HYDROGEN

Challenge and opportunity for local energy companies

CEDEC

Contents

INTRODUCTION 3

EXECUTIVE SUMMARY 5

A strong role for local energy companies in the hydrogen economy 5
Integrated infrastructures for hydrogen 5
Hydrogen generation at local level 6
Hydrogen, a partner for renewable electricity 6
Waste-to-energy for hydrogen 6
Policy recommendations in brief 7

INFRASTRUCTURES FOR HYDROGEN 8

Make use of existing gas grids 8
Integrated planning 11
Grid operators and power-to-X systems 12

GENERATION OF HYDROGEN 14

Decentralised generation 14
Development of electrolysis output 15

APPLICATIONS FOR HYDROGEN 16

Hydrogen in the existing building stock 16
Hydrogen in the neighbourhood 17
Hydrogen in CHP plants 17
Hydrogen in mobility 18
Possible applications for the by-products of hydrogen generation 19
Quality standards and certificates 20

POLICY RECOMMENDATIONS 21

INTRODUCTION

CEDEC sees a huge potential in innovative gas-related technologies, which entail the production and use of different forms of sustainable gases. When respecting sustainability criteria, molecules can serve the goal of climate neutrality. The existing gas grid, built for natural gas, could then guarantee an easy transportation, storage and distribution of the energy at a high level of security of supply and low cost. Much has already been invested in grid infrastructure for the distribution of gas, electricity and district heating. Many countries have now widespread high-density distribution grids that reach most customers. Therefore, CEDEC believes it is important to explore how these existing grids can be optimally used to develop our energy system in an efficient way. Taking local and regional circumstances into account, synergies between energy products and infrastructures can be developed by verifying how they can supplement each other.

Many renewable and decarbonised gases and technologies, such as power-to-gas (P2G), can play a role to achieve an integrated, reliable, sustainable and affordable energy system serving the energy transition.

As we highlighted in the CEDEC report on flexibility for gas DSOs in 2018[1], we believe that biomethane shall be privileged as a predictable and storable sustainable energy that is readily available to contribute to decarbonise the gas grid as from today. The easiest way to "green" the gas grid is to increase the volume of biomethane produced. Although there are EU-wide standards for biomethane[2], the terms for open access to the gas grid need to be addressed in a more comprehensive way. By 2030 a steadily growing number of decentralised biomethane production units are expected to be connected to DSO grids, representing a timely and adequate solution for decarbonising the building, transport and industrial sectors, and for seasonal storage.

Whereas the integration of biomethane at distribution level is ongoing and its role in the circular economy and in sustainable energy system integration has been recently recognised, the debate around the development of a hydrogen economy intensified only recently. However, in the light of the publication of the Hydrogen Strategy by the European Commission in July 2020[3], there appears to be a general lack of acknowledgement on the potential of hydrogen at local level, in connection with the gas distribution grids.

Despite being researched since the XVII century and being the most abundant element on earth, it is only in the last few years that hydrogen has crossed the science fiction stage. As the technology progressed, the potential of H2 as energy carrier has emerged and the European Commission has made it the child prodigy of its energy transition strategy. Thanks to its many possible applications in sectors where replacing fossil fuels is challenging, hydrogen is essential to support the climate neutrality by 2050 objective. In addition, the existing gas infrastructure, including distribution grids, can make an essential contribution to the cost-efficient development of hydrogen. Therefore, CEDEC supports the increasing attention raised by both the EU institutions and the single Member States around the need to develop a true hydrogen economy.

In practice, a number of promising hydrogen projects have already been realised or are being planned with the active involvement of local energy companies. These projects show that the technology works reliably and can deliver relevant contributions to integrated energy systems. Local energy companies provide essential knowledge and insights for decentralised approaches covering local energy requirements through sector integration.

Hydrogen has a long history and yet important steps have to be taken to make it an integral part of the reality in our homes, cars and factories. Therefore, all elements of the energy system need to be taken into account and allowed to play their role in the sustainable European energy system of the future.

EXECUTIVE SUMMARY

A strong role for local energy companies in the hydrogen economy

When designing a roadmap for the energy transition and the development of hydrogen economy, we believe it is key to take regional factors and strengths into consideration. Local energy companies embed this concept, by definition.

