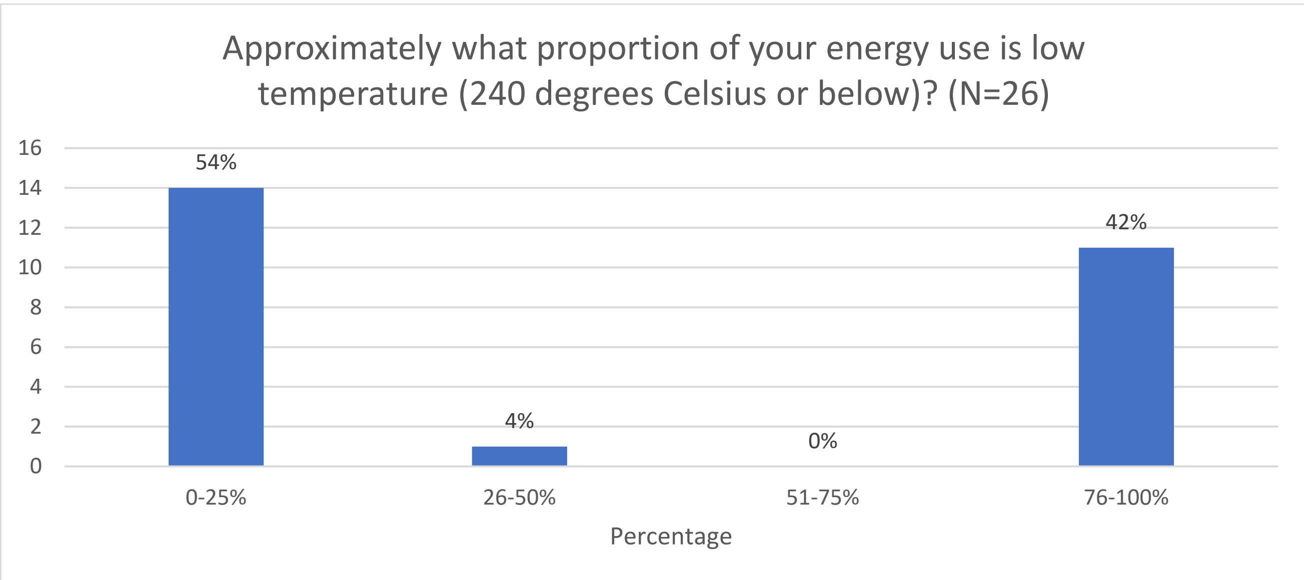
26 respondents stated the operating temperature of the main piece of equipment or process that their site(s) use (Figure 7). 38% of these technologies/processes operate at temperatures exceeding 1000 degrees Celsius.

Figure 7: What is the operating temperature of the main piece of equipment or process that your site(s) mainly use? (N=26)



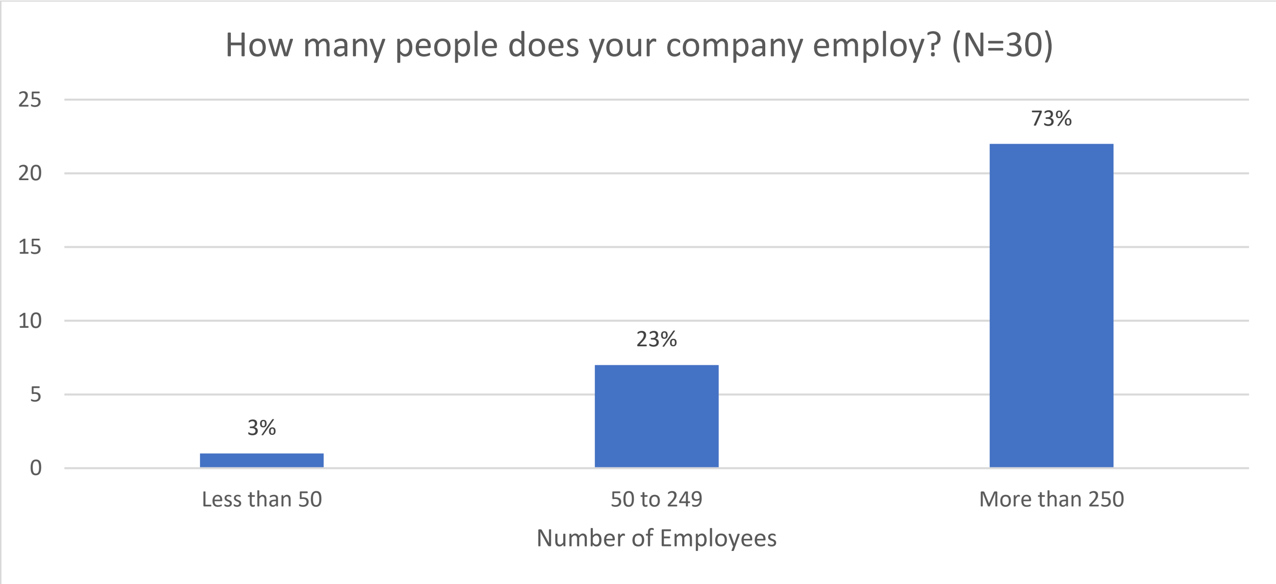
26 respondents stated the approximate proportion of their energy that is used in low temperature processes (defined as 240 Celsius or below) (Figure 8). Over 40% of respondents stated that over 75% of their energy is used in low temperature processes, with just over half of respondents stating that only up to 25% of their energy is used in low temperature processes.

Figure 8: Approximately what proportion of your energy use is low temperature (240 degrees Celsius or below)? (N=26)



