Department for Business, Energy and Industrial Strategy: Clean Growth – Transforming Heating

Decarbonised Gas Alliance response

February 2019

About the Decarbonised Gas Alliance

1. The Decarbonised Gas Alliance (DGA) is an alliance of 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.

2. 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.

3. The DGA is a broad-based alliance, established in late 2016, and has now expanded to 46 signatory organisations, which are listed in full in the diagram in the appendix. 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.

4. We welcome the opportunity to respond to this consultation, and we are happy to provide further detail on our responses, if this would be useful to BEIS.

Summary

5. Our response is detailed and addresses the full set of questions, but we make **several key points** in summary.

6. **All technologies** have the potential to make important contributions to low carbon heating, and we don't believe it is a simple either/or choice, although solutions may differ widely between regions, or between urban and rural areas. We believe that a decarbonised gas network plays an important role in supporting intermittent renewable energy sources.

7. Ensuring that **emissions from the various technologies are counted accurately** is essential to a fair emissions comparison between then. This includes a full accounting of the lifecycle emissions of hydrogen, biogas and electricity technologies, including the contribution from overseas interconnectors.

8. The experience and engagement of **consumers** is of paramount importance, and requires further consideration, including in the following respects:

a. **Fuel poverty:** A household is 50% more likely to be in fuel poverty if it does not have a gas grid connection. Currently, electricity costs around four times as much as gas per kWh.
b. **Consumer behaviour:** Since April 2014, only 2,000 properties a year used the Renewable Heat Incentive to switch from gas heating to a renewable alternative, but since 2005, around 1.2 million efficient condensing boilers a year have been installed. Consumers are continuing to choose gas-based solutions as a preference at present.
c. **Industry:** Maintaining industrial competitiveness is key to retaining skilled manufacturing jobs, avoiding emissions moving overseas, and taking advantage of export opportunities from growing low carbon markets. The UK currently has the second most expensive industrial electricity prices in Europe, but amongst the cheapest industrial gas prices.

9. An **integrated view of how the gas grid and the electricity grid can work together**, including opportunities for greater "sector coupling" needs further development. Within this, the role of **"decarbonised gas"** as a whole will be vital. It is not a choice between hydrogen and biogases – both will have a role to play. For example, hydrogen can be used to convert major towns and cities, biomethane and bio-SNG can help to reduce the emissions intensity of the remaining gas grid, bio-LPG can be used extensively in off-gas-grid properties, and hybrid heating systems can help to overcome the peak load issues with electric-only systems. The role of the gas and electricity grids in delivering low carbon transport should also be factored into this whole systems thinking.

10. **Low-regrets developments** should be pursued, as they can deliver emissions savings without prejudicing decisions on long-term heat decarbonisation. These include biomethane, bio-LPG for off-grid homes and industrial sites, use of hybrid heating systems, power-to-gas, and CCUS for industry and power.

11. To deliver change, firstly, **timely action** is essential, including consultations on the Industrial Energy Transformation Fund and CCUS delivery and investment frameworks. Secondly, **funding for deployment** will be needed for hydrogen solutions. Thirdly, **co-ordination** of various strands of policy and programmes is required. The Industrial Cluster Mission has great potential to deliver all three of these requirements in the industrial sphere.

12. The **Decarbonised Gas Alliance** would be pleased to work with Government and others to help co-ordinate and prioritise relevant initiatives, provide industrial experience and expertise, and assist on communication with consumers and other groups.

Discussion of the evidence base: Heat in the UK today; Characteristics of low carbon options

NB: In this section, we also consider the evidence set out in the "Heat in the UK today" part of the report.

A) Does this overview of the strategically important issues, as identified in the course of our review of the evidence, highlight the key issues? Are there important issues missing?

Heat in the UK today

13. One issue that we think has been mis-characterised is the future growth of **air conditioners** (para 2.17). The National Grid Future Energy Scenarios (FES) give a range of 0.3 million to 16.6 million air conditioning units by 2050, dependent on the scenario. This is projected to lead to additional peak electricity demand of 0.3-16.6 GW.[1] This has important implications, as even the higher FES air conditioning projections would do little to equalise summer and winter demand – the UK will still have much higher winter peak heating than summer peak cooling demand.

14. We also believe that **fuel poverty** needs to be given greater consideration in the characterisation of different forms of domestic heating (para 2.21). The most recent fuel poverty statistics for England show that 10.4% of households with a gas grid connection are fuel poor, compared with 15.5% of households without a gas grid connection.[2] This means that a household is nearly 50% more likely to be in fuel poverty if it does not have a gas grid connection, and that a gas connection can be a very effective way of reducing fuel poverty. The gas distribution networks have a target to deliver 91,000 new gas grid connections by 2021 through the Fuel Poor Network Extension Scheme.[3]

15. The **efficiency of new gas boilers** is mentioned, and we would emphasise the importance of this, alongside better insulation. In 2003, two years before condensing boilers were mandated, the typical domestic consumption value for a medium gas user was 20,500 kWh;[4] today, that figure has fallen to 12,000 kWh,[5] a reduction of 41%, equivalent to a saving of over £350[6] and 1.5 tonnes of CO_2 per annum, per user.[7] Since 2005, the proportion of condensing boilers has increased from 5% to 66%.[8]

