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Towards an EU Integrated Energy System

EUGINE and EUTurbines, the associations representing gas power plants technologies, welcome the European Commission's plans to develop an EU Strategy to enhance the connections and interactions within the energy system. Our technologies – gas engines and turbines – are at the centre of the energy system, connecting the gas, electricity and heat/cold networks, also in a future climate-neutral economy. The future Strategy needs to set the right framework that enables the smooth integration of the different sectors and, specific to the gas sector and entire infrastructure, facilitates their decarbonisation.

This document provides the industry's view on the future integrated energy system and how renewable and decarbonised gases – as well as their use in power generation – have an important role to play; not only in the transitional period but also in a climate-neutral economy. Addressing the questions raised by the European Commission in the on-going consultation, this paper also identifies existing barriers to sector integration and proposes measures to overcome these.

In a nutshell

- The future integrated energy system is made of electrons, climate-neutral gas and liquid fuels as well as heat/cold
- System integration should not be seen as the effort to maximise the electrification of energy supply but to benefit from the interactions of the electricity, gas and heat networks to find the best solution for each need
- Cogeneration is at the centre of system integration and is a key contributor to the EU energy efficiency targets
- The future energy system will need flexibility solutions of different kinds – including flexible gas power generation able to deliver on demand
- The gas network provides long-term and seasonal storage, which other storage and flexibility solutions are not able to cover and offers a cost-efficient option to utilise the existing infrastructure in a sustainable way with the introduction of renewable and decarbonised gases
- The use of renewable gases in power generation needs to be regarded as an important element of the energy system, in combination with the long-term and seasonal storage capability of the gas network – guaranteeing the stability of the grid and security of supply in a sustainable way
- The gas engine and turbine technologies are not fossil-based technologies: they can and often already operate with renewable and decarbonised gases
- Unused heat from industrial processes can be used to produce additional power (heat-to-power) and increase the energy efficiency of energy intensive industries
- A framework is necessary to make renewable gases/fuels available in large quantities and at an affordable price – similar to the support of renewable electricity in the past
- Other aspects such as sustainable finance and R&I priorities also need to support the needs of the future integrated energy system

A decarbonised and truly integrated energy system

Europe's target of becoming a climate-neutral economy by 2050 the latest implies an enormous effort and will require the use of all available ideas and solutions. During recent years, the focus was predominantly put on the decarbonisation of electricity generation. The success of these efforts is

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impressive. However, climate neutrality requires policy to shift the focus from electrification to overall decarbonisation: Europe's future economy will need to build on carbon-neutral energy carried via electrons, gas, liquid fuels and heat/cold into all sectors.

To ensure that energy is not only clean, but also affordable and reliable, all sectors of the economy should be able to choose the best suitable energy carrier for decarbonisation – may this be electricity, decarbonised and renewable gas and liquid fuels or heat/cold – and their source. During the transitional period, the energy system should be supported by sources that can provide decarbonised energy and, in the shorter term, low-carbon energy, as long as carbon lock-in is avoided.

The supply of heat/cold, renewable gas and liquid fuels and especially electricity – dominated by variable generation – will usually not match their demand in total quantities nor the exact quantities needed at certain moments by different consumers. System integration provides the infrastructure that allows electricity, gas and heat to be transformed into each other as needed, benefitting from their different storage possibilities.

Digitalisation will allow steering the streams in the most cost-efficient way, while markets define which amounts of a given energy carrier are needed. Balancing the different system needs and demands defines the beauty of smart system integration.

Electricity generation and electrification

The further massive deployment of renewable electricity generation from variable sources is an essential brick of any energy strategy for Europe. Electrification can provide an essential contribution to the decarbonisation of some segments of the economy. However, this does not automatically imply that electrification is the only or best solution for decarbonising sectors like mobility, the heating of buildings or process heat needed for industrial purposes.

The decarbonisation of heating in buildings can be done through electrification, heat pumps, on-site cogeneration or heat from district heating networks through central cogeneration plants, both using renewable and decarbonised gases: all options should be considered before choosing the best solution in a specific situation. The same applies for mobility: there are different equally valid carbon-neutral solutions, which should be evaluated before a decision is taken.

