Energy Strategy Call for Evidence

Response Template

How to Respond

This template replicates the questions asked in the Call for Evidence found at: https://www.economy-ni.gov.uk/energy-strategy-call-for-evidence

It is recommended that you should read the full consultation document before completing your response. Please note that the text boxes used throughout this template can be expanded to accommodate your response – there is no character limit.

For further information on how we handle your personal data please read our Privacy Notice

Early responses are encouraged but all responses should arrive no later than **5pm on 20 March 2020.**

Please send your response to:

energystrategy@economy-ni.gov.uk

Or alternatively by post to:

Energy Strategy
Department for the Economy
Netherleigh
Massey Avenue
Belfast
BT4 2JP

Quote the reference "**Energy Strategy Call for Evidence 2019**"

1. General Information

1. **Name (required)**

[redacted]

2. **Are you responding:**

   ☐ **as an individual (please complete 3 to 5 below)**

   X on behalf of an organisation / company (please complete 6 to 8 below)

If you are responding as an individual:

3. **E-mail address**

4. **Address**

5. **If you are responding as an individual, please read the Privacy Notice and tick the statement below as applicable.**

   ☐ **All responses will be published on the Department for the Economy website following completion of the Call for Evidence process. Please tick if you are content for your name to be published alongside your response.**

If you are responding on behalf of an organisation / company:

6. **Organisation / Company**

Mutual Energy

7. **Position within Company / Organisation**

[redacted]

8. **Contact details**

   a. **E-mail address**

[redacted]

   b. **Address**

[redacted]

2. Energy in Northern Ireland

Q1. What lessons can we learn from elsewhere in addressing energy within an overarching climate action framework?

Q2. What are the key considerations for decarbonising Northern Ireland's energy sector given existing linkages to other jurisdictions?

Q3. To what extent should Northern Ireland implement the key energy-related recommendations from the CCC 'Reducing Emissions in Northern Ireland' report?

Q4. Do you agree with the 30-year timeframe? If not, please state your preferred approach and reasons.

Energy in Northern Ireland A summary of this response is contained in the additional information section at the end.

3. The Energy Transition in Northern Ireland

Q5. What are the unique characteristics of Northern Ireland that need to be considered in a net zero carbon energy transition?

Q6. Is your organisation undertaking or planning to undertake projects to support the energy transition? If so, please provide further details.

5.1 Northern Ireland has a number of unique characteristics that need to be considered in a net zero carbon energy transition as detailed in the paragraphs below.

Higher Energy Costs & Fuel Poverty

5.2 As covered in our answer to question 7 below there are going to be significant costs for consumers, business and government in all jurisdictions as they transition to a net zero carbon energy position. As things stand there is already a high level of fuel poverty in Northern Ireland at 18% in 2018[1]. Rising energy prices will inevitably increase the % of the population in fuel poverty especially as Northern Ireland has the following characteristics: -

1. One of the lowest gross disposable household incomes per head of any region in the UK at 81%[2] of the UK average. Rising energy costs for all will disproportionately impact poorer regions such as Northern Ireland.

[1] https://www.nihe.gov.uk/getmedia/1f9e55a1-66c2-46b7-bf92-9ee192ce355f/estimates-of-fuel-poverty-northern-ireland-2017-and-2018-revised.pdf.aspx?ext=.pdf

[2]https://www.ons.gov.uk/economy/regionalaccounts/grossdisposablehouseholdincome/bulletins/regionalgrossdisposablehouseholdincomegdhi/1997to2017

2. Relative to the rest of the UK a relatively sparsely populated landmass at half the UK average[3] with consequently a greater proportion of the housing being harder to heat detached properties. This means that the costs of the electricity and heating networks should be proportionately higher than would otherwise be the case.

It is therefore imperative that cost considerations are thought through when pathways to decarbonisation are evaluated. As outlined in our answer to question 21 a hydrogen-led decarbonisation of the gas grid is likely to be the a very cost effective approach, and as discussed in our answer to question 30 the migration of transport energy demands to the gas and electric networks can provide another contribution to covering the network costs, helping with the fuel poverty issue.

Gas Network

5.3 The gas network is new compared to the rest of the UK and Europe. Natural gas was first introduced into NI in 1996 versus the 1970s in the rest of the UK. This affords NI the opportunity to transition to hydrogen or other alternative gases to natural gas more efficiently and at lower cost.

High Winds With A Small Poorly Interconnected Electricity Grid

5.4 The Met Office describes NI "as one of the windier parts of the UK"[4]. This affords NI the opportunity to generate a significant portion of its electricity and heating demand in a cost-effective manner.

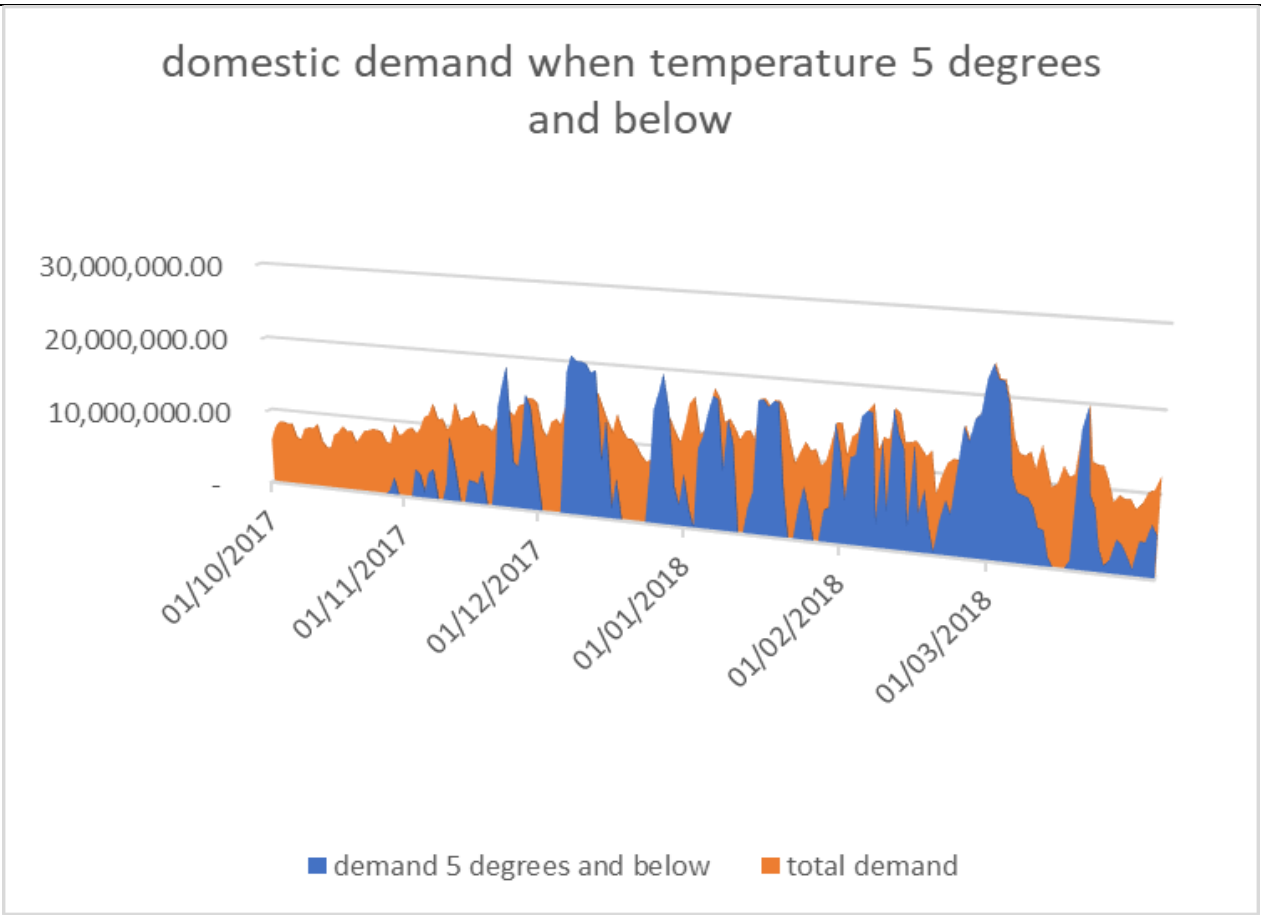
5.5 However, given the small size of the electricity grid the more wind power is used to meet electricity, transport and heating needs the more exposed NI will be when wind speeds are negligible given the small size and poorly interconnected grid network[5].

5.6 The Electricity Journal describes NI small, poorly interconnected grid "as a canary in the coal mine for the challenges of integrating large amounts of small, distributed generation". Larger grids will encounter these issues much later in the process of transitioning to net zero carbon.

5.7 With high levels of electricity being generated from intermittent renewable energy sources that are by their nature non dispatchable, a solution for energy storage will be required earlier in NI than in other areas. NI does not have the low carbon nuclear generation or the dispatchable hydro generation that is available in GB.

5.8 50% of the heat demand in the heating season in NI occurs when temperatures are below 5C, often for prolonged periods[6]:

[3] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/northern-ireland
[4] https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/regional-climates/northern-ireland_-climate---met-office.pdf
[5] https://www.sciencedirect.com/science/article/pii/S1040619017301938
[6] Gas volume analysis heating season 2017/18



5.9 This is at a temperature when air sourced electric heat pumps efficiency levels in studies have been shown to decline sharply. Consequently zero carbon gas heating should be the preferred method of space heating, combined from 2030 with heat pumps in a hybrid alignment to maximise the advantages of both technologies as outlined in question 18

Large Volumes of Anerobic Digestion (AD) potential

5.10 As a result of NI's large agricultural sector in NI it has significant potential for using AD to generate electricity or heat. A QUB study[7] calculates this this potential at 2,020 GWH of electricity (approximately 25% of NI electricity demand) or 2,885 GWH of heat (approximately 34% of domestic heating demand).

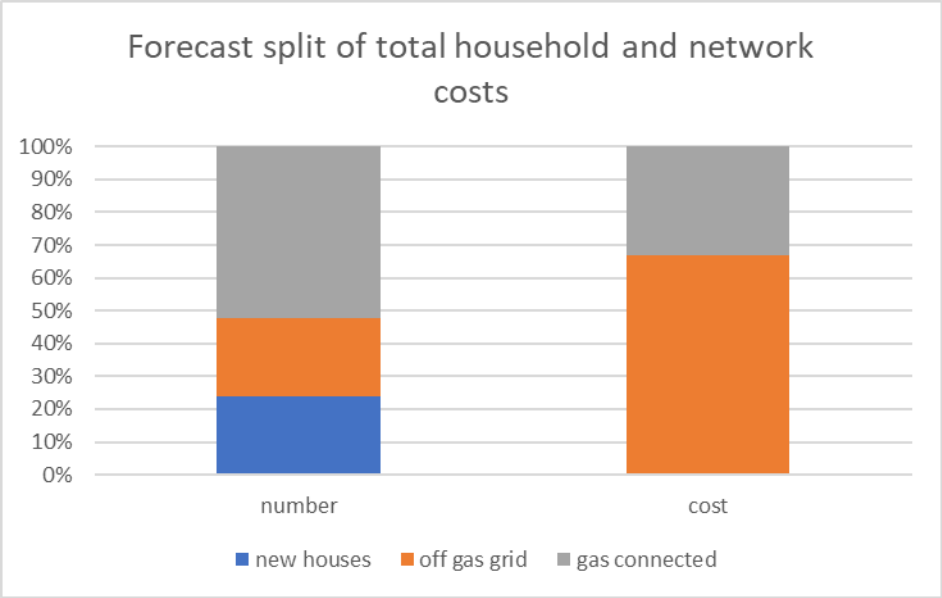
5.11 Long term if used on the gas grid this gives the option of the current gas system running on a hydrogen / biogas mixture as opposed to simply 100% hydrogen (see question 21)

Capital Expenditure & Retrofit Costs

5.12 The sparsely populated nature of NI means that a significant proportion of the homes cannot be added to the gas grid economically over the short term. A consequence of this is the much higher costs of retrofitting homes and reinforcing and expanding the electricity grid for electric heat pumps etc. will be disproportionately expensive for NI as a whole.

5.13 The impact of this is that where connection to the gas grid is not feasible and an electricity only solution is essential the costs to achieve zero carbon will be much higher. Our future modelling outlines that the c20% of off gas grid houses will attract over 60% of the costs of achieving zero emissions in domestic heat.

[7] https://pureadmin.qub.ac.uk/ws/portalfiles/portal/159416286/robin_curry.pdf



Low Levels of Forestry

5.14 NI has very low levels of forestry. The Committee on Climate Change's February 2019 report "Reducing emissions in Northern Ireland" states that forestry is 40% lower in NI than the UK as a whole[8].

Unusual Position Within Europe

5.15 NI has an usual position within Europe as the UK leaves the EU. NI will share an island with a EU member state with a land border whilst remaining part of the UK customs territory but continuing to align with the EU on specific trade regulations. Specifically, with electricity NI is part of an all island wholesale electricity market and there are plans for an increase in electricity interconnection with the Republic of Ireland. Changes in regulations etc. in the Republic of Ireland will inevitably influence things in NI.

[8] https://www.theccc.org.uk/publication/reducing-emissions-in-northern-ireland/

4. Consumers

Q7. How should we ensure that energy remains affordable for domestic consumers? What approach should be taken to eradicate fuel poverty?

Q8. What steps could be taken to improve the relative cost competitiveness of larger non-domestic consumers?

Q9. Is a strategic position of “enable and protect” the correct policy stance?

a) What policies or schemes are needed to enable active consumers?
b) What policies or schemes are needed to protect vulnerable consumers?

Q10. What types of advice and information are required by all consumers and what are the best mechanisms for facilitating this?

Q11. Are there examples of successful citizen energy projects in Northern Ireland and elsewhere that have delivered improved energy efficiency and/or clean energy to local communities?

Q12. What opportunities are there in both urban and rural areas for citizen energy communities in Northern Ireland? What role could government have in facilitating these?

Q13. What evidence can you provide that identifies the challenges and opportunities for NI energy consumers in decarbonising energy?

7.1 Electrical energy in Northern Ireland currently has a carbon intensity of 0.291t/MWh[9] and domestic heat from gas 0.2045t/MWh.[10] Electricity will be able to reach zero if, and only if, the intermittency and network balancing problems can be solved. In the view of the CCC this will require carbon capture use and storage. Gas will be able to reach zero if the gas in the network becomes decarbonised, likely a hydrogen - biogas mix as explained in our answer to question 21, again carbon capture use and storage will be required.

7.2 In this energy transition the costs to the consumer will encompass:

(a) costs for property alterations;
(b) increased tariffs to pay for investment in the networks;
(c) costs for balancing the electricity system; and
(d) any commodity cost for fuel and its associated decarbonisation.

Costs to the property

7.3 The best way to ensure energy remains affordable is to minimise the up-front cost to the consumer. Starting with a heat pump only heating solution which does not meet the needs of the existing housing stock and then trying to alter peoples existing houses is financially unsustainable as well as logistically impossible (see answer to question 18). Up front costs of €30,000 have been quoted by ESB, £10,000 - £12,000 by KPMG[11] and £12,000 by element energy[12]. Any solution predicated on such spending is not considering the fuel poor in Northern Ireland.

7.4 **From the customer perspective a domestic heating solution based upon the natural replacement cycle of boilers will have the least cost impact.** As the oil boiler reaches its end point it gets replaced by a gas boiler (anything between 14%[13] and 50% reduction in co2) and as the technology becomes more cost effective and electricity less carbon intensive, the gas boiler gets replaced by a gas hybrid heat pump, (which greatly reduces overall consumption but avoids the risk of very high electrical peak.) The boiler industry has already developed "hydrogen ready" technology[14], which means boilers are replaced in their normal cycle but then can be adjusted at the point of changeover to decarbonised gas. This pathway avoids the need to radically change the fabric of houses, a change which becomes a nice-to-have rather than a necessity.

Network costs and electricity system balancing

7.5 If there is a substantial increase in the peak electricity demand this will drive increased grid investment and increased balancing costs to the network. To put this in perspective the electricity system needs to be able to supply electricity even when the wind is very low or absent. As low wind conditions can be days rather than hours (see question 24 for

[9] https://mk0cruiefjep6wj7niq.kinstacdn.com/wp-content/uploads/2019/09/CRU19113-2018-Fuel-Mix-Disclosure-Report.pdf
[10] BEIS conversion factors 2019
[11] 2050 Energy Scenarios KPMG
[12] Analysis on abating carbon emissions on hard to decarbonise homes, medium package insulation
[13] https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting
[14] https://www.worcesternews.co.uk/news/18154950.worcester-bosch-reveals-new-eco-friendly-boiler/

experiences in January) either long term storage or dispatchable generating plant with very low running hours is needed. The capital costs to build battery storage to cover this common occurrence example from this January we estimate would be in the region of €48bn. This is based upon the current electricity demand. Covering these multi day periods becomes much more costly if the potential peak increases. Trying to cover a heating peak via electricity is prohibitively expensive (average heating load in Northern Ireland is 11,000 kWh, 3 times the average electricity load, and the heating season is much more concentrated).

7.6 Encouraging the migration of transport from diesel / petrol to electricity and gas networks also has the potential to provide more customers contributing to the upkeep of the networks and so reduce the cost for everyone. Electric chargers for cars, provided the time of use is correctly managed, will add c25% to the current peak load but possibly 35%[15] to [16]40% demand. This is finely balanced but recovering network costs from the additional demand may be sufficient to offset the increase in the network costs to cover the higher peak. The migration of HGVs and high mileage transport to the gas network is much more clear cut. A single HGV uses the same amount of gas as approximately 50 houses, depending on mileage. Although a special gas transport tariff will be necessary to achieve comparative costs for the haulier to GB, the transmission tariff and a special distribution tariff will all reduce costs to the gas customer base as a whole. While costs vary with market prices, diesel costs work out at c13 - 18p/kWh range, so migrating to gas with a commodity cost of c1.3p – 2.5p KWh range and electricity with a commodity cost(including all non-network costs such as balancing) of 8p – 12p KWh will contribute towards network costs and still leave room for consumer savings.

Commodity costs

7.7 In short to protect the customer, costs of alterations need to be low and the peak electricity demand needs to be minimised, but commodity costs of decarbonised electricity and gas must also be considered.

7.8 In the electricity market this will involve determining the correct balance between dispatchable plant (generators) and non-dispatchable plant (solar, and windfarms). Too much dispatchable plant running will put the onus on the effectiveness of the carbon capture technology that provides the fuel and too much of the non-dispatchable plant will push up the per unit costs of the dispatchable plant which is still needed in low renewable conditions.

Summary

7.9 Energy will only remain affordable to the wider consumer if :

- Up- front costs are minimised;
- We avoid a large increase in peak load and the associated extra network investment;
- We migrate transport to electricity and gas;
- We strike a cost-effective balance between dispatchable and non-dispatchable zero carbon generation.

Fuel Poverty

[15] Mutual Energy modelling

[16] KPMG Future Energy Scenario 2050 pro rata to Northern Ireland

7.10 Para 7.1to 7.9 explain the principles needed to keep the costs in total in check. Fuel poverty considerations mean that as well as considering the total costs policy must consider the charging of these costs across different customer groups.

7.11 Tariffing should also be addressed to ensure fairness. There are a number of competing concepts:

- per unit tariffs need to be *high* to encourage energy efficiency;
- Per unit tariffs should be *low* to encourage switch from higher carbon fuels;
- If better off consumers can afford to take steps to reduce their demand, the fixed network cost per unit gets bigger, adversely affecting the poorer consumers, with some suggesting a fixed charge to combat this effect, but with the downside of undermining energy efficiency incentives;

7.12 One concept worth exploring is a two-tier tariff – the first so many units attracting a lower per unit charge than the remainder, meaning higher consuming customers pay but poorer consumers, typically with much lower demand do not. This would need to be coupled with separate metering for vehicles to prevent disincentive to electrify domestic transport. This approach would target efficiency drives at those who 'over' consume ie consume more than average - this type of demand reduction should have least impact on an individual and so should be easiest to achieve through pricing signals measures. On the other hand energy demand from customers using the bare necessity is very inelastic and a two tier tariff would mean they are protected from price signals which would most likely impact on the health or productivity of the individual.

7.13 Tariffing should also be designed with reference to the key points of competition. We should not have factories in China fuelled by coal based electrical systems making materials for Northern Ireland if the core reason for importing is because energy policy priced out companies from carrying out these activities in Northern Ireland. This is worse for the planet and worse for the customers in Northern Ireland. Closer to home if the GB market price for CNG were say 10p kWh, this should be our price reference point and the gas distribution charge determined to achieve this end price. Anything higher means the HGV owner will either stay with diesel, fill up or relocate businesses to GB and the Northern Ireland consumers will pay more as the contribution to fixed costs of the tariff which could have been charged is lost.

8.1. Large energy users pay disproportionally high energy costs in Northern Ireland, some 30 % above EU average. This disincentivises business from setting up in Northern Ireland, reducing jobs and adversely impacting the economy.

8.2. Rebalancing charges with domestic customers will naturally conflict with the issues identified in our answer to question 7 in respect of fuel poverty, but the principles of minimising peak electricity demand and balancing costs will have a significant universally positive effect.

Network costs

8.3. Similarly the policy should actively encourage the mutualisation of core required energy infrastructure. The mutualised energy assets in Northern Ireland, the Moyle interconnector and gas transmission assets, have an NPV saving to date of £79m compared to being funded at the latest cost of capital on an equity basis, and will well exceed £100m saving over the lifetime of the assets.

Meeting industries needs

8.4. Whilst the onus is on industry to decarbonise, they can only do this if the networks and regulatory arrangements support them in doing so.

8.5. Looking firstly at companies in the transport sector, it is imperative that the Northern Ireland energy strategy prioritises the decarbonisation of transport. Large multi-nationals are already adopting aggressive carbon reduction targets and it is inevitable that they will be pushing these requirements down into the supply chain, which Northern Ireland companies will only be able to meet if the networks are geared up to support decarbonisation.

8.6. A typical example would be Waitrose, who have a firm net zero 2050 target and are phasing out their diesel vehicles, rolling out a fleet of biomethane-fuelled trucks which emit 83% less CO2 than standard diesel alternatives.[17] If and when they insist supplying hauliers comply with similar co2 standards, if the Northern Ireland network is not ready to accept biogas, hasn't got a certification system for renewable gas or hasn't got the infrastructure to support it , then Northern Ireland hauliers will find themselves locked out from the supply chain.

17 https://www.waitrose.com/home/inspiration/about_waitrose/the_waitrose_way/caring_for_the_environment.html

8.7.	This facilitation obligation will apply in other sectors. As noted in the answer to Q21 there are a wide range of industrial processes which require high levels of heat that cannot be supplied by electricity, and customers need a decarbonised gas option.

5. Energy Efficiency

Q14. What, if any, energy efficiency target or targets should be set for Northern Ireland?

Q15. How should we define, measure and monitor energy efficiency to optimise its potential in our homes, business, economy and environment?

Q16. What are the most important policy levers for government to ensure zero carbon in:

a) New domestic and commercial buildings by 2050?;

b) Existing domestic and commercial buildings by 2050?

Q17. What should the future of energy efficiency support look like and who should be the key delivery bodies?

