HyDeploy

HyDeploy Frequently Asked Questions

HyDeploy is being delivered by the HyDeploy consortium which has a variety of technical expertise and practical experience.

1. About HyDeploy

1.1 What is HyDeploy?

HyDeploy is an energy trial to establish the potential for blending hydrogen, up to 20%, into the normal gas supply to reduce carbon emissions.

HyDeploy is being hosted at Keele University in Staffordshire. It could be the first project in the UK to inject hydrogen into a natural gas network.

It will determine the level of hydrogen which could be used by gas consumers safely and with no changes to their behaviour or existing domestic appliances.

Subject to Health & Safety Executive approval in Phase 1 of HyDeploy, the aim is to run a year-long live trial of blended gas on part of the Keele private gas network in Phase 3 (2019).

HyDeploy is funded by Ofgem's Gas Network Innovation Competition, Cadent Gas Ltd and Northern Gas Networks.

1.2 Why is Keele involved?

Keele University is committed to developing a carbon free future through its innovative Smart Energy Network Demonstrator Project (SEND).

The University is the ideal location for HyDeploy, as it has:

- the largest campus in the UK served by its own private gas network;
- a mix of residential and commercial buildings, similar to a small town; and
- an international reputation for research excellence.

1.3 Which parts of the campus are involved in HyDeploy?	Visit http://hydeploy.lsweb.co.uk/keele/on-campus/ for a map of the campus showing the areas which are part of HyDeploy.
1.4 Why do you want to inject hydrogen into the normal gas network?	The UK is committed to a reduction in carbon dioxide (CO_2) emissions of 80% by 2050. Over 80% of UK homes are heated by gas, with heat accounting for around one third of UK CO_2 emissions. Progress has been made to decarbonise electricity, but very little on decarbonising heat. Although the gas network already delivers some green gases, like biomethane, further research is needed to understand the potential of other zero or low carbon gases to meet heat demand. HyDeploy is one of a number of research projects investigating the potential of hydrogen to help meet this challenge. Many experts see hydrogen as an adaptable alternative to fossil fuels. This is because when hydrogen is burned it doesn't produce CO_2, just water and heat; meaning it offers a way to deliver low carbon energy. Hydrogen (up to 20%) blended with natural gas has the potential to be delivered and used in the same as normal gas and reduce carbon emissions.
1.5 Why has this particular area of the campus been chosen for HyDeploy?	The specific HyDeploy area of the Keele private gas network has been carefully chosen because it can be easily isolated from the rest of the gas network, and minimises any disruption to the day to day activities of the University.
1.6 What is happening in Phase 1?	If your home is in the HyDeploy area, in Phase 1 you will be asked to consent to safety checks on your household gas appliances and gas system. This will help us provide the information required by the Health & Safety Executive so they can decide if a live trial can go ahead in 2019; and the specific blend of gas that can be delivered. Phase 1 runs to June 2018. During Phase 1 there will also be laboratory testing by Keele University and the Health & Safety Laboratory to provide further evidence for the Health & Safety Executive.

1.7 I'm a householder/ tenant in the HyDeploy area, what do I have to do?

Below is an outline of the three phases of HyDeploy (to March 2020) and how your home will be involved:

Phase 1 (To June 2018)

If your home is in the HyDeploy area, in Phase 1 you will be asked to consent to safety checks on your household gas appliances. This will help us provide the information required by the Health & Safety Executive so they can decide if a live trial can go ahead in 2019; and the specific blend of gas that can be delivered.

Phase 2 (July 2018 – Mar 2019)

If the HSE approve the live trial, HyDeploy will move into Phase 2. You will not be asked to participate in any activities during Phase 2, but will be kept up to date on progress. This phase will be the design and site build of the hydrogen blending unit; and some improvements to the gas pipe network on campus. We will communicate with all affected campus users and residents before works are done. Wherever possible this work will be coordinated with other estates work on the campus to minimise disruption.

Phase 3 (Apr 2019 – Mar 2020)

Following successful completion of Phase 2, the blend of hydrogen and natural gas will be delivered to homes and buildings in the trial area for 12 months. During this time you will be given an option to participate in spot checks on the performance of your gas appliances. You may also be invited to give general feedback on the performance of your appliances.

After Phase 3, the results of the live trial will be analysed. You will be kept up to date on progress and the final publication of the results.

1.8 I visit/work in one of the buildings in the HyDeploy area, how will it affect me?

If you visit/work in one of the faculty buildings that are part of the Keele HyDeploy area, you shouldn't notice any difference either before or during a live trial.

Below is an outline of the three phases of HyDeploy:

Phase 1 (To June 2018)

During this phase there will be safety checks on the gas appliances in homes and buildings in the proposed live trial area. This is to provide the information required by the Health & Safety Executive so they can decide if a live trial can go ahead in 2019; and the specific blend of gas that can be delivered. As with the routine gas safety checks in the buildings, the ones for HyDeploy will be scheduled to minimise disruption.

Phase 2 (July 2018 – Mar 2019)

If the HSE approve the live trial, HyDeploy will move into Phase 2. This phase will be the design and site build of the hydrogen blending unit and some improvements to the gas pipe network on campus. We will communicate with all affected campus users and residents before works are done. Wherever possible this work will be coordinated with other estates work on the campus to minimise disruption.