16. **Prices for industrial energy** are also very relevant, particularly given intense global industrial competition and thin margins for manufacturers, and so it's worth noting that industrial gas prices are far more competitive than industrial electricity prices. Including all taxes and levies, the UK currently has the second most expensive electricity prices in Europe, after Denmark, for larger consumers of over 20,000 MWh per year, but amongst the cheapest gas prices for larger consumers of over 1,000 GJ per year.[9]

Characteristics of low carbon options

<u>Emissions reduction potential and environmental impact</u>

17. We think that a crucial issue has been missed in this report, which is essential to the making of an accurate emissions reduction comparison between the various low carbon heat options. As the report correctly notes in the hydrogen (para 4.32) and bioenergy (paras 4.41-4.46) sections, the **supply chain process emissions** need to be included to make a fair assessment of the emissions reduction potential of these low carbon options – even though these process emissions may be outside of the UK. In the H21 North of England report, emissions from the

upstream gas supply chain are given as 2.4-35.3g CO2e/kWh, giving an overall total of 14.47-49.77g CO2e/kWh for the project.[10] There are also lifecycle emissions from plant and infrastructure construction, which it would also be fair to include.

18. But in the electricity section, although mention is made of future electricity emission intensities of 20-30g CO2e/kWh (para 4.26), no mention is made of the **lifecycle emissions** of various low carbon electricity sources – which should be added onto the above figures for consistency, even if these lifecycle emissions occur outside of the UK. There are numerous studies that provide differing figures, but all are above zero, and there are big ranges depending on various factors, for example, on where solar PV panels are manufactured and on the size of the installations. One meta-analysis provided mean lifecycle emissions of:[11]
    a. 50g CO2e/kWh for solar PV;
    b. 66g CO2e/kWh for nuclear;
    c. 34g CO2e/kWh for wind.

19. In addition, the greater use of **electricity interconnection** is mentioned as a way to meet electrified heating demand (para 4.27), and this imported electricity may not be low carbon. It is essential, therefore, that supply chain process emissions and lifecycle emissions from gas-based routes, and lifecycle emissions from electricity-based routes, are both counted on a fair basis, to allow an accurate emissions comparison to be made.

20. The other point that needs considering is that, generally, average electricity emissions are used to calculate the emissions intensity of electric heating. But most electric heating will be used at peak times of the year (or peak times of the day). In order to meet these demand peaks, higher-carbon electricity generation may be relied upon, for example gas-fired peaking plants. This would push up emissions from electric heating. Scenarios for these **marginal emissions** need to be taken account of.

Economic costs and benefits

21. We don't agree that heat pumps would have roughly similar **running costs** for fuel as current gas boilers (para 4.68). At the current average domestic gas price of 4.31 pence per kWh, based on usage of 15,000 kWh of gas a year[12] the total gas bill would be £646. Assuming a condensing boiler efficiency of 90% (although efficiency can be up to 98%), 13,500 kWh of heat output would be obtained. Taking the stated heat pump efficiency of 2.5, to obtain the same 13,500 kWh of heat output, a replacement heat pump would use 5,400 kWh of electricity a year. At the current average domestic electricity price of 17.78 pence per kWh, the total bill for the heat pump would be £960 – an increase of 49%. Of course, better insulation would bring down the heat pump energy requirement, but that would also be true of the gas boiler.

22. The costs of different **business models** for the decarbonisation of heat also needs consideration. Achieving a low cost of capital is essential to limit the overall costs of a transition – reducing the weighted average cost of capital (WACC) from 10% to 5% for an offshore wind farm would reduce the levelised cost of energy by 30%,[13] or to put another way, a 1% rise in WACC would increase the cost of energy by around €5 per MWh.[14] According to IRENA's latest renewable power generation costs report, one of the factors behind falling renewables costs is "falling or low cost of capital, driven by supportive policy frameworks, project de-risking tools and the technological maturity of renewable power generation technologies".[15] As an example, the H21 North of England plan is based on a regulated asset model, with a weighted average cost of capital (WACC) of just 3.4%, which is the current projected gas distribution network WACC.[16]

Consumer experience

23. How **consumers are actually behaving** is an issue that appears to be missing. In 2017, 22,000 heat pumps were installed, compared to 1.6 million gas boilers.[17] It is worth noting that, at this rate, it would take 1,000 years for the UK's homes to be converted to heat pumps. Consumer acceptance of retrofits to household heating systems, including the greater insulation required for heat pump systems, removal of existing "wet" central heating systems, and their replacement with underfloor or wall mounted heaters, is also a key issue that requires further investigation. This will need to include lessons learned from the Green Deal scheme, as well as the difficulties encountered in the smart meter programme.

24. The issue of **cumulative noise** of heat pumps in densely populated areas is addressed in para 4.105 and the associated footnotes, including the potential of new models to be quieter. We think that consideration of World Health Organisation (WHO) noise thresholds also needs to be made. The WHO produces environmental noise guidelines for the European region,[18] and these recommendations are often used in planning applications, including conditions requiring noise mitigation. Generally, the WHO recommends that environmental noise at night be kept to below 45dB or lower, and planning rules can restrict developments to producing no more than 10dB above ambient night-time noise.[19] It is likely, therefore, that only the new, quietest heat pump models would be suitable for urban deployment.

