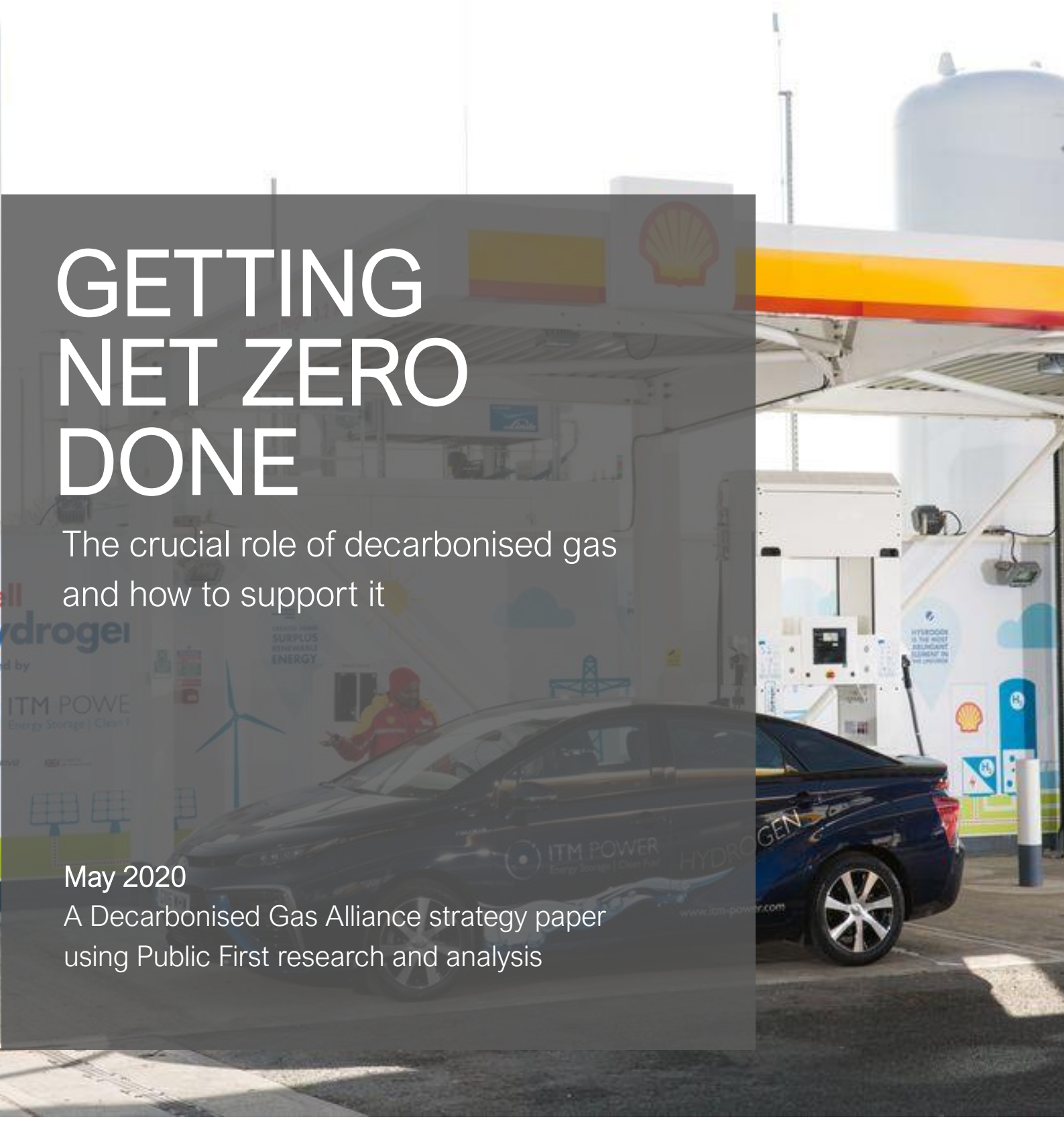
Decarbonised Gas Alliance



GETTING NET ZERO DONE

The crucial role of decarbonised gas and how to support it

May 2020

A Decarbonised Gas Alliance strategy paper using Public First research and analysis

PUBLICFIRST

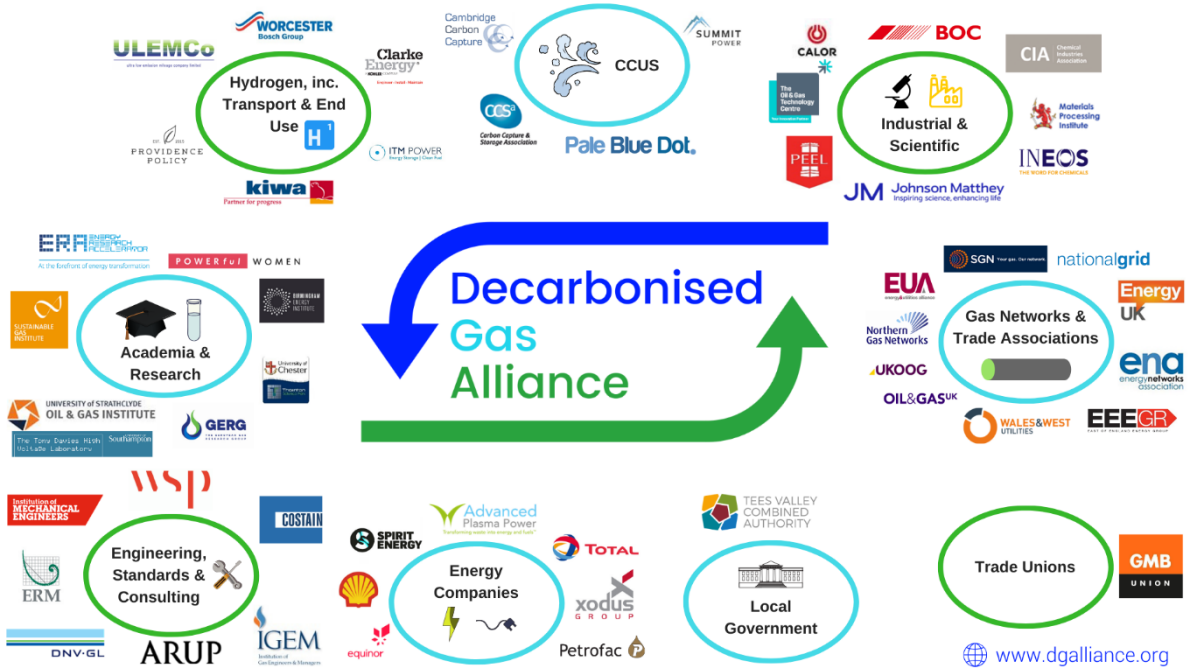
Contents

About the Decarbonised Gas Alliance

The Decarbonised Gas Alliance (DGA) is an alliance of over 50 gas producers, transporters, suppliers and users, hydrogen and carbon capture experts, alongside R&D, supply chain, trade union and local government specialists whose knowledge and expertise will be vital in decarbonising the UK's gas system and improving poor air quality.

Our aim is to work with all levels of government and with other expert organisations to use the gas system as a whole to help deliver our emission reduction and air quality goals. We believe that decarbonising gas – including biogases and hydrogen from a variety of low carbon methods – would make best use of our existing infrastructure and lower the overall costs of decarbonisation.

The DGA is a broad-based alliance, established in late 2016, and has now expanded to over 50 signatory organisations, which are listed in full in the diagram below. The DGA secretariat is managed by DNV GL, a global specialist firm which provides advisory, certification and other technical assurance solutions covering a range of energy sources.



About Public First

Public First is an opinion research and policy consultancy. They carried out the detailed opinion research which informs the report throughout, and provided advice on what public opinion means for credible policy. The full quantitative data can be found at www.dgalliance.org.

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Executive Summary and Recommendations

The term 'decarbonised gas' refers to biogases, hydrogen, and carbon capture, utilisation and storage (CCUS). This strategy paper sets out how decarbonised gas can help to get net zero done by tackling the hard-to-decarbonise sectors – industry, heavy transport and domestic heating – which together account for around 40% of UK greenhouse gas emissions. It also illustrates the crucial importance of supportive public opinion, and sets out in detail how decarbonised gas can help to ensure that net zero is achieved with public support. The report is based on extensive quantitative and qualitative opinion research on climate change in general, net zero emissions in the UK, and the specific decarbonised gas solutions in homes, transport and industry. The full quantitative data can be found at www.dgalliance.org.

Understanding public attitudes – net zero

Public First, the research agency, carried out extensive polling and focus groups to understand people's attitudes to net zero emissions in general, and to specific policy suggestions.

The public care about the environment and support the concept of net zero, but when you dig beneath the surface it is clear that they do not understand it. Few have really heard the term, and they at best had only a vague sense of what it meant – they associated it as much with removing plastics from the ocean and air pollution as they did with cutting emissions.

They have no idea of the trade-offs that might be involved.

In deeper conversations and explanation, however, it is clear the public is willing to bear quite a lot in the pursuit of net zero. But there are four red lines:

1. Global collective action. The public do not think the UK is primarily responsible for climate change. They are willing for the UK to play a 'leading' role, but only if other countries are seen to be making substantial effort. This is mostly an unsentimental view of who is actually emitting the most.
2. Cost. Many people do not think they can bear a couple of extra pounds on bills. Almost no one will bear substantial up-front costs to – for example – change their heating system. Cost has the potential to derail, utterly, net zero.
3. Energy security. People are worried that the Government might embark upon an energy policy that will leave Britain reliant on other countries for our energy – and the effects this might have on the predictability of supply and cost. In simple terms, they understand that the 'gas taps' could be turned off by a hostile power. This is a opportunity for net zero.
4. Jobs. People were optimistic that net zero would create, not lose jobs. At the same time, they were clearly worried about the future of the local economy – particularly if they lived near industrial areas. It was clear they would face serious economic difficulties if manufacturing plants or even warehouses closed. The shift in public opinion if faced with any industrial moves because of increased energy costs will, we believe, be dramatic.

The research was done before COVID-19. Our view is that the pandemic will have dramatically intensified all four of these issues and brought jobs much higher up the agenda. People will be nervous about cost, terrified about jobs, and increasingly sensitive to the vulnerability of global supply chains and foreign actors.

Understanding Public Attitudes – decarbonised gas

We tested specific policy interventions in industry, transport, and heating. In general, we were pleasantly surprised by people's willingness to engage with substantial change and possible disruption.

1. In industry there was the most scepticism. Knowledge and understanding was low, but there were also concerns about whether industry and government would spend the money (and if they would pass the costs to consumers), if they could deliver the technology, and whether carbon capture in particular would be safe.
2. In transport there was high enthusiasm, particularly among commuters – for example, 68% support biomethane buses and trucks, with just 5% opposed. This was partly because people cared deeply about air pollution, which they saw this solving. The only major concern was around ticket prices – people think these are already too high and are very resistant to increases.
3. In heating, the main alternative to decarbonised gas – heat pumps – were very unpopular, although a hybrid heating system went down better. Heat pumps were considered inconvenient and a poor substitute – people were unwilling even to entertain them.
   The idea of blending hydrogen and biomethane was popular, and pure hydrogen was also quite popular – 50% support a conversion of home heating to hydrogen, with just 18% opposed. There were a few concerns about a big 'switchover' in terms of digging up the road, and being off gas for a few days, but people were not very worried about replacing their boiler. There were mixed views on hydrogen safety – one focus group didn't have any worries, the other was a bit more concerned.

Underlying this was a clear desire for 'experts' to make the decision for people – although there was also irritation that politicians had given contradictory environmental instructions in the past, for example with diesel cars.

The hard to decarbonise sectors and decarbonised gas

While we have made substantial progress in decarbonising the generation of electricity, in other sectors emissions have barely budged. For the purpose of this report, we have identified three sectors that are particularly difficult to tackle, and where decarbonised gas could play a very substantial part:[1]

1. Industry – 76.5 million tonnes of CO_2 equivalent a year. There are a number of industrial processes where we don't have an alternative to gaseous fuels. Greenhouse gases are also a by-product of many industrial processes. And most importantly, industry should be decarbonised in the UK and not offshored to other countries, with the emissions following suit.
   To protect and increase jobs, we need industry to be able to transition without unbearable costs and with plausible technology – including low carbon gaseous fuels and carbon capture on industrial processes.

[1] BEIS, Final UK greenhouse gas emissions national statistics 1990-2018, Table 3

2. Heavy transport – 35.3 million tonnes of CO_2 equivalent a year.
   While cars can be electrified, long-distance lorries, ships, and aviation need alternative fuels.

