Unconventional Gas Extraction in Scotland: An update for Policymakers, Planners and Regulators

climate change
Scotland's centre of expertise connecting climate change research and policy

Introduction and overview of unconventional gas

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Department of Civil and Environmental Engineering

Energy is not just electricity

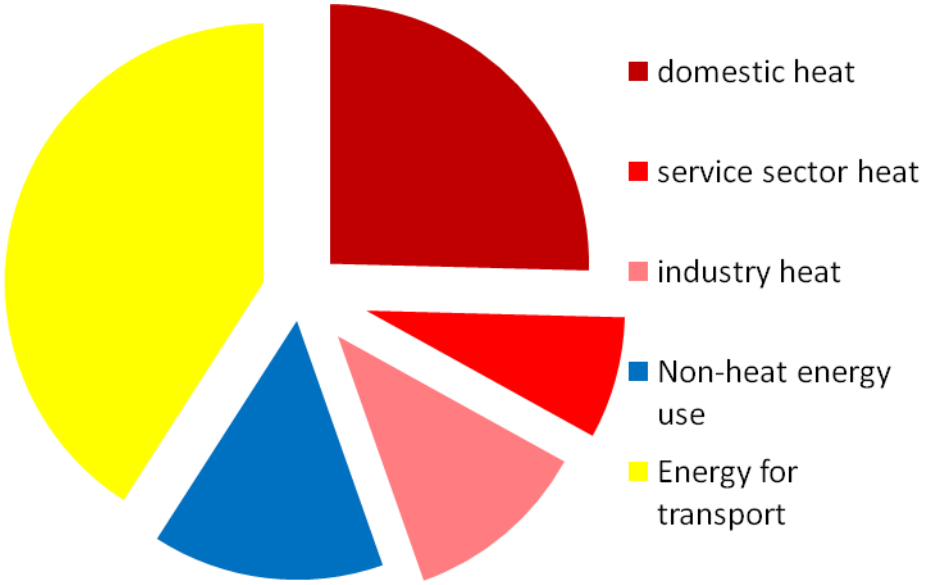
Discussion of energy policy often focuses on *electricity*

Heat = 45% of total energy use

- 2/3 of gas consumption
- > 40% of UK CO_2 emissions arise from heat use

Must focus on heat to hit our targets on energy security and carbon emissions.

UK energy use by sector, 2011

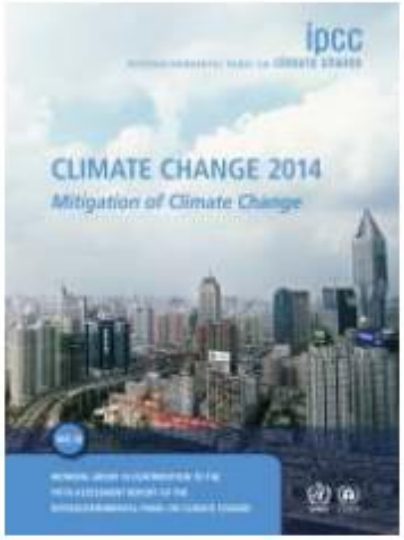


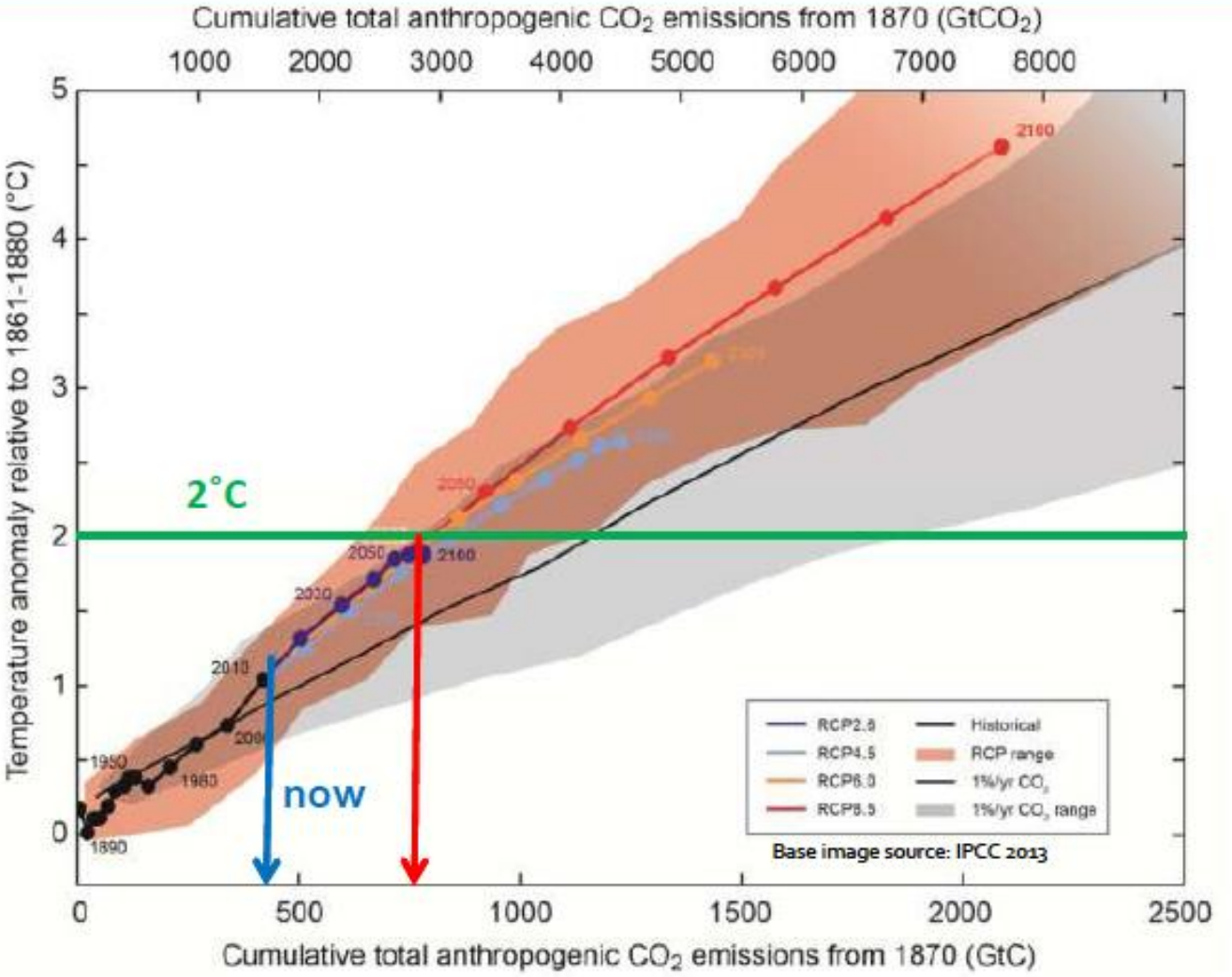
Source: '*UK Energy Trends*', DECC, October 2011

*2.8% of heat currently used in Scotland is renewable; Scottish Government is committed to increasing this to **11%** 2020* – even that is still far less than is needed

Annual UK gas consumption ~0.1 tcm (3 tcf)

