Unite response to the Department of Energy Security and Net Zero Consultation into Hydrogen to Power - on the Need, and Design, for a Hydrogen to Power Market Intervention

1. Introduction

1.1. This submission is made by Unite, the UK's largest trade union with over one million members across all sectors of the economy, including, manufacturing, financial services, transport, food and agriculture, construction, energy and utilities, information technology, service industries, health, local government and the not-for-profit sector. Unite also organises in the community, enabling those who are not in employment to be part of our union.

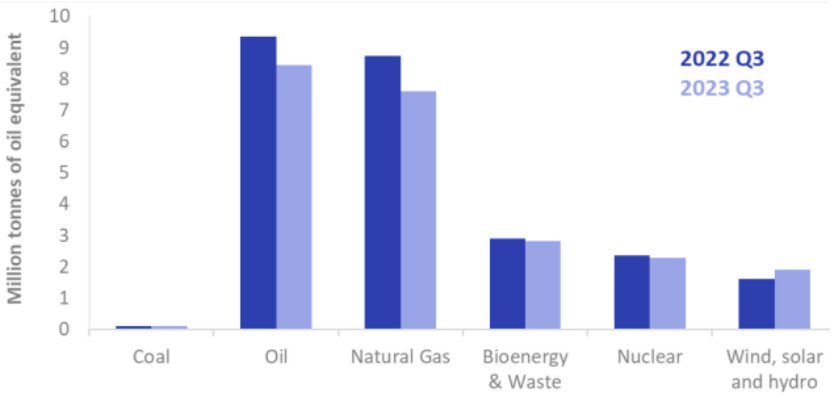
1.2. Of particular relevance, to this submission, Unite represents almost 31,000 engineers and technicians in the Energy and Utilities sector carrying out every task from the most menial to the most highly skilled engineers and scientists in the country within the nuclear energy industry.

2. Observations

2.1. According to the December 2023 energy statistics published by the Office for National Statistics, "Fossil fuel electricity generation decreased, down 31.0% largely to near a new record low because of stronger renewable generation and higher net imports from France. These imports contrast with last year where the UK was a net exporter of electricity". "The fossil fuel share of generation decreased nearly 10 percentage points to 37.0%. Final energy consumption by households fell 6.0% on the same period last year to a record quarterly low. Whilst the warmest September in our records will have contributed to lower demand, high energy and other prices also played a part". "Consumption by industrial users fell 2.0% and other final users (including commercial, public and agriculture) fell by 5.0%. Transport consumption rose by 3.0% but remains down 7.0% on pre-pandemic levels. Net import dependency increased slightly, up from 36.3% to 37.8%, similar to the annual figures from 2021 and 2022". "With European gas storage nearing capacity, the UK imported less gas for export through the pipeline infrastructure to Europe. In contrast to last year, the UK was also a net importer of electricity due to favourable pricing differentials through the interconnectors this summer".

2.2. This trend of reducing generation capacity due in part to the loss of coal fired generation and the decommissioning of nuclear power, will continue as more facilities reach a point where their life cannot safely be extended further. To put it bluntly we are running out of alternative power generation alternatives and relying on imports.

2.3. The graph highlights the scale of the challenge, given we need to end our energy supply demands on coal, oil and natural gas while it continues to produce greenhouse gasses. Biomass and Waste to energy if combined with Carbon Capture, Utilisation and Storage (CCUS) or mineralisation, can provide a way to reduce the total CO_2 footprint of the UK, but without it the carbon emissions are worse than coal.



2.4. The UK waters have the potential to generate vast amounts of near zero volumes of energy to the UK from a resource which the UK is blessed with in abundance, its tides and the difference between high and low tide (the tidal reach). While some of these options can be used to generate hydrogen either chemically or electorally some methods create huge amounts of CO_2 or have massive inefficiencies.

2.5. Once the energy is turned into hydrogen, burning it does not just produce water and power. Heating air in a confined space, at pressure, no matter what the fuel source, oxidises the Nitrogen in the air to create Nitrogen Dioxide (NO_2) and other oxides collectively known as NOX. NO_2 is a very powerful greenhouse gas whose small volume but significant impact on the global environment cannot be ignored, yet this does not appear to have been examined in the consultation or accompanying documentation. The option of using hydrogen fuel cell arrays appears to be absent also as have the useful byproducts of fuel cells – fresh water and Deoxygenated Air (DOA). In water scarce but largely arable farming areas such as Suffolk the provision of extra water would be very welcome.

2.6. The other major greenhouse gas to take into consideration is methane as it is, according to the IPPC's latest estimate, around 52 times as powerful at warming the planet than CO_2 over a 20-year time frame. While burning natural gas releases around half of the emissions of coal to obtain the same amount of energy[1], the transportation and leaks from the natural gas network add up. The latest IPCC AR6 synthesis reports[2] that methane has contributed 0.5ºC of the total global warming to date since the late 1800s, compared to 0.75ºC for carbon dioxide[3]. A major source of that methane comes from the leaks from gas networks and storage. In the USA, a recent report took the leaked methane into account when looking at the LNG exports and discovered that using natural gas could be worse than coal[4].

2.7. As stated by the IPPC "If warming exceeds a specified level such as 1.5°C, it could gradually be reduced again by achieving and sustaining net negative global CO_2 emissions. This would require additional deployment of carbon dioxide removal, compared to pathways without overshoot, leading to greater feasibility and sustainability concerns. Overshoot entails adverse impacts, some irreversible, and additional risks for human and natural systems, all growing with the magnitude and duration of overshoot".

2.8. Throughout this consultation, the author appears to assume an infinite supply of hydrogen and people to work the power supply management roles, to generate the power to keep our lights on and ensure that the UK can remain economically sound. The consultation takes no account of the demands for hydrogen from other sectors or the pull of staff away from the industry due to retirement and the lack of enough apprenticeships in these the highly skilled posts.

