An introduction to shale gas in the UK and The Netherlands

Henk Duyverman, Cuadrilla Resources
September 17, 2013
What is on your mind?

• What is the shale gas process?

• What are the risks? (such as groundwater pollution, water usage, emissions, visibility, “earthquakes” etc.)

• What are the challenges we are facing in the UK?

• What is being done in Holland, and what can we learn from the UK?
Agenda

• Overview of the story so far and exploration plans

• Cuadrilla’s vision of Sustainable Development

• UK situation

• What does this mean for Holland
Overview of Cuadrilla

• Formed in 2007, UK company
• First to spot shale gas opportunity in Europe
• Acquired most prospective acreage before anybody else identified the potential
• Diversified acreage portfolio throughout Europe – spreading the risk
• Largest acreage holding in Europe outside of the major oil companies
• Partnered with government or industry-specialist funds
• Ownership of own rig to reduce reliance on external service providers

Exploration assets
- Netherlands ≈ 680,000 acres
- UK Bowland basin ≈ 293,000 acres
- UK Weald basin ≈ 57,000 acres
- Poland ≈ 440,000 acres
Licenses in the UK, The Netherlands, Poland

CUADRILLA
EUROPEAN PLAYS

PEDL165, EXL269
Bowland Shale Fm
293,190 acres
Multi-TCF Shale Gas

KOSP (EDL244, EXL189)
Kimmeridge Clay FM
Limestone Oil Play
57,189 acres
Unconventional Oil

Noord Brabant
Carboniferous, Triassic, Jurassic
476,666 acres
Tight Gas, Shale Gas, Oil Shale

Noordoostpolder
Namurian Shales
202,379 Acres
Multi-TCF Shale Gas

Lublin Trough (Pionki, Ryki)
Silurian/Devonian/Carboniferous
446,741 acres
Multi-TCF Tight Gas and Shale Gas
Bowland in summary

- Bowland Basin is a very significant shale gas resource play
- Over 1000m (>3300 ft) thickness of shale
- Shale is naturally fractured (free + absorbed gas)
- Cuadrilla: Gas in Place (GIIP) > 200+ tcf
- BGS: 1300 tcf
  - Many places GIIP > 1 tcf / sq.mile
  - 1000’s feet below aquifers – not enough energy to frac into aquifers
  - Very close to major pipeline infrastructure
  - Market ready for this gas
- DECC/ HSE approved, in alignment with government policy
The timeline

- 2007: Cuadrilla formed in the UK
- Oct 2009: Temporary planning permission granted to drill at Preese Hall site, Weeton
- Aug 2010: Drilling commenced at Preese Hall
- Apr 2010: Temporary planning permission granted to drill at Grange Hill site, Singleton
- Oct 2010: Temporary planning permission granted to drill at Becconsall site, Banks
- Jan 2011: Drilling commenced at Grange Hill
- May 2011: Cuadrilla voluntarily suspends activity after two tremors at Preese Hall site
- Aug 2011: Drilling commenced at Becconsall site
- July 2012: 3D seismic survey, 100 KM2 in license area
- October 2012: Drilling begins at Anna’s Road site, Westby
- November 2012: Drilling at Anna’s Road site ceases
- November 2012 Anna’s Road extension proposal submitted
- December 2012: DECC announces resumption of fracturing
- Jan-Feb 2013: Lancashire County Council Planning decisions postponed
- March 2013: Announce suspension of current planning applications, initiates EIA/ERA process for multiple sites
- May 2013: Announce plans to drill for oil in Balcombe, West Sussex (no fracturing)
- July 2013: Rig mobilized to drill in Balcombe
Exploration in the UK – how it works

License is granted by DECC to explore
Drilling must occur within 5 years

Site temporary permission is granted by County Council

An exploration well is drilled and tested
Commercial viability of the well is calculated
Production/Development

- If the exploration finds producible hydrocarbons, then a field development plan is submitted
- This requires approval by the county council and DECC
- Entails more stringent environmental, social, health and community studies

(Artist’s impression, production pad 2013)
As of September 2013, three gas wells drilled

- Preese Hall-1 drilled to 9,100 feet (partially fractured)
- Grange Hill-1 drilled to 10,700 feet
- Becconsall-1 drilled to 10,500 feet
- Acquired detailed 3D subsurface mapping of 100 KM² through seismic survey
- Existing: Elswick-1 producing from 3,500 feet (existing sandstone well, vertical fracture in 1993)

- Balcombe-2 (West Sussex) conventional oil in limestone (vertical with sidetrack)
What’s happening in The Netherlands?