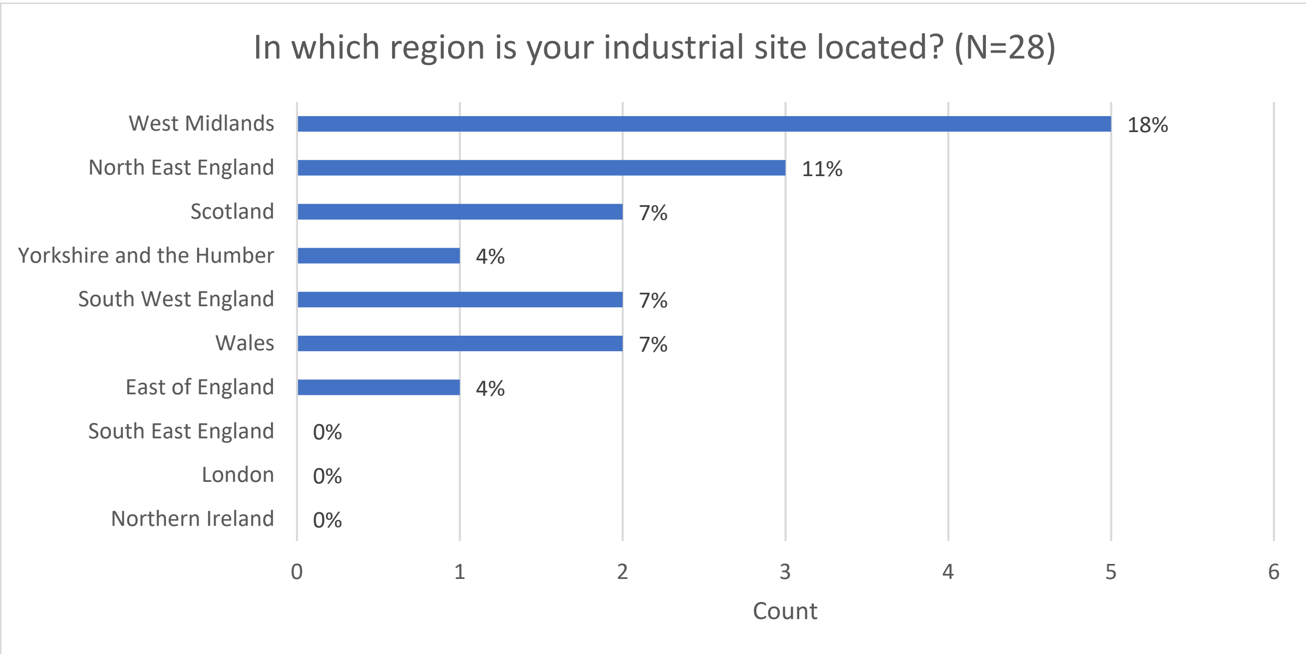
30 respondents stated the number of employees their company has (Figure 9). Over two-thirds of respondents represented a company that employs more than 250 people, almost a quarter with between 50-249 employees, and 1 with less than 50 people.

Figure 9: Number of Employees by Company (N=30)



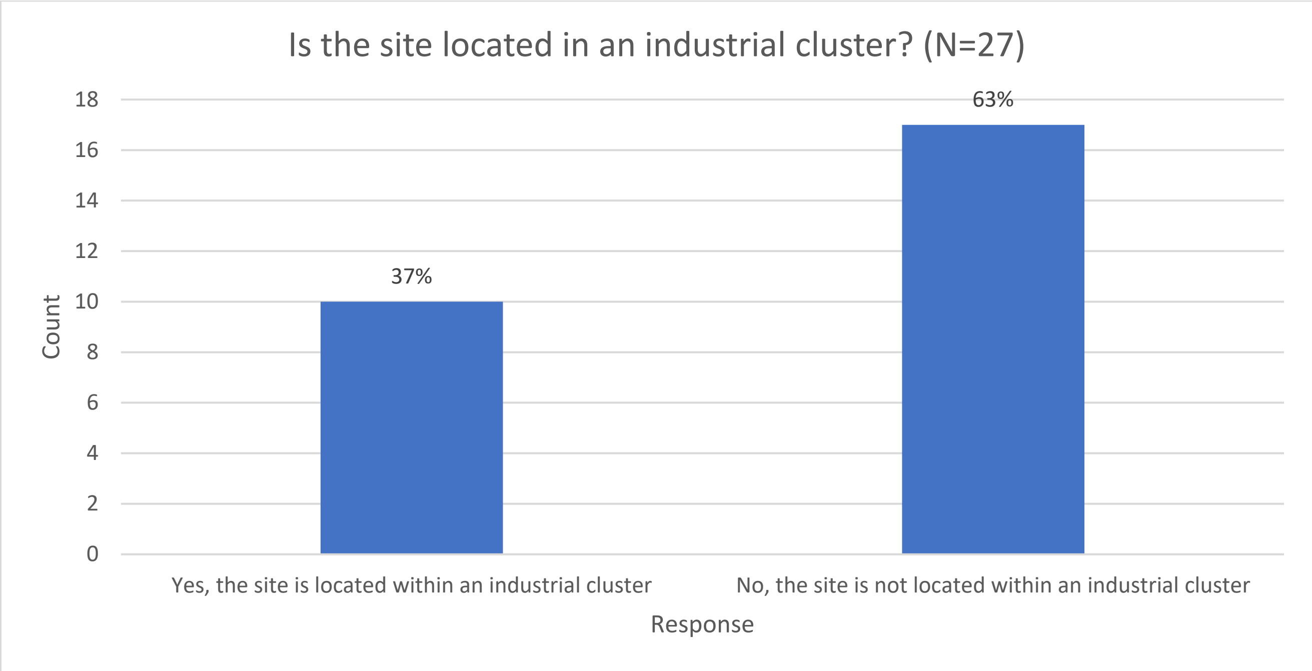
28 respondents stated where their main industrial site is located (Figure 10). 5 respondents stated West Midlands, followed by 3 respondents stating North East England. None stated London, Northern Ireland, or South East England.

Figure 10: Respondents by region (N=28)



27 respondents confirmed whether their site is in an industrial cluster (Figure 11), of which 10 were in an industrial cluster, with the rest reporting they are not.

Figure 11: Industrial cluster (N=27)



Annex B - Question by question responses

Q19. Do you know of any other advantages associated with electrification of industrial processes that have not been described here?

Respondents noted several additional advantages of electrification beyond those outlined in the call for evidence. Respondents most commonly cited the role electrification can play in enhancing process efficiency, improving occupational health and safety, and reducing compliance and pollution abatement equipment costs. It was also noted that electrification can help to reduce demand for hydrogen and bioenergy, allowing those options to be better targeted where they are most needed.

Respondents also mentioned that, once the grid is decarbonised, electrification results in very low or zero residual emissions. Additionally, electrification can help to ensure energy security, reduce wastage through local generation, and support circular economy practices. The potential for use of technological advancements, such as demand-side response and AI automation, are further benefits. Respondents also noted that legal structures may be simpler, and the equipment footprints can be smaller.

Q20. has been combined with Q29.

Q21. Do you agree with the information presented [regarding the TRL and specifications of various electrification technologies]? If you disagree, please provide specific details and supporting evidence?

Q22. Is there any new evidence you would like to submit on electrification technologies, either in relation to the technologies listed or technologies that might be missing? If yes, please provide details.

