Findings of the Structured Dialogue on Decarbonisation

December 2022

1. Context, objective, and methodology

Context

Hydrogen and other decarbonised gases produced from renewables have been attracting increasing attention across the energy sector in recent years. Their potential to help reduce the carbon intensity of "hard to abate" sectors in the heavy and energy-intensive industry and serve, via power to gas, as storage for electricity give them a prominent role in the energy transition.

Overall, there is a broad consensus that decarbonised gases such as hydrogen will become one of the top decarbonisation options for the industry when techno-economic conditions make that possible. For example, hydrogen, which is mainly used in the chemical industry today, especially to produce ammonia (for fertilisers) and hydrocracking, could, in the future, also replace fossil feedstock in some industrial processes. Renewable and decarbonised gases like hydrogen have thus the potential to decarbonise a wide range of industrial processes that today rely mainly on natural gas and coal.

However, the demand for decarbonised gases is still deficient today; Luxembourg has no dedicated grid infrastructure, and there is no global production capacity. The whole situation leads to the so-called chicken-and-egg problem. Apart from the relative price level and price uncertainty of renewable and decarbonised gases like hydrogen, its availability inhibits demand. But without demand, there will be no investments in significant renewable and decarbonised gases like hydrogen production or transport and distribution infrastructure that could help reduce supply, price levels and price uncertainty.

Objective and methodology

The Structured Dialogue on Decarbonisation (SDD) aims to break the chicken-and-egg problem by entering a dialogue between potential industrial hydrogen consumers and the grid developer despite incomplete information about the offer and demand of hydrogen.

In three workshops, we brought together industrial gas consumers, representing over 80% of Luxembourg's industrial gas consumption, with the transmission system operator, CREOS, to understand one another's requirements and expectations regarding the decarbonisation trajectory towards 2050.

Discussions focused on consumers' and grid developers' technical and investment constraints, scenarios, roadmaps, and visions about matching the supply and demand of carbon-neutral gases and electricity to contribute to the decarbonisation of Luxembourg's and the greater region's industrial sector.

2. Findings

Findings from the industry perspective

Starting with their current natural gas consumption, participants assessed how they could gradually revert it to power and hydrogen.

Figure 1 displays the cumulated projections of the seven participating companies' natural gas, power, and hydrogen consumption. The volumes of natural gas are steadily declining to reach a near-complete phase-out in 2050. At the same time, power and hydrogen combined replace the lost volumes of natural gas. The aggregated power demand increases slower than expected and less intensively than the one for hydrogen. Hydrogen shows an unexpectedly early and steep increase in demand between 2025 and 2035, then flattens until 2050. (As data has been collected for the specific years of 2030, 2035, 2040 and 2050 only, the expected transition timeline may be less smooth than illustrated in the chart, with most of the shifts assumed to happen right before or in the year of the selected milestone years.) In this scenario, which does not consider possible energy efficiency gains, hydrogen would substitute roughly two third of today's natural gas consumption, and power would cover the remaining third.