Energy system impacts

25. For the solutions that require **carbon capture, usage and storage (CCUS)**, the opportunities to re-use offshore oil and gas facilities also need to be considered. CCUS is not just a cost, but also an opportunity for the UK to capture a share of a growing global market. For instance, the value to the UK economy of developing a CCUS infrastructure has been estimated at £163 billion to 2060 – this is not just in the CCUS industry itself, but in the support and potential expansion of carbon-emitting process industries that would have an alternative investment location when existing plants need to be replaced or new processes are devised, including those that need low-carbon hydrogen as an input.[20] The future global CCS market is estimated to be around £100 billion a year.[21]

Industrial heating

26. We would emphasise that the Element Energy and Jacobs report on industrial fuel switching for BEIS, published in December 2018, concluded that options for **off-grid industrial sites** could include bio-LNG and bio-LPG, particularly for steam and indirect low temperature heating.[22] There are interesting potential synergies with off-grid domestic properties, where bio-LPG has considerable potential.

B) Are there important pieces of evidence that require further consideration?

Characteristics of low carbon options

Emissions reduction potential and environmental impact

27. We appreciate that this report was only published shortly after the publication of the **H21 North of England** report,[23] and some reference is made to it. We would urge that full consideration is given to the wealth of detailed evidence presented in H21 North of England, including the emissions from the hydrogen production process, costs and efficiencies, together with the

detailed conversion strategy – much of which has evolved considerably from the earlier H21 Leeds City Gate report.[24] We believe that H21 North of England presents a very credible pathway for the decarbonisation of heat for large parts of the gas network.

28. Further evidence needs to be considered on **NOx reduction techniques** for hydrogen production through methane reformation (para 4.39). The H21 North of England report provides details of possible nitrogen dilution and Selective Catalytic NOx Reduction units. This would reduce the NOx concentration in the flue gas to below 10 parts per million and the SOx concentration to less than 0.05 parts per million.[25]

Energy system impacts

29. The relative **storage capacities** of the electricity and gas systems need to be given further consideration, as this can be a crucial way to manage both intra-day and seasonal demand. The UK's gas system (including LNG storage) currently has the capacity to store 5.85 billion cubic metres.[26] This is equivalent to around 14.5 days of gas demand during a peak cold winter's day, where demand is around 400 million cubic metres.[27] Maximum daily withdrawals from gas storage total 133 million cubic metres per day,[28] around 33% of total demand on such a cold winter's day. This is equivalent to 60 TWh of total storage, and the ability to withdraw up to 1.4 TWh per day. By contrast, the electricity system currently has 3.3 GW of storage capacity,[29] of which 2.75 GW is pumped storage.[30] Assuming electricity supply duration of 5 hours for pumped storage and 1 hour for battery storage, the electricity system can currently supply up to 14.3 GWh per day. This is an order of magnitude lower than the gas system.

30. The H21 North of England report provides a detailed scenario for **nationwide roll out of hydrogen conversion** through to 2050, which would convert 62% of domestic heat and 48% of non-domestic heat that is currently provided by natural gas. It envisages 57.2 GW of hydrogen production capacity in total, with a growth rate of 1.5-4.1 GW per year – in most years, the growth rate would be less than 3 GW.[31] Although this is not covering 100% of the gas grid, the cumulative capacity and annual build required are considerably lower than in the Element Energy study cited in para 4.140.

C) Do you agree with the set of strategic inferences we have drawn out?

Characteristics of low carbon options

Emissions reduction potential and environmental impact

31. We don't think that the comparative strategic inferences around the **emissions reduction potential** of electric and hydrogen heating are accurate. This is due to the points we make above, that gas supply chain process emissions for hydrogen are correctly considered, but lifecycle emissions for low carbon electricity generation technologies (including imported electricity) are not – these technologies are zero carbon at the point of generation, but are not zero carbon when the emissions from manufacturing and installation are included. As we also explain above, the marginal emissions from peak electricity usage also need to be considered. In our view, therefore, the ultimate depth of emissions reductions from electric heating is also unclear.

32. We agree with the other inferences, particularly the inference that **all technologies** have the potential to make important contributions to low carbon heating, and we don't believe it is a simple either/or choice. For example, if the full UK-wide roll-out of H21 were to take place, it

would see 62% of the UK's domestic heat demand converted to hydrogen.[32] But that would still leave the remaining 38%, as well as the off-gas-grid heating, that would require other low carbon solutions. A mix of technologies will always be needed, although solutions may differ widely between regions, or between urban and rural areas.

Economic costs and benefits

33. We agree with most of the inferences, but we do not agree with the inference that gas-based solutions can be expected to involve **higher operating costs** than electric solutions. Although heat pumps may have higher efficiencies, the unit price of electricity is around four times that of gas – as we explained earlier, this would mean that a heat pump would cost around 50% more to run than a condensing gas boiler. This may be similar to the additional running costs of a hydrogen system if higher hydrogen costs are not socialised.[33] The reality is that all low carbon heating solutions will have higher running costs than current gas heating.

34. With regard to **consumer appliance costs**, greater consideration needs to be given to business models. For example, in the H21 North of England plan, hydrogen appliances would be purchased wholesale, which would result in a significant discount relative to retail appliance prices.[34] Unless similar models were adopted for heat pump deployment, this would widen the gap between the respective appliance costs.

35. As we detail above, business models are also vital to an understanding of the overall system cost of various options. For example, the low cost of capital from a **regulated asset model** needs to be considered.