12 respondents agreed with the information table presented in the call for evidence, 20 suggested specific examples of technology to be added, 11 provided new or updated Technology Readiness Level (TRL) information. Several other corrections were also given which we have considered in our analysis.

Table 3: Agreement with TRL and technical specifications presented

Comment	Count
Agree, no further information provided	12
Missing technology specified	20
Provided new TRL information	11
Example of sites with a technology given	4

Missing process specified	3
Other correction	8

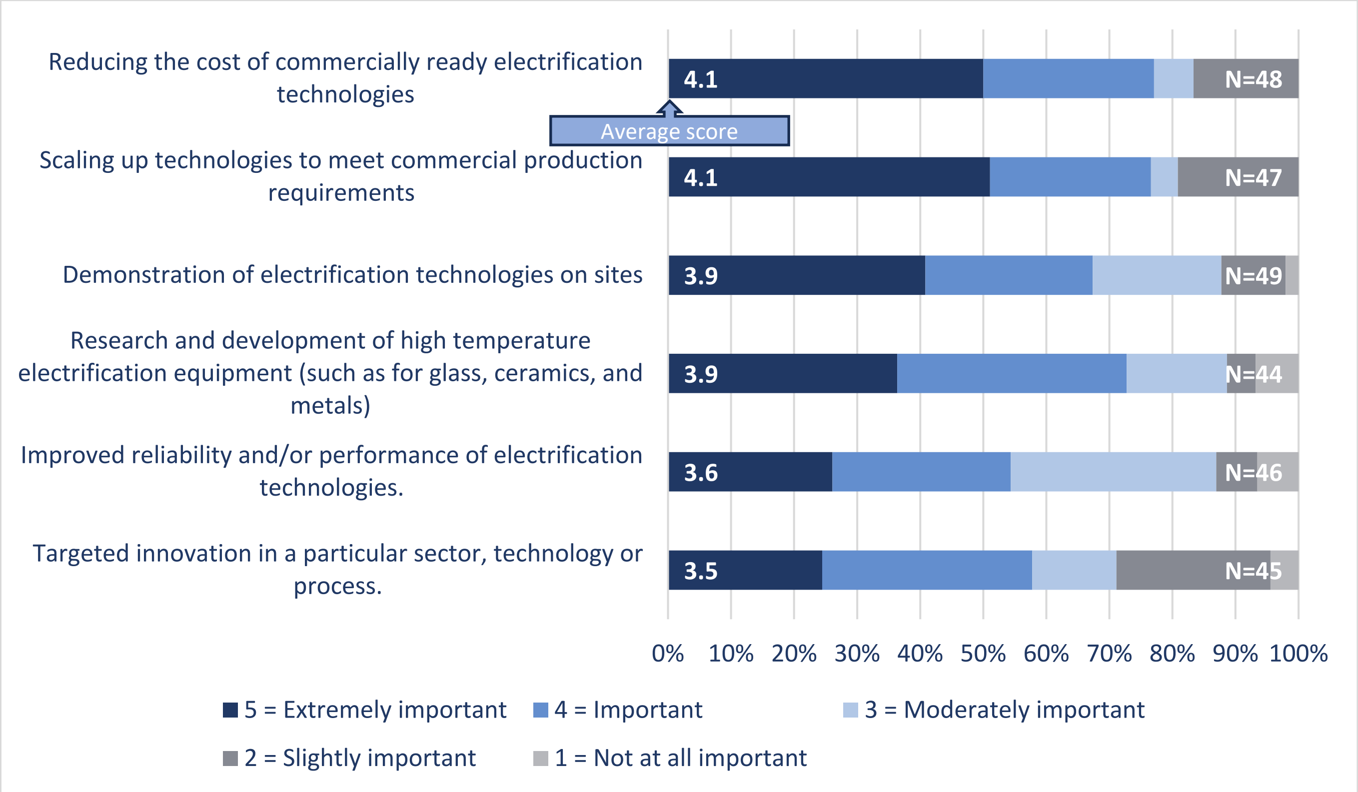
Q23. Listed below are the areas of focus for innovation of electrification technologies. Please rate their importance using the following scale: 0 = Don't know, 1 = Not at all important, 2 = Slightly important, 3 = Moderately important, 4 = Important, 5 = Extremely important.

- Reducing the cost of commercially ready electrification technologies
- Scaling up technologies to meet commercial production requirements
- Demonstration of electrification technologies on sites
- Research and development of high temperature electrification equipment
- Targeted innovation in a particular sector, technology or process.
- Improved reliability and/or performance of electrification technologies.
- Other, please provide details – including their ranking of importance.

Respondents were asked to rank the importance of the key areas for innovation (Figure 10). Reducing the cost of those electrification technologies already available and scaling up other technologies to meet wider commercial production requirements were ranked as the most significant areas for further development.

Figure 10: Areas of focus for innovation of electrification technologies

A note on the average scores in the Likert scales: The inner white number provides the average score of importance for each area where the degree of importance (ranging from one to five) is multiplied by its frequency.



Q24. If you rated "Targeted innovation in a particular sector, technology or process" at a 3 or above in the previous question, please provide details on your reasoning for this.

Respondents mostly indicated that resolving electrification challenges, particularly for high temperature processes, should be the priority for innovation. Respondents highlighted the need for further innovation in specific sectors or technologies, including the requirement for increasing the commercial availability of certain technologies for electrification. Respondents also mentioned that certain sectors have unique considerations for decarbonisation. We have taken this information into account in our analysis.

Q25. Do you agree with the site archetypes defined in this chapter?

Archetype 1 – Low temperature, dispersed
Archetype 2 – Low temperature, clustered
Archetype 3 – High temperature, dispersed
Archetype 4 – High temperature, clustered

Respondents largely agreed with the archetype definitions, with 34 indicating agreement and 12 indicating some level of disagreement or considerations to refine and improve the approach. On **temperature**, respondents emphasised that high temperature processes can vary widely and should not automatically be lumped together. Some respondents felt that the low temperature threshold should be higher or suggested that more than two temperature categories may be beneficial.

On **technology and equipment**, respondents noted that direct heating was not considered in definitions, the role of heat pumps and heat networks should be adequately reflected, and that the operating temperature of equipment can vary across a site making it difficult to classify into a particular archetype in some cases. The **cluster definition** was considered by some to be too broad, with the boundary of a cluster difficult to define, and the role of mini clusters also requiring consideration. Respondents highlighted **site considerations** such as the age of the current plant, temporary sites (e.g. construction), and site size as important factors that are not easily captured in the proposed archetype model.