Climate Change: Carbon Budgets





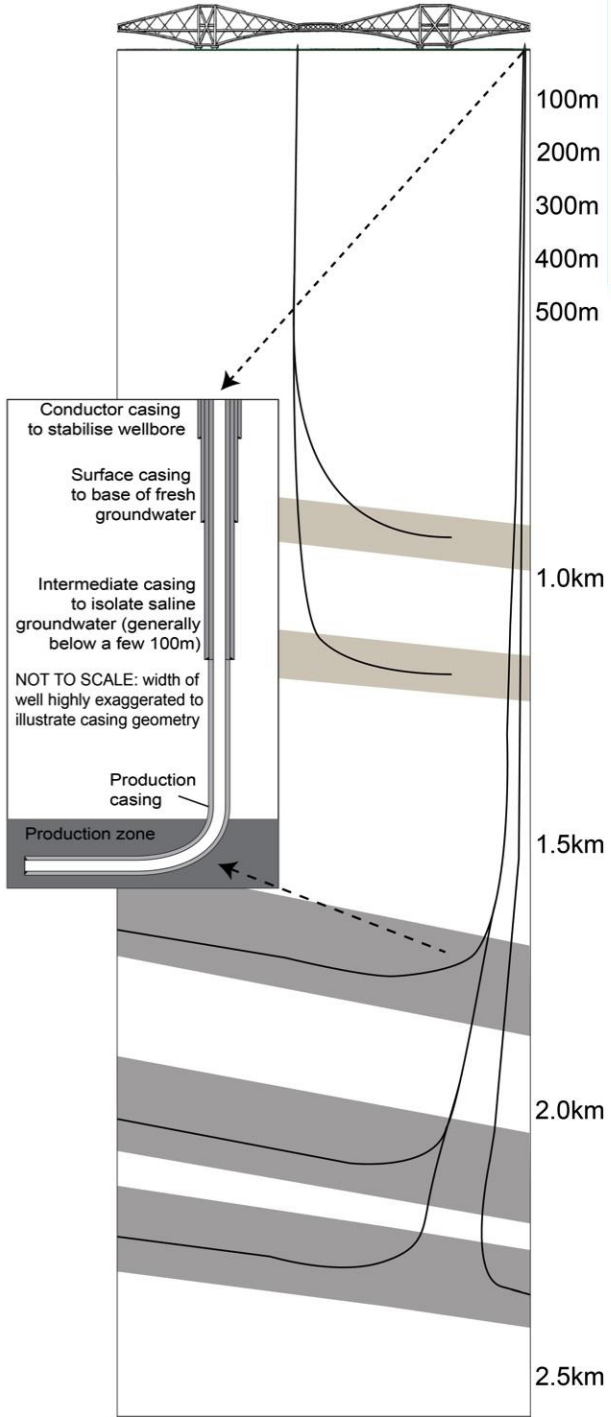
Remaining carbon budget:

~300 Gt C (1100Gt CO_2) for **50/50 chance** of **≤ 2°C**

What is unconventional gas/shale gas/CBM?

Tight gas: relatively impermeable rock, limestone or sandstone
Shale gas: gas trapped in fine-grained sedimentary rock -shale
Coal-bed methane (CBM): gas trapped in coal seams, adsorbed in the solid matrix of the coal

permeability can be increased by ‘fracking’

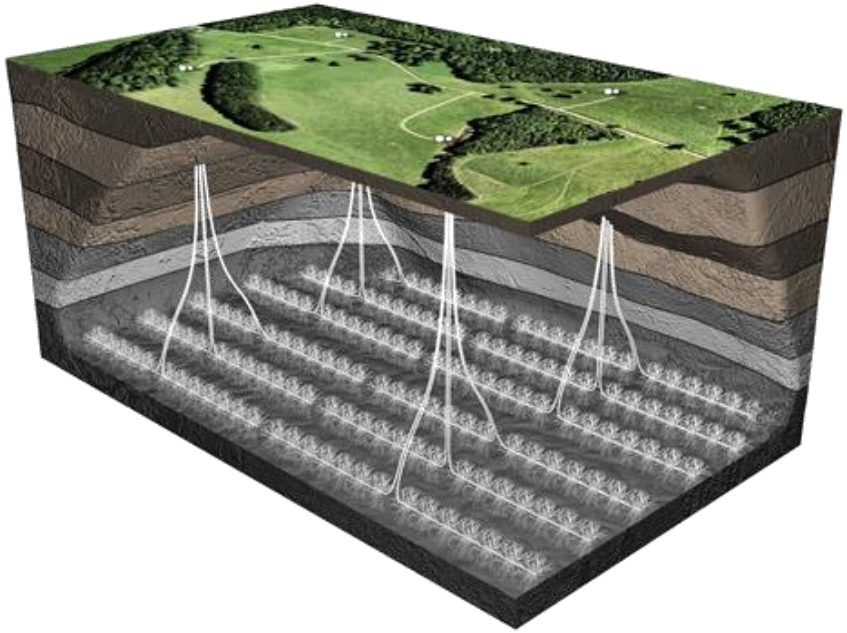


Scottish Government, 2014. **Independent Expert Scientific Panel – Report on Unconventional Oil And Gas.** 102 pp. ISBN: 978-1-78412-683-4 www.scotland.gov.uk/Resource/0045/00456579.pdf

1. Drilling & fracturing few weeks/well - largest footprint

2. Production 10-25 years – relatively low impact

3. After production Site is restored



- **Solutions to reduce surface impact exist:**
  - “cluster” based developments
- **Integration within the local industrial, urban or agricultural context is critical**

What's all the fuss? Shale Gas in the United States

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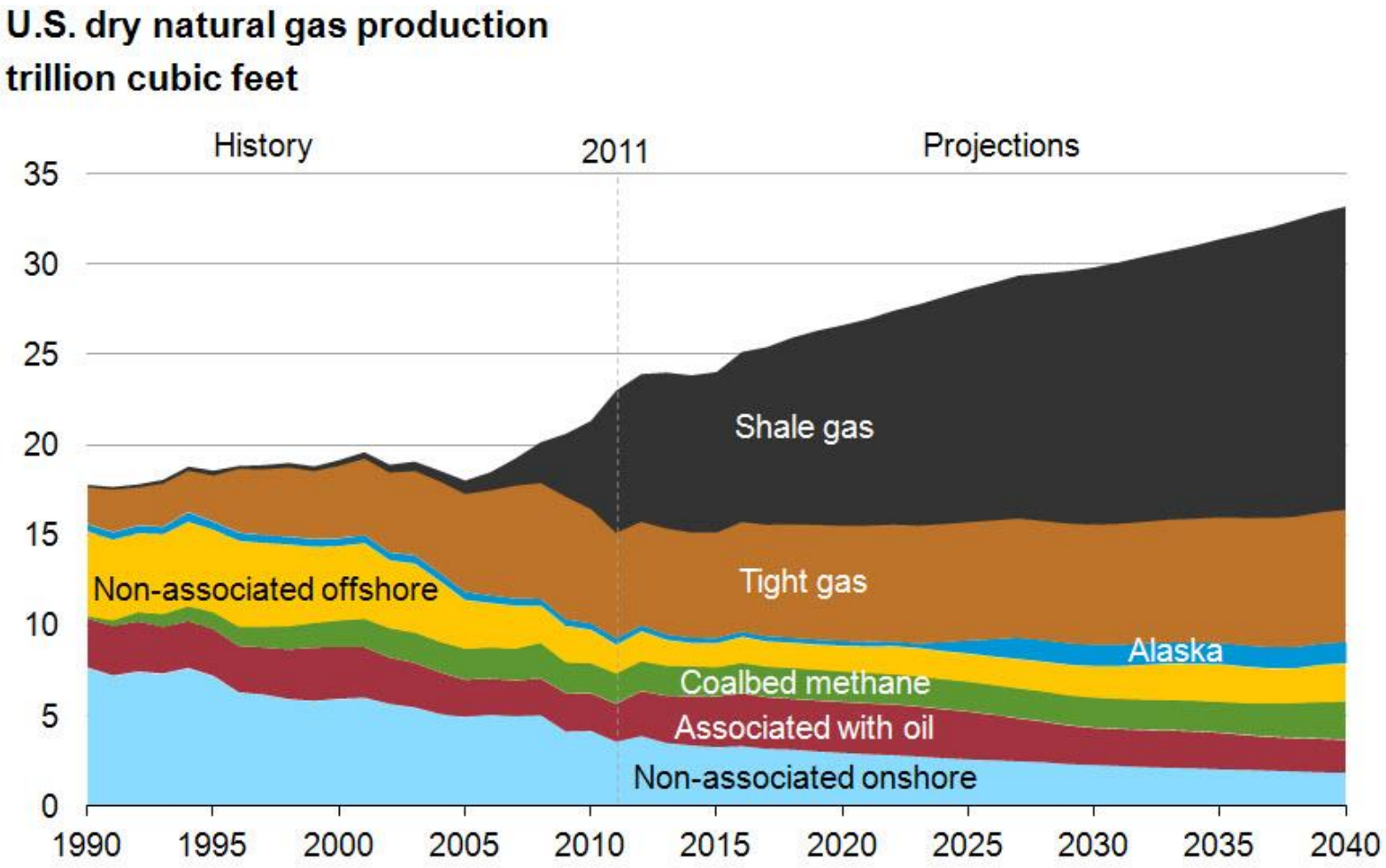


