Department of Energy & Climate Change

Securing the UK's Energy Future

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Joint IET / I-SEE Seminar
23 November 2015

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Our current targets: domestic

- For Greenhouse Gases, the UK has domestic targets that look ahead to 2050
- UK Climate Change Act - 80% cuts in greenhouse gas emissions by 2050

Energy Act 2008
Climate Change Act 2008

http://www.opsi.gov.uk/acts/acts2008/pdf/ukpga_20080032_en.pdf
http://www.opsi.gov.uk/acts/acts2008/pdf/ukpga_20080027_en.pdf

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The Climate Change Act 2008

The Act provides three elements of our climate change framework

Targets

The Climate Change Act commits the UK to an **80% reduction in Greenhouse Gases** (GHGs) in 2050 compared to 1990 levels (and a 34% reduction in 2020).

These figures are based on advice from the Committee on Climate Change (CCC) in 2008.

It was assumed to be an appropriate UK share of a global commitment to reduce GHGs by 50-60% compared to 2008 levels, which would be compatible with a 2 degrees target.

Budgets

The Act requires that we cap emissions over successive 5 year periods.

These budgets must be set 12 years in advance.

In setting budgets the SoS must take into account a range of matters including technology, and economic and social circumstances.

After setting a budget the SoS must then publish proposals and policies to meet our targets. This took the form of the Carbon Plan published in 2011.

Committee on Climate Change

The Act established an independent Committee on Climate Change.

The Committee advises Government on how to reduce emissions over time and across the economy.

The CCC advises on the optimum trajectory to 2050 by giving advice on budget levels and the level of effort across sectors.

Committee on Climate Change

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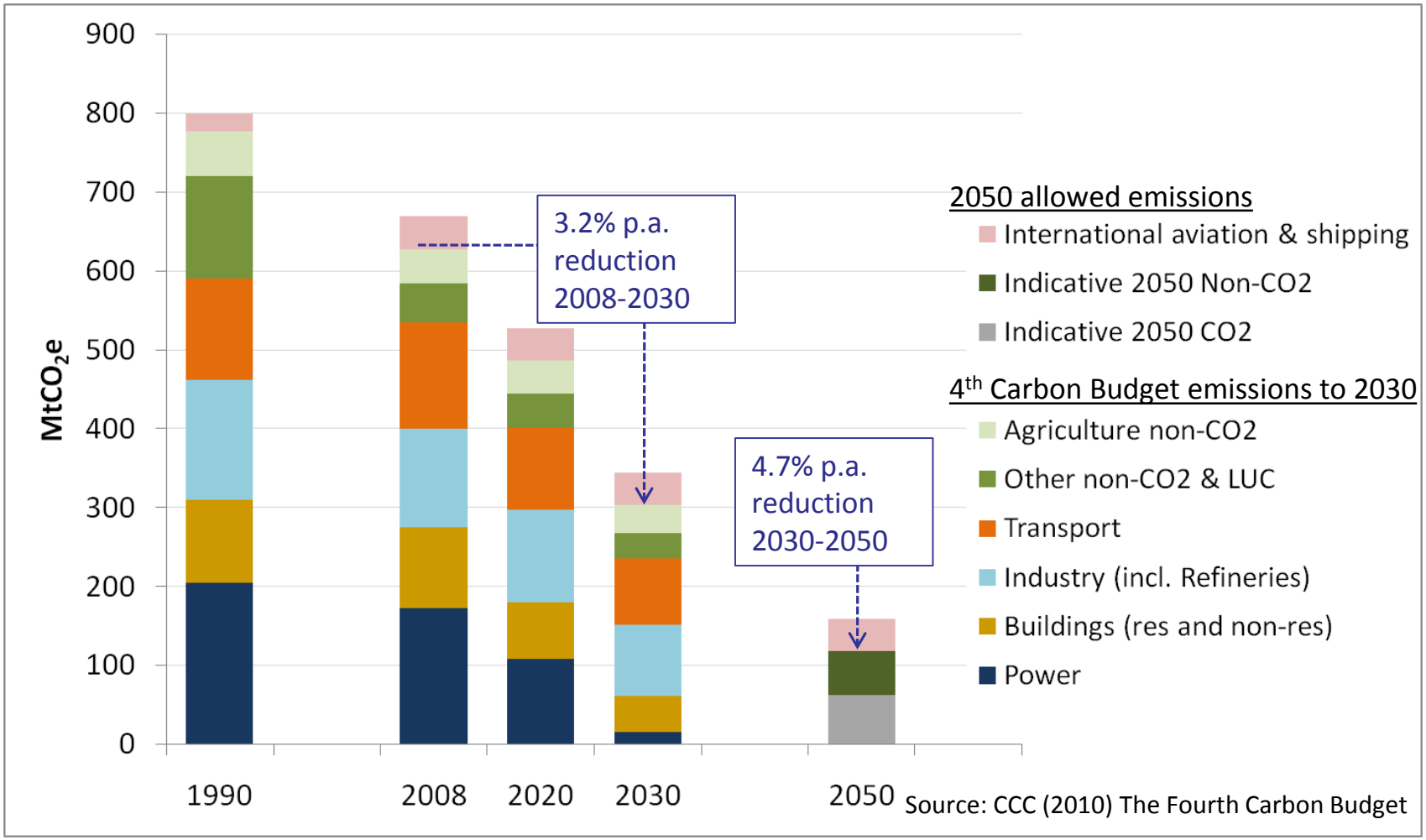
Large emissions reduction needed to 2050



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Emissions reductions since 1990

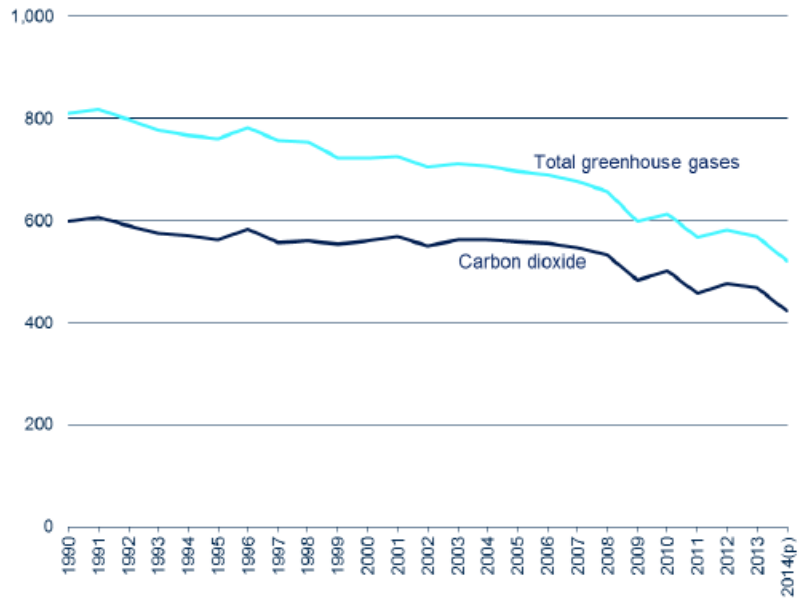
Where we were/are

Table 1: Emissions of greenhouse gases
UK and Crown Dependencies

			$MtCO_2e$
	2013	2014(p)	Change
Total greenhouse gas emissions	568.3	520.5	-8.4%
Carbon dioxide emissions	467.5	422.0	-9.7%

Note:
1. (p) 2014 estimates are provisional
2. Emissions are reported as net emissions, which include removals from the atmosphere by carbon sinks.

Figure 1: Emissions of greenhouse gases, UK and Crown Dependencies 1990-2014, ($MtCO_2e$)



Note: (p) 2014 estimates are provisional.

- 30% below 1990 baseline
- 8.4% reduction 2013-14 against growing economy (provisional)

Source: 2014 UK Greenhouse Gas Emissions, Provisional Figures – *Annex: 1990-2013 UK Greenhouse Gas Emissions, final figures by end-user sector including uncertain estimate* - DECC, March 2016

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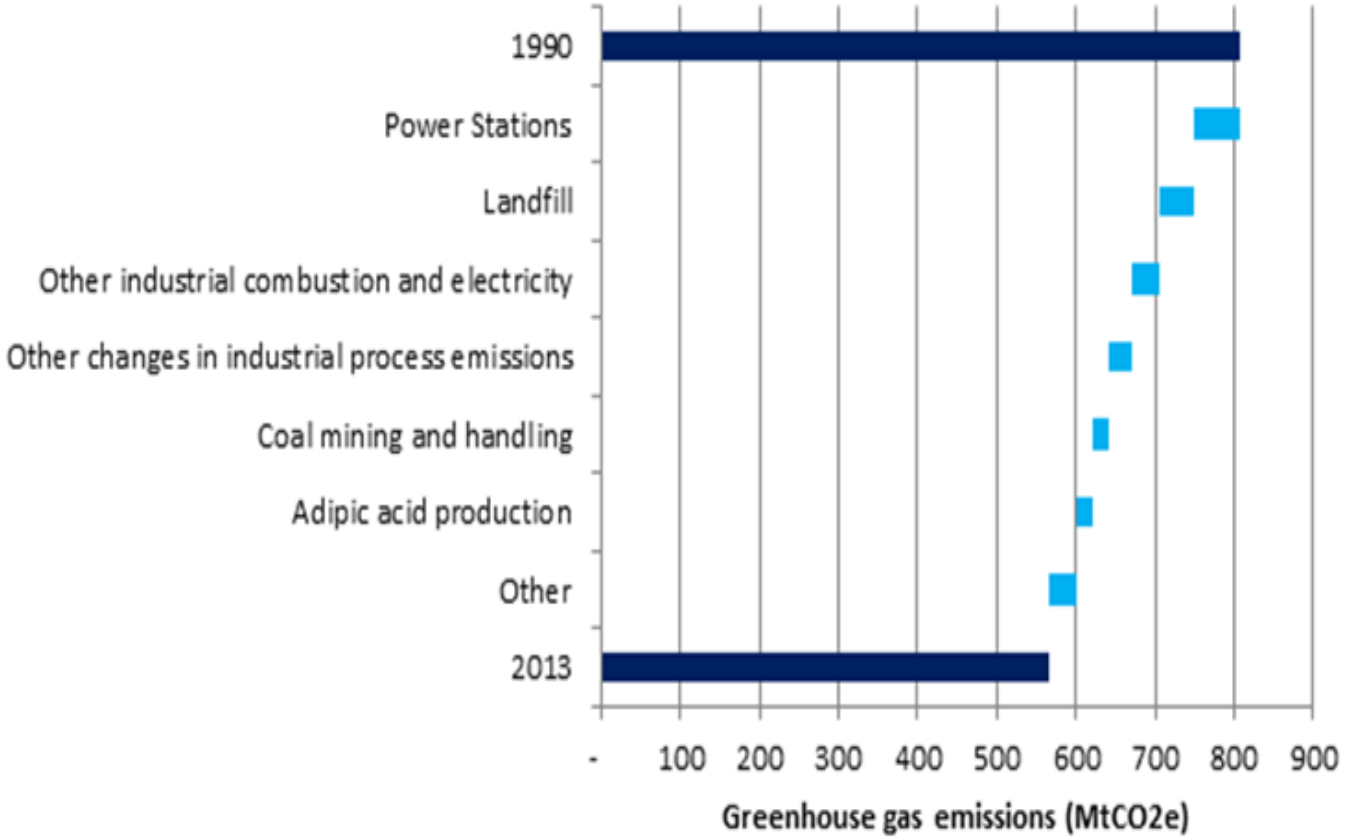
Emissions reductions since 1990

What's driving emissions reductions?



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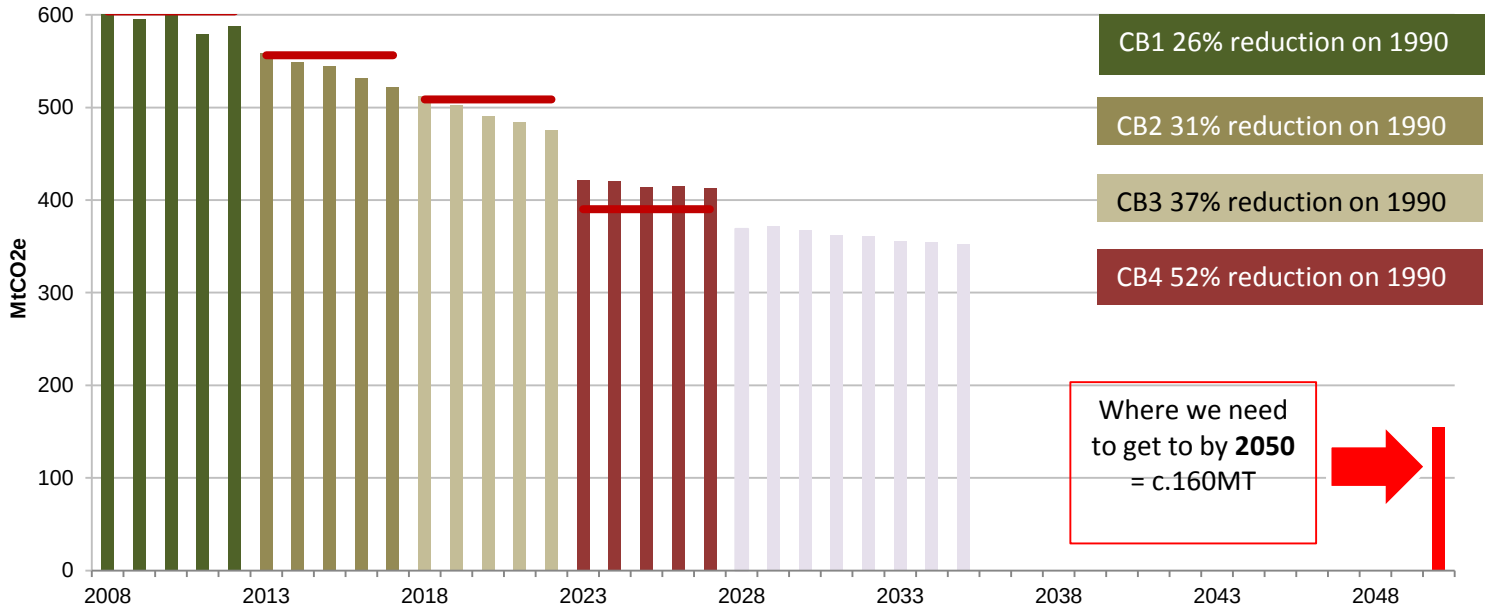
Getting to 2050 through carbon budgets

"Carbon budgeting"



	First Carbon Budget (2008-12)	Second Carbon Budget (2013-17)	Third Carbon Budget (2018-22)	Fourth Carbon Budget (2023-27)	2050
Level (million tonnes carbon dioxide equivalent (MtCO2e))	3,018	2,782	2,544	1,950	Approx.160 in 2050 compared to the 1990 base year of 811
% reduction below 1990 levels	26%	31%	37%	52%	80%

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Scale of the Challenge

Where we are

	CB1	CB2	CB3	CB4
	MET	ON TRACK	ON TRACK	OFF TRACK
PUBLIC PROJECTIONS	-36MT	-108MT -76MT -44MT	-153MT -80MT -16MT	-29MT +133MT +219MT

Why is this happening?