Phase 3 (Apr 2019 – Mar 2020)

Following successful completion of Phase 2, the blend of hydrogen and natural gas will be delivered to homes and buildings in the trial area for 12 months. During this time there will be some spot checks on the performance of gas appliances in buildings. Throughout the live trial, heating and hot water in buildings will continue to be provided as normal.

After Phase 3, the results of the live trial will be analysed and made publically available.

1.9 I live/work on a part of the campus that isn't in the proposed HyDeploy trial area. How will HyDeploy affect me?	You will not be directly impacted by HyDeploy. You may notice some minor disruption as works are carried out on-site associated with HyDeploy. Works will be co-ordinated with other activities on the site to minimise this wherever possible. If you are interested in HyDeploy, there will be opportunities to find out more on campus.
1.10 How is it being financed and will there be any cost to me?	£6.7m has been provided by Ofgem's Gas Network Innovation Competition. In addition, Cadent Gas Ltd and Northern Gas Networks have invested £375,000 each. Taking part in HyDeploy will not cost you anything. The funding by Ofgem requires the HyDeploy project team to make sure that the percentage of your normal gas bill, which will be hydrogen during HyDeploy, will not be charged to you. Your usual projected energy costs for March 2019 will reflect this. Ofgem are there to protect you, and will have to agree how this billing is done. The gas appliance safety checks in Phase 1 are free. Any repairs or replacements to domestic gas appliances, as recommended following these checks, will also be paid for by HyDeploy. In addition, if the HSE agree that HyDeploy can go ahead to Phase 2 and a live trial in Phase 3, you will also receive a free service for your gas boiler during the live trial period.

1.11 Will HyDeploy cause any disruption on the campus?	There are various activities related to HyDeploy which will happen on the campus between now and end March 2020. **Phase 1 (to June 2018)** As part of Phase 1 there will be gas safety checks on all of the appliances in homes and buildings in the proposed HyDeploy trial area. The checks will take approximately 2 hours and will be carried out with the householder's consent, at a time convenient for them. For faculty buildings, these will be planned to minimise disruption, e.g. when buildings are not in use. **Phase 2 (July 2018 - March 2019)** As part of Phase 2, the hydrogen generation unit will be installed in a compound behind the Horwood Energy Centre. There will also be upgrades to certain parts of the Keele pipe network in preparation for a live trial. The exact locations and timing are to be confirmed. All affected campus users and residents will receive information about this before works are done. Wherever possible work will be coordinated with other estates work on the campus to minimise disruption. **Phase 3 (April 2019 - March 2020)** No disruption is expected during a live trial. Throughout the live trial, heating and hot water in homes and buildings will be provided as normal.

1.12 What are the benefits of HyDeploy?	HyDeploy will help us to understand how hydrogen could help to reduce carbon emissions from heat in the UK. A live trial would provide practical evidence of how a blend of hydrogen (up to 20%) works on a live gas network and for gas customers. The results could give the basis for a trial on a public network, and wider roll out. This would help to lower carbon emissions relatively quickly with limited disruption to customers, while wider decarbonisation projects are progressed. If hydrogen were blended with natural gas across the UK at a similar level to HyDeploy, it could save around 6 million tonnes of carbon dioxide emissions every year, the equivalent of taking 2.5 million cars off the road.
1.13 How much of a difference could 20% hydrogen make to UK carbon emissions?	If HyDeploy is successful a similar public trial could be carried out on a larger scale, and beyond that a blend could be rolled out across the UK. This would help to lower carbon emissions relatively quickly with limited disruption to customers, while wider decarbonisation projects are progressed. If hydrogen were blended with natural gas across the UK at a similar level to HyDeploy, it could save around 6 million tonnes of carbon dioxide emissions every year, the equivalent of taking 2.5 million cars off the road.

1.14 Exactly how much hydrogen will be blended with natural gas in a live trial?	The exact percentage cannot be confirmed yet. However, in the live trial the amount of hydrogen blended with normal gas will not be above 20%. Three steps must take place before the percentage can be confirmed: **1. Data collection** The Phase 1 laboratory testing and gas appliance safety checks in homes and buildings in the proposed trial area will provide information on the performance of appliances and the network with different percentages of hydrogen. **2. Safety case application** The information collected in the testing and checks will be used as part of a safety case application to the HSE to deliver a blend of gas to homes in the trial area. A recommended percentage will be made in this application based on the data collected. **3. Safety case approval** Before any hydrogen can be blended with normal gas in the Keele network, the percentage of hydrogen that will be delivered must be approved by the HSE. The HSE must be satisfied that the approved blended gas will be as safe to use as normal gas. Any approval will be given as an exemption to the Gas Safety (Management) Regulations. These regulations ensure the safe use and management of gas through the gas network in the UK.

1.15 Why is the hydrogen level set at a maximum of 20%?	The decision to restrict the potential blend to 20% is based on: 1. Earlier studies (e.g. HSE Research Report RR1047 2015), indicate that the addition of up to 20% hydrogen by volume is unlikely to present significant changes to any risks already associated with natural gas delivery. 2. 20% is the level at which it is expected that gas customers supply and usage will not be affected by the change in gas composition. 3. Gas appliances manufactured after 1996 have been designed to operate with a hydrogen mix up to 23%. HyDeploy aims to provide practical evidence about the level of hydrogen that can be accommodated with requiring significant changes to appliances or the network. Beyond HyDeploy, other projects are looking at how higher concentrations of hydrogen could work on different parts of the national gas network in the future (Northern Gas Networks, H21), as well as with gas appliances (BEIS innovation funding).