Table 4: Site Archetype Definition

Agree or disagree with the archetype definitions	Count
Agree with archetype definitions	34
Disagree with archetype definitions	12

Q26. Do you agree with the role of electrification of these archetypes presented here? Please provide details.

This question sought to test the role of electrification presented for each of the archetypes. 25 respondents indicated that they agreed, with 15 disagreeing.

Respondents highlighted several additional considerations for the role of electrification in the archetypes. Some emphasised that many high-temperature electrification technologies are already commercially available. They also noted that electrification suitability and feasibility will be site and process-specific and is dependent on a reliable, low carbon electricity supply. The roll-out of a hydrogen network is also a factor, with dispersed sites potentially considering on-site hydrogen storage with road transport. While electrification is technically preferable for many sites, it is often considered too expensive. Electrification should be the default option for heating below 240 degrees, although not all low-temperature electrification technology is commercially available at scale. Other respondents stated that electrifying CHP plants is not seen as the optimal solution; the refining sector should sit in Archetype 4; the role of CCUS and bioenergy should be considered; and electrification is often the preferred option for the glass sector.

Table 5: Role of Electrification in Site Archetypes

View on role of electrification in archetypes presented	Count
Agree with role of electrification presented	25
Disagree with role of electrification	15
Unclear	2

Q27. Please rate the barriers to industrial electrification in terms of their severity using the following scale: 0 = Don't know, 1 = Not a barrier, 2 = low severity, 3 = moderate severity, 4 = severe, 5 = extremely severe, don't know.

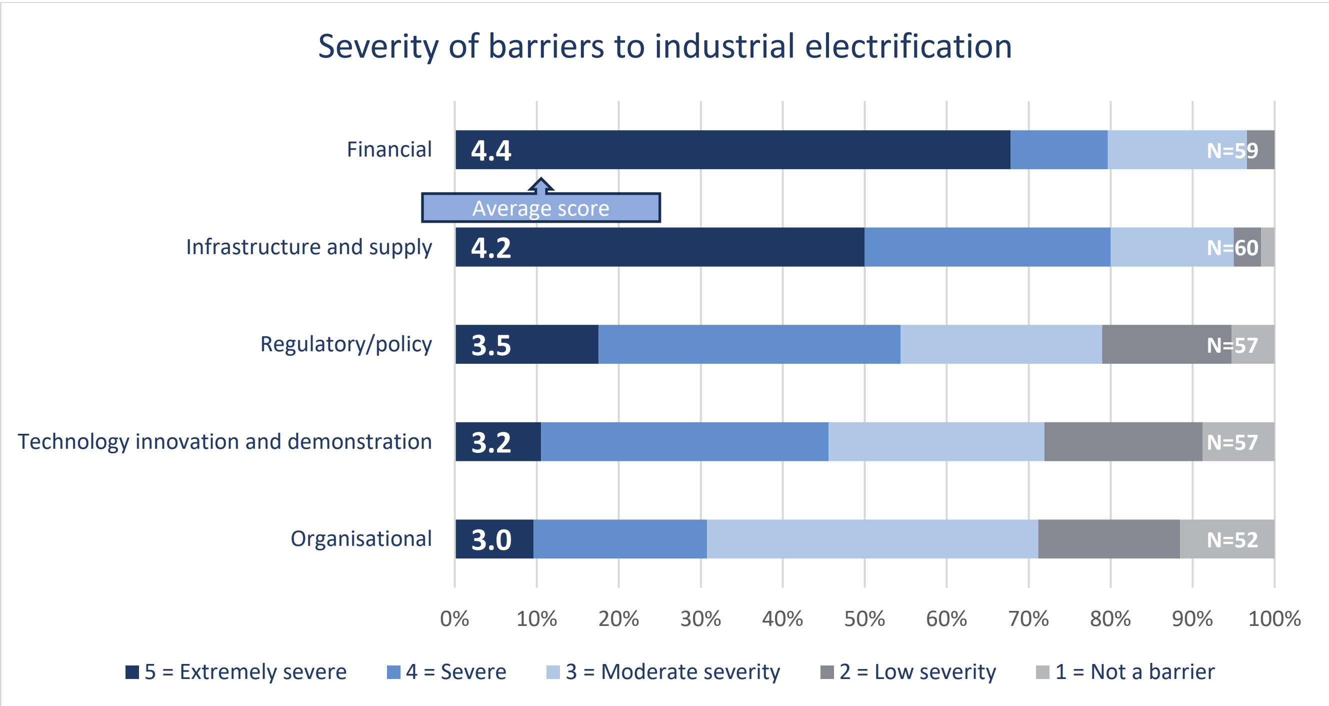
- Technology innovation and demonstration
- Financial
- Infrastructure and supply
- Organisational
- Regulatory/policy

Q28. If you rated any of the above barriers as 4 or higher, please provide further details.

These questions seek to identify and rate the severity of barriers to industrial electrification. In Figure 11, the shaded bars show the proportion of respondents rating each barrier from extremely severe (5) through to not a barrier (1). The inner white number provides the weighted average score of importance for each area. Q27 received a total of 61 responses, with some respondents not rating each barrier. The barrier regarded as being the most severe, when assessing based on weighted average score or the proportion that stated it as either 'Extremely important' or 'Severe' was 'financial', followed by 'infrastructure and supply' barriers.

Figure 11: Severity of barriers to industrial electrification

A note on the average scores in the Likert scales: The inner white number provides the average score of importance for each area where the degree of importance (ranging from one to five) is multiplied by its frequency.



Responses to Q28 yielded some rich qualitative data, including examples of challenges at a site level. Although not summarised here due to the complexity and potential commercial sensitivity of some of the data, we have taken this information into account in our analysis.

Q29: Are there any other barriers preventing the switch away from fossil fuels towards electricity? If yes, please provide details.

Owing to the similarity of the responses received, this question was combined with Q20.

Q20: Are there any disadvantages of electrification of industrial processes? If yes, please provide details.

Respondents highlighted several additional challenges with the switch to electricity which were not mentioned in the call for evidence**.** 10 respondents mentioned additional **infrastructure** challenges, including uncertainty of sufficient renewable electricity and grid limitations for onsite renewables. 6 respondents emphasised other **economic/financial** challenges, including mentions of uncertainty about future electricity and carbon costs, insufficient carbon taxation on gas, and unclear government policy direction hindering progress. 4 respondents cited **organisational** concerns, including safety considerations for high voltage electricity and the need for stronger advocacy. 4 respondents mentioned **technology availability and scalability** challenges involved such as supply interdependencies, backup power requirements, and the cost of retiring incumbent technology early. Lastly, 3 respondents mentioned **regulatory and policy** issues arising from adjacent policies that can disincentivise electrification.

