Sector coupling

KEY ISSUES FOR POLICYMAKERS IN DECARBONISING EUROPE'S GAS SYSTEM

Decarbonising the European energy system is likely to involve increasing use of electricity, particularly from renewable sources. This transition will pose challenges regarding the transport and storage of energy. Studies have found that continued use of gas storage and pipelines can help overcome these challenges. This note considers how policy needs to adapt to ensure that gas can keep providing flexibility to the energy system during decarbonisation.

The energy transition will be tough

To achieve the targets implied by the 2015 Paris agreement, greenhouse gas (GHG) emissions in the EU, particularly carbon dioxide (CO_2), will need to be slashed. Essentially, all energy-related GHG emissions in the electricity, heat, transport and industrial sectors will have to be cut to nearly zero by 2050.

A core element of the decarbonisation strategy will be replacing fossil fuels with renewable sources such as wind, solar and biomass (or with nuclear energy in some member states). Such a transition will create enormous challenges, as it requires:

- **producing** vast amounts of renewable and low-carbon energy and finding appropriate, publicly accepted production locations;
- **storing** large energy volumes over long periods, to match intermittent renewable supply with the pattern of energy demand; and
- **transporting** energy from where it can be produced most efficiently to where it is consumed. This will entail both long-distance transport, for example from offshore wind facilities to demand centres, and local distribution.

The gas system is part of the solution

Several recent studies have found that gases can contribute to addressing the three challenges set out above.

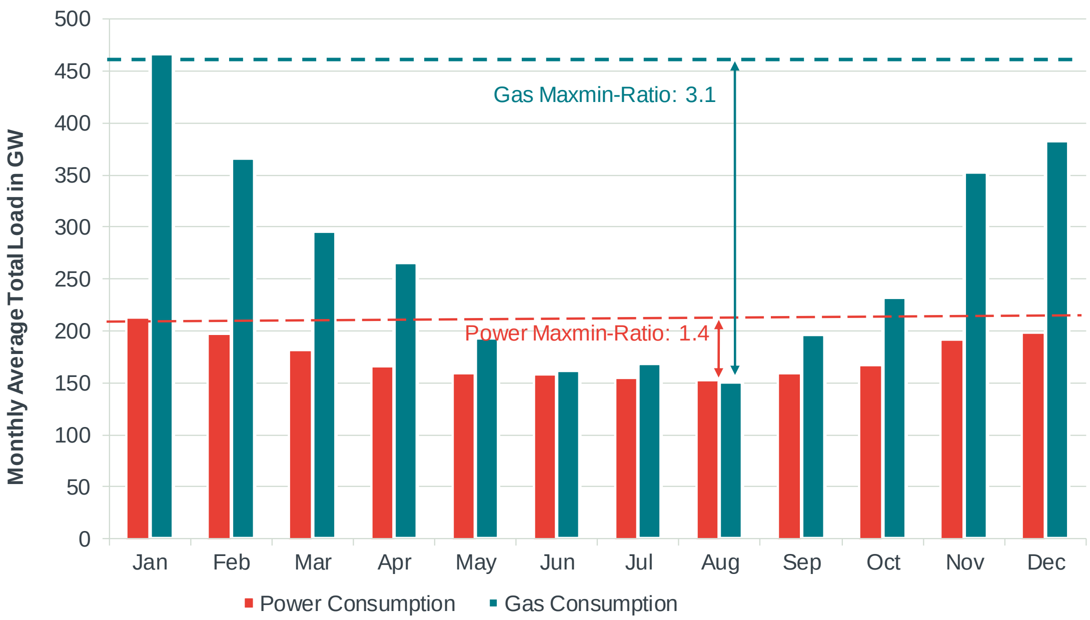
Low-carbon gases can be **produced** from primary sources. Examples include biogas and the reforming of natural gas to produce hydrogen (in conjunction with carbon capture and use or storage). The potential of these two gases is uncertain and might ultimately be limited by feedstock availability and public acceptance respectively. But there are fewer constraints on synthetic gases from electrolysis (also referred to as "power-to-gas", or PtG) generated using renewable or low-carbon electricity. PtG could be cost-competitive with natural gas under certain assumptions[1], including a robust carbon price. But the future story for gases does not rest solely on whether they can contribute to overcoming the production challenge. Rather, the focus needs to be on the potential cost savings from a "whole energy system" perspective.