3. Domestic heating - 67.5 million tonnes of CO_2 equivalent a year. While there are electric alternatives, electricity is four times the cost of gas. Some of this is due to conscious policy, but even without this decarbonised gas remains cheaper, more storable, and better able to meet peaks in heating demand.
   People are extremely cost-sensitive, and a cheaper option than electricity is needed.

Together these represent 180 million tonnes of CO_2 equivalent – 40% of the UK's emissions.

At the same time we need backup for electricity. We are going to massively increase the size of the grid as we electrify more of the economy. That means a huge increase in the proportion of electricity provided by renewables (currently 33% of a smaller grid). The problem is, renewables are 'intermittent' – the sun doesn't always shine and the wind doesn't always blow. Decarbonised gas – either gas-fired power with CCUS, or power from hydrogen – is a credible back-up source of electricity.

In all these areas, decarbonised gases can provide a solution:

- Biogases are recycled fuels that can be used for heating and transport. They are storable, and do not use fossil fuels in their production.
- Hydrogen can be used to decarbonise heating, transport and industry. Electrolysed hydrogen is zero-emitting. Hydrogen produced from methane creates some carbon dioxide, which then needs to be captured (see below).
- Carbon Capture, Utilisation and Storage (CCUS). Carbon dioxide capture and either usage for other processes, or storage underground, are particularly important for industry and if hydrogen is to work at scale. It makes fossil fuels 'zero emissions.'

We need decarbonised gas to work at scale. This has the ability to keep costs down for households, to protect existing jobs and create new ones, and to enhance our energy security. In the wake of COVID-19 meeting those public red lines is going to be even more crucial.

How to make decarbonised gas happen

Industry needs CCUS and hydrogen at scale. To do that we need:

Direct funding of clusters

1. The Government should bring together existing funding pots to ensure that *all* of the major cluster decarbonisation projects are funded – not least so that projects don't have to make multiple applications for small pots of money.

2. The government should speed up the planning process for major infrastructure. If it can't the funding window should be extended. Planning applications should be prioritised and decisions expedited. Otherwise, the Government should extend the time period for spending the money in the existing funding pots beyond 2024.

Private sector investment

3. **There should be Enhanced Capital Allowances for factories** that replace natural gas burners with hydrogen ones, and equivalent mechanisms for facilities not making a profit should also be considered.

4. **We need Contracts for Difference (CfDs) for hydrogen and carbon capture.** The successful investment and cost-reduction framework for renewable electricity, which was started nearly two decades ago, should be extended to decarbonised gas. This includes decarbonised gas used for power generation as well as sectors such as industry.

Infrastructure

5. **CO_2 pipeline infrastructure** with maximum future use in mind – when multiple plants in an industrial cluster will be connecting to the same carbon dioxide pipeline and when the UK will be storing not only its own carbon dioxide but potentially importing it. Pipelines and undersea storage facilities should be funded through Regulated Asset Base (RAB) funding, in the same way as the super sewer and gas and electricity networks are.

Transport needs support for biomethane and hydrogen:

Infrastructure

6. **The Government should make infrastructure funding available** for hydrogen and biomethane refuelling stations for buses and trucks in particular, and port bunkering facilities for hydrogen or ammonia ships. In line with other groups, we believe that 100 hydrogen refuelling stations should be established by 2025.

Incentivising take-up

7. **The Renewable Transport Fuel Obligation (RTFO) must be extended to hydrogen produced from all low carbon routes.** This includes hydrogen produced from gas with CCUS, and hydrogen produced from electrolysis with a grid electricity connection.

8. **We need large-scale trials to encourage switchover.** In addition to the RTFO change, further support should be given to fleet operators to switch to biomethane or hydrogen. Large-scale trials are likely to reassure companies considering whether to switch.

Heating needs to be made hydrogen-ready:

Make boilers and pipes hydrogen ready

9. **The Government should now mandate that all new boilers should be hydrogen ready.** This will mean that when parts of the gas network are ready to switch to 100% hydrogen, buildings and appliances will be ready to access it. This is a low-regret policy as the additional cost of a hydrogen-ready boiler is minimal (around £50).[2]

[2] https://www.bbc.co.uk/news/science-environment-50873047

10. **The Iron Mains Replacement Programme should continue, and it must work for hydrogen.**

11. **The permitted volume of hydrogen into the gas grid should move to 2 or 3 per cent immediately.** Once the HyDeploy project has been safely completed, the permitted volume of hydrogen into the gas grid should be raised to 20 per cent.

Accelerate trials and development

12. **Ofgem's network innovation funding should be equalised between electricity and gas.** While Electricity Network Innovation has £70 million a year available to them, the gas network's innovation scheme is limited to £20 million a year.[3] Ofgem and Government should also support the efforts of National Grid and gas distribution business in modifying network codes in preparation for future system operation.

13. **The Government needs to commit £50 million a year through this Parliament for new field trials.** This could include bio-LPG, hybrid heating, 100% hydrogen trials and efficient gas-based appliances.

14. **The planned new support scheme for biomethane should be ambitious.** The non-domestic Renewable Heat Incentive has supported around 100 biomethane facilities to connect to the grid. The Budget 2020 announced a new support scheme for biomethane, funded by the Green Gas Levy. The Government will be consulting on introducing levy-funded support for biomethane production to increase the proportion of green gas in the grid.[4] **Voluntary biomethane certificates** also have an important role to play in creating a market for decarbonised gases.

Public opinion needs to remain supportive:

15. **Public opinion tracking.** Carefully monitoring public opinion, how people are feeling and what they want, need and are willing to tolerate will be vitally important if the Government is considering future wide-reaching policy interventions on any scale like the one we have seen with COVID-19.

16. **Net zero communication.** Once the country returns to some semblance of normality, the Government should start to prepare the public for the reality of the changes required to meet net zero. A website, and a consistent presentation of facts and trade-offs, would be an obvious first step.

Overall, the creation of a market needs to be encouraged:

17. **Continue with RED II or its equivalent.** RED II is an EU objective that extends the existing Guarantees of Origin (GoOs) scheme to include decarbonised gases. It encourages investment and facilitates cross-border trade, which will drive competition and ultimately drive down prices, in the decarbonised gas market.

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[3] https://www.ofgem.gov.uk/system/files/docs/2019/11/2019_nic_decision_document_for_publication.pdf

[4] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/871799/Budget_2020_Web_Accessible_Complete.pdf

Chapter 1: Making net zero work: understanding public attitudes

We live in a democracy. As we have seen with COVID-19, any major policy change must have public support (or at least public consent). Politicians, officials and businesses cannot force major behaviour change or increases in cost without people's tacit agreement.
However, as we have seen recently, as long as people understand why drastic action is needed, they can be willing.

The DGA thinks this point – that public consent is crucial – is so important to our collective net-zero obligations that we have spent significant time trying to understand what the public thinks about the environment generally, net zero specifically, and the array of policy solutions the DGA might be involved in delivering, including carbon capture, hydrogen and biomethane.

This policy paper, and its recommendations, has the results of that public opinion work at its core. We want the public to be informed and comfortable with the requirements from a national to an individual level. This was important before – as we transition from 'lockdown', it is vital.

Our methodology

Through a mix of quantitative and qualitative opinion research, we have sought to understand:

- *public opinion on the environment and climate change; and*
- *views on potential changes to current high-greenhouse gas emitting sectors including heating, manufacturing, and transport – changes which can be expected to impact people's daily lives significantly.*

We conducted a large 50-question poll in October (before the outbreak of coronavirus in the UK) and ran four focus groups with the research agency Public First. The groups explored public attitudes to detailed policy recommendations in the northern industrial town of Warrington and the affluent southern commuter town of Bushey.

Public attitudes to the environment

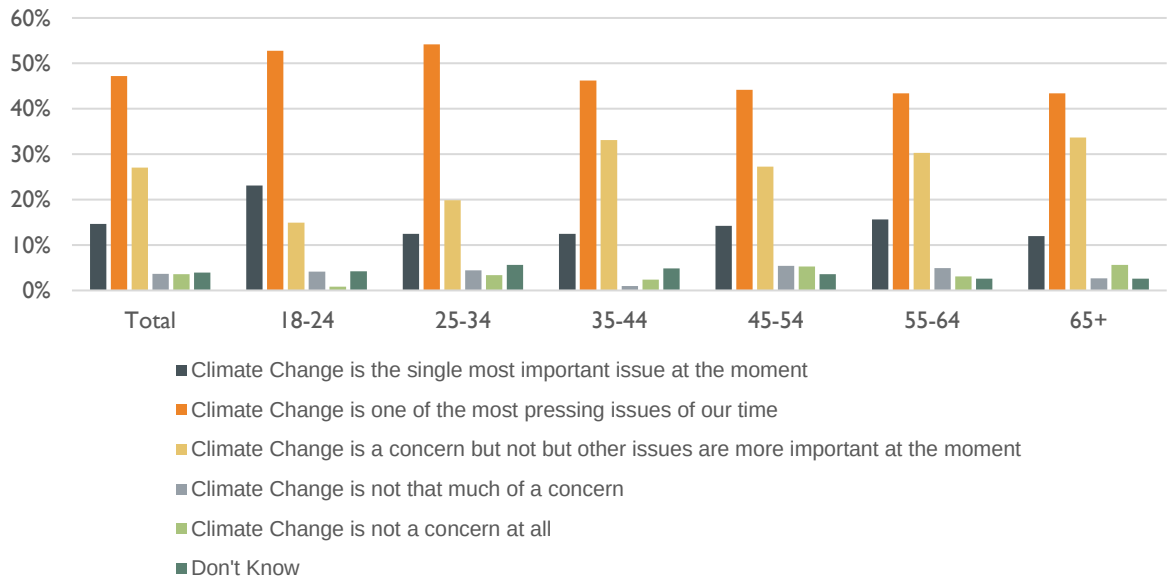
Environmental issues have become much more important to the public in the last five years, as they have risen up the political agenda and secured more intense media interest. We use the term 'environmental issues' because public concern goes well beyond climate change, as we explain below.

Concern about the environment is common across the various demographics. While younger people are even more concerned about climate change than older people, overall concern is pretty consistent across age groups, social background and between men and women. There are very few people who are actively hostile towards environmentally friendly policies.

In our poll 47 per cent said climate change was “one of the most pressing issues of our time”, and 15 per cent said it was *the* most important issue. Another 27 per cent said it was important, but other issues were more so. Only 8 per cent of the public say climate change is not much of a concern or “not a concern at all” (Figure 1).

In this case, our focus groups backed up the poll’s findings. The public worry about climate change but they are also optimistic about the role that technology (such as decarbonised gas) can play. While people naturally are not *enthusiastic* about the prospect of changing their boilers and gas supply, they are more sanguine than might be expected. This is particularly true of older people because of changes they have experienced in the past, most notably the shift from town gas to natural gas in the 1970s.

Figure 1: How seriously do people take the issue of climate change?



However, when we dug deeper we found there were different levels of interest in different aspects of environmental policy. For example, while young people profess deep concern about climate change specifically, older people appear more concerned about plastics pollution. On the issue of climate change specifically, younger people express concern about the changing nature of wildlife habitat while older people express concern about flooding.

These very significant differences suggest a lack of shared experience in the policy conversation. When people do not hear the same news stories, read the same comments and analyses or hear the same political conversations, then major divergences in opinion occur, even on relatively narrow issues. This is what seems to be happening here. Knowledge of the policy conversation appears to be extremely low. Our focus groups suggested it is even lower than shows up in polling, as we describe below.

Public confusion over net-zero

One of the ways in which the polling and the focus groups differed was on knowledge of net zero. The polling suggested high awareness. But in the groups, it was clear many had never heard the term. Those who had heard of it think of it as the logistical equivalent of putting on the Olympics: in other words, an effort, but largely a positive and invisible one. As well as different priorities, the focus groups also unearthed a lot of confusion over the difference between environmental policies: air pollution, plastics, and climate change.

Our focus group findings suggest we need to take polling on actual awareness of 'net zero' and climate change with a pinch of salt. There is an inherent 'nudging' factor with polls – the act of asking people whether they have heard of something makes it more likely they will say 'yes'. It's easier in focus groups to gauge people's true understanding.

Those that had heard of net zero in the focus groups had only a vague sense of what it meant – they associated it as much with removing plastics from the ocean and air pollution as they did with cutting emissions. They strongly support the 'brand' and message: the idea of net zero as much as they understood it. But there was no understanding of the sorts of policies that might be needed to deliver the Government's target.

People were also largely unaware of current policy – for example the carbon price element on electricity bills. While they want the Government to lead country-wide action, they are completely unprepared for the level of change that might be required to deliver net zero.

