



UNITED KINGDOM  
RENEWABLE ELECTRICITY 2002–2017

John Constable

*For The Canon Institute for Global Studies*  
2017

# About REF

- UK Registered charity, operating since 2004
- Part-time employees only
- Analysts and experts give their time at no cost
- Private donations only; no corporate support
- Publishes data and information: [www.ref.org.uk](http://www.ref.org.uk)
- Monthly output data for the majority of UK renewable electricity capacity

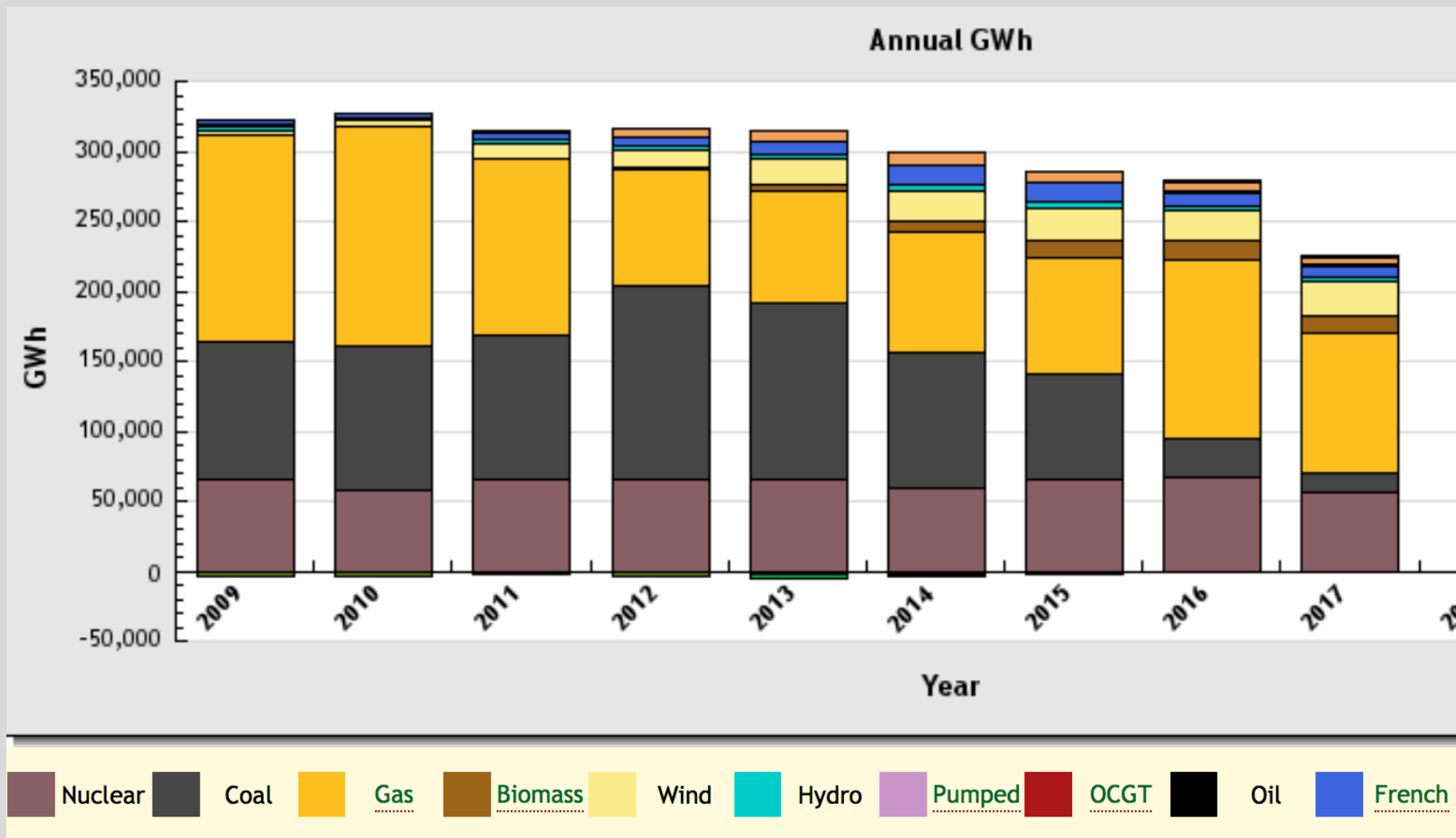
# UK Electricity Market History and Character