2.9. Unite is calling for the government to take a look at the big picture and consider the challenges that arise in the pursuit of Net Zero by 2050. Unite insists that workers should be considered a valuable resource, full of ideas, skills and the desire to power the nation, but if the tools are not available and the pathways are not established for a Just Transition, Unite fears that the industry will not be able to deliver what is needed when it is needed to remain on a path to Net Zero. Unite agrees with the Committee on Climate Change that not enough is being done and we are falling behind on targets, kicking difficult decisions into the long grass. In Unite's opinion we cannot afford that luxury.

2.10. Unite is a supporter of a diverse "mixed bag" of energy generation where no method of generation is overlooked. We believe that we cannot afford to put all or eggs into a limited number of generation methods. Every method of energy generation and storage has advantages and disadvantage. The challenge is to select methods which need a greater or lesser level of financial support to establish them in the energy sector. Equally it is vital that the UK plays its part in achieving Net Zero as soon as is practicable.

2.11. The transition from a carbon-based economy to one based on hydrogen requires a massive amount of financial support, especially from the government to force the transition quickly. The sooner we move away from a dependence on a fuel that creates greenhouse gasses the better. We have already experienced a year which was warmer than 1.5ºC[5] in 2023 so the chances of avoiding exceeding the limit set in Paris at

[1] Coal emits around 950 gCO2 per kWh generated while Natural gas emits just 350gCO2 per kWh. Based on data from the French generator RTE

[2] The IPCC AR6 synthesis report can be read by clicking here

[3] According to the IPCC the warming relative to 1850–1900 can be assessed from radiative forcing studies are: CO_2 0.8 [0.5 to 1.2]°C; methane 0.5 [0.3 to 0.8]°C; nitrous oxides (NOX) 0.1 [0.0 to 0.2]°C and fluorinated gases 0.1 [0.0 to 0.2]°C.

[4] Click here for the link

[5] Link to the BBC Coverage

COP21[6] have faded away in just 7 years due to delays and prevarication. The closer we get to 2.0ºC warmer the greater the chance of unrecoverable damage ending all life as we know it on earth. The world should therefore be on a war footing to tackle this issue as soon as possible but politics are getting in the way.

2.12. Unite therefore cannot be clearer that this transition needs to be done as swiftly as possible but also take with it the workforce which will be required to make this change possible, using every method possible that can be made to be sustainable.

3. Consultation Questions

1. What are your views on the vision we have set out for hydrogen to power?

3.1. Unite feels that the ambition needs to be greater, to ensure that there is enough hydrogen in the system, to fulfil all the plans the country has for it not just enough to provide a back-up power source. Hydrogen is being seen as the solution to all things from electrical generation to plug gaps left behind by not enough coming from renewable sources to a fuel to power aircraft on flights under 3700 km. The Committee on Climate Change (CCC) have stressed that if we fill the requirements for grid electrical power infill by using hydrogen, there will not be enough for everyone else[7] and the nation will be dependent on imports and the vagaries of the international market. The addendum to the AFRY report for the CCC, 'Net Zero Power and Hydrogen: Capacity Requirements for Flexibility'[8] highlights that "*without access to unabated gas technologies, a secure power system can be maintained through greater reliance on alternative low-carbon technologies, primarily gas CCS, Hydrogen GT and grid storage*" but this alternative would increase the overall system cost by **£1.4 billion** in 2035 if there was a phased introduction of a ban on unabated gas capacity in the power sector.

3.2. Given the section seeks to consider the wider economy Unite would highlight that in 2035, Airbus have stated that they will have their first commercial hydrogen aircraft available for operations under their ZEROe project[9] creating massive competition for hydrogen supplies as both national and international aircraft start buying up stocks of hydrogen.

3.3. Furthermore, the International shipping industry is looking to hydrogen as a fuel to allow it to move goods around the world and replace Liquid Petroleum Gas (LPG) following the release of a Transport & Environment (T&E) report[10] that highlighted how much unburnt methane is escaping into the atmosphere. Unite recognises that there are issues with this T&E investigation, in that it and parts of the shipping industry are promoting the use of ammonia which, agreed does not release any carbon into the atmosphere, it releases Nitrogen Oxides specifically Nitrogen Dioxide (NO_2) which is far worse. According to the second assessment report published by the International Panel on Climate Change (IPCC) [11], methane under this latest review is 52 times as bad as CO_2 but NO_2 is 280 times as bad over the same 20 year policy window or 310 times for NO_2 over a 100 year window while methane's relative impact over 100 years drops to 21 times as powerful.

3.4. These are just some of the demands for hydrogen coming from applications for the transport of goods and people. In addition, to these there are any number of engines being used currently to power equipment that burn fossil fuels. This could be as small as a model aircraft, drone or chainsaw, or as large as a port straddle carrier or combine harvester. Remote power units used for the construction industry or on farms as yet not connected to the grid. For this application, hydrogen is a real option, as it is portable and quickly refillable instead of the alternative of waiting for hours to recharge a battery.

---

[6] The 21st United Nations Conference of the Parties held in November 2016

[7] The report Net Zero and Hydrogen Capacity Requirements for Flexibility can be found here

[8] The report can be found by clicking here

[9] Please find details of the Airbus ZEROe project here

[10] Ther report is entitled "Methane escaping from 'green' gas-powered ships fuelling climate crisis – Investigation"

[11] The latest IPCC report can be found here

3.5. The sources of hydrogen generation in the UK currently comprise of black and grey hydrogen[12] supplies created out of coal and natural gas and a small amount of green hydrogen[13] from electrolysis. Plans to decarbonize grey hydrogen, by adding carbon capture and storage technology[14], has yet to happen. If blue hydrogen was to take off, some reports are suggesting that the emissions would be greater than simply burning natural gas[15], possibly only reducing greenhouse gasses (GHG's) by 18%-25%[16]. If the UK does rely on blue hydrogen going forward, it will forever link the price of hydrogen with the price of natural gas. Whilst turquoise hydrogen[17] provides an option to create a zero atmospheric carbon way of transforming natural gas, it too would, suffer from the same flaw. The two main methods of liberating hydrogen from Methane are to pass it through a plasma or molten metal where in the methane splits into hydrogen and carbon powder or by using a catalyst on a small or moderate industrial scale using a nickel or iron based, carbonaceous catalyst and noble metals for the creation of carbon nano materials (CNMs).

