

The logo consists of a dark blue square with the word "Cuadrilla" written in a bold, yellow, sans-serif font.

**Cuadrilla**

# An introduction to shale gas in the UK and The Netherlands

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Cuadrilla Resources  
September 17, 2013

The logo consists of a dark blue square with the word "Cuadrilla" written in a bold, yellow, sans-serif font.

**Cuadrilla**

# What is on your mind?

- What is the shale gas process?
- What are the risks? (such as groundwater pollution, water usage, emissions, visability, “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

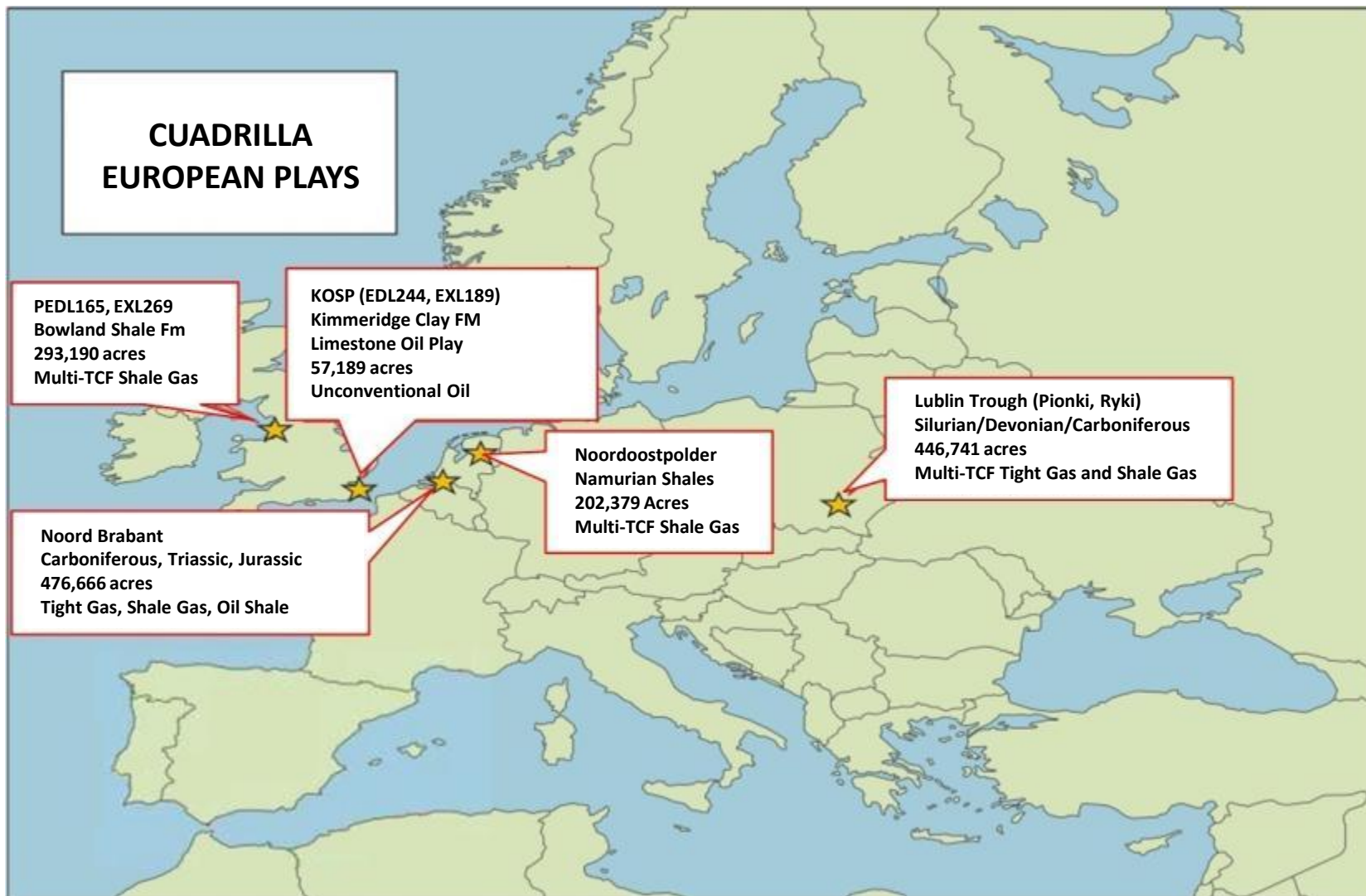
# Overview of Cuadrilla

- 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  $\approx$  680,000 acres
- UK Bowland basin  $\approx$  293,000 acres
- UK Weald basin  $\approx$  57,000 acres
- Poland  $\approx$  440,000 acres

# Licenses in the UK, The Netherlands, Poland



# 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



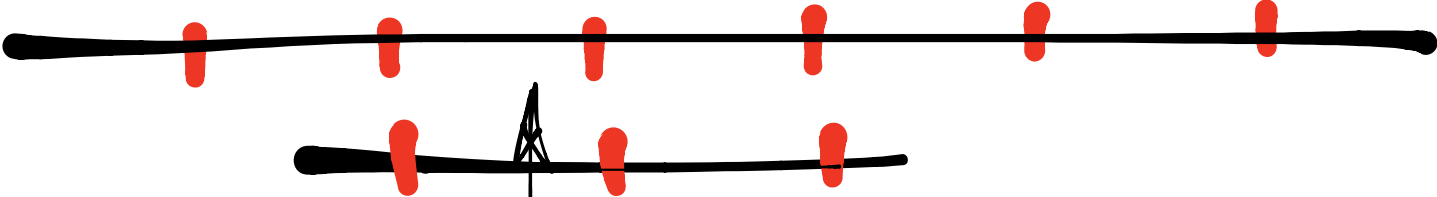
# The timeline

- 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

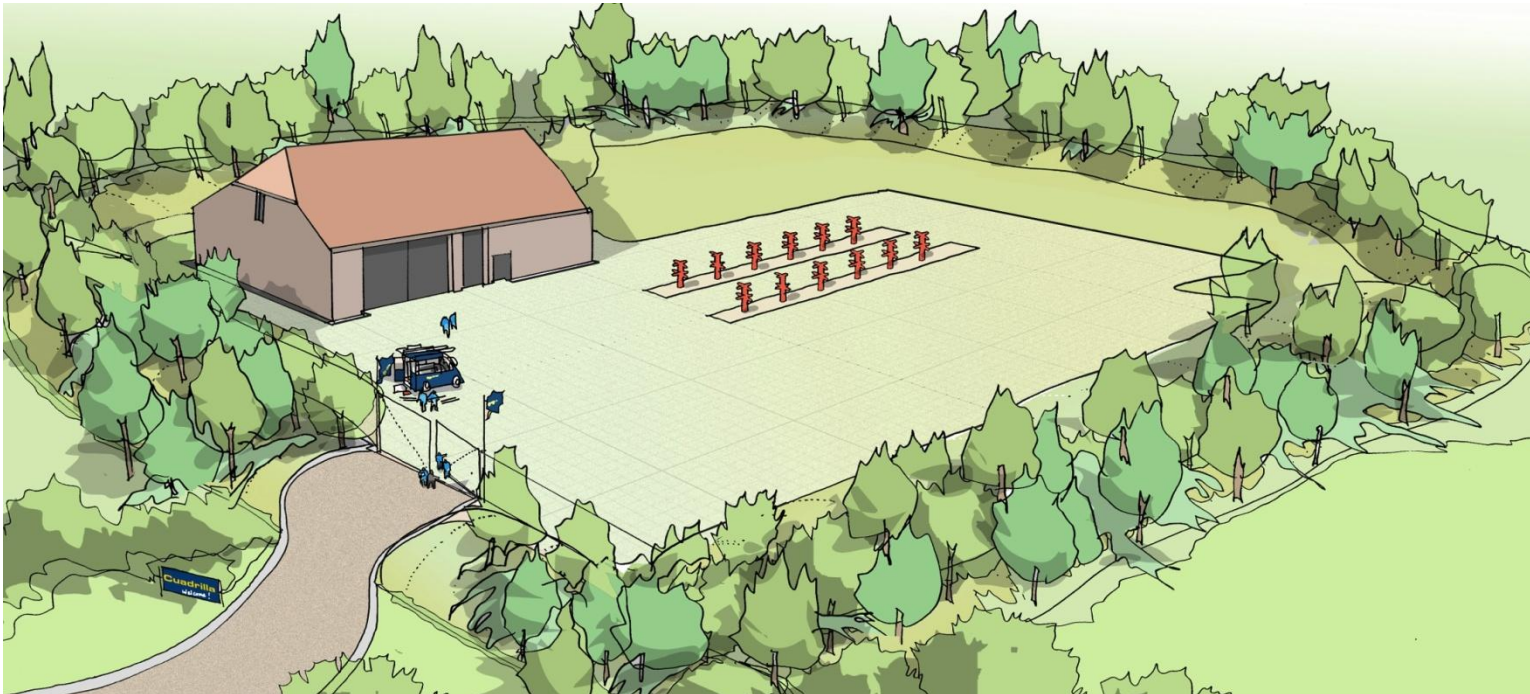
An exploration well is drilled  
and tested  
Commercial viability of the  
well is calculated





# 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



# 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
- Beconsall-1 drilled to 10,500 feet
- Acquired detailed 3D subsurface mapping of 100 KM<sup>2</sup> through seismic survey
- Existing: Elswick-1 producing from 3,500 feet (existing sandstone well, vertical fracture in 1993)

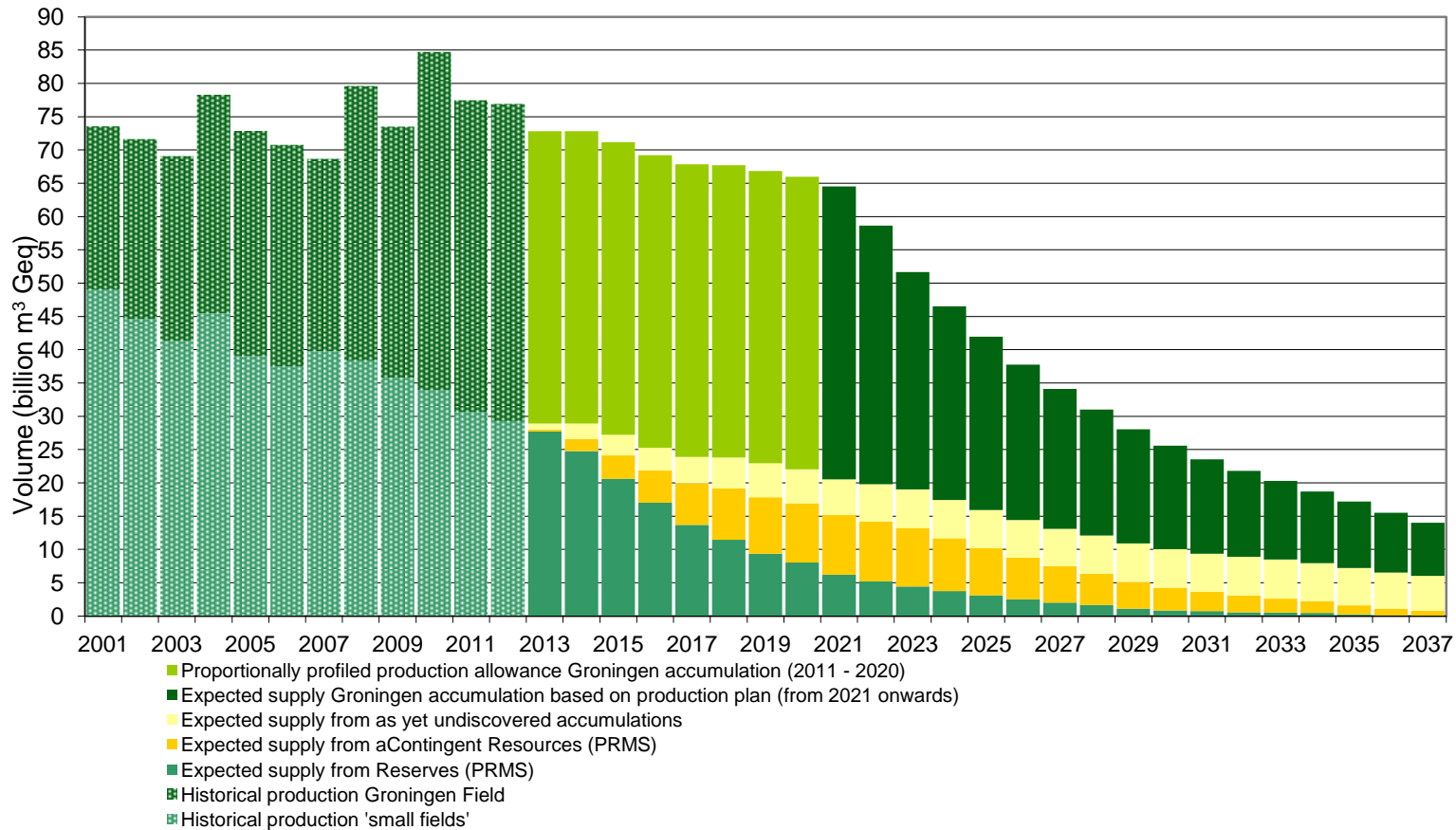


- Balcombe-2 (West Sussex) conventional oil in limestone (vertical with sidetrack)

