Power to Methane
An Integral Part of Biomethane Industry

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European Biogas Association
25 Countries – 36 National Organisations
55 Companies – Representing >7,000 Stakeholders

www.european-biogas.eu
European Biomethane Industry

Anaerobic digestion
- Organic waste, manure, crops
  - Landfill
  - Anaerobic digestion
  - Sewage sludge
  - Upgrading
    - Grid injection
    - CO₂
    - CH₄

Gasification
- Lignocellulose: wood, straw
  - Gasification
    - CO/H₂
  - Methanation
    - CH₄
    - Grid injection
    - CO₂

Power-to-Gas
- Electricity: PV, wind
  - Electrolysis
    - H₂
    - Methanation
      - CH₄
      - Grid injection
      - CO₂
Why Biomethane (and not H₂)?

- **Existing infrastructure**, feed-in without any restrictions at any time: Pipelines, network, facilities, storage in caverns/aquifers, gas turbines, appliances compatibility, ...

- 3,5 times **higher storage capacity**: Hydrogen needs much more space (or pressure...) for the same amount of energy

- **Existing and affordable consumer applications** – CH₄ is already an universal energy carrier - **CNG** cars and busses, CNG/LNG trucks, ships, industry

- Methane is also a **raw material**!

- **Flexibility**: depending on the market situation and the infrastructure, energy can be transferred between different energy carriers.
Bio

Gas in CHP applications (methane equivalent)

Annual biomethane production

Hydrogen could be methanised with 20 bcm CO$_2$

Electricity could be “methanised” only by our industries

With the existing production capacity!
Efficiency Power-to-Gas: Even low-level heat losses

- 60-65% SNG
- 35-40% Power
- 50-60% Combined heat power

Vs. 0% due to power cut off/power curtailment

BEV: 36% * 0.65 = 23.4% Efficiency W2W
CNG HEV: 60% * 0.25 = 15% Efficiency W2W

Source: Sterner, M.; et. al.: Renewable (power to) methane, Fraunhofer IWES, Germany
Power-to-methane in Werlte: A process scheme

Water → e-gas (Audi) → Biogas plant → Upgrading → Biomethane → GAS GRID

Electricity → e-gas

Substrate → Biogas plant

Heat 95°C → Biogas plant

Heat 160°C → Upgrading

Rohbiogas → Upgrading

Heat 160°C → CO₂ → Upgrading

CO₂ → Upgrading

Heat 95°C → CHP unit

Heat 95°C → CHP unit

Green electricity → CHP unit

Quelle: EWE
Coupled electricity-methane networks – a flexible system
Audi pilot project with 6 MW PtG plant in Northern Germany

Vehicle production

1,000 e-tron + 1,500 A3 TCNG

Electricity

53,000 MWh

27,600 MWh

20,100 MWh

* Annual values in all cases

E-gas plant

Water
4,600 t H₂O

Oxygen
4,000 t O₂

Electrolysis
H₂ tank

H₂
520 t H₂

CO₂-tank

CO₂ from
biomass, garbage

2,800 t CO₂

Methanation

CO₂ + 4H₂ → CH₄ + 2H₂O

Water
2,000 t H₂O

*4.78 kWh/ 1 m³ H₂

Electricity generation (combined power/heat/cooling)

Natural-gas vehicles: CNG

1,500 A3 TCNG

880 t CH₄

120 t CH₄

Gas network

Gas storage

53,000 MWh

Electrolysis

Methanation

Water
4,600 t H₂O

Oxygen
4,000 t O₂

CO₂ from
biomass, garbage

2,800 t CO₂

*4.78 kWh/ 1 m³ H₂

Electricity generation (combined power/heat/cooling)
Power-to-Gas: Audi e-gas plant in Werlte (Northern Germany)
## Technical Data Audi e-gas plant (Werlte)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy content e-gas (average)</td>
<td>13,85 kWh/kg</td>
</tr>
<tr>
<td>Electricity input (prognosis)</td>
<td>26 – 29 GWh/a</td>
</tr>
<tr>
<td>Power input electrolyzers</td>
<td>3 x 2 MW</td>
</tr>
<tr>
<td>Efficiency „power to gas“ (with using heat)</td>
<td>54 % ➔ 70 %</td>
</tr>
<tr>
<td>Max. H₂ output</td>
<td>1300 Nm³/h</td>
</tr>
<tr>
<td>Max. H₂ storage time</td>
<td>60 min</td>
</tr>
<tr>
<td>Max. e-gas output</td>
<td>325 Nm³/h</td>
</tr>
<tr>
<td>Operation time (prognosis)</td>
<td>4,000 h/a</td>
</tr>
<tr>
<td>e-gas output (prognosis)</td>
<td>1000 t/a</td>
</tr>
</tbody>
</table>
Greenhouse gas footprint: PtG as good as BEV running on green power

(Mileage: 200,000 km)

- 85% CO$_2$
  (well-to-wheel)
Gas Future: 2nd Transition in Progress

France – scenario from ADEME of gas energy in the grid
Source: GRDF 2016

Gas History in France
Source: ENGIE 2017
Conclusions

➢ Biomethane industry is a strong and mature partner for green electricity, with considerable production capacities today, and sound potential for the future.

➢ Power-to-Methane technology has no limits in conventional gas industry and its implementation is cheaper and quicker.

➢ Power-to-Methane technology and biomethane production are much synergetic, easily integrated, and with tremendous potential in utilization of existing CO₂ streams.