- Performance of climate policies
- Changes to the inventory e.g. data quality improvement
- International reporting guidelines
- Assumptions e.g. fossil fuel prices, economic growth

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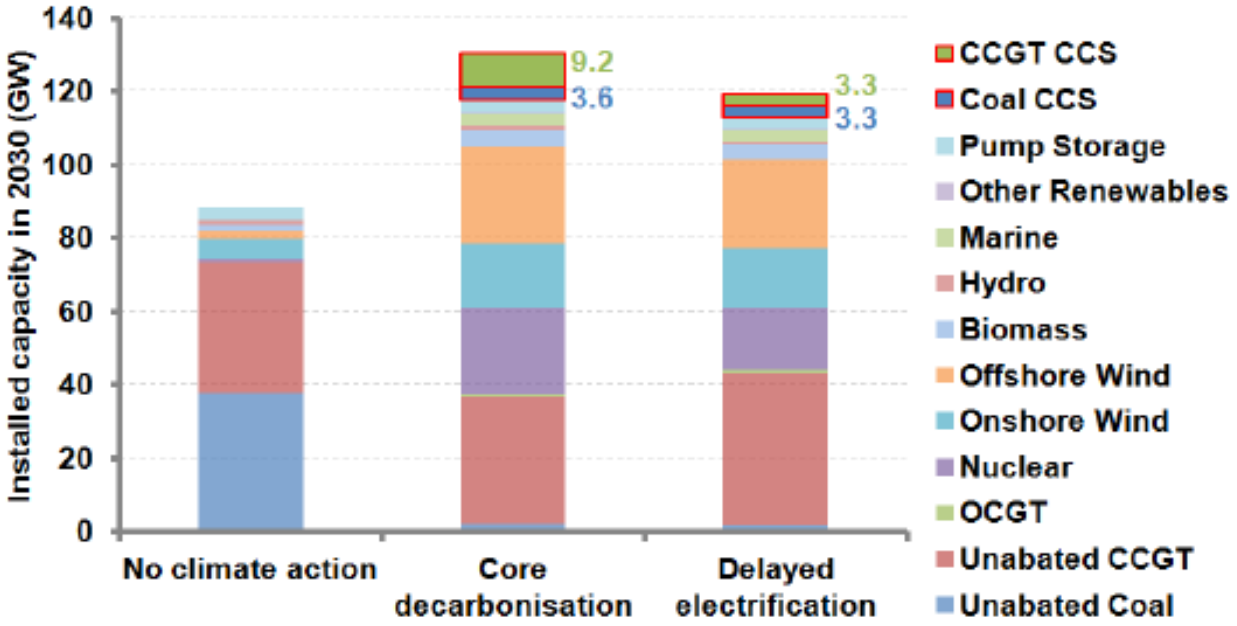
UK's electricity generation mix in 2030 in the CCC scenarios



Source: Infrastructure and in a low carbon energy system to 2030 – Carbon Capture and Storage Final Report for the Committee on Climate Change – Element Energy Limited, July 2013

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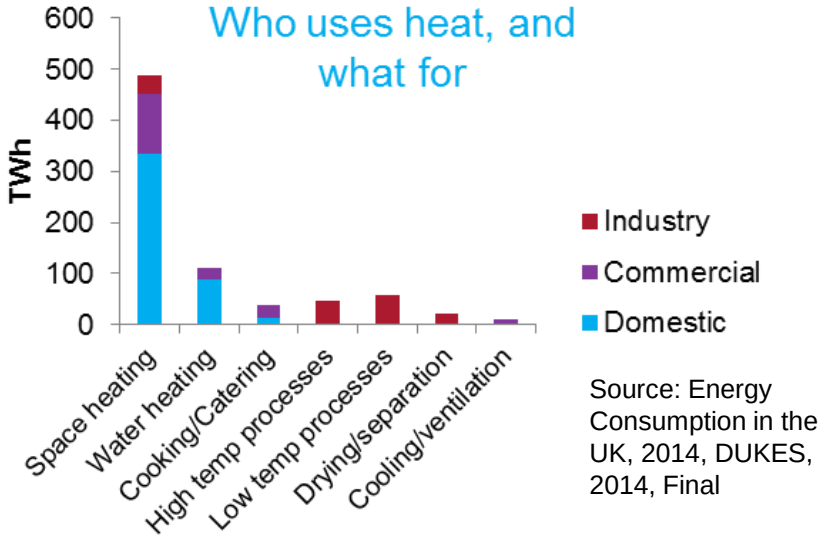
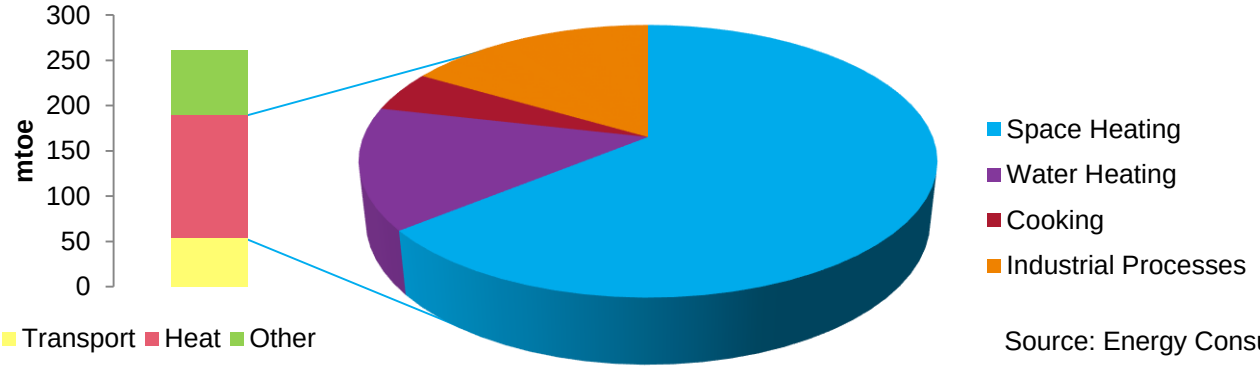
Heating: the biggest and hardest challenge of all?

- 45% of **all** energy use in UK
- ~ 1/3 UK GHG emissions
- UK = one of most extensive gas grids and largest gas boiler markets in the world



Source: Energy Consumption in the UK, 2014, DUKES, 2014, Final

Breakdown of final energy consumption in the UK



Source: Energy Consumption in the UK, 2014

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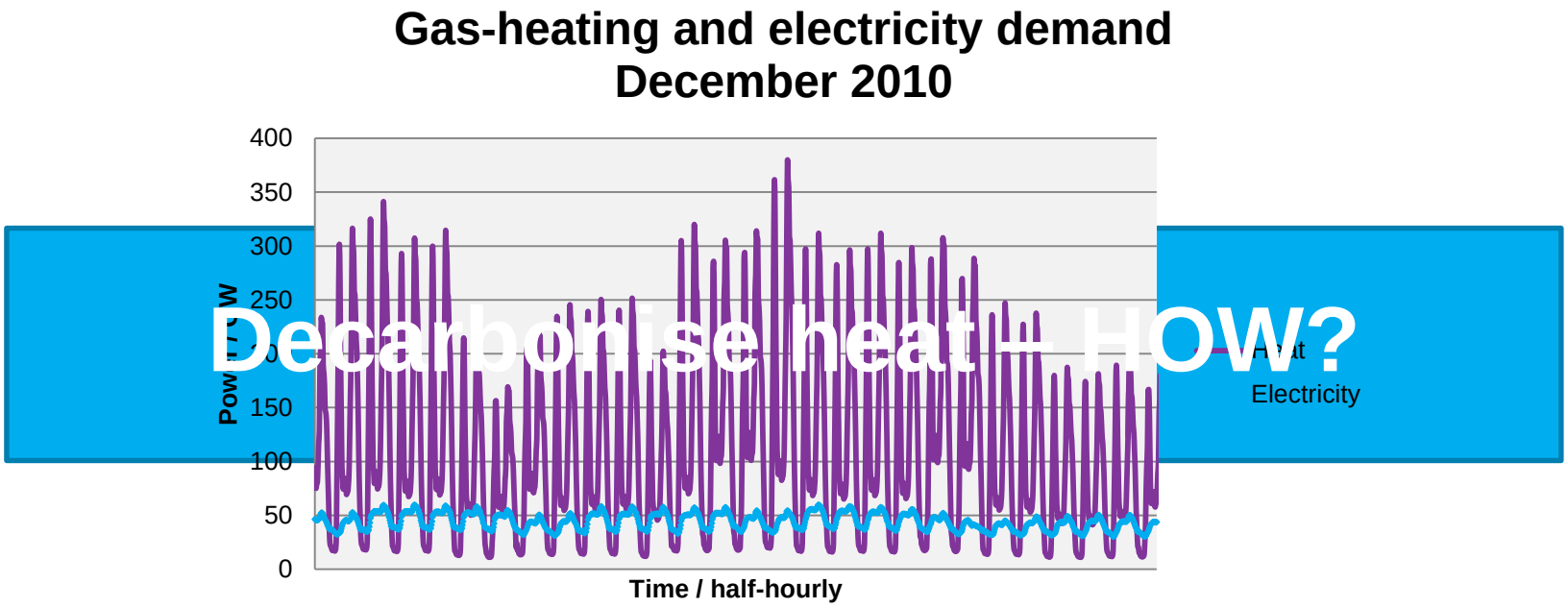
Heat – other considerations

- Seasonal & diurnal heat demand variation
- Energy system development
  - ‘Small’ number of power stations vs. ‘large’ number of boilers
- Consumer adoption



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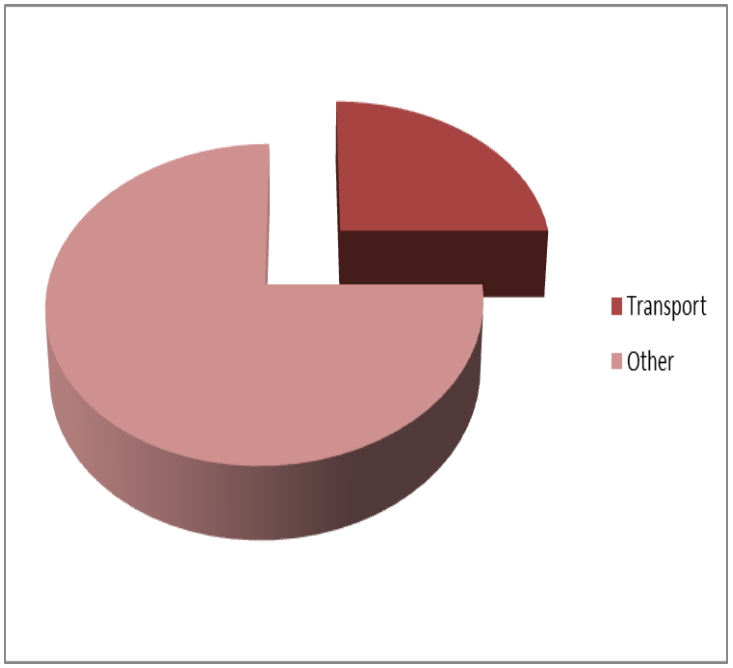
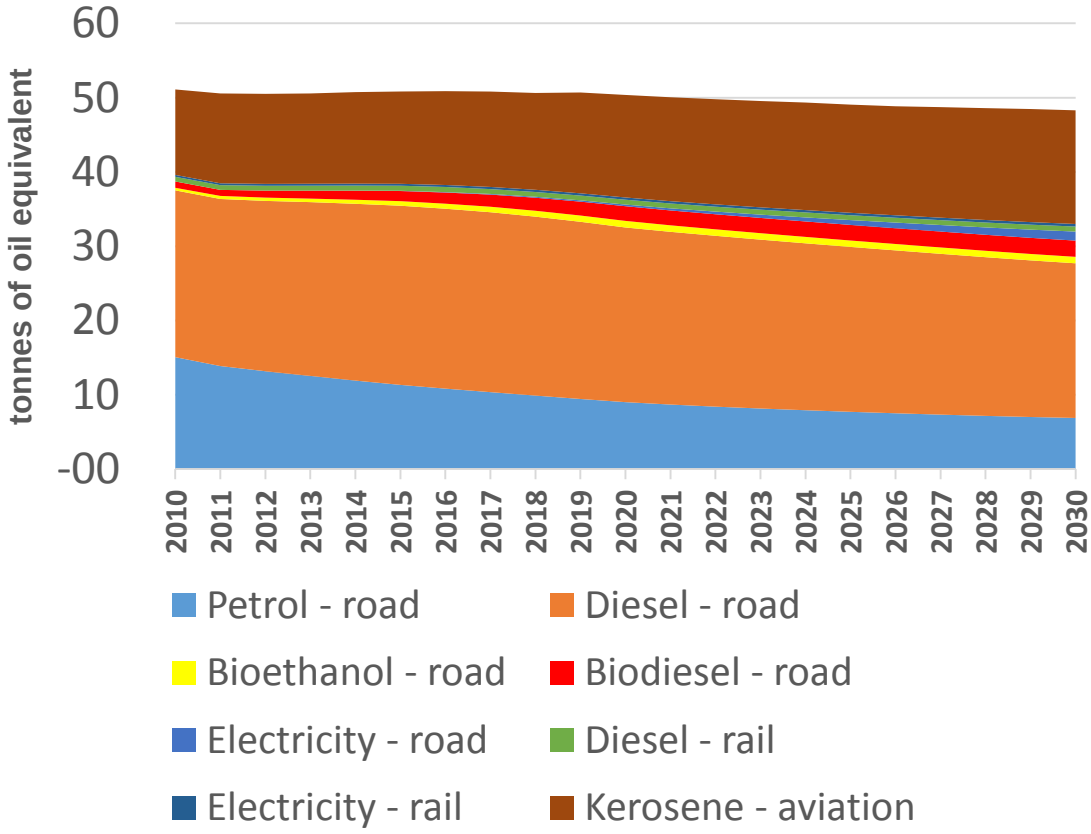
Transport



- Need low emission vehicles
- **Aim** – every car/van low emission by 2050

Projected transport energy consumption by fuel - high abatement scenario (carbon plan 2011)



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Transport – options?