36. We also believe that evidence on the **buildability** of all options needs to be considered alongside modelling on cost. This needs to include the size of UK and global supply chains and the size of the UK workforce with the necessary skills.

Consumer experience

37. One inference that is missing is how **consumers are actually behaving**. As we noted above, consumers are generally buying new gas boilers, not heat pumps. At the moment, consumer preferences are clear.

Energy system impacts

38. We generally agree with the inferences, including the issue of gas security of supply. But the issue of the **security of supply of electricity** is not considered in the same way. In para 4.27, making greater use of electricity interconnection is mentioned as a way to support the electrification of heat. But in the strategic inferences in this section, the security of supply of imported electricity, especially in the context of a cold, still period in North West Europe, is not considered. There is evidence that capacity margins are likely to fall in North West Europe over the coming years, which should be examined further.[35] Nor is the need to ensure that imported electricity is from a low carbon source.

39. We also agree that **hydrogen conversion** would require systems-level planning, and note the detailed consideration of the various issues in the H21 North of England report, including the ability of the global supply chain to build the necessary levels of hydrogen production capacity, and the volume of skilled engineers required to carry out the conversions (with suitable additional training). For example, SMR/ATR hydrogen production installations on a global scale are equal to 6-7 GW per year, several times higher than the annual H21 build-out, and the Oryx and Pearl

GTL projects are examples of mega-scale projects similar or above H21 North of England requirements.[36] For the conversion programme, an average of 3,000 engineers are needed each summer – the UK currently has 128,000 Gas Safe registered engineers.[37] The conclusion is that, although not without challenges, a widespread hydrogen conversion is feasible.

Industrial heating

40. One inference that is currently missing is the need to maintain **industrial competitiveness**, often concerning industries where there is significant international competition and thin margins – 70% of energy intensive businesses export.[38] This is of crucial importance not just for industrial employment in the UK, but also for our decarbonisation efforts. Between 1997 and 2015, the UK's *production* of greenhouse gas emissions fell by 33%,[39] but our *consumption* of emissions in goods and services only fell by 4%, as emissions embodied in imports rose by 31%.[40] Over this period, manufacturing fell from 17% to 10% of the UK's economy.[41] To give one example, the closure of Redcar steelworks in late 2015 led to 2,000 job losses and caused nearly half the fall in industrial emissions in 2016.[42] It is therefore vital to ensure that industrial heat decarbonisation does not lead to any relocation of industry (and emissions) outside of the UK, as this would not be compatible with the UK's clean growth ambitions.

41. At the same time, industrial cost competitiveness is not always zero-sum – the are opportunities to stimulate **demand for low carbon industrial products**, as well as to build capacity and expertise in industrial decarbonisation technologies. For example, the Hydrogen Council roadmap presents a 2050 vision where the global annual sales of hydrogen technology and services reach £1.94 trillion and create jobs for 30 million people.[43] Both the risks and the opportunities of industrial heat decarbonisation need more thorough consideration.

42. A second key inference that needs to be made is the **synergies** of various options across sectors. For example, establishing a source of low carbon hydrogen to meet significant industrial demand can provide hydrogen at reasonable cost for heavy transport in the region (trains, ships, heavy goods vehicles etc). It also builds hydrogen production capacity for a domestic conversion programme.

Overall

43. None of our points above should be taken as arguing against the development of low carbon electric heating solutions. We believe that these will play an important role. An **integrated view of how the gas grid and the electricity grid can work together** needs further development – ultimately, we will need both.

44. Within this, the role of **"decarbonised gas"** as a whole will be vital. It is not a choice between hydrogen and biogases – both will have a role to play. For example, hydrogen can be used to convert major towns and cities, biomethane and bio-SNG can help to reduce the emissions intensity of the remaining gas grid, and bio-LPG can be used extensively in off-gas-grid properties. Both hydrogen and bioenergy sources can be used by industry. A greater level of systems thinking on the role of decarbonised gas will be necessary.

45. The report looks at the range of solutions that could be optimal for the UK. But in order to achieve scale and cost reductions, **other countries** will also need to develop similar solutions, so that a global market can be created – as we have seen for wind turbines, solar PV panels and electric car batteries, for example. The report needs to look outside of the UK to a greater extent, not forgetting that many energy-intensive firms are have overseas ownership.

Discussion of the evidence base: Achieving change

NB: Our answers to the questions in the previous section are also very relevant for this section, as they all have implications for how change can be achieved. We will not repeat these answers here, but make a number of additional points.

A) Does this overview of the strategically important issues, as identified in the course of our review of the evidence, highlight the key issues?

Consumer engagement

46. We recognise that **consumer engagement** on low carbon heating is tough, as any option is likely to cost more than current gas-fired heating. We note the 2000 fuel protests in the UK, in reaction to rising prices for petrol and diesel, partly caused by rising fuel duty,[44] and how difficult it has been to raise fuel duty in recent years – headline fuel duty rates have been frozen since 2011-12.[45] We also note the "Gilets Jaunes" protests in France, where rising duties on petrol and diesel were a significant cause of the start of the protests, and where the planned fuel duty increases were then cancelled.[46] Consumer acceptance of the safety case is also vital.

