

POWER2GAS

DECEMBER 2011

1. Introduction

Wind power is the "Backbone" of renewable electricity on the fast lane. However wind power, is highly volatile and necessarily not in line with the demand of electricity. The priority use of renewables will lead to severe changes in the existing electricity supply system.

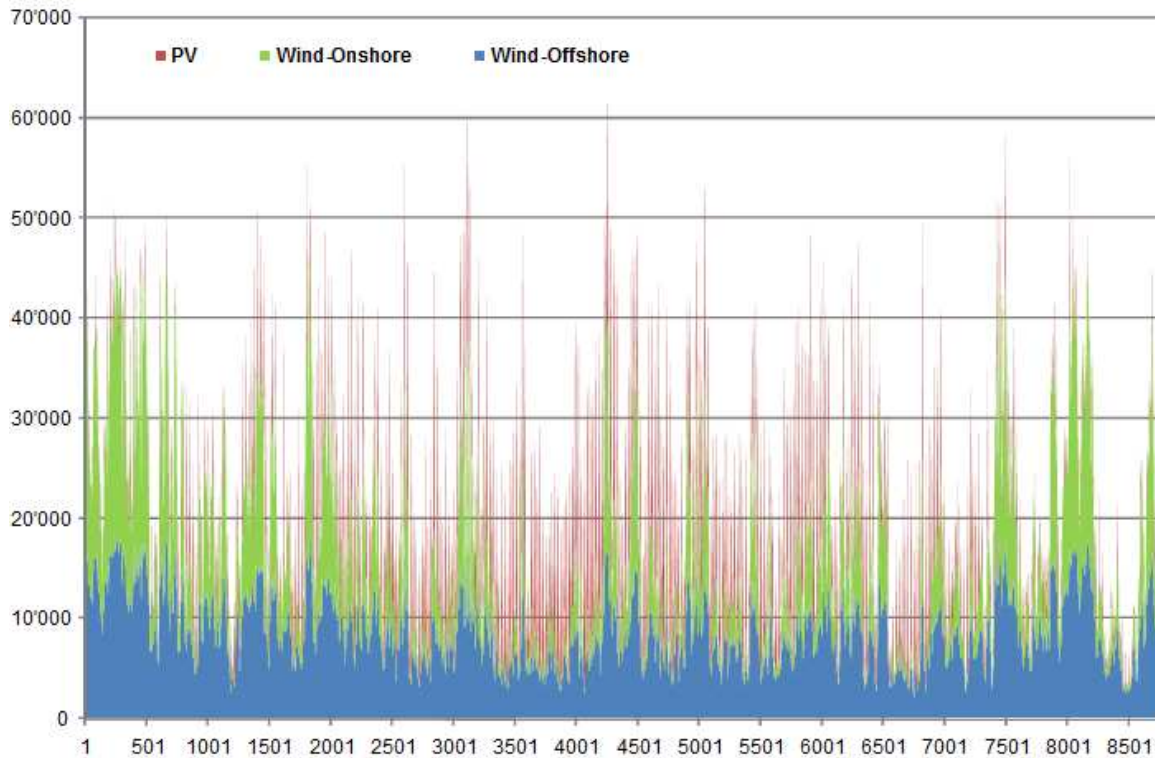


Figure 1 **Fluctuating levels of renewable energies fed into the grid in 2030 (in MW)**
Data forecast Germany 2009 Red=PV=Photo Voltaic, Green=Wind Onshore, Bleu = Wind Offshore
X-ax Time in Hours Y-ax Electrical Power produced in MW/h

Demand = renewables + residual load. The base load, middle load and peak load structures decrease. In the future the system will require more flexibility. The priority use of renewables will require storage of excess electricity. The ideal way is Power2Gas.