Challenges:

EVs

- improving battery energy density
- reducing cost

FCEV

- H2 fuelling infrastructure
- reducing vehicle cost

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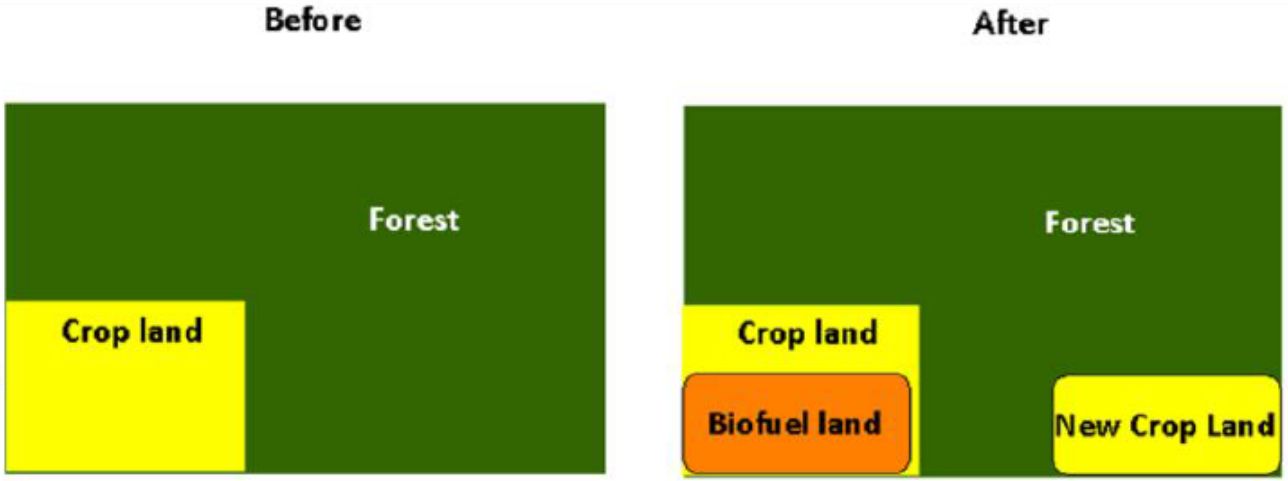
Transport

- We currently assume 8% biofuels for our carbon plan
- But biofuels can have some significant problems…

Indirect land use change (ILUC)



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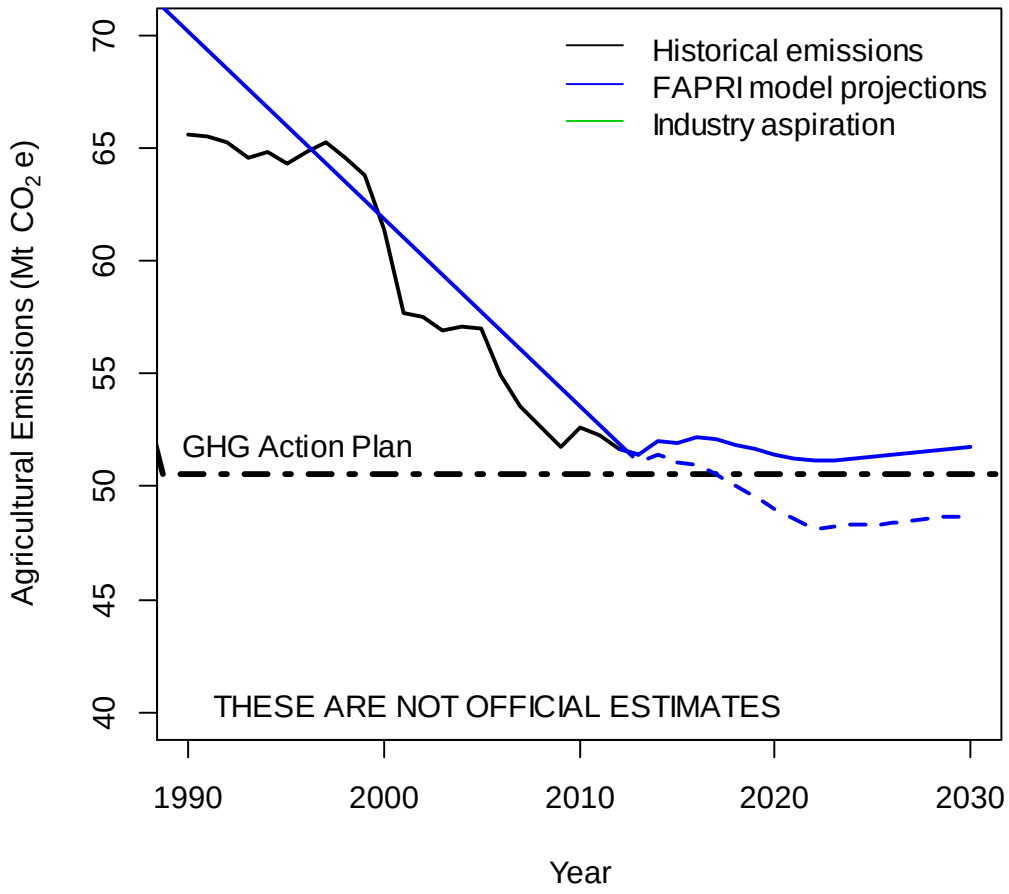
Agriculture – Forward look to 2030



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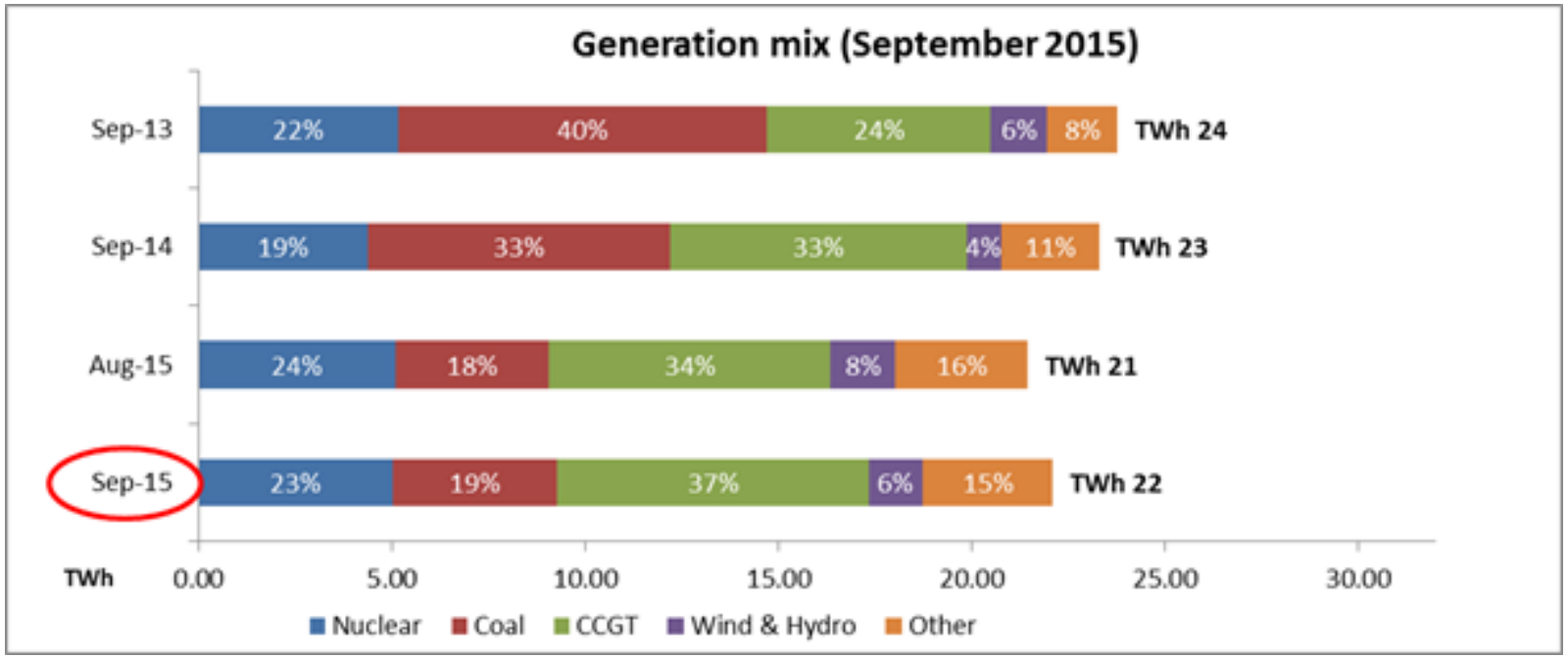
Power



Source: Elexon

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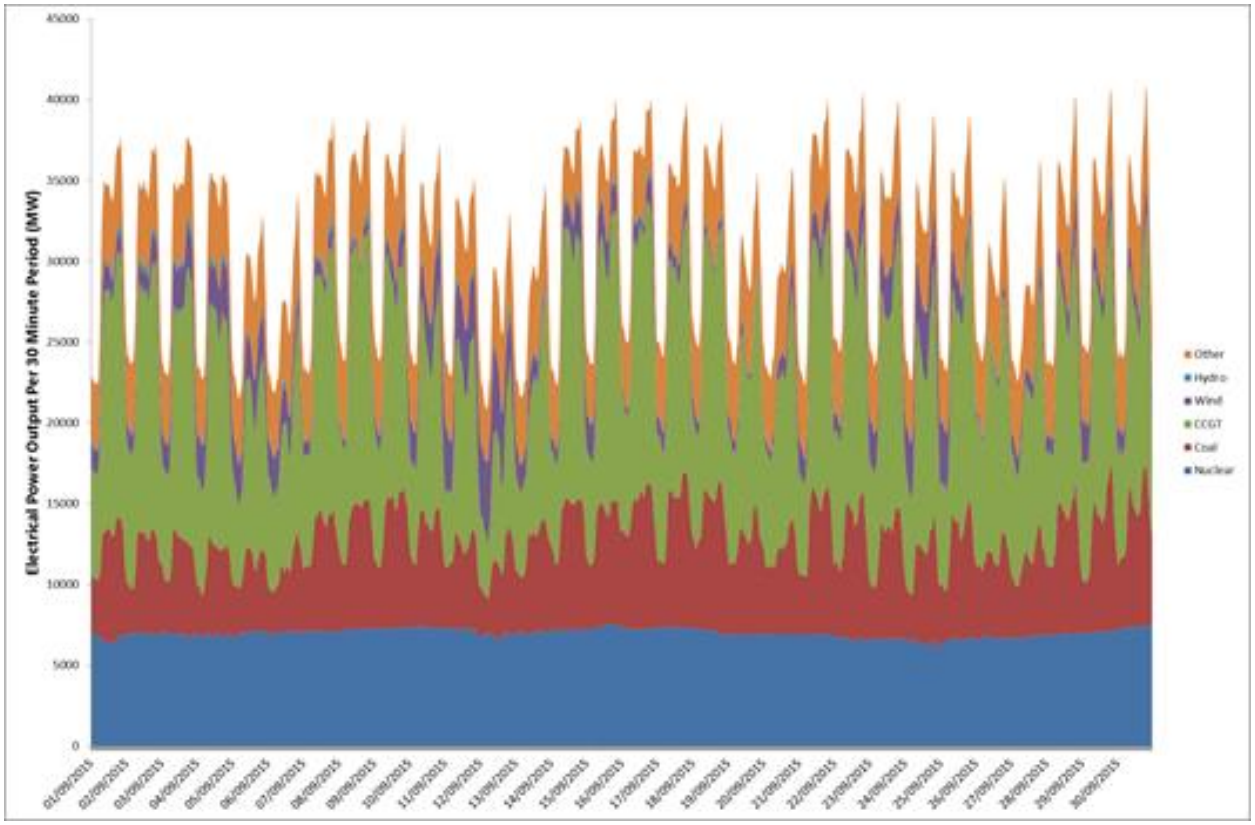
Power



Key:

Orange – Other

Light Blue – Hydro

Purple – Wind

Green – CCGT

Red – Coal

Dark Blue - Nuclear

Electrical Power Output Per 30 Minute Period (MW) September 2015

Source: Elexon

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Power

- Novel approaches need support through FITS, CfD – cost to consumers

- Push EU for EU ETS reforms for stronger, long-term price signals to drive investment

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Electricity Market Reform

- Two main mechanisms:
- **Contracts for Difference**
  - generator party is paid the difference between the ‘strike price’ and the ‘reference price’
- **Capacity Market**
  - providing payment for reliable sources of capacity, alongside their electricity revenues, to ensure they deliver energy when needed

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Energy technology deployment

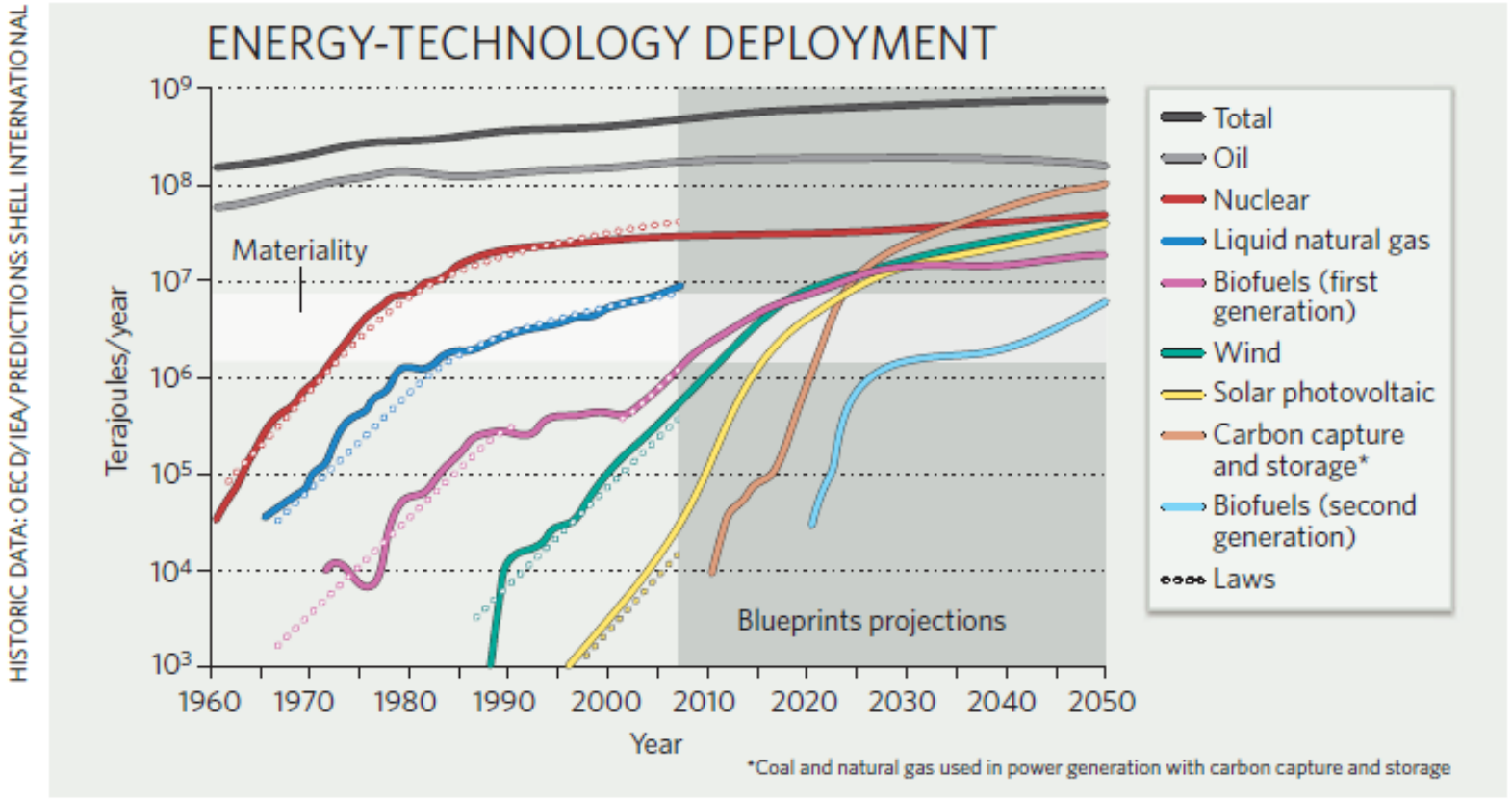

Figure 1 | Global production of primary energy sources. When a technology produces 1,000 terajoules a year (equivalent to 500 barrels of oil a day), the technology is 'available'. It can take 30 years to reach materiality (1% of world energy mix). Projections after 2007 taken from Shell's Blueprints scenario[3].