# 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

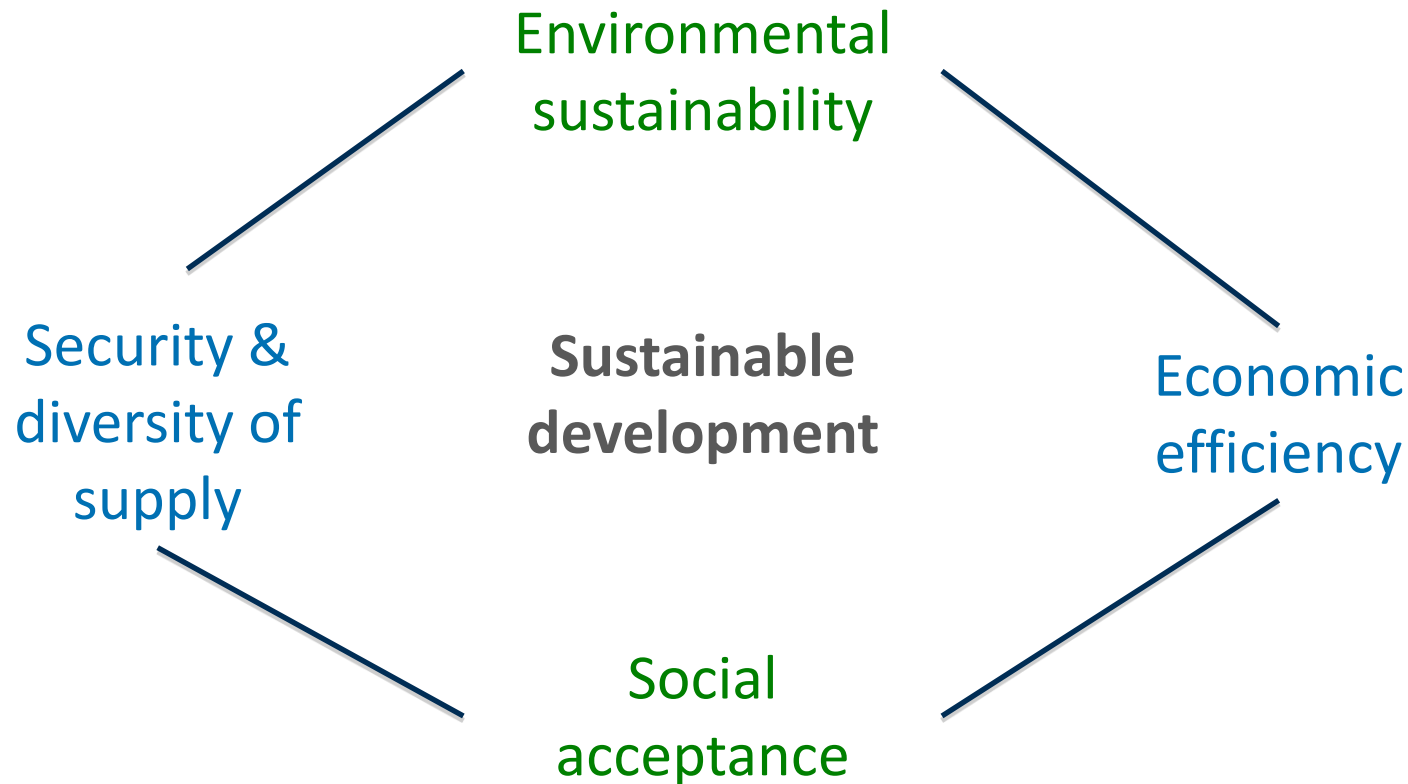
# The problem we are facing in The Netherlands



Our key message:  
Shale gas is about sustainable development

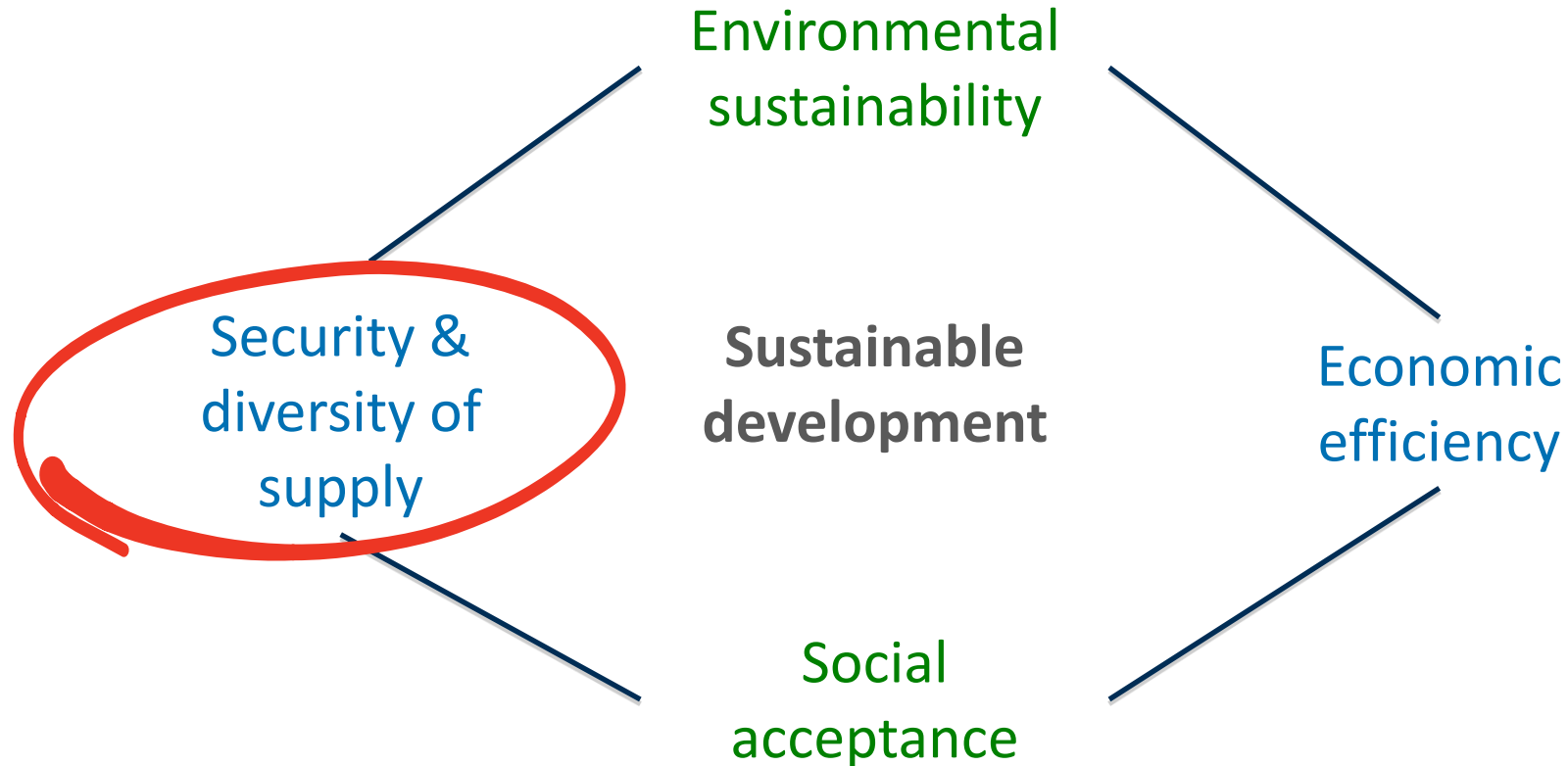
# Sustainable development

Meeting present needs without compromising the future

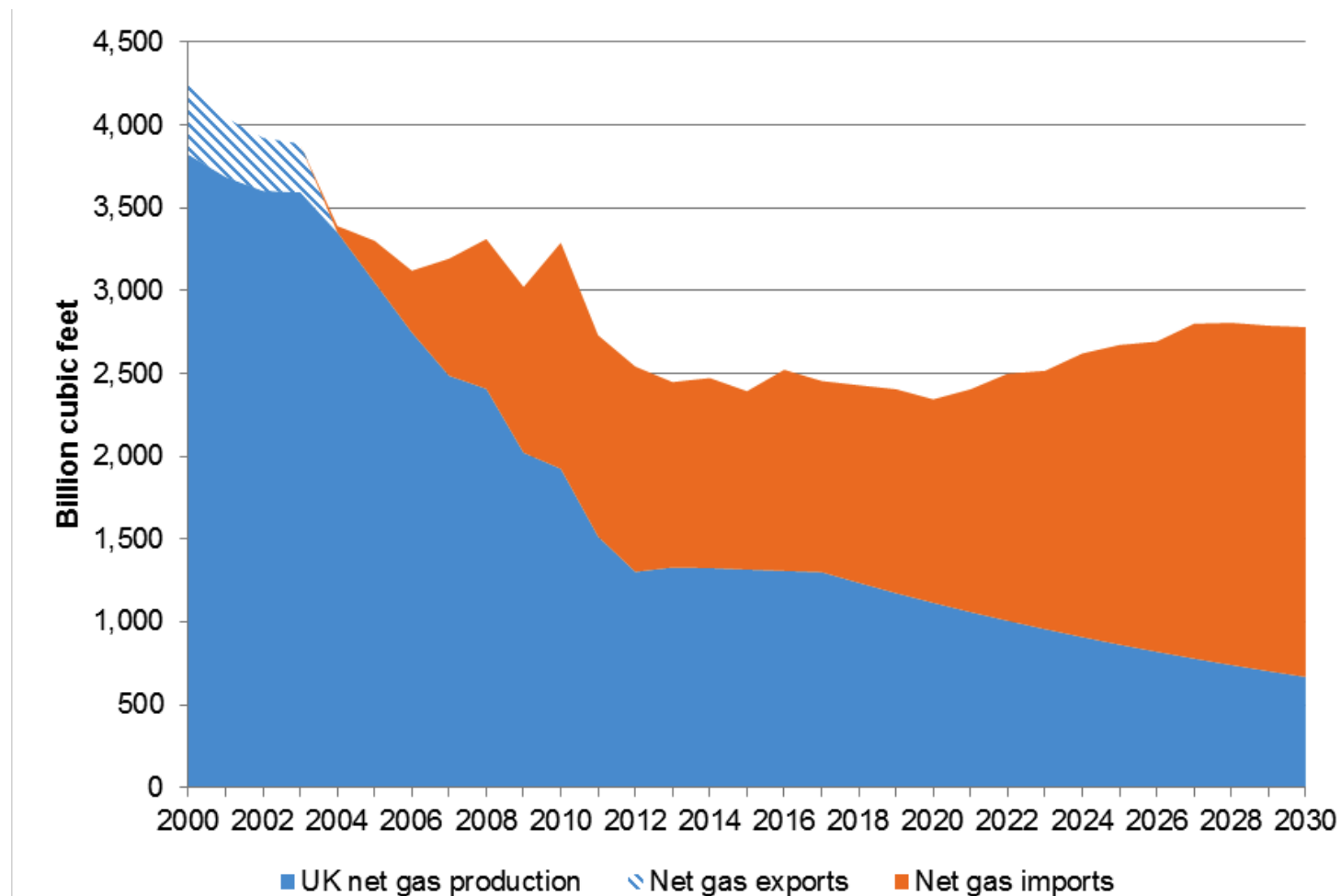


# Sustainable development

Meeting present needs without compromising the future



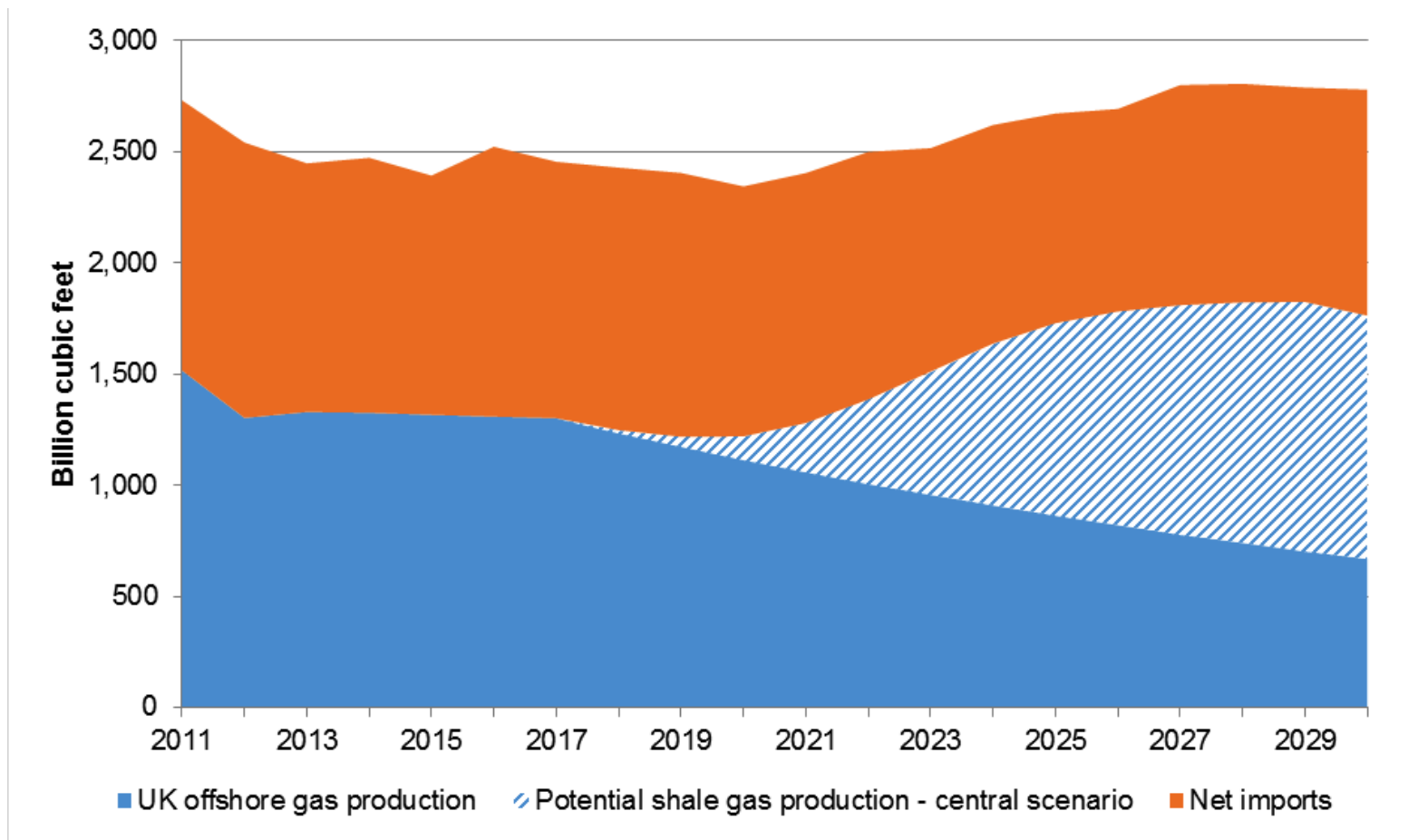
# Indigenous gas production supplies a decreasing share of UK demand



(Source: Department of Energy and Climate Change)