The first element to such a perspective is realising that there are no meaningful alternatives to the **seasonal storage** provided by the gas system. This is crucial given the seasonal swings in heating

[1] Agora Verkehrswende, Agora Energiewende and Frontier Economics (2018): The Future Cost of Electricity-Based Synthetic Fuels https://www.agora-energiewende.de/fileadmin2/Projekte/2017/SynKost_2050/Agora_SynKost_Study_EN_WEB.pdf

demand in most of Europe. In an analysis by Frontier covering eight European countries[2], gas demand at the winter peak is roughly three times as high as in summer, whereas peak electricity demand is only 40% higher (Figure 1). Gas is stored in underground storage formations to meet this surge in seasonal demand. We found that existing gas storage capacity exceeds electricity storage by a factor of almost 1,000[3]. Even in the (unlikely and expensive) scenario of limited end-use of gases, the gas system would be needed to provide seasonal flexibility.

Figure 1 Gas demand is seasonal while electricity demand is (nearly) flat



Source: *IEA Statistics, ENTSO-E Transparency Platform*

Note: *The figure includes data for Belgium, The Czech Republic, Denmark, France, Germany, The Netherlands, Sweden and Switzerland. The Maxmin-Ratio is the ratio between the absolute monthly maximum and minimum demand for gas and power, respectively. The unweighted averages across the national Maxmin-Ratios are 1.4 and 3.6 for power and electricity, respectively.*

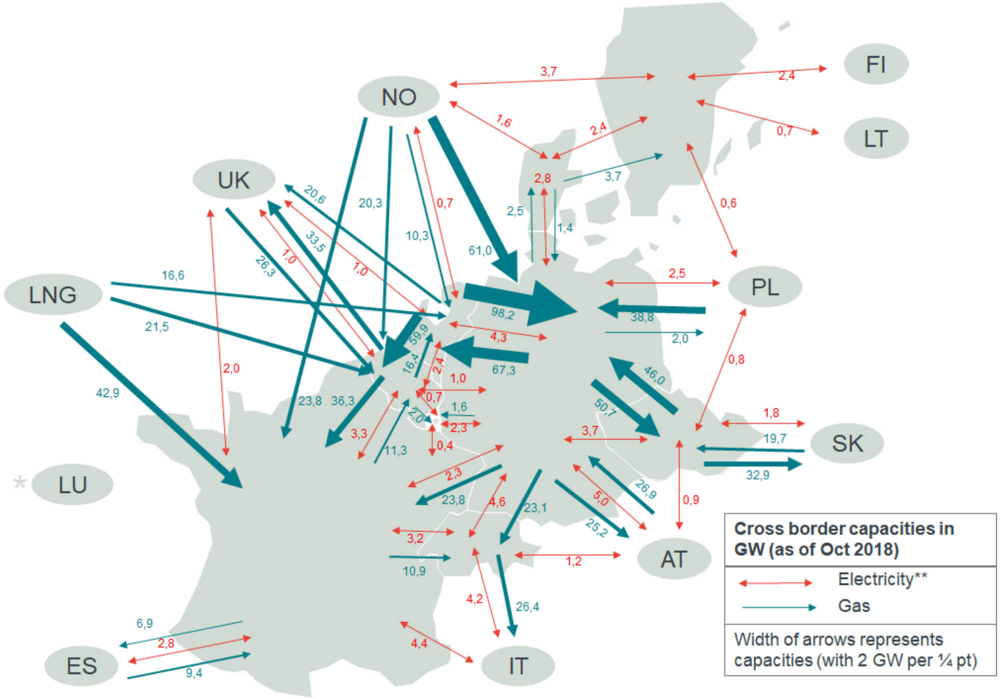
The other element is Europe's extensive **gas transport system**. The bulk of renewable generation is distant from load centres, requiring high-capacity energy transport grids. This is something that the (natural) gas infrastructure has been designed to provide from the outset:

- The existing **transmission capacity** of the gas network exceeds that of the electricity system nationally and internationally (Figure 2).
- The gas system also plays an important **distribution role**. Almost half of EU household end-energy consumers are connected to the gas network. On average, around four times more gas than electricity is distributed to households.