Krammer, G.J. & Haigh, M., Nature **462**, 568-569 (December 2009)

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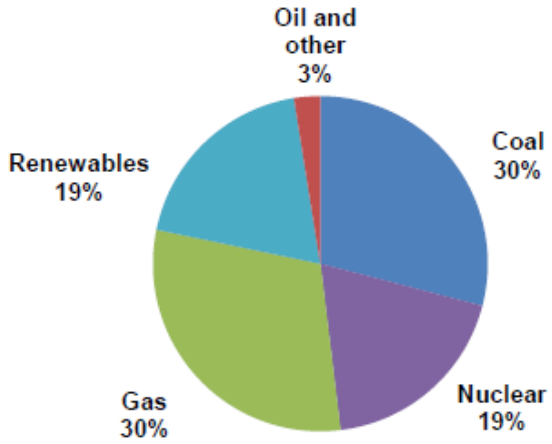
Sources

Gas and coal key generation fuels in 2014; significant growth in renewables



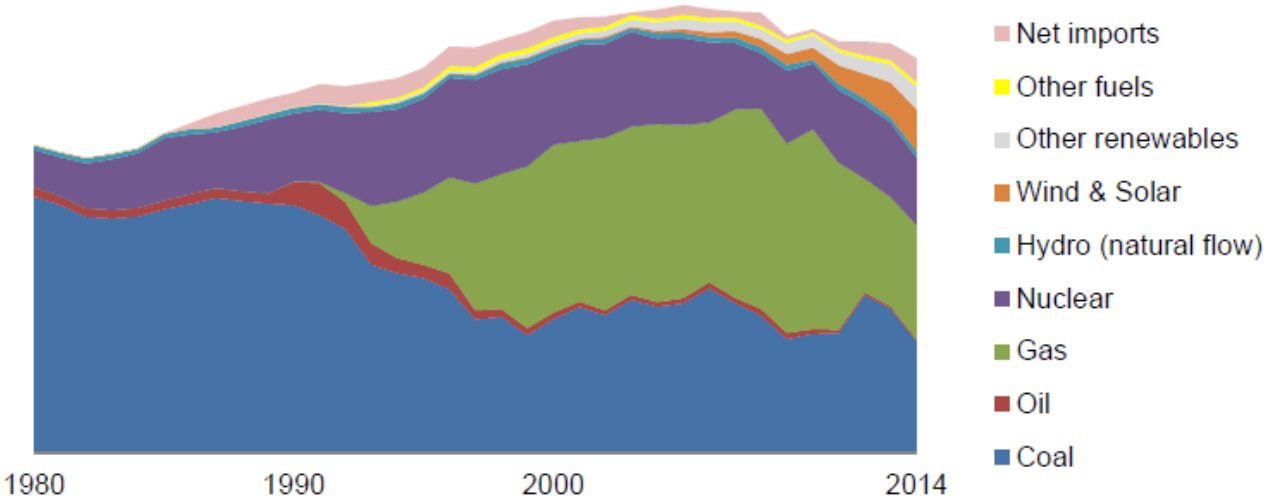
Renewables ↑ +21% on last year (share up 4.2 percentage points)

Gas ↑ +5.1% (3.0 pp)

Coal ↓ -23% (-6.7 pp)

Nuclear ↓ -9.7% (-0.8 pp)

Generation down 6% in 2014; final consumption lowest since 1995



Source: DECC, DUKES 2015

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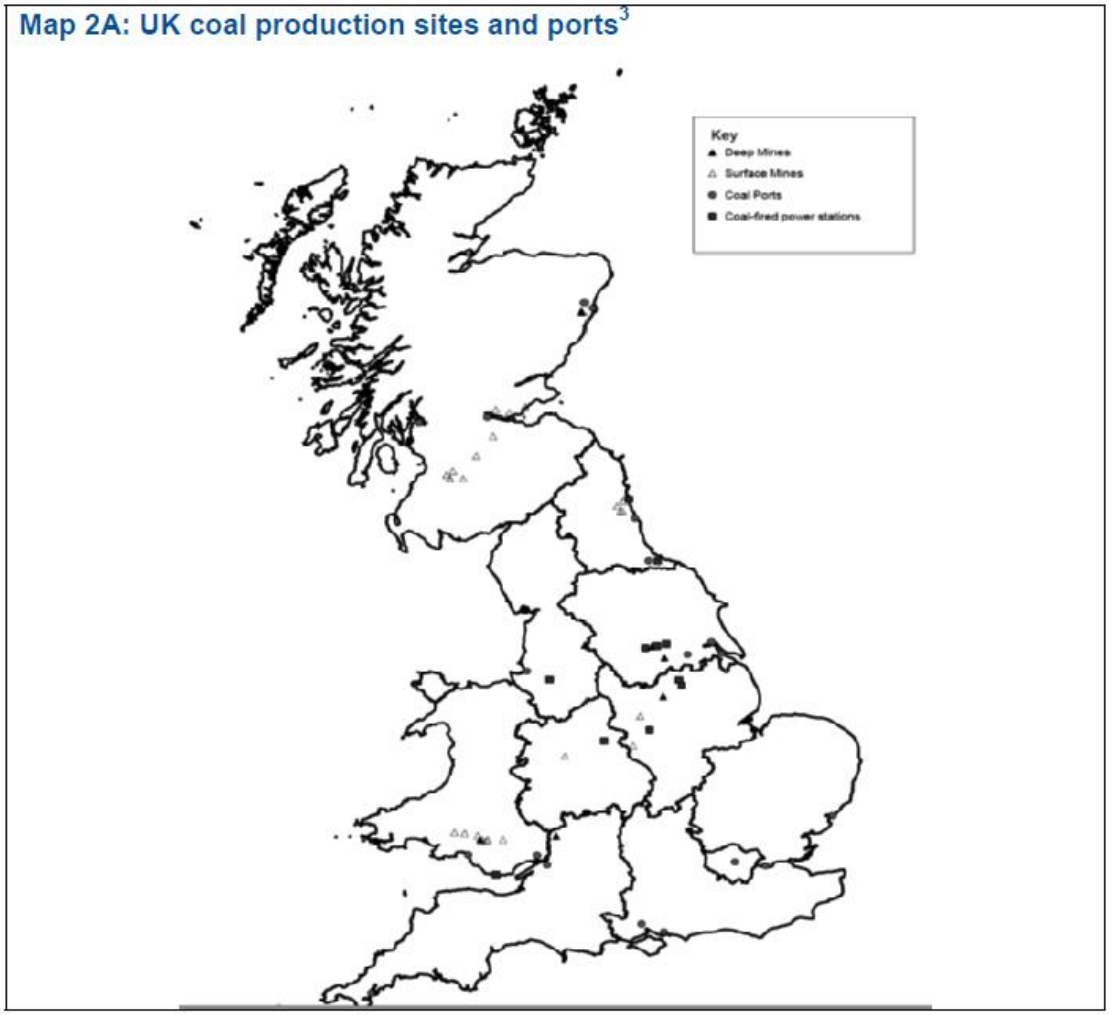
Coal: closure of unabated coal power by 2025?



Source: DECC, DUKES 2015

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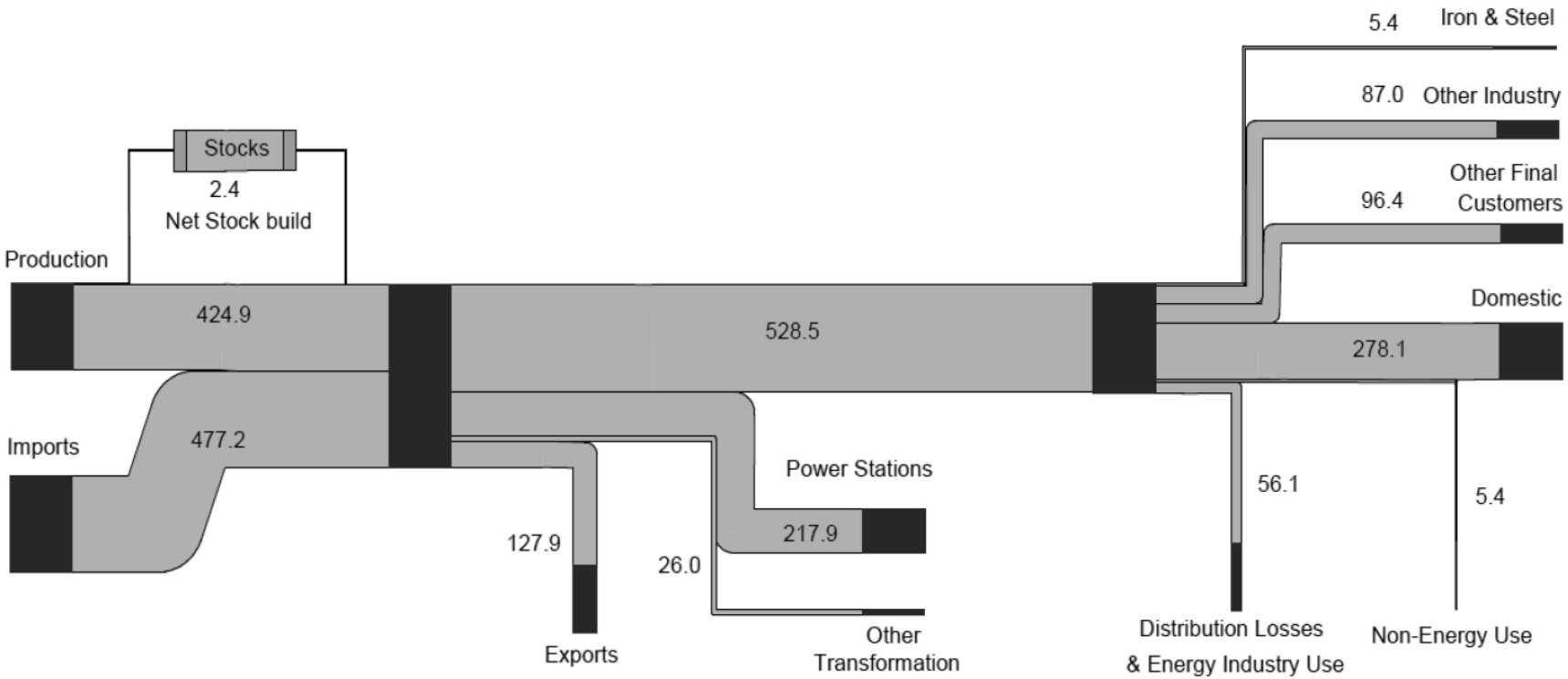
Gas

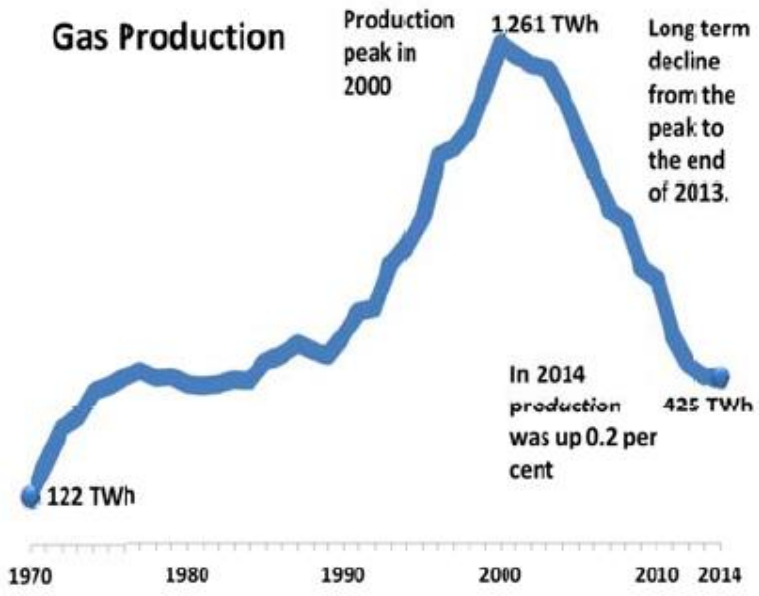
Natural gas flow chart 2014 (TWh)

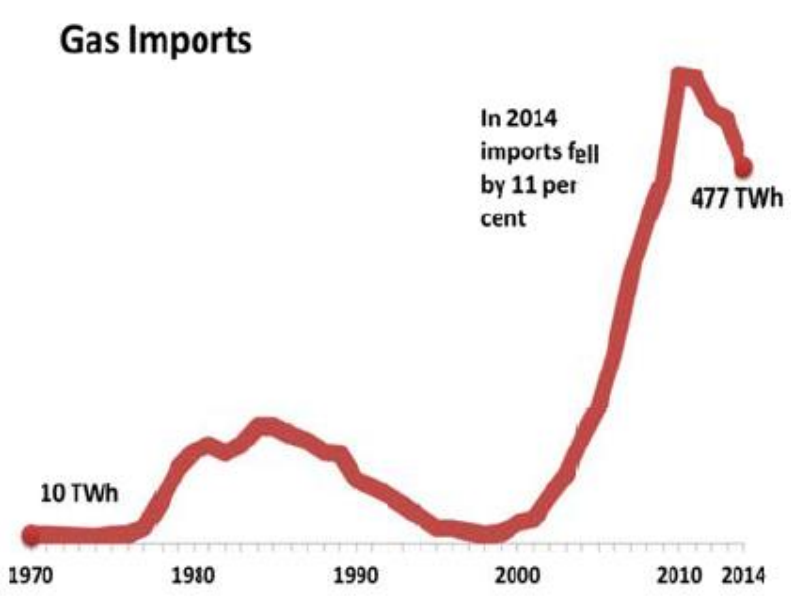


Notes:
This flow chart is based on the data that appear in Table 4.1, excluding colliery methane.