Local utilities are well-connected locally and know the local partners, with whom they maintain a longstanding and trusting relationship. This enables them to create synergies by using additional interfaces, e.g. with buyers of oxygen from sewage treatment plants, power stations, dairy factories and hospitals or with buyers of heat from the housing industry or locally based businesses. New wastewater treatment technologies (like plasmolysis) combine raw material recycling and energy generation in one process step. The clever use of interfaces increases the efficiency of hydrogen production and represents an economic advantage for local utilities and their customers. The close link between local utilities and their customers allows location selection with optimal system embedding and the use of by-products such as oxygen and heat, while also reducing transport requirements in the energy system. It also contributes to the development of innovative processes and products in a hydrogen economy that is emerging worldwide. The costs advantage of international large-scale locations for hydrogen production can be partially offset by such clever synergies, with the energy system becoming more flexible.

Integrated infrastructures for hydrogen

In order to make the most of the hydrogen potential, a coordinated and integrated planning for the further expansion of energy infrastructures is pivotal.

Locally embedded multi-utilities and their related grid operators will have to be involved in order to play a key role, offering a point of reference for a necessarily coordinated planning of the assets involved in order to reach a financially sustainable infrastructural configuration.

Through blending with hydrogen or complete reassignment to hydrogen, the use of the existing gas grid appears to be the most cost-efficient solution. Also, the introduction of increasing levels of renewable and decarbonised gases in the gas distribution grid can contribute stepwise to the decarbonisation objective of the EU.

The gas distribution network operated by local utilities has great potential, notably for decarbonising buildings and industrial sectors.

Hydrogen generation at local level

A key question for many actors is how the significant quantities of hydrogen that are intended to be used in the energy sector, industry and transport can be made available. To achieve the climate protection goal as a strategic political objective, all economically viable domestic and European production potentials must be leveraged, taking into consideration the right balance between large-scale centralized and smaller-sized decentralised solutions. The aim should be to assure the achievement of the hydrogen strategy targets by a balanced promotion of economies of scale and economies of scope, emphasizing the significant potential of all the new possible technological solutions.

All areas have to be addressed in a manner that is open to all technologies and applications.

Thus, the needed hydrogen quantities could come from decentralised plants, creating regional value, making use of existing local infrastructure and avoiding costs for new infrastructures; it could be produced in large industrial plants taking advantage of economies of scale; or it could be imported when needed to support domestic production.

Hydrogen, a partner for renewable electricity

According to the IEA World Energy Outlook 2019[4], demand for electricity is set to increase further as a result of rising household incomes, by the electrification of transport and heat, and by the growing demand for digital connected devices and air conditioning. At the current policy situation, in the EU alone, a 12% increase in electricity demand between 2018-2040 will result in minimum 42% higher flexibility needs. To cover this growing demand and also serve the generation of larger quantities of hydrogen, the pace of expansion of renewable energies has to accelerate in order to be in line with the expected consumption path.

While it is necessary to align the expansion of renewable electricity with the hydrogen production needed in the different regions, hydrogen will also become a key partner for providing flexibility to the electricity grid, including at local level.

To reach this double goal, EU policies need to be more determined in removing the obstacles to expansion. The EU Member States have to create favourable conditions for investment in renewable energies in planning and approval law. As renewable energies are available across the country, a decentralised approach to hydrogen production is also a contribution to the societal challenges of new transmission infrastructures.

Waste-to-energy for hydrogen

The opportunities offered by sector integration from waste management to the energy sector (generation of electricity, production of biomethane and district heating) and transport (waste collection vehicles, buses, etc.) can be illustrated clearly by the example of waste treatment. The electricity they produce can also be used to produce hydrogen.

Thermal treatment of waste is also indispensable in the long term to ensure the safe disposal of non-high-quality recyclable waste and residual waste from recycling measures, as well as to minimise landfill.

The waste heat released during waste treatment is available for the supply of electricity and district heating also in the medium and long term. In the context of a comprehensive Life Cycle Assessment, waste heat recovery is climate-friendly since fossil CO_2 emissions from plastic waste can be attributed to the footprint of the products, and not to the footprint of the waste. In addition, it is already about 50-60% renewable by virtue of the proportion coming from biological/biogenic waste components.

Policy recommendations in brief

1. The EU framework should be adapted in order to incentivise the development of both a European and decentralised hydrogen economy, by allowing specific network expansion, developing a new gases terminology and related certification system.

2. The EU legal framework needs to be adapted to reorient gas distribution infrastructures to allow further development and retrofitting of the gas network and make the most of valuable gas DSOs expertise.

3. European rules for the use of hydrogen in the distribution grids need to be developed, notably technical requirements, security rules and harmonised standards.

4. The national regulatory frameworks need to be adapted for the increased integration of hydrogen in the distribution grid, to ensure that infrastructure planning takes into account the long-term development perspective and the investments and costs related to retrofitting.

5. Relevant EU funding programmes, dedicated project financing and regulatory "sandboxes" should be further developed and strengthened with the aim to kickstart broad implementation of regional and local hydrogen projects.