- 1945–1990: Nationalised industry
- 1990–2001: Privatisation/liberalisation phase
  - Central Electricity Generating Board broken up into
    - Vertically integrated utility companies
    - National Grid (network owner, Transmission System Operator)
    - Distribution Network Operators (DNO) which owned low voltage network
  - Major growth in use of Combined Cycle Gas Turbines (CCGT)
- 2001: Privatisation at its peak: Electricity Trading Arrangements (NETA) introduced *bilateral trading* in electrical energy (MWh)
- 2000: Royal Commission on Environmental Pollution (RCEP) report *The Changing Climate* (2000) caused emissions reduction policies to drive a return of state management and even *administrative pricing*.
  - 2002: Renewables Obligation (RO);
  - 2010: Feed-in Tariff (FiT)
  - 2015: FiTs with Contracts for Difference (FiTs CfDs)
- Autumn Budget 2017: Low Carbon Levies Frozen...

# The EU Renewables Directive and the UK

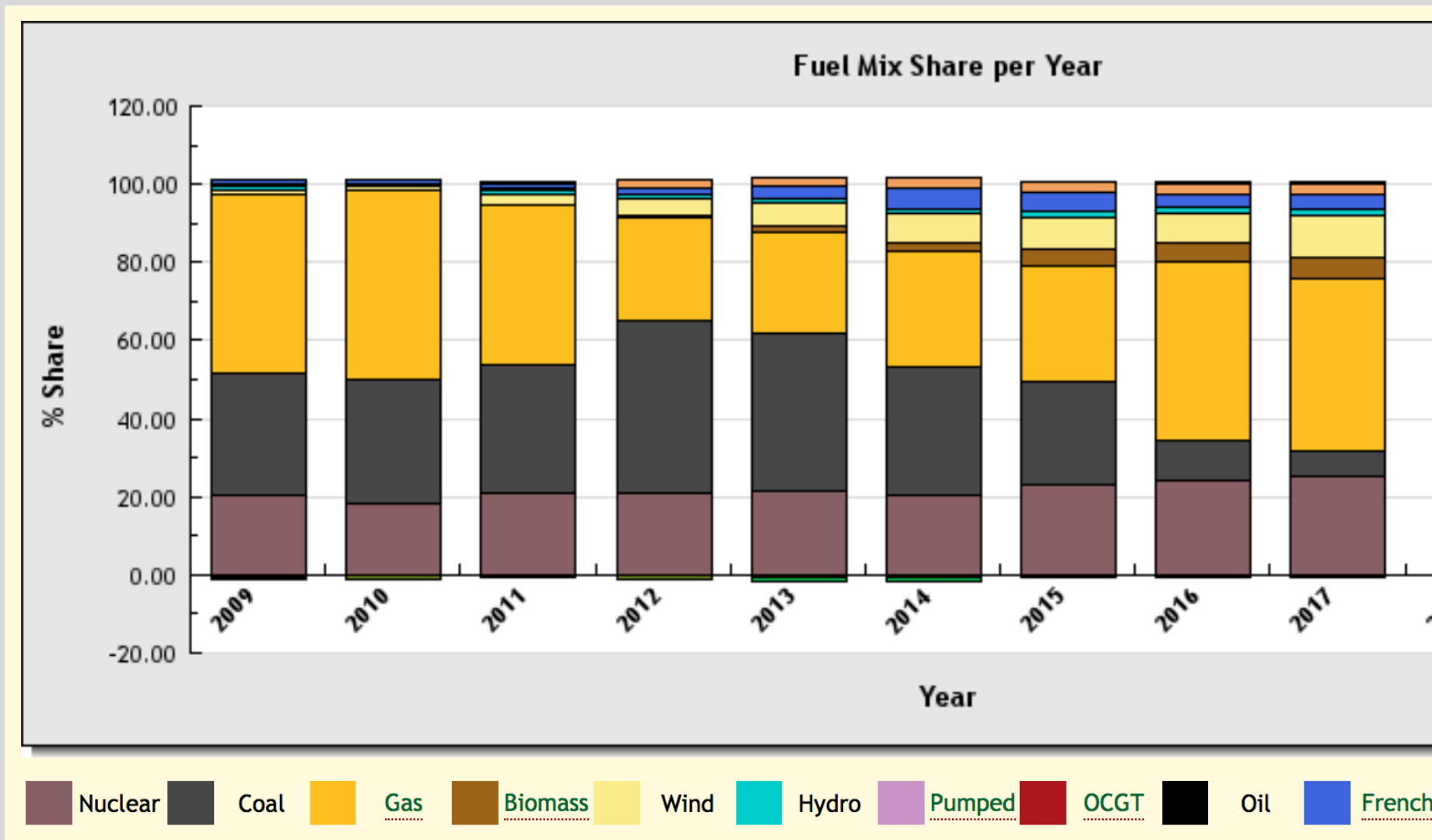
- EU Renewables Directive (2009): 20% of EU Final Energy Consumption (FEC) to be renewable by 2020
- UK burden share: 15% of FEC (up from 1.5% in 2009)
  - Target is a % of an unknown quantity
  - Approximately 230 – 270 TWh must be generated from renewable sources in 2020
- Approximate composition:
  - Transport fuel: 45 TWh (10% of UK transport fuel)
  - Electricity: 110 TWh (30% of UK electricity)
  - Heating and cooling: 70 TWh (12% of UK H&C)