Source: DECC, DUKES 2015

DUKES Natural Gas 2014





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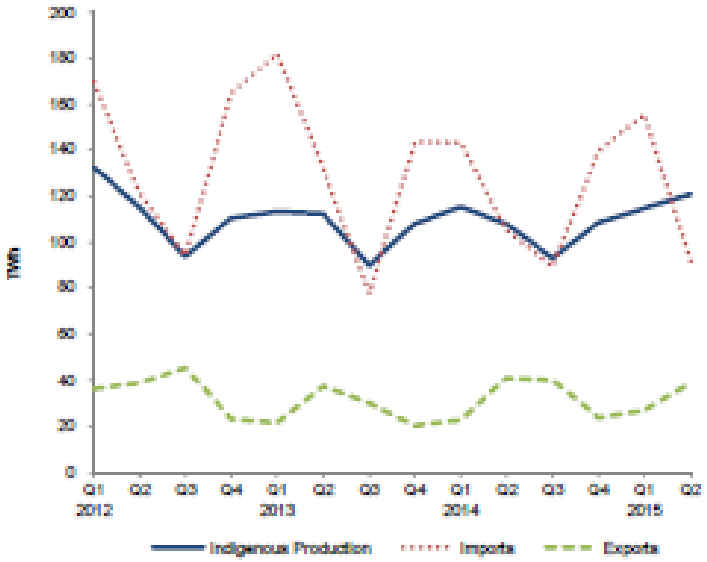
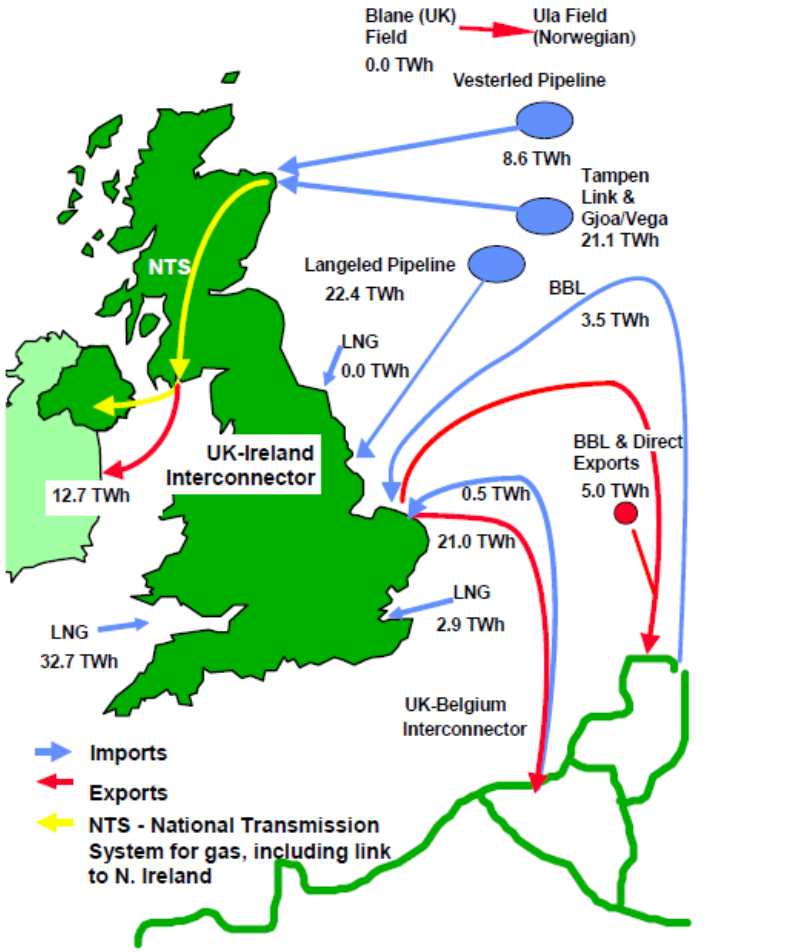
Gas

Chart 4.1 Production and imports and exports of natural gas



Gas

Map: UK imports and exports of gas Q2 2015[1]



1. Please note that imports and exports in this map uses nominated flows through the UK-Belgium Interconnector and BBL pipeline as in table 4.1. The figures here will differ from those in ET Table 4.3 which uses actual physical flows through the Interconnector.

Source: DECC, Energy Trends September 2015

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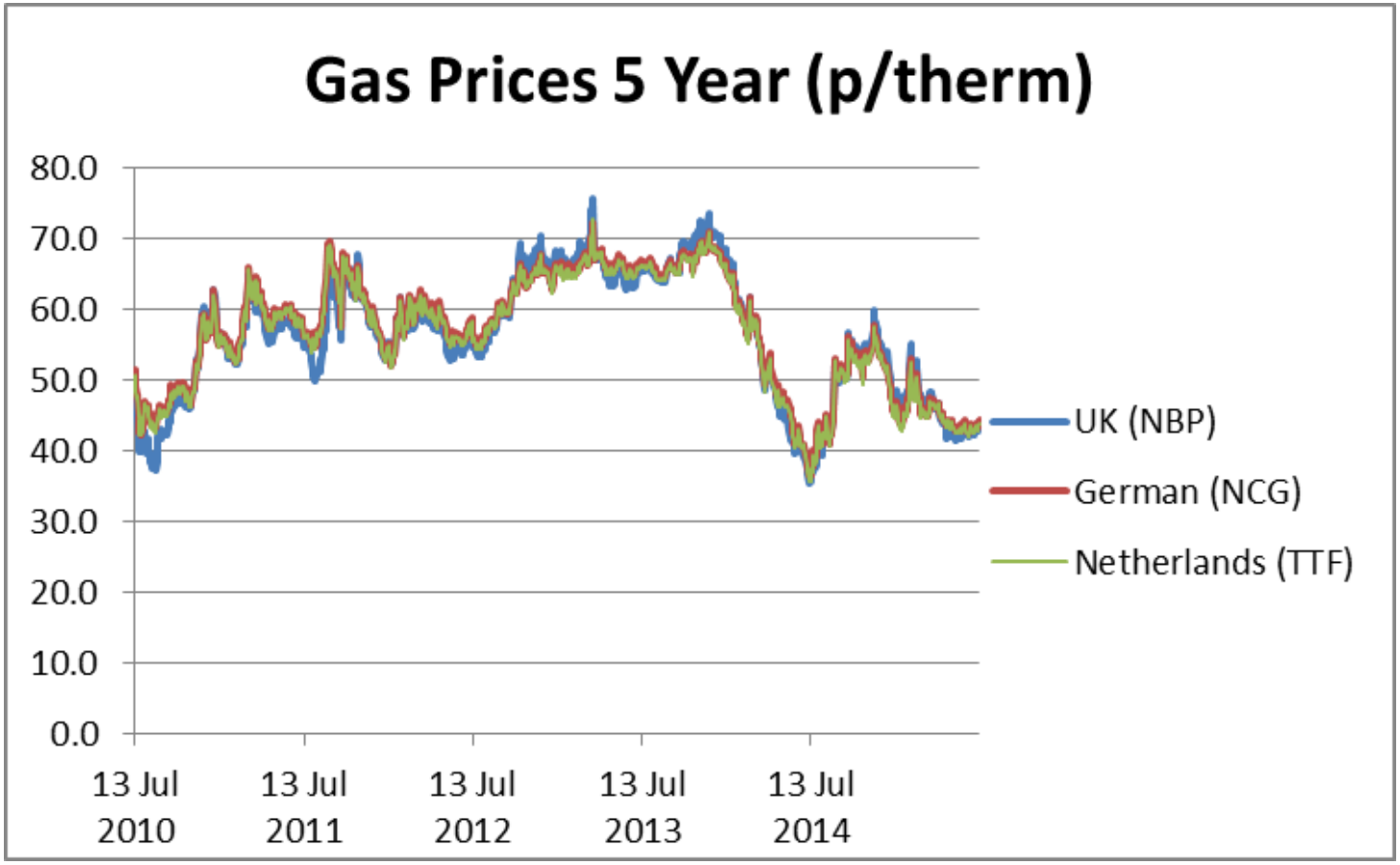
Historical trends in gas prices



Source: Argus Media

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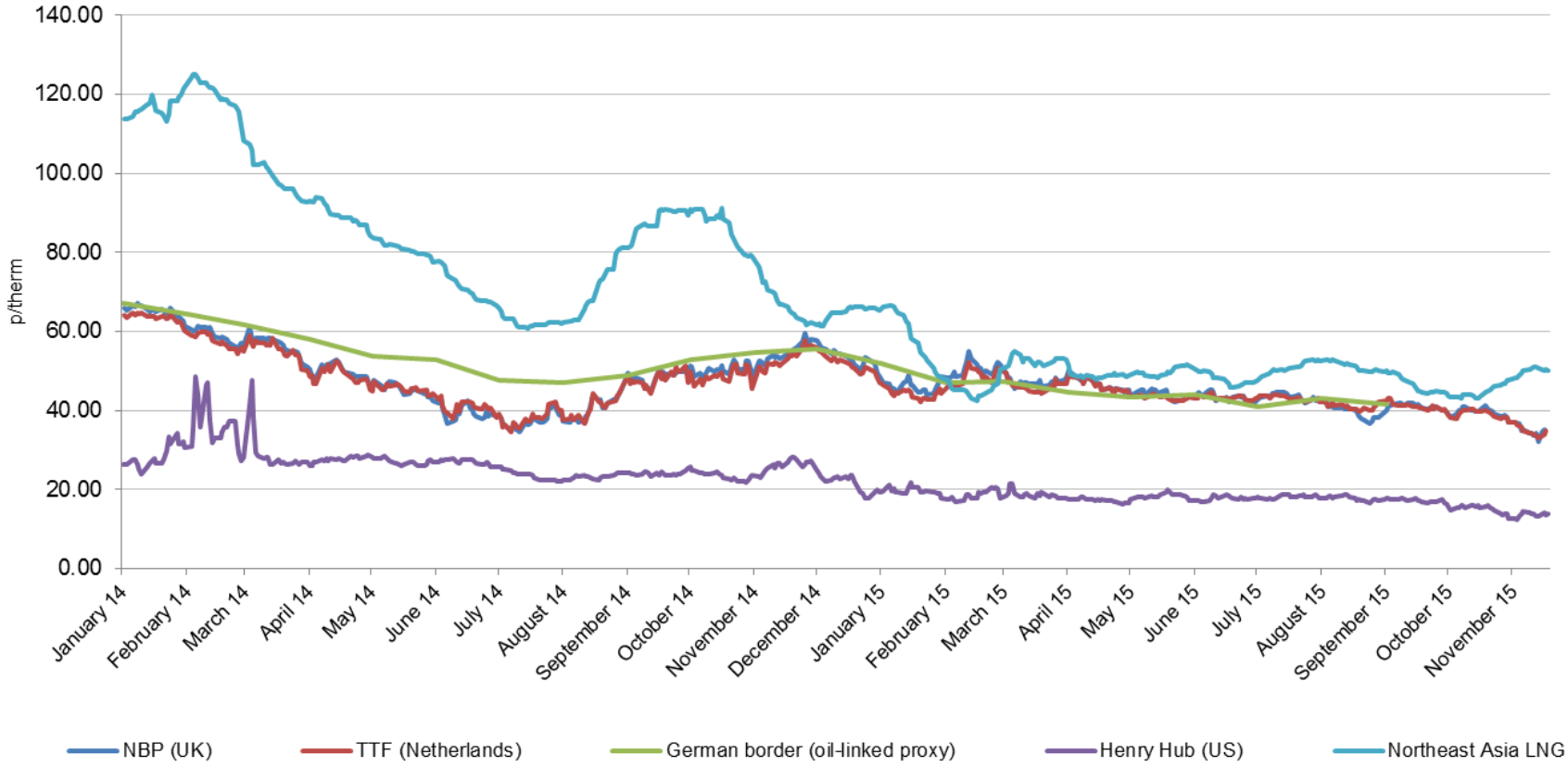
Economic value



Spot price	Source
UK NBP	Argus
TTF	Argus
German Border	Bafa
Henry Hub	Bloomberg
NE Asia LNG	Argus

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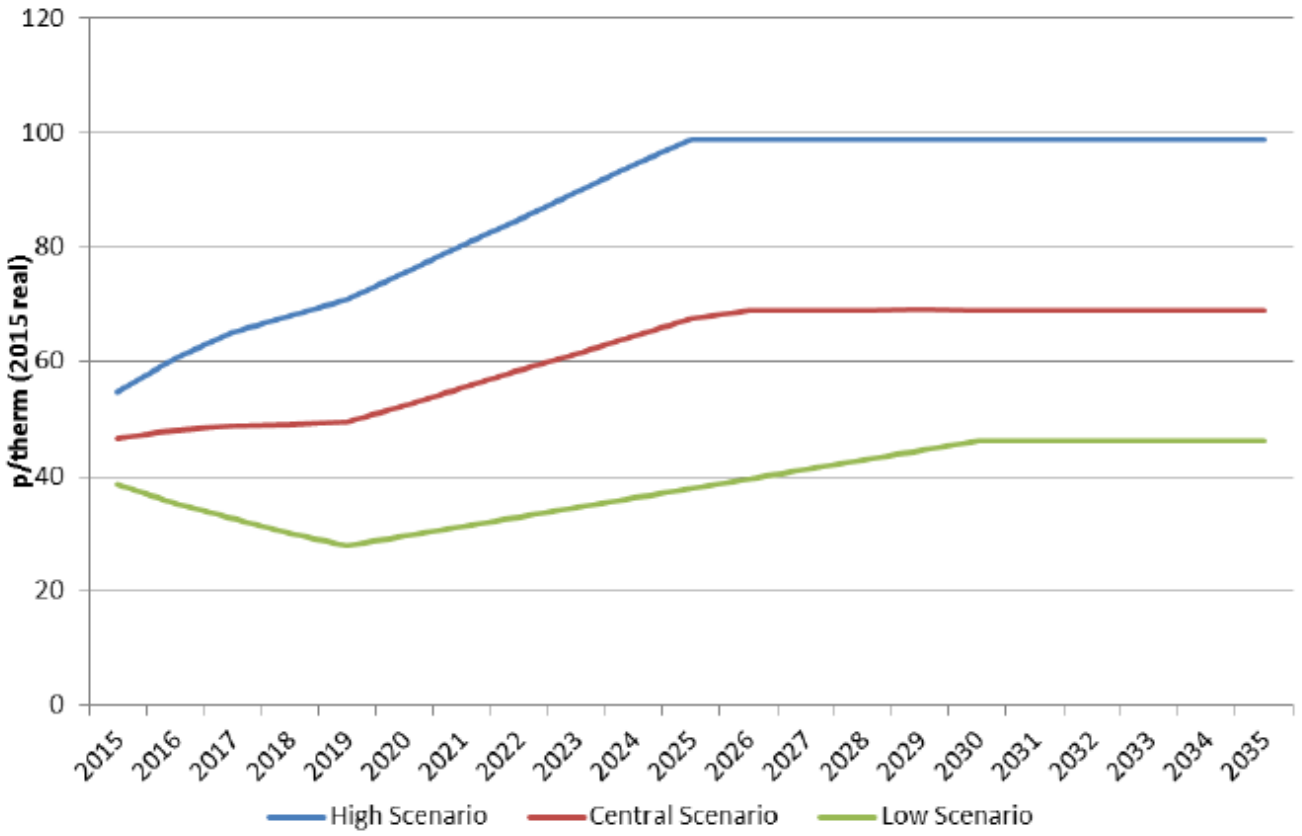
Natural gas price projections