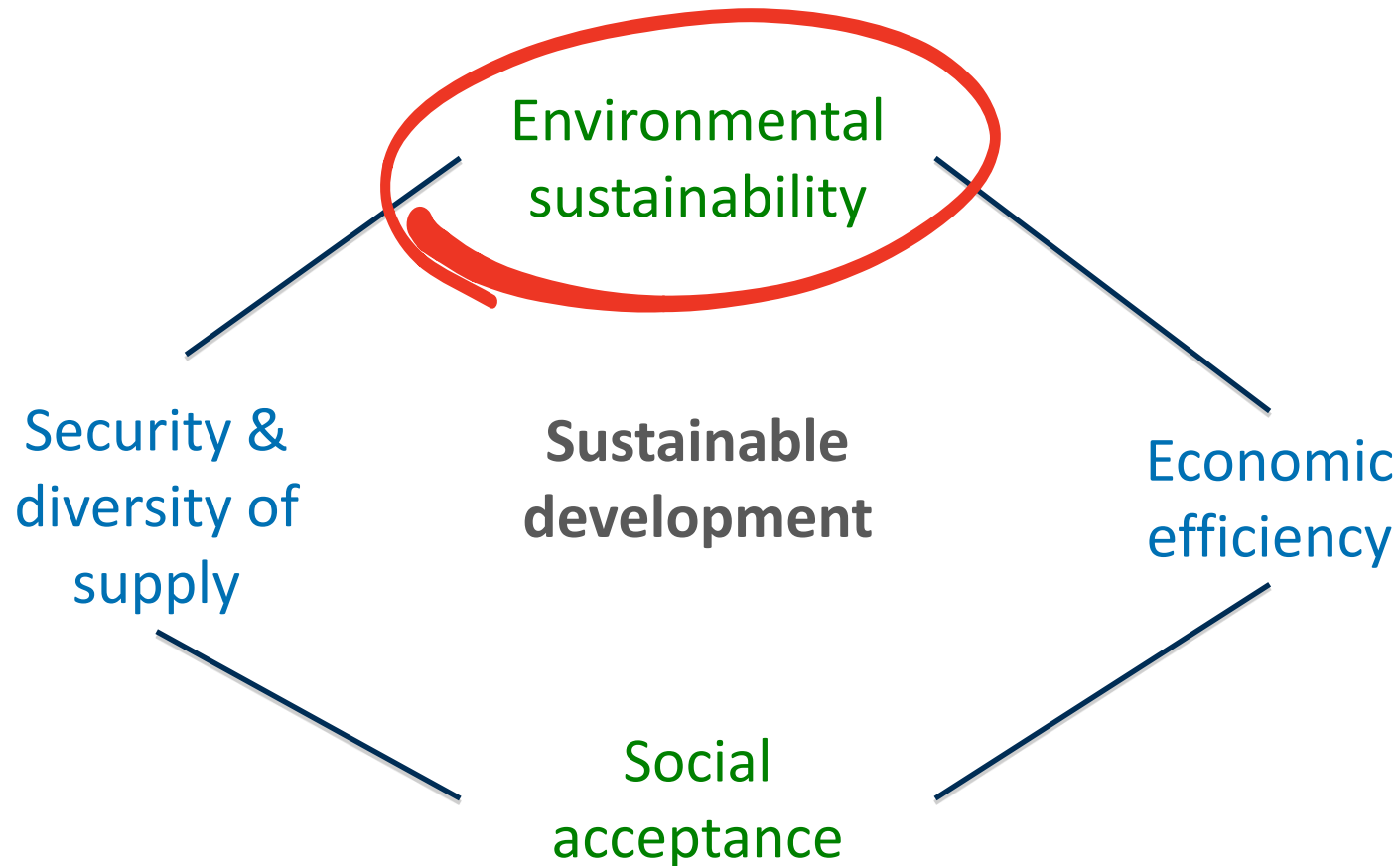
# UK offshore and shale gas production and net gas imports



(Source: IoD calculations)

# Sustainable development

Meeting present needs without compromising the future

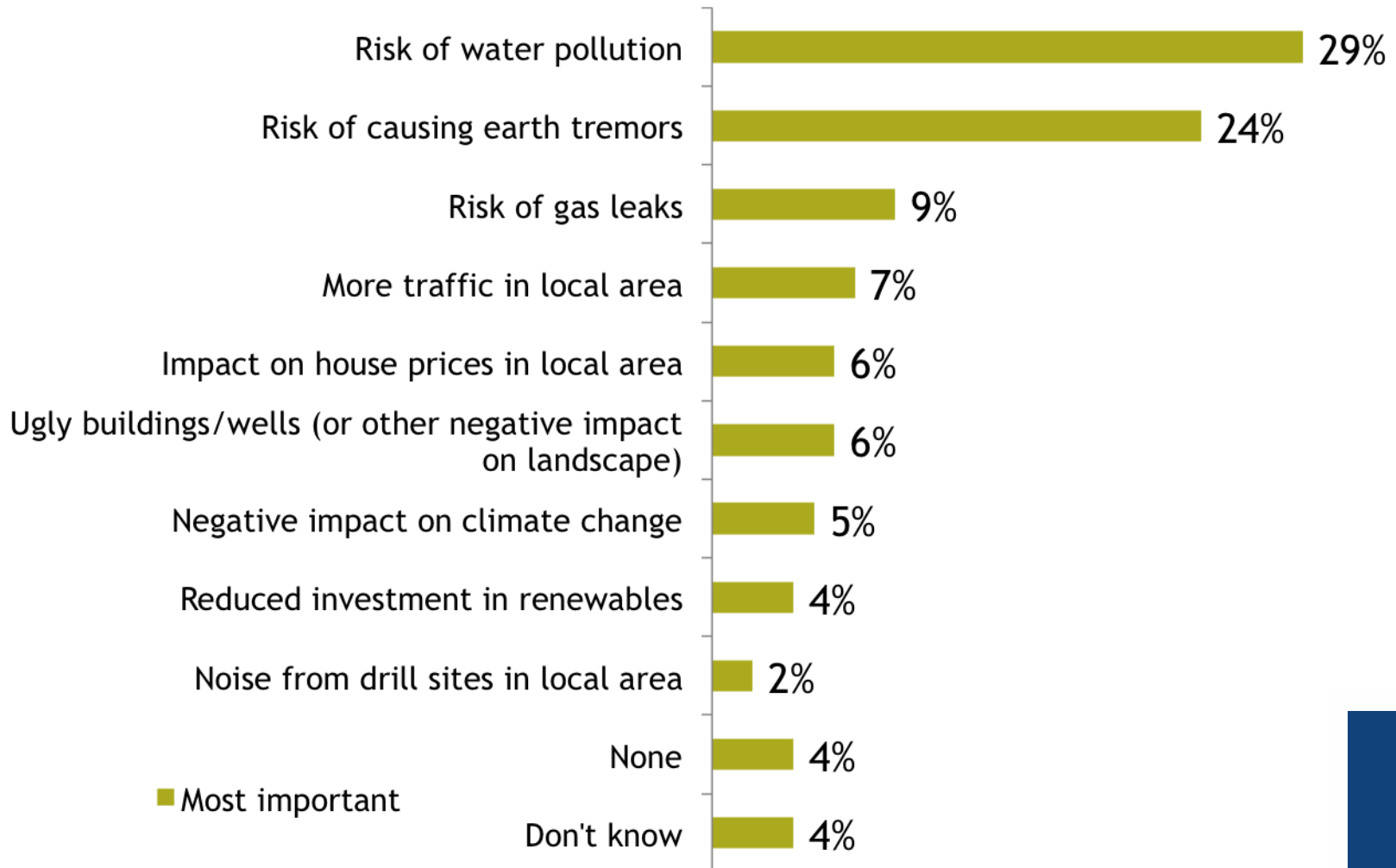


# Environmental sustainability

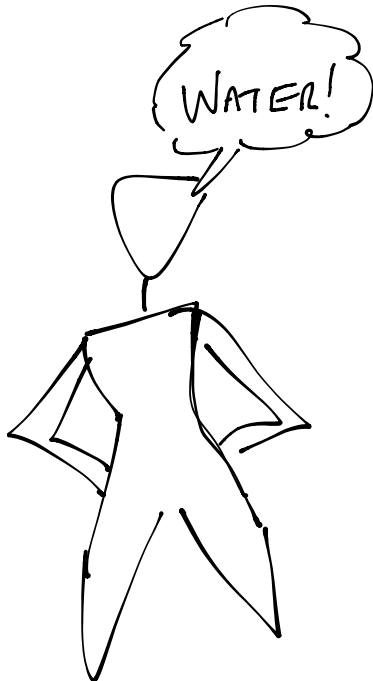
- **Issues of concern**

- 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



Men are more likely to support, and to see water pollution as the most important disadvantage (33% Men compared with 24% Women)

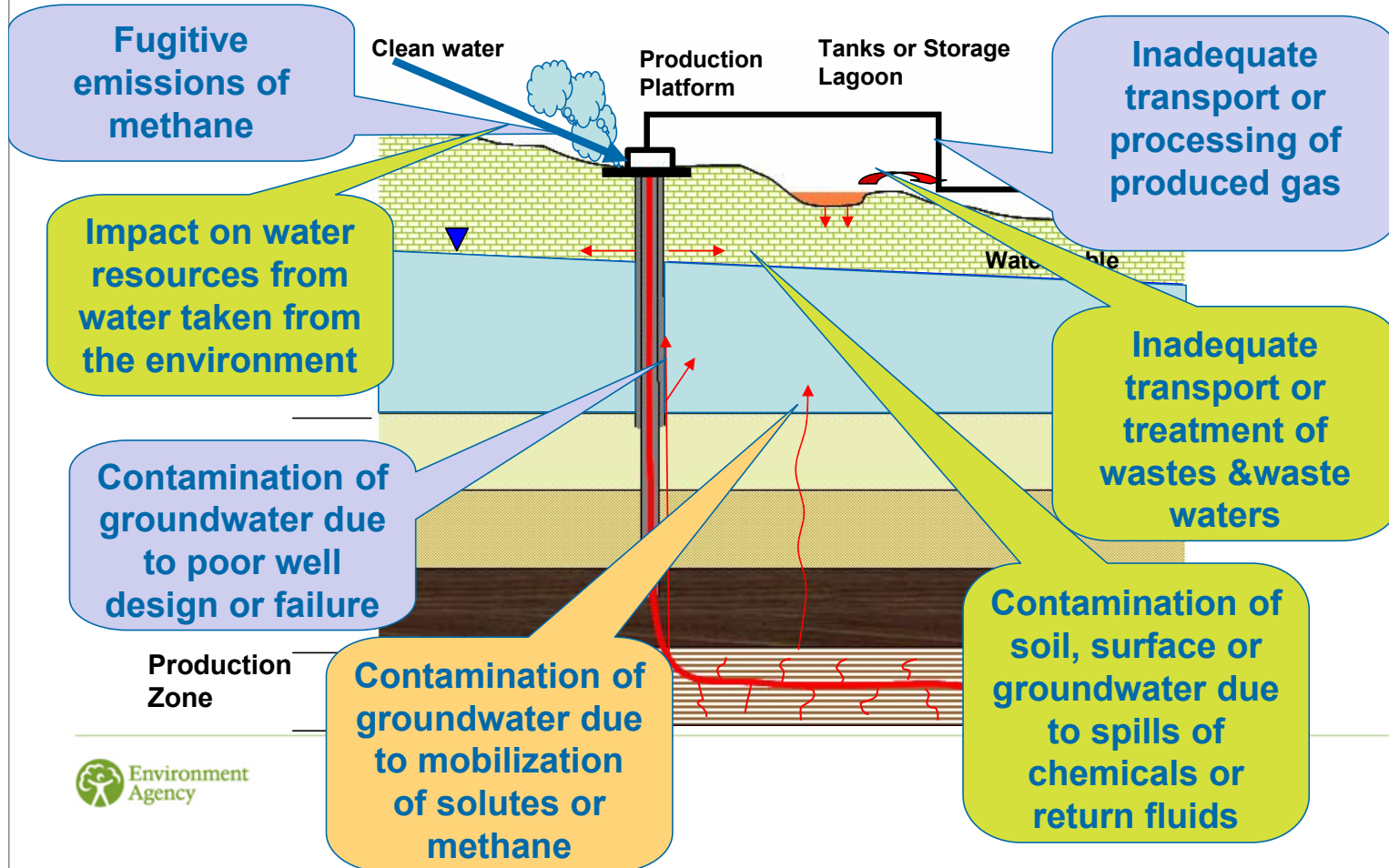


Opposers are more likely to be women, and to see earth tremors as the most important disadvantage (29% Women compared with 19% Men)