[2] Frontier Economics, IAEW, (2019) "The value of gas infrastructure in a climate-neutral Europe". On behalf of Green Gas Initiative (GGI) and Net4Gas.

[3] This excludes electricity storages with natural water inflows such as hydro reservoirs. Such facilities cannot readily store excess electricity from PV or wind energy peaks, but can at least reduce their output in periods of low demand and high PV and wind electricity production. This offers an additional ability to support winter peak demand (though more limited than other forms of electricity storage).

Figure 2 Cross-border transport capacity for gas vastly exceeds that for electricity



Source: Frontier Economics based on ENTSO-E and ENTSO-G

Recent work by Frontier has found that savings across the energy system from continued use of gas networks (as compared to switching all end applications to renewable electricity) could be around €12bn a year in Germany in 2050[4]. Together with seven other European countries[5], the savings could reach **€30bn-49bn**[6].This is equivalent to a saving of around €145-240 per capita per year.

Provided that gases are increasingly produced in renewable and low-carbon ways, the gas system therefore has an important role to play in meeting future energy needs. And with the development of technologies such as PtG and hybrid heat pumps[7], it will also become increasingly linked with other parts of the overall energy system. This is the notion of 'sector coupling' – a phrase used in particular to describe interlinkages between electricity and gas (Figure 3).

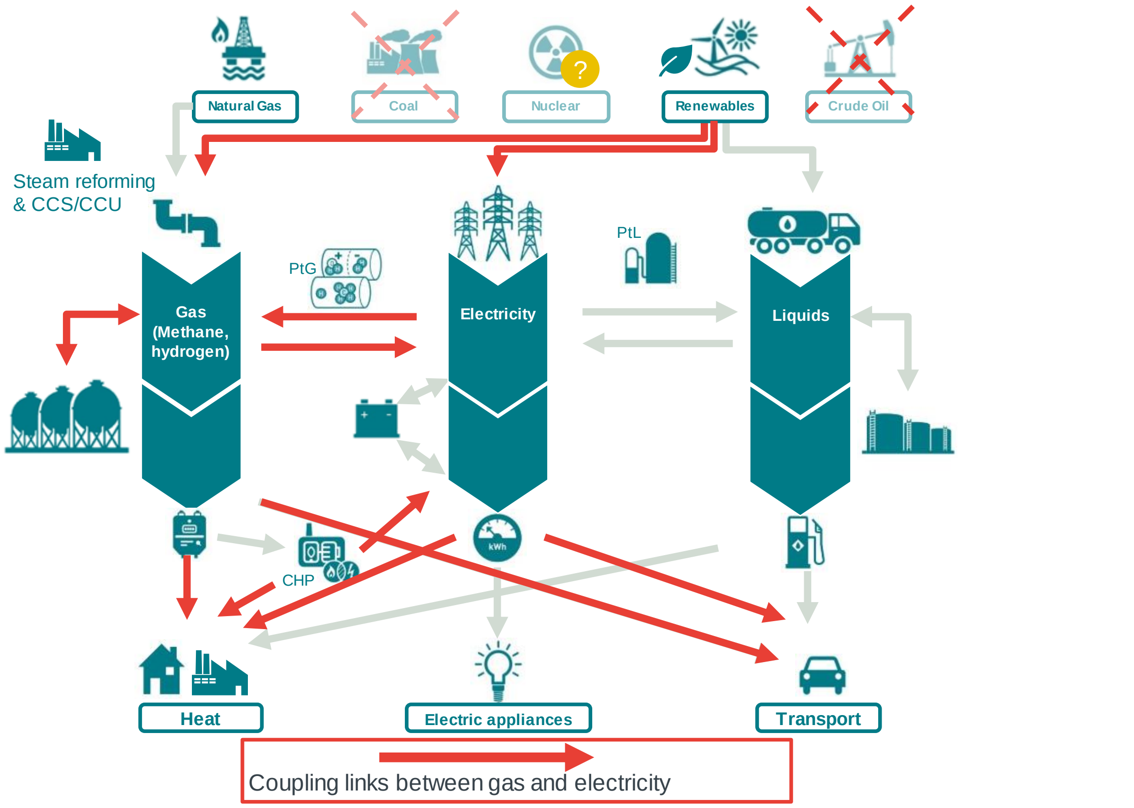
[4] Frontier Economics, IAEW, 4Management and EMCEL (2017) "The importance of gas infrastructure for the German Energiewende". On behalf of the Association of German gas pipeline companies. The figure also includes cost savings for end-user appliances in buildings.