Figure 1: DECC 2015 natural gas price projections



Source: DECC 2015 Fossil Fuel Price Assumptions

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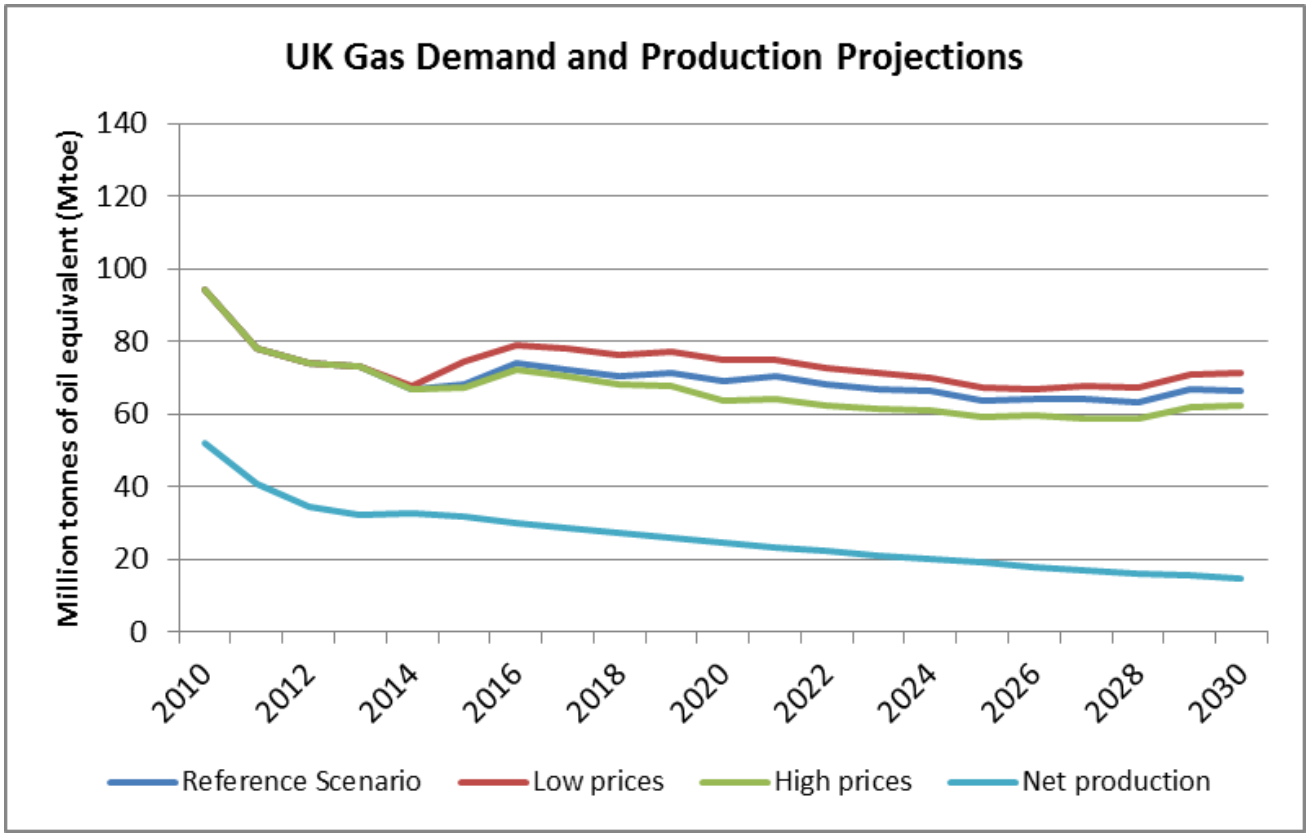
Economic value



Sources: Demand projections - https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2014#history
Production projections - https://www.gov.uk/guidance/oil-and-gas-uk-field-data

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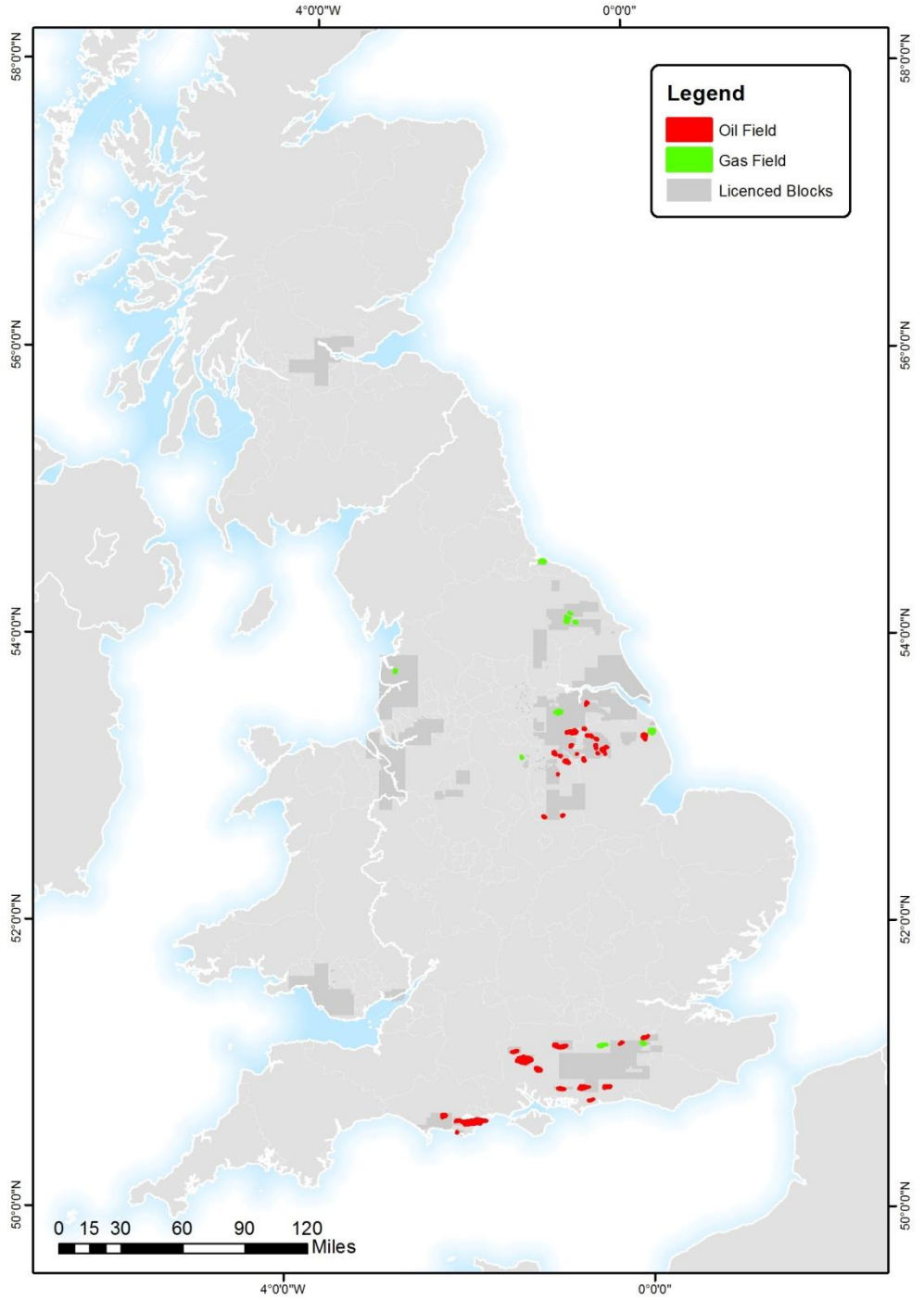
Current UK onshore oil and gas fields (prior to any 14th Licensing Round awards)

2189 onshore wells drilled up to 2014

378 wells active in 2014 *(not all actively producing but can be brought online at short notice)*



Source: Oil & Gas Authority

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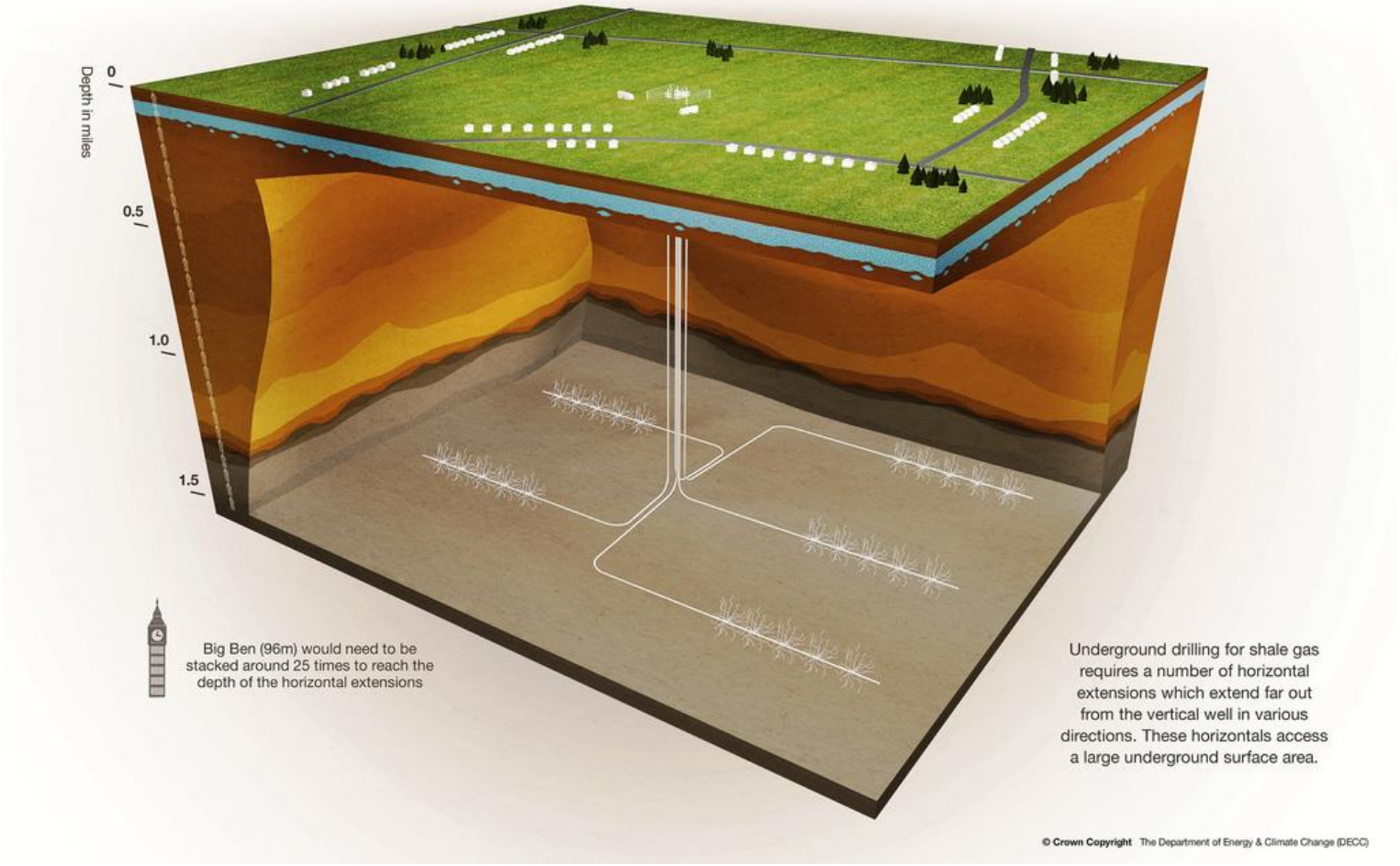
Hydraulic Fracturing

What might underground drilling for **shale gas** look like?



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Hydraulic Fracturing

IGAS Coal Bed Methane site - Warrington

Drilling stage

Production stage

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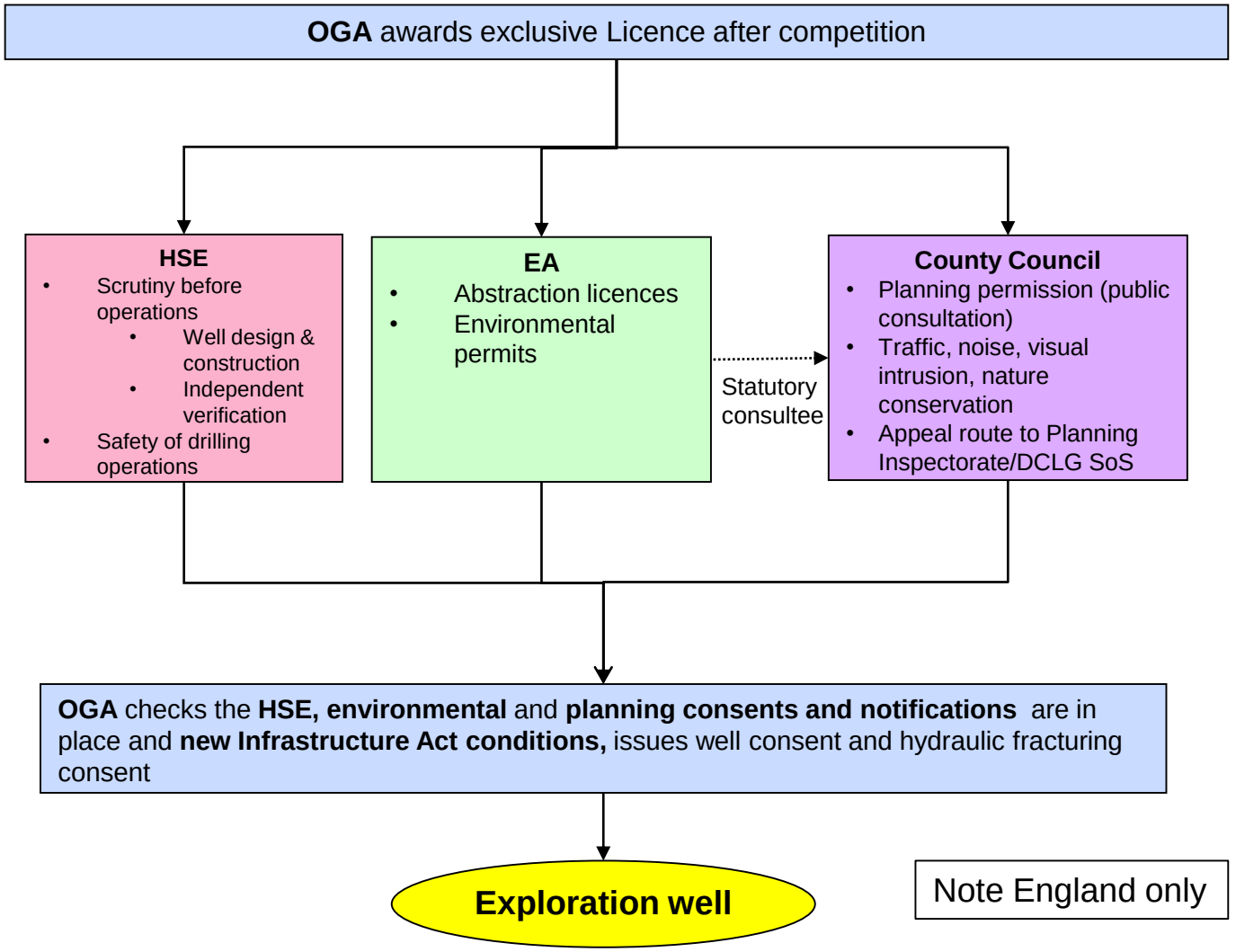
Regulatory regime