3.6. The problem is that the gasification of coal and the steam methyl reformation of natural gas (SMRNG) liberate around 20,000 Nm^3/h of hydrogen costing around US$1,934 to US$2,693 a tonne but while CDM splitting can be achieved at US$ 2,167-3,764 a tonne it will require 20 times the energy producing just 1,000 Nm^3/h[18]. The benefit is that while Coal gasification releases 29.01 tonnes of CO_2 to liberate a tonne of hydrogen and SMRNG will release between 11.04 and 12.49 tonnes of CO_2 per tonne, the CDM method will only cause the release of 6.6 tonnes of CO_2 per tonne of hydrogen.

3.7. Consequently, while "*capacity could be deployed through existing markets, primarily the Capacity Market (CM)*", Unite believe this is a terrible idea. Do not believe there needs to be a clear source of deployable hydrogen generation using green avenues, such as electrolysis of water or ammonia using renewable[19] or nuclear[20] over generation[21]. While the prospect of hydrogen created from solar generation in the Sahara, for example, appears attractive, the use of this resource will come at a premium, due to the transportation cost.

2. In your view, what role should hydrogen to power plants be playing in the power system? Please provide details and an explanation of your reasoning.

3.8. In a market where there is enough hydrogen to be used to provide power and a backup supply, Unite firmly believe in hydrogen fuel cells, should be used to provide power to the grid. This is provided that a way could be found to produce hydrogen fuel cells them more economically. This would not just create hydrogen and fresh water but also DOA. DOA is a combination of gasses which can be used as a fire extinguisher, to replace the use of CO_2 extinguishers as it is air without the oxygen needed for combustion.

3.9. What is of concern to Unite, is plans to simply use the combustion of hydrogen instead of Natural gas in a Combined Cycle Gas Turbine (CCGT) power station. When a fuel, even hydrogen, is burned in air, it does not just create water and DA but also due to the heat and pressure. This heat and pressure causes the Nitrogen in the air to combine and form NO_2[22], which understandably raises concerns as NO_2 is a very powerful greenhouse gas. Therefore, any continued use of gas turbine facilities would not only need to capture and store the generated CO_2, but, if there is a blend of hydrogen and natural gas in the supply, also capture and an equivalent value of carbon via nature based or industrial methods to capture and store carbon.

---

[12] Please see in the below appendix a list of the rainbow of colours to describe the hydrogen generation techniques.
[13] Please see in the below appendix.
[14] To create Blue Hydrogen as described in the below appendix.
[15] According to a report by Robert Howarth, professor of ecology and environmental biology at Cornell & with Mark Z. Jacobson, professor of civil and environmental engineering at Stanford – click here for the report
[16] See the times report from November 2021by clicking here
[17] Please see in the below appendix a list of the rainbow of colours to describe the hydrogen generation techniques.
[18] According to a recent paper by Safia Hameed and Elisabetta Comini of the Department of Information Engineering, SENSOR Lab, University of Brescia and INSTM UdR Brescia, Italy
[19] Yellow hydrogen as described in the below appendix.
[20] Pink hydrogen as described in the below appendix.
[21] This is where these energy sources produce more energy than is required by the National Grid.
[22] See the Royal Society of Chemistry article on Environmental Science: Atmospheres Click here for the link

3. Do you agree with our assessment that less CAPEX-intensive plants and/or plants with ready access to low carbon hydrogen fuel could deploy in the short term without bespoke support? Please provide an explanation of your reasoning.

3.10. Unite would firstly be concerned as to the source of the "low carbon hydrogen" fuel and as highlighted above how the hydrogen was deployed. If there is reason to suppose that the source of the hydrogen or the deployment would cause an impact on the environment, then there would be the need to intervene. If there was not any impact on the environment or a carbon negative impact, then the contrary would be true.

3.11. Unite is understandably concerned as to the future of workers at these existing CCGT power stations as we would wish them to have a long and productive future in the industry, and hence if we were not able to continue using these power stations then Unite would want to see a Just Transition to other opportunities, to preserve their very specialised skillsets, that we are sure , will be in demand elsewhere in the energy sector.

3.12. It has been highlighted in the press[23] that 2023 was the first year when the global average temperature exceeded 1.5ºC above the levels found in preindustrial times[24]. According to the Sharm el-Sheikh Implementation Plan the UNFCCC COP27 agreed to reduce emissions by 43 per cent by 2030 relative to 2019 levels[25]. At the current pace of change globally this challenge of keeping emissions below 1.5ºC continues to look unlikely, and now the world has to look to mitigate damages and reduce the volume of greenhouses gasses released so that we return to below 1.5ºC before the end of this century, ideally far sooner.

4. What are your views on our proposal to enable hydrogen to power (H2P) plants to compete in the Capacity Market as soon as practical?

3.13. Unite is committed to support efforts to reduce emissions. The move to use hydrogen in existing gas turbine facilities to reduce the carbon impact, is something that could achieve a swift reduction of emissions if the source of the hydrogen did not result in an increase in overall carbon footprint volumes. Due to the issues liberating hydrogen and the lack of green hydrogen supplies, Unite remains concerned that the end-to-end emissions are not higher than if the turbines continued to operate on natural gas. If the source of the hydrogen is indeed green, then Unite is minded to agree, that this should be allowed to compete in the Capacity Market as soon as is practicable. Such a move will hopefully enable the reduction of emissions from the UK economy and will form the platform necessary to move away from all forms of fossil fuel use.