Source: U.S. Energy Information Administration, *Annual Energy Outlook 2013 Early Release*

Shale gas extraction in the UK: a review of hydraulic fracturing

June 2012

THE ROYAL SOCIETY

ROYAL ACADEMY OF ENGINEERING

http://royalsociety.org/policy/projects/shale-gas-extraction/report/

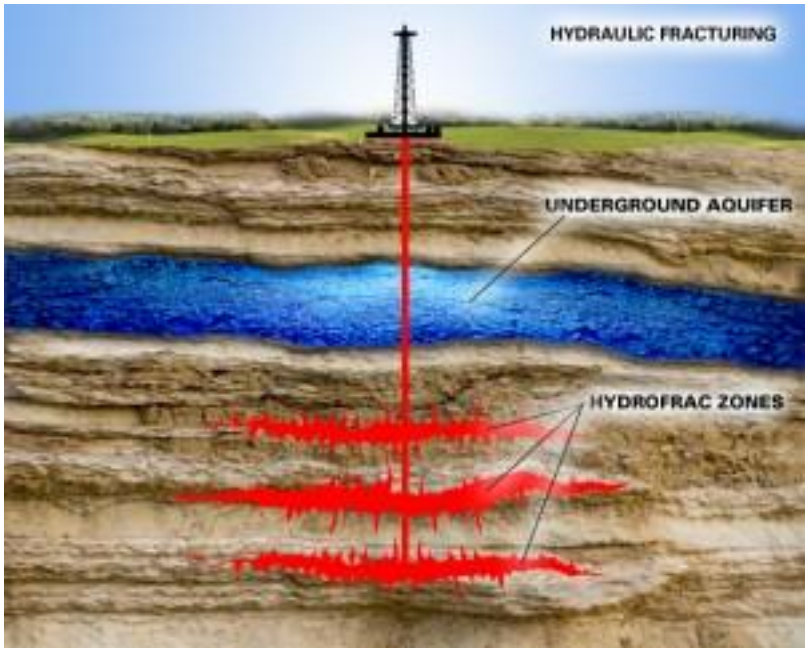
Shale gas extraction in the UK: a review of hydraulic fracturing

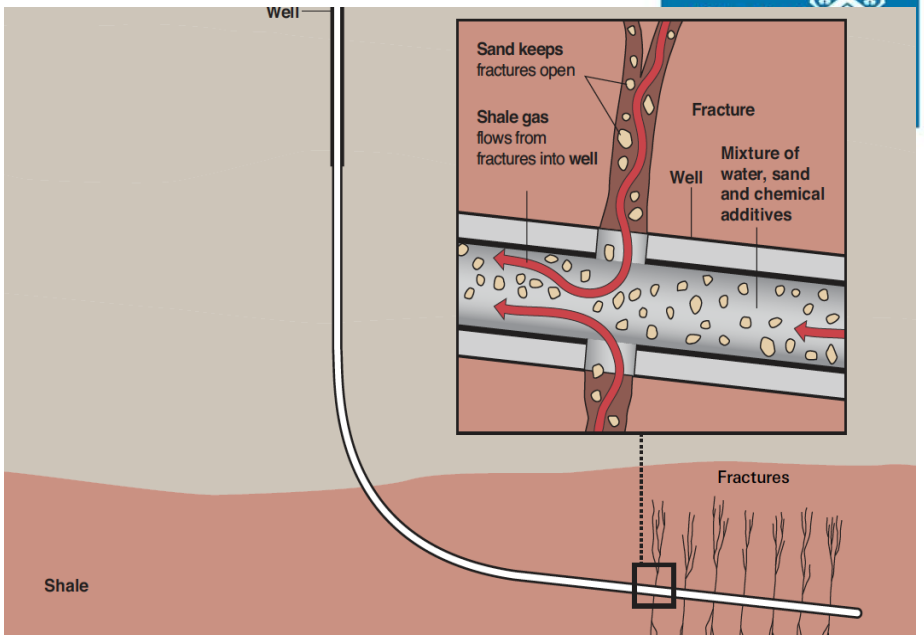
June 2012

Yes the risks can be managed, as long as operational best practices are implemented and enforced through strong regulation.