Find out more about our policy recommendations on pages 21-22.

INFRASTRUCTURES FOR HYDROGEN

Make use of existing gas grids

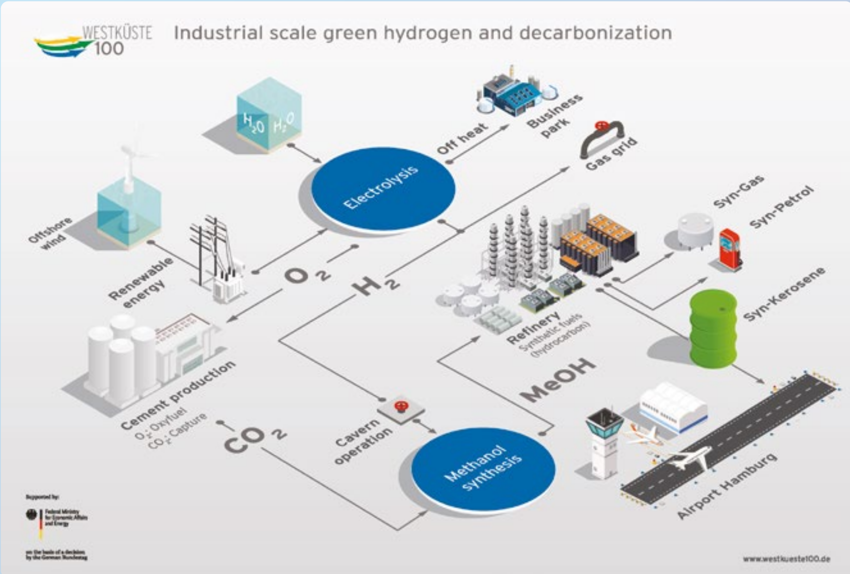
At present, the question concerning the infrastructures needed for the transport and distribution of hydrogen is not given sufficient attention in the public discussion. This aspect, however, is essential with regard to the demand-oriented provision and the infrastructure cost for hydrogen.

In addition to the further expansion of renewable energies and to the adaptation of the electricity and gas distribution systems with intelligent **flexibility** tools, it must be ensured that gases – as a storable and constantly available energy source – are reliably and economically available in all forms. This will continue to require an efficient gas infrastructure in the future.

FOR EXAMPLE

Examples of municipal projects include the power-to-gas project in **Augsburg** which combines local PV generation with electricity and heat supply in renovated buildings.

There are also projects at regional level on an industrial scale, such as the “**Reallabor Westküste 100”** in Schleswig-Holstein which, with the participation of municipal enterprises, combines the most varied areas of application from the heating market to aviation fuel, by using electricity that would otherwise be curtailed for the generation of hydrogen.



Continuing to use the **existing gas infrastructure** in a future decarbonised economy – through hydrogen blending or reassignment to hydrogen, or by gradually replacing natural gas with biomethane – makes a significant contribution to the profitability of a sustainable energy supply: this infrastructure has already been paid for by network users in the past. Like for the gas grid, the hydrogen grid will be an infrastructure based on pipes that must be subject to very strict technical safety requirements. The existing expertise and knowledge of gas grid operators should definitely be relied upon: they are well placed to identify an efficient cross-sector optimum for the integrated energy system and therefore for establishing and operating hydrogen infrastructure.

Gases in the **distribution** grids can contribute stepwise to the decarbonisation goals, by adding different renewable and decarbonised gases (biomethane, synthetic gas, hydrogen). This way CO_2-emissions can be reduced in sectors connected to the gas distribution grid today. This is for instance the case of the building sector, which constitutes around 40% of the EU energy needs and causes around a third of energy-related CO_2 emissions. These can be gradually reduced by adding hydrogen (or other renewable and decarbonised gases) to the natural gas grid. This is a cost-efficient and inclusive long-term decarbonisation option, especially for existing buildings.

The gas grids and the appliances of connected consumers must therefore be upgraded to enable hydrogen to be received and processed on a large scale. This will require a special attention to the upgrade and verification programs that will be necessary for the existing grids and appliances.

Although the allowed maximum concentration of hydrogen in the gas grid is still far from being reached, the distribution system operators are striving to rapidly leverage the potential of hydrogen and are assessing how to increase the maximum permitted admixture of hydrogen to the full extent technically possible.

Apart being already paid for, existing gas infrastructure has the advantage of allowing gradual addition of hydrogen ("blending") as well as complete conversion to hydrogen for specific user groups – with the appropriate technical adaptations. The addition of up to 10% hydrogen is now already considered to be uncritical[5]. Each additional percentage of hydrogen that is fed into the gas grid can increase CO_2 savings in the short term via the existing gas infrastructure.