[5] Belgium, Switzerland, Denmark, France, the Netherlands, Sweden and the Czech Republic

[6] Frontier Economics, IAEW, (2019) "The value of gas infrastructure in a climate-neutral Europe". On behalf of Green Gas Initiative (GGI) and Net4Gas.

[7] A system combining an electric heat pump with a gas boiler, together with a dedicated controller to switch between the heat sources.

Figure 3 Interaction between electricity and gas, and between different types of gases, will grow

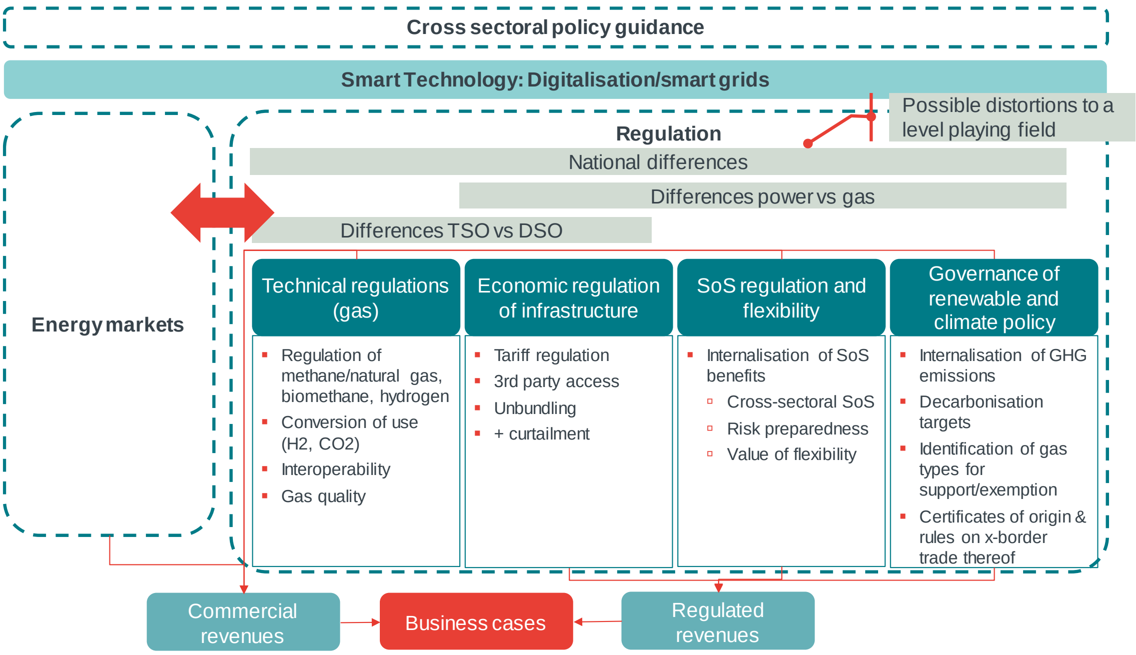


Source: Frontier Economics

Investors need to be able to make a positive business case

To ensure the gas system can decarbonise and continue to underpin energy flexibility, private business will need to be able to develop positive business cases for the investment required. But various regulatory barriers or gaps could stand in their way. These could be technical and economic in nature, or concern security of supply (SoS), flexibility and climate policy rules.