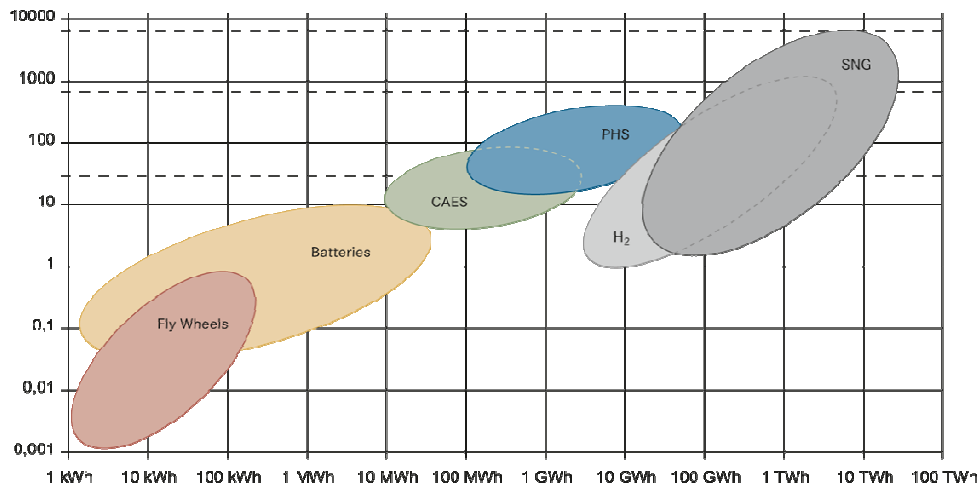


Figure 2 **Overview of energy storage systems.**
The storage of chemical energy has the highest potential.
CAES: Compressed Air Energy Storage, PHS: Pumped Hydro Storage, H2: Hydrogen, SNG: Synthetic Natural Gas
X-ax quantity of energy storage Y-ax Discharge time in hours

2. What is Power2Gas?

Power2Gas is a way to store and transport energy and recycle CO₂ as a carbon stock. It is easy and affordable to convert Electricity (Power) to Hydrogen (H₂) via electrolysis, a proven technology in the chemical industry. Hydrogen can be stored and used in the existing gas infrastructure in the single digit range, depending on technical regulations. Research is being undertaken to widen the use of hydrogen in the existing gas infrastructure.

When there is a need for more temporary storage it is possible to convert Hydrogen (H₂) with CO₂ into Synthetic Natural Gas (CH₄). CO₂-sources are for example biogas production plants, the industrial sector or coal power plants. Depending on the CO₂ price on the ETS market (Emission Trading System) this can be beneficial. Synthetic Natural Gas can be stored and used in the existing gas infrastructure without limitation.