Q30. How do these barriers impact electrification of sites in each of the below archetypes?

Archetype 1 – Low temperature, dispersed
Archetype 2 – Low temperature, clustered
Archetype 3 – High temperature, dispersed
Archetype 4 – High temperature, clustered

This question sought to understand how the barriers affected each site archetype differently. The below table summarises the barriers which respondents mentioned which are particularly severe for each archetype.

Table 6: Barriers to Electrification in Site Archetypes

Barriers	Archetype 1	Archetype 2	Archetype 3	Archetype 4	Common to All

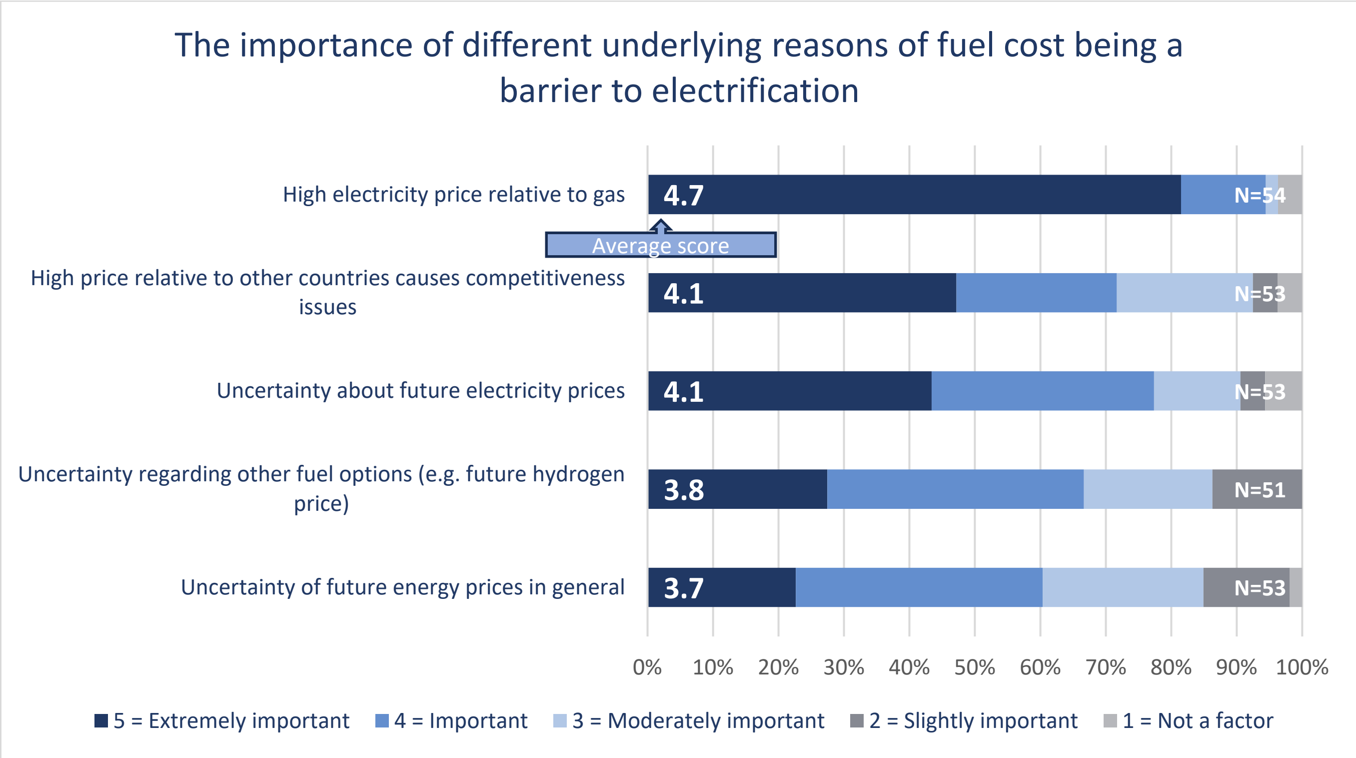
Infrastructure and supply	x	x	x	x	x
Economic and financial constraints	x	x	x	x	x
Regulatory/policy uncertainty (particularly hydrogen or CCUS network access)	x		x		
Technology availability and scalability (particularly low readiness for specific applications)			x	x	
Organisational challenges (particularly skills, qualifications, personnel shortage)			x	x	

Q31. Please rank the following factors to describe the underlying reason(s) for fuel cost as a barrier to electrification using the following scale: 0 = don't know, 1 = not a factor, 2 = slightly important, 3 = moderately important, 4 = important, 5 = extremely important.

- High electricity price relative to gas
- Uncertainty about future electricity prices
- Uncertainty regarding other fuel options (e.g. future hydrogen price)
- Uncertainty of future energy prices
- High price relative to other countries causes competitiveness issues
- Other, please provide details

The number of responses varied slightly, from 52 to 55 depending on the suggested reason (Figure 12). 'High electricity price relative to gas' is easily identified as the most important contributor to elevating fuel cost as a barrier to electrification, followed by 'uncertainty regarding other fuel options' and 'high prices relative to other countries causes competitiveness issues' which received a similar score in terms of average importance. In this question, respondents had the option to provide other suggestions that they feel are underlying reasons of fuel cost being a barrier to electrification. Respondents confirmed that electricity price is a key issue.