47. As we note below, however, **new product regulations** mandating condensing boilers have been very successful in delivering a roll-out of more efficient domestic appliances, without the requirement of wider changes to heating systems or insulation. This suggests that new appliances that can be swapped for old appliances when they come to the end of their life, without the need for wider changes, are solutions that work with the grain of consumer behaviour. Mandating hydrogen-ready boilers at least in certain areas, in a similar way to the condensing boiler regulations, would help to reduce any disruption from a future hydrogen conversion programme.

Markets, co-ordination and planning

48. The issue of **who pays**, particularly for lower-income consumers, is of vital importance. We have highlighted the fuel poverty issue above, and consider that some socialisation of costs is probably inevitable to manage the impact on individual households, as set out in H21 North of England. A useful element here is the Iron Mains Risk Reduction Programme, funding for which is socialised across all gas consumers, and which is set to be completed in 2032. Between 2032 and 2052, there will be increasing levels of network savings, adding up to 7% of the bill by 2052.[47] This could allow, instead, for a continuation of the Iron Mains Risk Reduction Programme funding for a hydrogen conversion, with less noticeable impact on bills.

49. For **industry**, the issue of who pays is also very important, as we set out above in our comments on industrial competitiveness. The Energy Transitions Commission recommended that carbon prices should be differentiated by sector, depending on the costs of abatement in different industries, and levied on domestically-traded products such as cement, rather than internationally-traded products such as steel.[48] An option to consider in this regard is tax credits for reducing emissions, rather than higher prices or levies on emissions – the 45Q tax credit for CCUS in the US is an example of this.[49]

Local leadership and action

50. The **importance of clusters** in decarbonisation of industry is recognised by the BEIS Industrial Clusters Mission, which sets out a laudable ambition of a net-zero industrial cluster by 2040, with at least one low-carbon cluster by 2030.[50] We strongly support this aim, and believe that clusters provide an opportunity for low carbon solutions across multiple sectors, with economies of scale and shared infrastructure. Integrating national, regional and local planning, and ensuring co-ordination of the various funding streams (including the Industrial Strategy Challenge Fund and the Industrial Energy Transformation Fund) and work packages (including the CCUS Action Plan) will be needed to ensure a success of the Mission.

B) Are there important pieces of evidence that require further consideration?

Consumer engagement

51. It is worth noting the **differing degrees of success from various policy mechanisms**. In particular, we would note the contrast between the domestic Renewable Heat Incentive (RHI), and the condensing boiler regulations:
    a. Between April 2014, when the RHI started, and December 2018, only 9,033 properties used the RHI to switch from gas heating to a renewable alternative[51] – around 2,000 a year.
    b. Between 2005, when all gas-fired boilers fitted had to be condensing boilers,[52] and 2017, the number of condensing boilers increased from 1.0 million to 15.9 million[53] – an increase of around 1.2 million a year.

C) Do you agree with the set of strategic inferences we have drawn out?

52. Comprehensive **testing of new technologies**, together with **field trials**, will be necessary to allow a fair comparison of all decarbonised heat options, to help inform long-term policy. This includes expanded funding levels. For example, £320 million is being invested in heat network deployment through the Heat Network Investment Project,[54] compared with £25 million in research around hydrogen for heating[55] and £10 million in low carbon heating technology innovation (covering gas-driven, hybrid and electric-driven solutions)[56]. To move to the next stage, deployment-level funding will be required for hydrogen.

53. With respect to **Ofgem network innovation funding**, which is a critical enabler for many low carbon heating projects, there is a large discrepancy in funding for electricity network innovation (£70 million) and gas network innovation (£20 million) in the annual Network Innovation Competitions. Equality of funding for network innovation, through levelling-up rather than levelling down, is needed to realise opportunities around decarbonising gas, and a broad approach to encouraging innovation across the supply chain will be needed for comprehensive field trials to take place.

54. There are a number of **low-regrets developments**, that can deliver emissions savings without prejudicing decisions on long-term heat decarbonisation. These include:
    a. *Biomethane*, which is already being injected into the grid at 89 sites and has delivered 6.7 TWh of renewable heat so far.[57] Whatever the future role of the gas grid, biomethane can help to deliver emissions reductions without the need for any changes to appliances.

b. *Bio-LPG*, which has considerable potential in off-grid homes and industrial sites. For domestic buildings off the gas grid, an old oil boiler would emit 3.6 tonnes of CO_2 equivalent per annum, with a new bio-LPG boiler emitting just 0.4 tonnes per annum, an 89% reduction.[58]
c. *Hybrid heating systems,* which were demonstrated by the Freedom Project to be effective across both off-grid and on-grid properties, with the use of smart controls to switch between gas and electricity, and without the need for wholesale changes to radiators and insulation that would be needed by full heat pump solutions.[59]
d. *Power-to-gas,* which would make use of excess renewable electricity to produce hydrogen, which can then be used for industrial and transport applications and/or blended at low concentrations in the gas grid.
e. *CCUS*, which will be needed for decarbonisation of parts of industry less suited to fuel-switching, for example cement and lime production, regardless of decisions on long-term heat decarbonisation. The CCUS infrastructure can then be used for low carbon hydrogen production from methane, or bioenergy with CCUS, for example. Consideration of the role of CCUS in providing low-carbon dispatchable power, especially in cold, windless winter snaps, or even negative emissions through BECCS, will also be needed – we believe that this will be the case regardless of decisions on heat decarbonisation, but if a predominantly electric heating option is chosen, CCUS in power would become even more important.