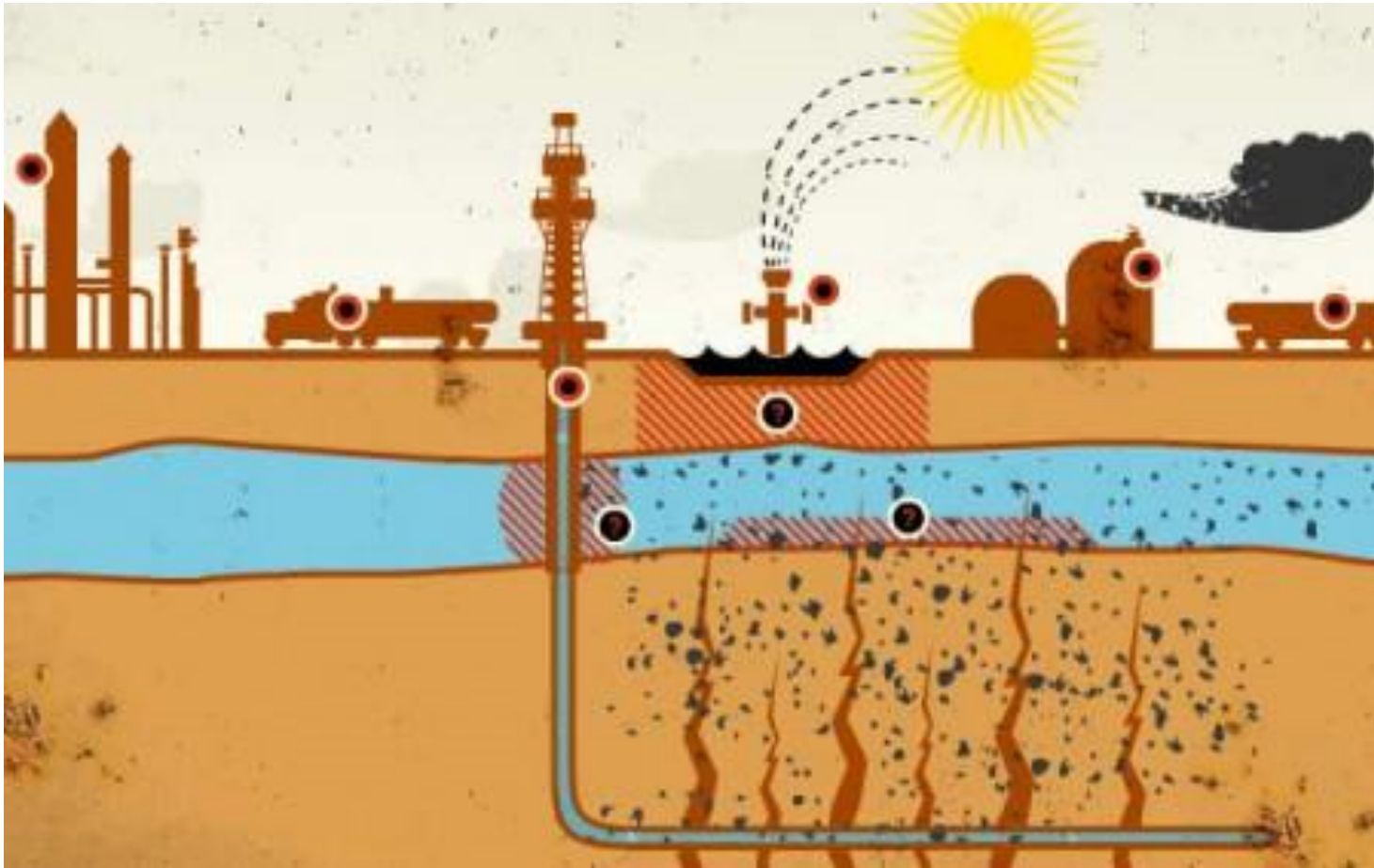


# Risks as EA represents

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

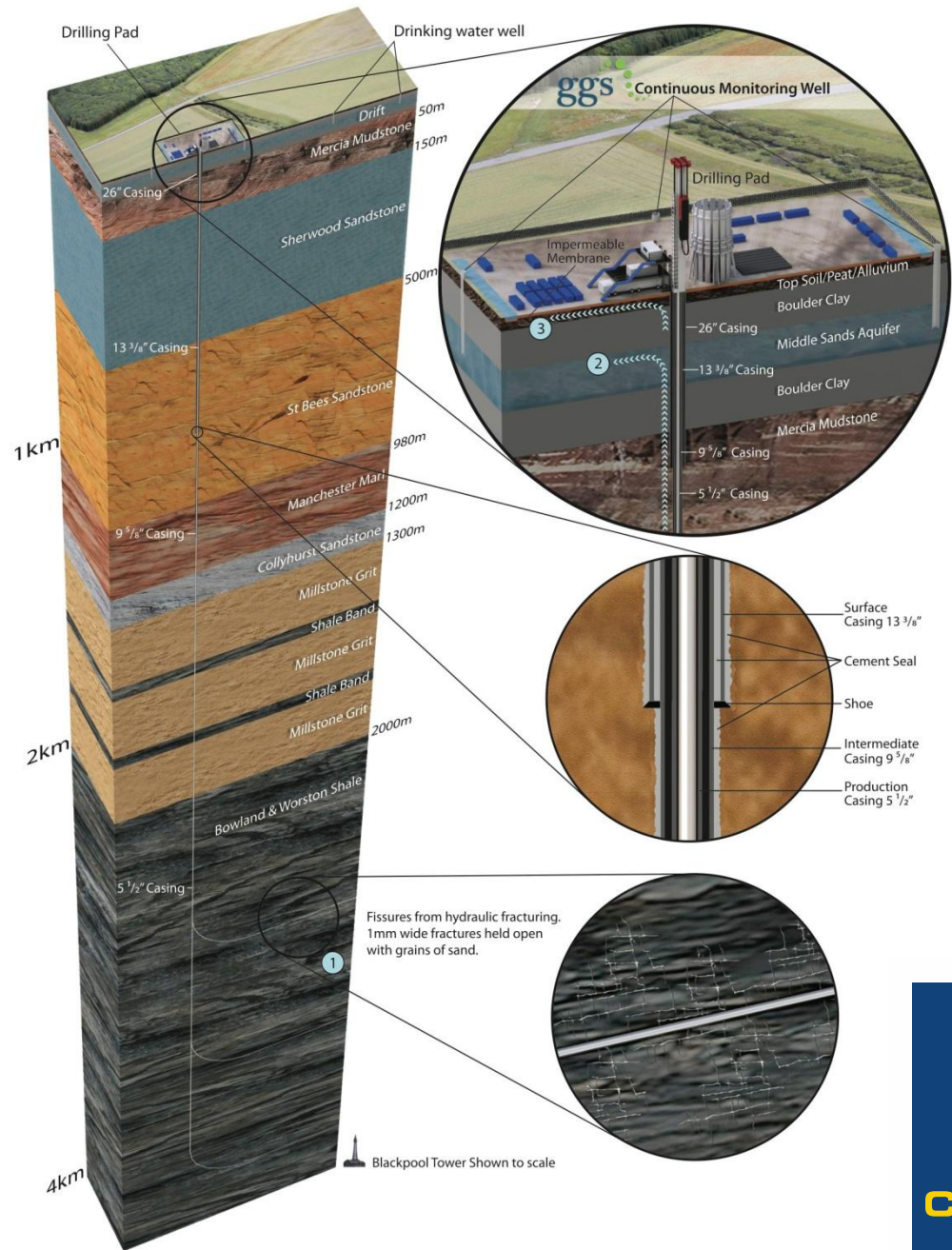


# We are always dealing with bad imagery



(4<sup>th</sup> Media 2012)

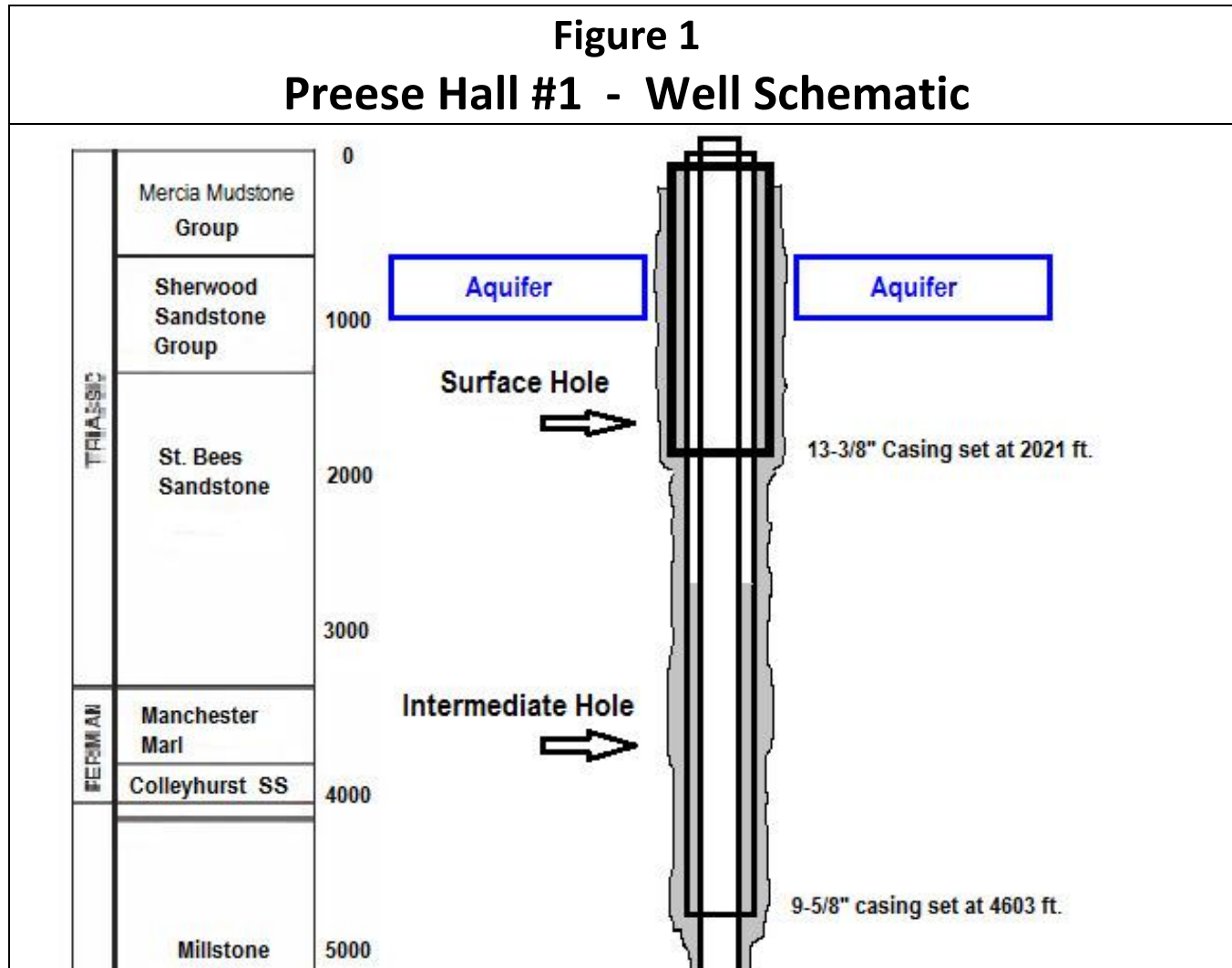
# The reality!






# Well integrity

Cuadrilla sets triple barrier through aquifer



# Water use – the scare story



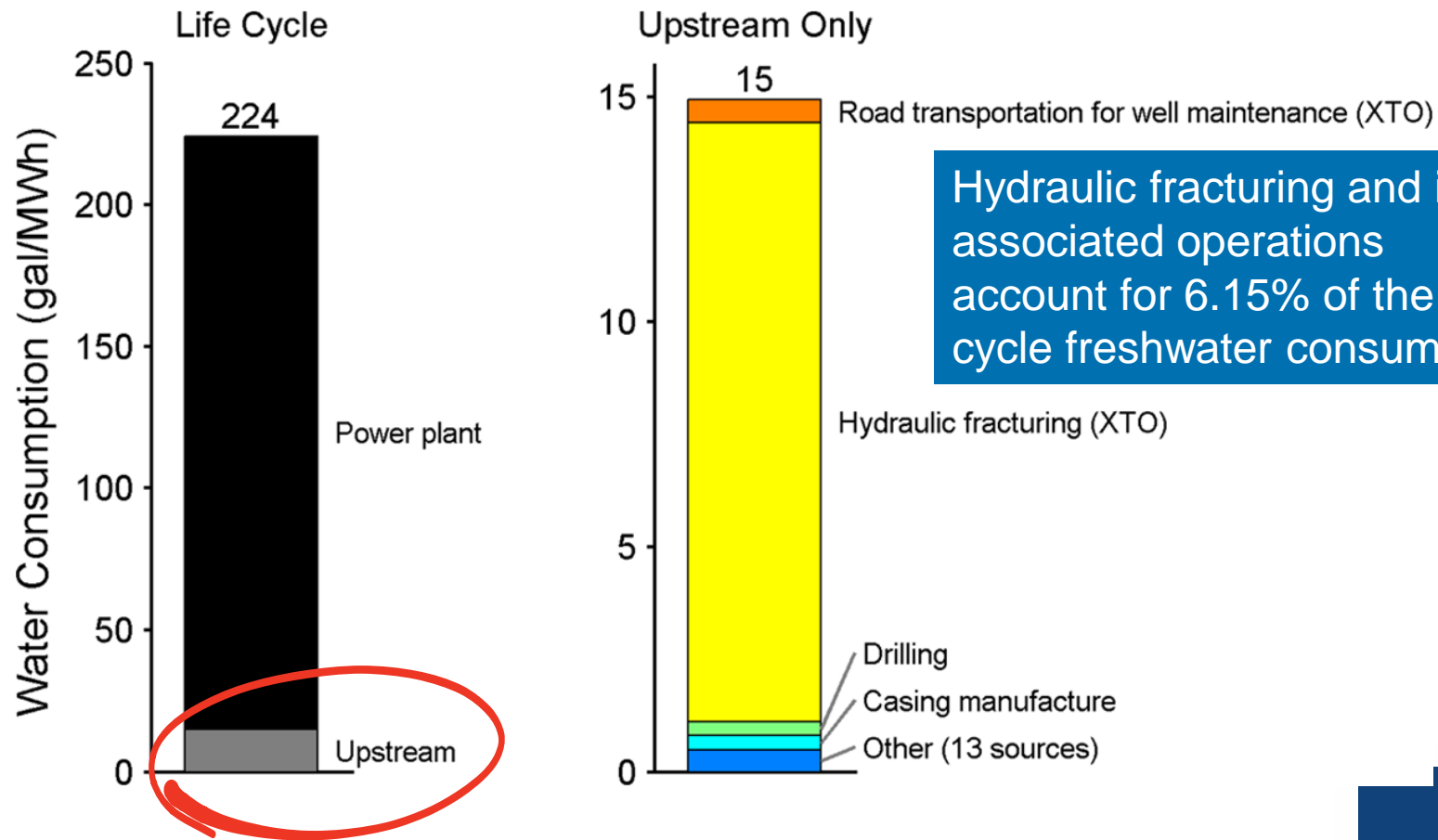
The infographic is divided into two main sections. The top section features a cross-section of the ground with labels for 'Surface Water' (a blue lake), 'Wastewater' (a grey pipe), 'Private Well' (a blue pipe from a house), and 'Municipal Well' (a blue pipe from a building). A central drilling rig is shown with a blue pipe extending into the ground, where a network of blue fractures is visible. To the right of this diagram, the text reads: **ONE FRACK JOB** Uses **4.5 million gallons of water** to drill and fracture a typical deep shale gas well. Below this, a white sign with red text asks: **4.5 MILLION GALLONS OF WATER: WHAT DOES THIS NUMBER MEAN TO YOU AND YOUR COMMUNITY?** The bottom section of the infographic shows a landscape with a herd of black cows grazing near a blue pond. To the right of the sign, there is a grid of 20 blue truck icons arranged in 4 rows and 5 columns.