1.16 How long does HyDeploy run for and what happens when?	HyDeploy runs for three years from April 2017 – March 2020. It has three phases. **Phase 1 (To June 2018)** Laboratory testing of gas blends; safety checks in homes and buildings in the proposed live trial area; and preparing the safety case for the Health & Safety Executive. **Phase 2 (July 2018 – March 2019)** Design, build and installation of the hydrogen production and blending units on the campus; any improvements to the campus pipe network. **Phase 3 (Apr 2019 – Mar 2020)** This is the proposed live trial phase.
1.17 What is the environmental benefit of using hydrogen?	When hydrogen is burned it doesn't produce carbon dioxide, just water and heat. Therefore it offers a way to deliver low carbon energy, providing it can be produced without creating carbon emissions.
1.18 What happens in Phase 1?	In Phase 1 (To June 2018) the following activities will take place: • laboratory testing of gas blends; • safety checks in homes and buildings in the proposed live trial area; and • preparing the safety case for the Health & Safety Executive.
1.19 How long would a live trial last?	A live trial would be expected to last 12 months, starting in Spring 2019. 12 months will give a full picture of gas demand/usage through the seasons.
1.20 How many homes/ buildings are included in the proposed HyDeploy trial area?	There are 101 domestic homes and 30 University buildings in the proposed HyDeploy trial area.
1.21 Will you stop using hydrogen after a live trial, and remove the infrastructure?	Yes. At the end of a live trial the normal gas supply will be resumed and the hydrogen production unit will be removed from the Keele University site.

1.22 How would a live trial affect my gas bill?	The funding by Ofgem requires the HyDeploy project team to make sure that the percentage of your normal gas bill which will be hydrogen during HyDeploy will not be charged to you. Your usual projected energy costs for March 2019 will reflect this. Ofgem are there to protect you, and will have to agree how this billing is done.
1.23 How is Keele University involved?	Keele University is a project partner for HyDeploy. Keele is: • **Hosting the live trial** – Part of Keele University's private gas network on the campus is the host for a live trial. This includes the homes and academic buildings on this part of the network. • **A research partner** - Keele University is studying the impact of hydrogen on (1) gas pipework; and (2) how the gas flame burns. HyDeploy is part of Keele University's commitment to world-leading research into environmental sustainability. It is part of the wider sustainability focus under the Smart Energy Network Demonstrator Programme (SEND). It is being led at Keele by the Directorate of Engagement and Partnerships, and the Estates and Development Directorate. Both teams have been closely involved with the planning phases for HyDeploy. Estates will be a central point of contact for householders and communities in the trial area.
1.24 Will there be any impact on the day to day operations of the university?	HyDeploy has been carefully planned to avoid impacting on the day to day operations of the University.

1.25 How was approval given for HyDeploy at the University?	HyDeploy was approved in September 2016 by Keele University's Council as the first large scale project within the SEND programme. The HyDeploy team is in continuous dialogue with the University's Research Ethical Review Panel to ensure compliance. HyDeploy is overseen by the SEND Project Executive Group chaired by the Deputy Vice-Chancellor. It is being facilitated by the Directorate of Engagement and Partnerships and the Estates and Development Directorate.
1.26 Is the Keele Estates & Development Directorate involved in HyDeploy?	Yes. The Estates and Development Directorate have been closely involved with the planning phases for HyDeploy. The team will be a central point of contact for householders and communities in the trial area throughout HyDeploy.
1.27 What is the difference between the blended gas for HyDeploy and old Town Gas?	Hydrogen was the main constituent of old Town Gas (40-60%). Town Gas also contained carbon monoxide which is a toxic gas. The blended gas proposed for the Keele HyDeploy live trial will contain a maximum of 20% hydrogen, with a minimum of 80% normal gas. The gas blend will not contain carbon monoxide.
1.28 In a live trial, will I notice any difference to the way my appliances work with a blend of hydrogen and natural gas?	The premise of HyDeploy is to establish the level of hydrogen blending that can be safely used in the gas network and in appliances without disruption to users. A key part of the laboratory testing and the onsite safety checks is to confirm that appliances operate as normal. Therefore, during the live trial at the permitted blend level, the gas delivered should work in your appliances in the same way as it does today.

1.29 How will personal data from householders be used and/or protected?	With householders consent, in Phase 1, gas engineers will be visiting homes to carry out gas appliance safety checks. To enable this, Keele University Estates Team will need to share the following information with specialist gas testing engineers from Kiwa and gas safe engineers as specified by Keele University: • Addresses of properties on the impacted section of the gas network at Keele University. • Details of the most recent gas safety check, if available. Any personal, identifiable data will continue to be managed by Keele University's Estates & Development Directorate in accordance with standard guidelines.
1.30 What will happen to personal data once HyDeploy has ended?	At the end of HyDeploy, any paper copies of customer's personal data (e.g. consent forms) will be destroyed following strict confidential waste procedures. Data held in electronic form for the purposes of the project will be erased completely from Keele servers.
1.31 How will data from my house (e.g. my gas appliances) be used and/or protected?	Details of gas appliance performance from the safety checks in homes and buildings in the proposed HyDeploy trial area will be used as part of the safety case presented to the Health and Safety Executive. Details of the types of gas appliances in the range of properties involved in the trial and their performance will inform the outcomes of HyDeploy and are expected to be published. Throughout HyDeploy the exact location of each type of appliance will be anonymised to Keele University campus.

