Green H₂ Production and Delivery for Transportation Applications in Wind Regions

André Steinau, GP JOULE GmbH
Boston, 12th of September 2018
Unique all-round.

GP JOULE is the universal, innovative, authentic and successful partner in the renewable energy sector.

GP JOULE’s goal is to ensure that **100% of the energy consumed** around our planet in the future is **produced from renewable sources**.
To the point.
Facts about GP JOULE.

- Founded in 2009
- Employees: 230
- Installed generation capacity since 2003: 600+ MW
- Divisions: Projects, Think, IPP, Service, Connect
- Germany: headquarters and 4 offices
- North America: 2 offices
To the point II.

Facts about H-TEC SYSTEMS.

- Founded in 1997
- Acquired by GP JOULE: 2010
- Employees: 20
- Business Divisions
  - Stack manufacturing
  - Elektrolysis systems
  - 0,14 - 140 kg/d H₂-production
  - Load range: 0,26 kW-350 kW
  - Compact Design
  - High power density
Hydrogen - the golden key.
Crucial Challenges.

- Climate Goals
- Creating "Regional" Value Through Renewables
- Decarbonization
- Energy-Grid Bottlenecks
- Acceptance of Renewables
- Defossilization
- NOx
Generation Wind & PV vs. Demand (2014)

Generation vs. Demand North Frisia

- Wind
- PV
- Demand

Time progress in hours
Green Hydrogen Valley.

NordLink 1,4 GW

Offshore 1,2 GW

Nuclear power plant Brunsbuettel 0,8 GW

West Coast SH - Wind Onshore 2018 *

* Ministerium für Energiewende SH

<table>
<thead>
<tr>
<th>Region</th>
<th>In operation</th>
<th>Under construction</th>
<th>applied</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Husum</td>
<td>1,8 GW</td>
<td>0,4 GW</td>
<td>0,8 GW</td>
<td>3,0 GW</td>
</tr>
<tr>
<td>Heide</td>
<td>0,9 GW</td>
<td>0,1 GW</td>
<td>0,1 GW</td>
<td>1,1 GW</td>
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<tr>
<td>Süderdonn</td>
<td>0,8 GW</td>
<td>0,1 GW</td>
<td>0,1 GW</td>
<td>1,0 GW</td>
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<tr>
<td>Total</td>
<td>3,5 GW</td>
<td>0,6 GW</td>
<td>1,0 GW</td>
<td>5,1 GW</td>
</tr>
</tbody>
</table>

Curtailments in GWh

308 262 239 1092 2934 2706 3258
A refinement of renewable energy.

Best opportunities for the future.

The missing link in the chain: **electrolysis technology bridges the gap** between oversupply of power and growing demand for hydrogen.
HYDROGEN MOBILITY JOINT PROJECT

Connection of production and consumption for Public transport

• **GENERATING** GREEN HYDROGEN at appropriate wind farms with 5 × 225 kW electrolysis systems and 30 MPa compression installed

• **TRANSPORTING** GREEN HYDROGEN with swap bodys each 140 kg H₂

• **PROCESSING** GREEN HYDROGEN at 2 hydrogen refilling stations 35/70 Mpa each

• **USING/CONSUMING** GREEN HYDROGEN with own 2 local public transportation fuel cell buses

• RES power used in emissions-free mobility
• Smart integration of decentralised hydrogen infrastructure
• Increase in acceptance through local use of regionally produced power

• Transferable, scalable model for the implementation of further concepts for cross-sector market integration of RE in regions and countries.
## Joint Local Partnership

**Organisation of the cooperation**

### Joint project shareholders engage in self investment

<table>
<thead>
<tr>
<th>GP JOULE</th>
<th>Wind farm operators</th>
<th>Manufacturers/operators of H₂ technology</th>
<th>H₂ filling station operators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public transport operators</td>
<td>H₂ tank truck operators</td>
<td>Others - Heat users - H₂ marketers</td>
<td>Citizens</td>
</tr>
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</table>
Creating the local value chain.

225 kW electrolysis system

Hydrogen swap body concept

Hydrogen refilling station (Linde AG, 2018)

Fuel cell bus (Solaris, 2018)
Upcoming value chain drivers.

Mercedes Benz GLC F-CELL

Hyundai Nexo

FAUN Commercial vehicle

Mercedes FC truck
Outlook

Hydrogen mobility rollout: HY.TRAIN

- 50+ trains for SH local transportation by 2021/2022
- Contract for 30 years 8-10to/d minimum 50% Green H₂
Cost degression and markets.
Thank you for your attention!