The impact of power-to-gas on distribution grids

Eva Hennig– Thüga Aktiengesellschaft
CEDEC Gas Day, 27.5.2015
8 million people, 450 cities and towns, 100 companies, one idea: 
*Working together to create energy for homes*

**Target partnership model**

- 450 Cities and municipalities
- Represented in 12 federal states
- Responsible for the living space of 8 million people
- Cities and municipalities are the majority shareholders of 90 municipal utilities
- Entrepreneurial network: Thüga group

**Cooperation among cities**
The Thüga group constitutes the largest municipal network in Germany

**Key figures of the Thüga group (2013)**

- Revenue: € 23.3 billion
- Investments: € 1.3 billion
- Gas sales: 120 billion kWh
- Electricity sales: 48 billion kWh
- Water sales: 287 million m³
- Gas customers: 2.1 million
- Electricity customers: 3.9 million
- Water customers: 0.9 million
- 105 Wind Generators with 204 MW
- Employees: 18,100

**Partners in the Thüga group**
Decentralised production of power from RES calls for decentralised storage of surplus renewable energy

Integration of power to gas into the local distribution networks

Share of the feed-in of renewable energies in the German electricity grids
- Distribution grid: 10%
- Transmission grid: 90%

Share of the distribution network in the German gas sales
- Gas distribution network: 30%
- Gas transport network: 70%

Decentralised production of power from renewables: 90%

Source: BDEW
Storage capacity of the German DSO can absorb 100% of RES forecasted for 2050

Potential of the German gas distribution network for the storage of electrical power from wind and solar

Hydrogen from renewable energy*  
→ 8 TWh

SNG from renewable energy

Need for electrical storage systems in 2050 → 50 TWh

Annual storage capacity of the German gas distribution network → 200 TWh

Our gas network – the battery of tomorrow

*For a max. share of 10% Vol. H₂ in the natural gas  
Source: BDEW, Thüga Aktiengesellschaft
It is no rocket science to integrate P2G plants into the local distribution grid

Advantages of the integration of PG into the gas distribution network

- All necessary infrastructure for the operation of the plants already exists on-site
- Increase of the system effectiveness of the plants in particular by waste heat recovery and injection into the district heating system
- Offering Stress-Relief for the electrical grid by a decentralised storage
- Reduction of the investments to expand the capacity of the electricity grid to accept high loads of RES
- Easier acceptance within the society: no noise, no smell, no danger
- Considerably less hydrogen-sensible consumers in the distribution network than in the transmission grid
13 partners of the Thüga Group jointly developed, built and operate a power to gas demonstration plant in Frankfurt/Main

"Strom zu Gas - Projekt der Thüga-Gruppe“
Our power to gas demonstration plant is operated on a site of our partner, Mainova AG, in Frankfurt/Main

- Technology: PEM – Elektrolyser (Polymer Electrolyt Membrane)
- Nominal electrical load: 315 kW
- **Hydrogen** output: 60 Nm$^3$/h at nominal load ≈ 180 kW$_{th}$, mixed with natural gas to 3000 m$^3$/h mixture gas
- First injection of hydrogen into the distribution network: November 26, 2013
- Official start of operation: May 7, 2014
- Operation period: 3 years (then, option of methanation)
The various components of the P2G plant are not very spectacular – they fit into standard size containers

Some impressions
A PEM-electrolyseur was chosen to be very flexible in potential markets and products for the hydrogen

Advantages of the PEM-technology:
- High flexibility for changes of the load
- Particular environmental friendliness
- Compact construction
- Water instead of potassium hydroxide

Quelle: Strom zu Gas
The gas pressure regulation includes mixing and measuring components is „slightly“ more sophisticated

Tasks

- Measuring and regulation of the gas flows (hydrogen and natural gas)
- Ensuring the compliance with the gas quality requirements of DVGW regulation

- Controlled mixing of the gas flows to keep the concentration below 2 %
- Feed-in into the local gas distribution network at 3,5 bar
Algorithms for the optimal operation will be developed through accompanying research team

The following questions have to be answered:

*Is it possible to provide all the electrical power needed by only using renewable energy sources?*

*Which degrees of efficiency can be reached?*

*How much storage and DSM capacity will be needed to match RES and demand?*

*Which percentage of \( H_2 \) can be supported by underground storages and gas vehicles?*

*How can a support system be implemented?*
Our first results: “Actual” and “set point” of the electrolyser over an automated 64 hour test

- The test was designed to expose the electrolyser to a variety of operating conditions over its full range
- Part of the test used a simulated wind profile
- The data is shown in terms of percentage of full load
The response times allow us to take part in the secondary balancing market

Electrolyser system being modulated from zero to nominal load (circa 85%)

Electrolysis system being modulated from nominal load to zero

- System response time is key for qualification on the balancing market
- In this case, the nature and time taken to achieve the set point is defined and limited by the algorithm used by the power station Control Room
- Faster response times with the ITM electrolysis should be possible → tests
The gas distribution network plays an important role in the future integrated energy system of Germany

Resume

Energy storage systems in the range of TWh will be needed. P2G is in combination with the existing gas grid a viable opportunity.

Currently P2G plants cannot be operated economically in Germany. For the phase of testing and commercial launch initial funding is needed - limited in time and volume.

Further analysis are needed for the percentage of H2 in the DSO grid e.g. turbines and NGV-tanks.

For the adaption of the technology to the future needs we must further develop and test its implementation and operation in the energy system.

The Thüga Group wants to demonstrate the integration of power to gas in local gas distribution networks and make a contribution to improve the regulatory framework for this system technology.
Kontakt:
Eva Hennig
E-Mail: eva.hennig@thuega.de

www.s zg-energiespeicher.de

http://www.mainova.ag/unternehmen/presse/14566.html

www.energie-und-wende.de