1.32 What happens if householders/ tenants in the proposed trial area refuse to participate in HyDeploy?	Householders/tenants on the impacted part of the Keele gas network can refuse consent for gas appliance safety checks. All evidence collected from laboratory tests and house/buildings checks will be presented to the Health & Safety Executive. They will decide based on this available evidence whether to approve a blended gas for delivery. If they do approve a blend of hydrogen/natural gas, the gas will be considered to be compliant gas and can be delivered to the homes on the network in the same way normal gas is delivered today. The Phase 1 safety checks will make sure gas appliances and systems currently connected to the network are safe and ready for a trial.
1.33 Will you be looking at 100% hydrogen injection as part of HyDeploy?	The maximum volume of hydrogen to be injected into the gas network as part of HyDeploy is 20%. HyDeploy was and always will be focused on the role for hydrogen as a blend. The use of hydrogen in this way provides a deliverable pathway to carbon reductions now, without requiring consumer changes, and delivers practical developments which could enable a wider hydrogen future. That is why HyDeploy does not include on-site testing of appliances or operation of the network on 100% hydrogen. If the project has the opportunity to provide valuable data from off-site laboratory testing to inform other industry work on higher levels of hydrogen it will do so (e.g. Northern Gas Networks H21 project).

1.34 Have you made any changes to the project since the original funding application?	The project has evolved since it was originally conceived. When HyDeploy was originally developed, there was an aspiration, where possible, to provide some scientific evidence to inform the use of 100% hydrogen, although not through live operation of the network or appliances. However, in light of other wider, more in depth, programmes looking at 100% hydrogen, this is not now as necessary.
1.35 How will you deal with complaints and concerns?	The Estates and Development office will be the first point of contact for complaints and concerns relating to HyDeploy. This is the normal process for raising an issue with energy supply at Keele.
1.36 Will those directly impacted have any say on the location of the infrastructure and the timing of the trial?	No. The location of electrolyser (hydrogen production unit) and the related infrastructure has been carefully chosen for safety and operational reasons by the Keele Estates team. The live trial will only begin when all the necessary safety checks are completed, and if Health and Safety Executive approval is given. If approval is granted, Phase 3, the live trial phase of HyDeploy, will start in 2019.
1.37 How will you be letting the whole university community know about HyDeploy?	Information about HyDeploy will be available in the University's normal communications channels such as internal newsletters. You can also expect to see HyDeploy at University sustainability events. For those who work in, use and visit impacted faculty buildings there will be opportunities to learn more about HyDeploy with targeted information in Winter 2017/18.

1.38 Who is involved in HyDeploy?	HyDeploy is being delivered by the HyDeploy consortium, which has technical expertise and practical experience. Consortium members: Cadent Gas Limited, Northern Gas Networks, Health and Safety Laboratory, ITM Power and Progressive Energy. Delivery of HyDeploy is also supported by specialist gas safety testing specialists Kiwa, industry research experts Dave Lander and technical consultants Otto Simon Limited.
1.39 What are the roles and responsibilities of the HyDeploy project partners?	HyDeploy is being delivered by the HyDeploy consortium, which has technical expertise and practical experience. The partners are: Cadent Gas (formerly National Grid Gas Distribution) is leading HyDeploy. It owns and operates four of the eight gas distribution networks in the UK, including the West Midlands. Northern Gas Networks is partnered with Cadent to deliver HyDeploy. The project supports its work exploring the future role of gas. It owns and operates the gas network in the North East, Northern Cumbria and much of Yorkshire. Keele University is hosting HyDeploy on its campus and the University's Materials Department are carrying out research on the impact of hydrogen on materials. Health and Safety Laboratory is the scientific arm of the Health & Safety Executive. It will be providing the scientific evidence which will support the safety case for the trial. ITM Power manufacture integrated hydrogen energy solutions. It will be supplying the hydrogen production unit for HyDeploy. Progressive Energy is an independent UK clean energy company. It will be supporting HyDeploy through development and implementation.

Continued.

1.39 What are the roles and responsibilities of the HyDeploy project partners?

Supporting companies

Kiwa specialise in gas testing. It is carrying out offsite testing on a range of common household appliances to inform the project, and will lead the gas safety appliance checks on the campus.

Dave Lander is an internationally recognised expert in gas quality and safety and is co-ordinating the application to the HSE.

Otto Simon Limited is an engineering consultancy and project delivery organisation, responsible for the installation of hydrogen equipment onsite.

1.40 What role does the Health and Safety Laboratory have?

The Health & Safety Laboratory is the scientific arm of the UK Health & Safety Executive. Its role in HyDeploy is:

- To provide impartial scientific evidence to inform the decisions of the HyDeploy project team. Evidence will include results from testing materials, appliances and gas detection equipment for potential interactions with gas blends.
- To provide reports to support the safety case application that will be evaluated by HSE. These reports will bring together literature reviews, theoretical analysis and results from off-site experimental testing using hydrogen and natural gas blends.

