Decarbonization

Implications of Hydrogen on Contracts

ENERGETIKA XXI: economy, policy, ecology
The Need for Energy Dialogue in a Fast Changing Environment
St. Petersburg, 15-16th of November 2018
Working Hypotheses

• European Customers want decarbonized natural gas

• Decarbonization technically, economically feasible

• Decarbonization to be provided by suppliers
Currently Contracted Product - Natural Gas

<table>
<thead>
<tr>
<th>Composition of Gas</th>
<th>Hydrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HighCal</td>
</tr>
<tr>
<td>Hydrogen*</td>
<td>H₂</td>
</tr>
<tr>
<td>Methane</td>
<td>CH₄</td>
</tr>
<tr>
<td>Ethane</td>
<td>C₂H₆</td>
</tr>
<tr>
<td>Propane</td>
<td>C₃H₈</td>
</tr>
<tr>
<td>Butane</td>
<td>C₄H₁₀</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>GCV</td>
<td>kWh/m³</td>
<td>11.46</td>
<td>9.78</td>
<td>11.08</td>
</tr>
<tr>
<td>NCV</td>
<td>kWh/m³</td>
<td>10.35</td>
<td>8.83</td>
<td>9.99</td>
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<tr>
<td>NCV/GCV</td>
<td></td>
<td>0.90</td>
<td>0.90</td>
<td>0.90</td>
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<tr>
<td>Wobbe GCV</td>
<td></td>
<td>53390</td>
<td>46163</td>
<td>53139</td>
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<tr>
<td>Wobbe NCV</td>
<td></td>
<td>48176</td>
<td>41639</td>
<td>47901</td>
</tr>
</tbody>
</table>

Compositions of natural gases are determined by origin

*Calculations based on data from: Schuster, Handbuch der Brenngase, Braunschweig

Implications of Hydrogen on Contracting claus.bergschneider@cbcgmbh.com 15.11.2018
Current Contracting of Russian Gas

- Gazprom exclusive sales channel for pipeline gas
- 165 bcm sold in 2017 to 21 European countries*
- Bilateral long term contracts, several beyond 2030
- Individual contract designs, many terms exceeding energy & price
- Many fixed delivery points, dedicated transport capacities
- Three major routes crossing several TSO – areas

* 194.4 bcm including 29.03 bcm to Turkey (Gazpromexport delivery statistics 2017)
Features of Hydrogen Supply

• Established product – global consumption > 550 bcm
• Production based on fossil fuels (95%), electrolysis (4%)
• Steam reforming most economical production method
  \[ \text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3\text{H}_2 ; \text{CO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2 \]
  Process be extended by carbon storage
• Large scale installations available
• Wobbe energy density in the range above low cal gas
• Different GCV, NCV energy content and transport specifics
• Needs some 20 % more transport capacity for same NCV
Hydrogen CO₂ Benefit and Transport Capacity

In case hydrogen transport replaces 1 bcm in natural gas transport, CO₂ benefits are reduced, depending on replacement at destination:

- 1 bcm natural gas saves 2.23 million tons CO₂

(If missing 0.2 bcm natural gas are replaced by renewables at destination)

- Benefit is reduced depending on replacement at destination to:
  - 1.78 million tons CO₂ (natural gas)
  - 1.64 million tons CO₂ (gas oil)
  - 1.48 million tons CO₂ (coal)

*Assumption: Energy equivalent supply of hydrogen needs 125% of natural gas transport capacity
Features of Decarbonized Gas

- Decarbonization means gradual substitution of Natural Gas by Hydrogen
- Decarbonized gas may be any mixture between of Natural Gas and Hydrogen
- Hydrogen share of 10% considered
- Energy content and transport specifics respectively lowered