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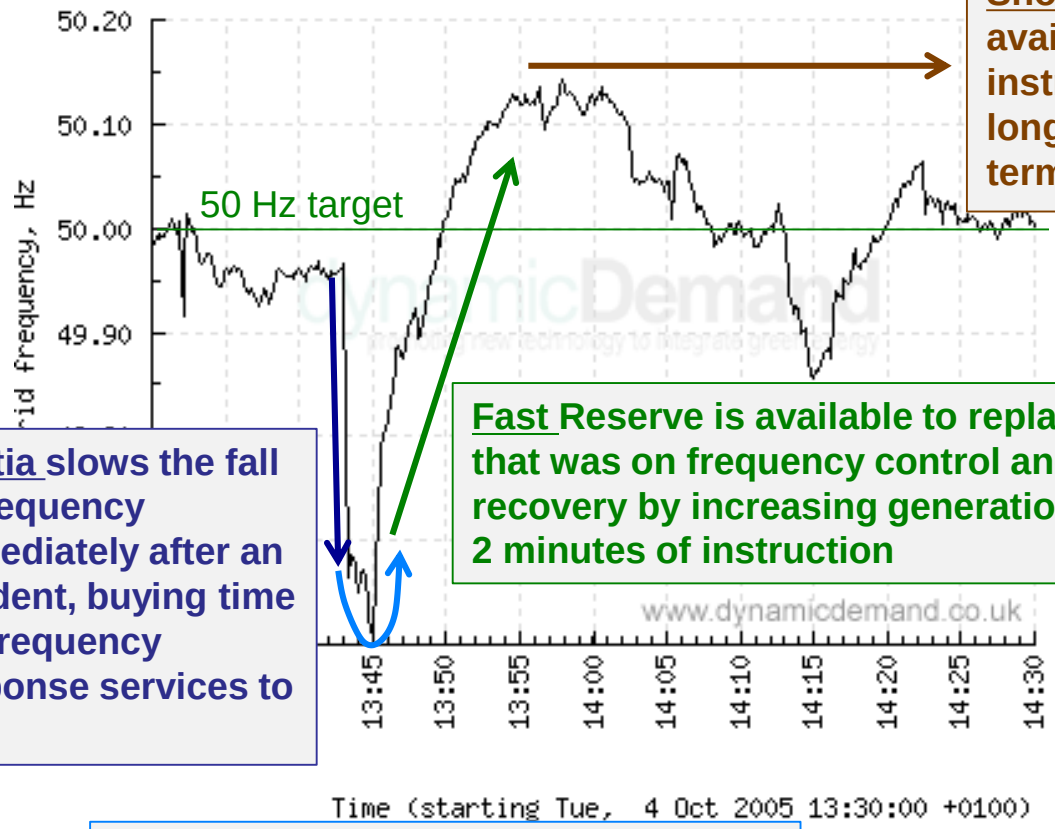
Systems, not technologies!

Essential Grid Services



Short Term Operating Reserve (STOR) is available within 5-20 minutes of instruction, although some can be as long as 4 hours. This provides a longer term replacement for the lost generation

Inertia slows the fall in frequency immediately after an incident, buying time for frequency response services to act

Fast Reserve is available to replace plant that was on frequency control and aid recovery by increasing generation within 2 minutes of instruction

Generator loss incident
1000MW is lost at 13:43. Frequency drops to 49.6 Hz before recovery begins. Statutory limit is 49.5 Hz.

There are 22 ancillary services NG buy, but these four are key for energy balancing + the need for firm capacity > peak demand*

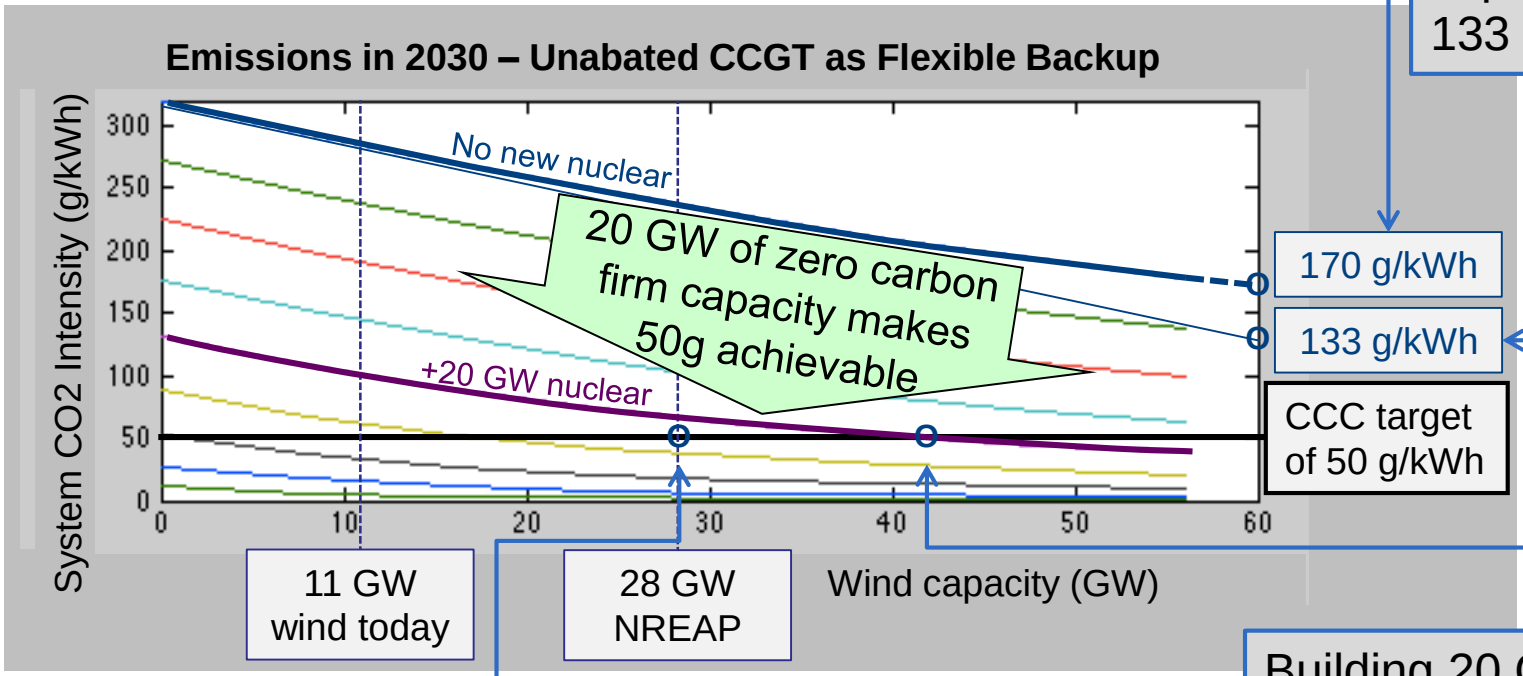
Frequency response automatically increases generation or decreases demand to begin recovery. Acts in 10-30s window (primary) or 30s-30m window (secondary)

* Others include: voltage control; MaxGen, warming and fast start contracts for fossil; intertrips; transmission constraint agreements; SO to SO (interconnector) services; black start.

The need for firm capacity

With no new nuclear (or any other zero carbon firm capacity), the best that 60 GW of onshore wind can achieve is about 170 g/kWh

Infinite storage or demand side response could improve that to 133 g/kWh



If wind build didn't exceed the National Renewable Energy Action Plant then 23 GW of nuclear would achieve 50 g/kWh

Building 20 GW of nuclear means 50 g/kWh can be achieved with 42 GW of onshore wind

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Final thoughts…

United Nations Framework Convention on Climate Change

- So far, so good!
- Challenges becoming **greater**
- Future milestones:
  - COP 21 (December 2015)
  - CCC Advice on 5th Carbon Budget (end 2015)
  - Set 5th Carbon Budget (June 2016)
  - New emissions reduction plan (after 5th CB)
- Limits to what can be done with today's technologies
- Innovation essential in:
  - Technology
  - Business models
  - Markets

Committee on Climate Change

Source: http://www.telegesis.com/our-markets/home-automation/

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Thank you

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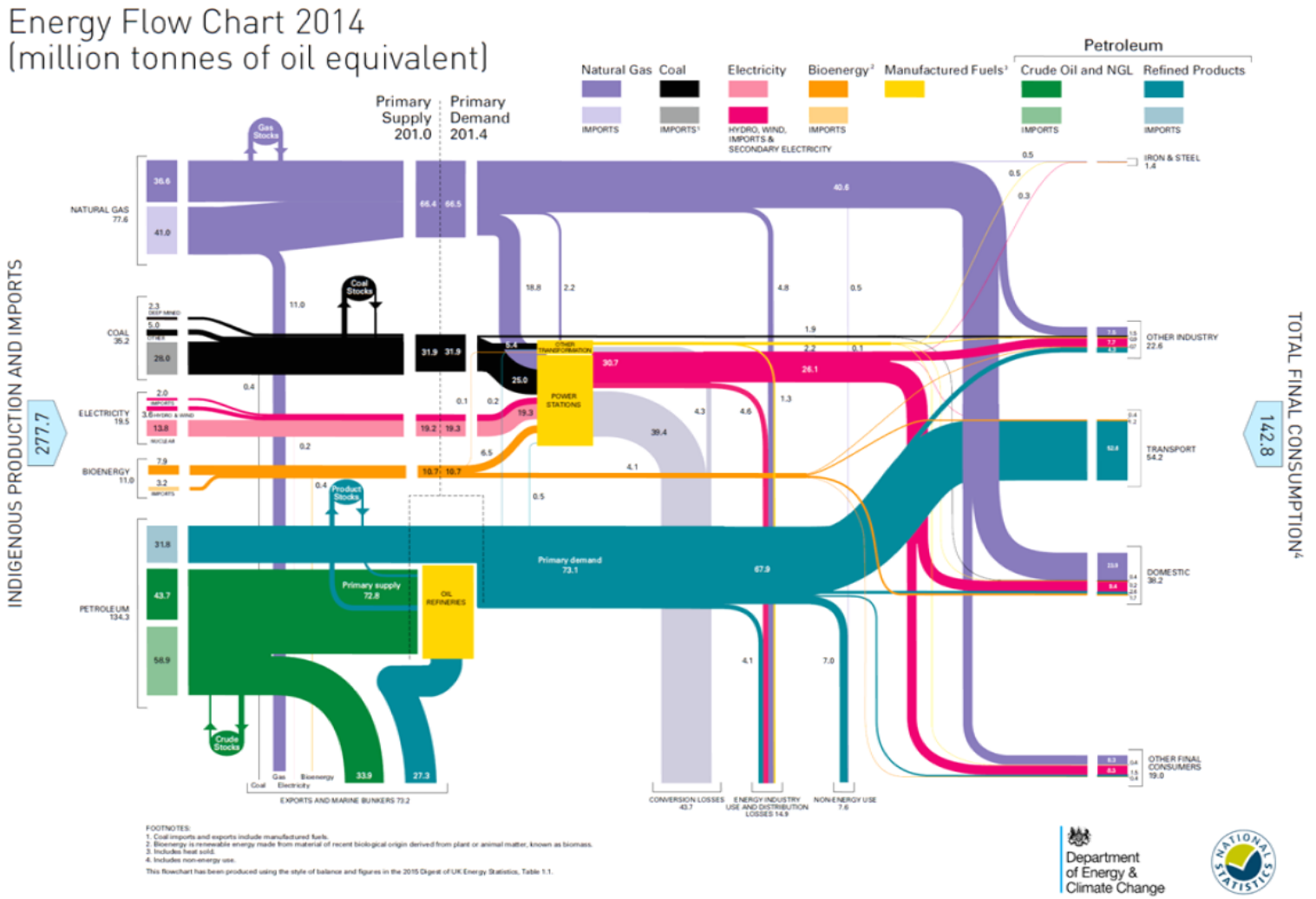
Picture of today's energy system



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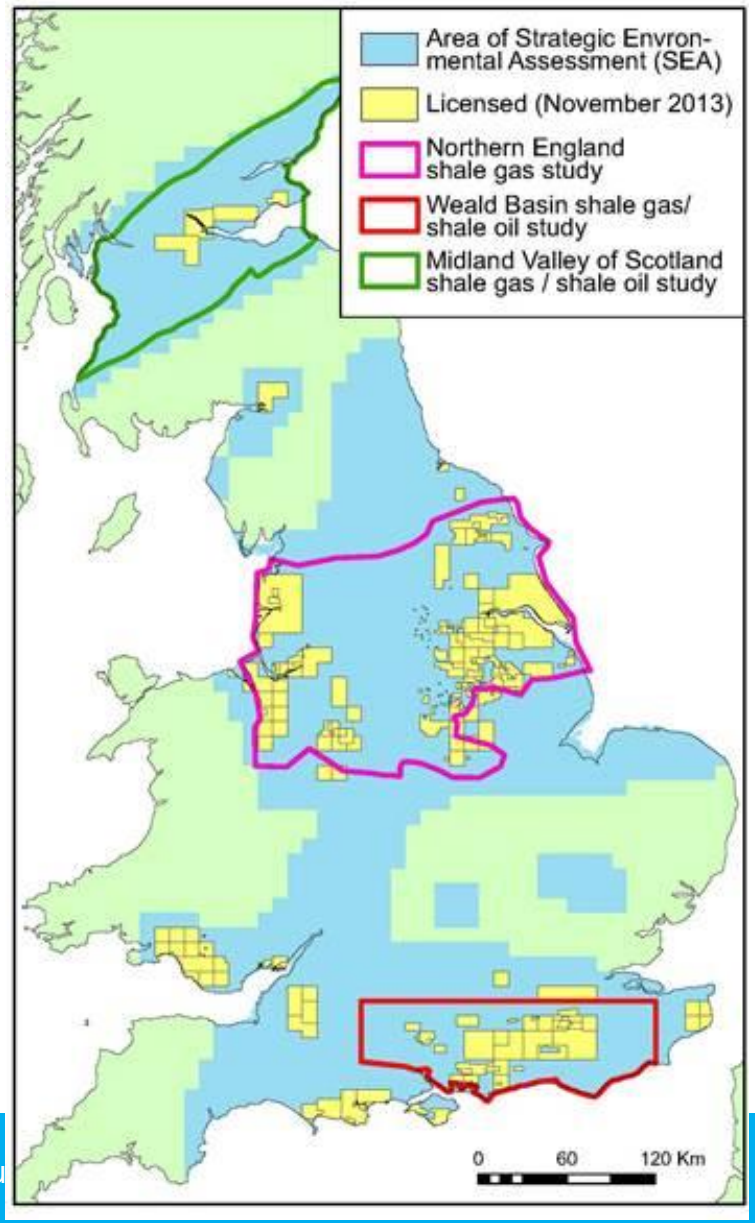
Shale: Where is it in the UK?