3.14. Unite feels, however that the move to just use existing CCGT's would be short sighted as this could cause an increase in the volume of NO_2 production given the increased calorific value of the gas being used as fuel at the turbine and when generating the steam for the SMR hydrogen production facility, if this is the method of hydrogen production. If NO_2 volumes increase even slightly this could wipe out the savings from the abolition of CO_2, given the difference in the relative warming potential.

3.15. Unite would therefore welcome further investigations to see if this fear over Non-CO_2 impacts is warranted. If so, then Unite would not support the move to use blue hydrogen in CCGTs. Instead Unite would call for the retained use of natural gas turbines until there is enough pink, green or turquoise hydrogen to warrant the move. Unite suggests that a move to hydrogen CCGTs would also need to be temporary, until there are enough hydrogen fuel cells connected to the network. Given fuel cells avoid the concerns over NO_2 Unite feels this would be a more long-term sustainable option. A move to hydrogen fuel cells would also eliminate the need to maintain a turbines spin, just in case it's output is needed to balance the grid, as the output from a fuel cell is instantaneous.

5. Are there any additional changes to existing markets which could support the deployment of hydrogen to power?
Please provide details and an explanation of your reasoning.

---

[23] Click here to see the BBC article

[24] By pre industrial the UNFCCC means the period from 1850 to 1900. See the Sharm el-Sheikh Implementation plan text.

[25] See section IV on Mitigation para 15

3.16. As the aim is to reduce the release of greenhouse gasses, not just CO_2, Unite would suggest the inclusion of all greenhouse gas releases in the UK emissions trading scheme (UKETS). The European Union will be incorporating measures to include Methane and NO_2 releases in their scheme from 2026. Unite is led to believe that these gasses will be charged at their equivalent impact on the climate over the next 20 years according to the latest IPCC estimates. i.e. a tonne of NO_2 would cost 280 times the cost of a tonne of CO_2. As the EUETS cost for a tonne of CO_2 is currently €56.24 a tonne under the EUETS and a under the UKETS is £ 36.32 a tonne[26], this would mean that a tonne of NO_2 would equate to €15,747.20 or £10.169.60 per tonne. Equally any escaping methane would similarly cost €2,924.48 per tonne or £1,888.64 per tonne. If these costs were factored into the end-to-end price and the same method applied to alternatives, then hopefully it will still sit in a far more favourable position that unabated releases of these gasses from rival methods of electrical generation. The scale of these charges under the UKETS should also further encourage investment to decarbonise across the sector.

6. Do you agree with the risks and barriers to hydrogen to power deployment that we have identified? Please provide an explanation of your reasoning.

3.17. Unite would not agree with the assessment in that it focuses on the impact on the energy sector in isolation without considering the demands for hydrogen from the likes of transportation, back up power supplies, agriculture, etc. Unite is concerned that the price of hydrogen will climb rapidly due to high demand and a lack of enough UK generation.

3.18. Aviation from 2035 will rely on hydrogen for all its short and medium haul flights to Europe (<3,700 km) and yet more for the creation of drop-in Sustainable Aviation Fuels (SAF). Without hydrogen and SAF there is no prospect of the civil aviation industry continuing and reaching net zero as battery electric aircraft can at best carry 9 people 1,610 km[27] or larger numbers but over far shorter distances. Enough to connect the highlands and Islands of Scotland but not enough for the budget airline flight to Spain.

3.19. Shipping is looking at hydrogen as a fuel as it can be stored as a metal hydride as ballast in the hold, using less than half the space of an armoured liquid hydrogen fuel tank[28]. This is the safest method of storing hydrogen and may be already found in laptops as part of a nickel -metal hydride battery. Using an array of fuel cell and wind assistance, it would not be impossible to complete around the world voyage. The internal volume of a CL-400A metal hydride container is 0.7 litres but that can hold 400 litres of hydrogen more than 500 times the size of the container. Multiply that up several times and you can see why navy's have used metal hydrides as the way of fuelling submarines instead of nuclear generators. Three Gorges Hydrogen Boat No.1 was the first hydrogen fuelled boat launched by the Chinese the vessel has a maximum range of 200 kilometres, and it is powered by a 500-kilowatt hydrogen fuel cell to replace the 103.16 tonnes of fuel oil it previously burned through each year[29].

7. In your view, what should industry's role be in addressing the barriers that we have identified? Please provide details and an explanation of your reasoning.

3.20. Unite believes that the barriers to energy sector use of hydrogen are simply down to the supply issues. There clearly needs to be further investment into green hydrogen production and energy generation from nuclear and renewables and its use to store the energy that has been over generated, beyond what is required by the grid by renewables, for later infill use.

3.21. Unite is aware of various methods to convert electricity to hydrogen but until recently was not aware of any method that could complete this transformation with 100 percent conversion. Solid Oxide Electrolyser Cells (SOEC) produces hydrogen at nearly 90 percent electrical efficiency without excess heat and can reach 100 percent efficiency when using excess heat[30]. Given the portability of and scalability of such a design these can be set up just about anywhere but would best be used at a location where there is a supply of waste heat, like a nuclear power station, pottery, metal foundry etc.

---

[26] Prices based on those at 14:00 on the 14/0202024

[27] https://builtin.com/transportation-tech/electric-plane

[28] Please see the Fuel cell Store article on Metal Hydrides by clicking here

[29] Please Click Here for the link to the article in the Global Times

[30] Please click here to see the Fuel Cell Energy website and their SOEC spec sheet

3.22. As stated, Unite believes there is a secondary product that could be explored as a direct replacement for CO_2 fire extinguishers, further limiting the ways in which the gas could enter the atmosphere. This would provide a way to offset and recover the initial cost of fuel cell arrays.

8. Are there any other potential risks and barriers that we should be considering? If so, which ones? Please provide details and an explanation of your reasoning.