<table>
<thead>
<tr>
<th></th>
<th>Russian Gas</th>
<th>Hydrogen 1.000</th>
<th>Decarbonized Russia, 10% H₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>H2</td>
<td>1.000</td>
<td>0.100</td>
</tr>
<tr>
<td>Methane</td>
<td>CH4</td>
<td>0.980</td>
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<tr>
<td>Ethane</td>
<td>C2H6</td>
<td>0.006</td>
<td>0.005</td>
</tr>
<tr>
<td>Propane</td>
<td>C3H8</td>
<td>0.003</td>
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<tr>
<td>Butane</td>
<td>C4H10</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>GCV kWh/m³</td>
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<tr>
<td>NCV kWh/m³</td>
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<tr>
<td>NCV/GCV</td>
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<tr>
<td>Wobbe NCV</td>
<td>47901</td>
<td>40893</td>
<td>47200</td>
</tr>
</tbody>
</table>
Decarbonized Gas – Successor or Companion?

• Timeline
  • Gas Sales Agreements with long remaining maturities
  • If started to comply with Paris agreement, decarbonization must happen within the lifetime of current GSA`s

• Route
  • Without own infrastructure, \( \text{H}_2 \) needs joint transport with natural gas

• Decarbonized gas cannot avoid interference with LTC Natural Gas
• Are GSA`s adjustable from natural gas to decarbonized gas?
Implications towards Contract Terms

In case Hydrogen calories substitute natural gas calories

• Sellers role, buyers role
• Compliance with EN 16726, TSO’s and contractual quality restrictions
• Contracted quantities, supply & take obligations
• Flexibility terms
• Deficiencies & penalties
• Contract price, regular price adjustment
• Price revision, calculation of obtainable market value

• Changes require commercial agreement – contract revision clauses limited to price adjustment
Implications along the Value Chain

Production (wellhead)
- Separation of partial volumes

Treatment
- Steam reforming investment & utilization
- Carbon storage
- Volume management

Transport (exclusive)
- Capacity reduction
- Management of capacity allocation
- Additional fuel cost

Transport (non exclusive)
- Compliance with contract terms & grid requirements
- Additional capacity needs

Entry/Exit Distribution & Sales
- Increased distribution costs
- Determination OMV
- Cost coverage

Delivery Point
Pricing for Decarbonized Gas

• Premium must cover costs
• Obtainable market price for decarbonized gas?
• No market price for decarbonized gas but for Hydrogen
• Regulated, cost related pricing?
• Value of service pricing (next best alternative?)
  • Value of saved carbon certificates (0.2 eurocents/kWh/10 € EUA)
  • Regulated price for Hydrogen from REN
  • Value considered in TSO`s entry fees
Separation from GSA`s a Solution?

In case hydrogen calories are sold on top as add on

• Interference with natural gas in transport unavoidable
• Synchronized or decoupled volumes
• Segregation at points of entry?
• Who takes the buyers role (investment guarantee)?
• How is risk sharing organized?
Requirements for Potential Implementation

• Coordination needed as much more parties involved than before due to TSO`s control of gas flows
• Virtual model required as physical allocation to end users not possible
• E/E tariffs need changes due to investments & changed transport efforts
• New view on required transport & storage capacities
• Policy makers challenged
  • to set up attractive environment for GSA-parties for consent to infringement of their property rights
  • to pave the way for infrastructure operators
  • to stop interventionist policy and allow consistent market allocation
## Implicit Carbon Pricing (CNG in Germany)

<table>
<thead>
<tr>
<th>Fuel tax</th>
<th>CO2 emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>tax on CNG</td>
<td>1.4 ct/kWh</td>
</tr>
<tr>
<td>tax on Petrol</td>
<td>7.4 ct/kWh</td>
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<tr>
<td>tax on Diesel</td>
<td>4.8 ct/kWh</td>
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</table>

<table>
<thead>
<tr>
<th>CO2 advantage</th>
<th>tax difference</th>
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<tbody>
<tr>
<td>0.059 kgCO2/kWh</td>
<td>CNG to Petrol</td>
</tr>
<tr>
<td>0.065 kgCO2/kWh</td>
<td>CNG to Diesel</td>
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<thead>
<tr>
<th>Implicit carbon price</th>
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<tbody>
<tr>
<td>1017 Euro/t</td>
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<tr>
<td>523 Euro/t</td>
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Большое спасибо за Ваше внимание!

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