# UK Electricity Fuel Mix 2009 to 2017 (GWh)



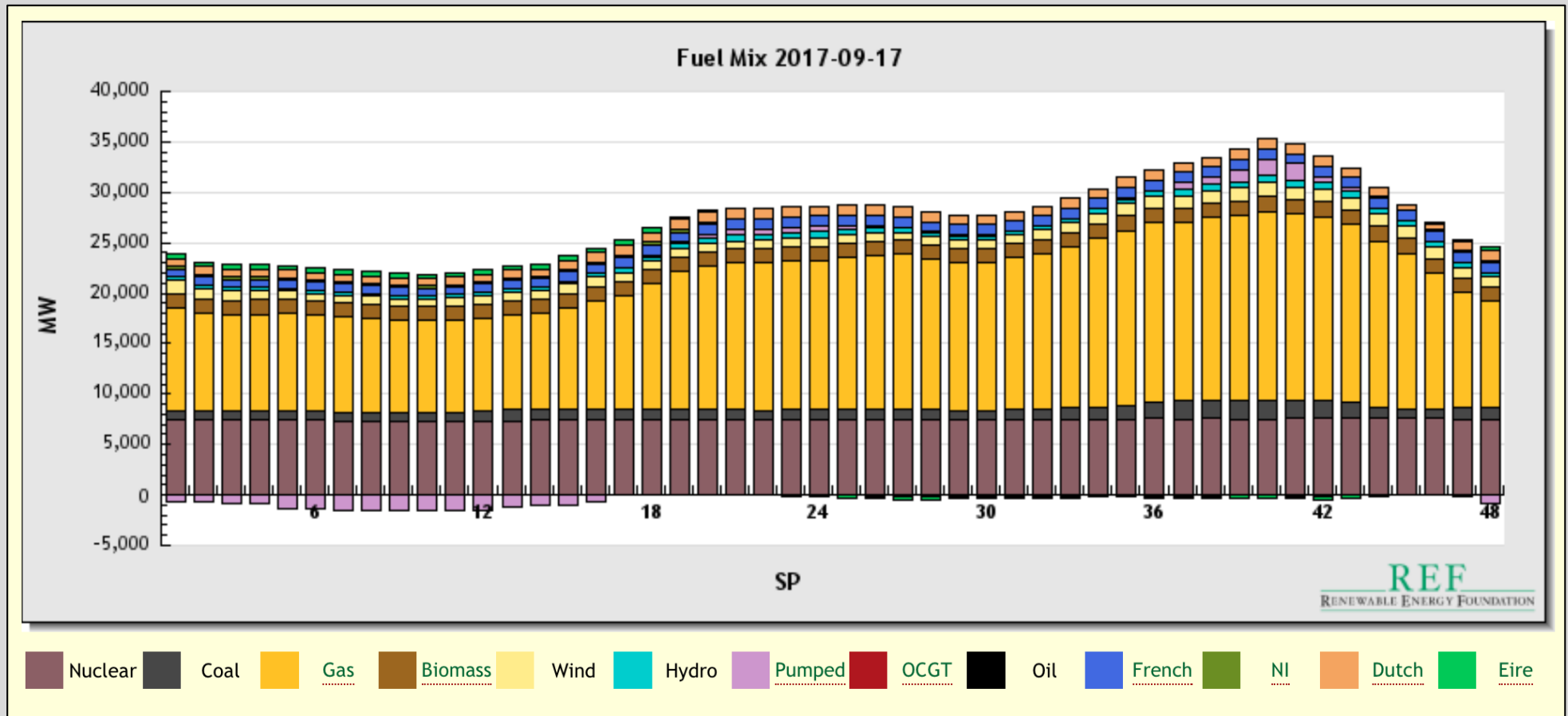
Source: GB Transmission System Demand (MWh), BM Reports; chart by REF, see [www.ref.org.uk](http://www.ref.org.uk).