55. Ultimately, though, carrying out **the easy actions will not be sufficient** to deliver the scale of heat decarbonisation needed. For example, as mentioned above, the domestic RHI has led to around 2,000 properties a year switching from gas-fired heating to a renewable source – at this rate it would take 10,000 years for all properties on the gas grid to switch. And while the gathering of sufficient evidence is essential to good policy-making, at some point long-term policy will have to be set. There are of course risks to premature policy-making, but there are also risks to the achievement of the UK's decarbonisation targets from waiting too long before making decisions.

Developing a new policy framework

NB: Again, our answers to the questions in the previous two sections are also very relevant for this section, as they all have implications for the design of a new policy framework. We will not repeat these answers here, but make a number of additional points.

A) Do you agree that we have identified the most important issues to be addressed as we develop our thinking? Do you consider that there are important omissions?

56. Our **answers to the questions in the previous section** are very relevant here, as they detail a number of issues that require further consideration. We will not repeat them all here, but will re-emphasise several key issues, and add several further points.

57. **Emissions comparisons:** There needs to be a fair and accurate lifecycle emissions comparison between gas and electricity based low carbon heating solutions. In order for a fair comparison to be made, it must include:
a. The emissions at the point of electricity generation/production of hydrogen.
b. Upstream process emissions from the gas supply chain.
c. Lifecycle emissions from plant and infrastructure construction for hydrogen.
d. Full lifecycle emissions of the electricity sources.
e. Emissions from imported electricity via interconnectors.

f. The marginal emissions intensity of peak electricity production/hydrogen use.

58. **Synergies:** Synergies across the various options need further examination. For example, establishing a source of low carbon hydrogen to meet significant industrial demand can provide hydrogen at reasonable cost for heavy transport in the region (trains, ships, heavy goods vehicles etc). It also builds hydrogen production capacity for a domestic conversion programme.

59. **Off-gas grid:** We would emphasise the importance of full consideration of all the options for decarbonising off-gas grid homes, including the potential of bio-LPG.

60. **Existing position:** It is worth noting what has been achieved already, and the implications for heating decarbonisation. For example, Scotland has already achieved very substantial electricity sector decarbonisation, so is well placed to develop power-to-gas projects using grid average electricity generation.

61. **Electricity tariffs for consumers:** How heating decarbonisation aligns with the smart meter programme is an important consideration. A move to time-of-day electricity tariffs, which may be needed to realise the demand-side response potential of smart meters, may not be helpful if people have no choice but to keep their heat pump on at peak times.

62. **Integrated view:** An integrated view of how the electricity and gas systems can work together to deliver low carbon heating in different settings will be needed, and within this, the role of "decarbonised gas" as a whole needs greater consideration. As we pointed out above, it is not a choice between biogases, hydrogen and electricity. All three will be needed.

B) Do you have any comments on the types of actions identified to meet these challenges? Do you have other suggestions?

63. We would recommend a **broad range of actions**, many of which are being addressed, and would emphasise the following.

64. **Speed:** Implementing actions in a timely manner will be essential to maintaining progress in heat decarbonisation. For example, the consultation on the Industrial Energy Transformation Fund should take place as soon as possible, and certainly in the first half of 2019, and the consultation on delivery and investment frameworks for CCUS should also be published before summer recess.

65. **Funding:** There should be greater equality in funding between heat network, electric, and gas-based solutions, to allow for a fair comparison of these low carbon heating options, as gas-based innovation moves to a deployment phase. This should include Ofgem as well as BEIS funding, as highlighted above. It would be helpful if funding was more concentrated, rather than the current patchwork, allowing larger schemes to bid, including field trials and the proposed H21 North of England FEED study.

66. **Co-ordination:** Co-ordination between the various strands of policy and programmes will be essential. This must include:
    a. The various funding streams under the industrial cluster "Mission", including the Industrial Energy Transformation Fund, the Industrial Cluster challenge in the Industrial Strategy Challenge Fund, and the Foundation Industries Challenge.
    b. The CCUS Action Plan.

c. Existing relevant BEIS low carbon funding sources and programmes.
d. Ofgem network innovation funding.
e. Department for Transport rail and other decarbonisation programmes.
f. Future demonstration projects, including trials of low carbon heat solutions.

67. **Blending:** As the HyDeploy projects work through, getting a safety case approved by the Health and Safety Executive for limited hydrogen blending (2-3%) will allow early hydrogen projects to commence, helping to build capacity for wider deployment, and increasing consumer familiarity and confidence.

68. **Efficiency:** As we noted above, new condensing gas boilers have led to a remarkable reduction in domestic gas use, demonstrating the importance of more efficient appliances. We would therefore emphasise the importance of continuing work to develop micro-CHP units and gas-fired heat pumps, that could use gas in the short term and then potentially switch to hydrogen subsequently. Depending on the capital costs of such appliances, they may be crucial in mitigating the impact on consumer bills from a higher unit price of energy for decarbonised heat.

