Interconnection of gas and electricity grids: challenges and opportunities in the new energy mix

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Yesterday, gas and electricity were considered as distinct and even competing and costumers had often to choose between them for cooking and heating. This choice was usually based on tariff, sometimes on safety perception, even more seldomly on sustainability concerns. For the companies that distribute them, gas and electricity had a major difference, gas could be easily stored, not electricity… and in the majority of the European countries, gas has to be imported when electricity can be produced locally. Obviously gas can be burned in power plants to produce electricity and the flexibility of these installations allows to insure the fit between production and consumption. In some parts of the world, such as some US states, the gas distribution network is much more stable than the electricity one and so some customers (usually the large ones) that cannot stay without power, have fuel cells as security backup to insure the 7/7, 24/24 power supply; an alternative to diesel power generators.

For some years, the ratio of renewable sources versus traditional ones has been increasing within the electricity mix. Wind as solar farms are producing when the weather is favorable; so not especially when the demand is high. At the top of that they don't have the frequency stability of rotating machines. The electricity grid is suffering. Gas power plants than can be rather quickly switched off and on, may help to solve part of this misfit. However, using a power plant only few days a year is uneconomical and this kind of solution is strongly centralized while the renewable sources open the possibility to have micro grids, at the scale of territories such as, for instance, islands. Today new solutions based on electrolyzers, fuel cells and hydrogen are emerging and may change the game. Local gas production could also be achieved through biogas generation.

Electrolysis allows to store the electricity through H2, and a blend of H2 and natural gas allow to distribute it as just as natural gas toward the citizen's boilers, and fuel cells allow to go back to electricity if needed, and when needed.

All these new technologies are the results of years of research and obviously some of them are still not fully ready. Their cost has often still to be reduced to allow these green solutions to be competitive versus the classical ones.

Which are the main challenges to solve ? They are numerous but I'll just discuss two of them that illustrate the variability of the efforts that have still to be done.

The optimization of a grid is not trivial, the optimization of a multifluid system is even more complex. For instance in case of a grid with wind and solar farms, batteries and electrolysers, charge but also frequency need to be jointly adjusted to fit to the demand whose usually can be only marginally shifted. Depending on the weather forecast and on the energy demand profile the energy management system (EMS) and on the grid elements optimization could be completely different. Digitalization and optimization are mandatory to have a working and stable system, pilots are currently ongoing to test this kind of microgrid.

The blend of natural gas with H2, issue of the electrolyze of renewable electricity, in the gas distribution network is clearly an elegant solution to store and use the surplus of the RES. Today various pilots aim to test such solutions, in Germany, France and UK for instance. Engie and its partners are testing such

an injection in the city of Dunkerque (GHRYD Project, //grhyd.fr). Pipelines and boilers have to be able to handle this mixture but the gas distributors need also to know what they will bill to the clients. When the ratio CH4/H2 changes, depending of RES production, the gas has a different heat capacity, so the price of m^3 have to be adjusted. As a group GERG (*Groupement Européen de Recherche sur le Gaz*) is also working on that issue in order to let the profession converges toward a standardization of the use of this new fuel.

The optimization, in terms of energy efficiency and costs, of all these complex systems require modeling and data. Another axis of research for the profession.