CEDEC welcomes the fact that many projects are currently committed to adding up to 20% of hydrogen to the gas distribution grid and are examining the hydrogen compatibility of the systems and components in the gas distribution network. In the future, hydrogen will not necessarily have to be fed in nationwide. Regional aspects such as existing pure hydrogen grids or the existing customer structure should be considered.

FOR EXAMPLE

In **Hamburg**, the mySMARTlife project is piloting the blending of up to 30% of hydrogen into the gas distribution network for the purpose of operating a climate-friendly heating system, even with fluctuating hydrogen percentages. The project serves to set up a climate-friendly heating network in the "Am Schilfpark" development zone in Hamburg-Bergedorf. The network supplies 273 homes with heating energy and hot water. The heat is supplied by two CHPs and two peak load boilers. In the project, the fuel comes via the gas distribution network as well as a hydrogen feed-in system. An infeed system mixes the natural gas with an H2 blending of up to 30%.

Therefore, it is important that the blending of larger quantities of hydrogen can be planned over the long term. There has to be a **reliable roadmap** in order to avoid consecutive new adjustments on the consumer side. The switch from L-gas to H-gas in Germany, the Netherlands and Belgium shows roughly how complex this can be. The experience in Belgium shows however that a clear calendar, a timely planned preparation of the whole operation and targeted communication can turn such a turn-around into a successful project.

Potential producers of and investors in renewable and decarbonised gases would benefit from greater clarity in the EU regulations with regard to the management of **gas quality**. In order to increase the production of renewable and decarbonised gases, there needs to be an EU-wide regulatory framework with clear definitions and requirements, preferably in the relevant gas directive.[6]

Integrated planning

Coordination on the further expansion of energy infrastructures (electricity, gas, heating) is imperative to interlink the different sectors, to leverage synergies and to develop consistently the path from a pure electricity driven transformation towards a coherent energy system transition.

The currently applied separate planning of the energy infrastructures needs to be switched to an integrated network planning that takes into account customer needs. By doing so, the energy transition in all sectors is brought in line with grid expansion paths.

The political goals and the regulatory framework for all market players need to be revised in order to plan and operate energy infrastructures for electricity, heating, gas and transport in a more integrated way.

FOR EXAMPLE

Wiener Stadtwerke Group and its subsidiaries Wien Energie, Wiener Netze and Wiener Linien are working together on a comprehensive hydrogen-strategy for Vienna, in order to ascertain how this energy vector can be introduced and integrated in existing and new installations.

In 2020 Wiener Wasserstoff GmbH was founded to operate a P2G-facility in the near future. As from 2023 Wiener Linien will operate 10 hydrogen busses in the City. The refueling infrastructure will be provided by Wiener Netze, the combi-grid operator (DSO). Wien Energie will produce, trade and provide the hydrogen fuel.

Wiener Stadtwerke Group considers hydrogen as an important cornerstone to improve sector integration on its territory. Therefore it plans to cover the whole value chain of the hydrogen economy, i.e. production, operation of P2G facilities, storage, refueling, use in power plants and industry, and blending in the gas grid.

Grid operators and power-to-X systems

Cooperation between P2X system operators and grid operators can make sense to enable P2X and create win-win situations. Regardless the current grid bottlenecks, a coordinated coupling and the synchronized expansion of grids and P2X systems can create the conditions to enable the use of decarbonised energy in interlinked sectors. Exploiting the sector integration potential requires earlier and coordinated grid expansion planning for system coupling.

Achieving CO_2-neutral energy use therefore requires integrated regulations and incentives for both P2X technologies and integrated grid orientation, promoting optimised location and operation of the different systems.

FOR EXAMPLE

In **Puglia**, the STORE&GO Project is supported by a partnership of 27 companies, with a budget of 28 Million Euro financed by Horizon 2020. The main target is to integrate Power to Gas technologies in the European power system. The main concept is based on the idea of exploiting the RES power surplus, to produce and store renewable gases. The Italian demonstration site has been realized at Troia, a municipality in the region of Puglia. In this region, high PV production capacities are available representing the South European RES situation. The innovative concept at this demo site consists of CO_2 capturing from ambient air, a modulated micro-reactor based on a methanation concept, a "small-scale" liquefaction to supply LRG (liquefied renewable gas) to a dedicated cryogenic tank and an optimized energy management able to follow a proper set of business and strategic objectives. The plant exploits the hydrogen produced by the electrolyser inherited from the INGRID Project, connected to the MV power grid and able to provide balancing services.