- 2 Licences awarded, Brabant in 2009 and NOP in 2010
- Independent study Witteveen/Bos published Sept. 2013
- Gov’t hearing 19th of September, decision Minister Kamp in October
- First well expected 3d/4d quarter 2014
- Cuadrilla to work on IEA issues like seismic risk, water issues and local environment
- Consensus culture means talking to stakeholders a lot
The problem we are facing in The Netherlands

Proportionally profiled production allowance Groningen accumulation (2011 - 2020)

Expected supply Groningen accumulation based on production plan (from 2021 onwards)

Expected supply from as yet undiscovered accumulations

Expected supply from aContingent Resources (PRMS)

Expected supply from Reserves (PRMS)

Historical production Groningen Field

Historical production 'small fields'

(NL Oil and Gas Portal 2013)
Our key message:
Shale gas is about sustainable development
Sustainable development
Meeting present needs without compromising the future

- Environmental sustainability
- Economic efficiency
- Social acceptance
- Sustainable development
- Security & diversity of supply

(Framework -- Brian Horsfield, Helm Holtz  GFZ Center Potzdam 2013)
Sustainable development
Meeting present needs without compromising the future

- Environmental sustainability
- Economic efficiency
- Security & diversity of supply
- Sustainable development
- Social acceptance

---

Dart rebuttal....

Laidlaw Egan...
Do spade word before or after
High level to start with, sedimicity etc Turks water...

state ownership mineral rights, vs private ownership
Dan Lewis. Philip booth. In iea
Pbooth@ica.co.uk
Indigenous gas production supplies a decreasing share of UK demand

(Source: Department of Energy and Climate Change)
UK offshore and shale gas production and net gas imports

(Source: IoD calculations)
Sustainable development
Meeting present needs without compromising the future

- Environmental sustainability
  - Security & diversity of supply
  - Sustainable development
  - Economic efficiency
  - Social acceptance
Environmental sustainability

• **Issues of concern**
  – Water
    • Aquifer contamination
    • Water use
    • Flowback water disposal
  – Seismicity
  – Landscape and community impact
  – Emissions – local health impact, greenhouse gas
  – Impact on renewables investment
Water is the biggest issue

- Risk of water pollution: 29%
- Risk of causing earth tremors: 24%
- Risk of gas leaks: 9%
- More traffic in local area: 7%
- Impact on house prices in local area: 6%
- Ugly buildings/wells (or other negative impact on landscape): 6%
- Negative impact on climate change: 5%
- Reduced investment in renewables: 4%
- Noise from drill sites in local area: 2%
- None: 4%
- Don't know: 4%

(Source: BritainThinks, Lancashire Tracking Sept 2013)
Men are more likely to support, and to see water pollution as the most important disadvantage (33% Men compared with 24% Women)

Opposers are more likely to be women, and to see earth tremors as the most important disadvantage (29% Women compared with 19% Men)

(Source: BritainThinks, Lancashire Tracking Sept 2013)
Risks as EA represents

What are the risks to air, land and water in the UK?

- Fugitive emissions of methane
- Impact on water resources from water taken from the environment
- Contamination of groundwater due to poor well design or failure
- Contamination of groundwater due to mobilization of solutes or methane
- Inadequate transport or processing of produced gas
- Inadequate transport or treatment of wastes & waste waters
- Contamination of soil, surface or groundwater due to spills of chemicals or return fluids

Impact on water resources from water taken from the environment

Contamination of groundwater due to poor well design or failure

Contamination of groundwater due to mobilization of solutes or methane

Inadequate transport or processing of produced gas

Inadequate transport or treatment of wastes & waste waters

Contamination of soil, surface or groundwater due to spills of chemicals or return fluids
We are always dealing with bad imagery
The reality!
Well integrity
Cuadrilla sets triple barrier through aquifer

Figure 1
Preese Hall #1 - Well Schematic

(Cuadrilla 2012)
Water use – the scare story
Water use – the reality
Upstream a very small percentage

Hydraulic fracturing and its associated operations account for 6.15% of the life cycle freshwater consumption.

(Laurenzi/ Jersey ExxonMobil LCA 2013)
Seismic risks

Cuadrilla Fracking Linked to Earthquakes

Two earthquakes in the area around Blackpool have been linked to hydraulic fracturing operations conducted by Cuadrilla Resources.
Seismic risks – the reality
Induced seismicity, all sources

(Davies et al, 2013)
Seismic risks

Injection can lubricate faults, cause small tremors
  – Cuadrilla’s two events: 1 April 2.3 ML and 27 May 2011 1.5 ML

Subsequently we have

1. Conducted 3D survey (better a-priori knowledge of faults)

2. Planned to hydrofracture in smaller stages

3. Placed seismometers and tiltmeters in arrays around sites (real-time data)

4. Agreed a “traffic light” mitigation system, at 0.5ML threshold
Fractures and contamination
Is fracture length a cause for concern?