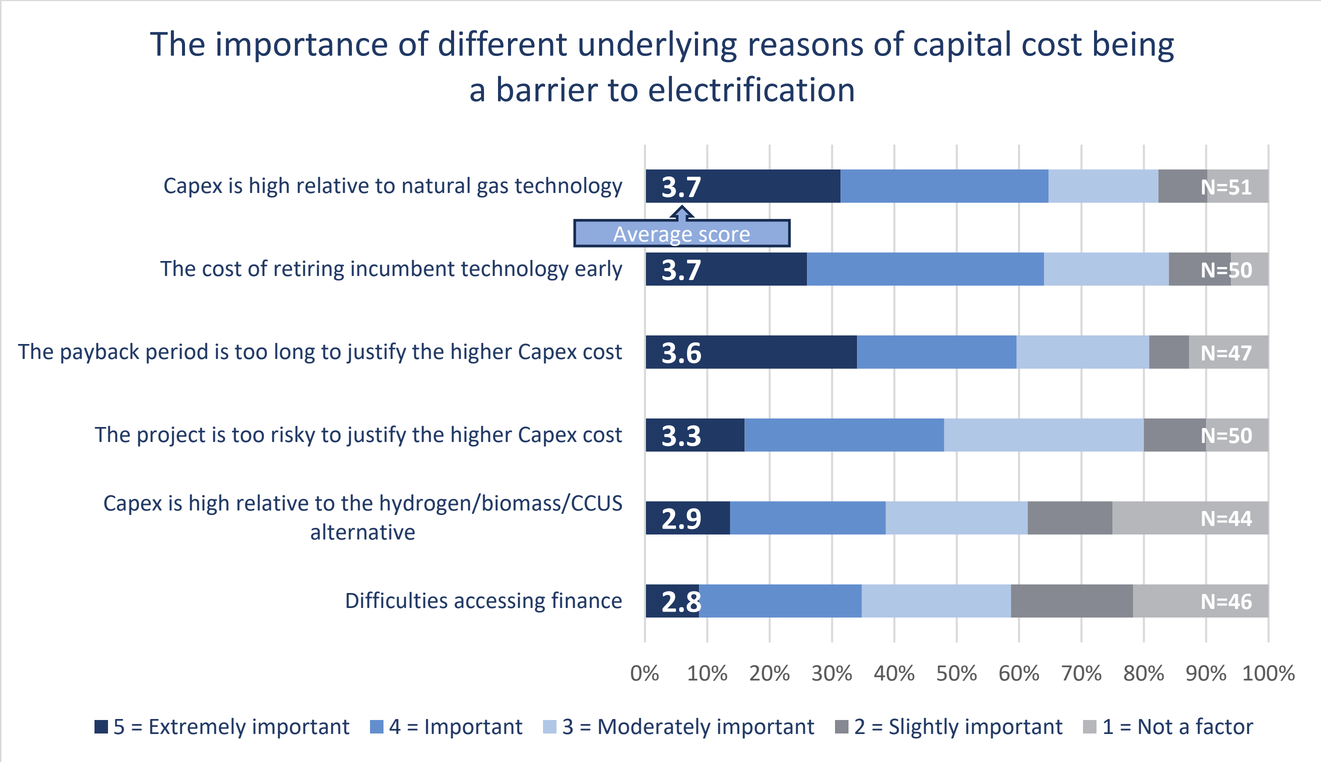
Figure 12: The importance of different underlying reasons of fuel cost being a barrier to electrification



Q32. Please rank the following factors [shown in Figure 13] to describe the underlying reason(s) for capital cost as a barrier to electrification using the following scale: 0 = don't know, 1 = not a factor, 2 = slightly important, 3 = moderately important, 4 = important, 5 = extremely important.

Q32 asked respondents to rank different factors contributing to the role of capital costs as a key barrier to electrification. Respondents also had the option to suggest other reasons for capital cost as a barrier (Figure 13). A commonly raised theme is the high capex involved in switching, which includes cost incurred from the grid connection/electricity capacity expansion, and the costs incurred from building modifications to accommodate the connection/expansion and the electric power technology.

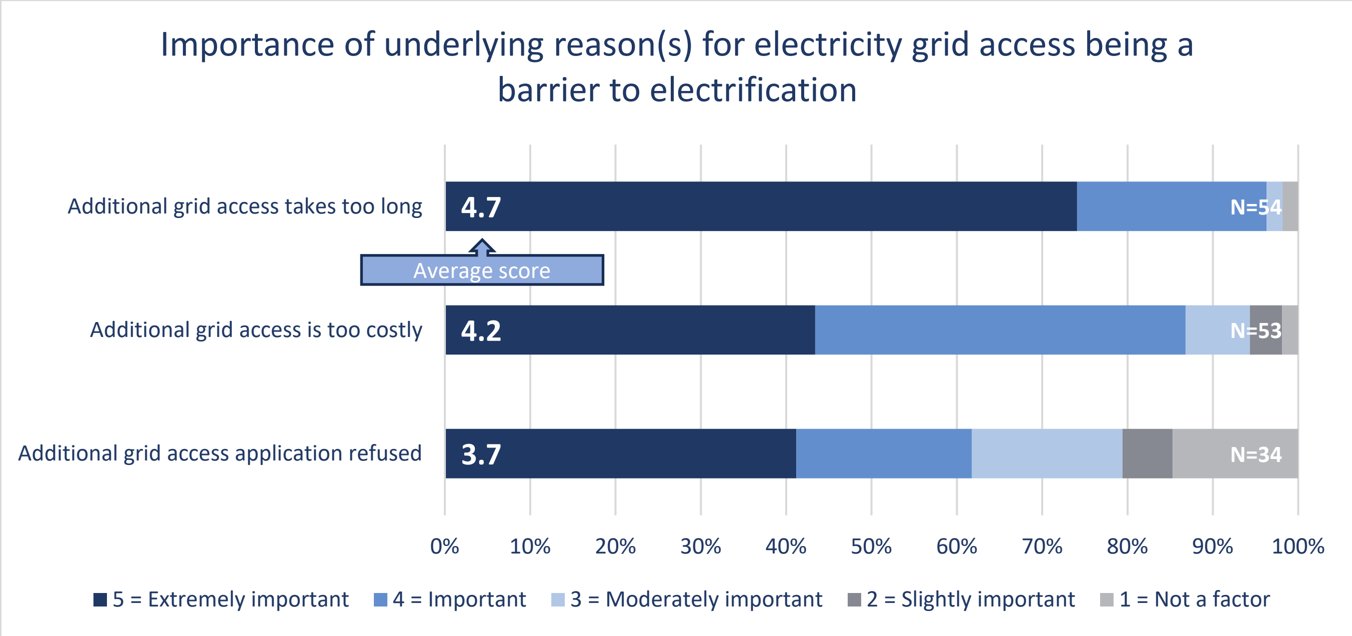
Figure 13: Ranking the underlying reasons of capital cost being a barrier to electrification



Q33. Please rank the following factors [shown in Figure 14] to describe the underlying reason(s) for electricity grid access as a barrier to electrification using the following scale: 0 = don't know, 1 = not a factor, 2 = slightly important, 3 = moderately important, 4 = important, 5 = extremely important.

Similarly, respondents also had the option to suggest other reasons for electricity grid access being a barrier to electrification (Figure 14). The most common explanation given was the lengthy wait for the necessary additional grid access to be delivered, followed by the prohibitive costs of these connections and issues relating to grid applications being rejected.

Figure 14: Ranking of the underlying reason(s) for electricity grid access being a barrier to electrification



Q34. Does private renewable generation act as an enabler for industrial electrification? Please provide details of your rationale.

