Towards Future Technological Developments/Potential of Shale Gas

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Hearing on „Prospects for Shale Gas in the European Union“
organised by the European Parliament
Brussels, 05. October 2011
Shale gas
- What is it?
- Where is it?
- What is the potential?

Development
- Wells and fracs
- Technology development
- Economics

Environmental compatibility
- Frac containment
- Frac fluids
- Foot print

Conclusions
SHALE GAS IS A SO-CALLED UNCONVENTIONAL GAS

Unconventional Gas
- Not the gas is unconventional but the reservoirs

Conventional Reservoirs
- Discret accumulation of gas
- Reservoir rock with good flow properties
- High production capacities

Unconventional Reservoirs
- Continuous deposits over large areas
- Extremely low permeabilities
- Low natural production capacities
SHALE GAS: RESERVOIRS TIGHTER THAN CONCRETE PAVEMENTS

- Unconventional reservoirs
  - Extremely low permeabilities
  - Not recoverable without elaborate technology
  - Enormous potential

Source: ExxonMobil, 2009
Source: ITE, 2011

Towards Future Technological Developments/Potential of Shale Gas

Shale gas is found

- In the North German Basin
- In the formations Wealden, Posidonia and Carboniferous
- In depths of approx. 800 - 3,000 m

The cap rock contains impermeable layers
SHALE GAS: AREAL TARGET

- Large areal extent of shale gas deposits
- Currently assessment of resources by BGR and GFZ
- Shale gas resources acc. to EIA 230 Milliard m$^3$ (recoverable)
- Unconventional resources equal 40-times of current yearly production

Quelle: Doornenbal & Stevenson (edts.), 2010
(Recoverable) Shale Gas Resource Estimates Western Europe (10.530 Mrd. m³)

Plus Poland: 5.300 Mrd. m³

Source: EIA ARI World Shale Gas Resources, 2011

(Conv.) Gas Reserves Europe: 4.550 Mrd. m³, Source: EIA, 2010

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Shale gas …
- is a natural gas in rock formations with high resistance to flow
- is far below drinking water horizons in approx. 800 – 3.000 m
- bearing rocks are overlain by impermeable layers
- potential is larger than the currently known reserves

Development
- Wells and fracs
- Technology development
- Economics

Environmental compatibility
- Frac containment
- Frac fluids
- Foot print
Wells are constructed to …
- provide a tight connection between the surface and the reservoirs
- high construction standard

Well design
- Sectional introduction of steel pipe
- Annulus cementation

Quality assurance
- Pressure tests
- Acoustic well logging
  = Cement Bond Log (CBL)

Source: Reinicke et al., 2011
Hydraulic fracturing
- Process of initiating and propagating a fracture in a rock layer, employing the pressure of a fluid as the source of energy
- Technology used since 1949 in >1 million U.S. wells (in D since 1961)
- Ca. 90% of U.S. gas wells have been fraced
- Fractures are typically contained within the formation fraced

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Number of fracs in gas wells in Germany (approx. 300 in total)
USA

- 2005: more than 35,000 shale gas wells → ca. 17 Milliard (10⁹) m³/a
- Initial shale gas production from deposits with natural fractures
- Recent shale gas boom technology driven

Key Technologies

- Horizontal drilling
- Frac/multifrac technology
- Recently multilateral-/ horizontal well and multifrac technology
DEVELOPMENT: OUTCROP OF SHALE GAS RESERVOIR

Source: USGS, 2011
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Source: BGR, 2011
Well

3: Gas flow in production well

2: Gas flow through fissures

1: Degassing by diffusion

Clay layer

Source: BGR, 2011
Until 2008: ca. 10,000 wells
therefrom
- until 2000: ca. 4,000 vertical wells
- until 2005: ca. 500 directional wells
- after 2005: ca. 5,000 fraced horizontal wells

Today: increasingly multifraced, multilateral-/horizontal wells
Barnett Shale, Texas

Until 2008: ca. 10,000 boreholes
- Until 2000: ca. 4,000 vertical boreholes
- Until 2005: ca. 500 directional boreholes
- Afterwards: ca. 5,000 fractured horizontal boreholes

Approximate area:
- ca. 36 km²
- ca. 15 km²

Dortmund, North Rhine-Westphalia
59,000 wells
1,700 wells deeper than 100m
600 wells deeper than 1,000m

29,000 Carboniferous Wells
approx. 90,000 wells NRW total
- 3,700 wells deeper than 100m
- 1,600 wells deeper than 1,000m

North Rhine-Westphalia
- 59,000 wells
- 1,700 wells deeper than 100m
- 600 wells deeper than 1,000m

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Quelle: EIA, 2011 Bochum

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Cost reduction is key

Costs for well construction and fracturing dominate

Several initiatives to cut costs under way in Germany
- DGMK joint industry initiative „Novel Ideas in Drilling“
- Niedersachsen collaborative research program gebo (Geothermics- and High Performance Drilling)

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Target shale gas
- Shale Gas is natural gas in rock formations with high resistance to flow
- Targets are far below drinking water horizons in approx. 1,000 – 3,000 m
- There are tight rock formations drinking water horizons and targets
- The potential is larger than the currently known reserves

Development
- Wells are constructed to provide a tight connection to the reservoirs
- “Fracking” is a tested and proven technology used since 60 years
- Horizontal well and frac technology provide a means to economically develop shale gas resources also in the EU

Environmental compatibility
- Frac containment
- Frac fluids
- Foot print
ENVIRONMENTAL COMPATIBILITY: CONTAINMENT

Cap rock
- Overburden must contain barriers to flow

Wells
- Well must provide a gas tight connection to the reservoir

Fracs
- Fracs must be contained
- Frac fluids must be compatible with the respective environment

Source: ITE, 2011
ENVIRONMENTAL COMPATIBILITY: FRAC FLUIDS

Typical composition of frac fluid for proppant frac

- Water = 90.6% (8.96%)
- Proppants = 8.96%
- Others = 0.44%

Source: Miskimins, SPE, 2011
**ENVIRONMENTAL COMPATIBILITY: FRAC FLUIDS**

Typical composition of frac fluid for proppant frac

- **Proppants** = 8.96%
- **Water** = 90.6%
- **Others** = 0.44%

Additives for Slick Water Fracs <0.2%

Source: Miskimins, SPE, 2011

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ENVIRONMENTAL COMPATIBILITY: FOOT PRINT

Cap rock
- Overburden must contain barriers to flow

Wells
- Well must provide a gas tight connection to the reservoir

Fracs
- Fracs must be contained
- Frac fluids must be compatible with the respective environment

Foot Print
- Foot print must be reduced by innovative subsurface development
ENVIRONMENTAL COMPATIBILITY: FOOT PRINT

“Classical” Vertical Well Technology

“Multilateral Well- and Multifrac Technology”

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Development
- Wells are constructed to provide a tight connection to the reservoirs
- “Fracking” is a tested and proven technology used since 60 years
- Novel technologies provide a means to economically develop shale gas resources also in the EU

Environmental compatibility
- Safe execution of wells and fracs to contain fracs fluids and gas
- Further improvement of frac fluid compatibility
- Innovative technology use to reduce foot print
Current conventional gas reserves in Europe are less than 5,000 billion (10^9) m^3

Shale gas resources in Europe are estimated to be larger than 15,000 billion (10^9) m^3

Shale gas resource estimate equals 50-times the current European gas production
Thank you for your attention