16.A.1 New buildings provide 'low-hanging fruit' for moving to a zero-carbon future, as they are essentially a blank slate which zero-carbon initiatives can be designed into, rather than trying to work around existing characteristics of properties. For example, many older properties have solid external walls, the cost of which to insulate can be up to £180 per square metre. In contrast, new build can be built

with cavity walls, which cost around £5-£6 per square metre to insulate[18], a cost which is negligible as part of the initial build costs.

16.A.2 The most cost-efficient policy lever is to update building and planning regulations to ensure high standards for energy efficiency and minimise emissions from as early as possible. The current Northern Ireland Strategic Planning Policy[19] states that:

a. The planning system should therefore help to mitigate and adapt to climate change by:

i. requiring the siting, design and layout of all new development to limit likely greenhouse gas emissions and minimise resource and energy requirements;

ii. considering the energy and heat requirements of new developments when designating land for new residential, commercial and industrial development and making use of opportunities for energy and power sharing, or for decentralised or low carbon sources of heat and power wherever possible;

16.A.3 This policy dates back to 2015 and could be updated to strengthen these requirements to ensure that all new developments are in a position to be carbon neutral by 2050 (or before) with minimal retrofit, rather than simply seeking to limit GHG emissions.

16.A.4 This could be achieved by high levels of insulation during the build phase and installation of either a hybrid heat pump or a "hydrogen ready" boiler[20] (which can run on natural gas in the first instance, but be ready for a transition to a hydrogen gas grid) for properties on the gas grid and a heat pump with underfloor heating for off gas grid properties.

16.A.5 Rural dwellings particularly single dwellings off the gas grid and away from main public transport routes are typically energy intensive (from a construction, electricity, heat, transport, water, telecoms perspective) and difficult to decarbonise and therefore should be avoided if at all possible. Such necessary new dwellings which would be expected to be still very serviceable in 2050 should be designed to the tightest energy efficiency standards, sized and zoned to minimise heat demand, come automatically fitted with low temperature heat emitters and heat pump technology or LNG boilers, rather than oil boilers. This is in line with the existing Northern Ireland Strategic Planning Policy which states that "policy objectives for development in the countryside are to… manage growth to achieve appropriate and sustainable patterns of development". Additionally developing new dwellings with oil boilers when there is other, cleaner technology available at similar cost should not be considered "sustainable".

16.A.6 While oil boilers are nowadays redundant and there are better alternatives available, it will be important not to discourage the necessary decarbonisation of the gas grid by removing gas boilers. This could make the gas network economically unviable for larger users who cannot electrify, which in turn could lead to businesses leaving Northern Ireland. A more appropriate mechanism may be to have a glide path of gradually decreasing minimum CO2 emission standards for domestic boilers. This would mean that the most polluting boilers leave the scene almost immediately, while there is

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18 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/656866/BEIS_Update_of_Domestic_Cost_Assumptions_031017.pdf

19 https://www.planningni.gov.uk/index/policy/spps_28_september_2015-3.pdf

20 https://www.homebuilding.co.uk/news/hydrogen-gas-boiler-prototype-unveiled-by-worcester-bosch/

then an incentive in place to gradually decarbonise the gas network over the longer-term. There is a need to consider an annual check on boiler emissions similar to the emissions check carried out during a vehicle MOT. This could be done during an annual service. The effect should be to encourage owners to properly service or replace their boiler, this would likely have a major impact on fuel demand and CO2 emissions and save money for the owner.

16.A.7 Immediately moving everyone to heat pumps rather than gas boilers could actually increase emissions. Northern Ireland carbon emissions for electricity generated in 2017 were around 383 gCO_2eq/kWh, calculated using BEIS figures[21] or 291gCO2eq/kWh[22] using more recent CRU figures. In contrast the emissions for burning natural gas are much lower, around 204 gCO_2eq/kWh[23]. This difference may be offset by the heat-pump's superior coefficient of performance (COP), however this is dependent on the ambient temperature of the air outside, and peak heating demand days are likely to be when the ambient temperature is at its lowest and the COP is minimised. Given a modern efficient condensing gas boiler can have a relatively constant efficiency of around 90%[24], when the COP of a heat-pump drops below around 1.9 then a gas boiler is more carbon efficient.

Existing domestic and commercial buildings by 2050?

16.B.1 Existing buildings are far more difficult to decarbonise than new buildings will be. Evidence from the roll-out of domestic gas suggests that domestic consumers are switching from oil to gas at a rate of less than 2% per year[25]. This relatively slow uptake is at a time where oil is typically more expensive than gas[26] and upfront costs modest. Retrofitting domestic properties, in contrast, could require a significant up-front capital cost of in the tens of thousands of pounds. (KPMG estimate around £30k per household.)[27]

16.B.2 Full electrification of heat would require significant retrofitting of existing properties, as technology such as air-source heat pumps cannot quickly ramp-up and down based on demand, as traditional boilers can, and cannot heat water to the temperatures that traditional boilers can, meaning that existing radiators will not be effective. This retrofitting will be in the form of improved insulation, as well as replacing internal heating systems. For example, current radiator heating systems may need to be replaced by underfloor or whole-wall heating. This sort of work is not only costly, it is also very disruptive, and many consumers will not wish to undertake this type of work.

[21] https://www.gov.uk/government/statistics/energy-trends-december-2018-special-feature-article-electricity-generation-and-supply-figures-for-scotland-wales-northern-ireland-and-england-2
[22] https://mk0cruiefjep6wj7niq.kinstacdn.com/wp-content/uploads/2019/09/CRU19113-2018-Fuel-Mix-Disclosure-Report.pdf
[23] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019
[24] https://www.consumerreports.org/cro/boilers/buying-guide/index.htm
[25] Based on UREGNI transparency data: https://www.uregni.gov.uk/publications/transparency-reports-2019
[26] https://householdquotes.co.uk/oil-fired-combi-boilers/
[27] KPMG 2050 Energy Scenarios: The UK Gas Networks Role in a 2050 whole energy system

16.B.3 The best solution to decarbonisation is one where the cost at the premises is minimised. This means decarbonising the existing gas network and getting as many people as possible onto the gas network.

16.B.4 There will always be circumstances where it is not practical to connect a user to the gas grid, and instead use other ways for heating. This may be electrification, but it may also be non-grid gas, such as LNG or, eventually, liquified hydrogen. This sort of decision will best be made on a case-by-case basis. However it will be expensive and there are much better short term opportunities for carbon abatement if using public money or targeting policies. Of course as mentioned above we should ensure that we do not unnecessarily build more of these types of properties.

16.B.5 Where electrification is the best option, there should be financial support available for people to retrofit their property to the required standard. The capital costs initially are a significant blocker to retrofitting, so an interest free loan system may be appropriate.

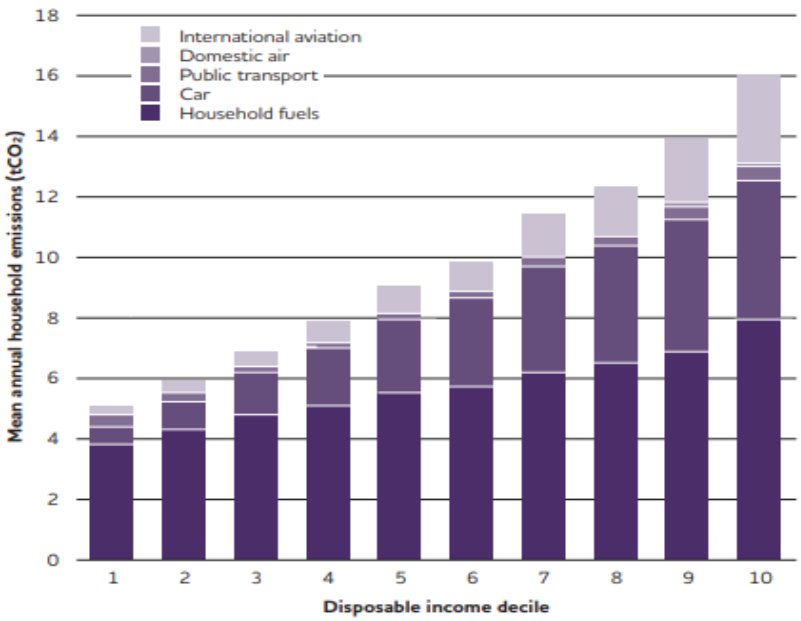
16.B.6 Evidence from the USA[28] suggests that grants have a higher uptake rate, but use considerable public funds and are better suited for smaller projects, whereas financing programs are better suited for larger scale deep retrofits and have a lower cost to the public purse, but reach fewer homeowners. If this uptake rate could be improved, for example by targeting homeowners at specific key points, such as a house sale or other large scale renovation (such as building an extension), then financing projects could conceivably deliver significant energy efficiency improvements to Northern Ireland's housing stock.

16.B.7 While there currently exists support for energy efficiency measures, these can often be confusing and disparate, and are often targeted at the least well-off. Ironically, those on the lowest income are often those with the lowest level of GHG emissions. For example, a UK-wide study suggested that the top 10% of households in income terms on average had triple the level of emissions as those in the bottom 10% of income, as shown in the figure below.[29]

[28] https://pdfs.semanticscholar.org/521b/753e73ae8846ce18a4e1f87d332e01ba67bb.pdf

[29] https://www.cse.org.uk/downloads/file/distribution_of_uk_carbon_emissions_implications_for_domestic_energy_policy.pdf

Figure 9: Mean annual household CO_2 emissions from all sources by disposable household income decile (GB EFS dataset)



16.B.8 The most effective way to reduce overall CO2 emissions, therefore, may be to widen the availability of support to all, not just those on lower incomes. Reducing confusion through establishing a 'one-stop shop' type funding and support body may also help improve uptake.

16.B.9 Where it is possible to connect a property to the gas grid, this presents a much easier pathway to decarbonisation. While electrification of heat necessarily requires deep retrofitting, decarbonising the gas network merely benefits from retrofitting, but it is not a pre-requisite. As such, a decarbonised gas network presents a more effective mechanism to reach net zero by 2050.

16.B.10 Connecting properties that can currently be connected to the network is an important first step. Moving from older, inefficient oil boilers to modern, condensing gas boiler systems can lead to CO2 reductions of around 50% per property[30]. Hydrogen ready boilers are coming onto the market[31], which can replace existing boilers when they need replacing as part of their natural life-cycle. Incentives could be put in place to promote the installation of these types of boilers going forward. The benefit of this approach is that the decarbonisation costs and the work required to achieve decarbonisation are taken away from the property and put onto the gas network.

16.B.11 We envisage that the pathway to this decarbonisation will, in the shorter-term, involve blending natural gas brought to Northern Ireland via the Scotland Northern Ireland Pipeline with biomethane produced locally using anaerobic digestion. In the slightly longer-term, this will then start to include blending with small amounts of hydrogen, and eventually a fully hydrogen gas transmission system. This conversion could be done relatively quickly. In Great Britain, the move from Town Gas to natural gas was done over ten years between 1967 and 1977, at a cost of £600mn in 1977 prices (£3.75bn in 2019 prices)[32]. Given the Northern Ireland system now is much

[30] Source Phoenix gas
[31] See above
[32] https://www.sciencedirect.com/science/article/pii/S0360319913006800#bib14

smaller and simpler than the GB system was in 1977, a full conversion to hydrogen could probably be done in a matter of years.

16.B.12 The wholesale electricity market can provide some insight on how to incentivise this transition to hydrogen. The increased penetration of wind and renewable generation is, in large part, due to the Renewables Obligation (RO) policy framework.

16.B.13 The GB RO scheme started in 2002 and required electricity suppliers to get an increasing proportion of the energy they supplied from renewable sources. To do this they had to purchase RO certificates (ROCs) from accredited renewable suppliers as proof. This mechanism meant that renewable generators gained an additional source of income for each MWh of electricity generated on top of that which they received via the normal market (where they were competing with non-renewable generators).[33]

16.B.14 The scheme was closed to new participants in April 2017, however from 2004 to 2017, the share of wind, solar a hydroelectric generation in Great Britain increased from 2% to 21%[34]. **A similarly designed scheme for gas could provide incentives to suppliers and gas providers to increase the amount of biogas on the system and subsequently the amount of hydrogen on the system.** Extending the incentives in the Renewal Transport Fuel Obligation (RTFO) scheme (see answer 30.20 for further details on this scheme) to qualifying fuels on the gas network no matter what their use would probably be enough to provide sufficient incentive for this sector in the short term.

16.B.15 Extending the RTFO and putting Compressed Natural Gas (CNG) infrastructure in place would focus the most commercially viable gas users to decarbonise first. We believe that with the CNG infrastructure, given that CNG is already cost competitive with traditional fuels,[35] commercial transport would be the first area to decarbonise in this way.

16.B.16 Eventually, other users of gas, and renewable gas requirements could be expanded so that hydrogen blending is supported as well as biogas. This can be done in accordance with the pathway for gas decarbonisation.

[33] http://researchbriefings.files.parliament.uk/documents/SN05870/SN05870.pdf
[34] https://www.gov.uk/government/statistics/energy-trends-december-2018-special-feature-article-electricity-generation-and-supply-figures-for-scotland-wales-northern-ireland-and-england-2
[35] https://www.oxfordenergy.org/wpcms/wp-content/uploads/2019/04/A-review-of-prospects-for-natural-gas-as-a-fuel-in-road-transport-Insight-50.pdf

6. Heat

Q18. What is the appropriate pathway and timeline for the decarbonisation of heat between now and 2030, and subsequently to 2050?

Q19. What are the appropriate ways to measure the progress of decarbonising heat?

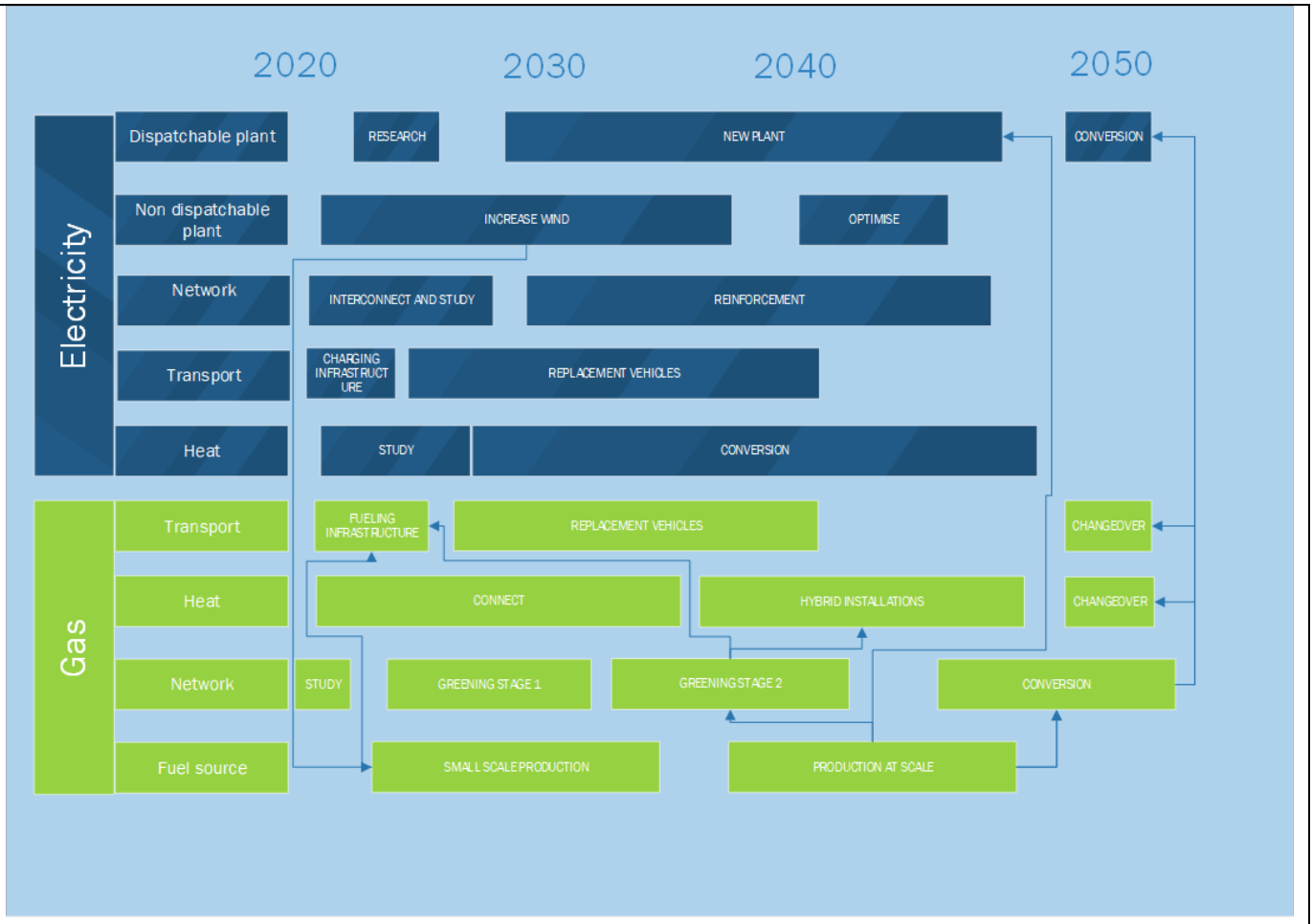
Q20. What are the most cost-effective and sustainable steps that government might take to accelerate the reduction of the carbon intensity of heating fuels?

Q21. Is decarbonisation of the gas grid a viable option and what evidence can be provided on both the speed and affordability of decarbonising the gas grid?

Q22. What evidence can you provide on the opportunities for district heating schemes in Northern Ireland and where should responsibility lie for facilitating these?

Q23. Can you provide any evidence or information on the opportunities for geothermal heat supply?

18.1 All electricity, gas, heat and transport decarbonisation paths are inextricably linked and the core tasks are to decarbonise the gas network, decarbonise the electricity network and convert the transport and heating sectors to the electricity and gas networks. The following diagram outlines the combined pathway:



18.2 Concentrating on heat for **on-gas grid** properties, the steps are: to connect as many homes as possible as quickly as possible; gradually migrate to newer technologies from mid-2030's onwards (namely hydrogen ready hybrid heat pumps); and achieve a full switch over to hydrogen before 2050. **Off gas grid** the first stage is to determine a more cost-effective way to electrify the housing before a roll out between 2030 and 2050.

18.3 The **appropriate pathway** for decarbonising heat can only be achieved by decarbonising the gas network for on-gas network housing and by electrifying heat in off-gas network properties:

- Utilising the gas grid is the only logistically credible way to achieve the numbers of houses as it does not require extensive and expensive work to consumers houses;
- It will work out the most cost effective as it involves significantly less costs in electricity;
- It is the most consumer friendly, involving less behavioural changes for customers;
- It will allow an integrated energy solution for domestic heating and for industries process needs;
- It will provide an infrastructure for decarbonising the heavy good vehicles.

18.4 The logistics of decarbonising the gas network are explained in para 18.7 to 18.12. Trying to achieve this by an electric heat-pump based model would require changes to an average of 35,000 houses per year[36] .

[36] MEL modelling based on 802,000 retrofit and 204,000 built under higher standards from 2021

The proposition to the customer being to spend between £3,000[37] and £34,000[38], to achieve a heating system with a cost per kWh of at least 38% higher than their current system[39]. The much less invasive change from coal/oil to gas in Northern Ireland over a period of 24 years averaged short of 11,000 conversions per year, with an offering of a better system and at times a cost saving of up to 40%. The 35,000 conversion rate per year is simply unachievable. At present there is neither knowledge, expertise, trained workforce or consumer demand and so the 35,000 p.a requirement will simply increase with every year that it passes unachieved.

18.5 The electrification of heat is predicated upon the electricity system being able to support it. Energy demand from heat is c3 times the size of energy demand for electricity and is concentrated in the winter rather than spread over the year. As such, moving to an entirely electrified heat system (on and off grid) will be difficult and costly, as both transmission and distribution networks will need to be reinforced, further impacting the logistical challenge.

18.6 In contrast, there is a readymade Transmission and Distribution network for gas in Northern Ireland. As gas becomes decarbonised at source (see section 21), then there would not need to be anywhere near the level of electricity network development and reinforcement necessary under an electrification only scenario. Additionally, while there would be benefits from retrofitting energy efficiency at the end user premises, such a move would not be a pre-requisite for a decarbonised gas heat scenario.

<u>On the gas grid</u>

18.7 The pathway to decarbonise heat for houses on the gas grid is as follows:

- Increase the penetration of gas using existing technology targeting substantial increase by 2030;
- Increase the renewable content of the gas by introducing gas from AD and a step increase in hydrogen content to at least 2% by 2030 (greening stage 1) but looking toward the 20% target for hydrogen by 2040 (greening stage 2);
- From 2030 onwards all gas technology introduced in the home can be required to be hydrogen ready (the technology already exists, with commercial installations already from 2012[40] and Worcester Bosch and Baxi have developed the Hyready boiler[41]);
- As the cost effectiveness improves gas boilers should become hybrid-based utilising the hydrogen boiler allied to heat pump technology but without the downside risks to peak electricity demand or being unable to meet the higher water temperature needs of the majority of houses;

18.8 Between now and 2030, connecting as many people as feasible to the natural gas network could deliver significant carbon emission reductions. As of September 2019, there are currently around 250,000 domestic properties connected to natural gas in Northern Ireland[42] with 330,000 homes and businesses to be connected by 2022. The three gas DNOs have approval in their price controls to connect up to around 550,000 households in total, and there are potentially an additional 90,000 households on top of that are

[37] Heat pump and low temperature emitters only from Element energy
[38] CCC large detached requiring full suite of upgrades
[39] See para 18.17 below
[40] https://pureenergycentre.com/hydrogen-boiler-pure-energy-centre-product-launch/
[41] https://www.worcester-bosch.co.uk/professional/hydrogen-future-of-fuel
[42] https://www.uregni.gov.uk/sites/uregni/files/media-files/2019-11-14%20Transparency%20Report%20Q3%202019%20FINAL.pdf

marginally economical to connect to gas. In total, this gives the gas network a 'catchment area' of around 640,000 homes in Northern Ireland. There are currently 783,000 residential dwellings in Northern Ireland[43]. If all of the homes in the gas catchment area were connected to the network, then over 80% of the housing stock would be using gas (an increase from 32% currently).

18.9 This alone could result in a minimum of 14% reduction in Northern Ireland's CO2 emissions from heat, based on the average CO2 emissions from fuel oil and natural gas[44]. In reality, the reduction would likely be far greater, as conversions are likely to happen at the end of an old oil boiler's life. These older boilers are likely to be far less efficient than more modern gas boilers, and therefore new boilers will have to burn far less fuel to produce the same heat than the boiler they are replacing. Figures from Phoenix Natural Gas show current experience is actually a 50% decrease in CO2 emissions per conversion.[45]

18.10 Alongside these conversions, there should be preparations for transitions to a zero-carbon gas system. A framework for this sort of transition, along with associated dates, has been developed for the GB gas system[46]. This framework could be easily adapted to suit Northern Ireland's needs. Given most of the natural gas used in Northern Ireland currently comes from GB via the Scotland-Northern Ireland Pipeline, following a similar transition would bring efficiencies as the gas flowing via the SNIP may change in composition as a result of GB's pathway to net zero. The answer to question 21 gives more detail on this transition.