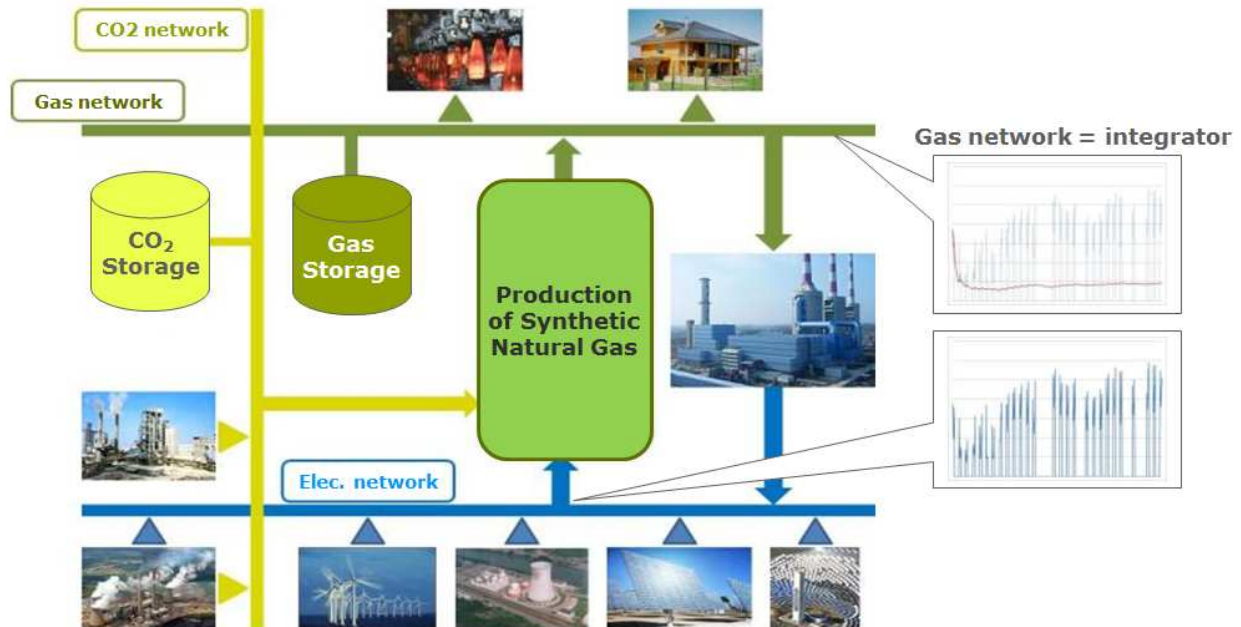


Figure 3 Smart connection of two energy supply systems

3. What is the Advantage?

- The gas infrastructure (transport, storage and distribution) is immediately available;
- Storing renewable electricity into gas leads to lower number of new power lines required;
- Transporting electricity is 20 times more expensive than transporting the same amount of energy via a gas pipeline. At the same time the pipeline is invisible. The Gas Industry is used to store energy during the summer to use it during the winter periods. Long distance transportation from photo voltaic Countries to Countries with less sun is affordable. Transportation from wind power on the North Sea to areas with less wind will also be affordable (backhaul).

4. Some background:

- The average household natural **gas price** (without taxes) for the lowest Eurostat annual consumption band is **6 EUR cent/kWh** (1st half 2008 – 1st half 2010). The average household **electricity price** (without taxes) for the lowest Eurostat consumption band is **20 EUR cent/kWh** (1st half 2008 – 1st half 2010). Source: Eurostat Energy Statistics 2010;
- The efficiency of the conversion from power to Hydrogen (H₂) is approx. 75%;
- The efficiency of the conversion from power to Natural gas (CH₄) is approx. 65%;
- The efficiency for producing Power from Oil, Coal or Gas in the existing power plants is between 35 and 60%.

5. What are the key elements of Power2Gas?

Specific economic conditions are required:

- The availability of electricity at a low price (excess of renewable electricity);
- For synthetic gas a negative CO₂ price;
- Intersection between natural gas and power transmission systems.

6. Technical breakthrough needed at least on the following main items:

- Flexibility & Reliability of the electrolysis process;
- Cost & ageing of the electrolysis process;
- Finding the maximum H₂ concentration admissible in the gas system.

7. Some initiatives worldwide on Power2Gas:

In Denmark, with the support of the Energy Technology Development and Demonstration Programme (EUDP):

The project, leaded by TOPSOE and Dong Energy, on a conceptual study for the conversion of carbon dioxide to synthetic natural gas where they use hydrogen from electrolysis.

In France, with the support of the French National Research Agency (ANR):

The project leaded by CEA together with GEG and Saipem, is to make Hydrogen with electrolysis and to convert the Hydrogen into synthetic natural gas. The project includes a demonstration plant.

In Germany:

DVGW has launched a gas innovation program to foster Power2Gas technologies and a national research program on electricity storage technologies has been set up. A demonstration project has been started.

Vattenfall, Enertrag, Total and Siemens have the Performing Energy Alliance for Hydrogen from Wind. The hybrid power plant is located 75 miles north of Berlin in Prenzlau.

The project consist of a biogas unit, three wind turbines of 2 MW each, two combined heat and power plants and an electrolysis unit that generates the hydrogen.