P2X systems should in principle be operated in a market environment.

CEDEC believes however that distribution system operators should also be able to operate and use P2X systems for the optimisation of their grid operations, resulting in enhanced system security.

FOR EXAMPLE

The Brussels distribution system operator **Sibelga**, in collaboration with John Cockerill (international provider of specialised energy technologies) and the Belgian gas transmission system operator Fluxys, launched the H2GridLab research partnership. The partnership aims at creating a living lab open to any stakeholders and supplied with renewable hydrogen. The designated experimental site will host a series of pilot projects including renewable hydrogen generation from on-site solar PVs, local storage of hydrogen and injection of hydrogen in the gas distribution grid.

This is a sensible and necessary step from the perspective of the resilience of energy systems. In this way, the benefits of a hydrogen system will be available to operators of critical infrastructures to ensure grid resilience and security of supply.

GENERATION OF HYDROGEN

Decentralised generation

The quantities required in the future to cover the demand for hydrogen can only be provided if the greatest possible variety of sources of hydrogen supply can be exploited, with the smallest possible carbon footprint. Decentralised generation in smaller flexible units therefore becomes the first pillar for supply, in addition to the pillars of industrial-scale hydrogen production and importation.

Therefore, from CEDEC's perspective, the needed hydrogen quantities require multiple sources:

- Generation in the EU Member States:
  - produced in decentralised plants. Local plants mean regional value creation and short distribution chains for the future hydrogen supply in the heating, transport and industry sectors. In modular structures, they also allow the necessary experimentation in cost-efficient units, by virtue of being scalable, thus avoiding high sunk costs. Moreover, they can make use of existing infrastructure and thus avoid excessive costs.
  - produced in large industrial plants, taking advantages from economies of scale.
- Import:

  In addition to European hydrogen generation, (renewable or decarbonised) hydrogen needs to be imported. When considering domestic generation and import, cost arguments need to be taken into account when weighing up available and new transport versus local generation.

Different available technologies for hydrogen generation have to be taken into account.

FOR EXAMPLE

The methane pyrolysis process can also be interesting for distribution network operators, when implemented as a **city gate variant**. In that scenario, natural gas is supplied as usual, e.g. to industrial customers or residential areas. There, the carbon is separated from the methane, and hydrogen (any mix of CH_4 and H_2 is also feasible) is delivered to the customer. This eliminates the problem of blending in the transport and distribution networks. Various research projects are currently underway.

In order to make enough renewable and decarbonised gases available, an **incentive programme** needs to be established which is market-oriented and promotes regional value added. One option would be a system of incentives based on tenders and market premiums.

Development of electrolysis output

Local utilities are already using water electrolysis technology in numerous projects. As modern electrolysers can work with both constant and fluctuating electricity supplies, practically all conceivable electricity sources can be used to operate a hydrogen generation plant.

With optimal operation, the electrolysis system can not only provide flexibility potential for the integration of renewable energies, but hydrogen generation can also provide flexibility for CHP systems that generate electricity and district heating continuously on the basis of a permanent waste disposal assignment (e.g. thermal waste and wastewater treatment plants).

For local utilities there are also a large number of options for increasing the overall efficiency of hydrogen generation. For example, potential applications exist – often even in close proximity – for the "by-products" of hydrogen generation, especially oxygen and waste heat.

FOR EXAMPLE

Localhy is a German network of actors from business, science and municipalities who have set themselves the goal of generating and using hydrogen in a decentralized manner. In the Localhy project, a pressure electrolyser is being installed at the Sonneberg-Heubisch sewage treatment plant, which produces H2 and oxygen. The aim of Localhy is climate-friendly solutions for the energy industry, mobility and municipal wastewater disposal.
The decentralized approach enables local added value and promotes not only effective climate, environmental and water protection but also sustainable development at the municipal level.

This decentralised potential for the generation of high-quality and climate-friendly hydrogen and its optimal integration into local and regional energy and transport systems can be ideally matched to local needs, making an important contribution to the development of a hydrogen ecosystem in Europe.

To ensure that this potential can be leveraged, favourable basic conditions have to be established – for all plant types and sizes. The regulatory framework must guarantee fair conditions for the different hydrogen qualities and, in particular, boost the competitiveness of renewable and decarbonised gases compared to conventionally produced gases.

APPLICATIONS FOR HYDROGEN

Hydrogen is intended for use in all sectors. The areas that should be supplied with hydrogen as a priority are those in which no alternatives (e.g. through electrification) are available or where such alternatives do not make sense in physical or economic terms. In addition to use in industry, which is in many Member States mainly supplied via the gas distribution networks, this also concerns mobility as well as the supply of heat, especially in local neighbourhood concepts and existing buildings.