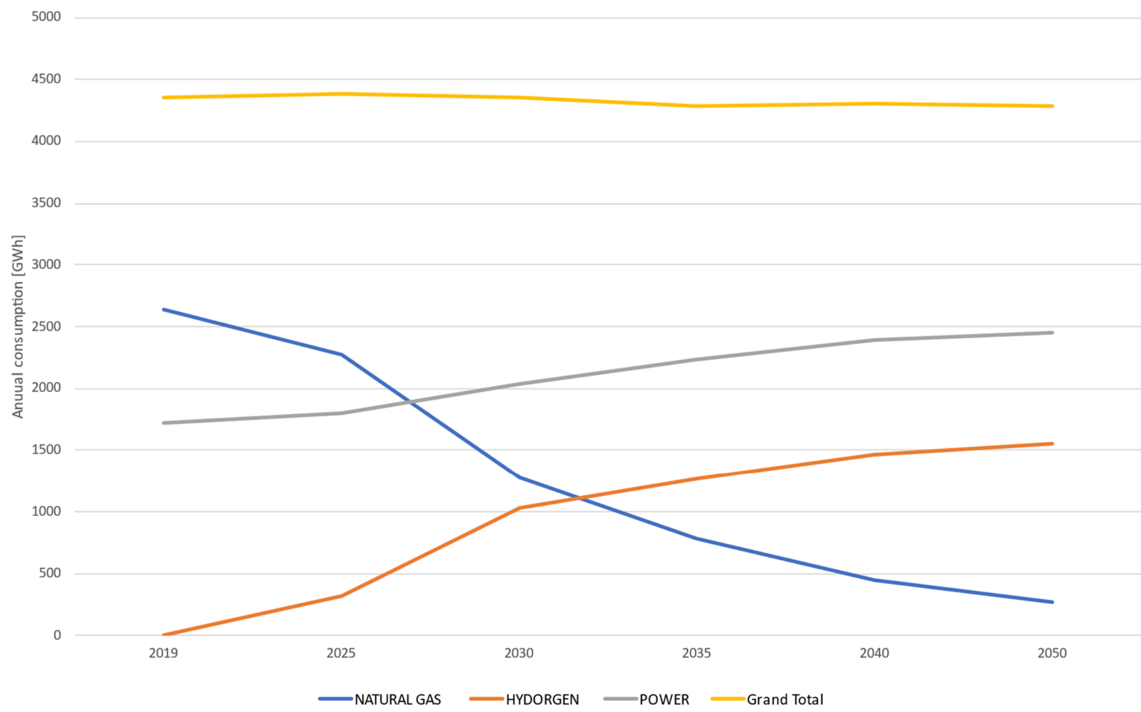

Figure 1: Forecasted fuel transition trajectories of Luxembourg's gas-intensive companies

The consolidated energy transition trajectories in Figure 1 do not follow the general assumption that decarbonisation will predominantly be made by substituting natural gas with power first and then hydrogen decarbonising all other remaining energy needs. That assumption might not apply in this order because of our case's specific sample of companies. In our sample of companies, a significant share of energy demand is used to run processes in high-temperature processes where power does not offer adequate decarbonisation solutions. The other reason may be that the implementation of power-based substitution may be economically prohibitive in some processes within the current operating and investment cycle without replacing current high capital cost assets with up to decade-long or even longer remaining economic life.

The left-side diagram of Figure 2 shows the geography of 2019's major industrial natural gas consumers in Luxembourg. Those consumers determine clusters in three regions of the country that can be considered potential future hydrogen consumers. The one in the country's south has the most significant demand, while the other two regions are less important. The right-side diagram of Figure 2 shows the existing Creos gas transmission grid as of 2022. It may be repurposed partly for hydrogen transport (see next paragraph).