69. **Low-regrets:** As longer-term policy is developed, continuing action on low-regrets solutions, such as biomethane and bio-LPG, will help to achieve continuing decarbonisation of heat without prejudice to any future decisions. This will also build scale and lead to cost reductions in these sectors. We would also recommend that hydrogen-ready boilers be developed, and if successful and cost-effective, subsequently mandated, at least in urban areas. This would reduce the cost and disruption of a future hydrogen conversion. Finally, given that it will be needed for parts of industrial decarbonisation in any case, as explained above, CCUS should also be developed in advance of any long-term heating decisions.

70. **Trials and demonstrator projects:** More detail is needed on forthcoming trials of low carbon heat. For instance, SGN is developing the "H100" project, which would use 100% hydrogen in around 350 new-build homes. It will be important to understand how projects such as this fit into the BEIS policy development process. Similarly, decarbonised gas industrial projects, including potentially bioenergy and hydrogen from both electrolysis and methane with CCUS, may be forthcoming through the industrial cluster "Mission" and the associated funding schemes. These will also provide valuable evidence to inform BEIS heat policy.

71. **Deployment at scale:** As the Committee on Climate Change pointed out in its recent hydrogen report: "continuing an incremental approach that relies on isolated, piecemeal demonstration projects may lead to hydrogen remaining forever an option 'for the future'." The Committee recommended the deployment of hydrogen technologies in the 2020s, including hydrogen production at scale as part of a CCS cluster.[60] We agree that deployment of hydrogen and other decarbonised gas technologies is essential to achieving scale and cost reduction, and would note that offshore wind and other renewable electricity generation technologies have seen large cost reductions through sustained government support for at-scale deployment over many years. A future policy framework will need to address this issue – supporting deployment at scale will help to achieve cost reductions that will reduce and ultimately eliminate the need for further support.

72. **Decisions:** At some point long-term policy will have to be set. There are of course risks to premature policy-making, but there are also risks to the achievement of the UK's decarbonisation targets from waiting too long before making decisions.

C) <u>Do you have views on which parties are best placed to deliver actions to address the key issues?</u>

73. **Industry and government collaboration** will be important to overcoming technology and other barriers to low carbon heat deployment. We would note the success of similar initiatives in other areas – for example, the Oil and Gas Technology Centre leverages both government and industry funding to deliver innovation to reduce costs and improve performance in the offshore oil and gas industry.[61]

74. Industry can also provide **experience and expertise** to assist in policy development, for example, on the size of global supply chains and the number of skilled people in the UK. This can help to inform an understanding of the buildability of various options, that would sit alongside energy systems modelling.

75. Finally, groupings such as the Decarbonised Gas Alliance are also aware of the need for greater **communication with consumers** – both domestic and industrial – on the need for heat decarbonisation and the various options to do so. We would be pleased to work with Government on this, and recognise that communication is not solely the responsibility of the Government.

D) <u>Do you have any views on priorities for further development and proving of emerging technologies with clear potential to provide strategically important options and benefits in relation to decarbonising heating? Please provide supporting argument for your views.</u>

76. We would **re-emphasise our answers to Part B** of this section, which are valid for this Part.

E) <u>Do you have views on how co-ordination and prioritisation of relevant initiatives across industry, academia and the public sector could be improved?</u>

77. Firstly, a **replacement for EU Horizon funding** will be needed, depending on the outcome of Brexit negotiations.

78. Secondly, the **Decarbonised Gas Alliance** (DGA) has 46 signatory organisations that span many parts of the gas industry (including major companies, specialised SMEs and trade associations), academia, trade unions and local government (see graphic below). We would be pleased to work with Government and others to help co-ordinate and prioritise relevant initiatives. As part of this, we would be happy to work alongside electricity sector representatives. Indeed, a number of DGA signatories also have expertise in the electricity sector and/or are interested in greater "sector coupling" between electric and gaseous forms of energy – the Freedom Project is a great example of co-operation between the gas and electricity networks.

F) <u>Do you have views on ways in which the Government and other actors could seek to engage stakeholders and stimulate a wider public debate?</u>