– Maximum fracture length circa 588m/1919 ft
– The top of the Bowland shale is at a depth of circa 6000 feet

(Davies et al, 2012)
Fugitive methane
Fugitive methane – the reality
Green completion methods eliminate fugitive methane issue

Hydraulic fracturing and its associated operations account for 1.17% of the life cycle GHG emissions (Marcellus operations)

(Laurenzi/ Jersey ExxonMobil LCA 2013)
Climate change
GHG Emissions – the reality

(Potential Greenhouse Gas Emissions Associated with Shale gas Production and Use- DECC 2013)
UK still uses a lot of coal
UK coal plants are being de-commissioned, but in the meantime, our electricity depends on coal and gas

(Gridwatch Sept 12 2013)
Shale gas does not disrupt low carbon investment

(Pöyry 2012)
Fracking water
Cuadrilla -- water makeup and management

• **What goes in**
  – Mains water from United Utilities (already has a biocide)
  – Polyacrylamide (classified as non hazardous by the EA), to reduce friction and improve the suspension of sand in the water
  – Sand

• **What comes out – flowback water**
  – Very salty water
  – Various minerals from the rock, metals (very dilute solution)
  – NORM (naturally occurring radiation)
  – Flow-back waters are classified as non-hazardous by the Environment Agency are captured, processed in an industrial facility

• **We are aiming for a water recycling model**
Sustainable development
Meeting present needs without compromising the future

- Environmental sustainability
- Economic efficiency
- Social acceptance
- Security & diversity of supply

Laidlaw Egan... Do spade word before or after
High level to start with, sedimenticity etc Turks water etc... w rebuttal

S tate ownership mineral rights, vs private ownership
Dan Lewis, Philip Booth. In IEA
Pbooth@ica.co.uk
Is this an economic prize worth pursuing?

- We have announced (conservatively) that the Bowland license area contains 200 tcf (trillion cubic feet) of gas in place
  - *What fraction of this can be extracted??*

- The theoretical market value of the whole 200 TCF at today’s wholesale gas prices is £1.40tn
- Let’s assume a conservative recovery percentage…. say 10%
- 10% recoverable = £140bn
Investment and jobs from a single production site

(Source: IoD calculations)
Potential Annual Investment

(Source: IoD calculations, central scenario)
Potential cumulative jobs – a high of more than 70K (direct, indirect and induced)

(Source: IoD calculations)
UK oil and gas tax revenue is forecast to fall significantly

(Source: HM Treasury, Deloitte analysis 2013)
Annual UK Government Bowland Basin tax revenues (using DECC gas price sensitivities)

(Source: HM Treasury, Deloitte analysis 2013)
Sustainable development
Meeting present needs without compromising the future

- Environmental sustainability
- Sustainable development
- Economic efficiency
- Social acceptance
- Security & diversity of supply
Cuadrilla mission

- To create value for all stakeholders,
- *including the communities where we work,*
- by identifying, securing and responsibly operating exploration opportunities in unconventional hydrocarbons in the UK and Europe
In one of the communities where we work…
The protests produced positive journalism

Fracking: here are the facts

Drilling can be safe if we follow the rules, argues Prof Robert Mair

Last year, I chaired a joint committee set up by the Royal Society and Royal Academy of Engineering to analyse the environmental, health and safety risks associated with shale gas exploitation in Britain. We came up with a set of recommendations for the Government to make it as safe as possible, if they decided to go ahead. The report concluded that these risks could be managed effectively if the Government accepted all the report's recommendations.

Last year, I chaired a joint committee set up by the Royal Society and Royal Academy of Engineering to analyse the environmental, health and safety risks associated with shale gas exploitation in Britain. We came up with a set of recommendations for the Government to make it as safe as possible, if they decided to go ahead. The report concluded that these risks could be managed effectively if the Government accepted all the report's recommendations.

Fracking in Britain would take place at depths of many hundreds of metres or several kilometres. So far, the only shale gas fracking in this country has been at depths of 1,066 metres (1.7 km) and 1,933 feet (583 km), equivalent to the height of many London Shard placed on top of each other. It would be highly unlikely for water contamination to occur by means of fractures extending upwards from these deep shales and intercepting an aquifer, since the two are separated by a vast cover of rock. Even if it were possible, pressure conditions mean that the fracking water would not flow that far upwards. If there is water contamination, it is much more likely to be due to poorly constructed and regulated wells. These are lined with a steel casing, which is sealed into the ground by cement, ensuring the well's integrity is very important. The risk of contamination is to be kept to an absolute minimum. Here in Britain, we have a long history of world-class oil and gas industry regulation, plus a unique examination scheme to ensure that the design, construction and abandonment of wells is reviewed by independent, specialist experts.