http://royalsociety.org/policy/projects/shale-gas-extraction/report/

Protestors' concerns

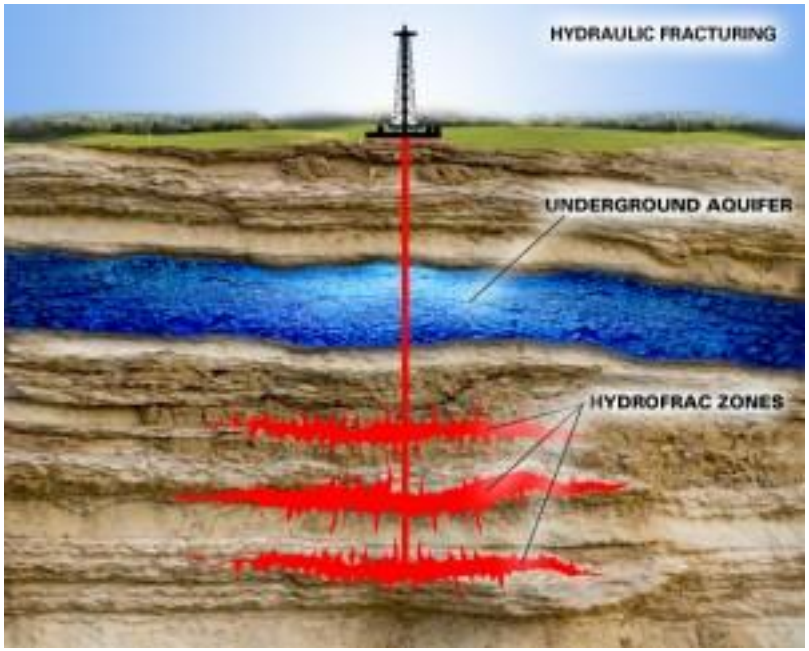


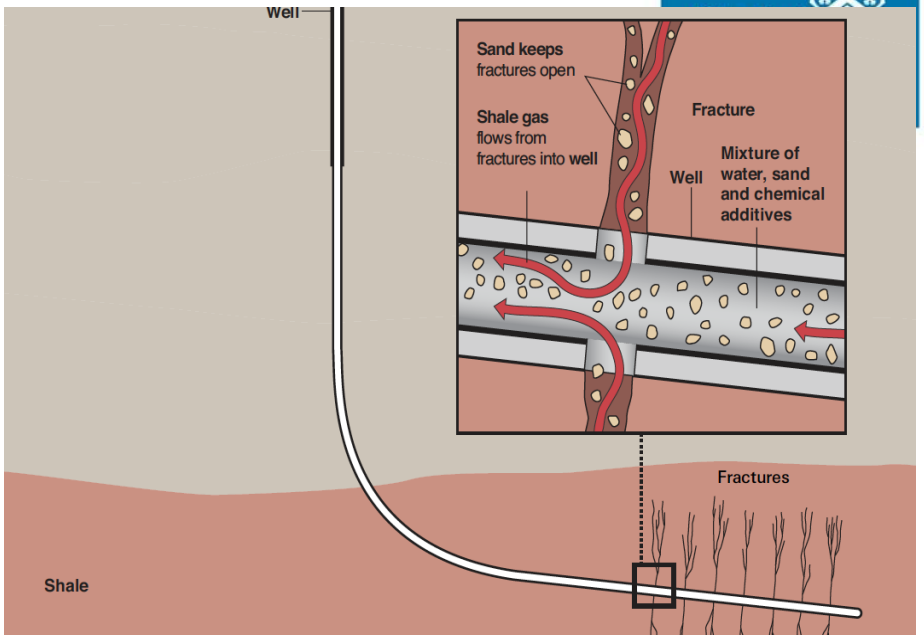


http://econews.com.au/news-to-sustain-our-world/britain-plans-major-tax-breaks-for-shale-gas/

- Seismicity and fracture propagation
- Water abstraction and use
- Wastewater and well integrity
- GHG emissions
- Public health implications

Protestors' concerns





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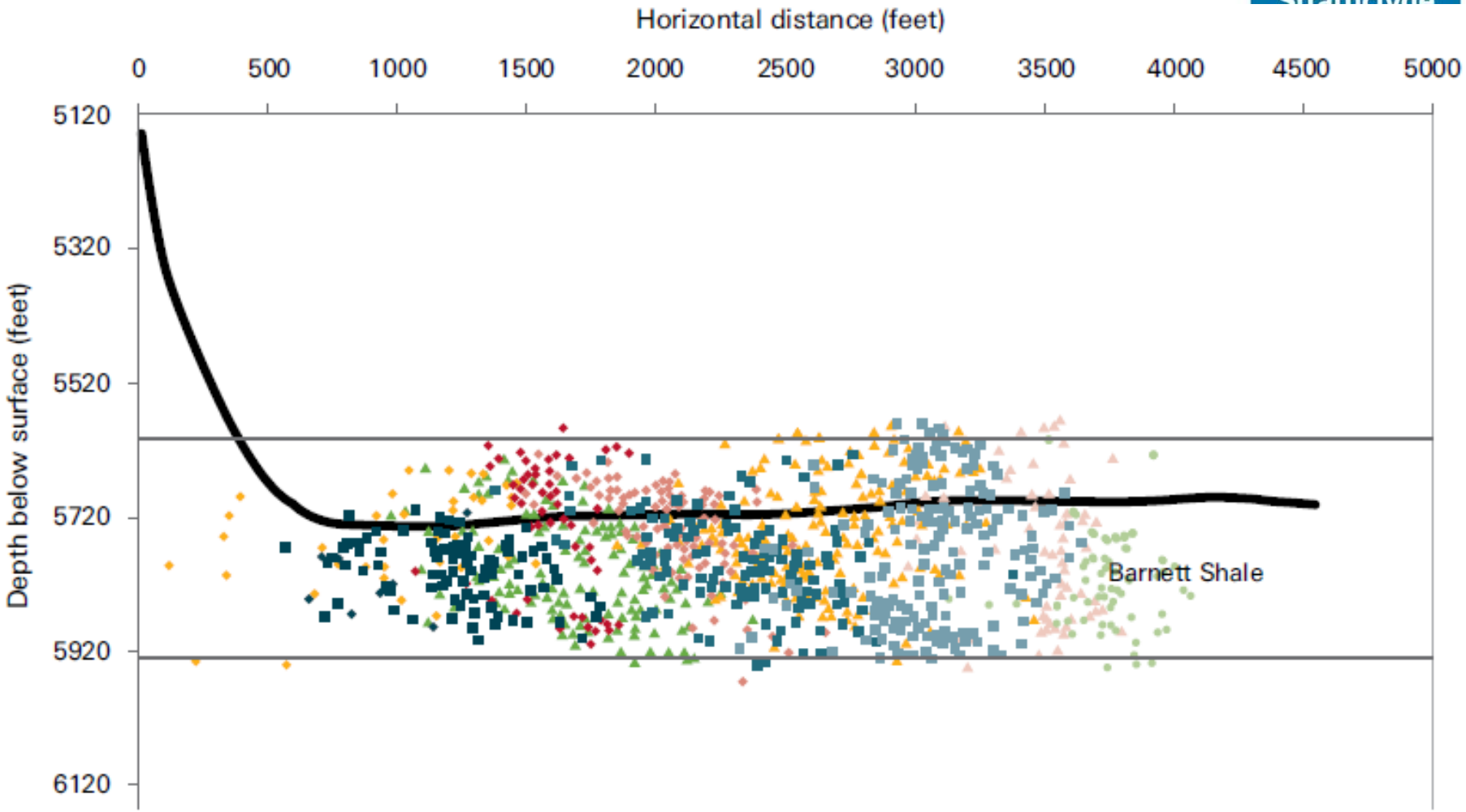
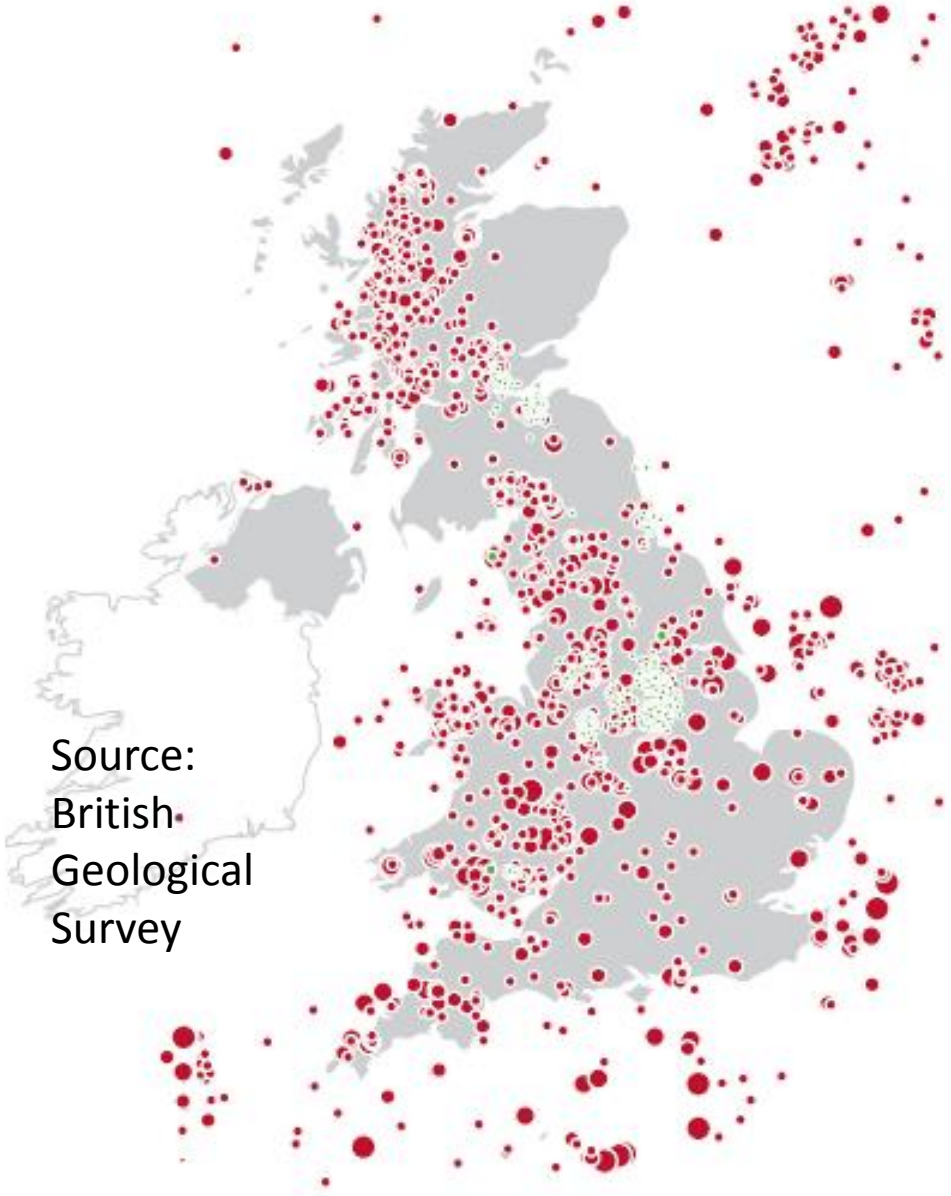
Seismicity is inherent to hydraulic fracturing