**ONE FRACK JOB**  
Uses **4.5 million gallons of water** to drill and fracture a typical deep shale gas well.

**4.5 MILLION GALLONS OF WATER: WHAT DOES THIS NUMBER MEAN TO YOU AND YOUR COMMUNITY?**

# Water use – the reality

## Upstream a very small percentage



(Laurenzi/ Jersey ExxonMobil LCA 2013)

# Seismic risks



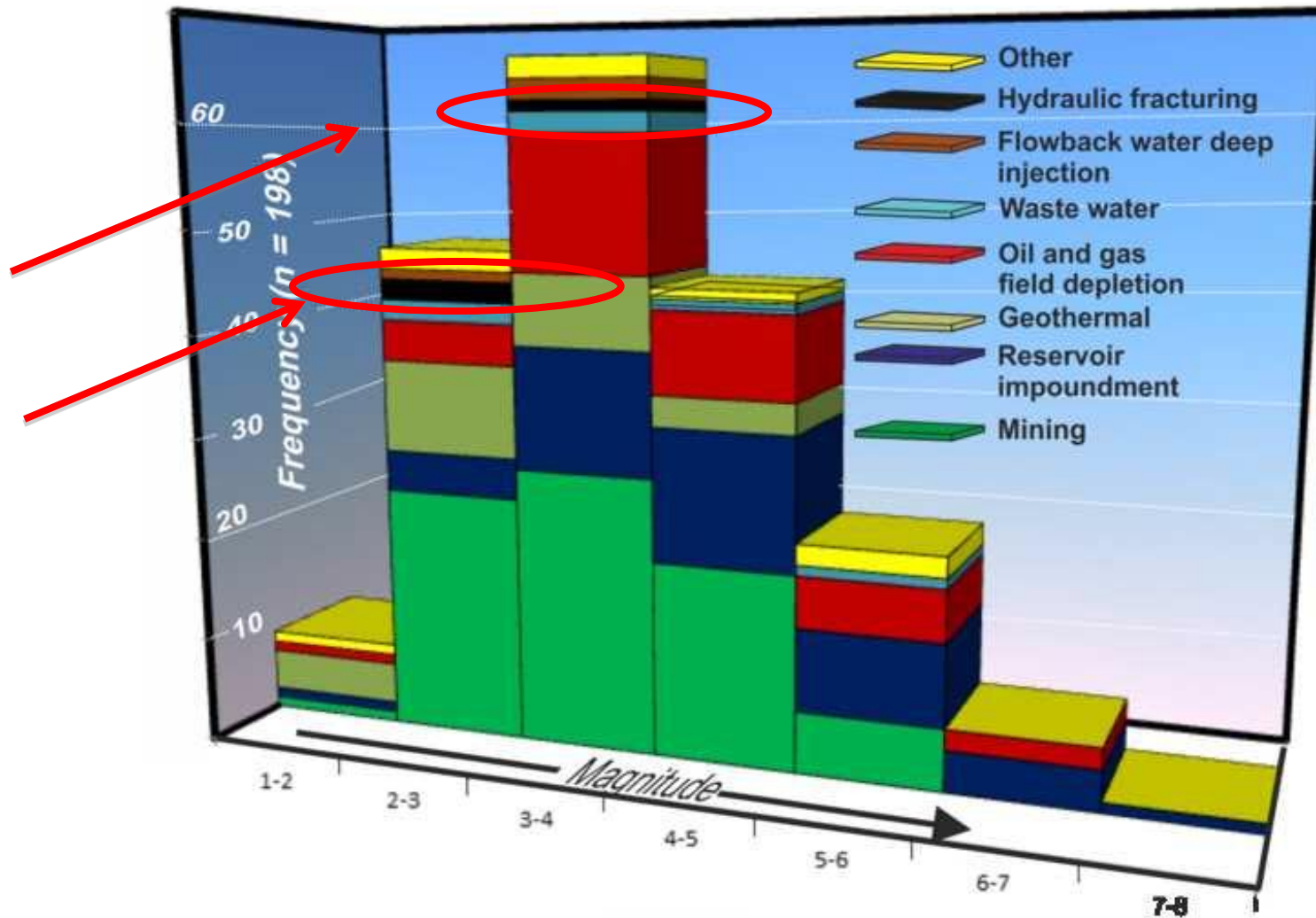
## Cuadrilla Fracking Linked to Earthquakes



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



# 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

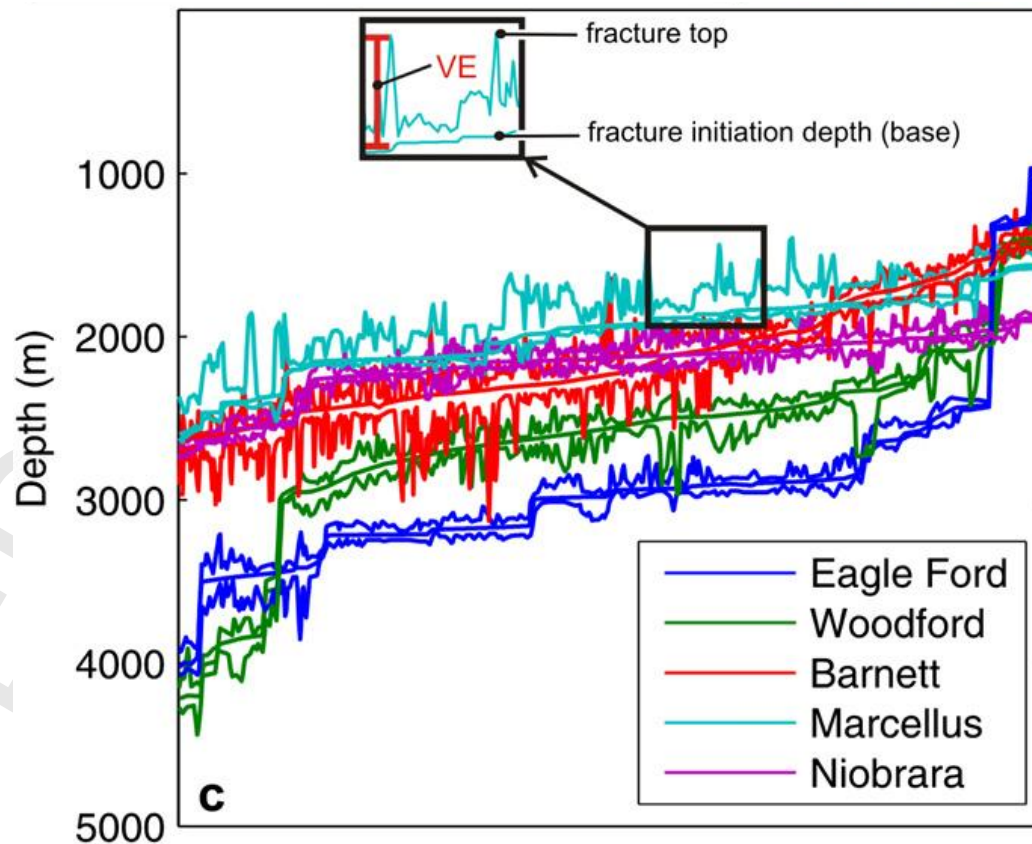
Subsequently we have

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



# Fugitive methane

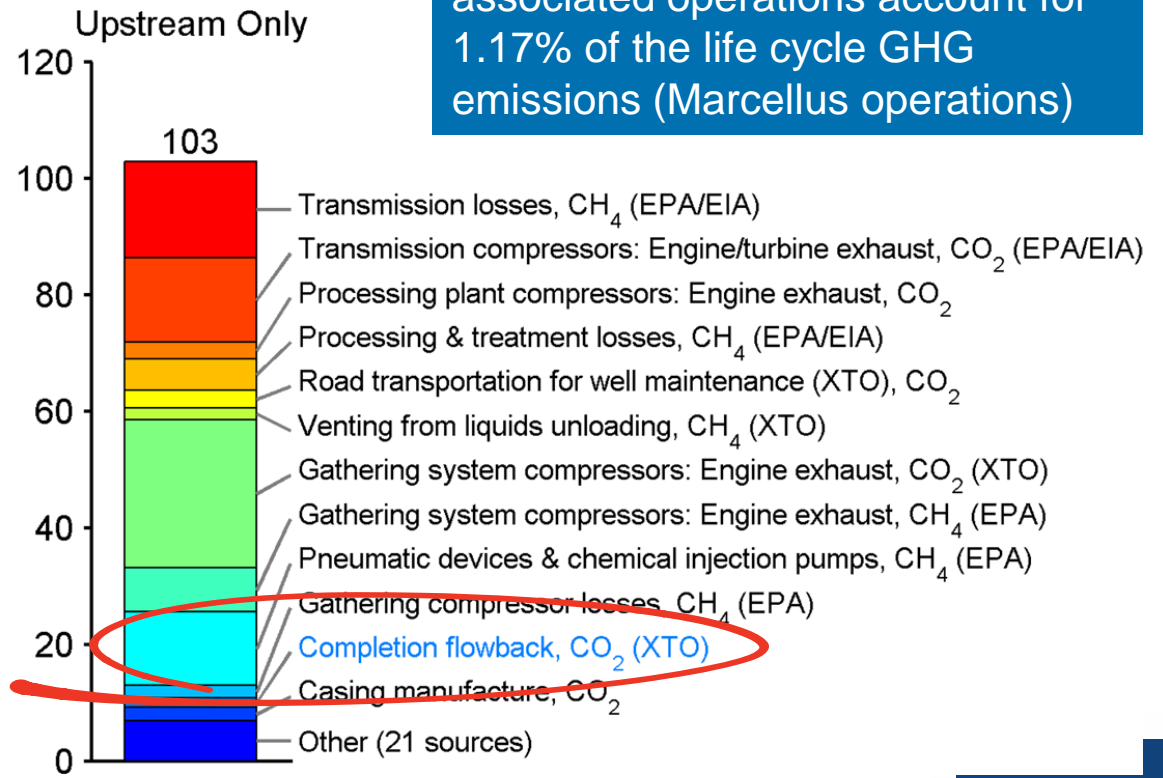
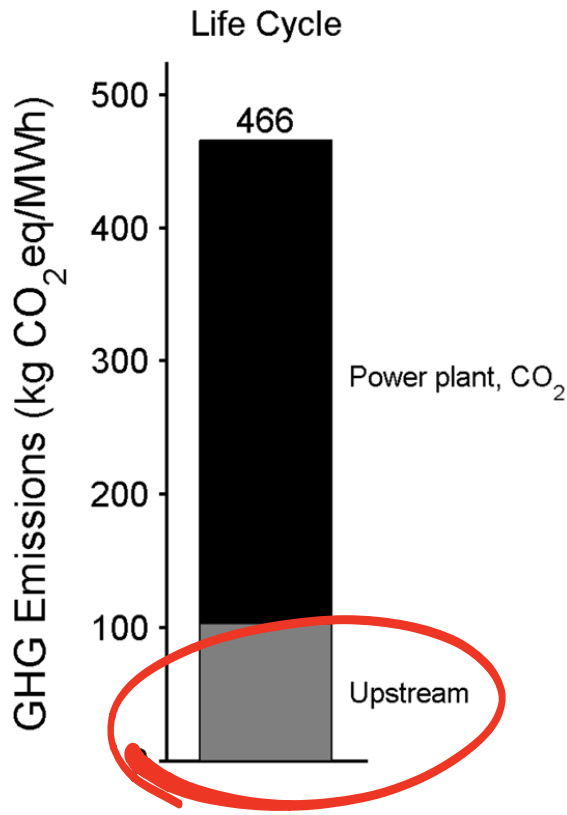




# Fugitive methane – the reality

Green completion methods eliminate fugitive methane issue

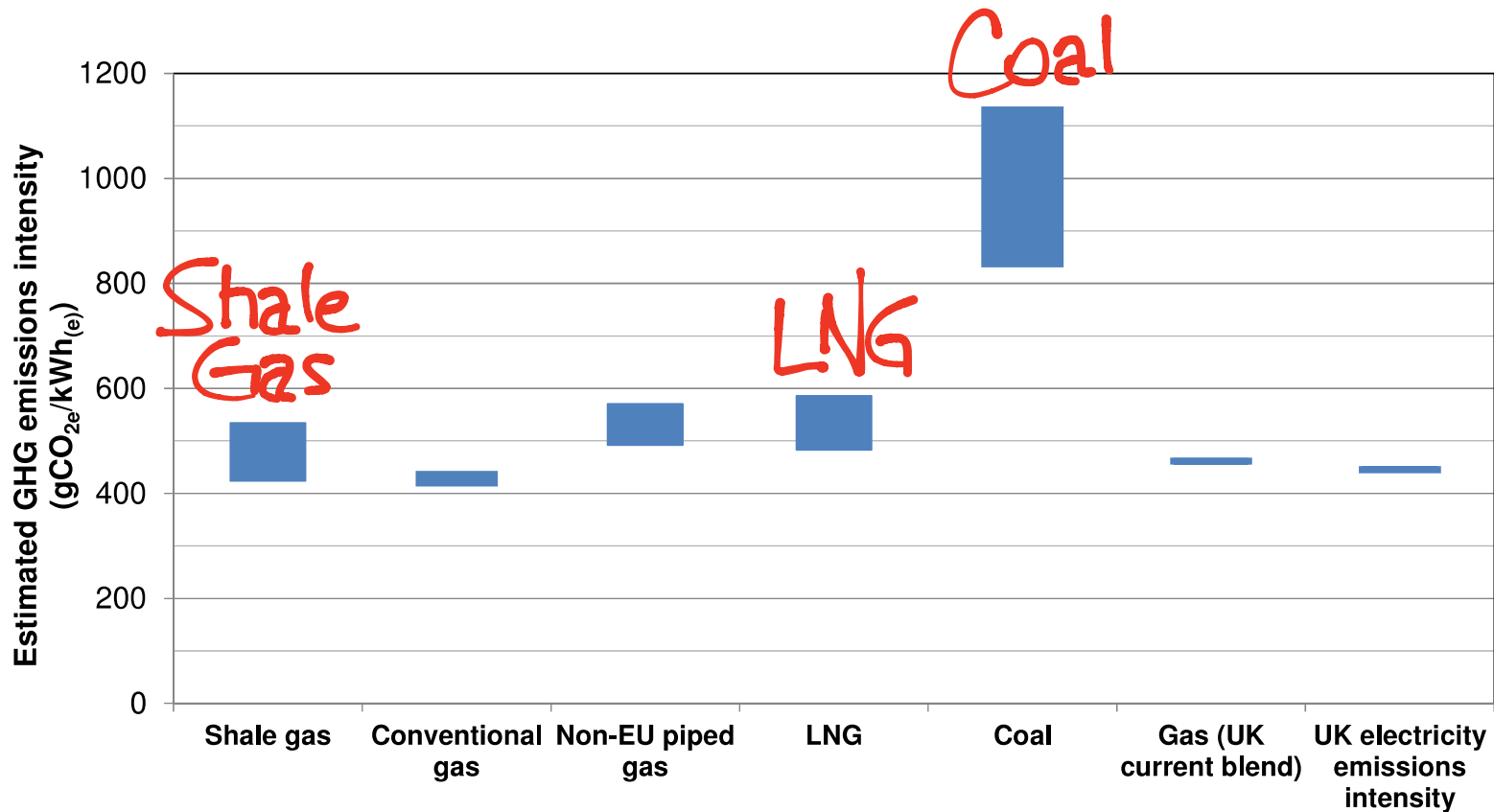
Hydraulic fracturing and its associated operations account for 1.17% of the life cycle GHG emissions (Marcellus operations)