1.41 What role does Ofgem have?	Ofgem (Office of Gas and Electricity Markets) is the energy industry regulator. Its overall role is to protect the interests of existing and future electricity and gas consumers. HyDeploy has received £6.7m in funding under Ofgem's Gas Network Innovation Competition. This competition is an annual opportunity for gas network companies to compete for funding to develop and demonstrate new technologies, operating and commercial arrangements for the industry. Funding is provided to the best innovation projects which help all network operators understand what they need to do to provide environmental benefits, cost reductions and security of supply as the UK moves to a low carbon economy. Annual and final reports will be provided to Ofgem on the progress of HyDeploy. In its role as regulator, Ofgem will also need to approve the approach used for billing customers during HyDeploy, to ensure their interests are fully protected.
1.42 Who has overall control and final say on HyDeploy?	Cadent is leading HyDeploy. It is supported by the steering committee which is made up of representatives of all the project partners. Keele University has oversight and final approval of all activities on the campus and the running of the live trial on the campus gas network. The Health & Safety Executive is responsible for approving the blend of gas that would be delivered in the live trial. Without its approval the live trial will not go ahead. Ofgem has awarded the funds to HyDeploy and through its governance process ensures that it is properly delivered. In its role as regulator it also must agree the billing arrangements for customers.

2. Safety

2.1 What are the risks of having hydrogen blended with normal gas in my home or in the gas pipes, compared with normal gas?

Adding hydrogen to natural gas grids is not a new idea. It has been carefully considered in Europe through a body of work over the last decade.

This work has included assessing its impact on the pipeline network (HIPS-Net project); how it burns as a blend to support demonstration projects such as GRHYD. The GRHYD project has permission from the French regulator to blend, distribute and use a 20% hydrogen natural gas mix for a trial due to start in late 2017. Such examples provide confidence in the principles and in the assessment of underlying risks. HyDeploy is seeking to address the same issues in the context of the UK gas network and its range of appliances, and to evaluate them within the UK regulatory framework.

The number of serious incidents related to gas supply and use in the UK are extremely low, particularly when compared with other day-to-day activities. This is because under the UK regulations including the Gas Safety (Management) Regulations (GS(M)R) managed by the HSE, equipment and operational procedures are well controlled.

Before any hydrogen can be blended with normal gas in the Keele network, the HSE must be satisfied that the approved blended gas will be as safe to use as normal gas, and that existing equipment and established procedures remain as effective in operating safely and managing the risks.

Continued.

2.1 What are the risks of having hydrogen blended with normal gas in my home or in the gas pipes, compared with normal gas?

The specific areas of risks being evaluated as part of HyDeploy are:

1. the effect of blended gas on how appliances operate
2. how blended gas interacts with materials (e.g. pipes)
3. the effect on gas leakage behaviour and detection
4. risk of fire or explosion
5. ensuring reliable blending of the hydrogen and natural gas.

The core work in Phase 1 is a detailed assessment of these risks based on the science, international experience and detailed testing.

2.2 How will the blended gas affect my gas appliances?

The effect of blended gas on how appliances operate is one of the areas which are being assessed as part of HyDeploy.

This is because there are some differences in the way that hydrogen burns compared with natural gas. Although these differences are limited when hydrogen is used at a blend below 20%, it is important to understand and evaluate these factors in assessing the risk and determining the proposed blend.

Factors to assess:

- The shape of the flame, which may change slightly. In general, this is not an issue, but it is important to ensure that any control systems on the appliance are not adversely affected by this.
- The flame may sit slightly closer to the burner itself. Therefore, it is important to understand the impact this may have on the temperature of the components and the conditions under which they are designed to operate.

Continued.

2.2 How will the blended gas affect my gas appliances?

- At high levels of hydrogen and under particular conditions it is possible for the flame to move back into the burner itself. This is a phenomenon called 'light back' which can cause the flame to go out. All appliances sold since 1996 have already been tested for this, using a hydrogen blend of 23%.
- In order to protect users, a number of safety devices are used in gas appliances, for example to cut off the gas flow if the flame goes out. As part of the testing programme, these devices are being tested to ensure that they continue to operate properly with the hydrogen and natural gas blend.
- If a fuel containing carbon does not burn properly, it has the potential to form carbon monoxide which is poisonous. Proper burning is controlled by managing the ratio of fuel and air in appliances. Although the addition of hydrogen to natural gas reduces the carbon content of the gas, it is important to ensure that it still burns properly.

HyDeploy's own research will build on the work done internationally on hydrogen and natural gas blends. The laboratory testing programme and the safety checks on campus are all designed to assess these aspects. The evidence collected through this process will inform the level of blending proposed. Only if the HSE is satisfied will permission be granted to proceed to the live trial.

2.3 Will the blended gas work safely in the underground pipe network?

Hydrogen is routinely and safely distributed as an industrial gas across the world and in the UK today. An important part of HyDeploy is to make sure that using a blend in existing gas infrastructure which delivers to homes and businesses, is also safe. How blended gas interacts with materials (such as gas pipes) is one of the risk areas that are being assessed.

There is already a good evidence base for many materials, most of which have no chemical interaction with hydrogen. Specific areas under assessment:

- Hydrogen embrittlement of high strength steel is recognised to be a potential issue in materials operating at high pressures and temperatures. At Keele, however, we are dealing with a gas blend of relatively low hydrogen concentration at low pressure and being delivered at ambient temperature. Under these conditions this phenomenon is not considered to be a risk, but a programme of testing is being undertaken to validate this.
- Much of the UK gas network uses plastic (typically polyethylene) pipes, and there are no adverse chemical interactions with hydrogen in these materials. Although very low levels of permeation of gases occurs through such materials, the rates are lower than the regulated safety levels for leakage from pipework and installations. HyDeploy will be building on existing data, developing this current understanding even further. For example, it is working with pipeline specialists to assess how a hydrogen blend could impact on jointing and repair work on plastic pipes.