18.11 Indeed, the composition of gas in GB is likely to change significantly over the next 30 years. Gas quality standards in GB are based on the characteristics of North Sea gas and outlined in the Gas Safety (Management) Regulations 1996[47]. Northern Ireland has a separate statutory framework and NI gas standards are outlined in the Gas Safety (Management) Regulations (Northern Ireland) 1997[48]. In practice the NI regulations follow the GB regulations given the interconnection between the two jurisdictions. However, as standards in GB change[49] to move away from North Sea natural gas and incorporate gas from further afield and 'novel' gases such as hydrogen, Northern Ireland's standards may become out of step with those in GB. This means that the gas being imported via the SNIP may not meet the quality parameters laid out in NI legislation. As such, NI legislation needs to keep pace with that in GB.

18.12 In the immediate future, this preparation means preparing the legal and commercial framework for transition and connecting existing technologies to the gas network. For example, Northern Ireland has a large potential source of biogas via anaerobic digestion which could be injected into the existing gas network quite easily. The main blocker to this happening now is a lack of regulatory support and perverse incentives for owners of the anaerobic digestor facilities to use the gas to generate electricity at source, which is not the most efficient use of the biogas.

Off the gas grid

[43] https://www.communities-ni.gov.uk/news/northern-ireland-housing-statistics-2016-17
[44] https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting
[45] Information provided by Phoenix Natural Gas
[46] ENA Report
[47] http://www.legislation.gov.uk/uksi/1996/551/contents/made
[48] http://www.legislation.gov.uk/nisr/1997/195/contents/made
[49] https://www.igem.org.uk/technical-services/gas-quality-working-group/

18.13 Where it is not possible or practical to connect people to the gas network, heat can be electrified, and power generated either via renewable generation or using gas turbines reconfigured to generate using hydrogen gas. Again, this means that the whole heat network can be run on a net zero basis.

18.14 To electrify heat, consumers will be required to have a heat pump installed. These can be either ground-source or air-source. Air-source heat pumps (ASHPs) are generally cheaper as they do not require as much invasive installation work[50], so we assume that the vast majority of off-grid properties in Northern Ireland would opt for an ASHP in any heat electrification scenario.

18.15 If everyone within the gas catchment area were connected to gas, the remaining circa 143,000 (likely over 160,000 by 2050) domestic properties would be using either non-mains gas (such as compressed gas) or an electrified heating system. Assuming they took the electrification path, then properties need to be energy efficient for the heat pump technology to work effectively. Additionally, traditional radiators may not work effectively with the lower temperatures produced by heat pumps compared to boilers, and larger radiators or under-floor heating may need to be installed[51]. This work can be costly and invasive, potentially up to £30,000 per home if the fabric of the building is addressed, or in the £3,000- £6,000 range for heat pump and replacement emitters only. The following table from the CCC [52]shows a typical estimate of costs for changing the fabric of the building:

	Internal	External	Cavity	Loft	Glazing	Total
	£	£	£	£	£	£
Apartments Small	2,800	5,300	380	320	2,400	11,200
Apartments Large	3,500	6,700	430	430	3,600	14,660
Terrace Small	3,700	6,800	460	1,950	3,900	16,810
Terrace Large	4,000	7,500	505	2,320	5,000	19,325
Semi Detached Small	6,800	7,800	529	2,560	5,500	23,189
Semi Detached Large	7,000	8,400	660	2,770	6,400	25,230
Detached Small	7,200	10,200	680	2,810	5,900	26,790
Detached Large	9,400	11,500	950	3,700	8,300	33,850
Bungalow	6,300	9,800	650	3,420	6,600	26,770

18.16 This large cost is one reason that *wholly* electrifying heating in Northern Ireland is not a feasible pathway to decarbonisation. Another is the additional load that this heat demand would put on the electricity system, both at a generation-level, and in the transmission and distribution systems. Currently the average electricity use per household in Northern Ireland is 3.6MWh per year[53]. In contrast, the current demand for domestic gas (primarily for heating purposes) is around 11MWh per year[54]. If we assume the average currently installed boiler is 90% efficient, this means that the average 'final' demand for heat is 9.9MWh per household and skewed towards the winter rather than all year round.

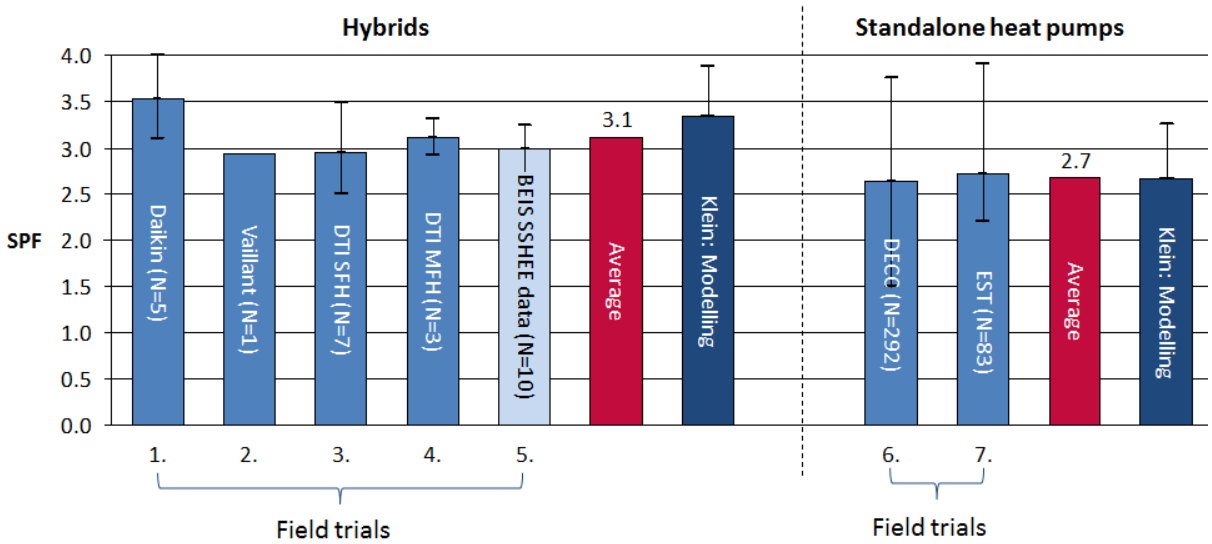
18.17 The reason for heat pump technology rather than direct resistive heating is to improve efficiency and avoid the unmanageable load on the electricity system. The heat pumps' produce more heat energy than the electrical energy put in. This is called the co-efficient of performance ("COP"). A cop of 2 means for each 1kWh of electricity in the house will benefit from 2kWh of heat. Heat pumps work poorly in colder

[50] https://energysavingtrust.org.uk/blog/air-source-heat-pumps-vs-ground-source-heat-pumps
[51] https://energysavingtrust.org.uk/renewable-energy/heat/air-source-heat-pumps
[52] https://www.theccc.org.uk/publication/reducing-emissions-in-northern-ireland/
[53] https://www.gov.uk/government/statistics/sub-national-electricity-consumption-statistics-in-northern-ireland
[54]

conditions. Norway installed a substantial number of heatpumps in 2002 and the official assessment was as follows

"For air-to-air heat pumps energy savings were estimated to be in the range 4,721–6,121 kWh per year depending on cooling agent for those households that reported that they had not raised average temperature or increased the number of rooms that they kept at comfort temperature. For an average Norwegian household this represents annual savings of 20–25 %"
This equates to a COP circa 1.3 and other studies suggested an even worse performance. [55]

18.18 A number of studies have been carried out on heat pumps and latterly hybrid heat pumps as the drawbacks from heat pumps' became apparent. One of the more definitive studies, commissioned by BEIS[56] estimated real life UK COP to be 2.7, rather than the more headline grabbing manufacturers claims[57], as shown in the following graph:



[55] A recent study published by Statistics Norway found that the actual energy-savings of homes with heat pumps was close to zero (Halvorson and Larsen 2013), and a study conducted in Denmark produced similar results (Christensen et al. 2013).
[56] Hybrid heat pumps study element energy for BEIS December 2017
[57] All manufacturers in the study claimed a cop between 4 and 5.5

No.	Source	Monitoring period	HP type	SPF type	Other details
1.	Daikin, 2017	April 2014 - March 2015	5kW hybrid, 8kW hybrid	H1	• HP does pre-heating only; storage tank required - Two bedroom terraced house - Three bedroom semi detached bungalow - Three bedroom semi detached house - Three bedroom semi detached house
2.	Vaillant	Unknown	5kW hybrid	H1	• Single system
3.	DTI, 2015	Oct 2014 - Sept 2015	5kW hybrid	H2	• Single Family Homes
4.	DTI, 2015	Oct 2014 - Sept 2015	25kW hybrid	H2	• 3 Multiple Family Homes - 15 apartments, 936 m^2 heated - 18 apartments, 1099 m^2 heated - 19 apartments, 1151 m^2 heated
5.	BEIS, 2016	N/A	Hybrid	H2	• Converted manufacturer SSHEE data • Average climate
6.	RHPP, 2016	Nov 2011 - Oct 2015 (subset Nov 2013 - Oct 2014)	Standalone	H2	• No intervention to correct usage or installation problems • Only data points with 1.5 < SPF H4 < 4.5 used • Residential properties • Sites all over the UK
7.	EST, 2010	Phase 2: Spring 2011 - Spring 2012	Standalone	H2	• Mostly radiator systems • Designed to produced DHW at 50-55 °C • Sites all over the UK

SPFH1: Core HP components only; SPFH2: Includes supply air fan; SPFH4: Includes immersion heater and pumps

18.19 Using a coefficient of performance of 2.7 (i.e. for every unit of electricity it used, it produced 2.7 units of heat), electrifying heat demand would add an additional 3.66MWh demand to the average consumer's demand for electricity. Using Airtricity current gas tariff and electricity tariffs this is a 38% increase in the bill – assuming the system is used efficiently.

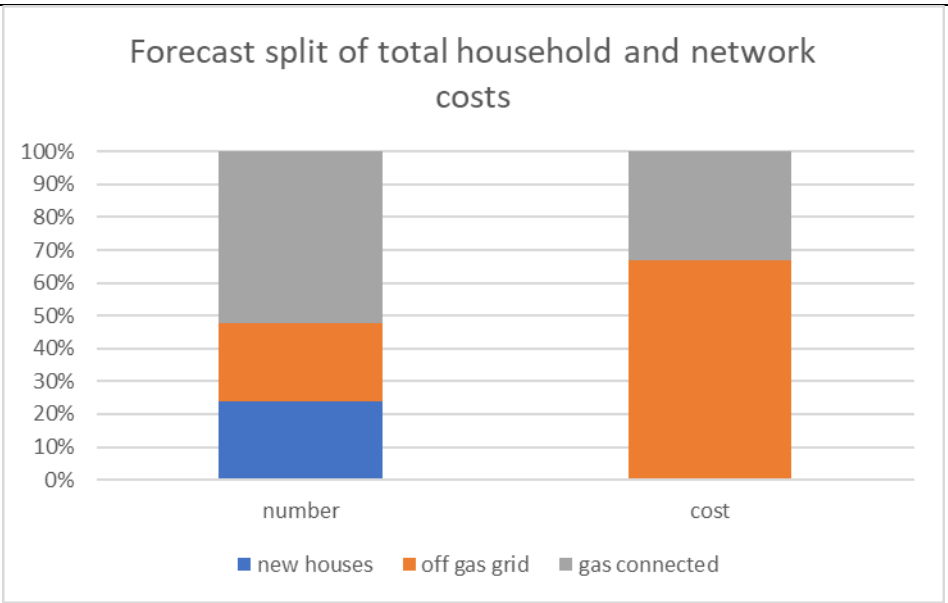
18.20 Potential pitfalls for the customer include setting the heating to run twice a day, having poorly insulated house, incorrect installation, incorrect control strategy followed, not replacing radiators with low temperature emitting radiators and the need to provide domestic hot water.[58]

18.21 The challenge for off gas grid houses will need to be recognised, therefore, and lower per year targets set for these houses. Due to the high up-front costs socialising some of the costs on the electricity bill should be considered.

18.22 Assuming an early stiffening of standards for new build, our own modelling suggests that by 2050 the split would be 204,000 newly built houses without need for retro-fit, 596,000 houses on the gas-grid and suitable for a solution at source rather than extensive retrofitting and 206,000 houses off-gas grid (or not supplied with gas) requiring an electricity based solution and retrofitting to varied extents. As noted earlier modest extensions of the gas grid could extend the potential to 640,000 houses.

18.23 The total capital cost of decarbonisation, from conversion/generation facilities, network investments and consumer costs at the premises will be much more for these 200,000 or so off gas grid homes than for the remainder combined[59]:

[58] Hybrid heat pumps study element energy for BEIS December 2017
[59] Mutual Energy modelling



New build homes

18.24 Despite the large cost associated with retrofitting homes for energy efficiency measures, similar levels of energy efficiency can be inbuilt at a fraction of the cost to new build homes, and this should be mandated via the planning process, as outlined in our answer in 16.A.1 to ensure that all new housing stock is built to the highest reasonable standards. Additionally, support should be available for those who do wish to retrofit their properties, either by grants or, more likely, financing opportunities.

Hybrid heatpumps

18.25 As noted in the above timeline we believe hybrid heat pumps (HHP), where a boiler suited to running on decarbonised gas (with a likely high hydrogen component as outlined in the answer to question 21) is coupled with a heat pump technology, have a significant part to play, if not in the next boiler replacement cycle for most customers then in the one after. Hydrogen ready boilers have already been developed by Worcester Bosch and Baxi[60] and a number of hybrid heat pumps are already on the market.

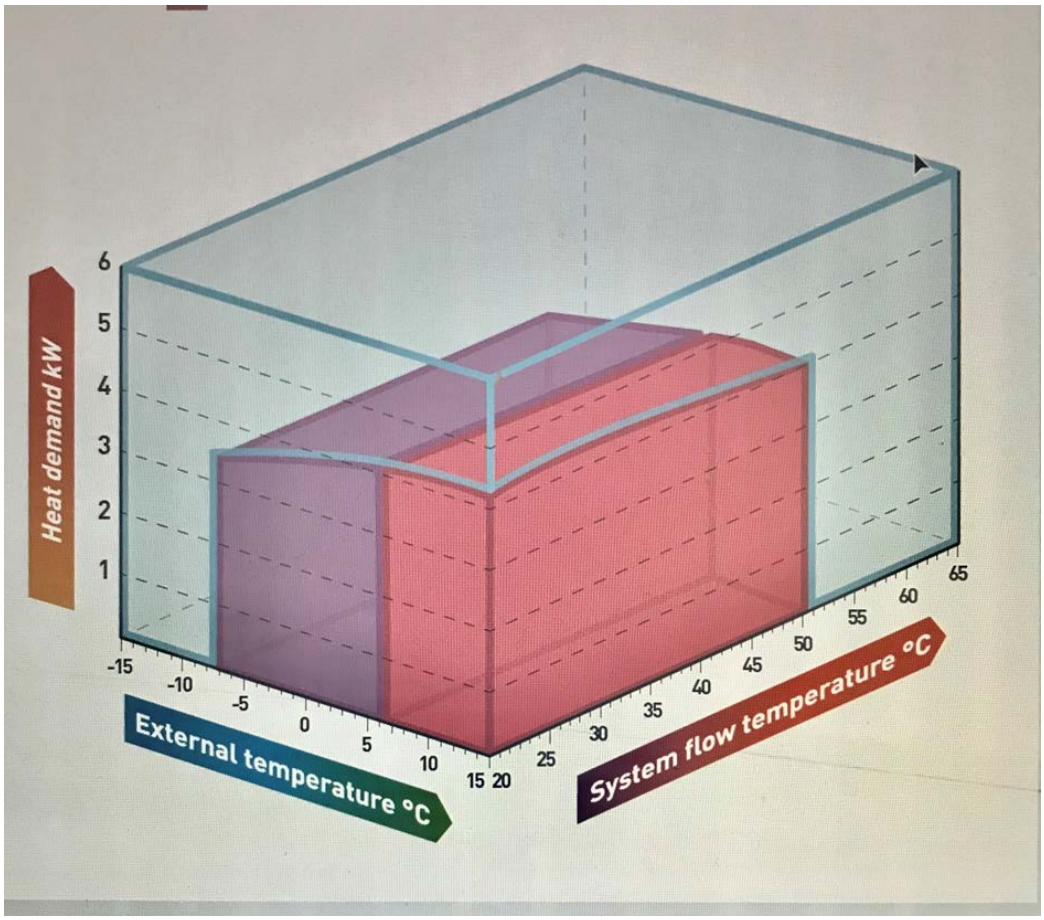
18.26 We expect hybrid heat pumps to become mainstream simply because they provide benefits to the customer, benefits to the electricity system and benefits to the gas system.

18.27 Looking first at the most important customer perspective, Hybrid heat pumps can:

- Provide heat to a higher temperature, thus avoiding widescale and costly house alterations, (a reduction to the major costs outlined elsewhere of between £480 - £2,800 per Element Energy, who are generally low in their estimation of costs at the household);
- Can be successfully and efficiently operated on a "twice a day" heat schedule used by nearly 70% of the population;
- Can be used to provide domestic hot water;
- Have control systems very similar to existing technology making them readily understandable;
- Remove the risk of excessive bills when solely heat pump technology struggles;
- Can show a reduction in running costs to help justify the initial capital outlay.

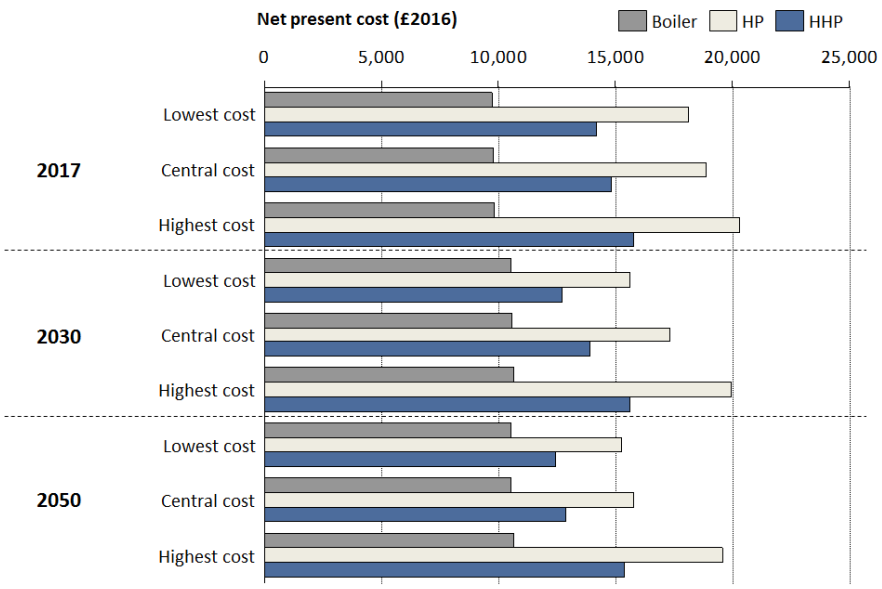
60 https://static1.squarespace.com/static/5b8eae345cfd799896a803f4/t/5e691204c104fd669e8f920a/1583944235259/hy4heat+march+2020+church+house+Slides.pdf

18.28 One such system is the Sime Murelle Revolution,[61] though there a number of manufacturers and different HP to boiler sizing. The following diagram explains the concept well. When conditions suit the use of a heat pump, this is the primary source of energy. When either external temperature, system flow temperature or heat demand temperature are outside the efficient running regime of the heat pump, then the boiler ensures the customer has access to the necessary heat. Red is "heat pump only" mode, purple "combined operation" and blue "boiler only":



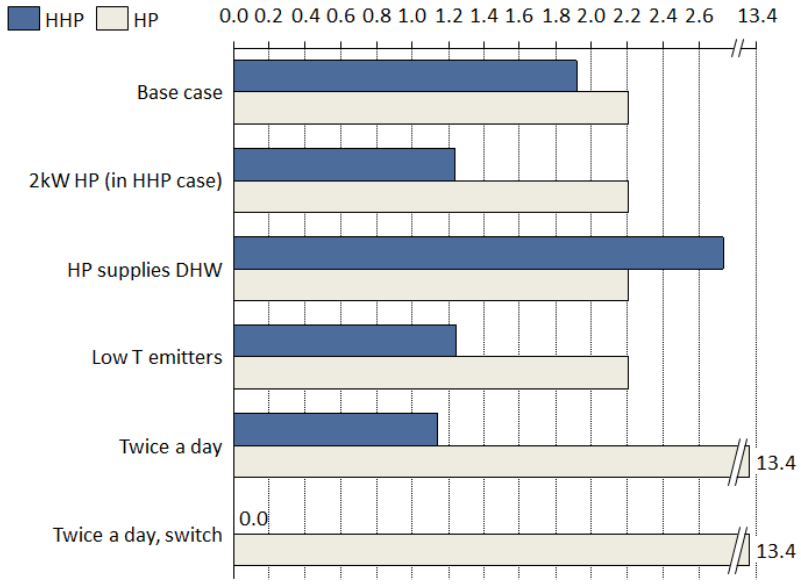
18.29 A key benefit to the customer is therefore that the system will avoid running on electricity when the COP is low, and as the diagram in 18.18 shows a close to 15% improvement in cop in field trials. Considering the cost perspective, the data provided to BEIS by Element Energy found the HHP to be notably cheaper:

[61] https://sime.co.uk/wp-content/uploads/2018/03/Murelle-Revolution30BrochureJan2018_EN.pdf



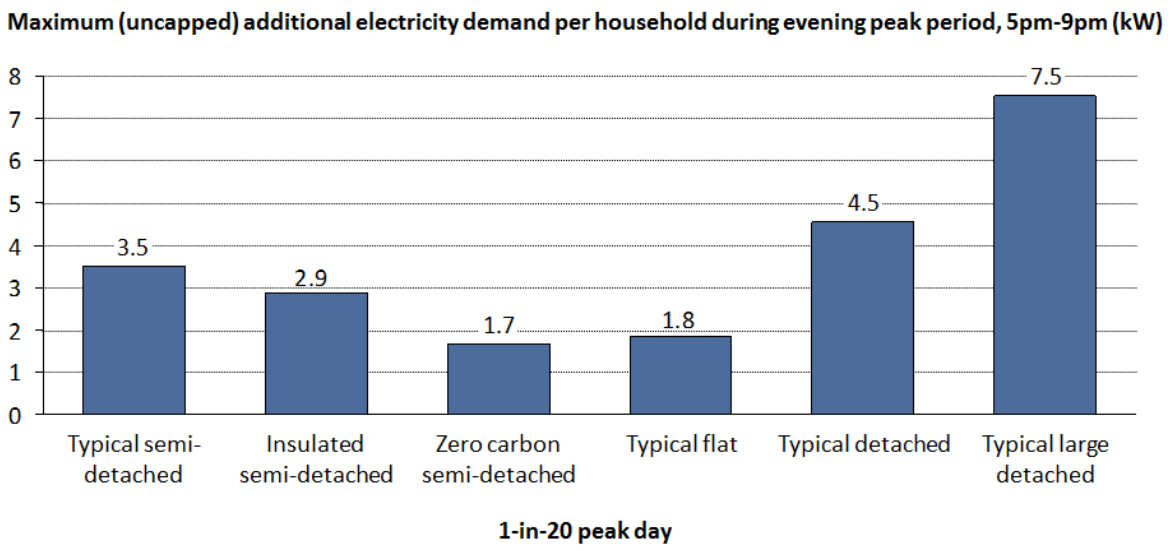
18.30 The benefits to the electricity system are that the total load is reduced, resulting in less of a demand and, more importantly the peak load, which drives a large proportion of the costs is also greatly reduced. The following analysis provided to BEIS by Element Energy explains the key risk:

Uncapped additional electricity demand per household during evening peak period, 5pm-9pm (kW)



18.31 The Hybrid heat pump **avoids the situation with stand-alone heat pumps where the most common regime of heating results in a 6-fold worsening of the assumptions used to model the peak electricity demand.**

18.32 It should be noted that the base case in this analysis was a semi-detached house. Northern Ireland has a much higher level of detached housing at 38%. Even when used on continuous heat mode the peak demand of a stand-alone heat pump is challenging to a system designed for average house loads of 2kW, with system design needing to accommodate a typical detached at 4.5kW at the peak just for the heating system:



The benefit to the gas system is a greatly reduced demand throughout the year. The study for BEIS indicated that circa 85% of the demand could be met via the heat pump part of the hybrid.. As this reduces the total volume of decarbonised gas required it makes it much easier to decarbonise the gas network and still accommodate industry and transport needs.