# Climate change



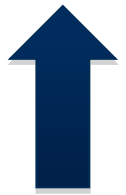
# GHG Emissions – the reality



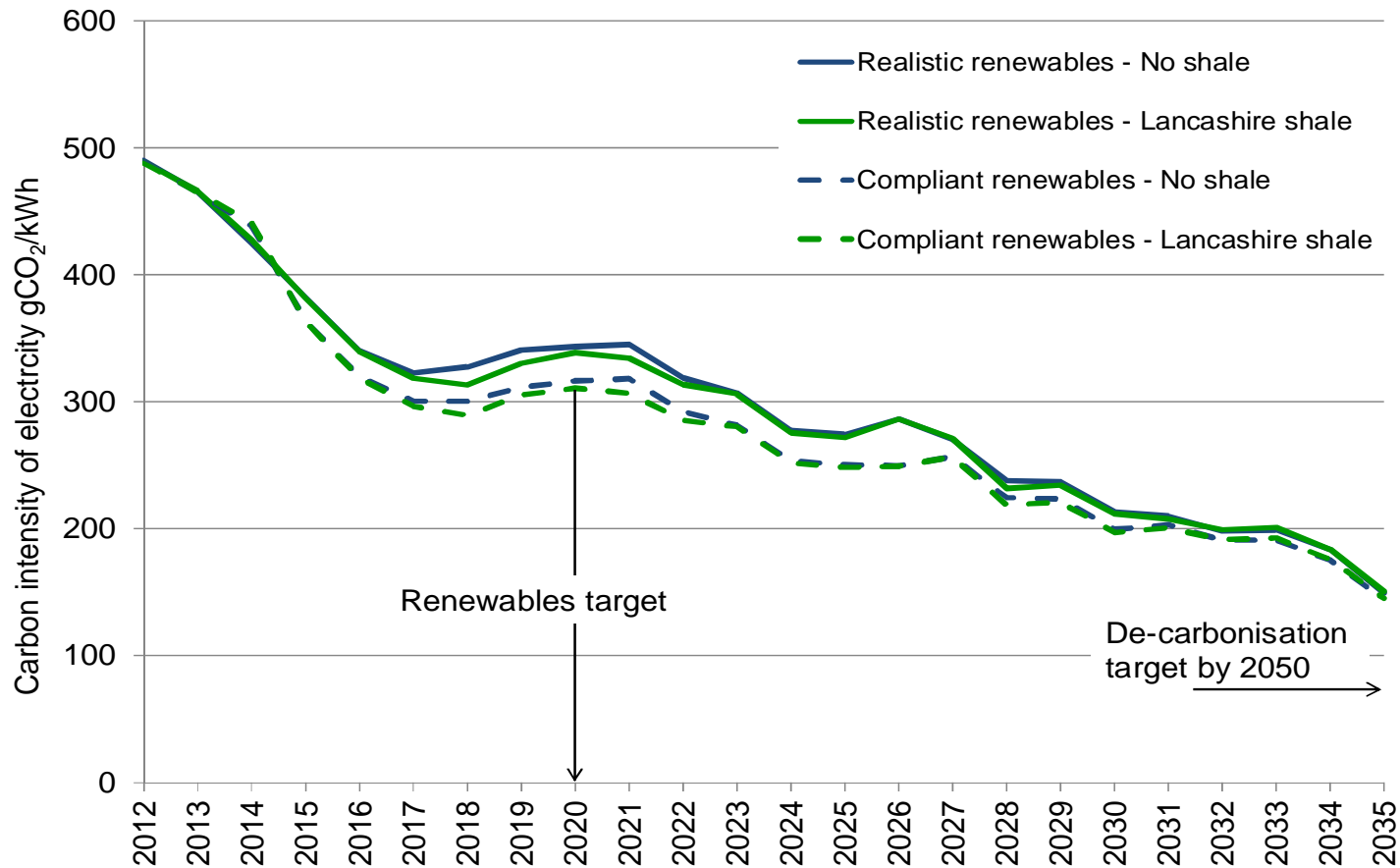
(Potential Greenhouse Gas Emissions Associated with Shale gas Production and Use- DECC 2013)