Microseismic monitoring of a typical hydraulic fracturing operation in the Barnett Shale, Texas, USA (Zoback et al 2010).

UK Natural seismicity (red) and Coal mining-induced seismicity (green) from 1382 to 2012



Source: British Geological Survey

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Magnitude	UK frequency	
-1.0		100 kg person jumps down 2 m
0.0	Not detected by BGS	
1.0	100s each year	
2.0	25 each year	Felt by very few in very quiet conditions
3.0	3 each year	Felt by people at rest; similar to passing of a truck
4.0	1 every 3-4 years	Felt by many people; some dishes broken.
5. 0	1 every 20 years	Felt by all people; fallen plaster; some chimneys broken.

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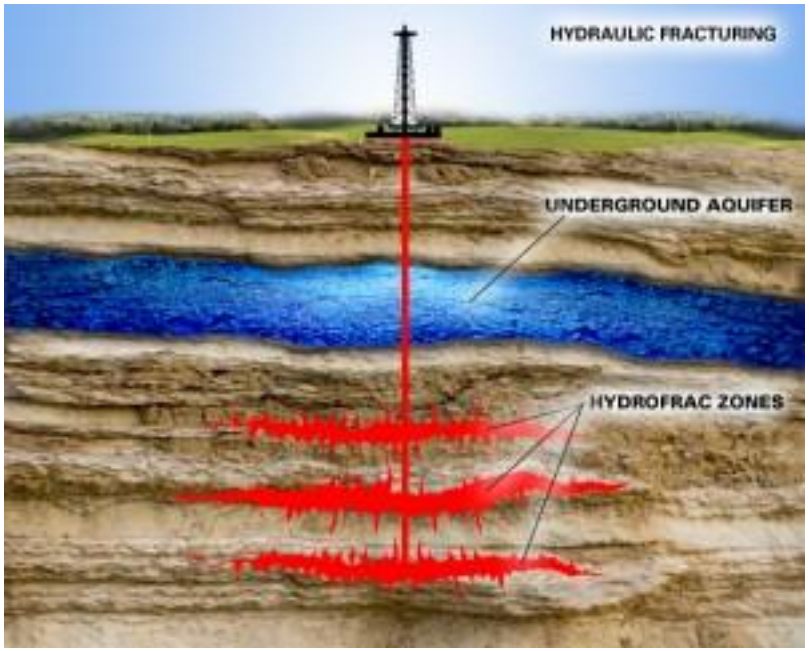

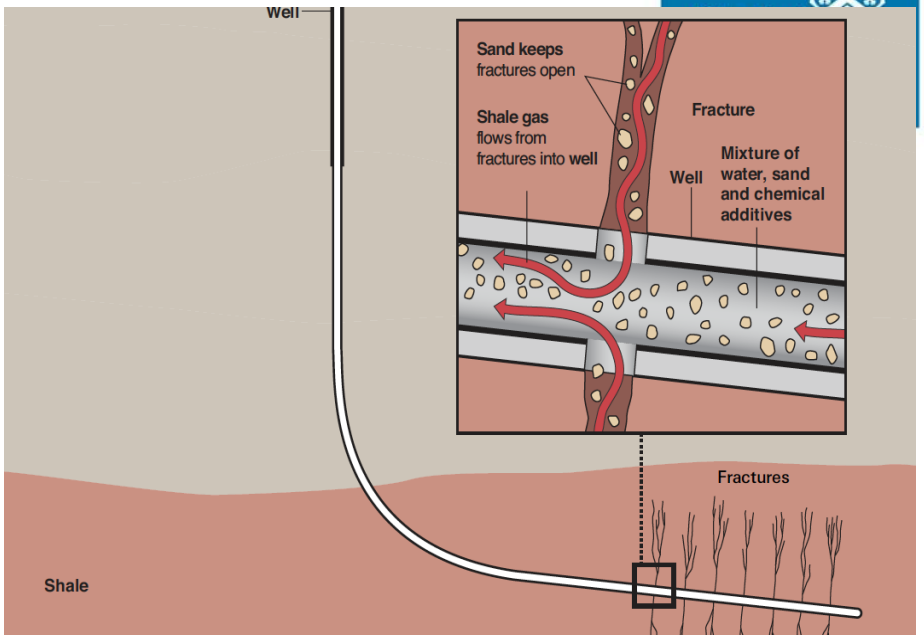

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Water consumption for a hydraulically fractured shale well for 10 yrs= 5 M US gallons (≈19,000 cubic metres)

- water a golf course for a month
- run a 1000 MW coal-fired power plant for 12 hours
- lost to leaks in United Utilities' region in northwest England every hour

Moore (2012), Gas works? Shale gas and its policy implications, Policy Exchange: London. http://www.policyexchange.org.uk/images/publications/gas%20works%20-%20feb%2012.pdf

	Gallons of water per million British Thermal Units	
	Range	Mid Point of Range
Deep shale natural gas	1-6	3
Nuclear (Uranium ready to use in a power plant)	8-14	11
Conventional oil	8-20	14
Synfuel - coal gasification	11-26	18
Coal (ready to use in a power plant)	13-32	23
Oil shale	22-56	39
Tar sands	27-68	47
Fuel ethanol from corn	2,510-29,100	15,805
Biodiesel from soy	14,000-75,000	44,500

Source: Ground Water Protection Counsel and the United States Department of Energy

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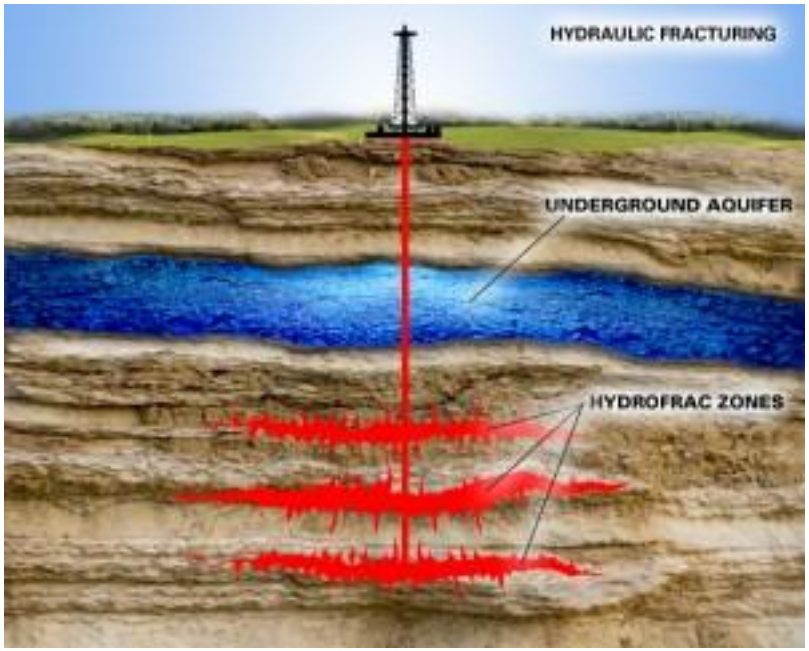