# UK Electricity Fuel Mix 2009–2017 (% of GWh)



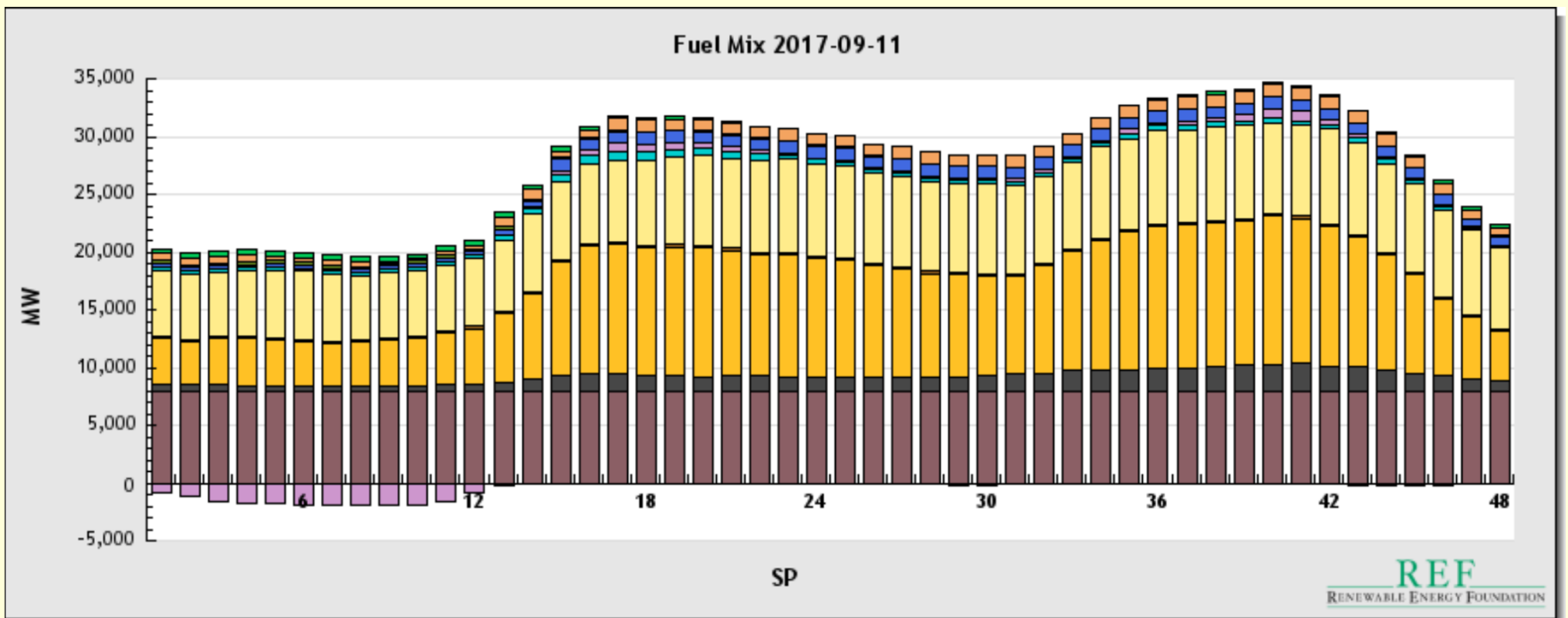
Source: GB Transmission System Demand (MWh),  
 BM Reports; chart by REF, see [www.ref.org.uk](http://www.ref.org.uk).