It is also important to understand who people hold primarily responsible for climate change in the first place. For the most part, it's the world's largest economies – but with a particular focus on the giant emerging economies of India and China. We say "hold responsible" deliberately. It is not that they *blame* these countries for wanting to industrialise and to provide better standards of living for their citizens. Rather, it reflects an unsentimental judgement that this is where the emissions are coming from. Their second target is, unsurprisingly, 'big business'.

Does all this matter? In our view, a great deal. This gap between expectations and reality risks a major correction in public attitudes when they realise that the route map to net zero demands at best serious trade-offs, and at worst significant financial sacrifice – and from people in a country who (in their view) are not contributing much to global emissions. This correction risks undermining the Government's overall strategy.

This perception gap will also be exacerbated by the health and economic fallout of COVID-19 and it will be interesting to monitor people's willingness to absorb costs for a policy like net zero at the same time as the country is rebuilding its economy.

This risk of a correction is a problem for Government and for DGA's members. Collectively, we are committed to the Government's net-zero target. We believe that it is the right thing for the climate and the country – with or without a global health pandemic. We also believe that the policy route to net zero offers new opportunities for the energy and industrial sectors to grow. It would be a tragedy if this was all put at risk because we lost public support for this long-term project.

The risks to public support for net zero

We picked up four key areas where public support was most moveable, and most vulnerable, to net zero.

1. Global collective action.

The judgment that others are primarily responsible for climate change is so strongly held that it risks undermining support for the Government's net zero strategy. It is easy to see how people might ask why they alone should make sacrifices when the UK is a very small part of the global population and total emissions.

When probed, people strongly questioned the merits of British over global action: why a "British net zero" and not a "global net zero"? In the polling there was a widespread belief (43 per cent) that a global emissions target being agreed with other countries (including US, India and China) would be one of the most effective policy solutions.

This is not to say that people do not think that Britain should play a role. Our polling showed that 57% of the public think Britain should take a lead in dealing with climate change. But a 'leading role' is on the basis that other countries play a significant role *at least.*

This is an area where COVID-19 may impact longer-term public opinion. We have seen, not just in the UK but globally, that collective action is possible when it is deemed necessary. This may feed into people's desire to tackle climate change knowing now what is possible in a way that they had not seen before. However, they are also likely to be more unwilling to see Britain bear much higher costs than other countries.

2. Cost

In our research, we found that **by far the biggest concern people had about prospective environmental policies related to personal cost.** In our focus groups, we found that, when it came down it, very few people are willing to sacrifice any meaningful amount of money to help deal with climate change, saying instead that 'big business' should pay.

Most people think that so-called 'green taxes' are a political ruse to get them to pay more in tax and are unrelated to actual environmental causes. Most people are currently unaware of how much of their current electricity bills support climate policy. This is likely to change, though, as the sums increase, as levies start to be put onto gas bills, and as people's attitude to tax changes in the wake of the coronavirus. Demands on the public purse are likely to change significantly over the coming years.

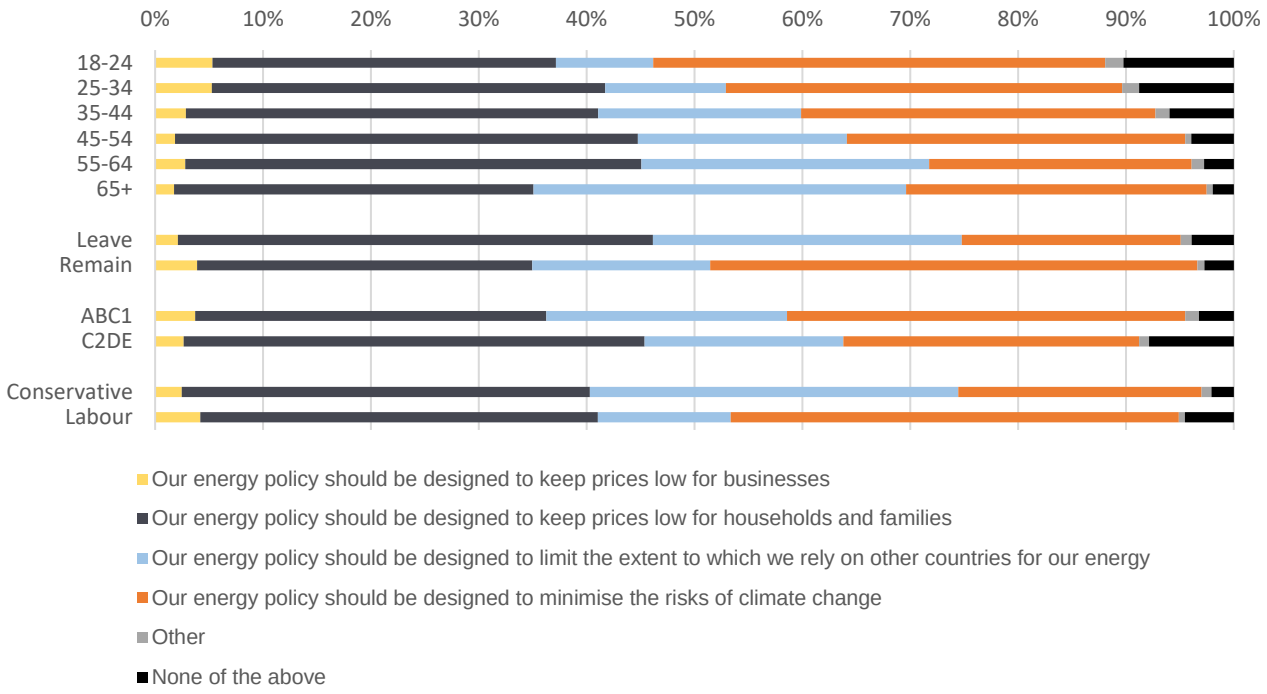
In the poll, we explored people's attitudes to energy policy more systematically. Having given them a list of possible priorities for the future of Britain's energy policy (Figure 2), people were divided between those that think energy policy should be primarily about minimising the risks of climate change (32 per cent), and those that think that energy policy should be around keeping costs low for ordinary bill-payers (37 per cent).

- Those that think policy should be focused on climate change include younger voters (under 35s); Remain voters; Labour and Lib Dem voters and Londoners.

- Those that think energy policy should be focused on bills include the middle-aged; Leave voters; and non-professionals.

- Interestingly, older people are most concerned that energy policy should be focused on energy security (chosen by 35 per cent of over 65s and 21 per cent overall).

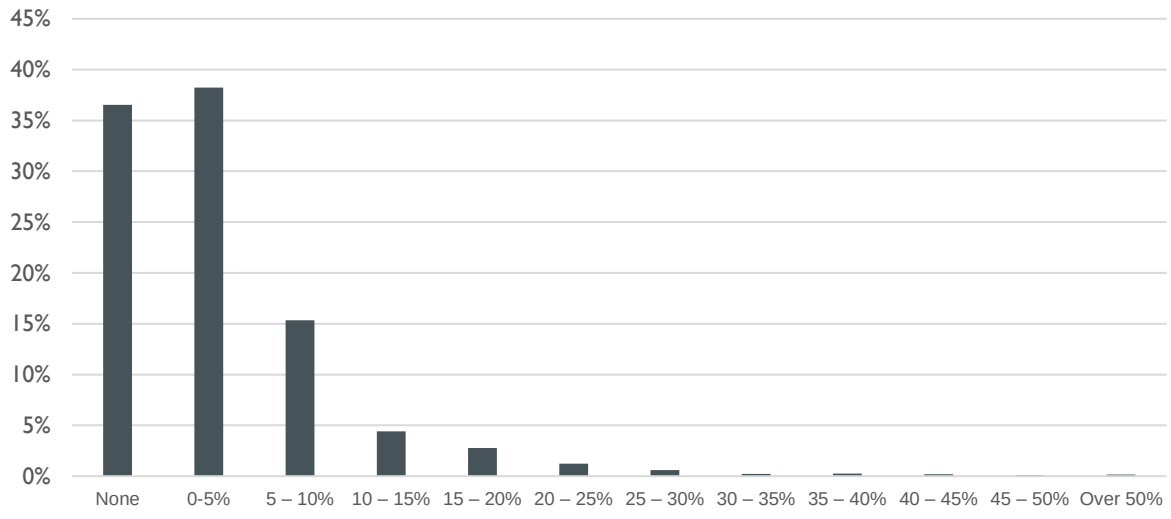
Figure 2: What should the focus of the UK energy policy be?



By far people's biggest concern about very rapidly cutting greenhouse gases was the prospect of paying higher energy bills (named by 70 per cent). This was much higher than the number who said they were worried about manufacturers leaving the country to go to less regulated markets.

When asked how much of their disposable income people would be willing to lose to help deal with climate change, 37 per cent said none and 38 per cent said less than 5 per cent (Figure 3).

Figure 3: How much of their disposable income individuals would be willing to give up to help the environment



This should be seen in the context of increasing general concern about tax. The recent massive cash injection into the NHS was welcomed, as was the cash injection into schools and policing. But there are signs that people are now demanding 'proof' that their taxes will pay off. It will be hard for the Government to justify new green taxes before demonstrating success in these areas.

This may change with COVID, where people are conscious that some of the money the government has to spend must be 'paid back'. It's very unclear though how they'd see green taxes in that context.

3. Energy security

Energy security – and a longing for a sense of security and self-sufficiency – is likely to be greater after the 'lockdown' is over and people re-emerge to a more normal way of life. Security, including energy security, is likely to rise up the list of people's concerns.

But even before COVID-19, energy security was already an area which risked undermining support for net-zero policies. People are worried that the Government might embark upon an energy policy that will leave Britain reliant on other countries for our energy – and the effects this might have on the predictability of supply and cost. In simple terms, they understand that the 'gas taps' could be turned off by a hostile power. This is particularly strongly felt among older voters, many of whom remember the energy crisis of the early 1970s.

When we asked people whether they agree or disagree with the statement that "The UK should not rely on other countries for our energy supply", people agreed overall by 76 per cent to 9 per cent.

Those in particular agreement were older voters, Leave voters and Conservative voters – although the view was held across the population as a whole.

While we did not put a counter argument to them – for example, something around being able to secure cheaper energy from abroad – the scale of the agreement was significant.

Older people, Leave voters and Conservatives are, of course, more likely to be temperamentally supportive of what amount to 'national security' arguments, but it is also true that older people will have remembered times when the energy supply to the UK was unpredictable and when the lights often went out.

It is easy to see how this public concern about relying on other countries for energy might evolve into a broader concern about an energy policy that might excessively rely on sources of energy that were less reliable (or less tested) than other sources.

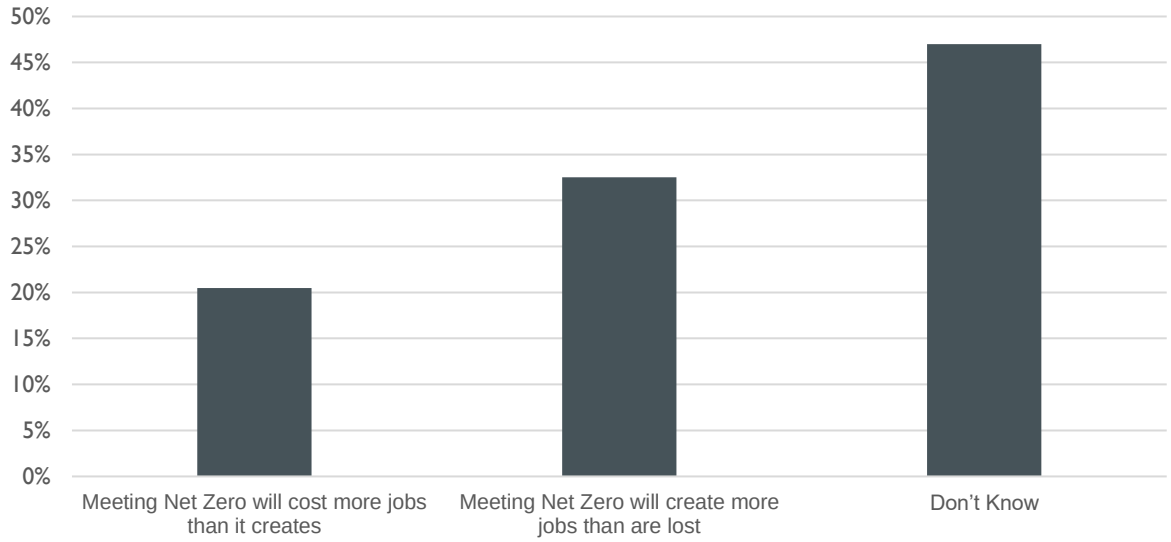
Knowledge about the reliability of 'classic' renewables (like wind and solar) is low and our research did not reveal any concern about this. However, we note that media attention on the reliability of renewables is not uncommon, and it is therefore possible that concern about energy security more broadly will rise in the future.