In this sense, expanding the capacities of variable electricity generation should not be automatically connected with the electrification of end-use applications. Wind and PV installations might also serve as suppliers of heat ("power-to-heat") as well as renewable gases ("power-to-gas", -liquids or -chemicals). Part of this electricity generation would be an interim production step – like the use of an electrolyser – enabling the provision of e.g. green hydrogen or sustainable heat for the decarbonisation of other sectors.

Role of gas

Gas as an energy carrier and the existing gas network enable the large-scale and long-term storage of energy and offer an efficient transport infrastructure. The progressive replacement of the natural gas transported today by renewable and decarbonised gases will allow us to continue benefitting from its properties and advantages – also in a climate neutral economy.

The decarbonisation of gas and of the gas sector can take place in different forms, through:

- renewable hydrogen produced from electricity through Power-to-Gas technologies
- bio-based gases, such as biogas and biomethane – increasingly being used in distribution grids
- synthetic methane and other fuels –processed from hydrogen, adapting to the needs of different end-users and sectors
- decarbonised hydrogen – based on natural gas through processes such as pyrolysis or steam methane reforming and in combination with Carbon Capture and Use or Storage (CCUS), as an interim step to accelerate the transition, while the amounts of renewable hydrogen are increased

Renewable and decarbonised gases should be recognised as energy that can contribute to a climate-neutral energy system, similar to renewable electricity. Their provision should therefore be incentivised and supported by legislation.

Replacing natural gas in the gas grid will mainly be achieved by producing and injecting large amounts of biomethane and hydrogen into the gas grid. As both have different properties and production sites and user preferences may differ, it will need an intelligent use of the transmission and distribution grids to ensure an optimal transport.

The use of renewable and decarbonised gases helps gas-based applications to decarbonise. In the power sector, their use in flexible gas power generation – both centralised and distributed – enables the provision of sustainable reliable power and heat/cold whenever needed. Flexible gas power generation ensures that the lights remain on when variable renewables cannot deliver – providing security of supply and stability of the (electricity) grid.

Gas power technologies (engines and turbines) are already capable to adapt and operate with different types and qualities of gases. Specific to the use of renewable and decarbonised hydrogen, the technology's capability to use different amounts of hydrogen will continue to increase, as higher amounts become available. Already today, there are several examples of gas engines running with more than 50% hydrogen and the turbine manufacturers have committed to provide 100% hydrogen solutions by 2030 (see www.powertheeu.eu).

In the same way, retrofit solutions are being developed to ensure that existing assets as well as investments in the short-term are future-proof and remain relevant in the future climate neutral economy.

The gas sector is coupled with the electricity and the heat sectors, where:

- gases resulting from Power-to-Gas solutions – using renewable electricity as "raw material" – can be stored and transported
- electricity and heat are provided through flexible gas power generation

Role of heat

The provision of heat – but also cold – is the third pillar of a well-integrated energy system: accounting for half of Europe's energy consumption, it is not only needed in buildings, but also in industries as process heat. In addition to electrification, there are other alternatives to ensure a sustainable, efficient and stable heat supply.

Cogeneration (and trigeneration) plants are at the centre of sector coupling, where the electricity, gas and heating (and cooling) networks are brought together. From micro-cogeneration in buildings (engines or fuel cells) to distributed or large cogeneration plants for district networks in cities (turbines or engines) and industry, these plants supply about 11% of EU's electricity and 16.5% of its heat, providing flexibility, synergies and efficiency gains to Europe's energy system.

Many European countries have district heating networks, making use of the extremely high-efficiency of cogeneration plants as well as allowing the transport of unused heat from industrial processes to other consumers like private households. Heat networks, by this, contribute to an efficient use of available energy.

The heat sector is coupled with the electricity and the gas sectors, where:

- heat can be produced by efficient cogeneration plants, using renewable or decarbonised gas as primary energy source
- heat can be produced from renewable power by power-to-heat facilities
- heat can be stored as a medium-term storage solution, which can in turn be converted into electricity when needed

Energy efficiency and cost-efficiency potential

The best approach towards the decarbonisation of the economy is the reduction of primary energy input resources through increased efficiency. In this sense, "energy efficiency first" has become a mantra of the EU's energy policy.