3.23. Unite believes that the main risks are associated with converting more natural gas to hydrogen. While this is feasible using SMR the process is dirty and damaging to the environment. If the science can be moved from the laboratory in a way that does not produce CO_2 using catalysts, electric plasma or molten metal etc. Further linking the supply of hydrogen to natural gas prices could be problematic but would save jobs in the offshore rigs and provide a source of another valuable raw material for agriculture, industrial applications, including filter manufacturers, industrial diamonds, Graphene nanotubes and even the owners of aquariums.

3.24. Unite believes also that the development of new technology such as that which has been developed by the likes of Graforce et al , provide opportunities which might offer potential if they can be scaled up.

3.25. The issue is going to be one of electricity generation capacity especially given the delays to the nuclear programme, caused by the development of Hinkley Point C. It is hoped that if all the lessons learnt at Hinkley point can be applied to Sizewell C the construction phase could be completed ahead of schedule while maintaining the levels of precision, remaining within tolerances. Unite feels that the nuclear industry cannot wait for one power station to be completed before the next begins as there is a limit to the number of times an aging nuclear station's life can be extended. Eventually the repairs will become too extensive and the stations will join those on the path to decommissioning, leaving a gaping hole in the power generation capacity.

3.26. The final and largest issue is the provision of skilled personnel. When a facility closes, it is frequently impossible for a family to follow the need to relocate for work. Power station workers are highly skilled and possess a wealth of knowledge that is very difficult to replicate in a new apprentice without a degree on mentoring. The problem faced is that numerous engineers are departing the sector without the opportunity to pass on the years of knowledge to a new starter. Given the age profile of the industry in general, Unite fears that there will not be the staff with the skills ready to fill the shoes of their colleagues that are leaving.

9. Do you agree with our assessment that bespoke hydrogen to power market intervention is required to mitigate our identified deployment barriers and accelerate the deployment of hydrogen to power plants, likely those which are more CAPEX-intensive? Please provide an explanation of your reasoning.

3.27. Unite is minded to disagree with the assessment, as it applies within the boundaries of the scope of the investigation. As an interim measure, until the investment can be found, to construct a series of hydrogen fuel cell arrays, then use of blue hydrogen into natural gas power stations is a way to deliver hydrogen to power relatively cheaply with the minimum of investment but it is far from sustainable. The problems remain, however, with leaking methane, CO_2 while there is a blend of hydrogen and natural gas and with the creation of NO_2. Any use of hydrogen from a green source will reduce the net greenhouse gas emissions, but so far not much appears to be happening on NO_2, despite the massive greenhouse gas potential impacts.

10. Have we considered all credible market intervention options for hydrogen to power?
Please provide details of any design options you think we may have missed and explain your reasoning.

3.28. Unite would note that if this analysis included so called "extensive stakeholder engagement" that this should have included all trade unions in every industry not just a select few contacts. Despite this Unite believes that if you limit the scope of the analysis, the conclusion is a reasonable assessment regarding market interventions. If you do not limit your scope and include other forms of renewable energy[31] and other colours of hydrogen from the spectrum that is out there this analysis is not reasonable.

[31] There are other forms of carbon neutral energy generation including tidal barrage, tidal stream and wave that can be predicted.

3.29. This analysis does not consider a renewable that will always produce a predictable known volume of generation year in year out that could be produced and delivered from tidal stream generation. The assessment only considers wind and solar generation when it talks about renewables, stating that renewables are unpredictable. Tidal stream[32] and tidal barrages are known renewable ways of capturing the energy of the tides, to power the electrolysis of water, in a way that is highly predictable and is not subject the whims of the weather. Paired with a power to hydrogen to power storage facility, that could regulate the flow of the electricity to the grid by storing the power of the tides as hydrogen and then releasing it through a fuel cell so it can be provided when needed. To provide tidal stream generation, one only requires something that looks like an inverted wind turbine, only with shorter fatter blades, in a location with a strong tidal reach/flow, such as the Bristol Channel or Menai Strait. Water is around 784 times as dense as air near the surface and therefore only needs a turbine 784 times smaller than a wind turbine to create the same amount of power. Tidal stream will not interfere with shipping if located away from the main routes into port, an issue that tidal lagoon or barrage projects have suffered from in the past.

3.30. The UK is at the forefront of tidal stream development in terms of active installed capacity, capacity under development and the number of tidal stream technology developers based in the country and yet the analysis in the consultation has taken the blinkered view that all renewables are unpredictable. This is clearly not the case. If a greater focus was given to tidal stream, then renewable energy would not be as unpredictable. Even without the buffering from hydrogen storage of energy and the release through fuel cells, tidal can be managed as the tide does not change at the same time at every point around the UK coast, which is home, by the way to some of the largest tidal reaches in the world.

3.31. Then the analysis only considers green and blue hydrogen but does not look at the Turquoise hydrogen methods of converting natural gas to hydrogen and black carbon powder. In theory, this could potentially include generating Turquoise Hydrogen at steel plants and other facilities where there is a molten metal. Another option is to liberate hydrogen from animal waste and human sewage, using a substance we sadly have too much of. Among the other methods is the catalytic conversion using metals like nickel. Unite believes that more needs to be done to explore the potential of these options which appear to have been ignored in this assessment. Turquoise hydrogen liberation techniques offer a future which concerts fossil fuels to solid carbon and hydrogen offering a way to continue to extract fossil fuels without the deposit of greenhouse gasses into the atmosphere, saving jobs and providing an option to provide additional hydrogen supplies.

11. Do you agree with our shortlisted three market intervention design options? Please provide an explanation of your reasoning.

12. Have we accurately identified the benefits and risks of a DPA-style mechanism? If not, are there any further benefits and risks to consider?
Please provide details and an explanation of your reasoning.

13. Do you agree with government's assessment that a mechanism based on the Dispatchable Power Agreement is the most suitable option for bespoke hydrogen to power market intervention to support the accelerated deployment of hydrogen to power?
Please provide an explanation of your reasoning.

