Sector Coupling at the System Level

Energy experts are all agreed: In the future the electricity and gas infrastructure systems must be coupled using the power-to-gas technology in order to initiate the next stage of the Energy System's Transition. The objective of this is to push ahead with the decarbonisation of the entire economy. Renewable energies are predominantly available as electricity (wind and PV) and today are as well integrated into the electricity system as possible; however, this is visibly reaching its limits. The planned additional volume expansion will thus have to be diverted proportionately into other sectors where there is the greatest demand for energy (approx. 80%) from the economy. Only in this way can Germany's green footprint grow sustainably and the entry into the hydrogen economy succeed.

Based on their system responsibility, transport system operators are intensely occupied with the future demands on their systems. This involves both the planning and operation of the infrastructure.

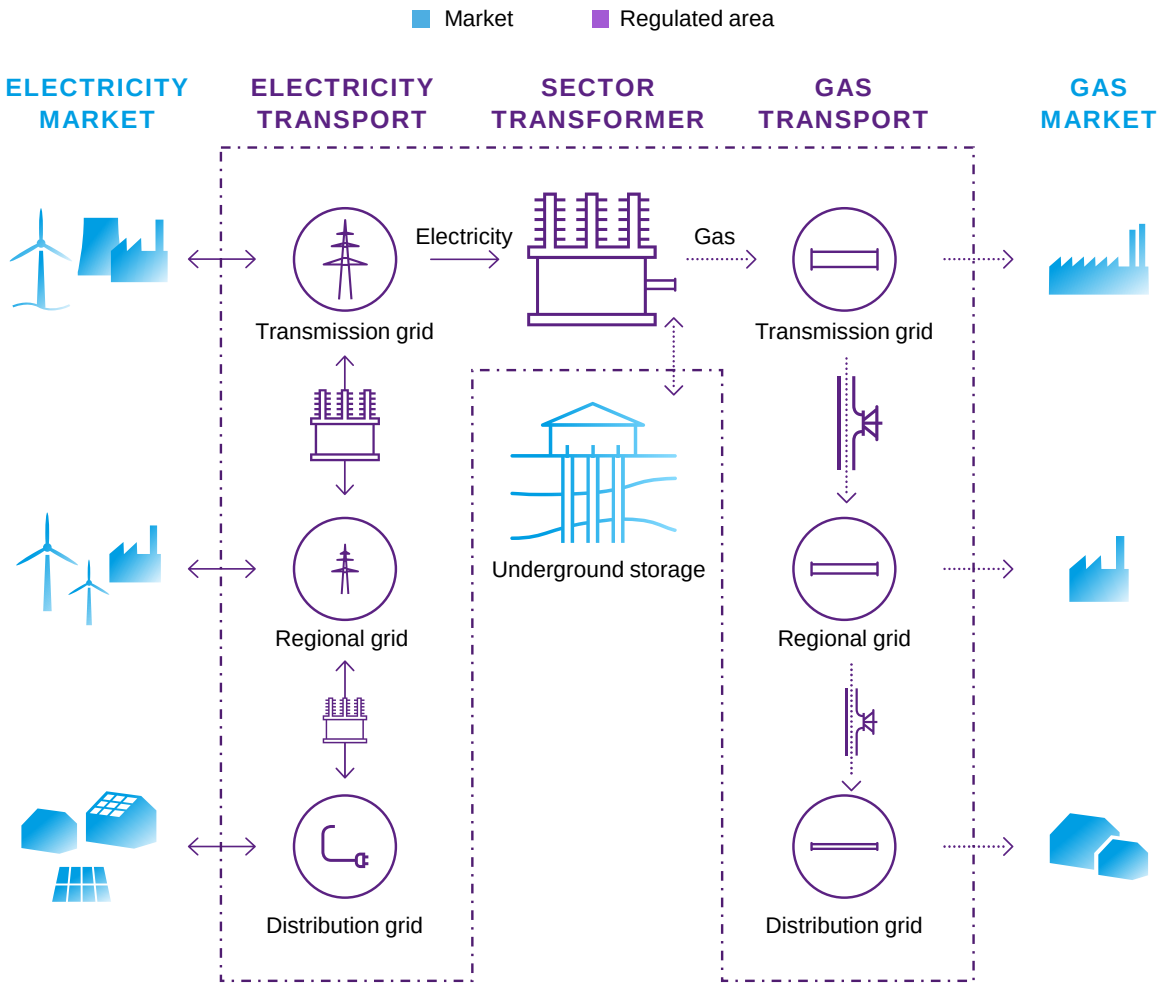
Sector coupling will be beneficial to the economy when the output from renewable energies exceeds the demand for electricity in a significantly high number of hours per year. This will be the case when the share of Renewable Energies reaches 60% of electricity demand.