20.1 As outlined in question 18, it would be impractical and prohibitively costly to fully electrify heating in Northern Ireland. Rather, the most efficient mechanism to decarbonise heat is to maximise the use of the existing gas network and decarbonise this at source, rather than attempting to decarbonise at user-level.

20.2 The most cost-effective way to decarbonise in the near-term is to connect as many people to the gas network as possible. The three gas DNOs have approval in their price controls to connect up to 550,000 properties, and there are potentially up to 640,000 properties in total where it is economical to connect them to gas mains. The cost to connect a customer to the gas network is on average between £3,450 and

£4,150. This compares very favourably with the £3,000[62] and £34,000[63] it would cost to convert the same home to electric heating.

20.3 To facilitate uptake of gas heating, restrictions on the CO2 emissions of newly installed boilers could be introduced, mandating that new boilers cannot exceed a certain emissions level. Gas heating systems have historically been cheaper than oil boiler systems over their lifespan anyway (at times up to 40% cheaper[64]) but forcing them to competition on emissions standards as well would essentially speed up the conversion rate. This is essentially a costless policy, which could deliver significant environmental benefits.

20.4 This could result in an immediate 14% reduction[65] in Northern Ireland's CO2 emissions from heat from those properties converting, based on the average CO2 emissions from fuel oil and natural gas. In reality, the reduction would likely be far greater, as conversions are likely to happen at the end of an old oil boiler's life. These older boilers are likely to be far less efficient than more modern gas boilers, and therefore new boilers will have to burn far less fuel to produce the same heat than the boiler they are replacing. Figures from Phoenix Natural Gas show current experience is actually a 50% decrease in CO2 emissions. If new gas boilers installed as part of the conversion from oil heating are 'hydrogen-ready', then this means that the direct costs to the end consumer end here.

20.5 There will be costs associated with converting the natural gas transmission and distribution systems to hydrogen, however these will be smaller in comparison than the costs of strengthening the electricity system to cope with the increased demand for heat that would result from fully electrifying heat. Each additional GW of electricity infrastructure is expected to cost an additional £1.2bn[66], and electrifying all of Northern Ireland's heat demand could require an additional 5GW of electricity infrastructure to meet the peak demand, so a £6bn potential cost[67]. In contrast, the expected cost for adjusting the gas network would be up to £0.2bn and a worst-case scenario for the cost of converting the entire Northern Ireland gas network is around £0.5bn[68].

20.6 Additionally, Northern Ireland's current connection to the GB gas transmission system means that, in practice, a lot of what we do will follow from GB. This means that we will be able to fully evaluate the hydrogen roll-out in GB and ensure that it is done as cost-efficiently as possible on this side of the Irish Sea.

20.7 Of course, there will still be some properties that it isn't economic to connect to the gas network. In this case, they will need to either use off-grid gas (potentially through some sort of local non-mains grids, or alternatively through standalone gas tanks), or will need to electrify. In the case that they need to electrify, then given the potentially large capital costs involved, public support might need to be provided. This could be in the form of financing agreements, rather than straight up grants. Financing support typically has a lower uptake than grants but is a more cost-efficient use of public money for larger

[62] Heat pump and low temperature emitters only from Element energy
[63] CCC large detached requiring full suite of upgrades
[64] https://www.consumercouncil.org.uk/sites/default/files/original/CCNI_Gas_v_Oil_Cost_Comparison_Final_Brief_May_2013.pdf
[65] https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting
[66] Own modelling based on KPMG 2050 Energy Scenarios
[67] Own modelling based on Element Energy
[68] Own modelling based on Element Energy

projects. Grants have a higher uptake but are more suited to smaller projects.[69] With targeting and focus on increasing the uptake rate, providing publicly-backed financing for people to convert their property to electric-heating is probably the best approach to ensure decarbonisation of heat off the mains gas grid.

21 Is decarbonisation of the gas grid a viable option and what evidence can be provided on both the speed and affordability of decarbonising the gas grid?

21.1 Decarbonisation of the gas grid is not merely an option, rather it is a necessity, as without a gas grid a large section of industry and commerce would be impossible as high heat processes cannot be provided via electricity. The table below shows the importance of high heat processes.

Table 1 - Characteristics of common industrial processes that require process heating 96 Manufacturing Operation

	Applications [1]	Typical Temperature Range [3]	Estimated U.S. Energy Use (2010) [4]
Non-Metal Melting	Plastics and rubber manufacturing; food preparation; softening and warming	1710–3000°F	265 TBtu
Smelting and Metal Melting	Casting; steelmaking and other metal production; glass production	1330–3000°F	1,285 TBtu
Calcining	Lime calcining	1150–2140°F	525 TBtu
Metal Heat Treating and Reheating	Hardening; annealing; tempering; forging; rolling	930–2160°F	270 TBtu
Coking	Ironmaking and other metal production	710–2010°F	120 TBtu
Drying	Water and organic compound removal	320–1020°F	1,560 TBtu
Curing and Forming	Coating; polymer production; enameling; molding; extrusion	280–1200°F	145 TBtu
Fluid Heating	Food preparation; chemical production; reforming; distillation; cracking; hydrotreating	230–860°F	2,115 TBtu
Other	Preheating; catalysis; thermal oxidation; incineration; other heating	210–3000°C	925 TBtu
Total			**7,204 TBtu**

[70]

21.1. **<u>Viability Of Gas Grid</u>**

In the local context cement manufacturing, glass making at Encirc and animal rendering at Linurgy are three examples of the many industries that require a decarbonised high heat source.

[69] https://pdfs.semanticscholar.org/521b/753e73ae8846ce18a4e1f87d332e01ba67bb.pdf

[70] https://www.energy.gov/sites/prod/files/2015/02/f19/QTR%20Ch8%20-%20Process%20Heating%20TA%20Feb-13-2015.pdf

21.2. Decarbonised gas is already available in two forms: gas from Anaerobic Digestion (AD) and hydrogen gas, and a decarbonised network can be a blend of the two.

21.3. Northern Ireland has one of the highest potential contributions of AD in Europe due to the large agricultural sector. Studies by Queen's University[71] suggest this to be as high as 2,885 GWh per year heat production from anaerobic digestion. This is less than the current domestic gas heating demand and close to 60% of the forecast domestic gas heating demand in 2050. And in respect of hydrogen the prevalence of wind power as the main source of decarbonised energy in Northern Ireland is well suited to producing hydrogen.

21.4. Worldwide major economies, having considered the needs of industry and the limitations of an electricity-only approach to decarbonisation, have turned to hydrogen as a solution. In Germany the economy ministry has just proposed a comprehensive hydrogen strategy involving a 5,900km hydrogen network.[72] In Japan the hydrogen economy has been government policy since 2014 and the comprehensive hydrogen strategy adopted in 2017[73] and China cut back incentives for electric vehicles and began targeting hydrogen fuel cell vehicles with ambitious targets as shown on the diagram below:

[74]

21.5. **There is no doubt that hydrogen can be a viable option as a gas grid**, as outlined by the ambitions of numerous countries and indeed there are several hydrogen pipeline systems that currently exist to serve the industrial market. These include systems in the North of Europe, (covering The Netherlands, Northern France and Belgium), Germany (Ruhr and Leipzig areas), UK (Teesside) and in North America (Gulf of Mexico, Texas-Louisiana, California). In all the pipelines total around 1,500 km in Western Europe, with around 900 km in the USA. Smaller systems also exist in South Africa, Brazil, Thailand and Indonesia.[75]

[71] https://pureadmin.qub.ac.uk/ws/portalfiles/portal/159416286/robin_curry.pdf
[72] https://www.energy-reporters.com/storage/germany-eyes-hydrogen-to-replace-nuclear-and-coal-energy/
[73] https://www.meti.go.jp/english/press/2017/pdf/1226_003b.pdf
[74] https://www.cleantech.com/hydrogen-in-china/
[75] https://web.archive.org/web/20080111063820/http://www.ika.rwth-aachen.de/r2h/index.php/Hydrogen_Transport_by_Pipeline

21.6. Extensive work has been carried out on converting existing gas networks to hydrogen, (by way of example 90% of the proposed 5,900km German proposal is reusing the existing network). In the UK the concepts have been well developed in a number of projects, and those of interest include:

- **HyDeploy and HyDeploy$_2$** - the UK's first practical project to demonstrate if hydrogen can be safely blended into the natural gas distribution system at concentrations of up to 20% hydrogen by volume without requiring changes to the network components or downstream appliances, and so avoiding any associated disruption.
- **HyNET NW** - The HyNET NW project will investigate two areas of the UK broadly described as the Mersey and Humber estuaries. The work includes an examination of some of the major industries in the area and the scope for a higher level of blending with hydrogen with a modest investment.
- **South Wales Hydrogen Study** - centred on the Port Talbot steelworks and the gas and oil industry cluster around the Milford Haven Waterway. This commenced by identifying the main CO_2 emitters in the area and examining the potential of each source for either conversion to hydrogen (in whole or in part) and/or coupling to a CCuS infrastructure, were one to be in place.
- **Hy4Heat** - The Department for Business, Energy & Industrial Strategy appointed Arup as the named programme manager, with technical and industry specialists: Kiwa Gastec, Progressive Energy, Embers and Yo Energy. Contractors are being appointed to deliver a number of work packages aimed at establishing how to convert the existing low-pressure (<7bar) gas network to 100% hydrogen.

- **H21 Leeds City Gate project** - the H21 Leeds City Gate project examined the technical and economic feasibility of converting the existing gas network in Leeds to 100% hydrogen. number of important conclusions were reached including:
    - Both the Medium Pressure (MP) and Low Pressure (LP) gas distribution networks have sufficient capacity to convert to 100% hydrogen with relatively minor upgrades.
    - Hydrogen storage to manage diurnal demand swings is possible using existing (or repurposed) salt cavern storage on Teesside.
    - Inter-seasonal storage would be in salt caverns on the East Humber coast (Figure 12).
    - It is possible for the existing gas network to be segmented and converted from natural gas to hydrogen incrementally through the summer months over a three-year period with minimal disruption for customers during the conversion.
- **H21 NIC** - the H21 NIC project will provide essential evidence to partner the Governments £25 million "Downstream of the meter" hydrogen programme (Hy4Heat), which examines using hydrogen as a potential heat source in the home. Phase 1 comprises controlled testing and includes:
    - Hydrogen testing of key gas (mostly metallic) network components by the Health and Safety Laboratory in Buxton, Derbyshire.
    - Hydrogen hazard testing under specified accident conditions;
    - The £10.3 million three-year project started in April 2018 and is funded by Ofgem's National Innovation Competition. It is led by Northern Gas Networks Ltd in partnership with all gas distributors to deliver the evidence required to underpin a safety case for hydrogen;
- **H21 North of England** – A development of the H21 Leeds City Gate project into a detailed engineering solution for converting 3.7 million UK homes and businesses from gas to hydrogen. **Importantly this projects conversion period is only 7 years for about ten times the number of connections in Northern Ireland**;

- **H100** - the objective of the Hydrogen 100 (H100) project is to demonstrate the safe, secure and reliable distribution of hydrogen. Described as the "H2 road to social proof" the project seeks to identify socio-economic and technical issues associated with a Southern Gas Networks (SGN) hydrogen feasibility study by developing and building an evidence base to satisfy customers and stakeholders. H100 covers all aspects of gas distribution that may be affected by the switch from gas to hydrogen;

- **Feasibility of hydrogen in the NTS** – National Grid have completed the assessment of the feasibility of converting the GB transmission system to hydrogen and concluded this is feasible from a materials perspective. The approach proposed for changeover includes a fitness for service assessment and then evaluation using standard BS7910;

- **Future Gas System Architecture** - IGEM-funded FGSA project has been commissioned to comprehensively identify all the new and existing functions that the gas system will be required to perform between now and 2050 as it transitions to a low-carbon energy sector. The outcomes of the project will describe robust, evidence-based conclusions and recommendations concerning the various transition pathways that could be adopted in order to achieve a low-carbon gas/energy system, along with guidance as to the timelines associated with successful delivery of each pathway.

21.7. The points noted in paragraphs 21.5-21.7 clearly demonstrate the progress and viability of hydrogen-based grids, but from a Northern Ireland perspective the potential for AD is much higher than elsewhere. Gas from AD is methane, exceptionally similar to natural gas. The UK first used coal gas as far back as the 1790's and for many decades the gas industry was centred around towns gas. The typical composition of towns gas was:

- hydrogen 50%
- methane 35%
- carbon monoxide 10%
- ethylene 5%[76]

21.8. So for a prolonged period, ending in Northern Ireland as recently as 1987,[77] the gas used was a high blend of hydrogen and methane, demonstrating this as a proven technology.

21.9. **With its high AD potential Northern Ireland can decarbonise the gas network on a blended basis with hydrogen and methane from AD, in the full knowledge this type of mix has been used before or** adopt a more hydrogen focused solution.

Speed Of Decarbonising The Gas Grid

21.10. The actual process of changing over the gas grid can be achieved in less than 10 years. As noted in 21.6 above the feasibility study completed for 3.7 million homes in Leeds has a 7 year timeframe and the GB conversion from high hydrogen content towns gas to high methane content natural gas, encompassing some 40 million appliances and over 12 million homes was carried out between 1968 and 1976. As Northern Ireland will have only properties in the 100,000's rather than millions and the network itself is very new and much more suitable to high hydrogen content the changeover cold be considerably quicker.

[76] https://en.wikipedia.org/wiki/Coal_gas
[77] http://www.flamegasworks.co.uk/concrete/

21.11. The limiting factor will not be the ability of the grid to change over, rather the availability of the gas.

21.12. Hydrogen is a widely produced product with over 70 million tonnes produced annually. [78] Northern Ireland faces the same choices Imperial College London outlined for the UK as a whole for sourcing hydrogen:

- Hydrogen produced by electrolysis, which is zero carbon if the electricity is zero carbon;
- Manufactured hydrogen from natural gas, a method better suited to CCUS than post combustion methods in electricity production;
- Imports from hydrogen producing countries;

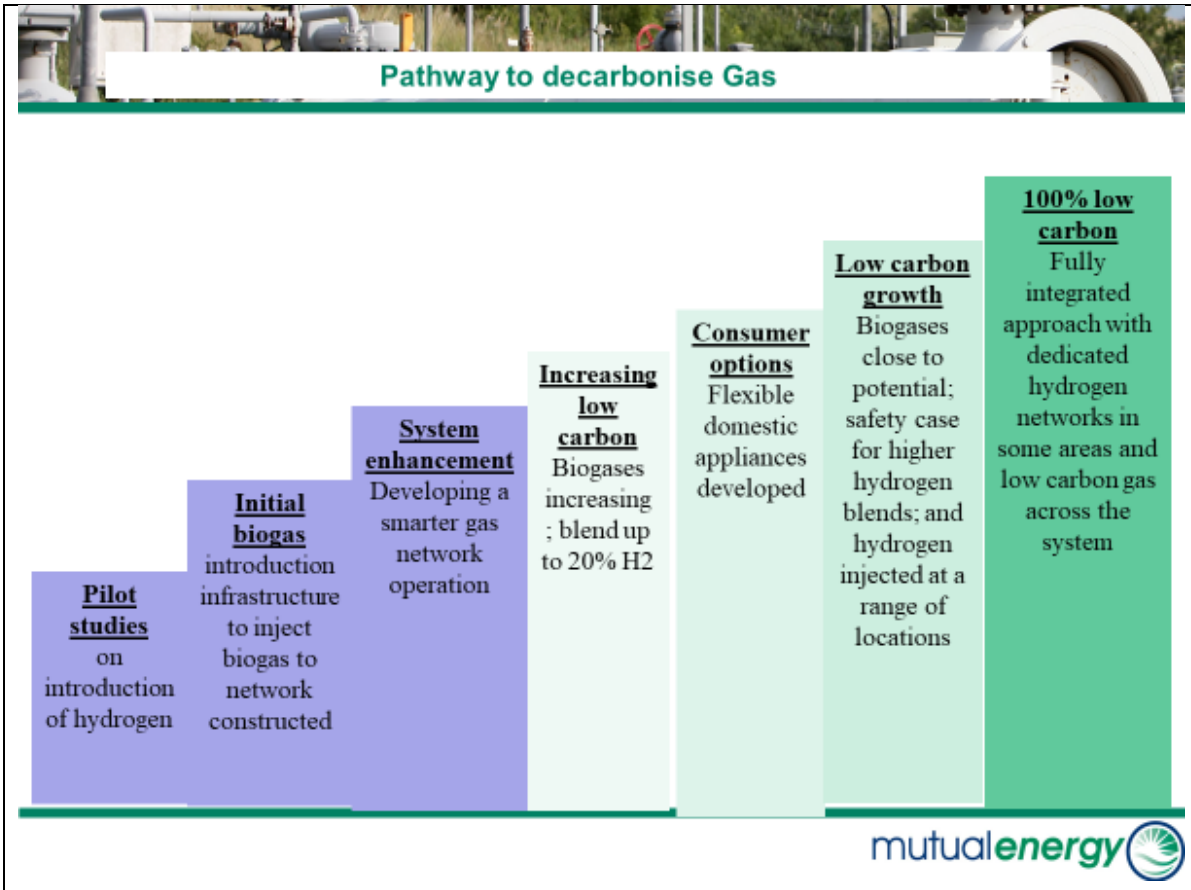
21.13. The production of hydrogen from electrolysis is particularly attractive in Northern Ireland given the preponderance of wind as the renewable energy of choice. As the number of MW of wind increases so will the restrictions on wind power, which already runs at over 10%.[79] There is therefore substantial potential for hydrogen from electrolysis in Northern Ireland, and indeed Energia[80] have already committed to the first project to produce hydrogen for Translink.

21.14. Hydrogen from natural gas is the established method of production using a range of technologies, the two most common being Steam Methane Reformation and Auto Thermal Reformation. Both can already achieve high levels of cost-effective carbon capture over 95%. [81][82]Northern Ireland is well placed to introduce these technologies which form the backbone of a hydrogen led strategy. In the absence of Nuclear power carbon capture of some form will be essential in Northern Irelands energy system and a decarbonised gas network supporting the dispatchable plant is the best approach.

21.15. Finally hydrogen is readily available as an imported product. South Australia have recently announced its ambitions to become a green hydrogen supplier[83] and Japan's entire energy policy is predicated upon importing from countries with high solar pv to hydrogen potential, with the first transport ship already constructed.[84] In Canada there is significant research being undertaken to change gas extraction to extract hydrogen only and leave the CO2 in the ground.

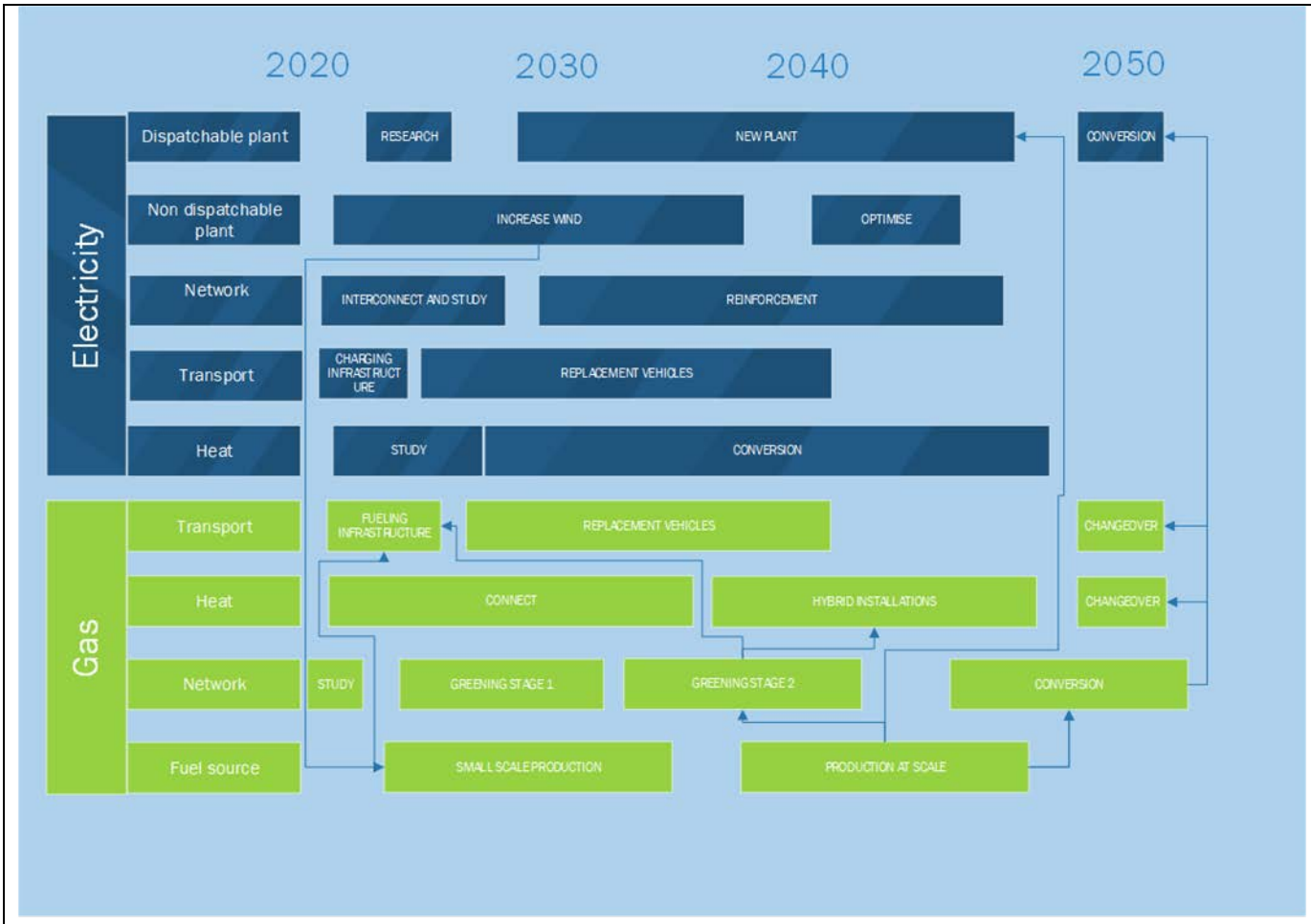
21.16. The Energy Networks association in GB have outlined a plan with a number of steps to decarbonise the grid, a Northern Ireland variant would follow a similar path:

[78] https://www.iea.org/reports/the-future-of-hydrogen
[79] Curtailment and constraints per SONI http://www.eirgridgroup.com/site-files/library/EirGrid/2019-Qtrly-Wind-Dispatch-Down-Report.pdf
[80] https://www.bbc.co.uk/news/uk-northern-ireland-51296312
[81] https://www.thechemicalengineer.com/features/clean-hydrogen-part-1-hydrogen-from-natural-gas-through-cost-effective-co2-capture/
[82] https://pdfs.semanticscholar.org/4bce/0493c6937d4a8e5a844e75e51d5471182a04.pdf
[83] https://www.pv-magazine-australia.com/2019/09/24/south-australia-government-releases-hydrogen-action-plan/
[84] https://asia.nikkei.com/Business/Energy/World-s-first-liquid-hydrogen-carrier-ship-launches-in-Japan



21.17. As we anticipate a hybrid heat pump as the best long term solution, both financially for customers and with the highest chance of success in reducing co2 emissions, **it is essential that every effort is made in the next 10 year window to convert as many properties to gas as possible.** In parallel the work to facilitate and incentivise low or zero emission gas onto the network must be progressed. From the early 2030's onwards hybrid heat pumps should be the only boiler type installed and the decision on the final decarbonised gas blend made.