3.32. Unite believes that a Carbon Market plus (CM+)[33] auction option, as defined in the consultations accompanying report of capacity payments, would serve to support low greenhouse gas options, is the front runner, in the union's view. This would mirror the way the electrical supply industries auction, allows the government to select the most environmentally sound options to generate power. This has its advantages in a free market environment as only the preferred supplies can obtain capacity payments. Unlike the supply of electricity through the grid where there is only a limited number of alternative ways to access the market for electricity, this would not stop the hydrogen being sold to industry without these payments, so it has this flaw. Additionally, the current energy market has allowed energy companies to make record profits while more have fallen into fuel poverty so Unite would not favour a market intervention that could a/ be circumvented and b/ allows profiteering while others suffer.

[32] For a fuller explanation of tidal Stream click here

[33] Click here to view that report

3.33. The Revenue Cap and Floor option means that the regulator is expected to collect overpayments and make good underpayments if the return exceeds a defined ceiling or drops below a specified floor. This would potentially prevent windfalls but at the same time ensures that there is a guaranteed minimum income. This would provide a reasonable compromise if it was able to support only industrial methods that are sustainable.

3.34. Unite agrees that a Dispatchable power agreement (DPA) as is proposed for Power CCUS projects to include two payment streams is a good intervention option. This variable payment, that is paid per unit of output, could be applied to other sectors of the economy including the potential to generate turquoise hydrogen. This would not be Unite's first choice, as it does not appear to provide a known minimum level of support, nor does it consider the vast array of alternative methodologies to create hydrogen sustainably. The other element is an availability payment, is paid per unit of capacity, that is available over time, regardless of its dispatch.

3.35. Out of these three options Unite would favour a blend of CM+ and Revenue Cap and Floor to provide those providers who can demonstrate green credentials with a floor price to help them compete. If it could equally rain in profiteering all the better. In an ideal world Unite would prefer a nationalised energy system which would avoid the need for any market intervention.

14. What are your views on the need for a Variable Payment? Please provide details and an explanation of your reasoning.

3.36. Unite believes that a variable payment would be a necessity, to favour new entrants and more sustainable options, than just blue hydrogen generation. Basing all the payment simply based on capacity to supply means that regardless of use in Hydrogen to Power, the industry could guarantee an income from a facility that in theory has capacity to supply hydrogen and when it is not the supplier could support some other industry on an interruptible supply contract. Unite views that as having the cake and eating it option. If all the payments were only based on capacity what is to stop a facility sitting in mothballs with staff on call, zero hours contracts. Only called in if the supply from that facility was required. This would mean the owners would be rewarded just for owning the facility and not for their efforts.

15. Have we accurately identified the benefits and risks of a Split CM? If not, are there any further benefits and risks to consider?
Please provide details and an explanation of your reasoning.

3.37. Unite believes that there are other risks and benefits that have not been identified by the consultation, as we have identified elsewhere in this response, not least of which is the potential for the government to under fund the industry and not attract the investment to over supporting the industry and permit the industry to make excessive profits to the detriment of the consumer.

16. Do you agree with our proposal to discount the Split CM as an option for bespoke hydrogen to power market intervention to support the accelerated deployment of hydrogen to power?
Please provide an explanation of your reasoning.

3.38. Unite believes that there is a need for rapid deployment of hydrogen at scale if we are to move from a situation that where the UK is wholly dependent on imports. Unite feels that this is still the best option to attract investment.

17. Have we accurately identified the benefits and risks of a Revenue Cap and Floor? If not, are there any further benefits and risks to consider?
Please provide details and an explanation of your reasoning.

3.39. Unite feels that the revenue cap and floor has many benefits in that it provides a platform for investment with a guarantee of a minimal return on investment. Unite has identified elsewhere in this response risks which have been overlooked.

18. Do you agree with our proposal to discount the Revenue Cap and Floor as an option for bespoke hydrogen to power market intervention to support the accelerated deployment of hydrogen to power? Please provide an explanation of your reasoning.

3.40. Unite believes that it is not the best possible option but it is better than some options for the reasons set out elsewhere in this response.

19. What is your view on the need for price-based competitive allocation within/between bespoke business models versus moving assets straight to a technology-wide competitive market? Please provide an explanation of your reasoning.

3.41. Unite does not wish to comment on this beyond highlighting that the union does not believe in the market led / industry knows best option as that thinking has failed repeatedly in the past.

20. How should a bespoke hydrogen to power business model be evolved to promote competition between low carbon flexible technologies?
Please provide details and an explanation of your reasoning.

3.42. Unite does not wish to comment on business models for promoting competition given we are supporters of a nationally owned power network. Unite believes that competition only drives a race to the bottom, reducing workers' rights, salaries, promoting job insecurity, etc. The idea that business knows best has failed time after time causing delays and prevarication.

21. What are your views on the alignment of hydrogen support and policies needed to enable the deployment of hydrogen to power capacity.
Please provide details and an explanation of your reasoning.

3.43. As highlighted Unite would wish to see an end to end assessment of the total carbon footprint of any changes to the energy network. If it can be shown that splitting natural gas into hydrogen and black carbon or CO2 with CCS and then burning increasing volumes of this hydrogen in a CCGT would result in lower greenhouse gas emissions thus lowering the total warming potential, then Unite would support the change. If the move to create green hydrogen is large enough to provide the enough volumes for CCGT then Unite would support this too, as long as, it would result in lower greenhouse gas emissions.

3.44. Unite remains to be convinced that the policies to promote hydrogen generation infrastructure is fit for purpose and will result in more sustainably sourced hydrogen, produced, transported, and stored. Capital and revenue support for hydrogen would need to be at a level that it would divert investments from elsewhere in the economy that are providing lower returns or greater insecurity. If the funds are promised but do not materialise then the investment will not deliver. One only needs to look at the government support for solar to see how a scheme to help households can be perverted to support solar farms.