4. Jobs

Our research before the COVID-19 outbreak showed that the public were relaxed about the impact net-zero policies will have on jobs (and economic growth). We think that nervousness about jobs will now increase dramatically.

Still, in terms of baseline views, our polling showed that people thought that jobs would be created, ultimately, not lost (Figure 4). And our focus groups showed that, even in industrial areas, people thought that 'big' manufacturing businesses would either soak up additional costs or just relay them to others.

Figure 4: Which of the following do people tend to agree with more?



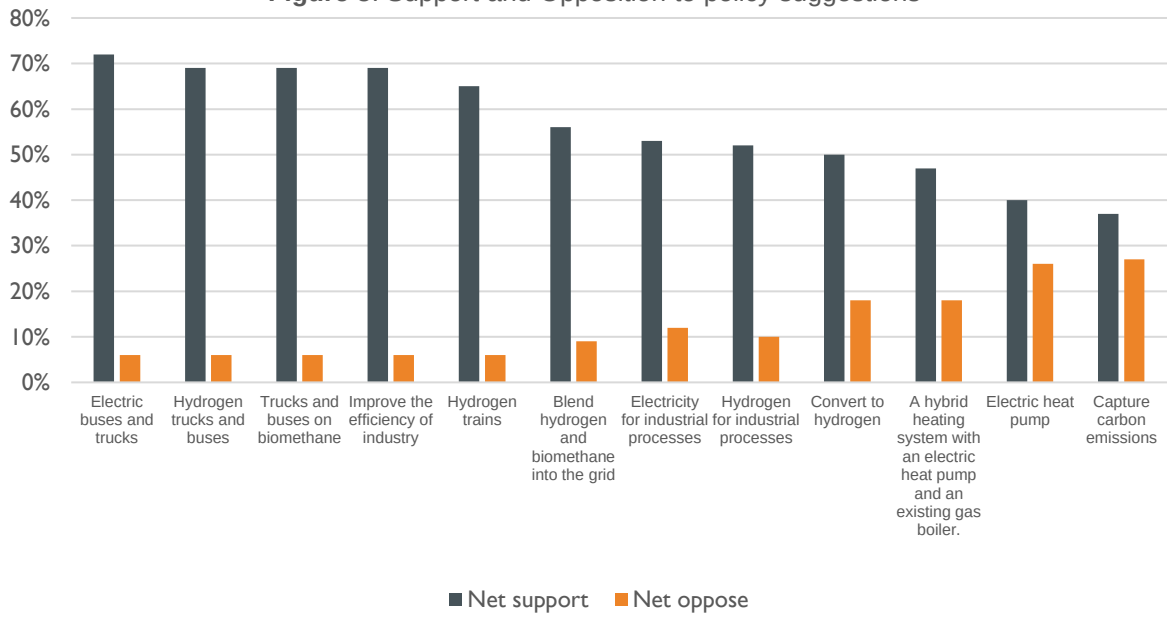
At the same time, people near industrial clusters were worried about the future of the local economy – before COVID-19. It was clear they would face serious economic difficulties if manufacturing plants or even warehouses closed. The shift in public opinion if faced with any industrial moves because of increased energy costs will, we think, be dramatic.

The challenge for Government is to have an extremely clear path to making the 'green jobs' and a 'green economy' true in a local context. While the result of a net-zero strategy might be to create jobs in the long term – arguably, jobs better suited to the future global economy – there are bound to be job losses in some sectors as environmental policies kick in. If these job losses fall disproportionately hard in particular areas, there will be terminal political consequences.

What people think about decarbonised gas

We also tested in our polling and focus groups people's attitudes to decarbonised gas – and electric alternatives – in three areas: industry; transport; and heating in the home (as we explain later in the paper, these are the areas decarbonised gas is most likely to make an impact). People's outline views in the poll are below.

Figure 5: Support and Opposition to policy suggestions



Industry

In our poll and in-depth focus groups we tested the following concepts:

- We should capture carbon emissions from chimneys of factories.
- We should switch from using gas to hydrogen for providing industrial heat in furnaces.
- We should switch some industrial process from gas to electricity.
- We should improve the efficiency of industry, meaning that it uses less energy to make the same amount of goods.

The poll found that carbon capture was only supported slightly more than it was opposed (a net support of 10 per cent). Switching industrial processes to hydrogen or electricity was largely supported, although the most favourably received policy was improving the efficiency of industry.

Perhaps unsurprisingly, the focus group conversation on industry was the most difficult because knowledge was low, and because people could not conceptualise the changes. It was a conversation that was, in effect, taking place amongst and about other people.

Because of this, there was widespread disagreement. For example, in Warrington there was significant enthusiasm about the impact that improving energy efficiency might have on industry. The group could grasp this easily because they thought it was simple and viable, and because it marked minimal and affordable change. However, the Bushey groups were sceptical about relying on greater efficiency as businesses would already have done anything that would make their running costs cheaper.

As it stands, there is significant scepticism about the merits of carbon capture and storage. But this was for different reasons:

1. Scepticism about delivery. In Warrington they argued that there were many places it could go wrong and cast doubt that either Government or industry would want to spend the necessary money.

"Look how long it takes to fix a water pipe or do some roadworks in the UK. Japan can do it overnight" younger professional man, Warrington

"If it was that expensive, there'd always be something that'd come first… It'll just keep getting pushed back if it's that expensive" professional woman, Warrington

2. Scepticism about safety. This was particularly true in Bushey

"What happens if you get leaks and the seafood dies?" professional woman, Bushey

"That's not natural to us, it's not eliminating it, what happens when it goes underground?" younger professional man, Bushey

"If we capture carbon and store it, won't we have the same problem we have with nuclear waste now? You can't leave carbon under the ocean for ever" older non-professional man, Warrington

3. Disagreements about whether business could and would bear the cost

The Warrington groups were less concerned about adding to the burdens of business. It felt as if the relative prosperity of the area – even with its reliance on precarious manufacturing – meant they were blasé about how much additional costs businesses could absorb. There was a small amount of concern raised, but it was a minority view.

"I think they could take the hit" professional woman, Warrington

"Do I really feel sorry for businesses that don't make £500 million they make £450 million instead and don't get their bonuses?" younger professional man, Bushey

In Bushey however there was more general cynicism about the motives of businesses, with the younger group believing it to be no bad thing if businesses lost some profits, and the older group believing the costs would be passed to them. The younger Bushey group were also vocally opposed to the idea of giving businesses grants to convert their energy use, citing concerns about corruption.

"They'd pass [the cost] on to us, they'd just charge more" professional man, Warrington

"Big businesses don't suffer, it's the small businesses that do" professional woman, Warrington

"When you say businesses and costs to them you mean us" professional woman, Bushey

"Do I trust the Government giving grants, like with Boris Johnson giving it to his friend from America, that lady, people in these circles will just abuse it, someone's cousin will open a green energy company and they'll get funds" younger professional man, Bushey

Transport

We tested the following policy concepts:

- New trucks and buses should run on biomethane rather than diesel.
- New trucks and buses should run on hydrogen rather than diesel.
- We should use hydrogen trains in place of diesel on rural train lines that don't have electricity.
- We should use electric buses and trucks.

There was strong net support for each of the policy proposals, with even the least popular (hydrogen trains in place of diesel) seeing 65 per cent support and 6 per cent opposition. In the focus groups, there would appear to be a genuine enthusiasm, although cost could clearly derail that support.

In Bushey, the (often commuting) participants were very animated about public transport. Of all of the options biomethane was the one they were most supportive of, with participants becoming visibly excited about the potential of 'recycling waste.'

"There are a lot of pluses to this" older professional man, Bushey

"I think it's a phenomenal idea" younger professional woman, Bushey

The Bushey groups were slightly more sceptical about hydrogen and very sceptical about electricity, particularly in terms of the ability to go long distances. But they recognised that they were preferable to the status quo, though their concerns focused on air pollution rather than climate change per se.

"If you had hydrogen buses it would be better for people's health, I was reading about how bad the pollutants are" older professional man, Bushey

Air pollution was named by 37 per cent of the polling samples as one of their top environmental concerns, rising to 51 per cent in London which may help solidify support for these changes in urban centres.

In terms of costs there was a strong resistance to anything that would lead to an increase in public transport ticket costs which were already seen to be too high.

"Workers' wages need to be going up at the same time [if you put fares up]" younger woman, Bushey

"If we nationalised trains, we could make it taxpayer-led" younger man, Bushey

The groups were less worried about the potential for increased transport costs leading to higher food prices, believing they would be able to shop somewhere cheaper, and that it will be less of an issue post Brexit as we will return to eating seasonal and local goods.

Of the three policy discussions, the conversation on public transport was the least animated in Warrington. This was for two reasons: firstly, because so few people actually took public transport regularly and therefore did not have strong views on the transport system; and secondly because they clearly thought they all sounded like decent ideas – assuming they were technologically viable and not prohibitively expensive.

Heating our homes

The discussion on decarbonising the home was by far the most lively in Warrington and also engaged the Bushey group. We tested the following policy concepts:

- Blend hydrogen and biomethane into the gas grid.
- Convert to 100 per cent hydrogen.
- Use an electric heat pump.
- Use a hybrid heating system with an electric heat pump and an existing gas boiler.

Before going into particular options it's worth reiterating that concerns about cost dominated all of the discussions. Some of the participants were very obviously, by their own public admission, extremely tight for cash. *Any* suggested increase in bills worried them. Others were better off but were still very worried about the prospect of upfront investment (in a new boiler or heat pump).

It's also worth noting that people seemed to prefer the idea of someone else making a decision, although in both groups a participant made the point that politicians often gave out mixed messages. It had not been long, for example, since politicians had actively persuaded people to turn to diesel before changing their minds and costing many a small fortune. In Bushey, solar feed-in tariffs were also cited, starting out as generous subsidises and then being scaled back to the point it was no longer economical to install solar panels.

"We don't need to know them. We need scientists to work out which is the most efficient" older professional woman, Bushey

"A blend would work for me, but it's all about future-proofing and you want to have the grid ready" younger professional woman, Bushey

1. Hydrogen options for home heating

This was a fairly popular option.

In the polling results, the suggestion to blend hydrogen and biomethane into the grid was very well received and converting to 100 per cent hydrogen was met with 50 per cent support and 18 per cent opposition.

There were mixed views on disruption, but it wasn't a primary concern

When asked directly in the poll about how they would feel about going off-gas for a few days in the summer to convert to 100 per cent hydrogen, the results were relatively split: 39 per cent unconcerned and 34 per cent concerned.

Many of those who expressed concern were willing to put these aside if offered meal vouchers, bottled gas or financial compensation during these off days, with these options reducing those who remained concerned to 19 per cent. We also found that only 9 per cent of people said they would not be worried at all about switching to hydrogen, and 52 per cent worried about the safety, 48 per cent about the cost (Figure 12).

In the groups, people were initially very concerned about the prospect of the 'big switchover' when their street or local area would all be off the grid for a few days in the summer while the gas supply was changed. How would they eat? What if they didn't like salad (yes, semi-seriously)? Would they get vouchers for local restaurants? What would the poor and vulnerable do?

One older man in the working-class group was able to soothe the group's concerns by his memory of the shift to natural gas in the 1970s and how it was not that much of a problem.

"The roads will be dug up, traffic problems…" non-professional man, Warrington

"I remember when we went from coal gas to natural gas, it's exactly the same thing… It was pretty painless, to be honest" older non-professional man, Warrington

People were generally more sanguine about changing their boiler.

"I feel this is what's happening now. When people's boilers break, they think 'I'm going to get a combi now'" professional woman, Warrington

"If your boiler packs up and there's only one option that will mean they have to change" older professional man, Bushey

Safety had mixed responses

In the poll when asked if they believed regulators could be trusted to make a hydrogen transition safe, people leaned towards agreement (38 per cent to 26 per cent).