21.18. As we outlined in our answer to question 18 it is vitally important that no pathway gets looked at in isolation, transport, heat, electricity and gas must become an interlinked system. Below we consider the transition to zero carbon gas network referring to the "whole picture" diagram we have used to illustrate the linked future pathways :



21.19. The lines titled "network" and "fuel source" show the pathway to decarbonising the gas grid. From the network perspective:

- the immediately vital stage is to catch up with the rest of the UK in respect of the understanding and planning for the network gas changes;
- This is followed by "greening stage 1", as noted elsewhere this will involve a target to introduce a set percentage AD on the network and increase the hydrogen content to 2%.;
- "Greening stage 2" will look for a 20% hydrogen content and a higher AD percentage (depending upon policy decisions);
- finally the full switch over to the final mix will be before 2050.

21.20. At this point it is important to note the interaction with transport decarbonisation pathway. We expect the commercial drive to introduce zero carbon gas, either hydrogen or AD, to be underpinned by a regime similar to that used for renewable electricity in the past. This allows the zero-carbon gas to be injected wherever it is sensible from an engineering perspective and then the offtake wherever it is sensible for customer use. Transport customers are a key target with CNG for large vehicles in the first instance.

21.21. We expect, and indeed it is imperative for the network development, that hydrogen production is encouraged both to contribute to the 2% hydrogen stage 1 target to be used in the grid by 2030, but also for direct use in the transport sector. Transport can only move to hydrogen if there is an infrastructure

available for the 100% hydrogen product and this must be encouraged. The recent Translink initiative is only the start and the burden of providing infrastructure would be better on the gas utilities rather than individual transport companies.

21.22. The stage 2 target of higher hydrogen volumes in the network should align with the targets and developments in GB and is likely to involve hydrogen produced from SMR or ATR as well as from electrolysis.

Affordability of gas grid decarbonisation

21.23. As noted in our answers to questions 7 and 8 the interaction of the solutions for gas, electricity, transport and agriculture will determine the ultimate cost to the consumer.

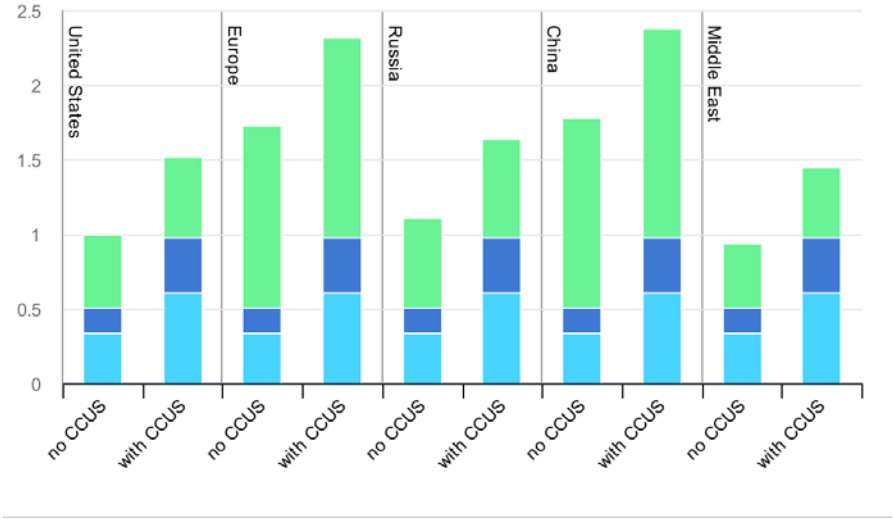
21.24. Decarbonising the gas grid is consistently noted as the least cost option. Our own modelling forecast this to be 22% less expensive than attempting a purely electricity based solution, which is consistent with studies by Element Energy carried out for the CCC in respect of GB[85], which estimated hydrogen led solutions to be between 20% and 50% less expensive per tonnes of co2 abatement and by the National Infrastructure Commission[86], again for GB, which states "hydrogen, either generated from electrolysers using curtailed generation or gas reforming with carbon capture and storage, has the potential to materially reduce the cost of highly renewable electricity mixes. In some scenarios costs are reduced by up to 30% ".

21.25. It should be noted that comparative studies from GB will overstate the costs of decarbonising gas and understate the costs of electricity viz a viz Northern Ireland. The GB gas network is much older than the Northern Ireland one and the Northern Ireland distribution networks are almost exclusively PE based and suitable for Hydrogen, so network reinforcement costs will be much less than GB and, on the electricity side GB has dispatchable renewable generation in the form of its Nuclear plants, which make the costs of network balancing much cheaper. (Studies by Imperial College London suggest absence of nuclear makes the electricity network c19% more expensive in an electricity-based future).[87]

21.26. At a high level the reasons that decarbonising the gas network proves to be the most cost effective are relatively straightforward:
- current gas costs for heating in Northern Ireland are about c4p/kWh and electricity costs c19p/ kWh. Customers either face a 400% or 500% increase in their heating costs, or upfront house alterations in the (£10,000- £12,000 range)[88] to make their houses suitable for heat pump technology followed by per unit costs 38% more expensive[89];

[85] https://www.theccc.org.uk/wp-content/uploads/2019/08/Analysis-on-abating-direct-emissions-from-'hard-to-decarbonise'-homes-Element-Energy-UCL.pdf
[86] https://www.nic.org.uk/wp-content/uploads/Net-Zero-6-March-2020.pdf
[87] https://www.theccc.org.uk/wp-content/uploads/2018/06/Imperial-College-2018-Analysis-of-Alternative-UK-Heat-Decarbonisation-Pathways.pdf
[88] Analysis on abating carbon emissions on hard to decarbonise homes, medium package insulation
[89] Element Energy heat pump study

- the IEA records hydrogen from SMR with carbon capture in 2018 at a range just under $1.5/kg to $2.5/kg[90] as outlined in the graph below. Using imports from middle east $1.5/kg equates to just over 3p/kWh[91] for the commodity cost.



- whilst modelling often uses the benchmark of about the 5p kWh level,[92] as research into alternative methods progresses far lower figures are proposed, notably the new methods developed by University of Calgary suggesting a 1p/kWh [93] potential.

21.27. A decarbonised gas network efficiently solves the need for system balancing, providing a natural store of energy and allowing zero emission peaking plant to be deployed in low wind scenarios, greatly reducing the need for more expensive electricity system balancing solutions. As noted by the electricity company Western Power in their research into hybrid heat pumps:

"One of the main aims of the Freedom Project was to demonstrate the potential for hybrid heating systems to decarbonise domestic heating in the UK. Heat pumps are generally lower carbon heat sources than gas boilers, but the impact they have on the electricity grid during times of peak demand is a huge barrier to their wide-scale deployment."

21.28 As noted above Northern Ireland may well have the choice for a high proportion of gas from AD which will avoid any concerns on achievability but change the economics somewhat. Gas from AD is expected to be similarly priced in the long term to Hydrogen, but again substantially cheaper than electricity which is closer to 19p/kWh before the necessary investments needed to increase its renewable content.

[90] https://www.iea.org/data-and-statistics/charts/hydrogen-production-costs-by-production-source-2018
[91] €1.50=£1.16 / 130mj/3.6
[92] Pathways to Net-Zero: Decarbonising the Gas Networks in Great Britain
[93] http://www.technologyreview.pk/scientists-extract-h2-gas-from-oil-and-bitumen-giving-potential-pollution-free-energy/

7. Power

Q24. What is the appropriate pathway for the decarbonisation of power from now to 2030, and subsequently to 2050?

Q25. What target for electricity consumption generated from renewable sources by 2030 is ambitious, achievable and affordable?

Q26. How can the new infrastructure necessary to meet a new renewable electricity target be delivered in a timely, affordable and acceptable way for consumers and society?

Q27. What innovations and solutions could contribute to meeting a new renewable electricity target?

Q28. What market incentives and support are necessary for investors to deliver the investment in renewable generation assets at a scale that will achieve a new renewable electricity target?

Q29. What steps need to be taken by Government to facilitate investment in offshore and marine renewables for NI?

24.1 Northern Ireland has made significant progress adding renewable wind generation to the system which, combined with interconnection to allow the excess wind to be exported, has reduced the carbon intensity of electricity to 0.291t/MWh (all island[94]), slightly more than

[94] https://mk0cruiefjep6wj7niq.kinstacdn.com/wp-content/uploads/2019/09/CRU19113-2018-Fuel-Mix-Disclosure-Report.pdf

the UK electricity sector and still some 40% above the average gas boiler heating in 2019 (at 0.275t/MWh and 0.2045t/MWh)[95].

24.2 The progress to date shows over 1200 MW connected[96] in a system with peak demand of over 1700 MW[97] in Northern Ireland. Importantly there remains enough conventional generation (at 1894MW) to meet the peak and up until recently the capacity of windfarms in Northern Ireland was lower than the average demand. In short the renewable generation to date has been added in a favourable environment where, provided the system operator operates efficiently, there has been alternatives available for periods when wind drops off, and the total level of wind is such that curtailment has been modest.

24.3 Moving to higher levels of renewable and indeed higher levels of demand if large swathes of transport and other economic areas are electrified, will fundamentally change the electricity network, in the scale of the renewable generation needed; the sources of electricity when the wind is not blowing; the increase in curtailment of wind when it is overproducing and in network investment and management.

24.4 The plan to decarbonise will centre on a number of interrelated factors: the size of the peak demand, how the peak demand compares to average demand and is there a storage solution for electricity generated when not required.

24.5 <u>The size of the peak:</u>

- The size of the peak demand dictates the amount of power the network has to move and the amount of generation needed in times of low renewable production. Consequently, this is a major driver of total cost. For example, KPMG estimated the total cost for an extra GW of peak demand at £1.2bn[98] for network infrastructure, BEIS estimate a new OCGT facility costing £200m for 600 MW or £865.2m for 619 MW for a CCGT facility with carbon capture;

- The increase in peak from transport will be extremely challenging, but, in our view, is manageable. The electric nation study in GB[99] experimented with a number of techniques to smooth the load from electric vehicles, including tariffing, apps linked to time delay charging, smart network control by the electricity network etc and the trial output infers that the use of these techniques can bring the peak demand down to about 600w (and possibly 400w at the evening peak)per charger. This trial over 2 years with c700 car owners gives good insight into what's possible, albeit with a sample population perhaps more environmental conscious than the average car user. Our own modelling infers an additional peak from Electric Vehicles of 0.26GW

[95] BEIS conversion factors 2019
[96] https://www.iwea.com/about-wind/facts-stats
[97] http://www.eirgridgroup.com/site-files/library/EirGrid/205079-EirGrid-Winter-Outlook-Brochure_LR5.pdf
[98] https://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf
[99] Electric Nation Smart charging trial

(10 – 15% increase from current peak) by 2030 and 0.49GW (or 25 – 30% increase from current peak) by 2050;

- Non-electric based energy used by business and homes is, however, of another scale entirely. The gas system alone transported just over 17,000GWh of energy in Northern Ireland in the gas year 18/19, over twice the electricity energy used and as kerosene is the most prevalent domestic fuel, the energy from liquid based fuels is also substantial. Peak is currently c6.5mcm in a day, about 72GWh or nearly 3.5 times average electricity used in a day. Attempting to decarbonise heat via electricity would add c0.8GW peak in 2030 and 4.6GW in 2050.[100] This would be prohibitively expensive;

- Alternatively, and more sensibly, attempting to electrify the heating of business and domestic customers <u>without access to the gas grid</u> would result in peak increases of c0.3GW in 2030 and c1.6GW in 2050[101]. This still constitutes an immense challenge to the electricity sector, but may be logistically achievable, if very expensive.

24.6 <u>Peak demand to average</u>

- As can be seen above the peak demand drives the total scale of the capital investment. Allied to this is how intensively the system is being used – if the peak demand is very high compared to the total electricity consumed it will be very expensive on a per unit basis.

- There are several initiatives that will help smoothing the load, such as the ideas tested in the electric nation study in 24.5 above, and potential to heat domestic water tanks with immersion heaters, repurposing used car batteries amongst others[102].

24.7 <u>Storage solution for electricity from wind</u>

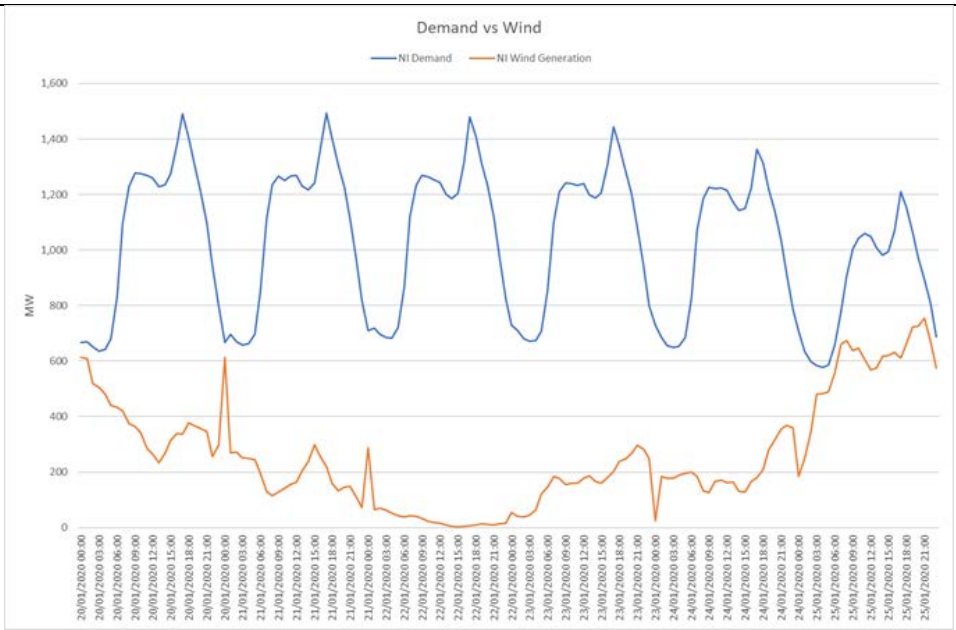
- There is no known local solution to store electricity cost effectively. Whilst a number of initiatives outlined in 24.6 will help smoothing the load, they should not be confused with energy storage as these will not come remotely close to achieving the scale for the system sized storage to manage the variability of wind.

- The following graph of wind production compared to system demand from 20 January 2020 to 25 January illustrates the issue. During this period wind production was less than 30% its capacity for nearly 80% of the time and nearly 60% of the time generation from other sources exceeded 75% of the total required.

[100] Based on element energy report to BEIS December 2017 of heat pump use at the peak and a forecast changeover rate

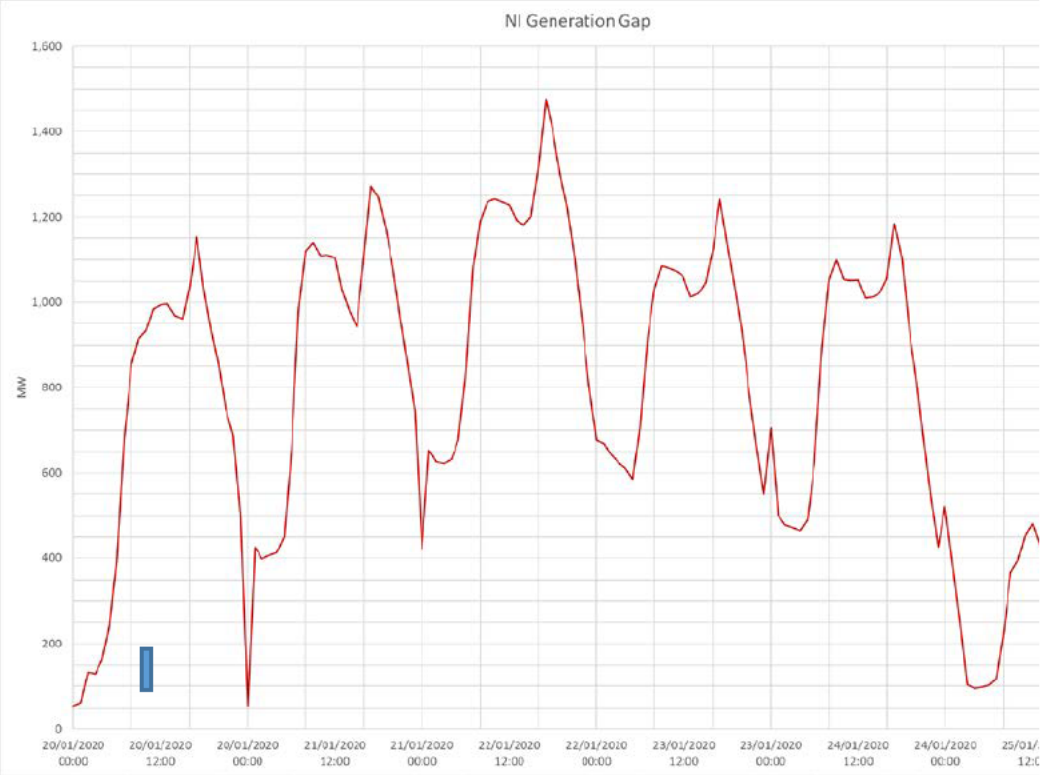
[101] Based on 80,000 premises converted and 30% of cars being electric by 2030

[102] http://www.element-energy.co.uk/wordpress/wp-content/uploads/2020/01/UKESL-Non-technical-Public-Report_2020.pdf



- The following graph shows this another way by plotting only the gap which needs to be supplied by some other form of power, being the difference between the demand and the wind generation. By way of illustration the blue box on the graph represents the "biggest battery project in the world", the Hornsdale power reserve[103], costing €56m. Trying to cover what is simply one of the more recent periods of low wind with this type of battery technology, would involve a capital outlay of some €48 billion. Trying to use a battery solution to cover a worst-case low wind scenario and a future higher demand driven by the electrification of transport is inconceivable.

[103] https://reneweconomy.com.au/revealed-true-cost-of-tesla-big-battery-and-its-government-contract-66888/



- It should be noted that battery technology has a vital part to play in the future of the electricity system, but it cannot provide a storage solution. For the electricity system to work on a zero carbon basis it requires **Dispatchable Plant** running from a zero carbon fuel. Fluence[104], the leading battery integrator illustrates a range of applications for batteries, such as frequency regulation, helping manage micro grids, critical power management, capacity peak power, and Tranmission and Distribution enhancement. Batteries can be used for some intermittency management, but within a short timeframe, typically up to 4 hours rather than prolonged periods.

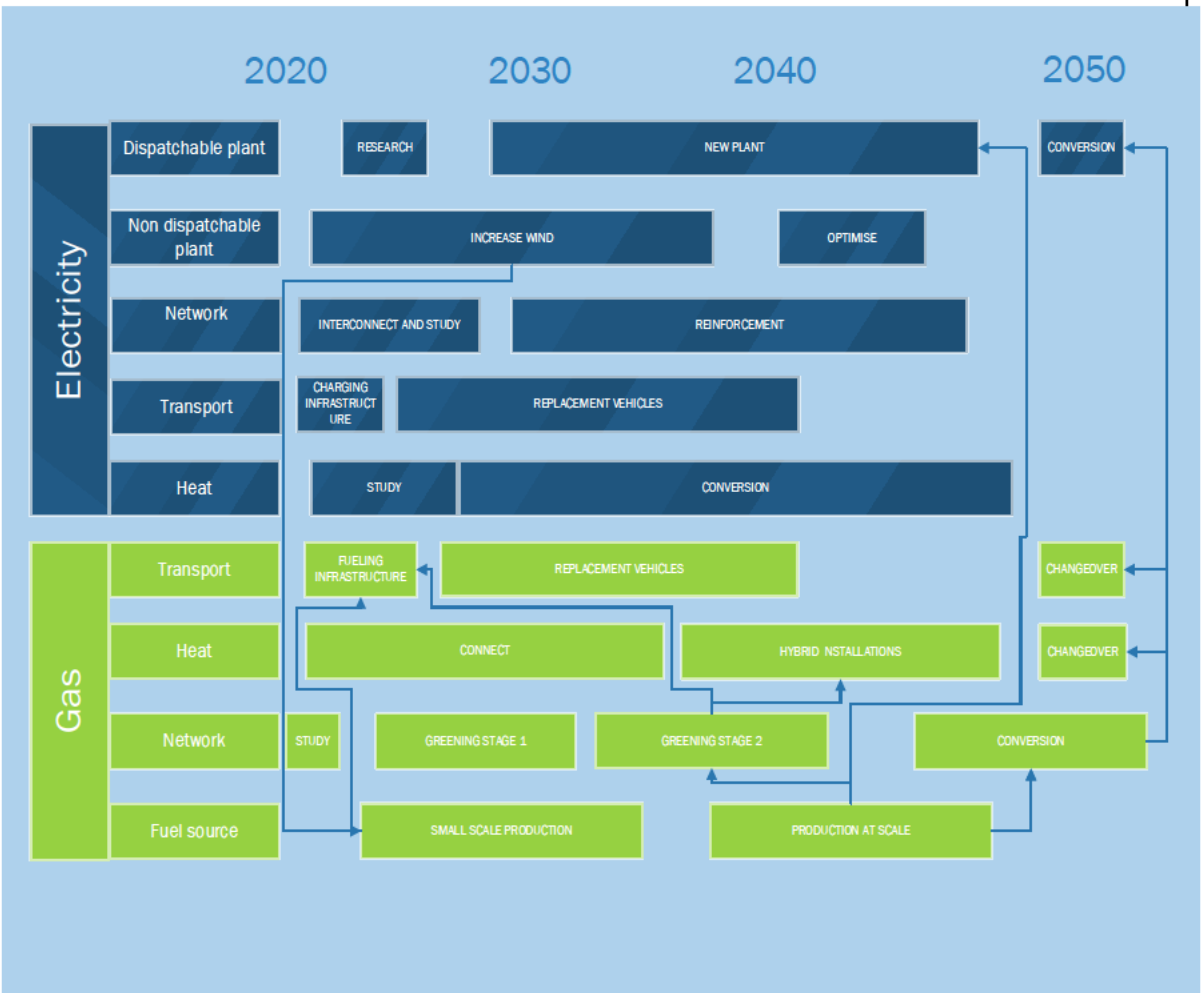
24.8 Therefore a pathway that is achievable requires a peak demand as low as possible and good utilisation of the network by having a "flat" demand profile and the storage problem will not be solved in the medium of electricity, rather it will be what's known as a "power-to-x" solution, married to dispatchable zero carbon generation.