We expect tremors at the surface to be no more severe than the passing of a truck.

Cuadrilla
Even villagers rebelled

We want you to go home, villagers tell fracking protesters

Juliet Samuel

Scores of residents living in the village at the centre of anti-fracking protests have defended oil extraction and urged “squatter” activists to go home.

A week after more than 1,000 protesters descended on the Sussex village of Balcombe, a group of 60 residents wrote to the 100 protesters still camped near the drilling test site.

The villagers said they are “fed up” with the disruption caused by attempts to stop the energy company, Cuadrilla, from drilling to look for oil. Last week, the protest culminated in the arrest of more than 30 people, including Caroline Lucas, the Green Party MP.

“We do not believe exploratory drilling or properly regulated further exploitation will unduly damage our environment,” says the letter. “Having regard to the outlook for energy prices, energy security and importance to the national economy, we believe that we, in common with other communities, should accept and facilitate this ‘new technology’.”

Cuadrilla has restarted drilling after suspending operations at the height of the protests. It could apply for a licence to frack if it finds sufficient resources.

Rodney Jago, one of the organisers of the letter, said: “A lot of the farmers are really fed up. They’ve been hit in the pocket by this squatter settlement. If it weren’t for the protesters, you’d hardly know the [drilling] was there.”

He said the village fete was politicised by people who “paraded around dressed as fish and distributed leaflets”. He said that “many, many” more people disliked the protest camps but felt nervous about going public.

Balcombe Parish Council has said that a survey it conducted last year indicated that 82 per cent of residents who responded were against fracking while many villagers have joined the protests. However, the survey had a response of under 30 per cent.

After two camps sprung up on fields, farmers in the area have barricaded their gates. Peter Dutton, 57, said: “It has been a massive inconvenience. We have land we can’t even get to.”

In one case, protesters stopped a lorry on its way to clear sewage pipes that run out of the village, mistaking it for a drilling delivery, he said.

“Most of us trust the Government to monitor [the drilling],” Mr Dutton added. “I respect the views of the people who are anti [drilling]. I just don’t like the mob they’ve brought in.”

Benjamin Skinner, the sub-agent for the Balcombe Estate, on whose land Cuadrilla is operating, did not sign the letter but said he would have done if asked.

“Not everybody feels the same way,” Katy Dunne, a local resident and organiser of the No Fracking in Balcombe Society, said. “Any supposed disruption from this camp is nothing compared to the effect of fracking.”
What we do

• Many forms of consultation
  – Small and large meetings
  – Site tours
  – Presentations, participation

• Research, to better understand how the issues are seen

• Communications – “early and often” -- before, during, and after permitting and operations
56% support vs 20% oppose
Un-decideds move to Support

Q. Thinking about everything we have discussed, how much do you support exploration, in your area, to understand the potential for natural gas from shale in the UK? [500 adults aged 18+ interviewed by telephone in October 2012] [December 2012 base: 503; October 2012 base: 1,001]

(Source: BritainThinks, Lancashire Tracking Sept 2013)
59% of men support exploration, compared with 39% of women

(Source: BritainThinks, Lancashire Tracking Sept 2013)
EIA’s/ ERAs

• Comprehensive
  – Technical consultation
  – Community consultation

• Applications to drill, fracture and flow test late 2013 / 2014
Environmental Statement

Front end
- Introduction
- Legislation
- Process
- Project description
- Baseline environment
- Scope
- Alternatives

Technical studies
- Geology
- Hydrogeology
- Contamination (ground & surface water)
- Air quality (incl. methane emissions)
- Climate change
- Noise
- Traffic
- Landscape character
- Visual impacts
- Ecology
- Land use & agriculture
- Lighting
- Community & Socio-economic
- Archaeology & heritage
- Resources and waste
- Site monitoring & management
- Soils
- Access (PRoW)

Analysis
- Direct impacts
- Indirect impacts
- Residual impacts
- Cumulative impacts
- Summary impact tables
- Appendices

Non-Technical Summary
What can we learn from this in The Netherlands?

- Two-party culture versus consensus culture
- Comparable EIA studies are beneficial for both countries’ activities
- Unified policies to talk to stakeholders
- Learn in NL from operations experiences in UK
- Work together!
Thank you