HyDeploy includes a survey of the materials on the Keele gas network. This will be combined with information from equipment suppliers and existing research into materials interactions. Where further information is required, specific laboratory tests are being undertaken, including work by Keele University materials department. This evidence base will form part of the information supplied in the safety case to the HSE who will decide if HyDeploy can go ahead to a live trial.

2.4 What happens if there is a leak?

Keele University and Cadent are responsible for managing gas leaks on their networks. Within homes, qualified gas fitters are trained to ensure that pipework is installed properly and without leaks. There are also a number of important safety measures in place to detect leaks.

Natural gas is given a distinctive smell. This means that members of the public and gas operatives are able to detect gas even at very low levels and report it so that a leak can be repaired. Adding some hydrogen to natural gas will dilute the smell, but will not change its effectiveness. If required, additional odorant will be added to compensate for this. Tests will be carried out on the Keele network to ensure the required levels are maintained through the trial so leaks can be detected in the same way they are with just natural gas.

On the network, routine leak detection is done using specialist equipment which is very sensitive to natural gas. When a landlord undertakes a gas safety check in a home, this includes a leak test. For HyDeploy, all the equipment and procedures used for leak detection on the network will be thoroughly tested to make sure they work as effectively with the blend as they do with just natural gas. During the gas safety checks all the pipework in the buildings will also be leak tested.

Continued.

2.4 What happens if there is a leak?

Specific risks around gas leakage and behaviour are being assessed and carefully managed as part of HyDeploy. These include:

1. The majority of leaks occur at joints and connections, and such a leak would occur for natural gas or a blend. Although the flow rate from a leak for a blend is likely to be slightly higher than natural gas, the lower energy density means that amount of energy released is similar. In the open, the lower density and higher diffusion is also likely to aid dispersion in the event of a leak. As part of HyDeploy, analytical modelling of these phenomena is being undertaken.
2. Very low levels of permeation of gases occurs through materials such as plastic pipes. Even though hydrogen will permeate more than natural gas, the rates are still lower than the regulated safety levels for leak tightness testing in buildings.

During the HyDeploy gas safety checks all the pipework in the buildings will be leak tested on natural gas and then on the blend. This will allow us to carry out any necessary repairs; and means that the installations may well be even safer than today.

Only if the HSE is satisfied that all of these issues are safely managed, will permission be granted to proceed to a live trial.

2.5 What is the risk of a fire or explosion with the blended hydrogen and natural gas?

For HyDeploy it is important to understand the effect of blending hydrogen with natural gas on existing gas management processes, and make sure that risks are as effectively managed as they are today with just natural gas.

A fire or explosion on a gas network can only occur if:

1. there is a leak, and
2. gas reaches the concentration in air required to be flammable or explode, and
3. if there is a source of ignition.

The existing gas management processes seek to minimise the risk of each of these stages, and HyDeploy builds on these principles.

In Phase 1 of HyDeploy during the gas safety checks, all the pipework in the University buildings will be leak tested. The gas will still have its characteristic smell and the equipment and procedures used for leak detection will be thoroughly tested to ensure they are as effective on the blend as on natural gas. The characteristics of leakages of a blend are being assessed through extensive modelling.

If a leak occurs, the mixture will only burn if it reaches concentration in air. This point is very similar for both natural gas and for the hydrogen blend. Both natural gas and a blend ignite readily at this point, therefore, both the characteristic smell and the leak detectors used by gas specialists are all designed to identify the presence of gas before this concentration is reached. An important part of the HyDeploy programme is to ensure that this continues to be as effective for the blend as for natural gas.

Only if the HSE is satisfied that this risk is safely managed, will permission be granted to proceed to a live trial.

2.6 Hydrogen is invisible and does not smell. How will we know if there is a leak?	Neither hydrogen nor natural gas smell in their normal state. Natural gas supplied via gas mains has a special odorant added to it to give it its characteristic smell, so that leaks can be detected. Adding some hydrogen to natural gas may dilute the smell, but will not change its effectiveness. If required, additional odorant will be added to compensate for this. Tests will be carried out on the Keele network to ensure the required levels are maintained through the trial. There are also other gas safety management processes in place on every gas network, such as routine leak detection. This is undertaken using specialist equipment, and when a landlord undertakes a gas safety check in a home, this includes a leak test. For HyDeploy, all the equipment and procedures used for leak detection on the network will be thoroughly tested to make sure they are as effective on the blend as on natural gas. During the gas safety checks all the pipework in the buildings will be leak tested.

2.7 How can you be sure we only receive 20% hydrogen when the gases are blended together? (v)	The Project team will make sure the hydrogen is blended with natural gas reliably, at a consistent level and maintains a steady flow. This is important for HyDeploy. The equipment to mix and inject the blend into the grid will be designed and supplied by one of two industry specialists who have built some of the 70 biomethane grid injection units in operation in the UK today, and who have the necessary expertise in gas handling. This equipment will be designed to ensure: • it never exceeds the permitted blend rate and mixes the two gases effectively, • it delivers gas over the range of flows experienced on the Keele network, • that the blended gas is within specification even when the quality of the underlying natural gas varies as it does today, • it maintains gas delivery to customers under all circumstances, • the gas has the necessary 'smell' for detection; and • the integrated system has the necessary control and Safety Instrument Levels required for this kind of processing equipment. The detailed design, hazard and operational review of the equipment will form part of the information supplied in the safety case. Only if the HSE is satisfied that it is safe, will permission be granted to proceed to the live trial.