Energy efficiency is not only about insulation of buildings and a reduction of electricity consumption in consumer goods. It is also about an efficient electricity generation, transport and storage in a smart integrated energy system, which utilises all available solutions in the best way. This includes avoiding curtailment of wind and PV generation as well as the use of generation solutions with an extremely high efficiency like cogeneration.

Energy efficiency is, however, not achieved by handpicking technologies and excluding energy carriers. Focusing on a full electrification of energy supply limits the innovation possibilities to find the most energy efficient decarbonisation option, potentially leading to costly solutions. For example, it is very likely, that electricity storage will not be the most cost-efficient storage solution over long periods. Also, there may be better alternatives to transport energy over long distances. In the same way, it might be more beneficial and cost-efficient to use and further develop already existing gas and heat networks for energy transport instead of building costly new electricity infrastructure – often also facing resistance from affected residents.

In industry, “waste heat” resulting from industrial processes should also be considered a valuable resource. Making use of this otherwise unused heat to drive a steam turbine and produce additional power increases the energy efficiency of a given industry and its energy intensive processes. This is additional useful energy without any negative climate impact.

Best practices and projects on integrated energy systems

Cogeneration plants are a typical example of best practice not only in terms of efficiency but also showcasing the concept of system integration – which can also run on renewable gases (e.g. biogas or renewable hydrogen).

Some examples of projects showcasing system integration include:

- In Haßfurt, south of Germany, a cogeneration gas engine converts on demand 100% renewable hydrogen into renewable electricity and heat
- The H_2ORIZON project, at the German Aerospace Centre, in Lampoldshausen: Renewable electricity from the Harthäuser Wald, the biggest wind farm of Baden-Württemberg, is converted by an electrolyser into renewable hydrogen, which is later used as a fuel for a cogeneration gas engine providing heat & power to buildings
- The Port Lincoln Project, in Australia, will combine a 15 MW electrolyser plant, distributed ammonia production facility, a 10 MW hydrogen gas turbine and a 5 MW hydrogen fuel cell
- The “Get H2” project in Lingen, Germany, connecting the sectors energy, industry, transport and heat along the entire value chain, will include two power-to-gas plants with up to 100 MW and a 60MW hydrogen gas turbine

So far, such projects are unique concepts, which cannot benefit from economies of scale and are more expensive than those based on traditional fuels.

Main barriers

The biggest barrier to energy system integration is the misconception of its role. An integrated system does not mean connecting more sectors to electricity, but connecting them to carbon-neutral energy in the best suitable and cost-efficient way. The contribution of system integration is the openness of the system in transforming large energy quantities from one carrier to another one, disconnecting the amounts of electricity, gas and heat/cold produced from the quantities stored and consumed, giving all users the freedom for choosing the best energy carrier.

Technology neutrality is therefore an important element. Today this neutrality is limited by technology-specific subsidies promoting electricity, preferences in legislation for certain technologies or the inaccurate connection of the gas system with the source of fossil gas in legislation. For example, the current considerations on a taxonomy for sustainable economic activities could endanger investment opportunities for essential decarbonisation solutions, such as renewable gas power plants, and threaten the achievement of the EU energy and climate targets.

The availability of renewable gases and heat/cold is another big barrier. Over the past years, the availability of renewable electricity has been successfully increased thanks to extensive privileges and subsidies. A similar approach to support the uptake of renewable and decarbonised gases supply is needed to achieve a supply that matches their demand. This includes the production of hydrogen as well as biomethane. In both cases, technologies for their generation must be further developed and scaled-up. Producing sufficient amounts of hydrogen will require – during a transitional period – the provision of decarbonised hydrogen. This needs solutions for CCUS, since their availability is currently too limited.

In the same way, the gas grids must be upgraded and, where necessary, retrofitted to be able to handle the different properties connected to new gases and heat networks need to be adapted different heat temperature ranges. Equally, the storage solutions must also be made fit for purpose.