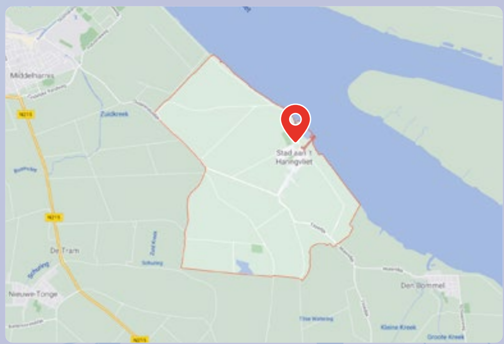
The suitability of consumer appliances to deal with greater concentrations of hydrogen has not been clearly established yet. It is therefore important that appropriately certified consumer appliances suitable for operating with a higher concentration of hydrogen are available. For this there need to be EU-wide specifications for equipment manufacturers.

Hydrogen in the existing building stock

As recently highlighted by the European Commission in the "Renovation Wave" strategy, the European building stock is currently responsible for 40% of energy consumption. At the current renovation rate of around 1% per year, approximately 30% of buildings will be renovated by 2050. Even if the renovation rate increases significantly, a large proportion of buildings will still not have been renovated in 2050. These buildings can then only become "Paris Agreement compatible" if the CO_2 emissions of the energy sources they use decrease over time. The use of renewable and decarbonised gases including hydrogen in the heating sector is in this regard imperative, along with other measures for building insulation and heating appliances renovation.

FOR EXAMPLE

In **Stad aan 't Haringvliet**, Stedin, a Dutch electricity and gas DSO, is working on a hydrogen pilot project, where 600 households currently connected to the natural gas grid will switch to a hydrogen based heating technology. In this project, Stedin aims to investigate how the existing natural gas grid can be refitted for hydrogen and how to convert heating technologies with minimum interference for residents.



Hydrogen in the neighbourhood

The use of hydrogen in the building segment and the required infeed into the gas grid is necessary and sensible. Therefore, the neighbourhood approach, which is now practised by many local utilities, offers great opportunities for synergy effects through sector integration. Public utilities as local partners can, for example, contribute with their know-how in projects with hydrogen as a district storage facility, or in connection with fuel cells or hybrid heat pumps.

FOR EXAMPLE

The New West City is currently being built in Esslingen (Germany): 600 apartments, offices and commercial spaces as well as a new building for the University of Esslingen are to be constructed here over the next few years. The district is intended to be climate-neutral, with excess electricity from renewable energies being converted into hydrogen. The heat generated during the process is used to heat the apartments and offices via a local heating network. Additional heat will be generated by a CHP that can run on hydrogen.

Hydrogen in CHP plants

Cogeneration (CHP) plants play a key role in covering electricity needs in combination with the secure supply of heat. In view of the phase-out of nuclear energy and/or coal in the majority of Member States, Europe needs additional capacity to cover the residual demand for electricity. At times when the sun is not shining and the wind is not blowing, CHP plants primarily produce the electricity that cannot be provided by the volatile renewable energy plants. Thus, flexible generation – to compensate for a rising share of non-flexible variable RES generation – brings also a decisive contribution for maintaining security of supply.

A CHP plant can be decarbonised by using waste, biogas/biomethane, synthetic methane and hydrogen.

FOR EXAMPLE

The Power-to-Gas plant of the Stadtwerk Haßfurt utility company, trials a bivalent H2/natural gas CHP plant, coupled to an electrolyser and H2 storage facility.

The **Augsburg project** mentioned above facilitates the coverage of the electricity and heat supply for a renovated multi-floor residential building with 20% of urban renewable energy.

The energy transition also implies a heat transition, for which the local utilities are an indispensable partner: they have local and regional roots and they are the operators of the gas distribution and heating networks, already making a significant contribution to climate-friendly heat supply. Hydrogen will play an important role to significantly reduce CO_2 emissions even further in the heating sector. Therefore, cogeneration plants operated with renewable and decarbonised gases will also be able to make a long-term contribution to a carbon-neutral supply for the electricity and heating market – with operating hours efficiently reduced compared with today.

Hydrogen in mobility

Hydrogen will mainly be used in the transport sector where battery-electric mobility does not make sense for reasons of economic efficiency, technical feasibility or transport efficiency (weight, range, turnover rate).

FOR EXAMPLE

The utility company **Wuppertaler Stadtwerke** (WSW) and the waste management company Abfallwirtschaftsgesellschaft Wuppertal (AWG) have joined forces to conduct the "H2-W – Hydrogen Mobility for Wuppertal" project.