# 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



# 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

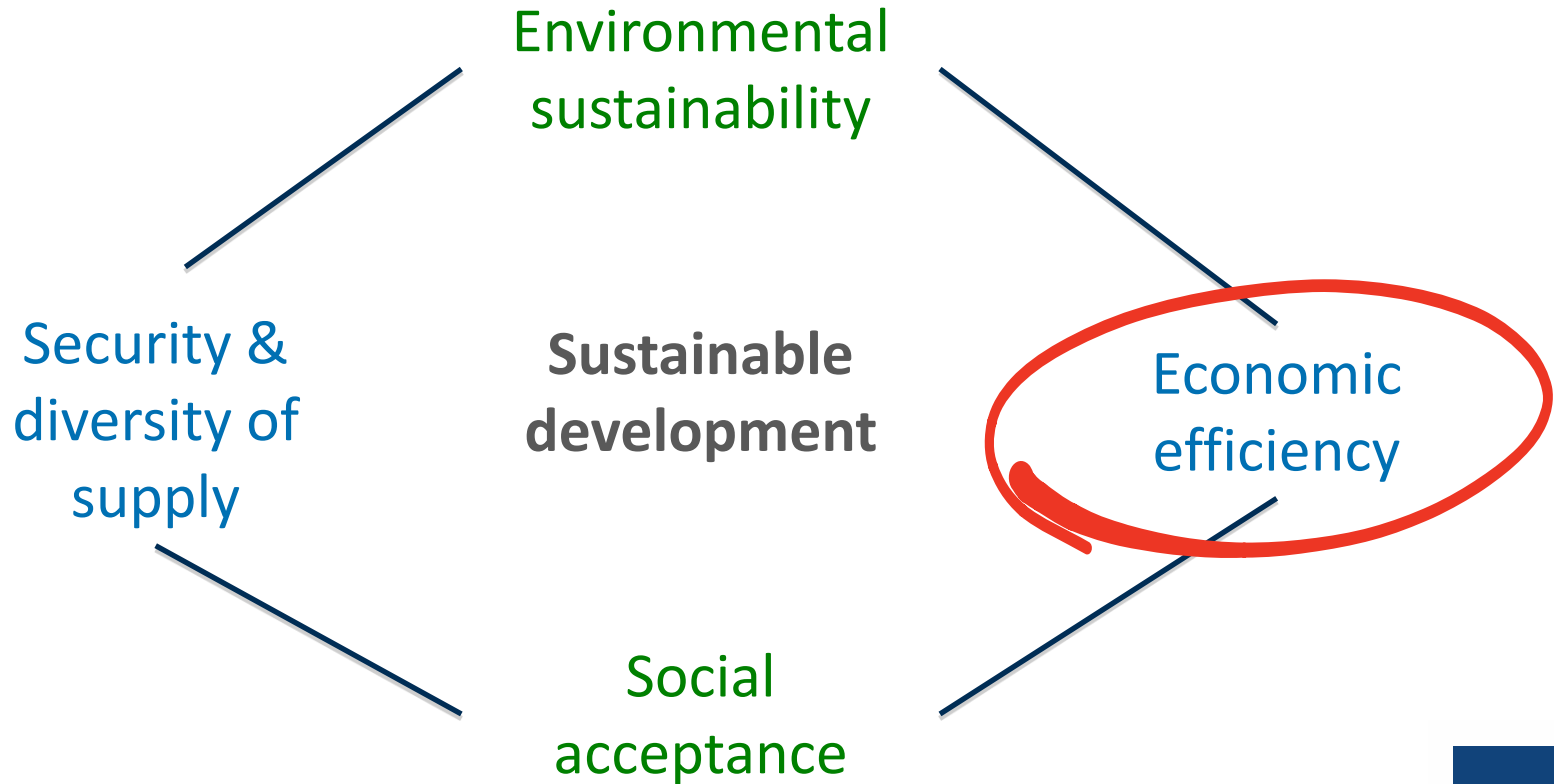
- **What comes out – flowback water**

- 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

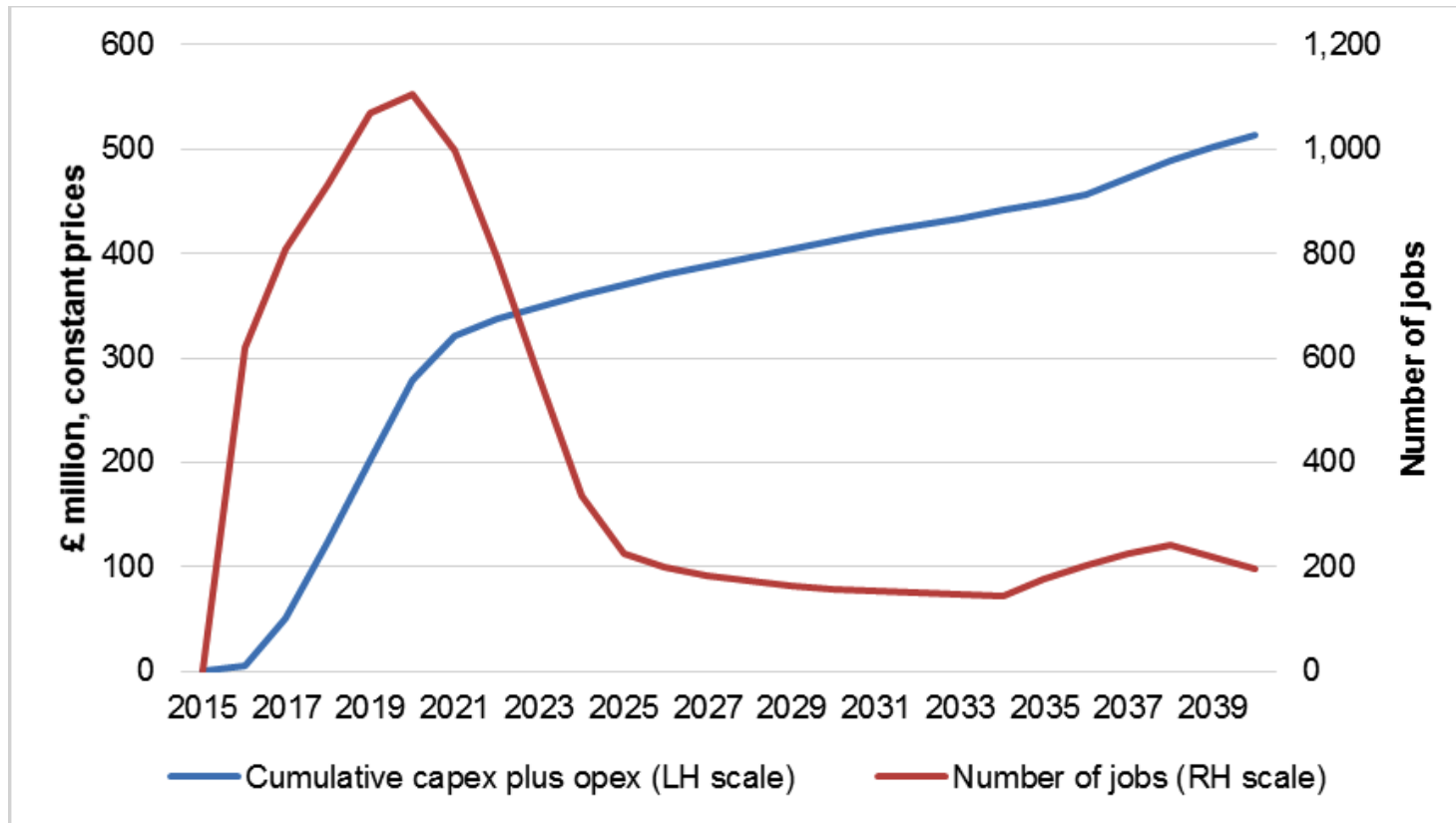




## Is this an economic prize worth pursuing?

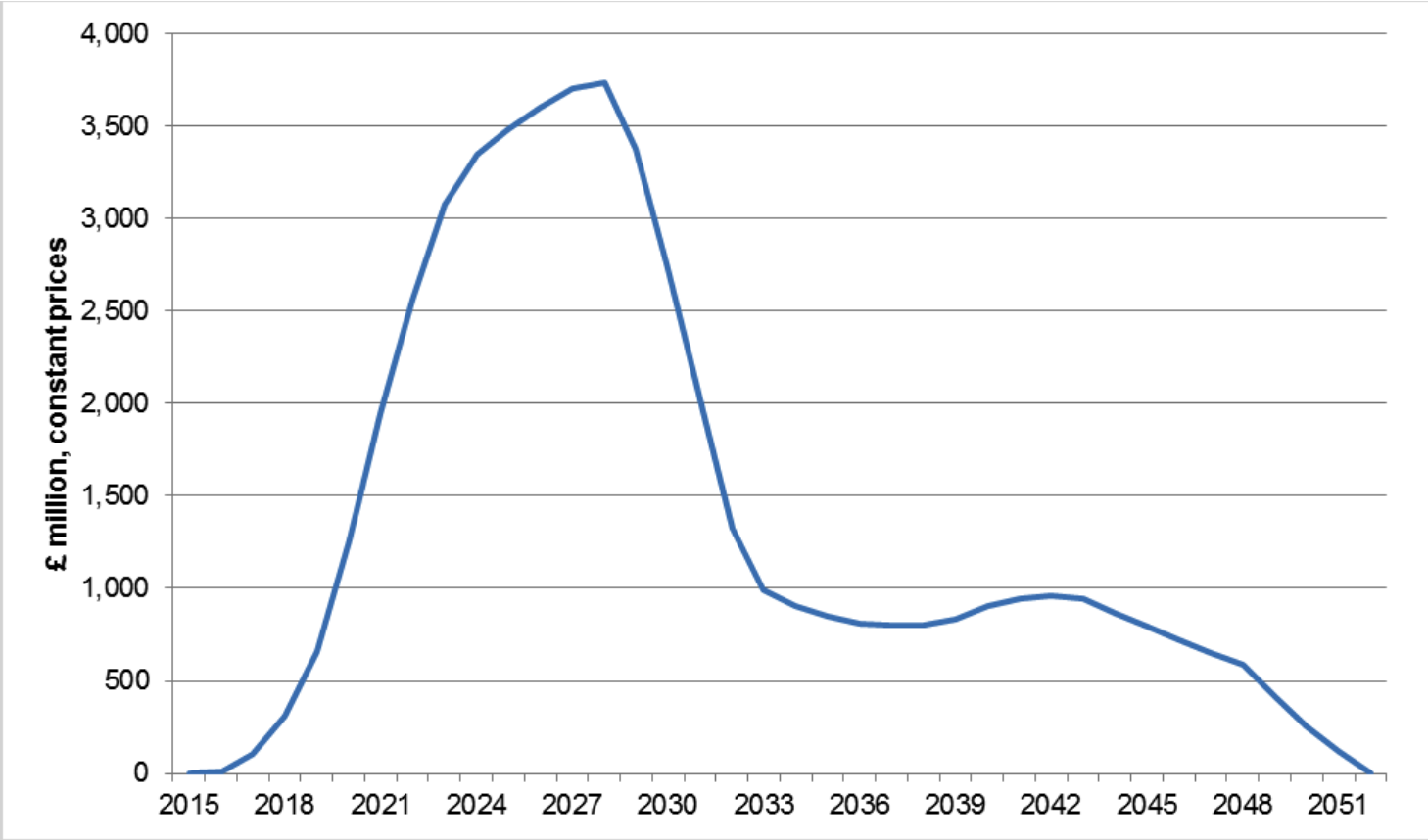
- We have announced (conservatively) that the Bowland license area contains 200 tcf (trillion cubic feet) of gas in place
  - *What fraction of this can be extracted ??*
- The theoretical market value of the whole 200 TCF at today's wholesale gas prices is £1.40tn
- Let's assume a conservative recovery percentage.... say 10%
- 10% recoverable = £140bn

# Investment and jobs from a single production site



(Source: IoD calculations)

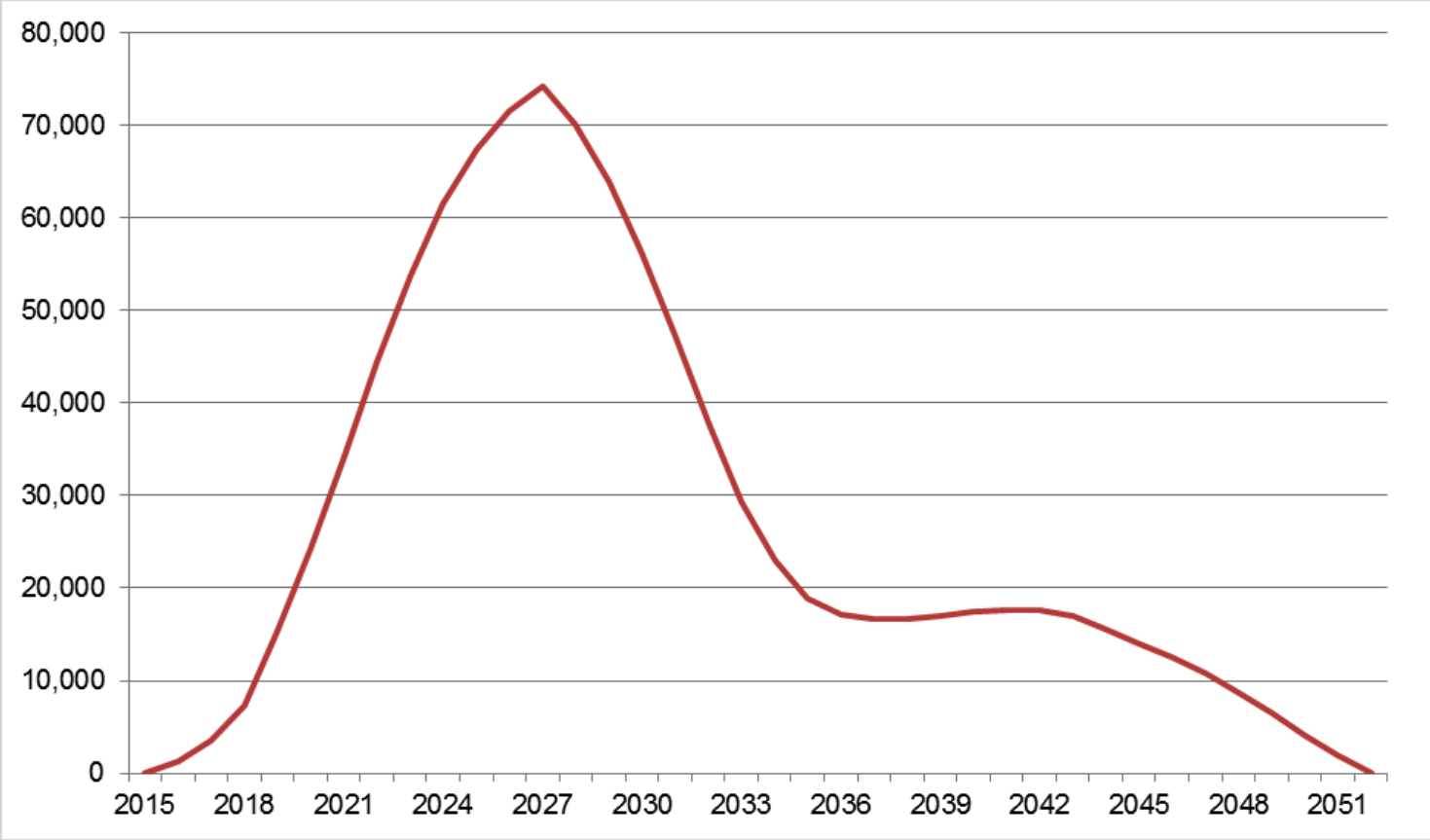
# Potential Annual Investment



(Source: IoD calculations, central scenario)



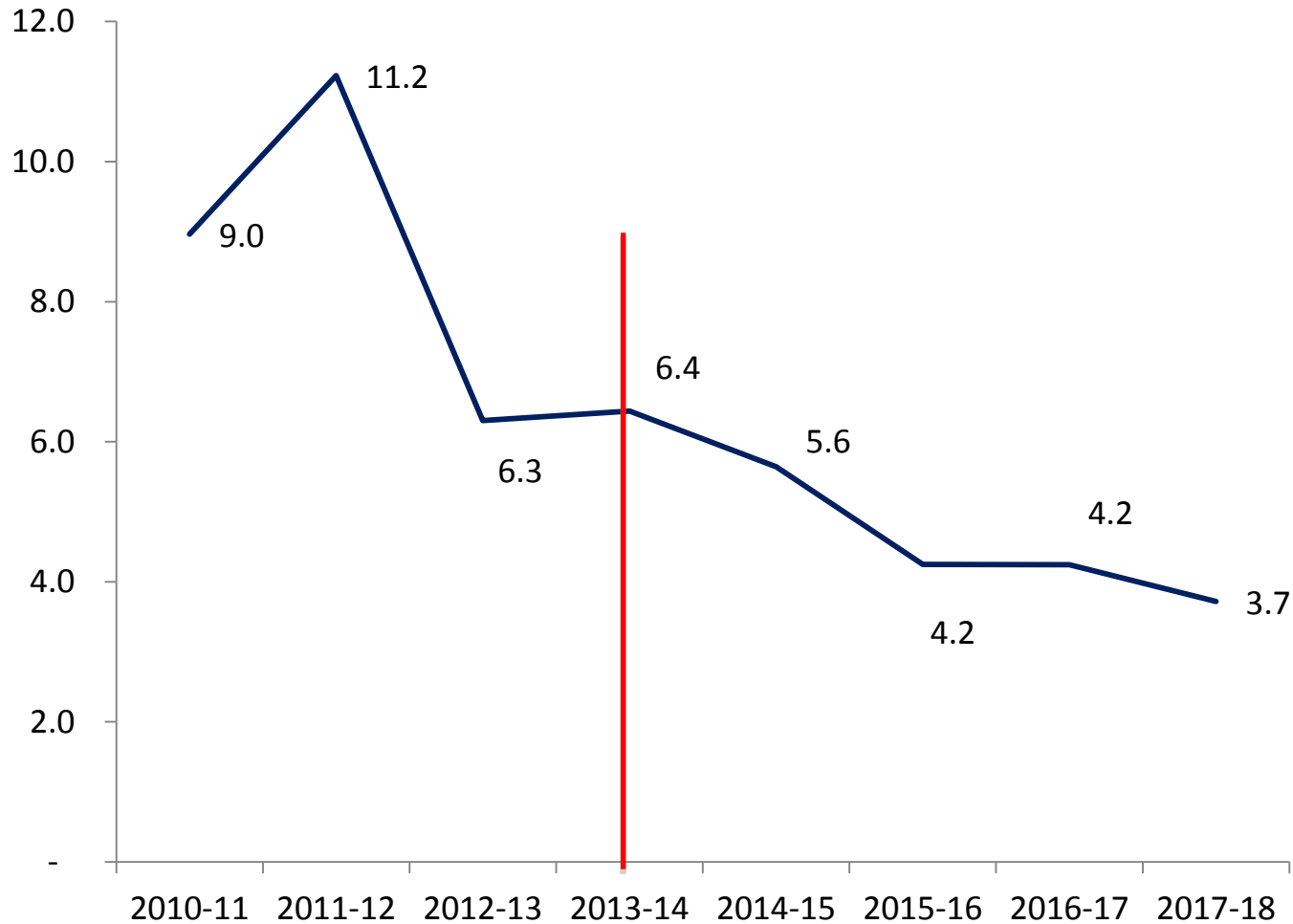
# Potential cumulative jobs – a high of more than 70K (direct, indirect and induced)



(Source: IoD calculations)

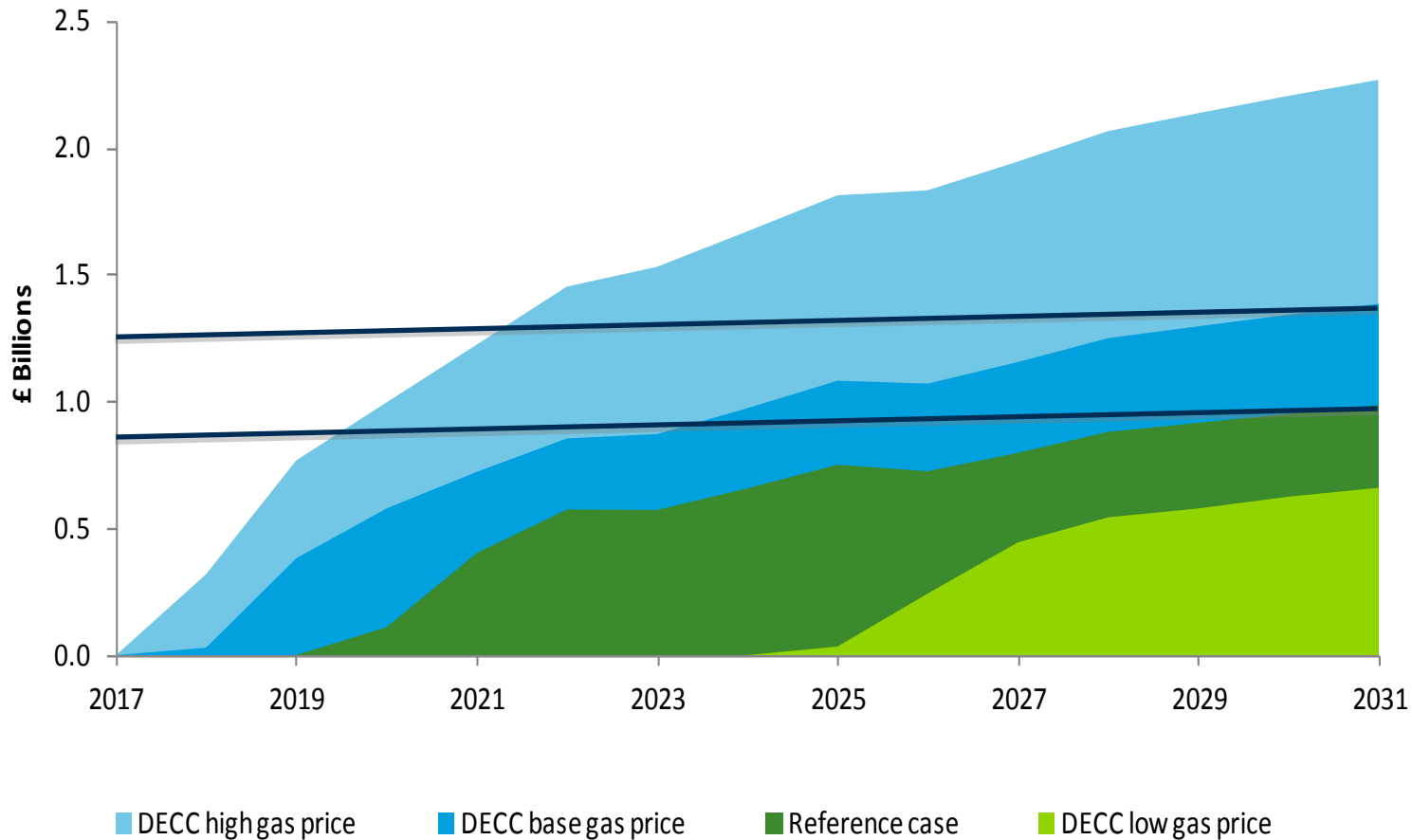


# UK oil and gas tax revenue is forecast to fall significantly



(Source: HM Treasury, Deloitte analysis 2013)