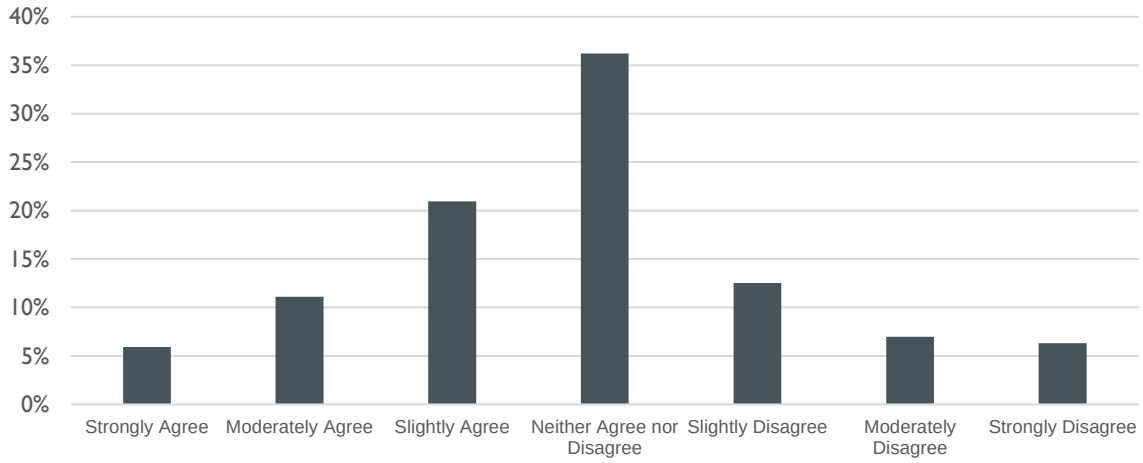
In the groups, no one brought up safety spontaneously. When the moderator explicitly raised the issue, people almost uniformly dismissed it in Warrington

> *"It's going to have regulations isn't it, like the gas" professional woman, Warrington*
>
> *"They wouldn't do it if it wasn't safe" younger non-professional man, Warrington*

They were more concerned in Bushey.

> *"I'm glad my house is fully electric. I wouldn't want hydrogen running through" older professional woman, Bushey*
>
> *"I don't know how detrimental hydrogen is to me or to the environment" younger professional woman, Bushey*

Figure 6: Do people trust the regulators to ensure the safety of Hydrogen?



2. Heat pump options for home heating

Heat pumps are unpopular, but more acceptable when combined with an existing boiler

The electric heat pump was not as popular in the polling as hydrogen with 40 per cent support and 26 per cent opposition, likely because of the costs of installation and upkeep. This was improved when the possibility of combination with an existing boiler was proposed, increasing support to 47 per cent and reducing opposition to 18 per cent, although this evidently remains unpopular compared to some of the other proposals.

This was mirrored in the groups. The idea of a heat pump in the home got no traction in either Warrington or Bushey. When we raised the fact that it would not heat water to high

temperatures on demand, that it would be big and bulky and would make a noise (particularly if it 'hummed' along with lots of other heat pumps in nearby gardens), and that it would likely mean the installation of new, larger radiators, the discussion was over before it began.

In Warrington nobody would even talk about the idea, which they viewed as a ridiculous non-starter, whereas in Bushey people mocked the idea even saying, "*we'd need climate change before it could happen*".

We had more success in getting people to consider a heat pump in the context of a shift to a generally smarter system – one that would combine a heat pump with an existing boiler, with the two combining to provide cheaper and greener energy over the longer period. To the extent people understood this, they thought it sounded like a good idea.

Chapter 2: The hard to decarbonise sectors and decarbonised gas

The net-zero target

Around 80% of the world's energy,[5] and 75% of the UK's energy,[6] comes from fossil fuels: coal, oil, and increasingly natural gas. Global energy demand rises every year.

Since 1990, the UK has reduced emissions by 43% overall, which on the face of it represents solid progress on the road to net zero. But this apparent success masks very different performances in different sectors:[7]

- **Electricity:** Emissions have fallen by 67% from power stations since 1990.
- **Domestic:** Emissions have only fallen by 14% since 1990.
- **Transport:** The transport sector has seen barely any reduction, with emissions only falling by 3%, as more efficient engines have been offset by more miles driven.
- **Industry:** Industrial emissions have fallen, but a large part of this is due to offshoring of manufacturing to other parts of the world. Per capita, the UK is the highest net importer of CO_2 in the world; our net imports from China alone are 80 million tonnes of CO_2 a year.[8]

The decline in emissions in electricity generation has been so great for two reasons:

- 33% of our electricity can now be generated with renewable sources of energy.[9]
- We have switched much of our remaining generation from coal (which is very emission-intensive) to natural gas (still a fossil fuel, but with lower emissions).[10]

Part of the path to net zero is therefore to electrify more of the economy and expand the size of the grid. For example, cars will be electrified.[11] This has major challenges – the grid must cope

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[5] The World Bank, Fossil fuel energy consumption (% of total). https://data.worldbank.org/indicator/EG.USE.COMM.FO.ZS

[6] BEIS, Digest of United Kingdom Energy Statistics 2019, Chart 1.6

[7] BEIS, Final UK greenhouse gas emissions national statistics 1990-2018, Table 3 https://data.gov.uk/dataset/9568363e-57e5-4c33-9e00-31dc528fcc5a/final-uk-greenhouse-gas-emissions-national-statistics

[8] Office for National Statistics, October 2019, Figures 11-12 https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/compendium/economicreview/october2019/thedecouplingofeconomicgrowthfromcarbonemissionsukevidence

[9] Dukes 2019 Chapter 6: Renewable sources of energy. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/840014/Chapter_6.pdf

[10] BEIS, UK Energy in Brief 2019, page 28. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/857027/UK_Energy_in_Brief_2019.pdf

[11] https://www.theccc.org.uk/wp-content/uploads/2019/07/CCC-2019-Progress-in-reducing-UK-emissions.pdf

with a large increase in demand, and often struggles even at current capacity – but it is technically feasible.

But many of the sectors that have seen little fall in emissions can't be electrified, and these are responsible for a high percentage of our emissions. Electricity also still needs some back up – for when the sun doesn't shine, or the wind doesn't blow – and for that we still need traditional fuels. It is important to remember that electricity is less than 20% of the UK's final energy consumption.[12]

The challenge with emissions statistics

Some of the figures in international emissions statistics are misleading because international carbon accounting rules only count where emissions are 'produced':

- *Emissions are* ***"produced"*** *in the country where the good is manufactured.*
- *But emissions are* ***"consumed"*** *in the country where the manufactured good is used.*
- ***Importing of emissions*** *occurs when a product is manufactured in one country and used in another. For example, if a steel bar is made in China but used in the UK, then its emissions count in China's statistics, not ours.*

Overall, the UK's consumption of emissions ***has only fallen by 9% since 1990[13].*** *Per capita, the UK is the highest net importer of CO_2 in the world. A recent WWF report concluded that, in 2016, almost half (46%) of the UK's carbon footprint came from emissions overseas to satisfy UK consumption.[14]*

This has happened in part because manufacturing has declined – from 17.3% to 9.9% of the economy since 1990.[15] For example, the Redcar Steelworks closed down in 2015 with a loss of over 2,200 jobs. Half the recorded fall in Britain's industrial emissions that year was due to the closure of this site.[16] We now import a greater proportion of our steel – and once we count the carbon costs of transport and of other countries' production processes, we have probably caused net global emissions to increase. High costs on industry could drive more losses abroad.

[12] BEIS, UK Energy in Brief, 2019
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/857027/UK_Energy_in_Brief_2019.pdf

[13] https://www.ons.gov.uk/economy/environmentalaccounts/articles/netzeroandthedifferentofficialmeasuresoftheuksgreenhousegasemissions/2019-07-24

[14] WWF, Carbon Footprint: Exploring the UK's contribution to climate change, March 2020
https://www.wwf.org.uk/sites/default/files/2020-04/FINAL-WWF-UK_Carbon_Footprint_Analysis_Report_March_2020%20%28003%29.pdf

[15] http://www.parliament.uk/briefing-papers/SN01942.pdf

[16] Cooper SJG and Hammond GP, Decarbonising UK industry: towards a cleaner economy, Institution of Civil Engineers paper 1800007, May 2018, p.3

The hard to decarbonise sectors

For the purpose of this report, we have identified three sectors that are particularly difficult to tackle, and where decarbonised gas could play a very substantial part:[17]

1. **Industry** – 76.5 million tonnes of CO_2 equivalent a year
2. **Heavy transport** – 35.3 million tonnes of CO_2 equivalent a year
3. **Domestic heating** - 67.5 million tonnes of CO_2 equivalent a year

Together these represent almost 180 million tonnes of CO_2 equivalent – 40% of the UK's total emissions.

Table 1: Emissions from hard-to-decarbonise sectors

Sector	Emissions in 2018 (million tonnes of CO_2 equivalent)
Industry	
All industrial processes	10.2
Iron and steel combustion and electricity	8.8
Industrial combustion and electricity (excluding iron and steel)	45.7
Commercial and miscellaneous combustion and electricity	11.7
Industry total	***76.5***
Heavy transport	
Domestic civil aviation	1.5
Buses	3.2
HGVs	20.7
Railways – mobile combustion	1.8
Shipping – national navigation	5.4
Shipping – fishing vessels	0.6
Military aircraft and shipping	1.6
Aircraft support vehicles	0.6
Heavy transport total	***35.3***
Domestic heating	
Residential combustion	67.5
Total domestic heating	***67.5***
TOTAL	**179.3**
UK TOTAL	***451.5***
Percentage of UK total from these hard-to-decarbonise sectors	***39.7%***
NB: Totals may not sum exactly due to rounding	

[17] BEIS, Final UK greenhouse gas emissions national statistics 1990-2018, Table 3 https://data.gov.uk/dataset/9568363e-57e5-4c33-9e00-31dc528fcc5a/final-uk-greenhouse-gas-emissions-national-statistics

The challenge for industry

Despite its relative decline, manufacturing remains an important part of the economy, a very large proportion of our exports, and vital in specific parts of the country. We therefore need a solution that allows it to remain competitive internationally.

Industry's contribution to the economy:

- *8 per cent of jobs (2.7 million in total),*
- *£191 billion of economic output, around 10% of the UK total,*
- *42 per cent of UK exports, worth £275 billion, and*
- *65 per cent (£16 billion) of UK research and development spending.*[18]

Industries have managed to reduce their carbon emissions in the last few decades. But three particularly large challenges remain:

- Many of our industrial processes require heating to very high temperatures and/or require a direct flame. Electrification cannot produce these temperatures at scale or these direct flames – currently, only gaseous energy can.
- Some of the chemical reactions release greenhouse gases. For example, the production of cement produces carbon dioxide as a by-product, regardless of the process used.
- As shown above, there has been so much offshoring of emissions – achieving net zero by continued offshoring will be, and will be perceived to be, a failure.

The challenge for heavy transport

The transport sector has seen the lowest emissions reductions (3 per cent) of any sector. Since 1990 aviation and van emissions have substantially increased.

Much of the transport system could be electrified, which will give us a path to net zero as electricity becomes increasingly renewably driven. That includes cars and vans in particular (in 2020, the Government announced that all new cars sold by 2035 would be electric vehicles), [1920] but also potentially small short-distance aircraft.

The challenge is with transport that carries heavy loads and goes long distances, where neither electricity nor batteries are a viable technical solution, including lorries and long-distance ships and planes.

It is not credible to expect people in the UK to stop flying – this is very clear in all our opinion research – or to halt the growth of international travel as countries whose populations were historically too poor to fly become richer. Our supply chains, including for food and other

[18] https://commonslibrary.parliament.uk/research-briefings/sn01942/ (2018 figures)

[19] DfT, Transport statistics, 2018 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/787488/tsgb-2018-report-summaries.pdf

[20] https://www.gov.uk/government/consultations/consulting-on-ending-the-sale-of-new-petrol-diesel-and-hybrid-cars-and-vans

essentials, rely on planes, ships and lorries carrying goods very long distances. Behaviour change alone, therefore, cannot be the answer. We need alternatives.

The challenge for heating

Over 85 per cent of households use gas to heat their homes and water,[21] and around 50 per cent use gas for cooking.[22] Given that there are around 28 million homes in the UK, between now and 2050, 1 million homes will need to be converted in one way or another every year.

Electricity is currently four times as expensive as gas,[23] which makes people reluctant to use it either in their homes for heating or in industry – and the electricity price tends to be higher in those hours when high heating load is required. Some[24] of the cost difference is due to carbon policy, which we would expect to be evened up in the coming decades. Even then, though, gas remains substantially cheaper and more storable.

UK fuel poverty figures show that households not connected to the gas grid are twice as likely to be fuel poor – 20.4 per cent of households with electricity as their main source were in fuel poverty compared with 10.1 per cent of people who heated their homes with gas.[25] This is also related to the type of housing that people occupy but it underlines the difference in the unit cost of gas compared with electricity.

The need for back up electricity

Almost half of our electricity is still generated by fossil fuels – particularly gas.[26] While it's a great achievement that 33% now comes from renewable sources, that percentage needs to increase radically as the overall size of the grid increases as we electrify cars and other activity.

But there is a limit to renewables – they are inherently variable in their supply, so we will need fast-acting and often long-lasting backup power. Decarbonised gas – in the form of gas-fired power with CCUS and hydrogen power – is one solution.