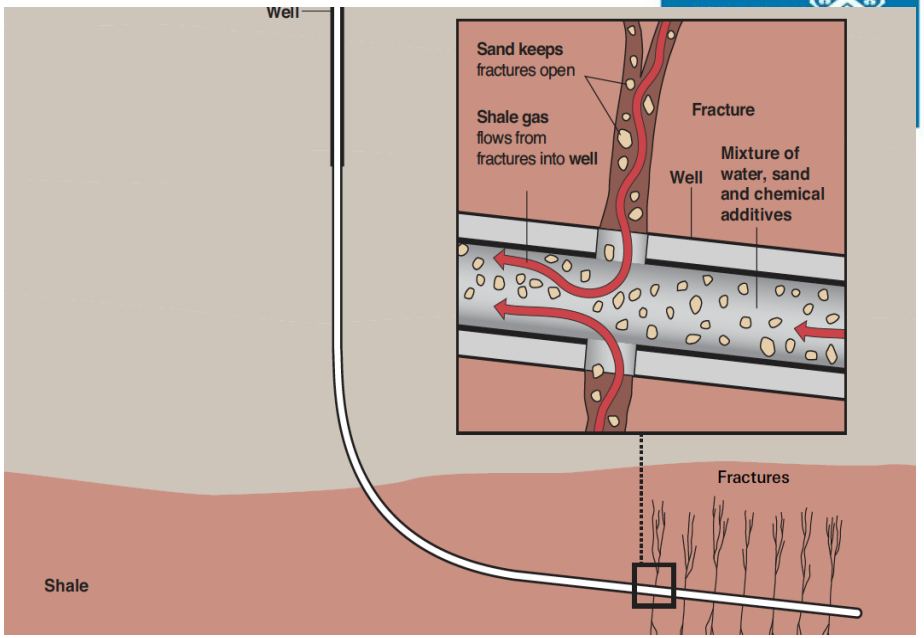

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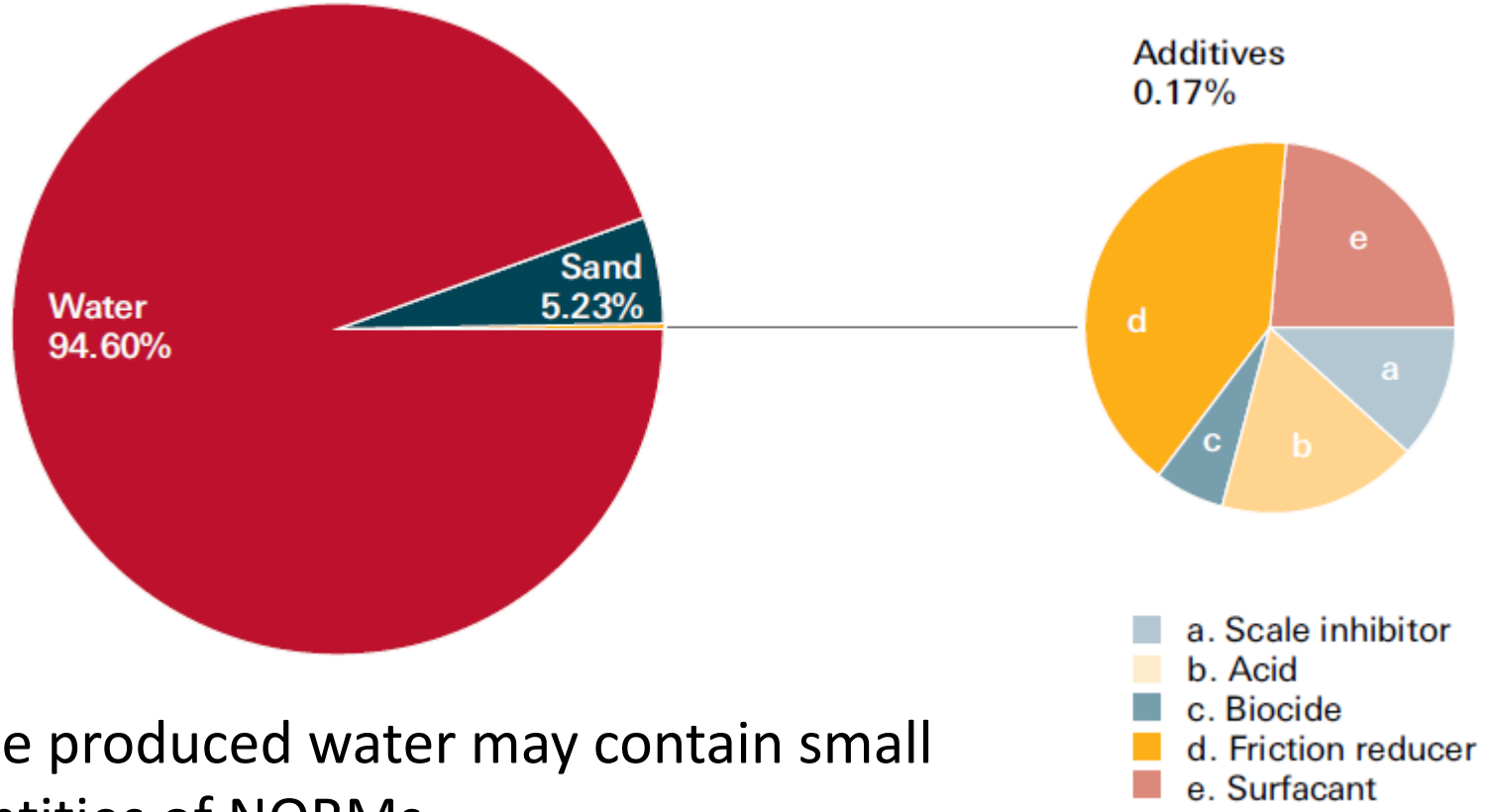
Are fracking fluids toxic?



Some produced water may contain small quantities of NORMs

In the UK:

