Experience from successful Power-to-Gas projects

Gregor Waldstein,
Zaragoza June 15th 2016
ETOGAS GmbH

As Pioneer of the Power-to-Gas concept
ETOGAS supplies Electrolyzers and Methanizers tailored for the required application

PRODUCTS AND SERVICES

Power-to-Gas turn-key systems
- Power-to-Hydrogen (PtH2)
- Power-SNG (PtSNG)
- Hydrogen-to-SNG (H2tSNG)

Consulting/Services
- Feasibility Studies & Power-to-Gas Business Model Design
- Basic Engineering
- Site Engineering

Project development → Engineering → Hardware supply → Site integration → Service

Megalyzer: Power – to – Hydrogen

Methanizer: Hydrogen – to – Hydrocarbons

Source: ETOGAS
## Content

1. About ETOGAS
2. Example of a successful Power-to-Gas project
3. What is the economic value of clean gas for clean mobility?
4. How can Power-to-Gas contribute to integrating clean power from volatile renewables?
5. Legal Framework
The Audi e-gas plant produces Hydrogen - and uses Hydrogen in a refinery to double the output of the local biomethane plant

**Audi e-gas plant built by ETOGAS 2012-2013**
Audis power provider adaptively sitches the electrolyzer for optimized renewable integration
Audi sells the clean fuel to CNG car customers

Impressions from the Audi e-gas plant (Werlte, Germany, 2013)

Source: ETOGAS
Since 2014 Audi successfully sells the clean fuel option based on clean hydrogen from clean power

Audi e-gas option announced for further new models in 2016

E-gas Option:
Energy consumed by cars = Energy injected into gas grid (Hydrogen or Methane)

Source: Audi
Power-to-Gas creates economic value if five factors are met

**Key economic drivers**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Attractive gas price</td>
<td>clean fuel for clean mobility has a high economic value</td>
</tr>
<tr>
<td>2) Smart adaptive power switching</td>
<td>support for renewable power integration creates value</td>
</tr>
<tr>
<td>3) Careful site integration</td>
<td>maximizes efficiency</td>
</tr>
<tr>
<td>4) Tailored technology</td>
<td>low CAPEX, high flexibility, low maintenance cost</td>
</tr>
<tr>
<td>5) Recognition in legal framework</td>
<td>obstacles from regulation can be crucial</td>
</tr>
</tbody>
</table>

Source: ETOGAS
Content

1 About ETOGAS

2 Example of a successful Power-to-Gas project

3 What is the economic value of clean gas for clean mobility?

4 How can Power-to-Gas contribute to integrating clean power from volatile renewables?

5 Legal Framework
Driving clean has a high value – does a clean gas allow for clean driving?

**Scope of lifecycle analysis**

What is the correct scope to measure emissions?

- **end of pipe**
- **fuel production and distribution**
- **vehicle production and recycling**

Without holistic view wrong judgement is likely!

Source: Audi
The source of energy is critical for driving clean - A clean gas (Hydrogen or Methane) can reduce the GHG footprint of driving by a factor of 20

Comparative lifecycle analysis

Audi: ... as good as BEV

EU FQ-Direktive: ... - 96% to conventional car

No end of pipe Emissions!

Content

1. About ETOGAS
2. Example of a successful Power-to-Gas project
3. What is the economic value of clean gas for clean mobility?
4. How can Power-to-Gas contribute to integrating clean power from volatile renewables?
5. Legal Framework
Does the production of clean gas contribute to supply more clean power?

**Power-to-Gas, the power-sector perspective**

What is the correct scope to measure emissions?

- **Synergy to renewable integration – less emissions in the power sector** → clean gas
- **Competition for clean power supply – more emissions in power generation** → no clean gas

Source: ETOGAS
Volatile production has below average market value – with more than 20% share serious problems arise

**Intermittency challenge for wind power**

The grid can take 20% windpower – the subsidy trap is triggered

- **controlled power**
  - increased cost
  - depressed prices

- **volatile power**
  - below average market value
  - To be backed by expensive subsidy?

Source: ETOGAS
Bivalent windparks generate more sable revenue from providing more stable power and from selling hydrogen

**Windpower + Power-to-Gas a bivalent production unit**

If power peaks are used for Hydrogen production the grid can take > 50% windenergy

- more stable and predictable power with increased market value
- additional revenue - erratic production plan - logistics challenging

Source: ETOGAS
Can erratic supply of hydrogen help to supply clean power?

**flexibility challenge for biogas**

If power generation from biogas should be restricted to low wind times!

- **Biogas continuous production**
- **steady power but expensive**

In high wind times, CHP should be turned off before electrolyzer switches on.

Source: ETOGAS
Bivalent biogas plants can adapt – If Hydrogen is available they produce Methane with double output – if power is short they supply power

Bivalent biogas plant – adaptive supply of power or gas

When hydrogen is available the CHP plant can stop

- Gas mixture becomes pure as CO2 is converted to CH4
- Alternating operation with continuous heat supply

Source: ETOGAS
With an adaptive Portfolio of assets steady power and clean fuel can be sold on forward markets with long term contracts!

**Steady power and clean fuel**

**Steady power – steady heat – clean fuel**

- **Wind Power**
- **Biogas continuous production**
- **adaptive assets**

- **PtH2**
- **H2**
- **Meth**
- **Biomethane**
- **e-gas**
- **Gas network**
  - transport
  - storage
  - trading
- **CHP**
- **Steady power Part 1/2**
- **Steady power Part 2/2**
- **clean fuel**

Source: ETOGAS
A localized time based analysis shows how assets must be combined and deployed in order to provide steady power and clean fuel at minimal cost.

**ETOGAS Visualization of asset operation level in 0-24 hours / 0-365 days**

Source: ETOGAS
ETOGAS technology is specifically designed to solve the renewables integration problem by production of clean fuel.

Typical annual production pattern for Power-to-Gas in renewables integration scenario

**MEGALYZER**
ETOGAS ELECTROLYZER TECHNOLOGY

- Megawatt scale
- Fast response
- High efficiency
- Low maintenance

Pressurized Alkaline Electrolyzer Technology

**METHANYIZER**
ETOGAS METHANATION TECHNOLOGY

- Megawatt scale
- Fast response
- High efficiency
- Low maintenance

Catalytic Methanation Technology

Source: ETOGAS
Content

1 About ETOGAS
2 Example of a successful Power-to-Gas project
3 What is the economic value of clean gas for clean mobility?
4 How can Power-to-Gas contribute to integrating clean power from volatile renewables?
5 Legal Framework
Why don’t we deploy the required assets today?
Regulation is key to attract private investment in cost minimizing infrastructure

**Regulatory requirements**

- **Regulation drives deployment of renewable technologies**
  - **Recognition of clean fuel**
    - Implement EU advanced biofuels regulations for Hydrogen or Methane on national basis
      - EU guideline: RED FQD 2015, national action to follow in 2017
    - Recognize clean fuel production in fleet emission calculations
  - **Market design for renewables**
    - Support demand conforming delivery from renewable asset portfolios
      - Demand conforming output is important - NOT extra support for backup power or storage
    - The production of Hydrogen in a bivalent wind system must not be burdened with electricity taxes
      - Supply driven electrolyzers are part of a power generation infrastructure taxation and tariffs on adaptive power conversion is not justified

Source: ETOGAS