3.45. On hydrogen transport, Unite remains unconvinced that the transportation can be achieved by blending hydrogen and natural gas, given the amount of metal pipe remaining in the supply grid. Transport to remote location by tanker, lorry or boat would be the same regardless of the gas or fuel oil being transferred. The only difference would be the storage system and method of transfer between the tanks. In the case of oil burning domestic boilers or industrial furnaces, the boiler/furnace would need replacement, and this is something the homeowner or business will need some support to achieve.

22. Do you have any reflections on the feasibility of hydrogen producers, or qualifying offtakers, to facilitate the volume of storage required for hydrogen to power – for example, regarding sourcing finance/capital? Please provide details.

3.46. On hydrogen storage, the infrastructure would be needed to deliver the hydrogen to the point of storage or use. Providing storage elsewhere would simply be a waste of energy to transport or pump the hydrogen to a third location, unless this facility is exceedingly capacious and used as a reserve. As highlighted Unite would recommend conversion of the hydrogen to a metal hydride storage due to the increased safety and reduced cost of armoured storage tanks. Unite would not recommend repurposing existing caves previously used for natural gas storage as exposure to any sulphur would case the loss of hydrogen and the creation of hydrogen sulphide, a highly corrosive gas especially if it gets wet.

3.47. Unite is aware of several companies that already provide an all-in-one solution that uses and electrolyser, hydride storage and fuel cell combination using sunlight to generate both the electricity and heat to increase the efficiency of the panels and electrolyser system. Given the transportability and scalability of such systems they could be delivered just about anywhere to store excess generation until needed[34]and potentially have more efficiency, capacity and capability that a battery storage alternative, thereby replacing the need to transport and store hydrogen over distances. Nonetheless few if any have realised the potential of the DOA.

3.48. These scalable solutions require one thing, a decent national grid connection to either draw power from or deliver power too. If these were infinitely scalable, the only delivery network required would be the national grid given the ease to generate hydrogen where it is needed rather than shipping the gas all over the country, which would eliminate the potential for leaks.

23. What are your views on the feasibility of developing commercial arrangements between hydrogen producers, storage providers, and electricity generators that meet the Hydrogen Production Business Model (HPBM) requirements relating to Risk Taking Intermediaries (RTIs)?

3.49. Unite would consider the prospects good if the correct commercial arrangements are entered into early enough. The race to provide solutions has already started with several nations manufacturers making early bids for the development of equipment to generate the hydrogen where it is required and use hydrogen as a method to create electrical power storage. The question remains as to how much the UK government is willing to invest in companies willing to provide competitive solutions.

[34] An example of such a system is the Power 2 Power produced by GKN

4. Conclusion

4.1. As highlighted Unite is highly supportive of a transition to a hydrogen-based economy. Unite would like to see this transition combine the benefits of every workable option which will achieve the goal of a diverse balanced mix of energy generation methodologies which will achieve the goal of delivering on the transition achieved as swiftly as possible. As stated, Unite would want this transition to happen in a just way to ensure that no individual is left behind. The challenge is too large to allow skills to go to waste, but equally there needs to be enough apprentices to fill the shoes of those who retire or die in service.

4.2. The financial cost of this transition should not be viewed as an issue given the alternative, but an opportunity to export UK technology and ideas by demonstrating what can be done, to nations dragging their heels. If someone has started work and has not retired in the meantime, there are just 5,708 working days until 01/01/2050[35]. This may sound like a lot, but it will, very quickly, tick away, especially if you consider that a typical apprenticeship lasts four years and the number of roles that need to be filled to reach net zero, are far larger than the number currently employed.

4.3. Unlike natural gas, there are any number of ways to create hydrogen where it is needed, requiring nothing more than a catalyst or some electricity. Methane generation takes time and something to rot down, but the conversion is dependent on the amount of material you have and the space of the digestor or landfill site. Hydrogen however can be created instantly, and it is claimed that it is possible to convert electricity to hydrogen and hydrogen to electricity with minimal losses. As such hydrogen-based storage and transportation of energy would appear to be far more practical than huge anaerobiotic digestors.

4.4. If the grid is incapable of delivering the power to where it is required as in a vehicle hydrogen appears more practical than batteries as the fuel cell will last far longer than any vehicle, unlike a battery which creates a literal mountain of issues especially when it comes to the recycling of the materials. The major concern with hydrogen is how it is generated, stored, and deployed.

4.5. Unite supports hydrogen to power delivery but has concerns about the end-to-end greenhouse gas footprint. If grey hydrogen is being delivered to a CCGT and blended with natural gas the result could be an increase in the greenhouse gas footprint rather than a reduction, due to the need to use some gas to create the steam for the SMR process. If the method of generating is from deep sea wind turbines, using electrolysis to produce hydrogen for delivery would make sense as the transportation over such distances creates significant signal and resistance losses with the amount of the loss dependant on the distance. With hydrogen metal hydride storage, the only issue is the integrity of the storage vessel and the heat of the container. Of course, if the hydrogen was delivered from such turbines as hydrogen, it needs some method of conversion back to the form of energy required. If a fuel cell then the water can also be used to irrigate farmland or augment the fresh water supply and the deoxygenated air used as a fire suppressant thus creating three useful products. Burning the hydrogen to create energy, produces steam, heat, and potentially NO_2, a greenhouse gas and gas associated with poor air quality creating health issues.

4.6. Regulation and financial support for the hydrogen economy would not be best left to Ofgem given their appalling record in the recent past to carry out its primary function of customer protection from the excesses of the energy companies. As stated earlier, out of these three options Unite would favour a blend of CM+ and/or Revenue Cap and Floor to provide those providers who can demonstrate green credentials with a floor price to help them compete. In an ideal world, however, Unite would favour the full nationalisation of the energy industry to remove the competition elements that have caused endless delays provocation, a growth in fuel poverty and cost to UK plc.