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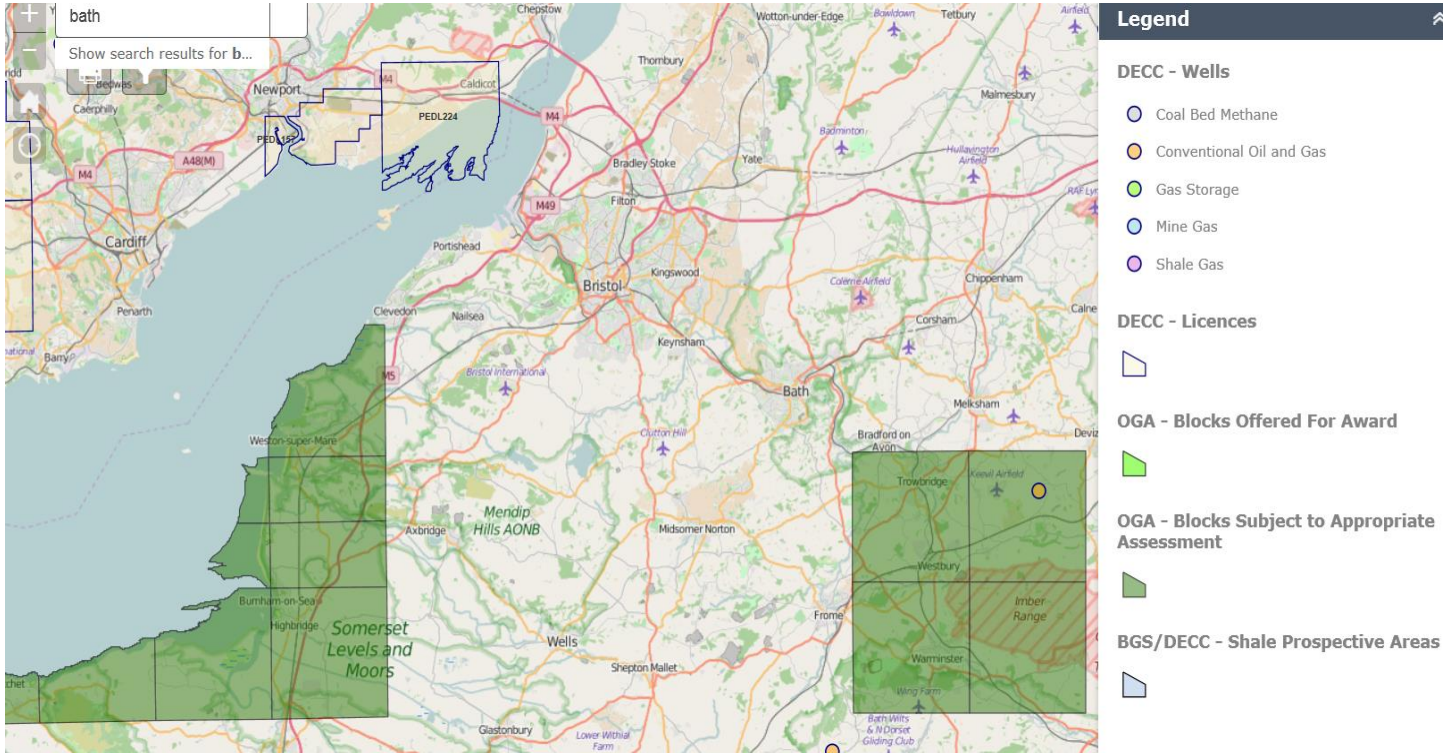
Bath & Somerset

- No active wells
- Handful of licence blocks being considered in region (subject to Habitat Regulation Assessments)



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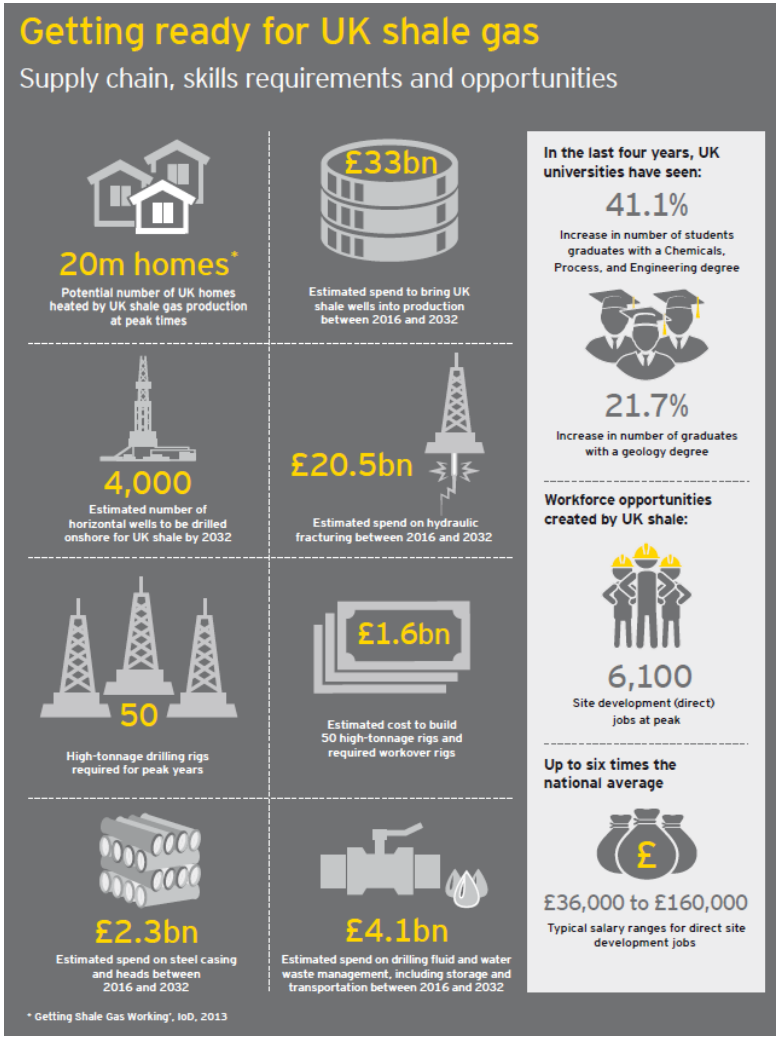
Shale gas – potential benefits?



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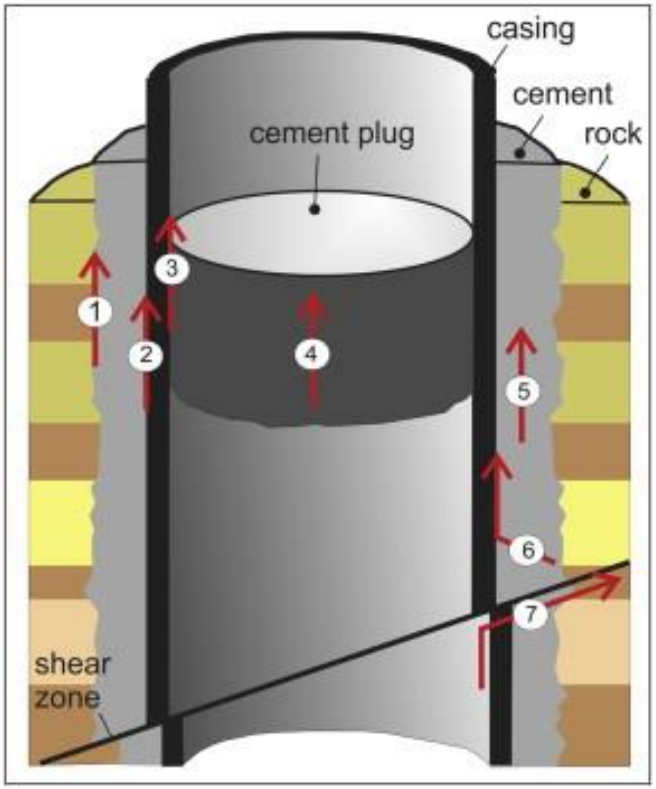

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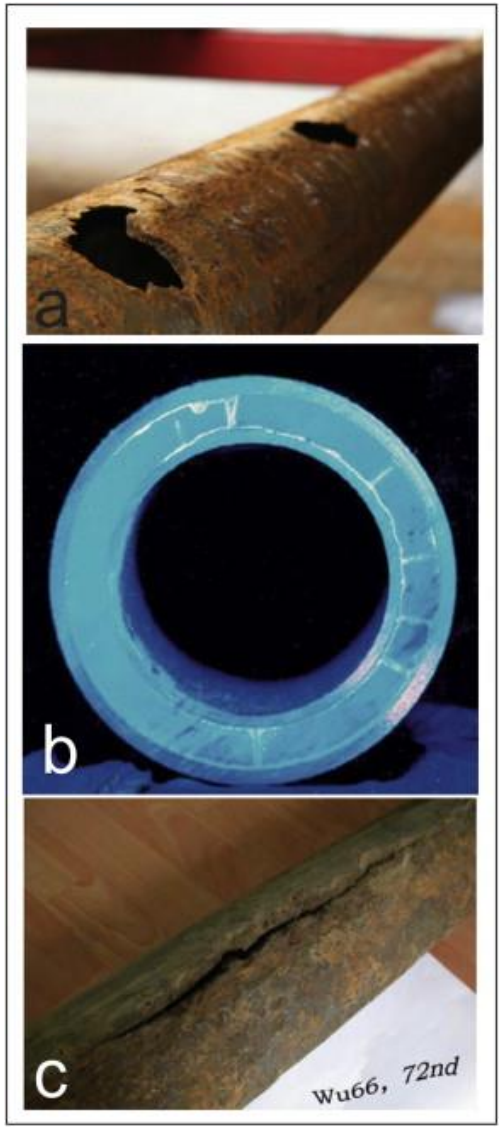

Davies R.J., et al., Oil and gas wells and their integrity: Implications for shale and unconventional resource exploration, Marine and Petroleum Geology (2014), http://dx.doi.org/10.1016/j.marpetgeo.2014.03.001

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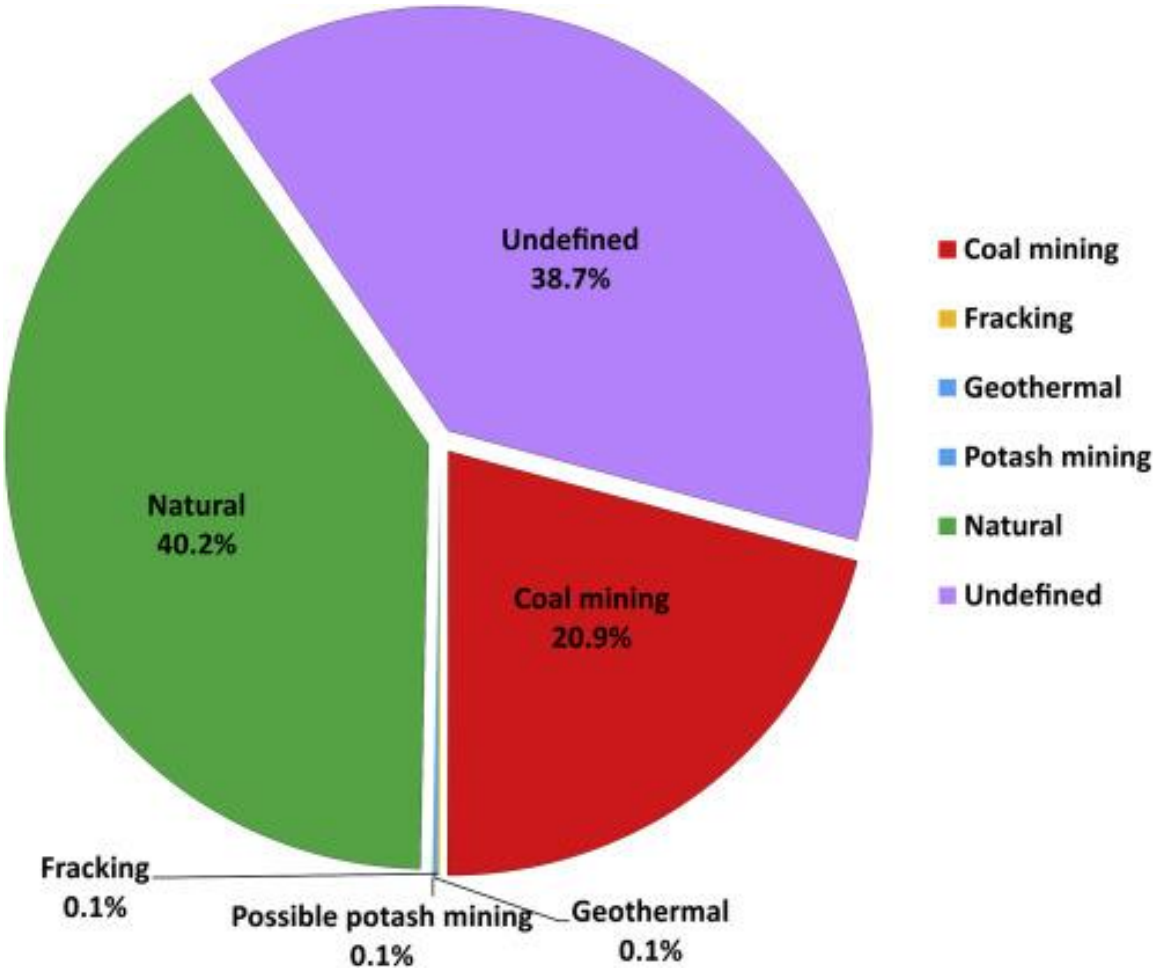
Seismic activity 1970–2012



Source: Miles P. Wilson, Richard J. Davies, Gillian R. Foulger, Bruce R. Julian, Peter Styles, Jon G. Gluyas, Sam Almond, **Anthropogenic earthquakes in the UK: A national baseline prior to shale exploitation,** Marine and Petroleum Geology, 2015, Available online 22 August 2015 http://dx.doi.org/10.1016/j.marpetgeo.2015.08.023

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Seismic activity