Electricity that is generated during the thermal treatment of residual waste in the incineration plant is used to produce hydrogen by means of electrolysis. This hydrogen is used, in turn, to refuel fuel-cell busses. Due to the topography of Wuppertal and the associated drive requirements, WSW opted for hydrogen technology instead of electric mobility.

In the local economy, this primarily affects the vehicle fleets of public transport, waste management and road-cleaning companies. Hydrogen fuel cell vehicles offer significant advantages in terms of the driving range, the size and the driving power. Battery vehicles quickly reach their limits in places where the topography requires particularly powerful drive systems or large masses have to be moved.

When mixed back with CO_2, hydrogen can also be processed further into synthetic gases and liquid fuels. One advantage of gaseous and liquid synthetic fuels is that they can be used in existing fleets without special modifications.

As the local utilities actively support the climate and environment policy objectives of their municipal shareholders, they are also promoting alternative drive systems in the transport sector. The battery-electric vehicles already used for many years have proven their value. Now it is a matter of gradually converting all areas of local economy mobility to climate-friendly drive systems. Developments in this area are making a promising start. With fuel cell driven vehicles coming onto the market in increasing numbers, more and more local utilities are planning to procure emission-free vehicles.

The special feature of many local hydrogen projects is the closed cycle from local electricity generation to local hydrogen generation, with the use of hydrogen in dedicated mobility needs and the operation of vehicle charging systems.

The decisive advantages include the appropriate provision of hydrogen as an energy source for local mobility, short distribution chains that avoid transport losses, optimal integration of components into the local or regional energy system, as well as regional value creation.

A final, but essential argument in favour of these decentralised supply concepts is the respect for the principle of subsidiarity. Challenges are addressed where they can be optimally solved, thus reducing the need for long-distance hydrogen transmission and hydrogen imports.

Possible applications for the by-products of hydrogen generation

The waste heat produced during hydrogen generation can be used as a by-product (e.g. for commercial use or in public networks). This shows a further advantage of using local infrastructures, with heat sinks primarily located in urban areas. By using the waste heat, the efficiency and profitability of hydrogen generation are also improved.

In addition to the use of waste heat, it is also possible to use the resulting oxygen which would otherwise have to be produced and transported elsewhere. Instead of transporting and discharging the waste heat and the oxygen resulting from the hydrogen generation process, it is possible to re-use and therefore extract value from them locally. The possible uses for the oxygen include the local wastewater treatment plant or the dairy factory. Moreover, being relatively easy to produce ozone from the oxygen, it is also possible to use this ozone to remove pharmaceutical residues from the wastewater.

FOR EXAMPLE

The **Berliner Wasserbetriebe** water utility company is examining the use of oxygen in the biological treatment of wastewater using excess wind energy to generate green hydrogen (status: development of E-WaKO project outline). Here, the company Graforce, a subsidiary of Berliner Wasserbetriebe, is currently building a plasmalysis pilot plant for the treatment of centrates from sludge dewatering in a sewage treatment plant owned by Berliner Wasserbetriebe. The wastewater from sewage treatment plants contains a high proportion of nitrogen compounds. The plasma process splits the water and nitrogen compounds contained in it into individual N, H and O atoms. These then reconnect. The now cleaned water can then be returned to the natural cycle, while hydrogen, oxygen and nitrogen are passed into a gas membrane, where they are sorted. Nitrogen and oxygen escape into the air, with the remaining hydrogen filled into a tank. The hydrogen is then mixed with biomethane. Berliner Wassersbetriebe wants to use the fuel extracted from the wastewater to fuel its own fleet of vehicles, among other things.

Also from a circular economy point of view, the local utilities are closely connected to the local economic structure (industry and commerce) and are therefore ideally placed to exploit local opportunities for re-use of by-products, further increasing the benefits of local hydrogen generation.

Quality standards and certificates

For a European and global market for renewable and decarbonised hydrogen to be able to develop, supporting the energy transition and strengthening export opportunities, the development of clear quality standards and, in particular, reliable certificates of renewable and decarbonised hydrogen and its derived products is needed. These certificates should support different levels of sustainability as well as value local implementation in order to incentivise the creation of local markets.

Besides enabling European and worldwide trading of renewable and decarbonised gases and their derived products, these certifications also form the basis for new sustainable products and services across all potential areas of application, like industry, heating or mobility.

In order for the trading of renewable and decarbonised gases to also work within the EU, there needs to be an **EU-wide Guarantees of Origin (GO)** scheme **for gases** similar to that for electricity. It should take into account the specifics relevant to gas, for example the longer validity of certificates over time.