These questions were intended to gather views on whether private renewable generation could act as an enabler for industrial electrification and whether there are any barriers to private renewable generation for industry.

Overall, respondents largely agreed that private renewable generation acts as an enabler for industrial electrification. 46 indicated that private renewable generation can be enabler and 3 did not think private renewable generation can be an enabler.

Table 7: Private renewable generation as an enabler to electrification

Private renewable generation as an enabler	Count
Yes, can be an enabler	46
Unclear	3
Not an enabler	3

Private Renewable Generation (PRG) was seen by respondents as a key enabler of electrification for several reasons. 25 respondents cited **financial and economic benefits**. Respondents emphasised that PRG can provide certainty on electricity costs, reduce fuel costs, and offer a payback on investment. PRG also avoids non-commodity costs associated with power imports and can generate revenue from exported electricity. 8 respondents noted **infrastructure** benefits, including the ability to circumvent grid connection requirements, support grid flexibility and capacity, and usefulness in dispersed sites where grid infrastructure is weaker. 3 respondents cited **technical** benefits; PRG supporting flexible energy consumption, improving site agility, and the potential of renewable thermal generation as an enabler. **Organisational** benefits also came up, with improved environmental performance from renewable energy. These factors make PRG an attractive option for off-grid/micro-grid generation models, where funding can be easier to obtain and lead times can be shorter.

Q35. Are there any barriers to deploying private renewable generation for industry? If yes, please provide details on how to overcome them.

The barriers to private renewable generation can be categorised into technical, infrastructure & supply, regulatory/policy, financial & economic, and organisational. 36 respondents cited **technical** barriers, particularly the limited generation capacity for industrial sites and intermittent generation profiles. Other technical barriers included installation challenges, large land requirements, stringent equipment requirements from DNOs, limited availability of installers, geographical limitations, long-term energy storage challenges, and maintenance issues. 33 respondents noted **infrastructure and supply** issues, particularly those involving challenges with grid connection applications and network security standards. Respondents also noted technical issues relating to private wiring. 16 respondents mentioned **regulatory and policy** barriers, particularly challenges relating to the planning regime. Respondents also mentioned regulations hampering onshore wind, Ofgem measures reducing embedded benefits of onsite generation, interactions with CHP policy, limited government support, and the longevity of the regulatory policy framework. 11 respondents mentioned **financial and economic** barriers, particularly increased Capex. Respondents also mentioned long payback times for renewable generation projects, lack of fiscal support, and risks associated with energy markets. 3 respondents **cited organisational** barriers, including complex PPA contracts, administrative burdens, and lack of clarity on ownership/responsibility for transmission and distribution.

Q36. Could demand side response (DSR) act as an enabler of industrial electrification? Please provide your rationale.

These questions sought to gather views on whether demand side response (DSR) could act as an enabler for industrial electrification and whether there are any barriers to DSR for industry.

Overall, respondents were split on whether DSR acts as an enabler for industrial electrification. 24 respondents indicated that DSR can be an enabler and 20 indicated that it is not an enabler.

Table 8: Demand side response as an enabler to electrification

DSR as an enabler	Count
Yes, an enabler	24
Not an enabler	19
Unclear	7

Respondents cited several reasons for Demand Side Response (DSR) as an enabler for industrial electrification. 12 respondents cited **financial and economic** reasons, particularly the potential for revenue generation from exported electricity. Respondents also mentioned reduced network charges, and lower fuel costs. **Infrastructure and supply** benefits were mentioned by 6 respondents, with the primary reason being the support for grid flexibility and capacity. 6 respondents cited **technical** benefits; DSR's ability to support flexible energy consumption, especially when combined with thermal storage, and its role in supporting energy efficiency and conservation.

Q37. Are there any barriers to using DSR for industry? If yes, please provide details on how to overcome them.

Respondents cited several barriers to Demand Side Response (DSR) for industry. The most significant barrier was **technical**, cited by 29 respondents, particularly the challenges presented by intermittent and large-scale industrial energy use. The challenges with installation and integration with existing equipment was also mentioned. **Financial and economic** barriers were cited by 10 respondents. These included a lack of fiscal support and incentives for DSR, challenges and expenses related to off-peak staffing, costs from final consumption levies on power imports, and increased capital expenditure. **Organisational** barriers were cited by 2 respondents and included administrative and legal burdens on sites and a lack of industry awareness of DSR potential. Finally, **infrastructure and supply** issues were mentioned by one respondent, specifically the administrative burden on the National Grid.

Q38. Are there other policies (either current or in development) that could positively or negatively impact industry's ability to switch away from fossil fuels to electricity?

This question sought to ensure that the call for evidence had captured all relevant policies which may impact the ability of industrial sites to electrify. The complex nature of industrial fuel switching, with long lead in times and a variety of factors to take into consideration, requires a comprehensive assessment of different policies to encourage the desired behaviour change.

The most responses were received for CBAMs (8 respondents) and the Hydrogen business model (5 respondents). As hydrogen and electrification are competitive alternatives to fossil fuels, the policy environment for both will be monitored closely as industry assesses which is best suited to site specific requirements. A single response was received for each of the following: Mandatory Product Standards, Carbon Capture Business Model, Mandatory Transition Plan Reporting, Energy Savings Opportunity Scheme, Mineralogical and Metallurgical Exemption Scheme, Mandatory Climate Related Financial Disclosures, Network Cost Compensation, Green Distilleries Scheme, Nuclear RAB Levy, Support for CHP through CHPQA Programme, and Onshore Wind Policy.

Q39. Considering the whole impact of existing policies and the exploratory/planned policies: is further electrification specific intervention needed to enable the electrification of industry in the 2020s and 2030s?

This question asked respondents to consider whether further electrification specific intervention is required to enable the electrification of industry in the 2020s and 2030s. The overwhelming majority (50) thought that further interventions are needed. Respondents also gave evidence of why further intervention is required, along with suggestions for what these interventions should entail, which we have considered in our analysis.

Table 9: Electrification specific policy intervention

Themes	Count
Yes, further interventions are needed	50
No further intervention needed	1

Q40. Do you agree with these principles for a policy that enables industrial electrification?

Policy should:

- drive decarbonisation of industrial sites in the 2020s and 2030s;
- be consistent with the wider industrial decarbonisation policy landscape;
- ensure value for money;
- provide confidence to those funding the electrification by allocating a proportionate level of risk;
- be affordable and fundable over time;
- be practical and simple, both from government and end user perspective.