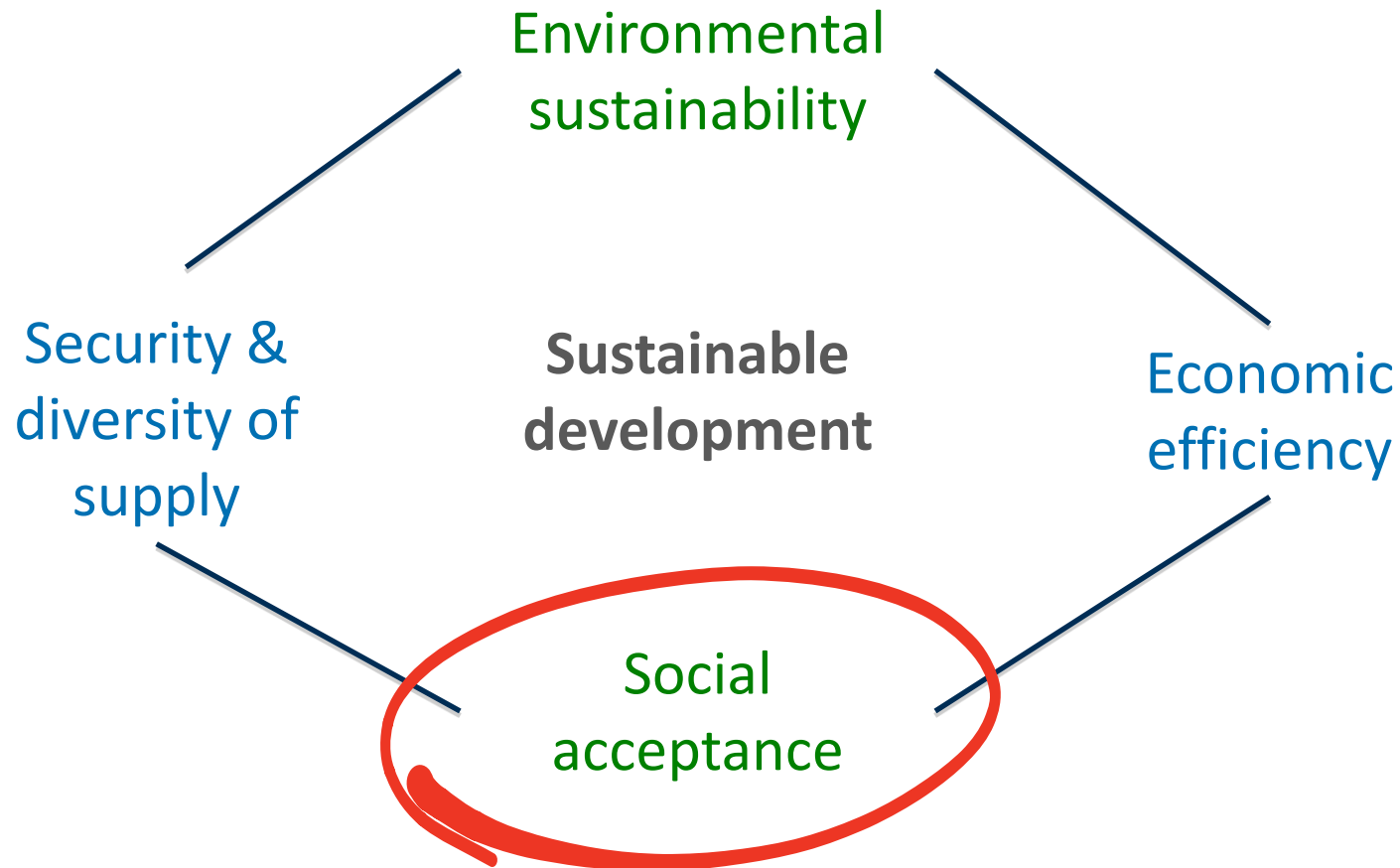
# Annual UK Government Bowland Basin tax revenues (using DECC gas price sensitivities)



(Source: HM Treasury, Deloitte analysis 2013)

# Sustainable development

Meeting present needs without compromising the future



# 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*

In recent weeks, the Sussex village of Balcombe has found itself at the centre of the argument around hydraulic fracturing, or “fracking”. This debate has become heavily polarised, and there has been much speculation around the environmental risks of shale-gas extraction, concerning water contamination and earth tremors.

There are many factors that policy-makers and local people must consider before deciding whether or not they are in favour of fracking – but I believe that the scientific and engineering evidence should play a key part in that decision. Everyone deserves to know the evidence, as it currently stands.

Over the past 30 years, more than 2,000 onshore wells have been drilled in Britain, approximately 200 of which have used techniques similar to fracking to enhance the recovery of oil or gas. Chief among these is Wytch Farm in Dorset – Europe’s largest onshore oil field, located in one of England’s most famous regions of outstanding natural beauty and special scientific interest, and therefore an area where the aesthetic and environmental impact of drilling are highly sensitive issues.

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 exploration 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 as long as operational best practices were implemented, and enforced through regulation. The Government has 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 1.06 miles (1.7km) and 1.93 miles (3.1km), equivalent to the height of many London Shards 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 if 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.

The other main potential cause of environmental contamination is poor site

construction at the surface. However, any risks can again be minimised by best practice and good regulation, which Britain has a good track record of upholding. For example, every company must disclose the contents of the fracturing fluid they use, which is not mandatory in America.

There has also been concern about fracking causing earth tremors – but the evidence indicates that this will not be a big issue in Britain. Coal operations have been causing barely noticeable levels of seismicity for many years, and we expect that those caused by fracking will be at an even lower level, no more severe at the surface than the passing of a truck.

Another allegation against fracking in America is that it can result in methane leakage. We must therefore start to monitor methane emissions and groundwater composition at potential sites now, before any fracking

takes place (as well as during and after such operations). This baseline monitoring is vital, since methane can be present in groundwater naturally. Such data will be the only way of keeping close track of the environmental impacts of fracking in situ, and should be submitted to regulators to inform local planning processes and address wider concerns.

Shale gas companies must also play their part in building public confidence. It should be mandatory for operators to conduct Environmental Risk Assessments. Local communities should be involved and informed from

“

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

the very start. People need have a say in the planning process and to feel their concerns are being addressed.

In our report, we did not assess the climate risks associated with shale gas exploration, although we recommended that the Government should do so. The chief scientific adviser to the Department for Energy and Climate Change is currently leading a study on the potential for methane and other greenhouse gas leakages during extraction. The results will help form a clearer idea of the overall carbon footprint associated with shale gas.

Difficult decisions lie ahead for the Government. Opinions on all sides of the debate must be heard and considered, and uncertainties explored. However, at the heart of any judgment should be evidence-based science and engineering, which will help to ensure that the best decisions are made, unswayed by preconceived notions of risk or benefit.

# 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 fête 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 sewerage 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.

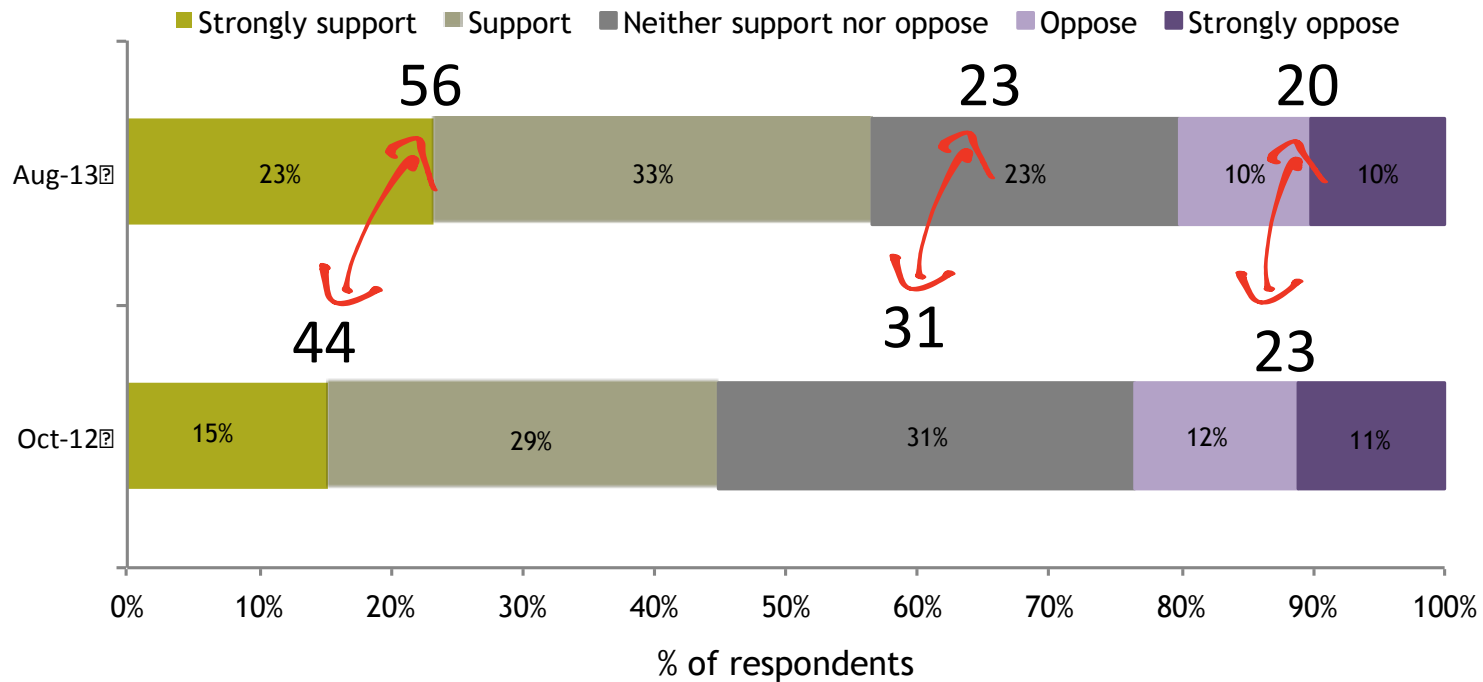
Not everybody feels the same way. Katy Dunne, a local resident and organiser of the No Fracking in Balcombe Society, said: "Any supposed disruption from this camp is nothing compared to the effect of fracking."

# 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

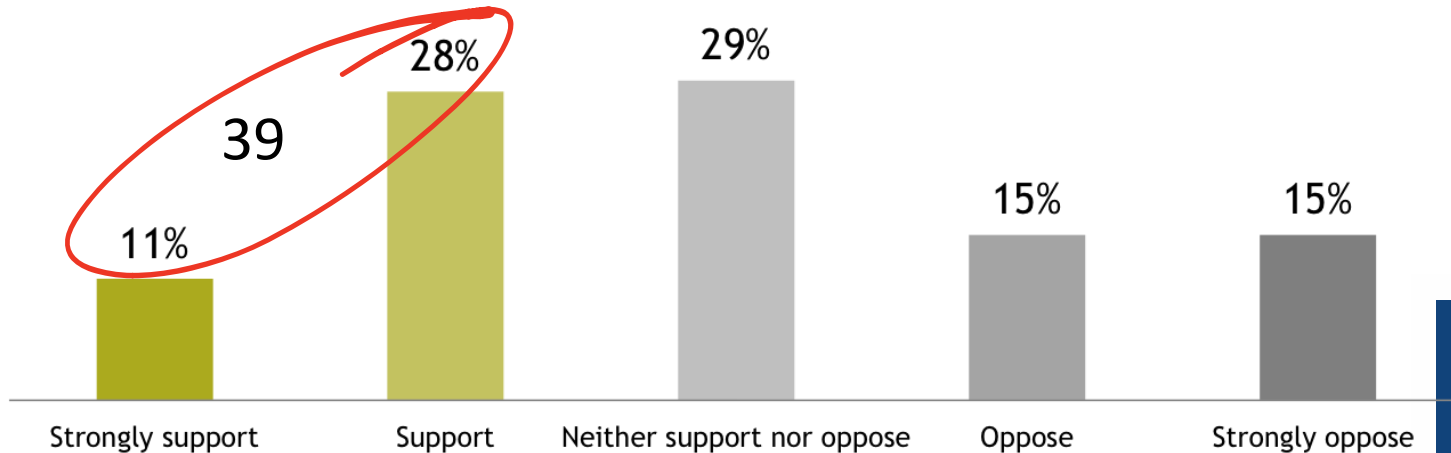
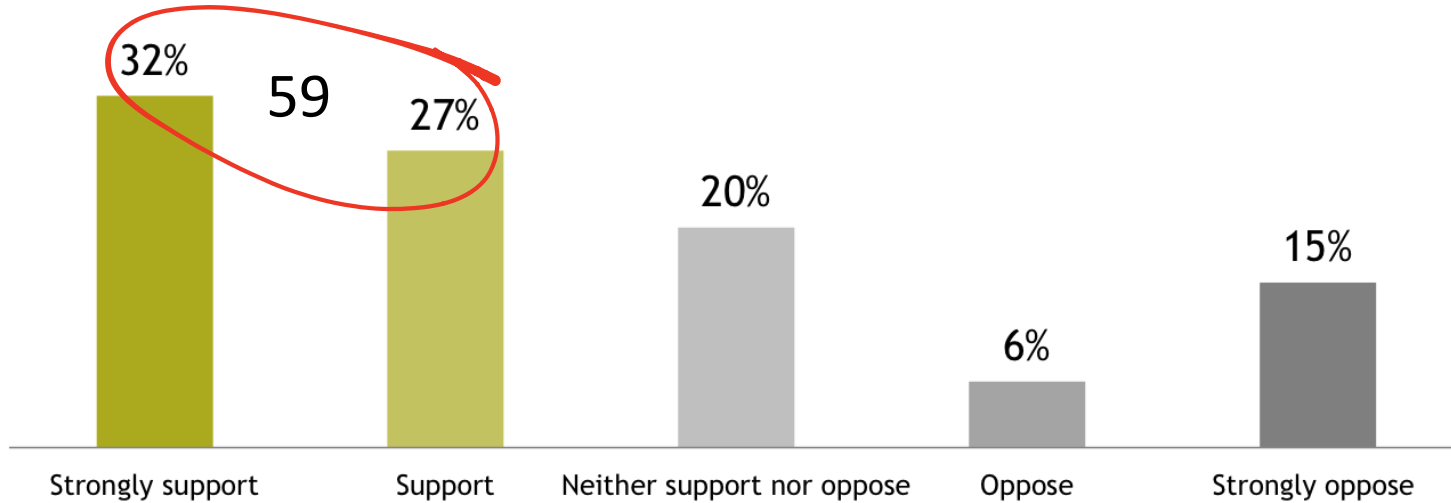
## Un-decideds move to Support



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, 1 December 2012, base: 503; October 2012 base: 1,001)



# 59% of men support exploration, compared with 39% of women



# 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