Simon Coop
National Officer
Energy and Utilities
Unite House
128 Theobalds Road
Holborn
WC1X 8TN

February 2024

[35] Based on the minimum number of days holiday per annum, a five day week and the UK's average number of sick days a year (5.7 days per annum)

For further information please contact Colin.Potter@unitetheunion.org for Energy and Utilities Colin Potter, Research Officer in the Unite the Union.

Appendix 1 Rainbow of Hydrogen Production Methods

Hydrogen is a colourless gas that burns with a very pale blue, almost colourless, flame when pure. The colour therefore, does not refer to the actual colour of the gas produced or the colour of the flame but the name given to differentiate between different methods of production or extraction.

Colour	Method to generate hydrogen
Green,	Normally used to describe the electrolysis of water or ammonia, to create hydrogen, the term also includes any other method that creates hydrogen, without creating or releasing any greenhouse gasses.
Yellow,	The electrolysis of water or ammonia using renewable energy as a way of storing generated electrical power. This is the method which is to be used on deep sea floating wind turbines platforms. I could also be used on renewables awaiting grid connections to provide a return on investment while on the National Grid's waiting list.
Pink,	The electrolysis of water or ammonia using Nuclear Generation as a way of storing generated electrical power generation. This is also referring to a method of returning the power back to the grid by passed the gas through a bank of hydrogen fuel cells as and when required. As there is no combustion there is no release of any greenhouse gasses not even NO_2 or NO_X and the "exhaust deoxygenated air (DOA) can be used to replace CO_2 as a fire extinguisher.
Grey,	The production of hydrogen using **Steam Methyl Reformation**, where natural gas passes through a chamber filled with steam, in a two-stage catalytic process. The steam breaks the methane into large quantities of hydrogen but also Carbon Monoxide, which then reacts further thanks to a catalyst to release CO_2 and some more hydrogen. The process is not perfect causing some unreacted methane and other hydrocarbons gasses, to escape into the atmosphere. $CH_4 + H_20 \Rightarrow CO + 3\ H_2$ $CO + H_20 + 206\ kJ/mol \Rightarrow H_2 + CO_2$ The reaction is endothermic, requiring heat to be supplied to the process for reactions in the temperature range 700–1,000°C. In general, the heat source is provided by combustion of up to 41% of the methane feedstock, causing 24% reduction in product energy content compared to the feedstock. There is also a requirement for large volumes of water compared to other methods.
Brown,	The production of hydrogen, using gasification, where carbonous materials like municipal or industrial, carbon-based waste, is heated into a gas. The gas is then treated in a method the extracts hydrogen, usually Steam Methyl Reformation. The method releases large volumes of Carbon Dioxide and other greenhouse gasses into the atmosphere but does reduce volumes going to landfill.
Black,	The production of hydrogen by using gasification of coal or oil, by heating it strongly in the absence of air to create "Coal Gas", sometimes known as "Town Gas" or "Syn Gas" = a mixture of Carbon monoxide and Hydrogen. By-products from the production process can included coal tars and ammonia. The process releases large volumes of CO_2 and other greenhouse gasses into the atmosphere.
Blue,	The production of hydrogen using either the Brown, Black or Grey methods above but where the gasses that would otherwise be vented to the atmosphere are past through an amine solution to extract and capture the CO_2 for later utilization, disposal via mineralization or long-term CO_2 storage/disposal. Sadly, the amine solution cannot also extract the other greenhouse gasses and unreacted methane that can still end up in the atmosphere.
Turquoise,	The production of hydrogen from a fossil fuel or carbonous material, such as anaerobic digestion methane, or the gasification of waste, where that material is then turned into carbon powder and hydrogen.

	One way of obtaining this uses pyrolysis (super critical heating of a substance to break the molecular bonds and release the elements in their natural state) by passing the gas or other material through an electric plasma in the absence of air. A method of achieving the temperatures is by bubbling the Syngas or hydrocarbon gas source through hot liquid metal. In theory it would be possible to therefore convert natural gas to hydrogen by passing an excess of natural gas through molten pig iron and then recycling the fumes through the metal. In this way a steel plant could produce excess hydrogen and black carbon powder. Early experiments into such technology allowed unreacted methane to escape but if there was hydrogen separation and sweetening of the fumes, it may be possible to in theory at least create an excess of hydrogen and carbon powder. Another method which currently remains largely experimental, even though there have been demonstrations of the technology deployment in Germany[36], is where sewage is converted into drinkable water and hydrogen, plus carbon powder using a high frequency electrical plasma[37]. A further experimental method uses an Isothermal Ceria Redox Cycle[38] powered by concentrated sunlight. This is very useful in areas of the world with large volumes of sunlight like deserts but after reading through the evidence, Unite remains to be convinced it would be viable in the UK. If carbon powder is produced instead of CO_2, from Natural Gas, methane or other hydrocarbon sources, the powder can be used to manufacture anything from carbon fibre to industrial diamonds or Graphene nanotubes and hence is a valuable commodity rather than a greenhouse gas. These offer a sustainable alternative to the use of fossil fuels as raw materials rather than a resource that needs to remain in the ground.
White, sometimes called Gold	Naturally-occurring geological hydrogen found underground, normally discovered as the by-product of industrial processes such as drilling for oil or natural gas extraction (fracking). As with any drilling or mining there can be pockets of radioactive substances unearthed too.

[36] Innovator Graforce claim that their method of methane electrolysis only needs 10 or 20 kWh from wastewater to make 1 kilogram of hydrogen, as opposed to water electrolysis, which takes 50 kWh/kg of hydrogen.
[37] This can be used to purify water and produce valuable gasses sorted via membranes as has been deployed by Graforce as the world's first plant for the generation of hydrogen from wastewater (3,000 l/h) on the premises of Berliner Wasserbetriebe at the Waßmannsdorf treatment plant.
[38] Click on the link for more details of the Ceria Redox Cycle