Are there other principles we should be considering?

Chapter 3 included a list of six principles which would guide future development of industrial decarbonisation policy. Question 40 sought to understand if these were the appropriate principles, and if any additional principles should be included. 34 agreed with the proposals, whilst 17 provided comment but did not specify whether they agreed or disagreed.

Table 10: Electrification policy principles

Agreement with principles	Count
Agree	34
Nil return/did not specify	17

The most common additional principle suggested was the maintenance of UK industrial competitiveness, mentioned in 9 responses. 6 respondents suggested that the timeframe should be extended into the 2040s, and 6 also suggested ensuring the most appropriate technology is deployed in pursuit of decarbonisation as an additional principle. Other suggestions included promoting collaboration across industry, enabling renewable energy and grid connections, ensuring policy support was similar to that available for hydrogen development, ensuring just transition, ensuring an efficient use of constrained resources (e.g., land) and support for research and innovation.

41. How could Government facilitate an enabling environment for electrification?

43. What regulatory approaches could the Government explore to incentivise or enable electrification?

44. How could a funding policy be structured effectively to incentivise or enable electrification while meeting the principles outlined above?

46. Are there smaller or indirect policy changes that could enable businesses to electrify? If yes, please provide details on what these might look like.

48. Is there anything further that you think we should be considering when thinking about policy options to enable electrification?

In our analysis, we have combined these five questions as they are all seeking to answer the same question of how government can facilitate an enabling environment for electrification. 39 respondents provided policy suggestions to address **network barriers**. Suggestions focussed around resolving grid issues and enabling increased onsite renewable generation. Respondents also mentioned enabling grid decarbonisation and grid infrastructure matched funding.

28 respondents provided views on policy for **Operational Expenditure (Opex)**, and the suggestions focussed on an electrification business model and/or Contracts for Difference (CfD) style support and exemptions from policy costs. Other suggestions included direct support or subsidies for electricity costs, decoupling the electricity price from the gas price, reduced network charges, and stability of electricity costs.

25 respondents provided views on policy for **Capital Expenditure (Capex).** Suggestions were centred on Capex for deployment, funding for Research & Development (R&D), alterations to

the Industrial Energy Transformation Fund (IETF) and other financial incentives. A respondent also mentioned funding for local area plans.

21 respondents provided views on **regulations**. The most cited view emphasised that additional regulation is not the appropriate course of action at this time, whilst others called for enhanced lead times for grid upgrades and compulsory reporting for carbon emissions. Calls were also made for national guidelines on public tender requirements for emissions-free construction, the implementation of equipment performance standards, legal net-zero target dates for industry, and product standards. Some underscored the importance of regulatory stability and the necessity for UK regulations to be in harmony with international regulations.

34 respondents provided views on **other policy measures**. Respondents most commonly cited the importance of consistent and simplified policies, long-term signals, and information sharing and industry co-ordination. Respondents also mentioned the following: robust carbon pricing, tax deductions/breaks, creating an environment which facilitates private investment, insurance-backed guarantees, allowing transitional fuels, Building Energy Management Systems, Carbon Border Adjustment Mechanism, changes to Climate Change Agreements (CCAs), continued acceptance of CE marked only Non-Road Mobile Machinery (NRMM), enabling growing supply chains, Renewable Heat Incentive schemes, timely transitions, and purchase incentives for zero-emission construction equipment.

Q42. In your view, which of the two options is preferable: policy specifically for electrification or a broader "fuel switching" policy, that allows sites to choose their optimal decarbonisation route?

This question aimed to understand stakeholder preferences between developing electrification-specific policy or a broader approach covering fuel switching more generally. 29 respondents supported a technology-neutral approach to fuel switching, while 11 were in favour of an electrification specific policy.

Table 11: Preferred policy approach

Policy	Count
Broader fuel switching policy	29
Electrification specific policy	11
Nil return/not specified	13

The most common reason given for supporting the broader approach related to site specific requirements. Respondents noted that the flexibility of this approach may allow greater autonomy for each site to proceed with their own optimal method.

Those supporting targeted electrification policy had a wider variety of reasons, with the most common being that electrification should be a priority in the short-term to avoid locking in fossil fuel use. Additional explanations included the concern that hydrogen and CCUS business models are reducing the feasibility of technology-neutral policy; the unique challenges and complexity of electrification warranting specific policy support; and the need for support in deciding between hydrogen or electricity for specific sites.

Q45. Are there any risks of a funding policy for electrification? If so, how could these be mitigated?

The main risk raised was that unsuitable solutions or technologies may be promoted through perverse incentives. To address this risk, respondents emphasised the need for balanced support across various decarbonisation approaches. Additionally, greater clarity regarding the role of hydrogen and infrastructure plans was mentioned.

To mitigate the risk of escalating costs for sites without immediate electrification options, respondents advocated for supporting interim solutions like Combined Heat and Power (CHP). Furthermore, some respondents highlighted the importance of not penalising those without viable alternatives.

The survey also identified the risk that grid-related issues may be exacerbated due to increased demand, with some participants emphasising the need for grid reform to mitigate this risk.

Other risks mentioned include funds not reaching the intended market; poor funding design leading to companies leaving the UK; funding being overpromised or not readily available; funds only being available for existing machinery and not for new sites; and potential restrictions or dependency on funding.

Q47. Are there policy options or international examples that could enable or incentivise electrification that we should be considering?

Respondents gave several international examples and policy options related to incentivising electrification that the UK could consider.

The most cited was the carbon contracts for difference scheme (8 respondents) and Ardagh – NextGen Hybrid Furnace (5 respondents), both in Germany. The full list of suggestions is below:

- **Germany**: Carbon Contracts for Difference Scheme; Ardagh - NextGen Hybrid Furnace; Federal Funding KsNI - Climate-Friendly Commercial Vehicles; RWE Programmes, and E.ON Programmes.
- **Spain**: Power Purchase Agreements (PPAs)
- **US**: Inflation Reduction Act; Texas University - R+D for Electrification; Department for Energy's Office of Clean Energy Demonstrations - Advanced Industrial Facilities Deployment Program.
- **EU**: Fit for 55; Tax Benefits and Commercial Incentives for Construction Vehicles; Innovation Fund.

- **The Netherlands**: The Environmental Protection Act - Energy Efficiency and Decarbonization Requirements; National Subsidy Scheme for Construction Equipment.
- **France**: EDF Programmes.
- **Norway and Sweden**: National Purchase Incentive Schemes for Construction Equipment.
- **Portugal**: EDP Programmes.