– subject to regulatory approval

– operators need to publish fracking fluid composition

http://royalsociety.org/policy/projects/shale-gas-extraction/report/

Groundwater pollution

(1) Methane migration through rock

- Shale permeability very low

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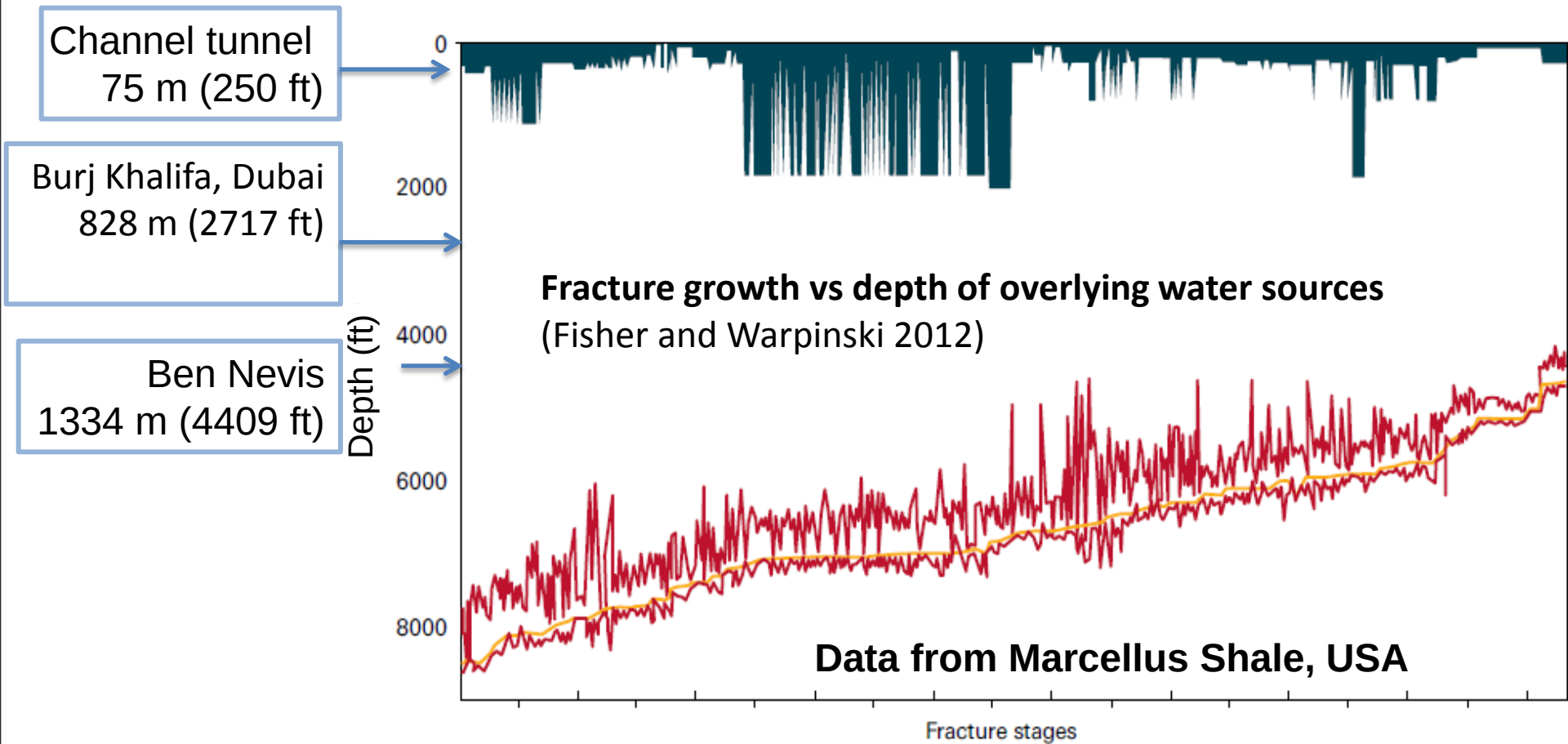
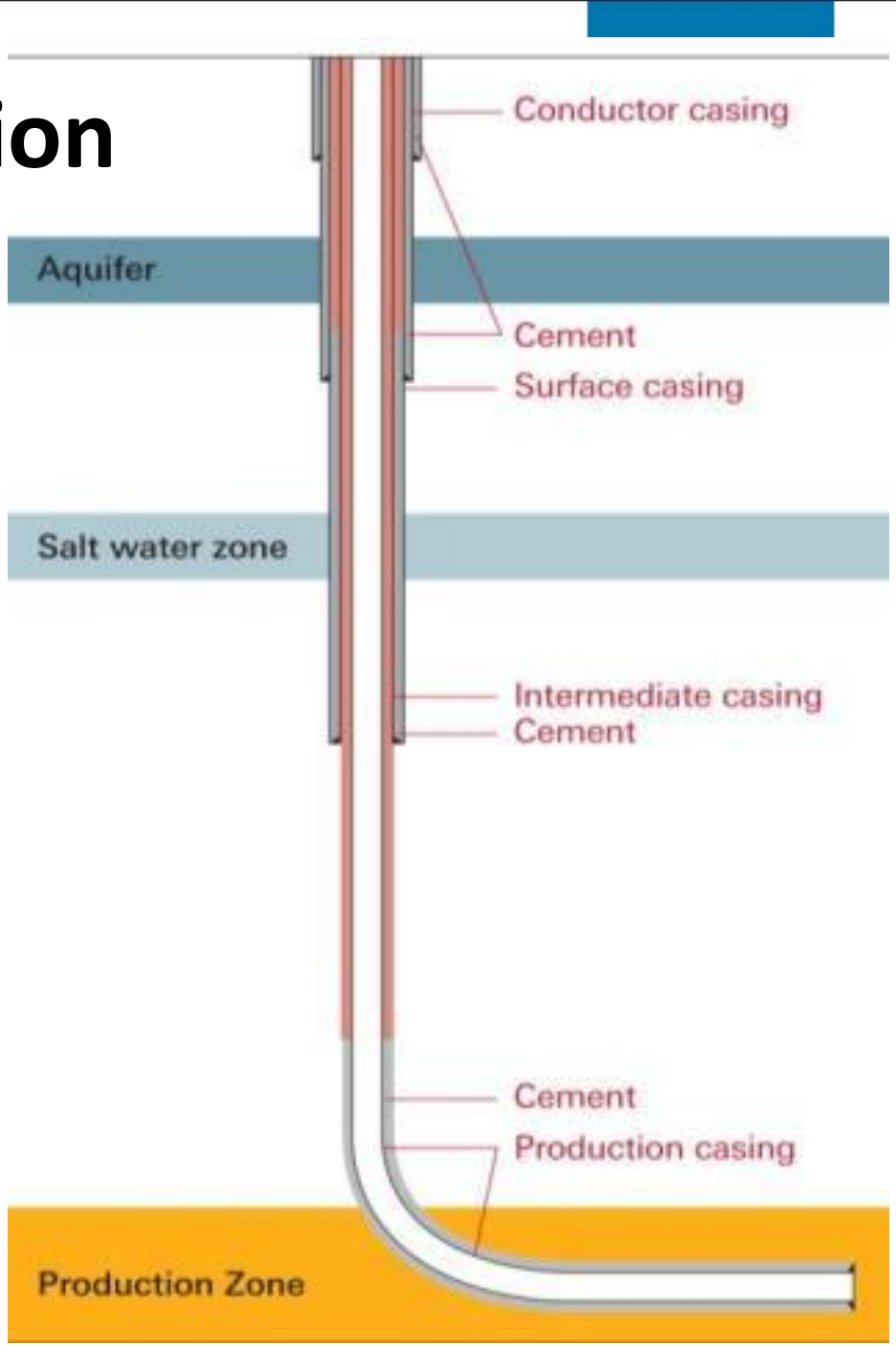


Groundwater pollution

(2) Methane migration through poor well integrity

- UK requires triple well casing
- Cement bond integrity monitored using ultrasonic logging
- Public and regulatory confidence needs baseline aquifer methane concentration data
- Well design and construction inspected via independent well examination scheme