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[21] Committee on Climate Change, 2017, Energy Prices and Bills – impacts of meeting carbon budgets https://www.theccc.org.uk/wp-content/uploads/2017/03/Energy-Prices-and-Bills-Committee-on-Climate-Change-March-2017.pdf

[22] Energy Networks Association, Gas Networks for the UK. https://www.energynetworks.org/assets/files/news/publications/GAS%20FAST%20FACT%20CARDS%20-%20ALL.pdf

[23] The current average retail price of electricity is 18.55 pence per kWh as opposed to gas which is 4.37p/kWh https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/853753/QEP_Q3_2019.pdf

[24] https://www.ofgem.gov.uk/data-portal/breakdown-electricity-bill; https://www.ofgem.gov.uk/data-portal/breakdown-gas-bill

[25] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/829006/Annual_Fuel_Poverty_Statistics_Report_2019__2017_data_.pdf p26

[26] DUKES 2019, Chapter 5: Electricity, Chart 5.6 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820708/Chapter_5.pdf

Wind and solar: variable supply

***Load factors** are the difference between the full capacity of a wind or solar farm and the electricity they actually generate. They are:*

- *26.5 per cent, for onshore wind*
- *40.5 per cent for offshore wind*
- *10.8 per cent for solar*[27]

Periods where wind generation fluctuates below the average can last a long time, even up to several years. This far exceeds the length of time our current battey storage is able to handle.[28] *The inflexibility of the electricity grid and its finite size also means that balancing the grid can be a problem when there are sudden surges of power.*

The decarbonised gas technologies

Decarbonised gas is a combination of 'recycled' gases derived from waste, or hydrogen produced by electrolysis or by reforming methane, a process which produces carbon dioxide which is captured and stored. In this chapter we look at the main decarbonised gas technologies:

- Biogases
- Hydrogen
- Carbon capture, utilisation and storage (CCUS)

A. Biogases

Biogases[29] are naturally produced from organic waste materials such as food and animal waste which is broken down in an anaerobic digester (AD) to produce a mixture of gases, including methane and carbon dioxide.

This 'recycled' gas can be combusted for heat or electricity. Biogas can be purified to biomethane and injected into the gas grid and used as a renewable heating and transport fuel. Biogases are already starting to complement natural gas in the grid and replace diesel in buses and trucks.

[27] Energy Trends: UK renewables, Table 6.1 https://www.gov.uk/government/statistics/energy-trends-section-6-renewables

[28] Vox, 2019, Getting to 100% Renewables Requires Cheap Energy Storage. But How Cheap? https://www.vox.com/energy-and-environment/2019/8/9/20767886/renewable-energy-storage-cost-electricity

[29] The Official Information Portal on Anaerobic Digestion http://www.biogas-info.co.uk/about/biogas/

Biogases are…
✔ *'Recycled'. Biogases are produced from waste materials that would otherwise vent greenhouse gases into the atmosphere. By re-using them to replace natural gas in the grid and in transport, they are effectively 'recycled'.*
✔ *'Natural'. Biogases have the same qualities as natural gas once they are concentrated to biomethane and have the same properties and advantages.*
✔ *Storable. Biogases are storable for longer than batteries can store electricity and can be used to generate electricity.*
✔ *Low carbon. Biogases do not use fossil fuels in their production.*

B. Hydrogen

There are three main ways of producing hydrogen:

- Electrolysed hydrogen (sometimes called green hydrogen) is produced by running an electric current through water in an electrolyser to split water into hydrogen and oxygen. Electrolysers can be small-scale and work on small appliances or feed into a large-scale hydrogen production facility. If the electricity used in this process is renewable or nuclear, then this process is zero-emitting.
- Steam-reformed methane (SRM) (sometimes called blue hydrogen) is more common. The methane reacts with steam (at temperatures of up to 1,000 degrees C) under pressure to produce hydrogen, carbon monoxide and carbon dioxide. The carbon monoxide reacts with the steam to produce carbon dioxide and more hydrogen. Once the carbon dioxide is removed, the final product is hydrogen. With a by-product of carbon dioxide, it means that steam-reformed methane must be accompanied by carbon capture and storage to ensure that it is decarbonised.
- Auto-thermal reforming (ATR) is a more efficient process to produce blue hydrogen which uses oxygen and carbon dioxide with methane. This can be useful for particular processes. ATR is smaller (so takes up less space), lower cost, and can capture almost 100% of the CO_2.

Hydrogen, whether from renewable sources or from methane, is more expensive than natural gas or direct use of the electricity as it must go through an extra production stage to be formed. Currently, hydrogen production from methane with CCUS is cheaper than from electrolysis, although we expect electrolysis costs to fall considerably.

Hydrogen is…

✔ ***Zero emissions***. *When used in a fuel cell, hydrogen's only emission is water (steam). The only real emissions associated with hydrogen are in its production.*

✔ ***Storable and reliable***. *Hydrogen can be stored in large volumes for long periods of time. It can be stored under pressure or as a liquid at temperatures below -253 degrees C.*[30] *Sometimes both methods are used, which adds cost but reduces the space needed. Hydrogen can also be stored at large capacity in the UK's salt caverns which have the potential to add tens of GWe to the grid.*[31] *Hydrogen is a good backup for electricity. When wind and solar produce excess electricity, it can be used to convert water into hydrogen which, again, can be stored.*

✔ ***Less costly***. *Hydrogen can use some of the existing gas pipeline infrastructure, avoiding replacing the whole gas and radiator infrastructure in a home. Hydrogen can provide backup for electric heat pumps in hybrid heating systems.* [32] *Hydrogen costs could fall by up to 50% by 2030 with investment support.*[33]

✔ ***Useful to industry***. *There are certain industries such as ceramics, chemicals and steel which need naked flames to fire kilns and furnaces. These cannot be provided by electricity, but hydrogen could be used to replace natural gas.*

C. Carbon capture, utilisation and storage (CCUS)

There are already 51 large-scale carbon capture and storage facilities around the world capturing more than 25 million tonnes of carbon dioxide every year.[34] There are two main categories:

- Capture and utilisation. Uses for carbon dioxide includes speeding the growth of fruits in greenhouses and the manufacture of bricks. Products made from carbon dioxide are estimated to be worth over $1 trillion per year.[35] The UK's first carbon capture and utilisation plant is expected to start operations in 2021, capturing the CO_2 from a gas-fired combined heat and power plant and using the CO_2 to manufacture sodium bicarbonate.[36]

[30] Hydrogen Europe, Hydrogen Storage https://hydrogeneurope.eu/hydrogen-storage

[31] Energy Technologies Institute, The Role of Hydrogen storage in a clean responsive power system https://d2umxnkyjne36n.cloudfront.net/insightReports/3380-ETI-Hydrogen-Insights-paper.pdf?mtime=20160908165800, p.3

[32] Committee on Climate Change, 2018, Hydrogen in a low-carbon economy, https://www.theccc.org.uk/wp-content/uploads/2018/11/H2-report-draft-20181119-FINALV3.pdf, p.8

[33] Hydrogen Council, Path to Hydrogen Competitiveness, January 2020 https://hydrogencouncil.com/en/path-to-hydrogen-competitiveness-a-cost-perspective/

[34] Global CCS Institute, Global Status of CCS 2019 https://www.globalccsinstitute.com/wp-content/uploads/2019/12/GCC_GLOBAL_STATUS_REPORT_2019.pdf p17

[35] XPRIZE Foundation, 2019, The Carbon Opportunityhttps://assets-us-01.kc-usercontent.com/5cb25086-82d2-4c89-94f0-8450813a0fd3/d248a9c8-055f-4bdf-9692-b682847ba54d/Carbon_Finalist%20Team%20Deck%20for%20Investors_V15.pdf p.2

[36] Chemicals Technology, 2019 https://www.chemicals-technology.com/news/tata-chemicals-ccu-plant/

- Capture and storage. Here carbon dioxide is captured, transported and stored deep underground (for example, in a disused gas storage facility or in a spent oil or gas well under the seabed). There are different carbon capture and storage methods[37]:
    - Pre-combustion capture where the carbon dioxide is captured before the fuel is burned. Hydrogen production from methane uses this.
    - Post-combustion capture where the gas, coal or oil is burned, the emissions captured, the carbon dioxide separated out from the other gases, and then transported and stored underground.
    - Oxy-fuel combustion where power plants burn the methane in oxygen which releases steam and carbon dioxide. The gases are separated, and the carbon dioxide is transported and buried.

Capturing carbon dioxide at both the pre and post-combustion stage allows the capture of at least 90 per cent of the carbon dioxide, and new facilities will be able to capture almost 100% of the CO_2.[38] CCUS is essential if hydrogen is to work as a decarbonised gas solution and help the UK to meet its climate change mitigation targets.

Finally, combined with bioenergy, CCUS can deliver negative emissions, given that the bioenergy itself is zero carbon (BECCS). Capturing CO_2 emissions directly from the air is also a possibility (Direct Air Capture, or DACCS). These negative emissions can offset emissions in harder-to-reach processes and sectors where carbon capture and storage is sometimes not possible.

As an enabler to decarbonisation, CCUS has many advantages…

✔ *Enabling zero emissions. By capturing and sequestering carbon dioxide in the process of producing hydrogen from natural gas, a low-carbon fuel replaces a carbon emitting one. CCUS also helps decarbonise industrial processes by capturing emissions directly, and in power generation.*

✔ *Storable. Carbon dioxide is storable in large quantities both in disused gas storage facilities as well as in spent oil and gas wells off the coast of the UK. There is already some pipeline infrastructure in place, that could potentially be repurposed, and other infrastructure can be built – especially around the largest industrial clusters.*

✔ *Importable. Once established, it is estimated that the UK already has capacity to store all of its carbon emissions for the next 100 years as well as being able to store carbon dioxide from other countries once a market is created.* [39]

✔ *Useable. Carbon dioxide can be used to make fizzy drinks; to create fuels and help make cement; and in chemical processes.*

[37] Carbon Capture and Storage Association, http://www.ccsassociation.org/what-is-ccs/

[38] Global CCS Institute, Global Status of CCS 2019 https://www.globalccsinstitute.com/wp-content/uploads/2019/12/GCC_GLOBAL_STATUS_REPORT_2019.pdf p.68

[39]Department of Energy and Climate Change, 2012, CCS Roadmap https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48317/4899-the-ccs-roadmap.pdf p.40

Chapter 3: How decarbonised gas can cut emissions – and how to make it happen

In the last two chapters we described:

i. Public views on net zero;
ii. The challenge with reaching net zero, particularly in industry; parts of the transport sector; and domestic heating; and
iii. Some of the most developed technologies to decarbonise gas.

In this chapter, we describe how decarbonised gas can be used to tackle those hard-to-abate sectors.

This could have an enormous effect. As we set out in Chapter 2, these hard-to-decarbonise sectors are responsible for almost 180 million tonnes of CO_2 equivalent – 40% of the UK's total.[40] Our largest industrial clusters alone emit nearly 40 million tonnes of carbon dioxide.[41] While decarbonised gas cannot on its own eliminate all emissions from these sectors, it can make a major contribution.

Decarbonised gas in industry

As we described in the previous chapters, fossil fuels are currently the only plausible option for many industrial processes. We therefore need to decarbonise the emissions from those fuels, and capture emissions from other processes.

We also need to do so at the lowest possible cost. While there are a lot of reasons for the decline in manufacturing in this country, imposing high environmental costs will drive more industry overseas (at least without credible carbon border adjustments) – and increase end costs to consumers. That is why the Committee on Climate Change said: *"The UK should ensure that action to reduce emissions within its own borders does not result in an increase in the imported part of its consumption emissions."*[42]

CCUS and hydrogen for industry

A key decarbonising technology for industry is carbon capture, utilisation, and storage, although there is also scope for hydrogen in conjunction with CCUS or separately.

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[40] BEIS, Final UK greenhouse gas emissions national statistics 1990-2018, Table 3 https://data.gov.uk/dataset/9568363e-57e5-4c33-9e00-31dc528fcc5a/final-uk-greenhouse-gas-emissions-national-statistics

[41] UK Research and Innovation https://www.ukri.org/innovation/industrial-strategy-challenge-fund/industrial-decarbonisation/

[42] Committee on Climate Change, 2019, https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/ p163

The good news is that the UK is well set up for CCUS clusters: the UK has world-leading research centres and universities, and the North Sea has given us world-renowned expertise in the oil and gas industry.