24.9 In order to plan a pathway to decarbonise electricity there needs to be **clarity on the plan for heat and transport,** because only then can the scale needed be assessed. The fundamental issue of storage can then be considered. Using the analysis in 24.5 of a move to electrify heat in off gas grid homes only using heat pump technology, and the electrification of car transport (by way of example), would suggest an additional peak load c1.1GW, almost a 65% increase in 10 years. What's more the question of how to supply electricity in low wind conditions becomes very stark – the peak at this time would exceed

[104] https://fluenceenergy.com/

the current level of dispatchable plant and either energy storage has been solved in this time or more dispatchable plant and / or interconnection is needed.

24.10 As noted elsewhere in our response the interconnected nature of the challenges and their solutions is the key point. The following diagram illustrates the pathway for electricity and how it interacts with the pathway for zero carbon gas, the pathway for heating and the pathway for transport. In practice several of the activities would be expected to progress in parallel, but for clarity are shown in sequence :



24.11 The gas part of the pathway is discussed in more detail in our answer to question 18 (see 18.7 – 18.12)

24.12 Looking at the <u>electricity pathway</u> the key tasks by 2030 are:

- **Charging Infrastructure For Transport**

Determine a strategy for electric car chargers, balancing at home chargers with public chargers and also the plan for encouraging public transport. At home chargers are clearly preferable as car battery sizes increase, but need to be designed to avail of the load

balancing techniques so essential to the network balancing, and sufficient public chargers are needed to ensure consumers have the confidence to use the vehicles for all journeys.

- **Increase Wind Capacity**

Northern Ireland has **an extensive wind resource and this needs to be maximised**, including the commencement of offshore wind development. In order to achieve an optimal solution complementary renewables such as solar are also essential to help reduce the probability of periods of little renewable generation. This will involve substantial work on maintaining system integrity via frequency response and other management tools.

- **Interconnection And Network Studies**

Interconnection is one of the keys to managing the generation and demand balance in a cost-effective way. The North South Interconnector is one example, though it needs to proceed through both planning and construction. More immediately the National Grid artificially imposed limits on the Moyle Interconnector should be removed as a matter of urgency to facilitate the balancing our system badly needs.

- **Research On Dispatchable Plant**

As the future is a zero carbon gas mix, the characteristics of the existing plant need to be assessed by 2030 and clear design parameters given for any plant constructed in the future. In practice we do not expect this to be an issue for future plants and even some existing plants could opersate with adjustments, for example the data sheet for some of the existing turbines in NI states "Standard combustion supports heavy oils, naphtha, bioethanol, methanol, synthetic gases, and steel mill gases and capable up to 95 percent hydrogen, or heavy fuel oil with up to 200ppm vanadium"[105]

- **Heat Study**

As outlined in our answer to question q18 on decarbonising heat (see 18.13 – 18.23), the off-gas grid solution is likely to be electricity based (as this is the only network the houses are connected to) but potentially extremely expensive. A clear study of the alternatives for these houses is needed before a changeover program starting no later than 2030, simply because of the expected complexity of the requirements.

24.13 Between 2030 and 2050 the electricity network and its customer needs will go through a transformation:

- **New Plant** will come online, some of which may be hydrogen powered or more AD supplied plants, eventually leading up to a switch over of fuel to the zero carbon gas mix at some point before 2050.
- As the optimum generation mix and demand requirements become clear there will need to be a program **optimising** the non dispatchable generation, determining the required mix between onshore wind, offshore wind, and solar.
- **Network Reinforcement** is in our view inevitable, though will be delayed until this period due to practical considerations such as planning consents, but also to allow the "smarter grid" solutions to be tried first, again to find the most cost effective approach.
- In the transport sector the steady **replacement** of diesel and petrol vehicles with electric vehicles must make steady progress. In order to hit 2050 targets no new internal

[105] GE6b turbine

combustion engine (ICE) powered vehicles should be allowed past 2035 and the older vehicles gradually removed.

- In the heat sector, after the requisite pilot projects and research, the 2030-2050 period will involve the electrification of the heating in the off-grid housing stock, this **conversion** is expected at a manageable run rate of under 10,000 houses per year average.

24.14 A general point not covered explicitly in the diagram is the need for Carbon capture use or storage. The provision of low carbon dispatchable generation is fundamental to the achievability of decarbonisation in electricity. As the CCC state **carbon capture is essential, not an option**[106]. The absence of nuclear baseload makes the low carbon electrification much more difficult for Northern Ireland. The most sensible source is turbines powered by low / zero carbon gas. In order for this to happen **immediate policy direction to decarbonise the gas network is required**.

8. Transport

Q30. What would be an appropriate pathway to decarbonised energy for transport to 2050?

Q31. What role should active travel have in the decarbonisation of the transport sector and what should government do to support this?

Q32. What energy infrastructure is needed to facilitate the uptake of electric vehicles in line with UK Government's 'Road to Zero' targets?

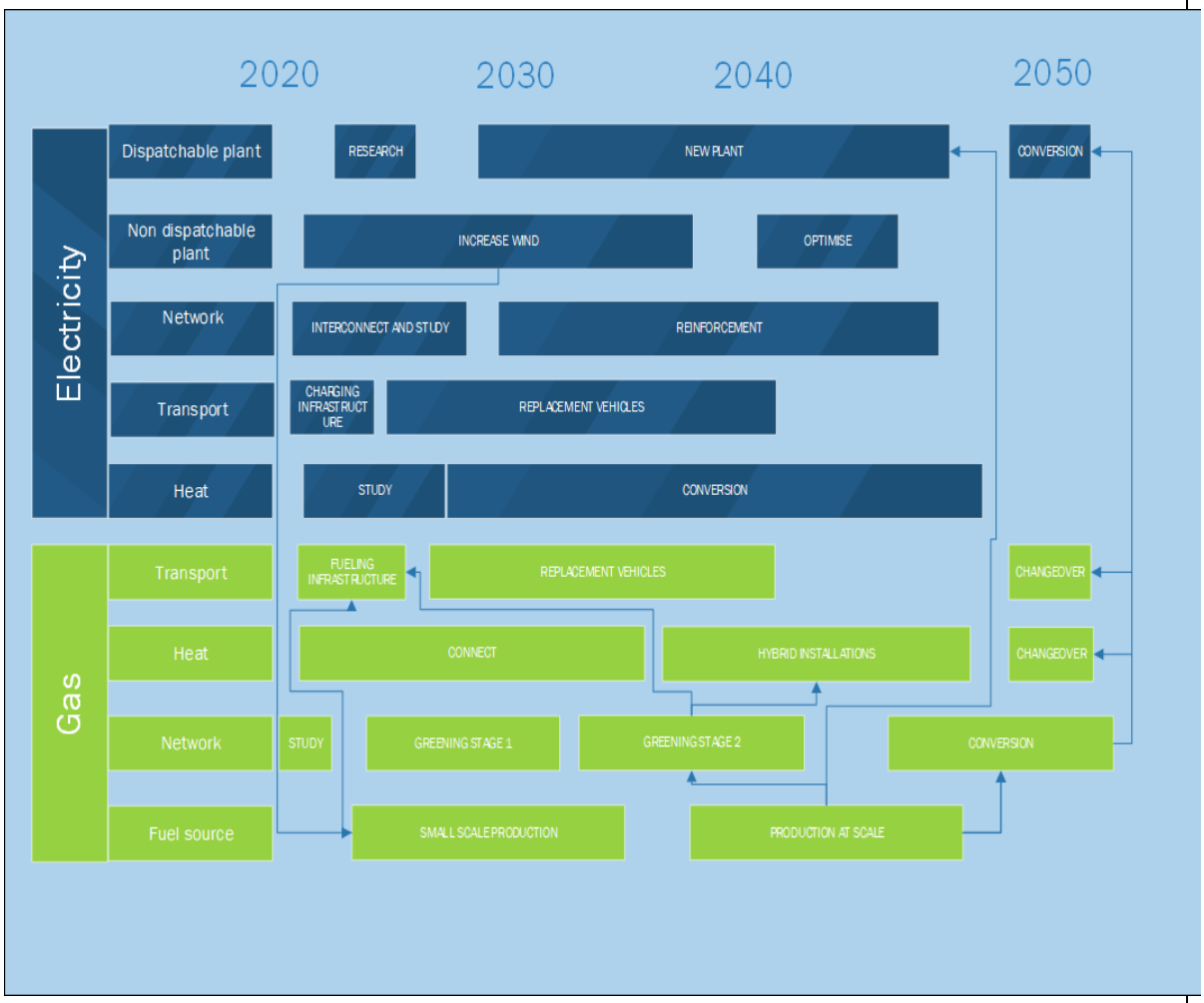
Q33. How will transport integrate with other energy uses (e.g. homes with solar generation, battery storage, EV charging) and what can government do to optimise the opportunities represented by this integration?

[106] https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf

Q34. To what extent can alternative low carbon transport fuels contribute to decarbonisation of the transport sector?

Q35. Do you have any data/research to help inform and reduce the carbon intensity of our transport energy in order to achieve net zero carbon by 2050?

30.1 As noted earlier all electricity, gas, heat and transport decarbonisation paths are inextricably linked and the core tasks are to decarbonise the gas network, decarbonise the electricity network and convert the transport and heating sectors to the electricity and gas networks. The following diagram outlines the combined pathway:



30.2 As the diagram illustrates, the decarbonisation of transport involves both the electricity and gas networks. As the following analysis explains the optimum solution is electricity-based solutions for lower mileage / lower weight vehicles and gas-based solutions for higher mileage / higher weight vehicles.

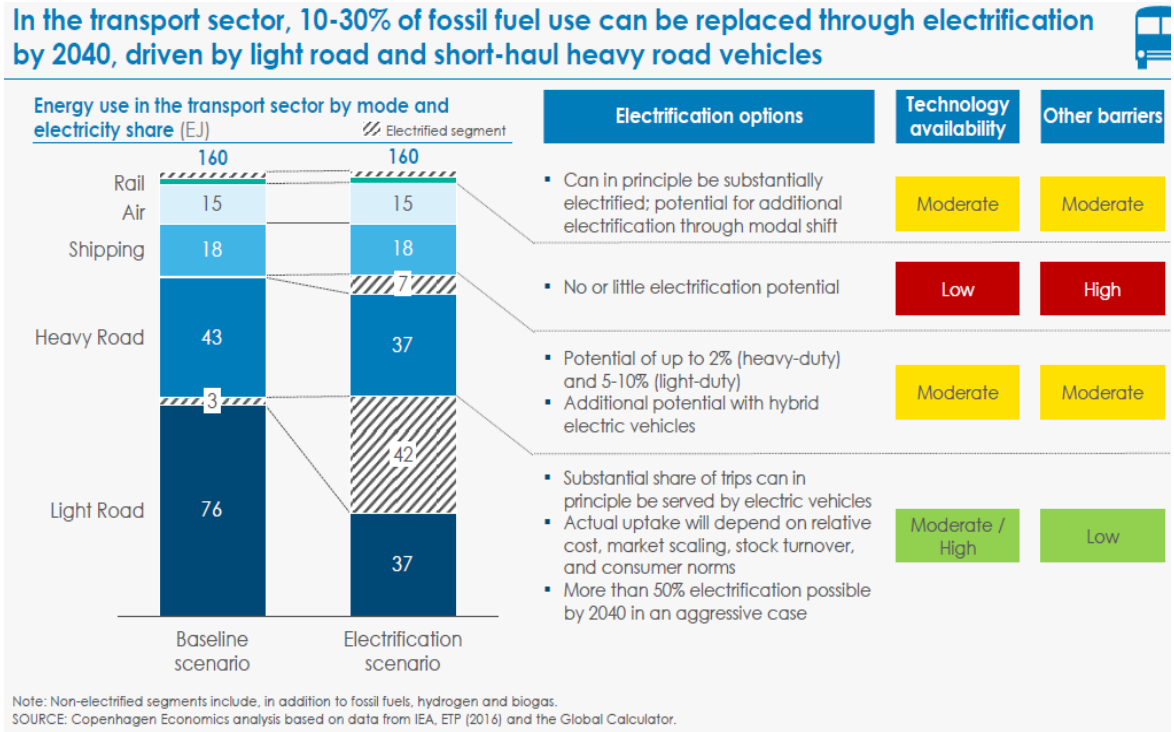
30.3 The pathway for electric vehicles requires charging infrastructure and then an ongoing replacement program. The pathway for heavier vehicles involves CNG infrastructure (which can be adapted in the future to hydrogen infrastructure as required), hydrogen infrastructure, particularly for public transport, and a suitable scheme to encourage the production of zero carbon gas, initially on a small scale directly for transport and later on a larger scale.

30.4 In order to facilitate the decarbonisation of transport it is essential to deliver the infrastructure to support it and the economic incentives to enable it to happen. This will involve:

- the build out of public charging points to support electric vehicles and co-ordinated schemes to allow for efficient home-based chargers;
- the build out of CNG fueling for heavy good vehicles;
- the use of the Renewal Transport Fuel Obligation scheme which allows producers to introduce methane from Anerobic digestion, or hydrogen from electrolysis, and have them certified as zero emissions needs more incentivisation to allow hauliers to purchase these gases for transport.

Scale of the problem

30.5 Transport contributed 23% to NI's CO_2 emissions in 2017[107].Transport is the second largest sector of CO_2 emissions for NI behind agriculture and has registered the largest increase in emissions from the 1990 base year. **Decarbonisation of transport should be a priority area for the first part of any plan.** There are four main forms of transport that produce CO_2 emissions namely road, rail, aviation and marine/ shipping. The energy transitions commission summarised the world's position as set out below in terms of electrification as a solution to transport emissions.



30.6 Clearly electrification will contribute considerably to this transition but cannot do everything required. Each of these areas is covered separately below.

[107] https://www.daera-ni.gov.uk/sites/default/files/publications/daera/ghg-inventory-statistical-bulletin-2017.pdf

Road Transport

30.7 This forms the vast majority of NI's transport CO_2 emissions, for 2016, the last year of figures available from DAERA, it equated to 88%[108] of transport's CO_2 emissions. Clearly this should be the prime area of focus for decarbonising transport in NI.

30.8 Approximately 89.4%[109] of mileage travelled on NI's roads in 2014 was by cars. No more up to date data is available but there is no reason to think that road use has changed dramatically in the last 6 years. This in turn means that approximately 74% of road CO_2emissions come from cars[110].

30.9 Hydrogen, either produced via electrolysis from electricity or from the alternatives outlined in paragraphs 21.11 to 21.14 or using electricity generation to charge battery electric vehicles (BEVs) seem to be the best ways currently available to decarbonise energy for this mode of transport. Electricity in Ireland currently entails 0.291t/MWh[111] CO_2. Hydrogen production <u>without</u> carbon capture entails 0.249t/MWh[112] or 0.024t/MWh with carbon capture or, if from renewables which would otherwise have been constrained, 0t/MWh.

30.10 Research from Nationale Akademie der Wissenschaften Laopoldina et al (2017) suggest that BEVs are more efficient in their use of electric than fuel cell vehicles[113]. The analysis is fairly typical starting from a "100% renewable energy scenario", which is a long way in the future, and assumes vehicle charging at times when this criteria is met, which is also not the reality. The study does illustrate that battery use efficiency is currently c86% efficient compared to fuel cell efficiency of c60% from the source hydrogen.

30.11 From a CO_2at the point of use perspective then, BEV will currently produce 0.291t/MWh / 0.86% = 0.338t/MWh and Hydrogen power vehicles between 0.04t /MWh (0.024t/MWh /60%) and 0.415t/MWh (0.249t/MWh/60%) depending on whether the hydrogen was sourced from carbon capture facility or not.

30.12 **Whilst both hydrogen and BEVs are plausible for Northern Ireland we are of the view that**, since the car manufacturers are more advanced with BEVs and Northern Ireland customers should have less issues with range and recharging time, **BEVs should be the preferred approach for Northern Ireland domestic vehicles.**

30.13 Per DVA statistics from December 2017 in NI 63.7% of vehicles registered were less than 10 years old[114]. With incentivising the adoption of battery electric vehicles it would be possible to decarbonise the vast majority of the NI fleet within 10 years. Only 2.6% of vehicles in December 2017 were older than 20 years. This is all predicated on the availability of the charging infrastructure.

Other Motorised Vehicles

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[108] https://www.theccc.org.uk/publication/reducing-emissions-in-northern-ireland/

[109] https://www.infrastructure-ni.gov.uk/system/files/publications/infrastructure/annual-road-traffic-estimates-vehicle-kilometres-travelled-in-northern-ireland-2014_0.pdf

[110] Based on 3 and https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019

[111] https://mk0cruiefjep6wj7niq.kinstacdn.com/wp-content/uploads/2019/09/CRU19113-2018-Fuel-Mix-Disclosure-Report.pdf

[112] 1kg h2 = 130MJ=36.111KWh, and produces 9KgCo2 without carbon capture and 0.9kg with carbon capture. IEAGHG technical report 2017-2

[113] https://www.acatech.de/wp-content/uploads/2018/06/ESYS_Stellungnahme_Sektorkopplung.pdf

[114] https://www.daera-ni.gov.uk/publications/northern-ireland-carbon-intensity-indicators-2018

30.14 Approximately 10.6%[3] of mileage on NI's road was by vehicles other than cars, i.e. buses, heavy goods vehicles etc. which in turn results in approximately 26% of road CO_2 emissions.[4]

30.15 The appropriate pathway for these vehicles is unlikely to be as straightforward as for cars. These vehicles can be very large in terms of size and weight (> 8.7m in length, > 33 tonnes in weight) and will often have journeys that are significantly longer than that of the average car with little downtime for refueling. Given the power to weight ratios of batteries it is difficult to foresee them being able to propel the vehicle over a sufficient range to enable the vehicle to perform its task.

30.16 Vans, and light goods vehicles that are not carrying out long journeys could be powered by an electric battery for the same reasons stated above for cars.

30.17 For heavy goods vehicles, and vehicles performing longer journeys, electricity is unlikely to be the solution as the batteries are unable to deliver the required range and weight. **The use of gas for these types of vehicles is likely to be the best solution**, initially via CNG produced from anaerobic digestion and ultimately from the decarbonised gas grid. Synthethic fuels could also be used in the future, though if supply is scarce these synthetic fuels will likely be used in aviation or shipping where moves to decarbonise are likely to be more difficult.

First stage - CNG

30.18 Encouraging hauliers etc. to transition to compressed natural gas (CNG) should be encouraged. This is a cheaper fuel[115] than diesel and emits less CO2[116]. This would be the natural economic catalyst for decarbonising the gas grid if combined with a certification of origin type system.

30.19 Modelled Well-to-Wheel (WTW) emissions for CNG trucks[117] suggest that an 83% emissions saving is possible when using 100% biomethane, compared to diesel equivalents. This is comparable to real-world trial data[118] which estimated WTW emissions savings of 76-81% with pure biomethane and with biomethane from manure, emissions can be net-negative using official accounting[119]

30.20 CNG vehicles would be fueled via the gas grid and can be determined as zero CO_2 if suppliers and hauliers made use of the Renewal Transport Fuel Obligation (RTFO) scheme[120]. The scheme encourages the production of biofuels that are less damaging to the environment. Suppliers of transport fuels must prove that the fuels provided are renewable and sustainable. When this is proven they are given a Renewal Transport Fuel Certificate (RTFC) which are publicly traded. Suppliers are given 1.9 certificates for every 1 KG of biomethane produced or 3.8 certificates if produced from waste products. The certificates have a value of £0.15 to £0.20[121].

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[115] https://www.oxfordenergy.org/wpcms/wp-content/uploads/2019/04/A-review-of-prospects-for-natural-gas-as-a-fuel-in-road-transport-Insight-50.pdf

[116] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019

[117] . Element Energy, *Development of a Well to Tank Emissions Model for Heavy Duty Vehicles*, 2018 and Element Energy for TSC and DfT, *Hydrogen to Smart Mobility: Review of Opportunities for Hydrogen for Heavy Vehicles,* 2019

[118] Cenex, An Innovative UK Research Project to Assess the Viability of Gas Vehicles, 2019

[119] Wet manure has an emission facture of -103 gCO_2e/MJ under the Renewable Energy Directive

[120] https://www.bioenergy-news.com/news/generators-of-biomethane-can-claim-rhi-and-rtfo-payments/

[121] http://adbioresources.org/about-ad/government-policy/financial-incentives/

30.21 Governmental and regulatory support would help facilitate investment in infrastructure and suppliers injecting anaerobically digested biomethane onto the gas grid for CNG vehicle owners to avail of it in NI. Just like the beginning of the decarbonisation of electricity, where electricity generated from wind was introduced in one part of the network and the electricity drawn from another was regarded as zero CO_2 due to the purchase of the relevant certificate, HGVs from CNG can achieve the same result if a suitable scheme is put in place.

30.22 Availing of the scheme is an ideal way to kick start the greening of the gas network as the green gas will compete with diesel at 15p kWh equivalent rather than delivered heat at less than 4p KWh.

Second stage – Hydrogen fueled

30.23 With the conversion of parts of the gas network to a greener form of gas then the emissions from HGVs would be very substantially reduced. This would in turn aid the conversion of the gas grid to hydrogen in a systematic manner. HGVs would have their CO_2emissions gradually reduced until, if a process such as electrolysis is used to generate the hydrogen, there was no CO_2emissions at all.

30.24 The challenge facing early adopters of the transition to Hydrogen Fuel Cell technologies, such as Translink, is the lack of capacity. Translink has embarked on a pilot project in conjunction with Energia and has formed a consortium to deliver the first Hydrogen fuelled buses and the first Hydrogen refuelling station in Ireland by the end of 2020. In turn the buses will use hydrogen gas produced on a wind farm as a transport fuel. The project which is supported by funding from DfI and OLEV will cost £4.7m.

30.25 These early adopters should be encouraged as breaking down the initial barriers to implementation is a key challenge. As outlined in question 21 hydrogen can be produced with carbon capture for less than $2.50 / kg provided the scale is achieved. Current hydrogen gas costs and the capital investment in terms of vehicles and infrastructure is a barrier to roll out and to upscale the use of electricity and hydrogen as a transport fuel additional financial support is required to cover the initial capital outlay for vehicles and infrastructure.

Rail Transport

30.26 The Rail network in NI transport is relatively small and carried passengers 506.6 million kilometres for the year to March 2019[122]. This translates to less than 1% of NI's transport CO_2emissions.

30.27 Use of hydrogen or electric to power the network, both of which can become zero carbon, seems like the right approach to take, but would be dependent on the best approach for either based on cost and the amount of hydrogen or electric which will be available. With the electrification of cars, a not insignificant percent of the housing stock's heating needs and the huge infrastructure costs associated with rail electrification, hydrogen fuel cell powering of the trains is likely to be the most cost-effective path to take.