Figure 4 Scope of regulation and policy with effect on sector-coupling technologies



Source: Frontier Economics

When considering business cases, it is important to note that revenue streams for investors could be either commercial or regulated:

- **Commercial** – Some of the revenues may relate to unregulated and commercial activities. In a sector-coupling context, an example could be a hydrogen electrolysis facility installed at the premises of a commercial end-user, e.g. a chemical plant, that earns revenue from both providing energy and hydrogen as a feedstock to the plant.
- **Regulated** – Some of the revenues may relate to monopolistic or regulated activities (e.g. a gas-blending facility or a power-to-gas plant operated at the system level and linking power and gas transmission system operators (TSOs)).

Figure 4 captures the key consideration that some socially desirable technological solutions may require revenues from both sources to be viable. An example could be a PtG facility that operates at the system level (between power and gas TSOs) but also supplies an industrial customer, who might take off some of the hydrogen for his production process. A key challenge in such instances is to allow achieving both commercial and regulated revenues while respecting EU legislation, for example in relation to unbundling.

How policy can underpin positive business cases

Policy can help support economically justified business cases by:

- Rewarding the positive climate contribution of low-carbon gas;
- Ensuring tariffs, taxes and levies do not distort the playing field between electricity and gas and between different gases;
- Ensuring co-ordinated infrastructure planning between gas and electricity and between the transmission and distribution levels; and
- Preserving the integrity of the European gas market.

> *"There is no single solution for achieving a renewable energy system. The optimal technology mix requires technology openness and a level playing field."*

Rewarding the positive climate contribution

Europe's currently fragmented policy does not systematically reflect the positive impact of renewable and low-carbon gases:

- The EU ETS does not cover emissions from buildings and transport. Decisions on whether to tax GHG emissions in these sectors are left largely to member states.
- The scope of the Renewable Energy Directive does not extend to non-renewable low-carbon energy.

Policymakers will need to settle on the right mix of stick (carbon pricing) and carrot (subsidy). They must also ensure consistency in measuring and valuing different environmental attributes across sectors and, ideally, across member states.[8]

Ensuring a level playing field

Unlike a carbon price, which reflects an economic cost to society, other levies and tariffs are not usually intended to induce a particular behaviour. Instead, they are a means of recovering irreversibly incurred costs - subsidies for renewable energy, for example.

The way such costs – e.g. for renewable support - are recouped can distort the playing field. Take different gases. Power used in PtG facilities would today be treated as final consumption in many European countries[9], making it subject to taxes, levies and grid fees and putting it at a disadvantage relative to other gases (such as biomethane) which do not incur such state administered surcharges such as energy taxes and levies.

[8] An as yet unanswered question is whether Germany's proposal to introduce emissions trading in heating and transport could help boost the case for EU-level intervention or delay the rationalisation of EU climate policy.

[9] For example Germany, the Netherlands and Spain.

A further concern is that over the recovery of the cost of historic gas grid investment in a scenario of declining gas demand – e.g. as result of decarbonisation policies. If a simple pass-through to users of average grid costs (including ‘sunk costs’, i.e. those costs associated with legacy investments that have been irreversibly incurred and which do not vary with consumption) were to be applied in such a scenario, gas network tariffs would rise. This may discourage the use of gas infrastructure for transportation of low-carbon gases, even when such transport activity may be socially desirable. Use of infrastructure would be more in line with society’s interests if users faced tariffs reflecting the incremental costs of their usage. In the absence of a requirement for new investment in the grid, this would imply significantly lower tariffs (reflecting forward-looking costs only). Policymakers clearly need to take a holistic view of the issues at stake when reviewing their policies and regulations.