Endnotes

1 http://www.cedec.com/files/default/flexibility-in-the-energy-transition-a-tool-for-gas-dsos-2018.pdf
2 EN 16723-1: 2016 for the injection of biomethane in the natural gas grid and EN 16723-2:2017 on natural gas and biomethane for use in transport
3 https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf
4 https://www.iea.org/reports/world-energy-outlook-2019/electricity#abstract
5 Hydrogen tolerance of the natural gas infrastructure - DVGW German Association of the Gas and Water Industry, 02.05.2020
6 Directive 2009/73/EC concerning common rules for the internal market in natural gas

POLICY RECOMMENDATIONS

In order to make the generation and use of hydrogen and its derived products an effective building stone of the future integrated energy system on the road to 2050 decarbonization goals, the following adjustments to the legislative and regulatory framework are deemed necessary.

1 Adapt EU framework to incentive the development of both a European and decentralized hydrogen economy

- The role of renewable and decarbonised gases, including hydrogen, in the energy supply will need to increase. It is therefore important to develop a clear strategy and answer fundamental questions about the generation, transmission and distribution of these gases at the European level.
- Differentiated cross-sectoral approaches should be developed to create European, cross-border and local markets, specifically taking account of the needs of network transformation and network expansion for the decarbonised energy supply for industry, mobility and housing.
- An EU-wide framework for renewable and decarbonised gases, including a uniform terminology for those gas types, should be introduced in the gas directive in order to accelerate the establishment of a European market for these gases.
- A European labelling and detection system (through Guarantees of Origin (GO) or certification) should be developed for the different types of renewable and decarbonised gases (including hydrogen), possibly also differentiated to their regional origin.

2 Adapt EU framework to reorient gas distribution infrastructures

- Feeding hydrogen into gas distribution grids makes economic sense if parallel hydrogen infrastructures are not economically viable, or if connection of decentralised hydrogen production to a hydrogen 'backbone' is economically inefficient. In order to turn the transportation and distribution infrastructure of natural gas into a solid basis for a hydrogen economy, the regulatory framework that applies currently to them needs to be adapted. The valuable technical expertise of gas distribution system operators should be valorised for the retrofitting of existing gas grids and the construction and operation of dedicated hydrogen grids.
- The expansion and conversion of gas distribution grids for the storage and distribution of renewable and decarbonised gases must be recognised as sustainable investments in the delegated act on the Taxonomy Regulation.
- It must be clarified whether hydrogen grids are operated as a private, commercial activity or fall within the regulated domain. Where DSOs will operate hydrogen grids, they will fall in the regulated domain; where commercial operators operate hydrogen grids with open third-party access, they should fall under

the same regulated regime. In general, for all hydrogen networks operated in comparable conditions, comparable rules should apply.

3 Define European technical rules for use of hydrogen in distribution grids

- The development of harmonised and certified European standards for hydrogen-based energy sources and chemicals is required.
- Regarding technical and security rules, harmonised terms and conditions would avoid obstacles to an integrated approach of the energy systems.
- EU-wide minimum percentages should be introduced for the admixture of renewable and decarbonised gases (like biomethane and hydrogen) into the distribution grid, along with according EU-wide regulations for equipment manufacturers.

4 Adapt national regulatory frameworks for increased integration of hydrogen in distribution

- The transformation process includes some open questions that will be tackled in the course of implementation, whereas investments decisions for the grid infrastructure are made upfront, taking into consideration the long-term development perspective. Therefore it should be ensured that the costs incurred for retrofitting the grid infrastructure – as part of a clear strategy to integrate higher hydrogen proportions – are given appropriate recognition in the national regulatory framework.
- DSOs can take on further tasks related to the quality management of renewable and decarbonised gases (transformation stations, recompression units, purification and conditioning) in order to ensure operational and investment security for producers and to accelerate market development.
- The structure of taxes and levies on different energy vectors should be examined and reviewed, in order to ensure a level playing field and avoid that fiscal obstacles would hinder the development of a hydrogen economy.

5 Develop a supportive financial framework for R&D and first implementations

- European and national funding programmes for hydrogen must be strengthened, and allocated in a targeted manner. This is particularly indicated to further increase public awareness of hydrogen technologies. Local utilities have already implemented initial projects, e.g. with electrolysers, H2 storage facilities and hydrogen CHPs, or have initiated projects on hydrogen mobility to connect with future users. These initiatives contribute to a broad societal debate that is conducive to social acceptance. This is, in turn, an essential prerequisite for the market uptake of hydrogen-based technologies.
- The promotion of experimental pilot projects, involving gas DSOs, such as “regulatory sandboxes”, could offer an added value for the wider development of the hydrogen business.

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