Aviation

[122] https://www.infrastructure-ni.gov.uk/publications/northern-ireland-transport-statistics-2018-2019

30.28 Aviation has the highest CO_2emission rate per passenger of any form of transport[123]. There were 9.1 million air passengers that flowed through NI's airports in the year to March 2019 which by our calculations likely contributes up to 10% to NI's transport CO_2emissions.

30.29 This clearly is an important sector area to find a solution to its high CO_2emissions but given the difficulties of power to weight ratios etc. there currently is no viable solution to replace aviation fuel in a cost effective and passenger safe way. Work is continuing to produce hydrogen and synthetic hydrocarbon fuels for sectors such as aviation that require high energy densities in a cost-effective manner. Currently the costs of these fuels can be three to six times more expensive than existing jet fuel[124]. In a competitive market this cost differential will need to be significantly reduced before aviation can begin decarbonising in earnest.

30.30 A very negligible percentage of NI aviation travel is confined within its borders. Co-ordination and co-operation with other jurisdictions will be necessary for NI to decarbonise aviation. Aircraft are not necessarily refueled in NI, airlines chose to fuel at the cheapest location ,when they can.

30.31 The decarbonising of aviation is likely to occur much nearer to 2050 than any other transport sector. The prohibitive cost reductions required of zero carbon options and the level of coordination worldwide make it likely the last of the transport sectors to decarbonise.

Shipping/Marine Transport

30.32 2.1 million passengers in 2019 travelled by sea to and from NI[125]. Freight tonnage through NI ports was 483.3 million tonnes in 2018.[126]

30.33 Like aviation, with the high energy densities required, it is unlikely that electric batteries are going to provide a pathway to decarbonising shipping and marine.

30.34 Heavy fuel oil is considerably cheaper than zero carbon fuels; currently 180% - 240% cheaper[127]. It is highly unlikely that ship operators would be the first to make a switch to zero carbon options given that these prohibitive cost rises would make them highly uncompetitive. Given this and the likely limited biofuels available to effectively decarbonise the fueling of ships, coordinated international action is likely to be required.

30.35 Given the above, it is likely that decarbonising of this sector, like aviation, is likely to arise much later in the period to 2050 than other transport sectors.

Other Measures That Could Facilitate & Speed Up The Pathways To Decarbonising Transport In NI

30.36 Further incentivisation of the Renewable Transport Fuel Obligation scheme in NI.

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[123] https://easac.eu/publications/details/decarbonisation-of-transport-options-and-challenges/
[124] http://www.energy-transitions.org/sites/default/files/Accelerating-The-Transitions_Report.pdf
[125]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/867867/sea-passengers-short-sea-routes-2019.pdf
[126] https://www.nisra.gov.uk/statistics/other-surveys/ports-traffic
[127] http://www.energy-transitions.org/sites/default/files/Accelerating-The-Transitions_Report.pdf

30.37 The points below would lead to less energy being required for transportation needs

- Improvements to public transport
- More encouragement for people to walk, run or cycle as a means of transport
- Tighter targets on emissions to remove gas guzzling vehicles and to incentivise the design of more efficient vehicles
- Building up infrastructure for electric cars, CNG and hydrogen fuel cell vehicles
- Setting up of car sharing schemes and the use of bus lanes or lanes on motorway for those that are car sharing
- Integration of new housing and public transport to encourage more people to use public transport
- No detailed road traffic information has been available in NI since 2014. The shift to a decarbonised road network would be aided by having up to date and more accurate information
- Encouraging businesses to allow staff to work from home utilising videoconferencing etc. would help curtail business travel

31.1 There are several things that need to be done to decarbonise the transport sector. All these things will involve significant costs and the higher the demand for energy for transport the higher the costs of decarbonising will be. Anything that will reduce energy demand will consequently reduce the costs of decarbonising.

31.2 Encouraging people to walk or cycle rather than using a car for their journeys will clearly reduce energy demand and so play a role in decarbonising the transport sector in a very inexpensive manner. The Committee on Climate Change modelling suggest that displacing 9% and 6% of short car journeys with cycling and walking can lead to a reduction of 1.6% in overall car's transport distance travelled[128].

31.3 Most people (61%) are happy with walking conditions in NI as per the survey of the Attitudes to Walking, Cycling and Public Transport for 2018/19. For those expressing unhappiness in the survey over 40% did so due to poor lighting, poor, or no, footpaths and traffic moving too fast[129]. The costs for resolving these issues seem relatively inexpensive especially when the benefits to the overall public health of the populace are considered.

31.4 A small majority (53%) of people were happy with cycling conditions in NI as per the survey of the Attitudes to Walking, Cycling and Public Transport for 2018/19[2]. As with walking those expressing unhappiness in the survey with cycling did so for reasons that appear that could be inexpensively resolved, i.e. poor or no quality cycle lanes and the excessive speed of traffic.

31.5 Promoting active travel with advertising and marketing, making more green spaces for walking and cycling available and more areas for storing bikes for example available are all low cost items that will encourage people to be more active. In addition, tax saving and other schemes could be introduced to encourage the buying of public transport annual tickets.

[128] https://www.theccc.org.uk/publication/reducing-emissions-in-northern-ireland/

[129] https://www.infrastructure-ni.gov.uk/publications/walking-cycling-and-public-transport-northern-ireland-201819

32.1 Electric vehicles clearly will lead to more peak electricity demand and more electricity demand. The electricity grid is built typically to enable it to handle whatever the peak demand will be. To facilitate the uptake of electric vehicles significant investment will need to be made to the electricity grid to expand it and reinforce it. KPMG in their report put the capital cost in excess of £1.2Bn per GW of peak. [130]

32.2 There are currently just under 1 million cars on NI's roads[131]. If all these cars were electric and charging at the same time at a charging rate of 3.7KW[132] this would result in an increase to peak demand of close to 3.7GW. This is over double what Eirgrid has recorded as NI's peak electricity demand for 2016/17[133]. Assuming car users are fully engaged in the process of charging their car it is still likely to result in an average charging rate at best of 0.6KW[134] at peak, so a potential increase of 0.6GW or one third of NI's peak electricity demand for 2016/17. In terms of overall demand for electric, assuming electric cars are travelling on average 10,000 miles a year, and averaging 5 miles per KWH, there would be an increase of over 25% on what current electricity demand is. [123]

32.3 With the uptake of electric vehicles there will need to be a substantial investment in charging infrastructure to enable car owners to be able to charge their cars. Ensuring that manufacturers use a standardised way to charge all types of vehicle will help keep costs lower for car owners and facilitate the uptake of electric vehicles.

32.4 The Committee on Climate Change estimate that NI will require significant numbers of public charging points, 30-35 fast charging points at a cost of £112,000 per point and 800 – 950 of top up charging points at a cost of £10,000 per point[135]. There will also be significant costs in electricity grid upgrades where the charging points are put in.

32.5 It may also be necessary to fund charging points at some car owners homes to incentivise their transition from diesel and petrol to electric cars, and again a standardised metering functionality may prove fundamental to successful use; the 0.6KW peak noted above is predicated on tariff differentials which in turn rely on the correct metering.

33.1 Whole system analysis will be essential for a coherent energy strategy, as shown in the following diagram produced for the Dutch Ministry of Economic Affairs and Climate:

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[130] https://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

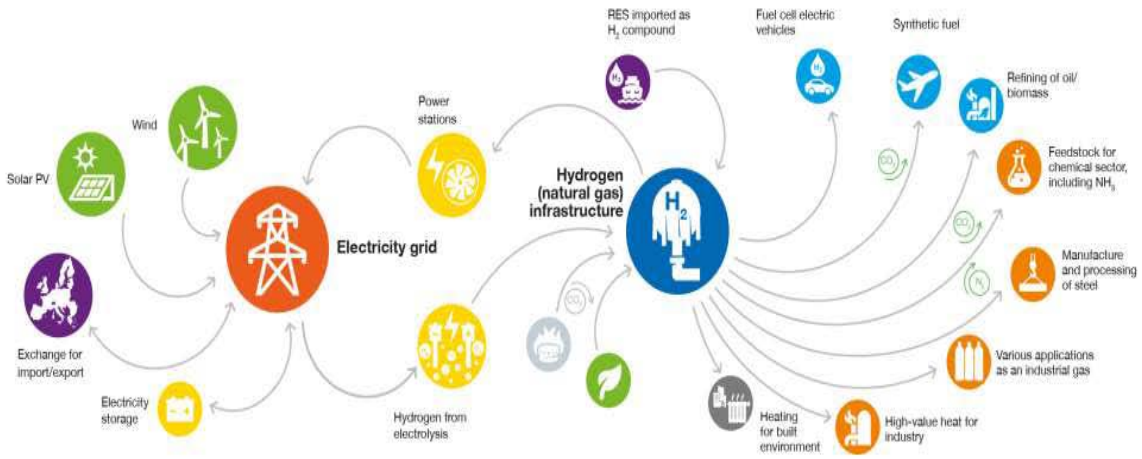
[131] https://www.infrastructure-ni.gov.uk/system/files/publications/infrastructure/dfi-driver-vehicle-operator-and-enforcement-statistics-2019-20-q3-report.pdf

[132] https://pod-point.com/guides/driver/charging-electric-car-at-home

[133] http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-Group-All-Island-Generation-Capacity-Statement-2019-2028.pdf

[134] Energy Nation study

[135] https://www.theccc.org.uk/publication/reducing-emissions-in-northern-ireland/



33.2 As detailed in question 32 the use of electric vehicles will place a strain on NI's electricity grid increasing both demand and peak demand for electricity. As detailed in 32.2 electric cars is likely to add one third to peak electricity demand and over 25% to overall electricity demand.

33.3 The use of electric heat pumps in around 30% of homes will also substantially increase the demand for electricity. If one assumes 240,000 homes in NI have 6KW electric heat pumps then this means that this could add 1.44GW to the peak electricity demand, or 80% of today's current electricity peak demand of 1.8GW[136].

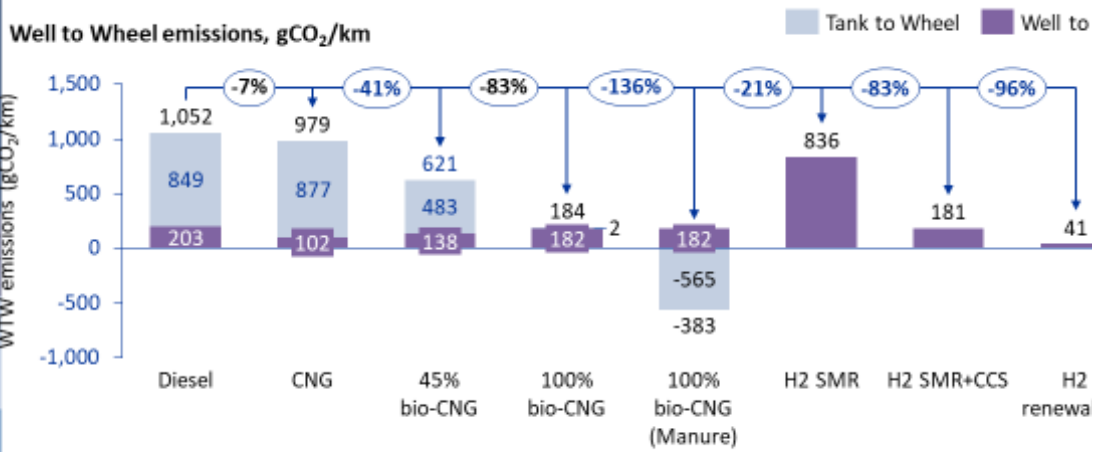
33.4 The integration referred to in the question is actually very narrow in scope. In order to decarbonise the economy, a deep and complex integration of transport, heat, electricity and gas networks is required, with a key aim of minimising total energy use and using each related system to minimise the peak loads.

33.5 **Transport customers need to have a clear option to utilise the electricity and gas networks.** CNG filling stations must be provided for HGVs and a clear strategy for how electric vehicles are to be charged is essential. The following slide demonstrates the potential CO2 saving from integrating biogas into the network and using it in transport as BIO- CNG:

[136] http://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid-Group-All-Island-Generation-Capacity-Statement-2019-2028.pdf

Bio-CNG trucks have CO2 emissions over 80% lower than diesel equivalents

- Modelled Well-to-Wheel (WTW) emissions for CNG trucks[1] suggest that an 83% emissions saving is possible whe using 100% biomethane, compared to diesel equivalents. This is comparable to real-world trial data[2] which estim WTW emissions savings of 76-81% with pure biomethane.
- Emissions savings with 100% biomethane are comparable to those achieved by FCEVs running on "blue hydrogen (made from steam methane reforming with carbon capture and storage, SMR+CCS)
- Higher emissions savings are possible with "green hydrogen" (produced by electrolysis using only electricity from renewable sources)
- With biomethane from manure, emissions can be net-negative using official accounting[3]



1. Element Energy, *Development of a Well to Tank Emissions Model for Heavy Duty Vehicles*, 2018 and Element Energy for TSC and DfT, *Hydrogen to Smart Mobility: Review of Opportunities for Hydrogen for Heavy Vehicles*, 2019; 2. Cenex, An Innovative UK Research Project to Assess the Viability of Gas Vehicles, 2019; 3. Wet manure has an emission facture of -103 gCO_2e/MJ under the Renewable Energy Directive

cng service

33.6 Peak electricity load should be managed by :

(1) Having sufficient dispatchable plant running off the gas grid and the gas grid is used to store excess energy which has previously been converted to hydrogen via electrolysis;

(2) Spreading the electricity load using smart charging, tariff price signals and load management techniques, particularly for EVs;

(3) Minimising the number of houses which rely on heat pumps and from 2040 onwards allowing the hybrid heat pumps gas component to reduce the risk to peak electricity demand;

(4) Utilising embedded generation, such as solar, fuel cells or embedded batteries to reduce the strain at peak times;

33.7 Similarly, <u>excess</u> electricity production should be managed by:

(1) Converting the excess electricity to hydrogen rather than curtailing it, and injecting the hydrogen into the gas grid;

(2) Providing infrastructure to allow the transport sector to access the gas from the grid;

(3) Exporting the electricity to other jurisdictions via interconnectors;

(4) Applying the excess electricity to loads which are discretionary, EVs or in some cases heating domestic hot water tanks with good thermal insulation

33.8 In order to optimise these opportunities the market structures need to be correct and the infrastructure available:

- Time of use electricity tariffing with lower prices at off peak times for the larger loads such as electrolysers is essential;
- Time of use functionality should be an integral part of any new electricity meters installed, for example any EV charging points;
- Consideration should be given as to whether it is cost effective to implement time of use electricity meters for smaller existing loads, bearing in mind the costs needed to install meters may make the overall proposition too costly;
- Infrastructure for access of transport vehicles to the gas network needs to be a priority;
- A renewable obligation for zero carbon gas and certification system for zero carbon gas should be used to encourage gas network decarbonisation;
- Access points for AD gas should be immediately progressed; and
- The plan for accepting hydrogen onto the gas network developed.

34.1 As detailed in the answer to question 30 above there are four main forms of transport that produce CO2 emissions namely road, rail, aviation and marine/ shipping. As noted we agree that EV is the likely path for car users due to the more developed offering from the manufacturers.

34.2 For some car users the issues with the driving range and charging time of BEVs may mean they seek alternative means of powering their cars. This is likely to result in fuelling these vehicles in the same way as heavy goods vehicles (HGVs) and long-haul buses etc. which are covered in the paragraphs below

34.3 Alternatives to electrification are particularly important in the HGV sector, where electrification is really not an option. These vehicles disproportionately emit more CO2 for the same length of journey as cars due to their larger size and weight. This greater weight and size mean that the use of batteries to power such vehicles presents even greater issues with driving range and charging times than cars. It is highly unlikely that these issues will be overcome in the next 10 – 15 years so an alternative lower carbon fuel for these vehicles will be vital in contributing to decarbonising this area.

34.4 Compressed natural gas (CNG) has 23% lower CO2 emissions than diesel[137]. The cost of running HGVs etc. with CNG is also lower with the additional cost of the CNG vehicle commonly paid for in reduced fuel costs in 2 – 4 years[138].

34.5 Modelled Well-to-Wheel (WTW) emissions for CNG trucks[139] suggest that an 83% emissions saving is possible when using 100% biomethane, compared to diesel equivalents. This is comparable to real-world trial data[140] which estimated WTW emissions savings of 76-81% with pure biomethane and with biomethane from manure, emissions can be net-negative using official accounting[141]

[137] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019

[138] https://www.oxfordenergy.org/wpcms/wp-content/uploads/2019/04/A-review-of-prospects-for-natural-gas-as-a-fuel-in-road-transport-Insight-50.pdf

[139] . Element Energy, *Development of a Well to Tank Emissions Model for Heavy Duty Vehicles*, 2018 and Element Energy for TSC and DfT, *Hydrogen to Smart Mobility: Review of Opportunities for Hydrogen for Heavy Vehicles,* 2019

[140] Cenex, An Innovative UK Research Project to Assess the Viability of Gas Vehicles, 2019

[141] Wet manure has an emission facture of -103 gCO_2e/MJ under the Renewable Energy Directive

34.6 **CNG vehicles would be fueled via the gas grid and can be determined as zero co2 if suppliers and hauliers made use of the Renewal Transport Fuel Obligation (RTFO) scheme[142].** The scheme encourages the production of biofuels that are less damaging to the environment. Suppliers of transport fuels must prove that the fuels provided are renewable and sustainable. When this is proven they are given a Renewal Transport Fuel Certificate (RTFC) which are publicly traded. Suppliers are given 1.9 certificates for every 1 KG of biomethane produced or 3.8 certificates if produced from waste products. The certificates have a value of £0.15 to £0.20[143].

34.7 Governmental and regulator support would help facilitate investment in infrastructure and suppliers injecting anaerobically digested biomethane onto the gas grid for CNG vehicle owners to avail of it in NI**. Just like the beginning of the decarbonisation of electricity, where electricity generated from wind was introduced in one part of the network and the electricity drawn from another was regarded as zero co2 due to the purchase of the relevant certificate, HGVs from CNG can achieve the same result <u>if a suitable scheme is put in place.</u>**

34.8 Availing of the scheme is an ideal way to kick start the greening of our gas network as the green gas will compete with diesel at 15p kWh equivalent rather than delivered heat at less than 4p KWh.

34.9 With the conversion of parts of the gas grid to a greener form of gas then the emissions from HGVs etc. would be very substantially reduced. This would in turn aid the conversion of the gas grid to hydrogen in a systematic manner. HGVs. would have their CO2 emissions gradually reduced until, if a process such as electrolysis is used to generate the hydrogen, there was no CO2 emissions.

34.10 As stated in above the rail network is relatively small in NI and contributes little to NI's transport CO2 emissions. Using hydrogen or electric powered trains in the future could and should effectively decarbonise this area. Therefore, there shouldn't be any great need for low carbon fuels (beyond hydrogen) to decarbonise rail in NI.

34.11 As stated in 30.28 aviation has the highest CO2 emission rate per passenger of any form of transport. Given this clearly there is plenty of scope to improve the CO2 emissions from this sector.

34.12 The high energy density required for flight is the prime reason for the use of high CO2 emitting aviation fuel. Unfortunately, the low energy densities of hydrogen and batteries and high costs relative to aviation fuel mean that significant technological advances will need to be made before they are cost effective options for decarbonising aviation. Hydrocarbon and synthetic fuels are likely going to need to be used in the meantime to assist in lowering CO2 emissions.

34.13 Similar to aviation and HGV vehicles much of marine and shipping requires a power source that has a high energy density. Potentially substitute fuels for this mode of transport that are low in carbon could help reduce CO2 emissions in this area. Currently there are no zero emission technologies in this sector so the need for low carbon fuels in this area will be important in reducing its CO2 emissions in the meantime.

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[142] https://www.bioenergy-news.com/news/generators-of-biomethane-can-claim-rhi-and-rtfo-payments/

[143] http://adbioresources.org/about-ad/government-policy/financial-incentives/

34.14 The main issue with marine / shipping moving to low carbon fuels is going to be that they are going to be more expensive which will make the transition more difficult to affect in a highly competitive market.

9. Other Issues:

a. Security of Supply

Q36. What specific risks to security of energy supply are likely to emerge as a result of our changing energy mix, and what actions can be taken to mitigate these?

Q37. What measures or indicators could be adopted or developed to monitor energy security of supply?

b. The Role of Data

Q38. What is the most cost-effective method of capturing consumer energy usage data in electricity and natural gas (where meters are in place)? In heating oil (where there is no metering obligation)?

Q39. What concerns need to be addressed regarding data privacy, security and/or ownership?

Q40. What are your views on applying the key recommendations of the Energy Data Taskforce for NI?

Q41. What organisations or businesses do you see as having a key role in optimising the value of data? How will they do this?

c. Carbon Capture and Storage

Q42. What steps, if any, should NI policy-makers consider with regard to the development or implementation of CCUS in NI?

42.1 Devolved Responsibility

Carbon capture and storage is an area along with nuclear energy that the NI government does not have responsibility for. Therefore, NI policy-makers will need to co-ordinate their development and implementation in this area with the rest of the UK government.

However due to the essential need to promote carbon capture technology it would be beneficial if energy or other projects supported by carbon capture achieved priority status or financial incentives.

42.2 Definition

CCUS stands for carbon capture usage and storage. It mitigates fossil fuel, industrial processes and other emissions to global warming by capturing and using or storing the carbon dioxide (CO2) before it is released into the atmosphere. Typically, the carbon dioxide is captured and then transported and stored underground in oil or gas fields or in deep saline aquifer formations. It is also possible for the CO2 captured to be used in industrial processes (e.g. the production of cement) or in the production of new products (e.g. biochar).