2.8 What safety requirements does HyDeploy have to meet?

Before any hydrogen can be blended with normal gas in the Keele network, the percentage of hydrogen that will be delivered must be approved by the Health & Safety Executive (HSE).

The HSE manage the UK Gas Safety (Management) Regulations (GS(M)R). These regulations ensure the safe use and management of gas through the gas network in the UK. GS(M)R currently restricts the hydrogen level in the UK to 0.1%. This level was set based on the supply of North Sea Gas which has naturally low hydrogen levels.

Under GS(M)R, there is a formal process allowing permission to be sought from the HSE to vary particular attributes of the gas being delivered – called an 'exemption'. The HyDeploy team must submit a safety case to the HSE for approval. This will include the evidence collected from the laboratory testing and checks in Phase 1, alongside existing literature data and a Quantified Risk Assessment that will compare the risk of a blend with the existing base level using natural gas only. Based on the evidence, this safety case will propose the percentage of hydrogen that can be delivered safely to homes (to a maximum of 20% volume).

The HSE will evaluate the exemption application and make a decision about whether an exemption will be granted. If granted, the exemption will also confirm the concentration of hydrogen that can be delivered in a live trial. HyDeploy can only go ahead to a live trial in Phase 3 if this safety case is approved by the HSE.

The HSE must be satisfied that the blended gas is 'as safe as natural gas' to give permission for it to be distributed through the Keele network. If the HSE is satisfied that it poses no greater risk to safety, and grants permission, then the gas is compliant with the regulations under the terms of the permission. This means it can be supplied to customers for the 12 month trial, as normal gas is today.

2.9 How will you make sure the installation and construction of the hydrogen blending facility is done safely?	As with any construction project on the Keele University site, it is important that the work is undertaken safely. This work will be done under the Construction (Design and Management) Regulations 2015, which defines the roles and responsibilities for those undertaking the work, to ensure projects are carried out in a way that secures health and safety. The Principle Contractor for the works will undertake the activities under the University's existing contractor management procedures.
2.10 Will the gas safety advice be different when the hydrogen is added?	Gas safety advice for consumers will remain the same during a live trial of blended natural gas and hydrogen, and the number you call in an emergency remains the same. General gas safety advice can be found on the Gas Safe Register Website.
2.11 What happens if something goes wrong at any time during HyDeploy?	As in any gas related emergency, the 24 hour National Gas Emergency Service will attend. This service is operated by Cadent. As part of the safety case application to the HSE, the suitability of the emergency procedures will have to be demonstrated, and appropriate training provided to emergency response engineers in the West Midlands.
2.12 Will appliances still be safe to use during a live trial?	Extensive laboratory testing is being carried out on a range of domestic gas appliances to ensure that all appliances will operate safely with a hydrogen and normal gas blend. In addition, the condition of the gas appliances on the Keele network will be assessed during the safety checks. If required, appliances will be repaired or replaced.

2.13 Will this affect household insurance policies?	No. The gas delivered will be approved for delivery as an exemption under the current Gas Safety Management Regulations.
2.14 Has there been any safety incidents associated with blending hydrogen with normal gas?	No incidents have been found that relate to the use of the hydrogen and normal gas blend proposed for use at Keele.
2.15 Have there been other trials showing safe use of hydrogen blended with natural gas?	Hydrogen and natural gas blends have previously been used safely in Europe. **Netherlands** A project in Amerland in the Netherlands was safely undertaken to inject hydrogen at up to 20% volume into their natural gas grid for use by domestic consumers. **Germany** A trial was successfully carried out by E.ON Technologies in the Klanxbüll/Neukirchen region of Germany where around 170 gas customers were supplied with a natural gas blend containing up to 10% volume hydrogen. **France** The GRHYD project is currently underway in France. It will be injecting up to 20% volume hydrogen into natural gas to deliver to around 100 domestic customers and a hospital. As with HyDeploy, this project has gathered the scientific evidence to support the case for the trial. Based on this, permission has already been granted by the French authorities and injection is due to commence towards the end of 2017.

Continued. **2.15 Have there been other trials showing safe use of hydrogen blended with natural gas?**	These trials are all different in a number of respects from each other and from HyDeploy. In particular, HyDeploy is focused on using an existing gas network and one designed to UK specifications. If you would like further details of these trials please contact the project team at info@hydeploy.co.uk. The permitted levels of hydrogen in the gas supply vary across Europe. Visit http://hydeploy.lsweb.co.uk/about/safety/ to see a graph showing permitted levels. Safety is the most important factor for this project. That's what the checks are all about, ensuring that it meets the highest standards demanded by the Health and Safety Executive before it can proceed any further.
2.16 What is the difference between the Health & Safety Laboratory (HSL) and the Health & Safety Executive (HSE)? What are their different roles in HyDeploy?	HSL is part of HSE's Science Directorate. Its role is to provide impartial scientific evidence to inform the decisions of the HyDeploy project team and to provide reports to support the safety case and exemption application. HSE's regulatory experts are not involved in obtaining the evidence. They will evaluate the safety case and exemption application.
2.17 Is there additional danger for buildings which are close to the trial area?	The hydrogen blended gas must be approved by the Health & Safety Executive to be 'as safe as natural gas' for any potentially affected party. This means the blended gas should not pose a greater risk to buildings on or close to the live trial area than the normal gas supply.