Our industry is also appropriately concentrated so they can benefit from economies of scale, shared infrastructure, and expertise. Five UK industrial clusters – Scotland, Teesside, Humber, the North West, and South Wales – form the backbone of UK manufacturing. They are also some of the highest greenhouse gas emitters. Together these clusters account for:

- 31 million tonnes of carbon dioxide emissions a year[43] (6.8 per cent of the total[44]);
- 1.5 million jobs in the UK; and
- £320 billion worth of exports of goods and services.[45]

As we set out in the Appendix, these clusters have major plans to decarbonise through CCUS and hydrogen. If all these projects are developed to the maximum, including abating emissions from the areas surrounding the clusters and in other sectors such as transport, then around 100 million tonnes of CO_2 could be abated each year by 2040, making a major contribution to net zero. The first phases of these four projects, most delivered well before 2030, would abate around 13 million tonnes a year.[46]

The Government's Clean Growth Strategy[47] estimates that the CCUS market could be valued at £100 billion a year by 2050, while the Hydrogen Council estimates that the hydrogen market could reach £2 trillion globally[48]. Along with developing our supply chains, there are huge opportunities for the creation of new jobs, especially in our manufacturing heartlands where jobs are less abundant.

To make CCUS work, we need the government to act in three areas:

- Adapting the direct funding of CCUS cluster projects;
- Making it easier for the private sector to invest in CCUS;
- Building better infrastructure.

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[43] BEIS Industrial Clusters Infographic https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/803086/industrial-clusters-mission-infographic-2019.pdf

[44] BEIS, Final UK greenhouse gas emissions national statistics 1990-2018, Table 3 https://data.gov.uk/dataset/9568363e-57e5-4c33-9e00-31dc528fcc5a/final-uk-greenhouse-gas-emissions-national-statistics

[45] BEIS Industrial Clusters Infographic https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/803086/industrial-clusters-mission-infographic-2019.pdf, jobs and exports figures include Southampton industrial cluster

[46] See appendix

[47] BEIS, 2017, The Clean Growth Strategy, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf p.69, the Clean Growth Strategy quotes Trades Union Congress and Carbon Capture and Storage Association, 2014, The Economic Benefits of Carbon Capture and Storage in the UK https://www.tuc.org.uk/sites/default/files/carboncapturebenefits.pdfp.6

[48] Hydrogen Council, 2017, Hydrogen, Scaling Up https://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-Scaling-up_Hydrogen-Council_2017.compressed.pdf, p.8. Currency conversion made 27/04/2020

Direct funding of clusters

There are a very large number of separate budgets for the funding of CCUS clusters, including:

- £170 million for the Industrial Decarbonisation ISCF challenge,[49]
- c.£150 million for the Industrial Energy Transformation Fund (2020 – IETF is £315 million overall, and other IETF funds will be used for industrial energy efficiency),[50]
- £100 million for the Low Carbon Hydrogen Production Fund (2021),[51]
- £250 million for the Clean Steel Fund (2023/4),[52]
- £800 million for CCUS infrastructure announced in the recent Budget.[53]

This is very welcome investment. There is, however, a risk funding is either spread too thin and that different clusters are concentrating on competing with each other for limited funding rather than collaboration. There is also a large administrative burden – with projects making multiple applications for small pots of money. Finally, there is a risk that projects don't get off the ground because of planning, and in the meantime the funding window has run out.

1. **The Government should bring together the existing funding pots** – Industrial Strategy Cluster Fund, Industrial Energy Transformation Fund, low carbon hydrogen production, and the £800m CCUS infrastructure to ensure that *all* of the major cluster decarbonisation projects are funded – not least so that projects don't have to make multiple applications for small pots of money.

2. **The government should speed up the planning process for major infrastructure. If it can't the funding window should be extended.** Planning applications should be prioritised and decisions expedited. Otherwise, the Government should extend the time period for spending the money beyond 2024 so that the projects can finish their FEED studies, including obtaining planning permission and environmental permits, and get construction underway.

Supporting private sector investment – for both CCUS and hydrogen

As with wind technology two decades ago, CCUS and hydrogen are still costly. This is partly because they are still in the development stages in the UK (though they are well established globally), and partly because we do not have policies to make CCUS investible. As with

[49] UK Research and Innovation, https://www.ukri.org/innovation/industrial-strategy-challenge-fund/industrial-decarbonisation/

[50] BEIS, 2019, The Industrial Energy Transformation Fund, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/838309/ietf-finalising-design-consultation.pdf

[51] Clean Steel Fund and Low Carbon Hydrogen Production Fund: Written Statement to Parliament https://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2019-09-03/HCWS1807/

[52] Ibid.

[53] Carbon Capture and Storage: Answer to written question to Parliament https://www.parliament.uk/business/publications/written-questions-answers-statements/written-question/Commons/2020-01-13/2480/

renewables, once we move into full-scale production and implement similar long-term market measures, these costs are likely to drop.

3. There should be enhanced Capital Allowances for factories that replace natural gas burners with hydrogen ones. This is a well-understood industrial mechanism. Equivalent mechanisms for facilities not making a profit should also be considered.

4. We need Contracts for Difference (CfDs) for hydrogen and carbon capture. The successful investment and cost-reduction framework for renewable electricity, which was started nearly two decades ago, should be extended to decarbonised gas. The DGA supports the work on business models for CCUS and hydrogen being undertaken by BEIS, and responded in detail to the CCUS business models consultation in 2019. Our preferred options are:

    a. CfDs for hydrogen production, which could have as a reference price the natural gas price (including the carbon cost). A mechanism to offtake and trade hydrogen freely would also be needed.
    b. CfDs for carbon capture, which would have as a reference price the wholesale power price for power sector capture, or the carbon price for industrial capture. For power generation, the options are:
        i. Baseload CfD: to ensure that there is adequate backup for renewable electricity. This type of scheme will be essential for the earliest CCUS power plants to enable them to run continuously. If new nuclear is not developed at scale, then higher levels of CCUS electricity will be needed to decarbonise the additional electricity capacity.
        ii. Flexible CfD with a capacity payment: The greatest advantages of gas are that it is reliable, transportable and storable. Gas use can easily be dialled up or down. If new nuclear is developed at scale and if heat decarbonisation is primarily through decarbonised gas, then lower levels of CCUS power generation will be needed. A flexible CfD allows for CCUS plants to operate at higher load factors in earlier years (dialled up) and lower load factors (dialled down) in subsequent years – as more renewables are developed.

    For power generation, our preference would be for a baseload CfD for the first CCUS plants, providing greater certainty, including for the developers of CO2 pipelines and storage infrastructure. A baseload CfD would also be the best model for BECCS plants that provide negative emissions. Then a flexible CfD with a capacity payment should be introduced subsequently, allowing CCUS plants to play the most suitable role supporting renewable generation.

Building CCUS infrastructure

To make CCUS work, we need to be able to transport the Carbon Dioxide that is captured. This can happen, as gas or liquid, via pipeline or by lorry or ship from the point of capture to storage.

5. The pipeline infrastructure needs to be built with maximum future use in mind – when multiple plants in an industrial cluster will be connecting to the same carbon dioxide pipeline and when the UK will be storing not only its own carbon dioxide but potentially importing it. Pipelines and undersea storage facilities should be funded through a Regulated Asset Base (RAB), as per the super sewer and gas and electricity networks.

Decarbonised gas in transport

Transport emissions are, by their nature, distributed – they disappear into the air over a very large surface area. They cannot be captured on site the way that industry emissions could be. Instead, the opportunity for decarbonised gas comes from the intelligent use of biomethane and hydrogen.

There are two plausible technologies being developed heavily across the world:

- **Fuel cell technology.** Hyundai,[54] Honda[55] and Toyota[56] are developing fuel cell cars, whilst hydrogen-fuelled short distance ferries are also being developed.[57] Hydrogen fuel cell buses are being used in Aberdeen[58] – and NASA has launched a hydrogen fuel-cell shuttle into space.[59] There are 14 passenger vehicle hydrogen filling stations in the UK, with another 4 in development.[60]
- **Biomethane technology.** At the same time, biomethane buses are already reducing greenhouse gases and air-pollution in cities such as Reading,[61] and companies such as John Lewis are replacing their diesel HGV fleet with biomethane.[62]

To develop these further in the UK, we need the government to act in two areas:

- Building the infrastructure;
- Incentivising take-up.

Building the infrastructure

As with CCUS, delivering these technologies requires up-front infrastructure investment. There would need to be a network of hydrogen and biomethane refuelling stations for buses and trucks, and port bunkering facilities for hydrogen or ammonia ships.

6. **The Government should make infrastructure funding available** for hydrogen and biomethane refuelling stations for buses and trucks in particular, and port bunkering facilities for hydrogen or ammonia ships. In line with other groups, we believe that 100 hydrogen refuelling stations should be established by 2025.[63]

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[54] Hyundai NEXO, https://www.hyundai.co.uk/new-cars/nexo

[55] Honda Fuel Cell, https://global.honda/innovation/FuelCell.html

[56] Toyota Mirai, https://www.toyota.co.uk/new-cars/new-mirai/

[57] Energy News Live, 2019, https://www.energylivenews.com/2019/07/02/worlds-first-hydrogen-car-ferry-to-hit-the-water-in-2021/

[58] H2 Aberdeen, http://www.h2aberdeen.com/home/H2-Aberdeen-hydrogen-bus.aspx

[59] NASA, Glenn Research Center, https://www.nasa.gov/centers/glenn/technology/fuel_cells.html

[60] UK H2Mobility, http://www.ukh2mobility.co.uk/stations/

[61] Clean Fleets, A Fleet of Biomethane Buses in Reading, UK https://clean-fleets.eu/fileadmin/files/documents/Publications/Reading_CleanFleets_CaseStudy.pdf

[62] John Lewis, Reducing Emissions with Biomethane-Powered Trucks, https://www.johnlewispartnership.co.uk/csr/never-wasteful/reducing-emissions.html

[63] Hydrogen Task Force, 2020, The Role of Hydrogen in Delivering Net Zero http://www.hydrogentaskforce.co.uk/wp-content/uploads/2020/03/Hydrogen-Taskforce-Report-Feb2020-website-FINAL.pdf, p.7

Incentivising take-up

At the moment, many of our incentive mechanisms do not encourage the use of hydrogen or other decarbonised gases.

7. **The Renewable Transport Fuel Obligation (RTFO) must include hydrogen.** The RTFO is an existing mechanism which requires suppliers of transport fuels to demonstrate that a certain percentage of their fuel comes from renewable sources.[64] It has worked for biomethane but has not yet worked for hydrogen – it needs to be extended to cover all forms of low carbon hydrogen fuel, including hydrogen produced from gas with CCUS, and hydrogen produced from electrolysis with a grid electricity connection.

8. **We need large-scale trials to encourage switchover.** In addition to the RTFO change, further support should be given to fleet operators to switch to biomethane or hydrogen. Large-scale trials are likely to reassure companies considering whether to switch.

Decarbonised gas in heating

The challenge for domestic heating, as we described earlier in the paper, is fundamentally about cost and disruption to households. Our public opinion research shows while some disruption can be managed, cost is a red line.

Heat pumps, combined with insulation, are one of the potential solutions that use electricity and can be more expensive to run day-to-day than gas (as a reminder, gas is generally a quarter of the price of electricity). But up-front costs are a major challenge:

- **Ground-source heat pumps** cost between £11,000 and £15,000 and need a land area of 700 square metres.[65]
- **Air-source heat pumps** cost between £5,000 and £8,000 – both depending on the size of the house.[66]
- **External solid wall insulation** ranges between £300 and £22,000, depending on the type of house, and type of wall insulation required.[67]
- **Internal insulation** can cost up to £6,700, depending on the size, age and type of house as well as whether loft, floor, double-glazing or other interventions are required).[68]

[64] Department for Transport, Renewable Transport Fuel Obligation https://www.gov.uk/guidance/renewable-transport-fuels-obligation

[65] Renewable Energy Hub, A Guide to Heat Pump Prices in 2020, https://www.renewableenergyhub.co.uk/main/heat-pumps-information/a-guide-to-heat-pump-prices-in-2019/

[66] Ibid.

[67] Ovo Energy, The Ultimate Guide to Solid Wall Insulation, https://www.ovoenergy.com/guides/energy-guides/the-ultimate-guide-to-solid-wall-insulation.html

[68] Energy Savings Trust, https://energysavingtrust.org.uk/home-insulation; Double Glazing on the Web, https://www.doubleglazingontheweb.co.uk/news/double-glazing-prices-2018/

This isn't feasible for most households without major government subsidy. Overall, 18.9 million households (69 per cent of the total) have less than £10,000 in savings. Of those, 12.6 million have no or less than £1,500 of savings.[69] While the Government has made grants available to help households cover these costs over years, there will still be an initial outlay that could far exceed this.[70]

Of course, for some households – depending on the building people live in, household income, and the location – heat pumps and other forms of electrified heating could be a good solution. But for others, we need hydrogen delivered through the existing gas network. The good news is that this is often cheaper than heat pumps, with much less upfront cost, and is deliverable.