Ensuring co-ordinated infrastructure planning

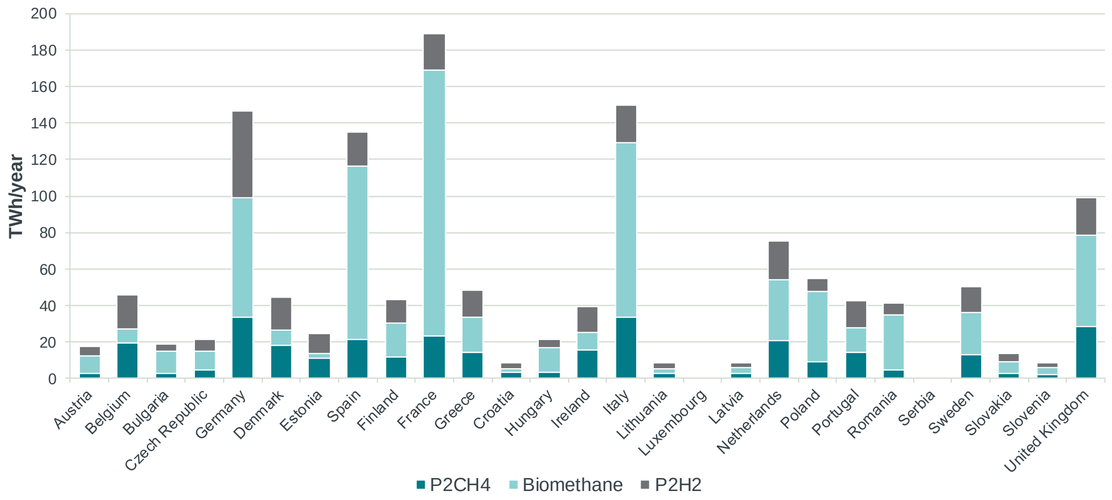
ENTSOG and ENTSO-E are now carrying out joint scenario planning and are developing an integrated gas and electricity model. This is clearly an important step towards better co-ordinated energy infrastructure planning. However, regulators must also ensure operators have the right incentives. Instead of a bias towards investment into the types of assets for which individual operators are responsible (gas or electricity), they must encourage solutions that lower overall system costs.

Preserving the integrity of Europe’s gas market

As explained above, transportability in bulk over long distances can be a key advantage of renewable or low-carbon gas over electricity. Also, gas markets in significant parts of Europe are highly liquid. Gas trading provides an opportunity to bridge gaps between supply and demand of gas in parts of Europe, perhaps as result of the uneven distribution of renewable energy sources and energy demand.

However, various types of low carbon gas options are on the table (Figure 5). This raises the risk of a product fragmentation of Europe’s gas market, which in turn could threaten the integrity of the internal market for gas and damage the business case for investing in new gases. The challenge is to sustain an integrated and liquid gas market, even if the physical gas differs in its chemical specification.

Figure 5 European gas market may become fragmented due to national differences in amount, types and relative share of gases.



Source: Frontier Economics based on the “Distributed Energy Scenario” of the TYNDP 2020 Scenario report draft

It will therefore be important to ensure maximum interoperability between countries and between gases. It will also be important to:

- Review whether gas quality standards are fit for purpose in an age of low-carbon gas;
- Look into technical solutions, such as ‘de-blending’, that could allow greater technical flexibility in gas quality supplied, while maintaining a standard product in gas trading terms.;
- Identify which parts of the gas infrastructure are particularly at risk from gas quality variations and identify cost-effective solutions to handle these; and

- Consider standardised rules (both within the EU and internationally) for renewable or low carbon certificates of origin to facilitate efficient cross-border trading of the environmental properties of gases, separately from the gases themselves, to help meet renewable energy and emissions targets.

Conclusion

Decarbonising the gas system and taking full advantage of the opportunities from sector coupling will eventually require positive business cases for investment. There is no single solution for achieving this. The transition towards a low carbon and increasingly renewable energy system is a complex task.

Policymakers will need to harness market forces – both in terms of incentives for decarbonisation and ensuring that market arrangements reflect the costs and benefits different technologies bring to the system.

But this alone will not be sufficient. Policymakers will also need to address a range of other issues, including setting overall levels of ambition and addressing areas where significant co-ordination, e.g. a mass regional switchover to hydrogen, is required.

All elements in the value chain need to be considered to ensure a level playing field between technologies and energy carriers and in turn to ensure that the energy transition happens at least cost to society.