Shale Gas: Promise or Economic Bubble?

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De Pers
EBN noemt immense getallen.
Slochteren is minigasbel vergeleken bij de nog onontdekte voorraden

Er zit volop gas in onze bodem, stelt Energie Beheer Nederland. Niet iedereen is overtuigd. Ons gas is nog niet op. Als we Energie Beheer Nederland (EBN) mogen geloven, tenminste. Die stelt dat Nederland beschikt over grote hoeveelheden onontdekt gas, waarmee we nog vele decennia onze staatskas kunnen verrijken en ons potje kunnen koken. In deze week verschenen rapport stelt EBN dat, als we het zogenaamde ondiepe gas en kleisteengas meetellen, het volume kan oplopen tot 500.000 miljard kubieke meter. Ter vergelijking: de aardgasbel van Slochteren, de grootste in Nederland, bevatte bij ontdekking 2.800 miljard kubieke meter gas.

"Groningen is tiny gasfield compared with what is still to be found."
Volume could be as much as 500 000 bcm
(>100 times the volume found to date...)
US Dry Natural Gas Production

Henry Hub Gas Price Development

Recent Developments in Gas Price

Marine Source Rocks and Climate Conditions

The "Greenhouse" World
- Small difference in temperature between poles and equator
- Expanded tropical and temperate climate belts
- Sluggish oceanic circulation
- Upwelling decreases
- Oxygen poor bottom waters
- Sea level rises - anoxic shelves common

Example: Expanded Oxygen Minimum Zones

The "Icehouse" World
- Large difference in temperature between poles and equator
- Compressed tropical and temperate climate belts
- Intense oceanic circulation
- Upwelling increases
- Oxygen rich bottom waters
- Sea level drops - restricted basins common

Example: Oxygen Rich Bottom Waters
**Global Sea Level, Temperature & CO₂ Variations**

- **Global Sea Level**
  - NOW: 0 m
  - 100 m: +200 m

- **Average Temperature**
  - 0°C, 10°C, 17°C, 25°C

- **CO₂ in Atmosphere**
  - 300 ppm, 600 ppm, 1000 ppm, 2000 ppm

**Devonian - Early Carboniferous**

The Netherlands was located on the southeastern margin of the large Laurussian plate, in a warm tropical sea with large coral reefs, facing a closing ocean.

**Hydrocarbon Generation Process**

- **Organic-rich shales**
  - Barnett Shale
  - Haynesville Shale
  - Marcellus Shale

- **Processes**
  - Biogenic CH₄ (methane formation)
  - Kerogen formation
  - Thermal cracking
  - Pressure-induced cracking

- **Shale Gas**
  - A source rock with gas
  - Normally considered an impermeable sealing formation
  - It must have been deep enough to become gas mature
  - It must now be sufficiently shallow so that it can be developed (pre-existing fractures through uplift)
  - It must be “fraccable” (high in silica or carbonate & low in clay especially smectite)
Shale gas is also called 'unconventional gas'

Shale Gas

Typical Pore size 0.5 – 100 nm
Typical Permeability 10 – 100 nD

Hydraulic Fracching

- Groundwater supplies are protected by 1000’s of feet of impermeable rock and well casing design
- Hydraulic fracturing has been used since the 1940’s in over 1 million wells worldwide
- In NL, more than 200 wells have been fracked already

Composition of Fracching Fluid

Typical fluid volumes used for 1 frac-job: 5000 - 20,000 m³
Frac Fluid Volume and Seismicity

McGarr relationship (1976):

\[ \sum M_0 = K \mu |\Delta V| \]

- Change of volume connected with induced seismicity
- \( K \) = geometric factor (0.5 – 1.33)
- \( \mu \) = shear modulus [Pa]
- \( |\Delta V| \) = volume change [m³]
- \( M_0 \) = Seismic moment [Nm]
- measure of energy release of seismic event (micro earthquake)

Unconventional Gas Production

- Stimulation by hydraulic fracturing
  - Geomechanical setting needs to be understood
  - Orientation of natural stress-field and fractures
- Needs solution for back-produced frac-water

EUR/Well

Recovered volume per well is leading
Total recoverable volume less important
Unconventional Gas – Sweet Spots are Key

- Sweet Spots can be mapped
- But here it took 8000+ wells!

Fort Worth Basin
Barnett Shale

Value Drivers in UG Developments

- EUR per well is key, but its uncertainty is much larger than any other factor!

Cashflow Comparison

For comparison: a Groningen well produces on average 3 mln m³ per day
Development of Unconventional Gas typically requires large numbers of wells

Jonah Field, Wyoming, Basin Centred Gas

1986

2008

700+ wellpads

Number of Well locations can be Reduced

By multiple wells

Or ‘Multi-laterals’

6 horizontal wells + 7 fracs each

Source: Statoil

Shale Gas – Land Use

Maps to Scale

Nature Reserves (MER-obligatory)

"Aandachtsgebieden”

Built-up areas

Exploration Licences for Oil & Gas

Noordoostpolder

Cuadrilla Resources Ltd

Midden Nederland

Peel

DSM Energy (Pips-BV)

De Kempen

Cuadrilla Resources Ltd

Breda - Maas

Cuadrilla Resources Ltd
Technically Recoverable Reserves in NL

Potential very uncertain
Large variations in estimates:

- TNO/EBN 2009: 5500 – 22000 BCM
- Herberde Jager 2010: 10 – 30 BCM
- EIA 2011: 480 BCM
- TNO 2012: 200 – 500 BCM
- EIA 2013: 740 BCM

Shale Gas candidate in NL

Epen Fm. Geverik Mb (Namurian)

Good
- High average TOC (8%)
- Proper thickness (60 - 80m)
- Uplifted in Peel area
- Depth range 900 – 1500m

Not good
- Lateral continuity of high TOC uncertain

NL Onshore Shale Gas Potential

Geverik Claystone:
Assumption:
- areal coverage 850 km²
Which means:
- gas reserve: 10 – 30 BCM (= billion m³)
- production per well: av. 10.000 m³/day
- lifespan per well: 7 – 10 years
- EUR of 0.03 BCM per well
- approx. 1000 wells required
- Production level: 3.6 BCM per annum

Gasproduction in the Netherlands

Slochteren
Offshore
Land

Source: EBN, 2010

This takes approx. 1000 producing shale gas wells.
"Draagvlak" for Subsurface Activities does not Come Automatically...