So that the coupling of the infrastructure systems at the transmission level will result in maximum economic benefit and maximum sustainability, the following three factors are critical:

- Size: Power-to-gas plants must be integrated into the systems in the appropriate dimensions and at the highest level - notwithstanding any further small-scale, decentralised power-to-gas solutions - in order to make the transport capacity of the transmission systems and gas storage usable. The power ratings for offshore wind alone argue in favour of a configuration of power-to-gas plants at the highest system level.
- Location: The plants must be installed at appropriate connection points between the electricity and gas transmission systems in order to realise the system transitions in a physically useful and economically efficient way. Their suitability can only be shown if the electricity and gas networks are considered together at the planning horizon. In many cases, project planning close to potential major customers falls short systemically.
- Timing: The timing of the operation of plants must be coordinated in such a way that the power flows in the electricity transmission system, the volumetric flows in the gas transmission system and the levels of gas storage are considered as an overall system at all times. This will achieve a temporal decoupling of weather dependent renewable energies from the demand profiles of customer in every sector.

Power-to-gas as sector transformer

A power-to-gas plant allows one form of energy to be transformed into another, i.e. the transformation of electricity into hydrogen and methane. Looked at in this way, the plant is in principle equivalent to a transformer in the classic sense:



Up until now network operators have carried out the transformation of energy vertically, according the illustration above. Using the example of electricity transmission: Generating plants feed electricity into the grid. This electricity is then transported via powerlines, directed via electricity transformers to different voltage levels and then transported further - until it reaches the end customer. With gas transmission it works more or less the same. This uses gas pressure regulators instead of transformers. The flow is therefore, for technical reasons, only possible in one direction.

In the future, there will also be the option of transporting the energy between sectors. Electricity will then be directed into the gas system using a sector transformer (see diagram) and there transported accordingly in the form of gas to the respective customer. Operation by transmission system operators makes it possible to relieve the national economy by boosting the potential synergies between the networks and optimising both systems as a whole.

A consistent development of non-discriminatory third-party access

A fundamental feature of the liberalised energy market is the fact that energy traded is at no time in the ownership of the "carriers", that is to say the system operators. System operators are remunerated for their transmission services via a regulated network charge. The infrastructure is provided to third parties without discrimination. If you now couple the electricity and gas infrastructures at the system level, this fundamental principle can and must be maintained. The model of the future will therefore be adjusted to the regulatory framework as follows: Like the current electricity or gas network infrastructure, the sector transformer will be planned, built, operated and financed via network charges by the transmission system operators. This transformation will take place between two regulated sectors - namely the electricity grid and the gas transmission network.

Since the "bridging capacity" between the systems is limited, network operators will auction the capacity of the sector transformer at any time to traders or direct customers. Here too, third-party access is the fundamental non-discriminatory principle. As a result, the electricity and gas trading markets will thus be linked together and allow competition across the two commodities. The proceeds of the auction will be used by network operators to reduce network charges. This principle has now been applied for some years within the electricity sector at the cross-border interconnectors.

This way no state subsidy mechanism, allocation mechanism or suchlike will be required for these new kinds of infrastructure component. The better the system integration progresses, the more the network customer will be relieved of high re-dispatch costs. A systemic approach and operational improvements to both infrastructures will benefit network customers and ultimately society as a result of the economic benefits of the concept presented. In concrete terms this means: The synergies boosted as a result of the coupling of the operation of the electricity and gas networks will also have the effect of reducing network charges, among other things. It is questionable therefore whether there is an increased financial burden on network customers in prospect at all.