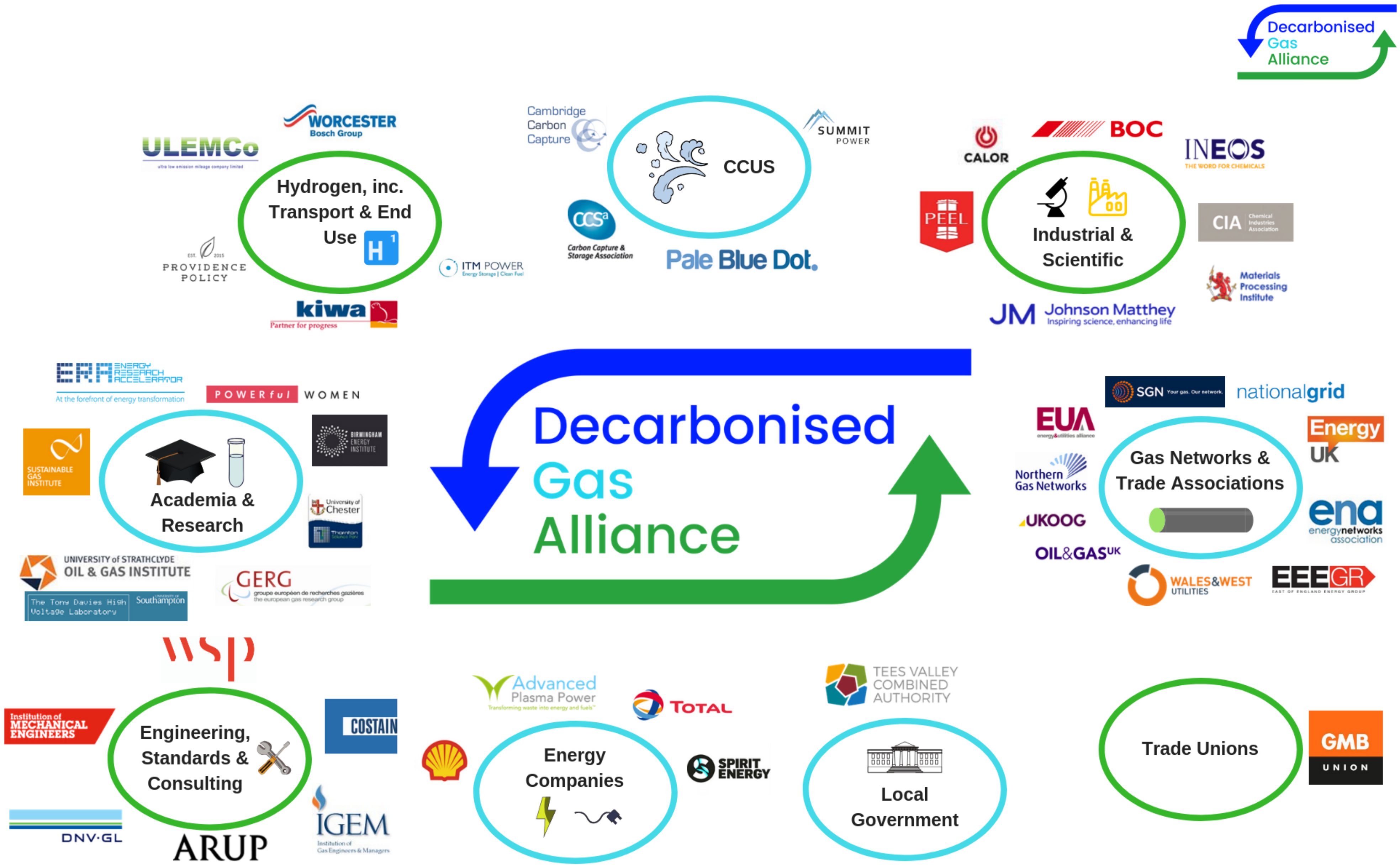
79. A comprehensive programme of **opinion research** is necessary to understand in detail what the public think about low carbon heating, in both domestic and industrial settings, and what their opinions are on the price rises and disruption that may result from decarbonisation.

80. Following this work, there needs to be a **concerted communications effort** spanning many years, explaining the need to decarbonise and the realistic tough choices the country has to make to achieve it. It will be important to involve a number of different parties, including Government, industry, academia and consumer groups. We also think that regional-led communication will be important, as solutions will differ across regions, and there may be a greater level of trust in regional rather than national institutions.

81. Nonetheless, we recognise that this is tough, and **honesty on likely bill increases and/or capital costs** will be essential. We note the 2000 fuel protests in the UK, in reaction to rising prices for petrol and diesel, partly caused by rising fuel duty,[62] and how difficult it has been to raise fuel duty in recent years – headline fuel duty rates have been frozen since 2011-12.[63] We also note the "Gilets Jaunes" protests in France, where rising duties on petrol and diesel were a significant cause of the start of the protests, and where the planned fuel duty increases were then cancelled.[64] It doesn't require too much imagination to foresee the difficulties of increasing gas bills significantly.

G) Are there practicable ways in which we could facilitate greater transparency on the exchange of views and analysis on relevant issues?

82. We believe that transparency is important, and that the evidence-gathering process, including practical safety evidence, is already quite transparent. We would be happy to engage in initiatives to increase transparency further. DGA signatories would also be happy to facilitate visits to, for example, testing sites, to promote understanding of the rigorous process of safety testing to a wider audience.


Decarbonised Gas Alliance
Hydrogen, inc. Transport & End Use
CCUS
Industrial & Scientific
Academia & Research
Gas Networks & Trade Associations
Engineering, Standards & Consulting
Energy Companies
Local Government
Trade Unions
ULEMCo
WORCESTER Bosch Group
PROVIDENCE POLICY
kiwa
ITM POWER
Cambridge Carbon Capture
CCSA
Carbon Capture & Storage Association
SUMMIT POWER
Pale Blue Dot.
CALOR
BOC
INEOS
PEEL
CIA
Materials Processing Institute
JM Johnson Matthey
Inspiring science, enhancing life
ERA Energy Research Accelerator
At the forefront of energy transformation
POWERful WOMEN
Sustainable Gas Institute
Birmingham Energy Institute
University of Chester
Thornton Science Park
University of Strathclyde Oil & Gas Institute
The Tony Davies High Voltage Laboratory
Southampton
GERG
SGN
nationalgrid
EUA
Energy UK
Northern Gas Networks
UKOOG
OIL&GAS UK
ena energynetworks association
WALES&WEST UTILITIES
EEEGR
wsp
Institution of MECHANICAL ENGINEERS
COSTAIN
DNV·GL
ARUP
IGEM
Advanced Plasma Power
TOTAL
SPIRIT ENERGY
TEES VALLEY COMBINED AUTHORITY
GMB UNION

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