Audi is financing the construction of 4 wind turbines on the North Sea that will generate up to 53GWh of electricity. Audi will use wind generated electricity to produce hydrogen and something Audi calls e-gas. Harnessing the power of wind to produce hydrogen through electrolysis, Audi can power fuel cell vehicles. But until fuel cell vehicles enter production, the hydrogen will be combined with CO₂ to produce e-gas, a synthetic form of methane. Audi will use the e-gas to power the CNG (Compressed Natural Gas) cars

E.ON has a pilot project for Power2Gas started in Falkenhagen. The 5 Million EUR unit will from 2013 on convert Wind power by means of Electrolyse into up to 360m³/hr. Hydrogen. The Hydrogen will be stored into the existing Ontras natural gas grid and will be used as normal (Green) Natural Gas.

The Fraunhofer Institutes for Wind energy together with IWES are running a pilot project in Hünserück. They make synthetic natural gas from the oversupply of a wind turbine. They are storing the gas in bottles. In case the wind turbine is not delivering sufficient energy, the stored gas is fuelled into a co-generation plant to produce power and heat. The project is successful and they think, according their publications, that they have solved the oversupply problem of Wind and Photo Voltaic systems.

Several communications on the subject at IGRC2011 (Seoul) and elsewhere:

From DONG Energy, Tokyo Gas, SIEMENS, Areva, GTI, ...

Many projects are presently studied and may be launched in the next future.

8. Conclusion: Power2Gas: The gas infrastructure is the storage of electrical renewable energy.

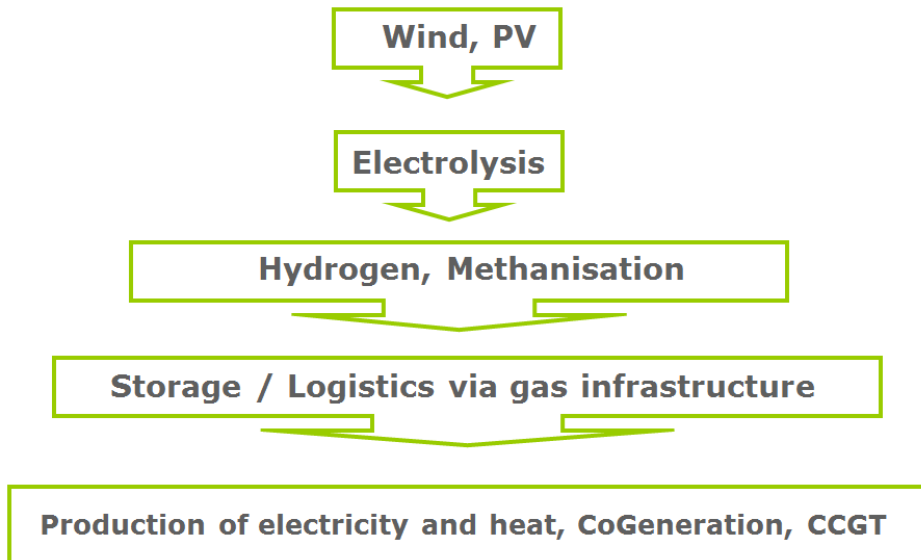


Figure 4 (Figures 1, 2, 4: source DVGW. Figure 3: source GDF SUEZ).

NOTE

The information and data included in this document have been compiled by MARCOGAZ from a variety of sources from its Members. MARCOGAZ will not accept any liability for the data accuracy and completeness.



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- MARCOGAZ chief mission is to serve its Members as the European window for any technical issue regarding natural gas.
- As the representative organisation of the European Natural Gas Industry, it aims at monitoring and taking influence when needed on European technical regulation, standardisation and certification with respect to safety and integrity of gas systems and equipment and rational use of gas.
- Environment, Health and safety issues related to natural gas systems and utilisation are also of paramount importance for MARCOGAZ

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