42.3 Examples Of Carbon Capture And Storage

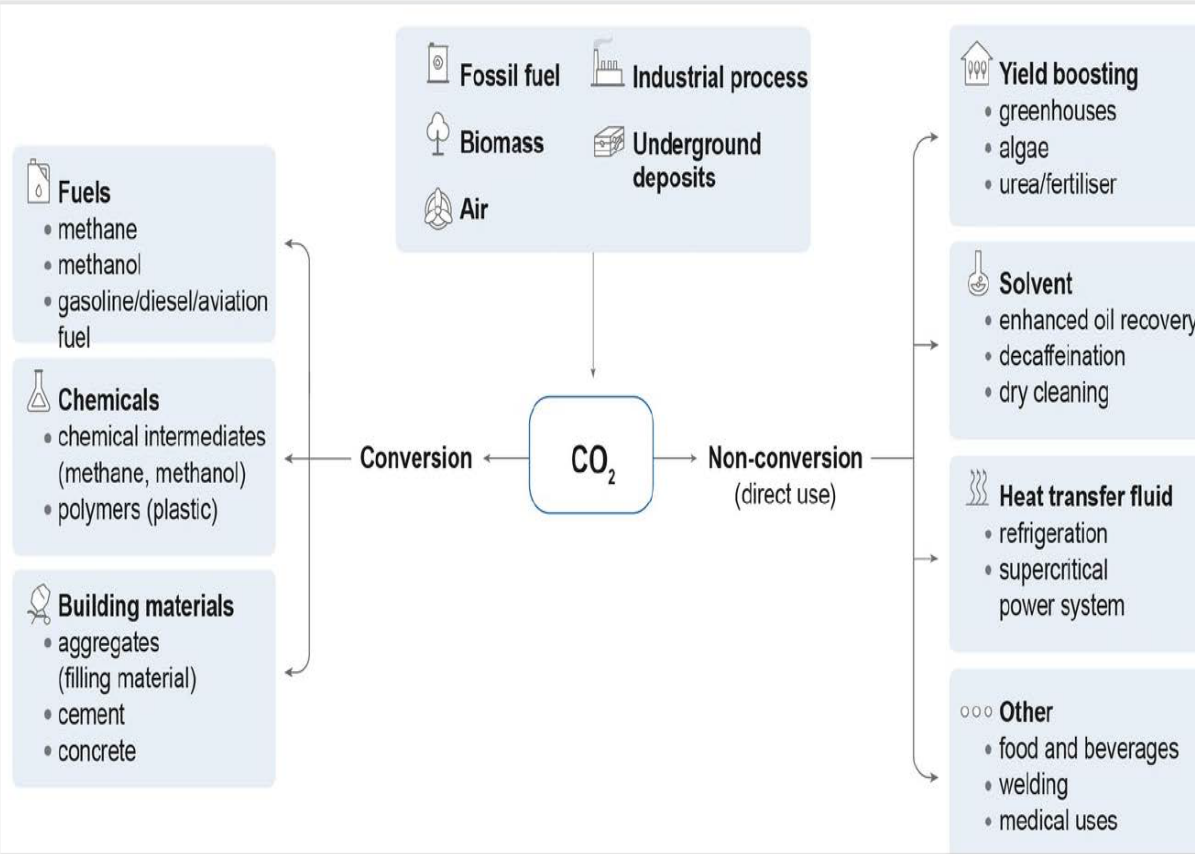
Examples of carbon capture and storage projects around the world are as follows: -

- **Terrell Natural Gas Processing Plant – US – From 1972** CO2 has been captured during gas processing and transported via pipeline where it is injected at Sharon Ridge oil field for use in enhanced oil recovery (EOR)[144].
- **Enid Fertilizer – US – From 1982** CO2 is captured in a high purity byproduct of nitrogen fertilizer. The process is made economical by transporting the CO2 to oil fields for EOR[145].
- **Shute Creek Gas Processing Facility – US - From 1986** 7 million tonnes of CO2 is recovered from gas processing which is transported by pipeline to oil fields for EOR[146].
- **Sleipner CO2 Injection – Norway – From 1996** it is expected that 600 billion tonnes of CO2 can be stored in the Ultsira saline aquifer. This is the first project to inject captured CO2 for storage rather than for EOR reasons[147].
- **Abu Dhabi – United Arab Emirates – From 2011** is the first commercial carbon capture and storage (CCS) facility for the iron and steel industry. The CO2 captured is transported for EOR[148].

42.4 Examples Of Carbon Capture And Use

Perhaps one of the more promising areas is the focus on using the CO2 rather than storing it. The IEA summarises the potential and current uses for carbon capture and usage as set out in the figure below.

[144] https://web.archive.org/web/20180721134809/http://www.globalccsinstitute.com/projects/val-verde-natural-gas-plants
[145] https://sequestration.mit.edu/tools/projects/enid_fertilizer.html
[146] https://sequestration.mit.edu/tools/projects/la_barge.html
[147] https://web.archive.org/web/20110721193257/http://www.co2captureandstorage.info/project_specific.php?project_id=26
[148] https://sequestration.mit.edu/tools/projects/esi_ccs.html



42.5 Need For CCUS

The Committee for Climate Change considers it to be an essential element of decarbonising[149]. The International Energy Agency (IEA) see CCUS contributing 13% of cumulative emissions reductions required which is third largest contribution to emissions reductions behind energy efficiency (39%) and renewables (36%). There are many reasons why CCUS is required as part of the energy transition as detailed below: -

- **Cost -** the IEA consider that even limiting CO2 storage will substantially increase the cost of the energy transition (an additional USD4 trillion of investment for the world[150] or 40% higher cost of investment) in the power, industrial and fuel transformation sectors.

- **Need For Negative Emissions –** For some industries such as aviation and agriculture it appears that it will be almost impossible to cut emissions to zero[151]. Therefore, the use of bio-energy with carbon capture and storage (BECCS) that can result in negative emissions will be needed to help compensate for industries and areas that are hard to decarbonise such as aviation.

[149] https://www.theccc.org.uk/publication/reducing-uk-emissions-2019-progress-report-to-parliament/
[150] https://webstore.iea.org/exploring-clean-energy-pathways
[151] https://www.carbonbrief.org/uk-could-become-net-zero-by-2050-using-negative-emissions

- **Greater Diversity In Generation Options**

o All modelling and projections suggest that demand for electricity is going to increase in the future with the electrification of cars and other areas of transport that lend themselves to it and also from electric heat pumps to provide space heating.

o Generating electricity only from renewable sources such as wind and solar given their inherent intermittency would lead to real issues with balancing the market and lead to a need to store electricity in batteries etc. that is likely to be very expensive.

o CCUS offers electricity grid operators the option of using CCGT facilities in the future to generate electricity in times of low renewable electricity generation.

o Without CCUS a higher level of solar and wind generation will need to be produced with consequent issues with land (a 100 MW solar installation requires 100 hectares of land) [7].

- **Solution For Deep Emissions From Key Industrial Processes**

CCUS offers solutions for deep emissions from hard to abate industrial processes such as iron, steel, cement and chemicals production. Two thirds of emissions from cement production for example are process driven and in a CO2 free future the alternatives to CCUS to resolve the issue would be very expensive[7].

- **Infrastructure For Further Developments**

The development of CCUS is likely to aid and assist in the development of related developments and technologies that will assist and help reduce CO2 emissions.

42.6 Using CO2 is not the same as it being avoided. Using the CO2 generally reduces emissions but not always. The carbon retention period varies by product. The IEA considers that CO2 used in fuels for example is less than a year whereas in building materials could be millions of years[152].

42.7 Using CO2 should be seen as a complement and not an alternative to storing CO2. The IEA considers that using CO2 in a future where CO2 storage is limited would deliver less than 13% of emission reductions that storage would otherwise provide[142]. The areas it should be used in are where it can deliver the most cost competitive products that can retain CO2 the longest (for example in building materials).

42.8 Carbon Capture And Storage

Given that using CO2 has a role in complementing CO2 storage most focus should be given to carbon capture and storage. Capturing and storing carbon are clearly then the main steps in the CCUS process. Both present different issues, challenges and in some cases opportunities.

42.9 Capturing Carbon

[152] https://www.iea.org/reports/putting-co2-to-use

The main steps to be considered by policy-makers in terms of capturing carbon are as follows: -

- Consideration of what processes carried out in NI can carbon be captured from. Capturing the carbon pre or post combustion should also be considered at this point.
- Engagement with industry to get their understanding etc. of the issues involved.
- Consider of what barriers exist to stopping the capturing of carbon and working to remove these if possible.
- Work with other government and jurisdictions to enable and encourage the development of carbon capture businesses.
- Consideration of the costs of capturing carbon and prioritisation of processes where it can economically be captured.
- Quantification of the amount of carbon likely to be captured in an average year in NI.
- Alternative solutions may need to be found for processes that CCUS is particularly expensive for.

42.10 Storing Carbon

The main steps to be considered in terms of storing carbon are as follows: -

- Consider the areas of NI that can be used to store carbon underground.
- Consider the environmental repercussions of storing the carbon in the areas identified.
- Consider how much carbon can be stored within NI and is there sufficient places to store the carbon that can be captured.
- If there are insufficient areas to store the carbon within NI then other jurisdictions and countries where it can be stored will need to be found.
- Consider what is the most efficient way of transporting carbon captured to where it is going to be stored

42.11 Key Policy Decisions & Considerations For Policy-Makers In NI

- CCUS technology and adoption initially is likely to be expensive and is likely to arise only with larger scale projects where economies of scale can be brought to bear. Therefore, it is likely that NI will be one of the later areas to use CCUS and will do so after a lead has been given on the correct route to take by GB and other larger countries.
- If the cost of carbon emissions is increased this will inevitably increase the economic case for removal of CCUS and encourage innovation and research and development in the area.
- Given the high investment costs in CCUS projects governmental support may be required to incentivise investment. Innovation in CCUS is key and government support may be required to get projects of the ground.
- Establishing a legal and regulatory framework for CO2 storage will be key. This will result in stability and transparency for operators in the sector. For example,

clarifying and perhaps capping liability in the case of leakage of stored CO2 would take away uncertainty for potential investors in the sector.

- CCUS is one of the few ways to obtain negative emissions and given the difficulty of decarbonising agriculture and the importance of agriculture to NI it is likely that the use of BECCS will be required.
- The use of biochar created from carbon capture and usage should be considered for sprinkling on land in NI to increase the carbon that soil will store[8].
- Capture and storage and use have to be matched. There is no value in capturing carbon if there is nowhere to put it underground or no use for it as this carbon will inevitably be lost to the atmosphere.
- Usage of CO2 cannot act as a substitute for storage in the short term. There are currently insufficient uses for CO2 that would store the CO2 in either the short or longer term.
- Government should consider prioritising the purchase of building materials produced using carbon capture for example. These are already cost competitive.
- Public procurement of low carbon products could create early markets for products derived from CO2.
- The development of CCUS hubs could enable costs for CCUS to be reduced as a result of economies of scale and less transportation of the CO2.
- Strong and consistent government policies will be required across all sectors of the economy to aid CCUS.

d. Energy and the Economy

Q43. What specific economic opportunities will arise from the decarbonisation of energy?

Q44. What skills are needed to realise the potential economic benefits of energy in the future?

Q45. What are your views on the future of overall energy demand in NI and how can we ensure that any potential demand growth aligns with our net zero carbon target?

e. Delivery Framework for an Energy Strategy

Q46. Do the existing division of responsibilities and powers across government enable the most effective approach to the overall aim of decarbonising energy? If not, what are your suggestions for improvement?

Q4Q7. What are the opportunities for local government to contribute to the delivery of the net zero carbon target?

Q48. What are your views on how statutory duties and accompanying legislation and regulatory frameworks would need to change to facilitate the transition to net zero carbon by 2050?

Q49. Is there a need for a dedicated organisation to champion, lead and deliver sustainable energy interventions? If so, what should this look like?

48.1 It is clear that the decarbonisation agenda will ultimately make energy more expensive for consumers. This additional cost can be kept to a minimum through choosing the correct pathways to decarbonisation. However, it is important that everybody, including the industry, government and regulators are open and transparent and admit that consumer costs will go up as we move towards a zero carbon 2050. These costs can further be mitigated through effective regulation in Northern Ireland, where the Regulator actively facilitates decarbonisation innovation which will help keep costs as low as possible for consumers, whilst meeting challenging environmental targets.

48.2 The energy market in Northern Ireland is currently regulated by the Northern Ireland Authority for Utility Regulation in accordance with The Energy (Northern Ireland) Order 2003. The Energy Order outlines several statutory duties of the Regulator. These include:

a. The principal objective of the Department and the Authority in carrying out their respective electricity functions is to protect the interests of consumers of electricity supplied by authorised suppliers, wherever appropriate by promoting effective competition between persons engaged in, or in commercial activities connected with, the generation, transmission , distribution or supply of electricity.

b. The principal objective of the Department and the Authority in carrying out their respective gas functions is to promote the development and maintenance of an efficient, economic and co-ordinated gas industry in Northern Ireland, and to do so in a way that is consistent with the fulfilment by the Authority, pursuant to Article 40 of the Gas Directive, of the objectives set out in paragraphs (a) to (h) of that Article.

48.3 Article 40 paragraphs (a) to (h) of the Gas Directive (Directive 2009/73/EC) state outline the tasks of national regulatory authorities with respect to gas are:

a. promoting, in close cooperation with the Agency, regulatory authorities of other Member States and the Commission, a competitive, secure and environmentally

sustainable internal market in natural gas within the Community, and effective market opening for all customers and suppliers in the Community, and ensuring appropriate conditions for the effective and reliable operation of gas networks, taking into account long-term objectives;

b. developing competitive and properly functioning regional markets within the Community in view of the achievement of the objectives referred to in point (a);

c. eliminating restrictions on trade in natural gas between Member States, including developing appropriate cross-border transmission capacities to meet demand and enhancing the integration of national markets which may facilitate natural gas flow across the Community;

d. helping to achieve, in the most cost-effective way, the development of secure, reliable and efficient non-discriminatory systems that are consumer oriented, and promoting system adequacy and, in line with general energy policy objectives, energy efficiency as well as the integration of large and small scale production of gas from renewable energy sources and distributed production in both transmission and distribution networks;

e. facilitating access to the network for new production capacity, in particular removing barriers that could prevent access for new market entrants and of gas from renewable energy sources;

f. ensuring that system operators and system users are granted appropriate incentives, in both the short and the long term, to increase efficiencies in system performance and foster market integration;

g. ensuring that customers benefit through the efficient functioning of their national market, promoting effective competition and helping to ensure consumer protection;

h. helping to achieve high standards of public service for natural gas, contributing to the protection of vulnerable customers and contributing to the compatibility of necessary data exchange processes for customer switching.

48.4 Whilst the Regulator is constrained by legislation as to what it can do, their remit should be strengthened significantly going forward, with references to the Directive removed in light of Brexit, and requirements for facilitating decarbonisation brought solely into domestic legislation. We would propose that the statutory duty is updated to reflect a requirement "to promote the development and maintenance of an efficient, economic and co-ordinated gas industry in Northern Ireland" as currently, but also to proactively support both the gas and electricity industries in Northern Ireland with regard to the decarbonisation agenda. This may mean permitting additional spending on decarbonisation activities in the near-term, even with the associated additional cost to the consumer, in order to allow the industry to meet its objectives by 2050 cost-efficiently.

48.5 As technology in both the electricity and gas sectors changes at pace, and new ways of using data to manage the energy grids are rolled out, it is important that the Regulator is in a position to allow these to be implemented as soon as practical. Old ways of working risk stifling the net zero transition and potentially mean that targets are missed. A 2019 report

by NESTA[153] outlines a new approach to regulation which facilitates innovation, whilst at the same time ensuring that adequate protections remain in place, called "anticipatory regulation". This approach has six principles towards regulation:

a. It should be inclusive and collaborative, engaging the public and diverse stakeholders where new technologies and how they are deployed raise ethical issues, and in leveraging the capabilities of businesses, cities and civil society to secure policy goals.

b. It should be future-facing, developing resilient, adaptive strategies that can cope with the inherent uncertainty of fast-changing markets.

c. It should be proactive, engaging with innovators and innovation early in the cycle to provide predictability and enable timely, proportionate responses to issues that may scale rapidly.

d. It should be iterative, taking a test-and-evolve rather than a solve-and-leave approach to novel problems, for which there may be no established playbook.

e. It should be outcomes-based, focusing on validating companies' efforts to achieve well-defined goals rather than setting rules, and particularly on incentivising platforms to support regulatory objectives.

f. It should be experimental, facilitating diverse responses to regulation of early-stage opportunities and risks, and where national or global policies and standards are still to be established.

48.6 In practice, this means that traditional price control methods may be a blunt tool in a rapidly changing world. If a new technology which can help move us to net zero becomes available, then roll-out should not be done according to an arbitrary timeline based on waiting for the next round of price controls if it could be done earlier. Similarly, price controls should not be overly prescriptive, and should allow flexibility, focussing more on ensuring that companies deliver on their decarbonisation objectives and commitments to consumers, rather than being overly prescriptive about how they do that. Furthermore, all companies should contribute to decarbonisation, and the Regulator needs to ensure that where required they are allowed adequate resources to deliver on this. This will require the Department to ensure that the Regulator has the appropriate resources, skills, leadership and political cover to drive this agenda forward.

48.7 As part of a move towards an outcomes-based, rather than prescriptive, regulatory approach as recommended by NESTA and others such as Imperial College London[154], measurable targets will be required. For the heating sector, a target of the percentage of total heat demand generated by zero carbon gas should be considered and given equal footing with any new renewable electricity targets to ensure that it is taken seriously.

48.8 To ensure that there are appropriate incentives in place to meet these targets, a scheme similar to the Renewables Obligation scheme previously used in the electricity market[155] should be considered. Under this scheme, suppliers of electricity had to ensure that a

[153] https://www.nesta.org.uk/report/renewing-regulation-anticipatory-regulation-in-an-age-of-disruption/
[154] https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/collaborative-publications/Reshaping-Regulation-Powering-from-the-future.pdf
[155] https://www.edie.net/library/Edie-explains-Renewables-Obligation-Certificates-ROCs/6538

certain percentage (increasing over time) of the electricity they provided was sourced from renewables. To prove this, they had to purchase Renewable Obligations Certificates (ROCs), which were allocated to accredited renewable generators. This provided renewable generators with an additional income stream on top of the money they received in the wholesale market for the energy itself. A similar scheme could see generators of hydrogen compensated on top of the price they would receive for the hydrogen gas itself. This would incentivise production of renewable gas and make it competitive with natural gas.

48.9 As the majority of greenhouse gas emissions in Northern Ireland come from agriculture and transport[156], and both of these sectors have significant overlap with the energy sector in terms of potential anaerobic digestion in agriculture and electrification/gasification of private transport, there should be a statutory duty for public bodies across all three sectors to work together collaboratively. Transitioning to a net zero 2050 cannot be done through silo working, and public bodies from these sectors must have some ownership of parts of the new Energy Strategy to ensure that it is implemented as effectively as possible.

48.10 Finally, Gas Safety Standards as outlined in paragraph X must be considered. The composition of gas in GB is likely to change significantly over the next 30 years. Gas quality standards in GB are based on the characteristics of North Sea gas and outlined in the Gas Safety (Management) Regulations 1996[157]. Northern Ireland has a separate statutory framework and NI gas standards are outlined in the Gas Safety (Management) Regulations (Northern Ireland) 1997[158]. In practice the NI regulations follow the GB regulations given the interconnection between the two jurisdictions. However, as standards in GB change[159] to move away from North Sea natural gas and incorporate gas from further afield and 'novel' gases such as hydrogen, Northern Ireland's standards may become out of step with those in GB. This means that the gas being imported via the SNIP may not meet the quality parameters laid out in NI legislation. As such, NI legislation needs to keep pace with that in GB.

10. Additional information

Q50. Is there anything else you would like to add in response to this Call for Evidence?

[156] https://www.daera-ni.gov.uk/sites/default/files/publications/daera/ghg-inventory-statistical-bulletin-2017.pdf
[157] http://www.legislation.gov.uk/uksi/1996/551/contents/made
[158] http://www.legislation.gov.uk/nisr/1997/195/contents/made
[159] https://www.igem.org.uk/technical-services/gas-quality-working-group/

The following summarises our response

An integrated view

1. Historically efforts on decarbonisation have been carried out in silos, on an industry by industry basis but to achieve large scale cost effective decarbonisation it is essential that the use of energy be considered as a whole system, incorporating heat, industrial use, transport, electricity and gas.
2. The major progress in Northern Ireland has been in two sectors, and largely dominated by two approaches. The electricity sector has decreased its co2 per kWh used, predominantly by integrating large levels of wind unto the system, up over 40% ahead of the target 2020 date. This is a CO2 saving of approximately 1.5m tonnes.
3. The gas sector approach has centred on conversion of higher co2 fuels over to gas and the industry has converted the majority of industrial load from heavy fuel oil, kerosene, and or coal, over to gas and has converted c250,000 houses mostly from oil over to gas. As oil use is not really measured the CO2 saving is harder to calculate but using the standardised calculations published by BEIS this is approximately a co2 savings of 1.3m tonnes.
4. Electricity initiatives have concentrated on reducing the carbon intensity of electrical energy, which is now down to 0.291t/MWh
5. Gas initiatives have concentrated on converting more carbon intensive energy users over to gas, as gas is one of the least carbon intensive energy sources at 0.205t/MWh, still below electricity at the household level.
6. The energy strategy must ensure that both the electricity industry and the gas industry adopt both approaches – reducing carbon content of their energy medium and conversion of energy users of more CO2 intensive fuels over.
7. Cost must be a major factor in decisions, whilst not standing in the way of the overall imperative to decarbonise. The high levels of fuel poverty and risk of businesses becoming uncompetitive and therefore closing must be taken into account.

Gas Transport Agriculture and Heat

8. The key **conversion** targets for the gas industry are, domestic heat close to the existing network and high mileage / high weight vehicles such as HGVs, buses, etc.
9. The key **decarbonisation** target is to decrease the carbon content of the gas supplied, by introducing gas from Anaerobic Digestion onto the network and moving to a hydrogen based system.
10. Early priority needs to be given to decarbonising the network as we lag far behind GB, which is the source of all our gas. As early as the late 2020s GB could be introducing Hydrogen into its grid and, unless Northern Ireland catches up, we will be in the embarrassing position of making the gas more carbon intensive before it can be used.
11. Work should concentrate on securing a supply of hydrogen and preparing the networks to take it. Hydrogen produced from electrolysis will be a major link between the gas and electricity systems.
12. In respect of conversions the gas distribution companies are set up to connect domestic properties and should be incentivised and targeted to ramp up the connection rate. A key priority will be the provision of infrastructure for transport to convert and this must also be an early priority.
13. From a cost perspective a hydrogen led approach is the most cost effective due to being more in line with existing housing stock and consumer behaviour, therefore requiring much less upfront cost and less consumer change.

Electricity, transport and heat

14. Historically electricity industry has been centred around decarbonising and the priority needs to be given to **conversion**. In particular the conversion of domestic transport to electricity should be an immediate priority.
15. Supporting this conversion requires the public infrastructure to allow consumers' confidence to purchase electric vehicles, a systematic approach to home charging incorporating the need for smart charging to ensure grid costs do not become excessive.
16. Conversion of off-gas grid properties is the most difficult challenge, largely due to the prospective costs. The priority in the early part of the strategy should be to determine the most cost-effective approach to these properties and pilot alternatives.
17. In respect of further **decarbonising** electricity, while there is clearly merit in increasing the ability of the system to incorporate more wind, it is imperative that the issue of dispatchable low carbon plant is addressed. There is a clear and obvious overlap with decarbonising the gas network as the base fuel for decarbonised plant.

Pathways not to be followed

18. As important as the paths that need to be addressed are those which should not be.
19. In our view hydrogen domestic vehicles should not be progressed at this point because:
    - There are insufficient vehicles produced at present;
    - A clear message to consumers that BEVs are the way forward will increase uptake;
    - Hydrogen infrastructure can be centred around HGVs and buses rather than public stations for vehicles
20. Similarly a heatpump solution for domestic heating on the gas network should not be progressed as:
    - The upfront costs are prohibitive;
    - The ongoing costs for customers are higher than alternatives;
    - The impact on the electricity network will be significant;
    - Logistically such a conversion program is extremely challenging

Other key points

21. Building standards for new houses must be severely tightened as soon as possible, as this is most cost effective in the long run;
22. Tariffing and incentives in both electricity and gas must be completely reworked to
    - incentivise conversion from other fuels;
    - Incentivise decarbonised energy over higher carbon emmitters;
    - incentivise energy efficiency;
    - protect fuel power households with low consumption from bearing the brunt of other changes;
    - manage the long run cost to consumers