The technology that transforms gas into electricity and heat/cold – gas power or cogeneration with turbines or engines – needs to adapt to the use of renewable and decarbonised gases. This applies to new power plants as well as to the retrofitting of existing ones. However, their ability to progressively switch from natural gas to renewable and decarbonised gases and, therefore, to contribute to climate-neutrality is not sufficiently recognised. For that purpose, the technology providers need to develop solutions that have a long lead-time without sufficient payback. Research and innovation support but also solutions to finance pilot plants are not available in suitable ranges.

Policy and legislative measures

Achieving climate-neutrality by 2050 requires an ambitious, comprehensive and long-term strategy, which includes specific implementation plans and milestones as well as policy and legislative measures to enable a full decarbonisation of the energy system.

First of all, a suitable framework that enables and encourages investments in the transformation of the gas network as well as the use of renewable and decarbonised gases in the future is needed. Investments in the gas infrastructure itself (including power and heat/cold generation) do not lead to carbon lock-in or stranded investments – the **Sustainable Finance and Taxonomy** file needs to acknowledge the importance of gas infrastructure, including in gas power generation, and recognise them as sustainable activities. This is not to be misunderstood as support to natural gas as one feedstock.

In the same way, to increase the efficiency of the EU energy system, **revised state aid guidelines** should provide a long-term support to high efficiency cogeneration, waste heat recovery in industrial facilities as well as to heating/cooling networks.

Adequate research funding at both EU and national levels will be key to accelerate and scale up existing developments – paying special attention to projects that showcase the concept of smart system integration from different views, the development of the hydrogen economy and the adaption of technologies to the use of different renewable gases.

To make renewable gases/fuels available in large quantities and at an affordable price, the European Union should adopt the following measures:

- **A binding target for renewable gas consumption** in total EU gas consumption by 2030. Binding national targets for renewable gas consumption should add up to reach the EU target.

- **A framework supporting the production of renewable gases** – like existing schemes supporting electricity produced by wind and PV technologies – to help scale up renewable gas production and make economies of scale.

- **Guarantees of origin certifying the renewable or decarbonised nature of the produced gas** to give a higher value to renewable or decarbonised gases and liquid fuels than to the traditional ones and facilitate cross-border trade. Such certificates will also help disconnect renewable gas production from renewable gas consumption: renewable gases could be produced in large quantities – e.g. in farms or in the North Sea area – be fed into the gas grid and be later virtually consumed and credited to a specific gas user in another parts of Europe, thanks to the certification system.

- **An update of relevant European standards.** With the introduction of renewable and decarbonised gases – biogas, biomethane, synthetic gas and hydrogen – into the gas pipelines to replace natural gas, the European and national standards for the gas transmission and gas distribution will need to be adapted. This will ensure that the different properties of the new gases are taken into consideration and the networks and end-users are prepared for them.

- Tightened ETS provisions leading to **increased CO_2 prices** and making renewable gases competitive.

Beyond the availability of renewable and decarbonised gases, the new strategy should also foresee a common approach for blending the new gases into existing gas pipelines: the European Commission should invite gas grids operators, manufacturers and operators of technologies connected to gas pipelines to draft **a common roadmap** enabling the increased penetration of renewable and decarbonised gases.

About EUGINE and EUTurbines:

EUGINE is the voice of the European engine power plants industry, representing the leading European manufacturers of this flexible, efficient, reliable and environmentally sound technology. Engine power plants are an optimal solution for both backing-up and generating renewable energy (e.g. with biogas). Cogeneration, the combined generation of power and heat/cold, is a typical engine power plant application providing highest efficiency. For more information please see www.eugine.eu

EUTurbines is the only association of European gas and steam turbine manufacturers. Its members are Ansaldo Energia, Baker Hughes, Doosan Skoda Power, GE Power, MAN Energy Solutions, Mitsubishi Hitachi Power Systems, Siemens Gas and Power and Solar Turbines. EUTurbines advocates an economic and legislative environment for European turbine manufacturers to develop and grow R&I and manufacturing in Europe and promotes the role of turbine-based power generation in a sustainable, decarbonised European and global energy mix. For more information please see www.euturbines.eu