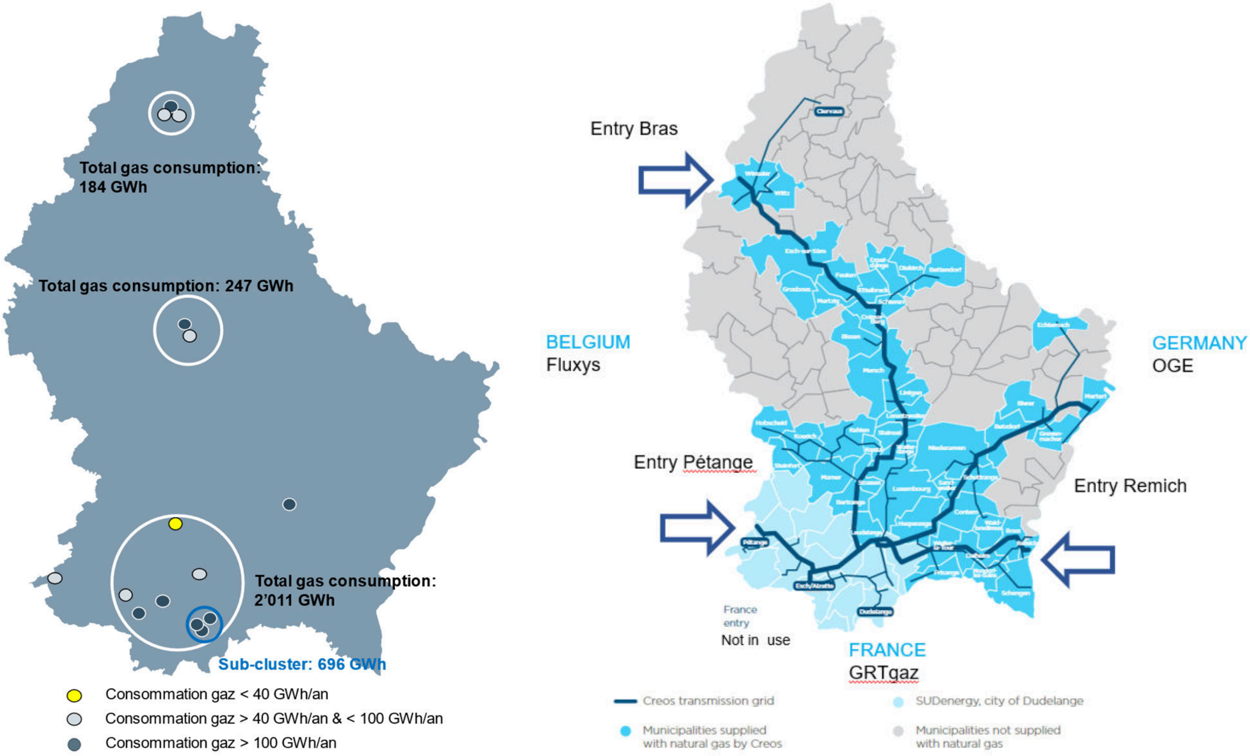

Figure 2: Left: Industrial clusters of natural gas consumption (data: 2019); right: Creos Gas transmission grid 2022

Findings from an infrastructure perspective

The forecasted fuel transition trajectories of Luxembourg's gas-intensive companies show clearly that the currently planned supply options on the infrastructure level might not be able to cater to the demand as early as 2025. Repurposing major parts of Luxembourg's existing gas infrastructure (see Figure 2, right) for hydrogen is possible, at the earliest, after 2040. New renewable and decarbonised gas infrastructure development projects must thus accelerate to support the industry's 2030 decarbonisation goals. It includes accelerating assessment activities of the different infrastructure interconnection options with our three neighbourhood countries:

- Belgium: Possible connection to the EU Backbone, the first interconnection to Belgium should be possible until 2030
- France: Detailed technical feasibility study planned for 2023
- Germany: Possible interconnection at the German border to be further analysed.

The Structured Dialogue on Decarbonisation (SSD) identified three potential hydrogen industry clusters. However, those clusters sit geographically apart, have non-homogeneous demand volumes, and have different levels of transition speeds towards hydrogen. Further, as an adequate hydrogen infrastructure will only happen over an extended period, we must envisage decentralised solutions using electrolysers needed as a bridging option to complement the long-term infrastructure development. They could produce green hydrogen via GO or PPA-sourced electricity, allowing them to supply some clusters earlier than others.

Finally, the SDD identified the need for bi- and/or multilateral recurrent structured exchanges between implicated industrial companies and Creos to coordinate and further sharpen the common understanding about creating a hydrogen infrastructure. Discussions should notably address the possible electricity/hydrogen demand, location, timing, as well as technical & commercial aspects.

3. Framework conditions

At first sight, the energy transition scenario described in the previous chapter pictures the image of a continuous and smooth decarbonisation of the industry until 2050. The reality is, however, that many conditions must be met for the trajectories of Figure 1 to materialise. The following point must be considered:

1. There is a need to accelerate the legal & regulatory framework design allowing the development of an adapted hydrogen infrastructure. It includes clarifying roles and responsibilities for developing new hydrogen networks and repurposing existing gas networks for the use of hydrogen. Furthermore, affected investors (i.e. concerned grid operators) must be provided with the necessary guarantees and/or state aid to ensure long-term investment security.
2. An EU internal and external supply chain of renewable hydrogen must be set up to satisfy the industry's demand. Security of renewable and decarbonised gas supply like hydrogen must be guaranteed before the industry can invest in new production equipment. The public authorities' plans need more tangible elements clarifying how hydrogen could be sourced and transported to Luxembourg in industrial quantities. Renewable and decarbonised gas grid and storage infrastructure development roadmaps are thus needed that show how Luxembourg's industrial areas will be connected and supplied.
3. Increasing the opportunity costs (CO_2 price) to create a business case for hydrogen must give way to the ambition to produce sufficient volumes of renewable hydrogen to enable competitive prices via a balance of offer and demand.

   Switching industrial production to carbon-free energy is currently not a positive business case because of the relatively high prices of low-carbon fuels. However, a steady increase in the CO2 price to improve the European business case is inappropriate as long as it does not equally apply to international competition. Unilaterally increasing the CO2 price only increases carbon leakage. Instead, contracts for difference can bring long-term price stability for renewable and decarbonised energy.

   Further, renewable power production across the EU must ramp up massively if at least parts of the renewable and decarbonised gases shall be produced domestically within the EU. At the same time, the EU and national authorities must identify trade partners across the globe to secure the import volumes necessary to decarbonise the EU's industry. In this context, the role of the carbon border adjustment mechanism needs clarification.

   The latest energy price increases in Europe due to the conflict in Ukraine are cruelly demonstrating that Europe has a vast energy supply challenge. If carbon leakage is not to be followed by "energy leakage", Europe must invest significant efforts to increase energy sourcing and bring down production at costs allowing energy-intensive products to be internationally competitive and also affordable for EU-based end consumers in the very short term. Further, the temporary decoupling of power prices from gas prices is necessary to stop further energy demand destruction in the EU industry rendering all efforts to create low-carbon fuels for the industry obsolete.
4. R&D, CAPEX and OPEX aid are essential to kick off early developments, investments and to support running costs in the transition phase as long as technologies are to mature and market demand for low-carbon products has yet to pick up. R&D, CAPEX

and OPEX aid may promote, for example:

- The electrification of heat, i.e., replacing natural gas-powered heat with power-based heat production. Switching to decarbonised technology is not straightforward for most companies. For some processes, the Technology Readiness Level (TRL) of alternative technologies and fuels must improve to deliver on a production-ready or industrial scale. For others, a switch would require a significant capital investment (CAPEX) into new production technologies without the perspective of much higher productivity. On the contrary, we expect that most low-carbon technologies will entail higher operating costs (OPEX) than traditional technologies with no substantial productivity gains. This combination represents one of the least attractive scenarios for companies to invest in: On the one hand, R&D and CAPEX without the perspective for a good return on investment; on the other hand, low-carbon higher OPEX with no predictability on CO_2 price and the relative price of the alternative energy source. These are the worst arguments for encouraging a low-carbon investment.

- On-site H_2 production via electrolysers using green power may be necessary to inject hydrogen into the industrial production process. It would enable front runners to switch to H_2 much faster without waiting until a fully-fledged transport grid is in place.

- Financial support for purchasing "decarbonised-gas-ready" production equipment industries will be vital to reaching decarbonised production modes while avoiding stranded assets because of the long investment cycles of energy-intensive sectors.

- Financial support for feasibility studies and R&D activities to promote tests and ramp-ups of new low-carbon technologies. Before a large-scale phase-out of natural gas and other fossil fuels from industrial production can be considered, grants are needed to support feasibility studies and R&D activities to promote tests and ramp-ups of new low-carbon technologies to give industrial consumers confidence in shifting to the new technologies.

5. Finally, creating market demand for low-carbon products on the European level is of utmost importance to drive decarbonisation at the European level.

FEDIL - The Voice of Luxembourg's Industry
LUXEMBOURG OFFICE
7, rue Alcide de Gasperi
Luxembourg-Kirchberg
Telefone: +352 43 53 66-1

POSTAL ADDRESS
P.O. Box 1304
L-1013 Luxembourg