2.18 Are there any risks associated with producing the hydrogen?	The hydrogen for HyDeploy will be generated on demand at the Keele site in an electrolyser using water. Electrolysis uses electricity to split water into hydrogen and oxygen. The electrolyser installation will be assessed to ensure safe operation (for example, compliance with industry standards). In addition, the electrolyser and blending units will be fitted with gas detection and response systems. The electrolyser produces oxygen as a by-product. The oxygen will be vented at a high level such that it readily disperses. A number of electrolysers produced by ITM are currently operating in the UK and abroad for both blending into the gas grid and for hydrogen refuelling stations.
2.19 How and when will the hydrogen and normal gas be blended?	A blending unit will be installed next to the electrolyser behind the Horwood Energy Centre. This will take gas from the existing supply and add the hydrogen before it is delivered to the gas distribution network on the relevant part of the site. This equipment will be designed and supplied by specialists to make sure the permitted blend rate is not exceeded; that the gases are mixed effectively and; that gas supply is always maintained to customers.
2.20 Is there any risk to the buildings close to the electrolyser site?	The electrolyser installation will be assessed to ensure safe operation (for example, compliance with appropriate industry standards). In addition, the electrolyser and blending units will be fitted with appropriate gas detection and response systems.

3. Technology

3.1 How will the hydrogen be generated for HyDeploy?	The hydrogen for HyDeploy will be generated using an electrolyser on the Keele University site. An electrolyser uses electricity to split water into hydrogen and oxygen so hydrogen can be used as energy. Electrolysis is widely used internationally for hydrogen production, with a number of units operating reliably in the UK, primarily for use in the transport sector. In the unlikely event of a shortfall in hydrogen production, the existing gas supply is more than adequate to maintain sufficient gas supplies on the network.
3.2 Will you be producing the hydrogen on the Keele site?	Yes. The hydrogen for HyDeploy will be generated on the Keele site using an electrolyser. Electrolysers use electricity to split water into hydrogen and oxygen so hydrogen can be used for energy. This is the most practical way to produce hydrogen for a project of this size and duration. It avoids the need to transport and store hydrogen on site or build extensive infrastructure. On a larger scale, hydrogen can be produced using renewable energy such as wind and solar power.
3.3 Why are you using an electrolyser to produce the hydrogen?	This is the most practical way to produce hydrogen for a project of this size and duration. It avoids the need to transport and store hydrogen on site or build extensive infrastructure. On a larger scale, hydrogen can be produced by electrolysis using renewable energy such as wind and solar power.

3.4 What if you cannot produce enough hydrogen to meet demand? Will our gas supply be affected?	No. The existing natural gas supply is more than adequate to meet the needs of the site. Any shortfall in hydrogen production would be made by an increase of natural gas from the network. Reducing the blend rate in this way would not present any safety risk.
3.5 What will the processing plant look like?	The plant will be an electrolyser. An electrolyser uses electricity to split water into hydrogen and oxygen so hydrogen can be used as energy. Visit http://hydeploy.lsweb.co.uk/faqs/will-processing-plant-look-like/ to see a photograph of an electrolyser unit similar to the one that will be used for HyDeploy.
3.6 Where will the electrolyser be situated at Keele?	The proposed electrolyser site is in a compound behind the Horwood Energy Centre.
3.7 Where is the electrolyser coming from?	HyDeploy project partner ITM Power will supply the electrolyser. ITM Power manufacture advanced hydrogen energy solutions and have provided electrolyser units to several other projects. These include two in Frankfurt and Ibbenbüren, injecting hydrogen into the German gas network; as well as several hydrogen filling stations for Fuel Cell Electric Vehicles in the UK.

3.8 Is electrolysis the best way to produce hydrogen?

There are a number of ways to produce hydrogen.

Electrolysis is the most practical way to produce hydrogen for a project of this size and duration. It avoids the need to store hydrogen on site or build extensive infrastructure.

Producing hydrogen at a larger scale

Efficient large scale hydrogen production is a fast developing area. Ideally, hydrogen production uses renewable energy sources, such as wind or solar power.

Electrolysis connected to renewable energy sources is currently used for the majority of low carbon hydrogen production for commercial use.

Steam Methane Reforming (SMR) is an alternative way of generating hydrogen which could increase in the longer term to support future hydrogen projects. In SMR methane reacts with steam in the presence of a catalyst to produce hydrogen, carbon monoxide, and a small amount of carbon dioxide. To use this method to deliver low carbon hydrogen it would require the use of Carbon Capture and Storage. There are projects in the UK and internationally looking to develop this.

Biohydrogen is a further option. This involves producing hydrogen from certain kinds of biomass, e.g. waste (see BioH2 project - Cadent, Advanced Plasma Power and Progressive Energy).

3.9 Will the hydrogen have a long-term effect on my domestic gas appliances?	The Health & Safety Laboratory and Kiwa have tested hydrogen blends (up to 20%) on a range of common household gas appliances. This has shown that hydrogen at this level does not affect the safe day to day operation of appliances. As part of the laboratory testing programme, the impact of long term operation on hydrogen is being evaluated, and will form part of the definition of the hydrogen blend proposed. The gas appliance safety checks that will be carried out on the Keele site and spot checks during the live trial will provide valuable additional information about the performance of appliances on a real network. All appliances sold after 1996 must comply with a 1990 Gas Appliance Directive which demonstrates that they can operate on a wider range in gas quality than specified in the current regulations. This includes a gas composition of 23% hydrogen.

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