To make it happen the government needs to:

- Make boilers hydrogen ready
- Accelerate trials and development

Make boilers hydrogen-ready and build the infrastructure

Homes could use hydrogen instead of gas through our current pipes and radiator systems. This requires:

9. **The Government should now mandate that all new boilers should be hydrogen ready.** This will mean that when parts of the gas network are ready to switch to 100% hydrogen, buildings and appliances will be ready to access it. This is a low-regret policy as the additional cost of a hydrogen-ready boiler is minimal (around £50).[71]

There is precedent for this:

- A boiler-replacement scheme has happened before. Until the early 1970s, the gas grid ran on town gas whose main constituent is hydrogen.[72] After the discovery of North Sea gas there was a nationwide conversion programme where, street by street over a period of a decade, homes were switched from town gas to natural gas.

[69] The Money Charity, The Money Statistics, December 2019 https://themoneycharity.org.uk/media/December-2019-Money-Statistics.pdf p.16

[70] Renewable Energy Hub, A Guide to Heat Pump Prices in 2020, https://www.renewableenergyhub.co.uk/main/heat-pumps-information/a-guide-to-heat-pump-prices-in-2019/

[71] BBC, 2020, Climate Change Hope for Hydrogen Fuel, https://www.bbc.co.uk/news/science-environment-50873047

[72] Frazer-Nash Consultancy, 2018, Logistics of Domestic Hydrogen Conversion https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760508/hydrogen-logistics.pdf p.20

- In 2005, Government mandated that all new boilers and boiler replacements should be condensing. This roll-out has occurred smoothly and relatively quickly, given that over 1.2 million gas boiler replacements occur in England per year.[73]

10. **The Iron Mains Replacement Programme should continue, and it must work for hydrogen.** This scheme was launched by the Health and Safety Executive in 2002 to replace the UK's ageing 250,000km iron gas pipeline network with polyethylene, which would be suitable for transporting 100% hydrogen through the network. The work is paid through domestic bills and is set to be completed by 2032.[74]

11. **The permitted volume of hydrogen into the gas grid should move to 2 or 3 per cent immediately.** This would allow more electricity-generated hydrogen access to the gas grid and encourage production of hydrogen from methane (with carbon capture and storage). Once the HyDeploy project has been safely completed,[75] the permitted volume of hydrogen into the gas grid should be raised to 20 per cent.

Accelerate trials and development

12. **Ofgem's network innovation funding should be equalised between electricity and gas.** The fund has been very successful in encouraging research, development and demonstration projects by electricity and gas network providers, but while Electricity Network Innovation has £70 million a year available to them, the gas network's innovation scheme is limited to £20 million a year.[76] Ofgem and Government should also support the efforts of National Grid and gas distribution business in modifying network codes in preparation for future system operation.

13. **The Government needs to commit £50 million a year through this Parliament for new field trials.** This could include:

    a. **Bio-LPG:** Bio-LPG boilers are provided in off-grid properties, which offer a potentially cost-effective deep decarbonisation, without the need for wider retrofits that heat pumps may require. At present, there is insufficient consideration of bio-LPG for off-grid.
    b. **Hybrid solutions:** Following on from the Freedom Project,[77] further trials of hybrid solutions may be useful, including with bio-LPG boilers in off-grid properties.

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[73] Regulatory Policy Committee, Domestic Heating Replacement Regulations, Impact Assessment https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/649958/Boiler_2017_Final_IA.pdf

[74] Health and Safety Executive, Ofgem, 10 Year Review of the Iron Mains Replacement Programme, https://www.hse.gov.uk/research/rrpdf/rr888.pdf

[75] HyDeploy, https://hydeploy.co.uk/

[76] Ofgem, Decision on the 2019 Gas and Electricity Network Innovation Competitions, https://www.ofgem.gov.uk/system/files/docs/2019/11/2019_nic_decision_document_for_publication.pdf, p.3

[77] Wales and West Utilities, Freedom Project, https://www.wwutilities.co.uk/media/2715/freedom-project-short-paper-2018.pdf

c. **100% hydrogen:** The H100 project in Scotland,[78] to test 100% hydrogen in a small new build area and the community trials that would follow-on from the Hy4Heat programme.
d. **Efficient gas-based appliances:** As set out above, the move to condensing boilers has been a great success, but gas-based appliances could get more efficient still. Gas-driven heat pumps and micro-CHP units could be developed to run on the existing gas grid, reducing emissions and consumer bills in the short term, and then be adapted to run on hydrogen blends or 100% hydrogen in the future. Given the 4:1 cost ratio between electricity and gas, more efficient gas-based appliances should be given further consideration.[79]

14. **The planned new support scheme for biomethane should be ambitious.** The non-domestic Renewable Heat Incentive has supported around 100 biomethane facilities to connect to the grid.[80] The Budget 2020 announced a new support scheme for biomethane, funded by the Green Gas Levy.[81] The Government will be consulting on introducing levy-funded support for biomethane production to increase the proportion of green gas in the grid.[82] **Voluntary biomethane certificates** also have an important role to play in creating a market for decarbonised gases.

Decarbonised gas, net zero and public opinion

Public opinion needs to remain supportive, not just for the sake of decarbonised gas, but for the UK's overall efforts to meet net zero:

15. **Public opinion tracking.** Carefully monitoring public opinion, how people are feeling and what they want, need and are willing to tolerate will be vitally important if the Government is considering future wide-reaching policy interventions on any scale like the one we have seen with COVID-19.

16. **Net zero communication.** Once the country returns to some semblance of normality, the Government should start to prepare the public for the reality of the changes required to meet net zero. A website, and a consistent presentation of facts and trade-offs, would be an obvious first step.

[78] SGN, Hydrogen 100, https://sgn.co.uk/about-us/future-of-gas/hydrogen/hydrogen-100
[79] UK Power, Compare energy prices per kWh, https://www.ukpower.co.uk/home_energy/tariffs-per-unit-kwh
[80] BEIS, RHI Monthly Deployment Data, March 2020 https://www.gov.uk/government/statistics/rhi-monthly-deployment-data-march-2020-quarterly-edition
[81] HM Treasury, Budget 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/871799/Budget_2020_Web_Accessible_Complete.pdf, p.62
[82] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/871799/Budget_2020_Web_Accessible_Complete.pdf ibid., p.81

Creation of a market for decarbonised gas

Overall, the creation of a market for decarbonised gas should be encouraged, allowing competition and price reduction over time.

17. **Continue with RED II or its equivalent.** RED II is an EU objective that extends the existing Guarantees of Origin (GoOs) scheme to include decarbonised gases.[83] It encourages investment and facilitates cross-border trade, which will drive competition and ultimately drive down prices, in the decarbonised gas market.

[83] Official Journal of the European Union, Directive (EU) 2018/2001 of the European Parliament and of the Council, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=EN, p.90

Conclusion

Decarbonised gas gives the UK an opportunity to get net zero done – crucially with public support by keeping cost and disruption to a minimum. If we get this right, we will also save jobs and create new ones, as well as open up large export markets to UK products and expertise.

This will be at a premium post-COVID-19. Questions will be asked about the feasibility and affordability of net zero – decarbonised gas allows us to answer those questions and emphasise the vital importance of pursuing our 2050 net-zero target.

But none of the industrial cluster projects highlighted in this report are yet operational – nor will we have biomethane, hydrogen and carbon capture and storage at the speed and scale we need to meet net-zero greenhouse gas emissions by 2050 unless policymakers make decisions that allow investment in infrastructure for the future now.

Decarbonised gas will be an essential stepping-stone, not just to reach the net-zero greenhouse gas emissions target, but to provide reliable backup to intermittent renewable electricity generation technologies while they develop and evolve.

Industry is itself providing match-funding to support progress, and while previous Governments have introduced a number of helpful measures to start the decarbonisation of gas, these measures need to be stepped up and industry provided with policy consistency and certainty over the long-term.

Particularly in the harder to decarbonise sectors, there are some inbuilt advantages as well as opportunities:

- The fact that the UK's industries have clustered in certain areas means that many sectors and industries can be decarbonised under one local scheme. It also means that infrastructure can be shared and economies of scale maximised.

- Added to the UK's other natural advantage, the enormous carbon dioxide storage facilities in our offshore waters, we have the perfect environment for both hydrogen production and carbon capture and storage.

The UK has led the world in legislating for action to tackle climate change; we have led the world in technologies for renewable electricity. To get net zero done by 2050, the UK now needs to lead the world in making decarbonised gas happen.

Appendix: Industrial cluster decarbonisation projects

The main clusters have detailed plans to achieve deep decarbonisation of multiple facilities using shared infrastructure:

- HyNet: HyNet is based in the North West of England, and would create hydrogen and CCS infrastructure to capture industrial emissions and supply hydrogen (from both natural gas and renewable electricity) for industry to use in place of natural gas. By 2026, with construction complete, over 1 million tonnes of CO_2 would be saved every year. By 2035, with wider hydrogen supply constructed for flexible power and transport, and negative emissions from bioenergy with CCUS, up to 25 million tonnes of CO_2 could be saved per annum.[84]

- NECCUS: NECCUS is an integrated plan for hydrogen and CCS in Scotland, incorporating the Acorn project. It would produce hydrogen from natural gas at the St Fergus terminal in North East Scotland for use in the gas network to decarbonise domestic heating, as well as for transportation and industrial use, and would also use a re-purposed pipeline to collect CO_2 from Scottish industry. The first phase would capture and store around 340,000 tonnes of CO_2 emissions from the St Fergus gas terminal, and could be operational in 2024. Subsequent phases would see large additional volumes of CO_2 abated each year. The nearby Peterhead port could also receive up to 16 million tonnes a year of CO_2 by ship from other clusters and countries, to be stored in the same offshore geological formations.[85]

- Net Zero Teesside: Net Zero Teesside would create CCS infrastructure to capture emissions from industry and from gas and biomass power generation. The project is currently in the pre-application stage for a Development Consent Order (DCO), which it hopes to gain by the end of 2021. By 2030, up to 6 million tonnes of CO_2 would be captured and stored each year.[86]

- South Wales Industrial Cluster: SWIC will establish a net zero carbon landscape for industry in South Wales – connecting together mini-clusters into a unique super-cluster along the coastline from Newport to Milford Haven, which will act as a catalyst for decarbonisation of other sectors such as rail, heavy surface transport, power generation and home heating. Large-scale hydrogen infrastructure and CCUS options will be developed to help shape a future low carbon economy, creating value with regional market development opportunities for residual carbon use in industrial processes and through establishing an international carbon shipping hub. SWIC will identify process solutions to reduce industrial carbon emissions at least cost and examine the architecture options for hydrogen production, transmission and distribution infrastructure to meet whole energy system demand across the year, enabling large scale CO_2 emission reduction across Wales and beyond. The cluster across the South Wales region is seeking to eliminate over 17 million tonnes per year of CO_2 emissions from industry and power generation as part of the future low carbon economy, which would be further compounded through the coupling of both heat and transport vectors.

[84] Hynet, https://hynet.co.uk/

[85] Pale Blue Dot, Acorn CCS and Acorn Hydrogen, https://pale-blu.com/acorn/ and NECCUS, https://neccus.co.uk/

[86] Net Zero Teesside https://www.netzeroteesside.co.uk/project/

- **Zero Carbon Humber:** Zero Carbon Humber would create CCS infrastructure, facilitating the Humber's transition to a net zero cluster before 2040. This infrastructure would support a hydrogen fuel switch and post combustion capture decarbonisation programme as well as capturing the 16 million tonnes per annum negative emissions (BECCS) from Drax power station. Humberside is the largest emitting cluster by a large margin, and it is anticipated that the CCS infrastructure could be in place as early as 2026. The Humber has projected that annual capture rates in 2040 from industry across the cluster (13 million tonnes), hydrogen production (15 million tonnes) and BECCS from Drax power station (16 million tonnes) are achievable. This would result in 44 million tonnes of CO_2 stored each year.[87] There are additional opportunities for hydrogen from renewable electricity which are also being developed within the cluster.

If all these projects are developed to the maximum, then around 100 million tonnes of CO_2 could be abated each year by 2040, making a major contribution to net zero. The first phases of these four projects, most delivered before the Fifth Carbon Budget period starts, would abate around 13 million tonnes a year, helping to meet the carbon budgets in practice.

[87] Zero Carbon Humber, Capture for Growth, https://www.zerocarbonhumber.co.uk/wp-content/uploads/2019/11/Capture-for-Growth-Zero-Carbon-Humber-V4.9-Digital.pdf