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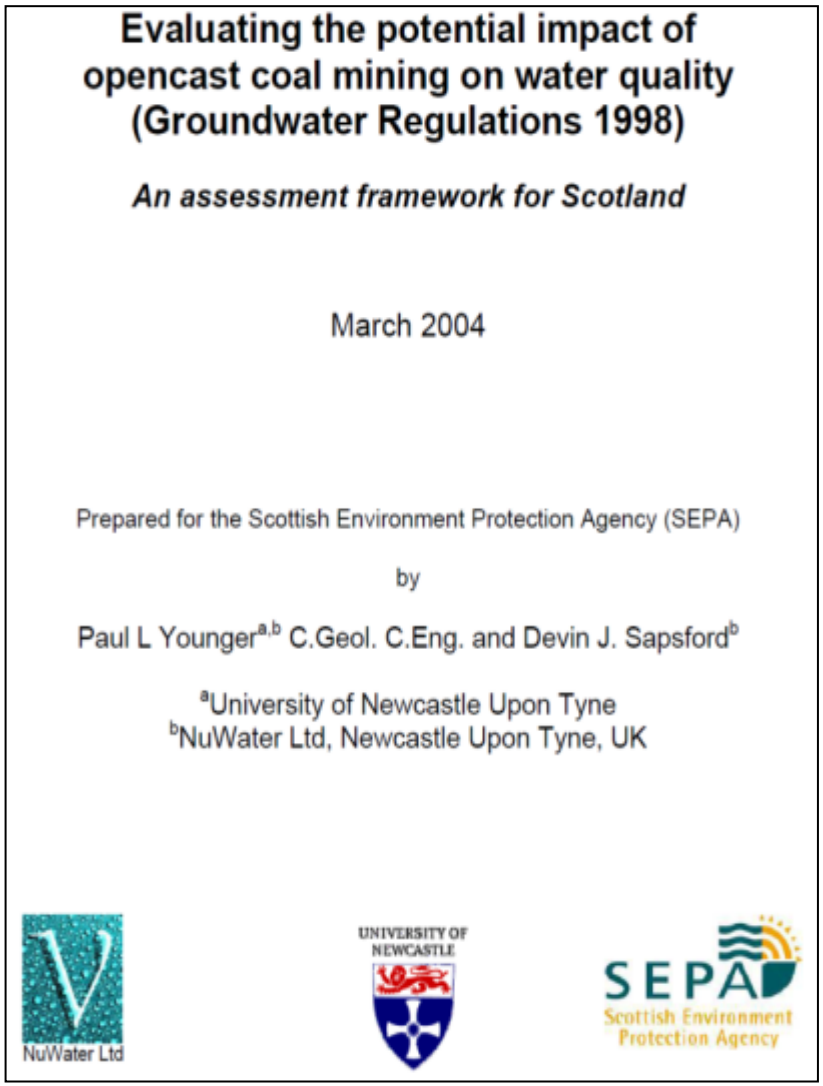
Water pollution: surface site management

- Risk is from failure to follow best management of injection / produced water at surface e.g. bunded sites, waste water stored in tanks not open ponds
- Much transferable knowledge from mineral exploitation



Evaluating the potential impact of opencast coal mining on water quality (Groundwater Regulations 1998)

An assessment framework for Scotland

March 2004

Prepared for the Scottish Environment Protection Agency (SEPA)

by

Paul L Younger[a,b] C.Geol. C.Eng. and Devin J. Sapsford[b]

[a]University of Newcastle Upon Tyne
[b]NuWater Ltd, Newcastle Upon Tyne, UK

NuWater Ltd

UNIVERSITY OF NEWCASTLE

SEPA Scottish Environment Protection Agency

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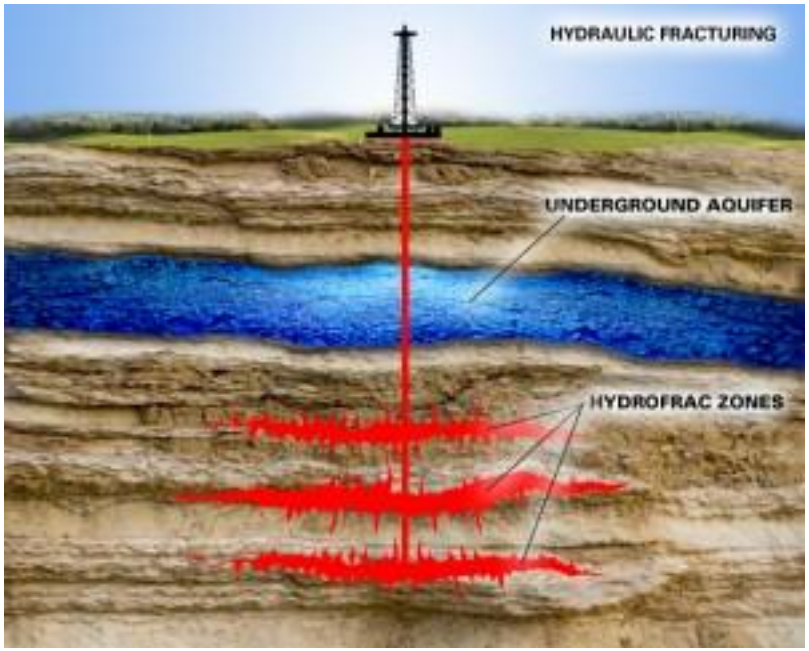

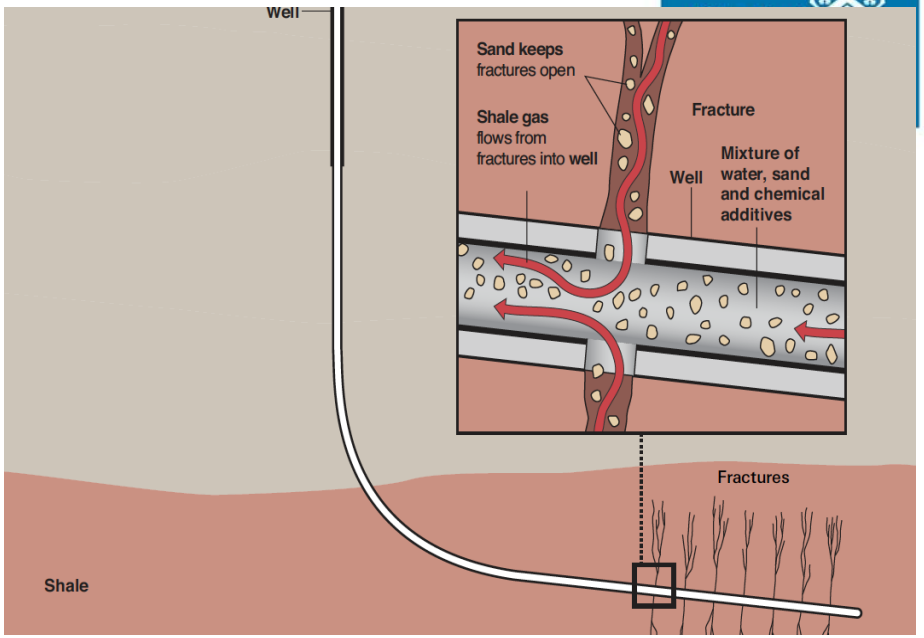

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Key differences between US practice and what would be allowed by UK/EU

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- open pits vs. closed tanks
- Venting and flaring vs. venting only in emergencies
- “green completions” vs. best available techniques
- “Halliburton exemption” vs. water framework directive etc.
- commercial confidentiality vs. full disclosure (FrackFocus)

Landscape footprint?

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to make a significant difference to the UK energy supply mix i.e. 10% = 320 BCF/Y = 20% of Bowland Basin GIIP

with current technology, realistic decline & EUR analogues (Barnett) - will require a minimum of 7500 –10,000 wells over > 65 years

initial 5 year ramp-up period of 1200 wells drilled (240 wells per year), a further 130 wells per year will be required for +/-60 years to maintain production levels i.e. 1 new well every 3 days

(numbers from Chris Cornelius)

Implications for jobs, communities, environment…?

BMJ

BMJ 2014;348:g2728 doi: 10.1136/bmj.g2728 (Published 17 April 2014)

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EDITORIALS

Public Health England's draft report on shale gas extraction

Mistaking best practices for actual practices

Mistaking best practices for actual practices

Public perception/trust/social justice

……Over to you!

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Glasgow