# UK Daily Electricity Fuel Mix 17.09.17 (MW)



Source: GB Transmission System Demand (MWh). BM Reports. Chart by REF. See [www.ref.org.uk](http://www.ref.org.uk)

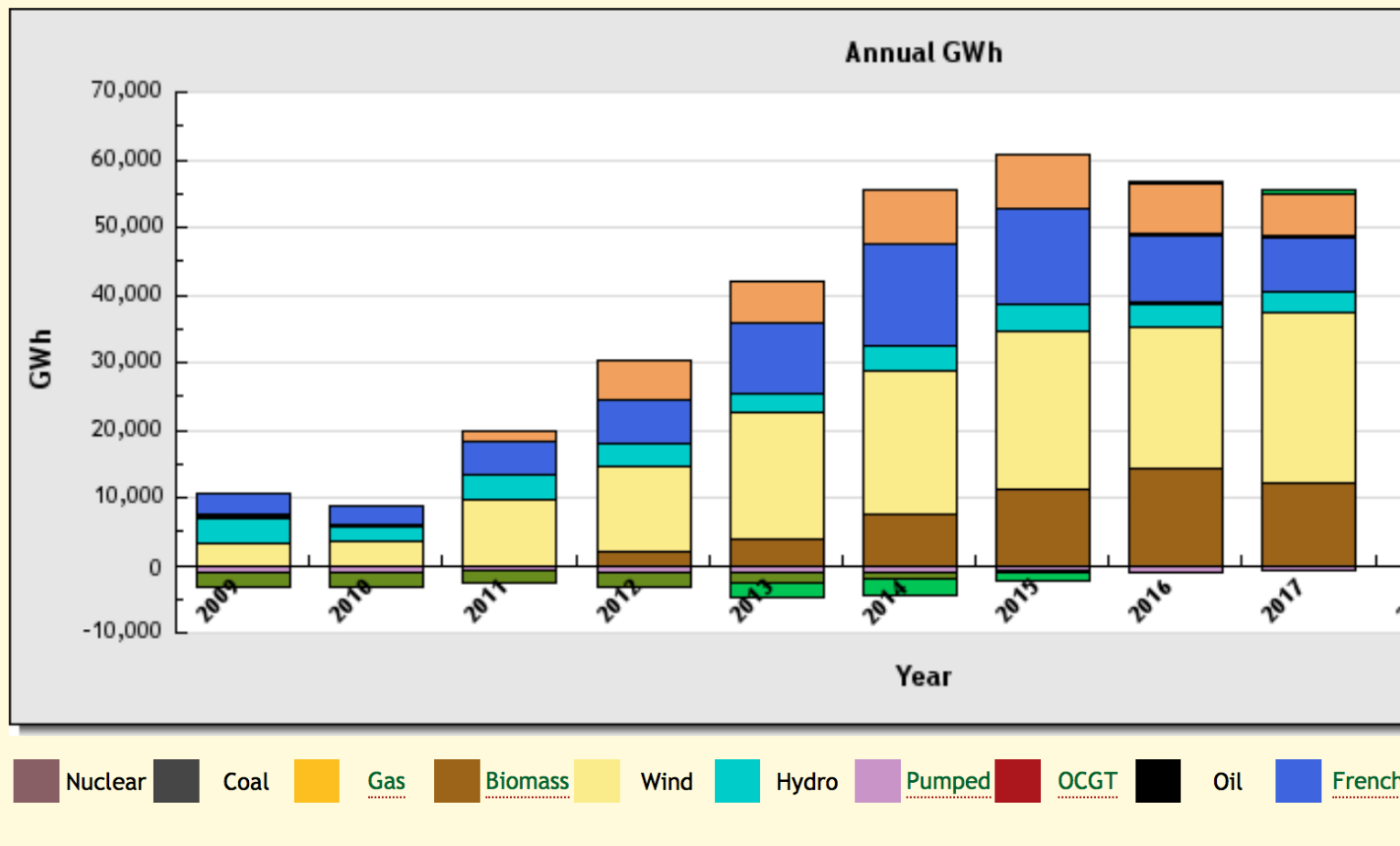
# UK Daily Electricity Fuel Mix 11.09.17 (MW)



Source: GB Transmission System Demand (MWh),  
BM Reports; chart by REF: see [www.ref.org.uk](http://www.ref.org.uk).



# UK Electricity Fuel Mix (2009-2017): Renewables and Interconnectors (GWh)



Renewables and Interconnectors. Percentage of Transmission System demand (MWh).

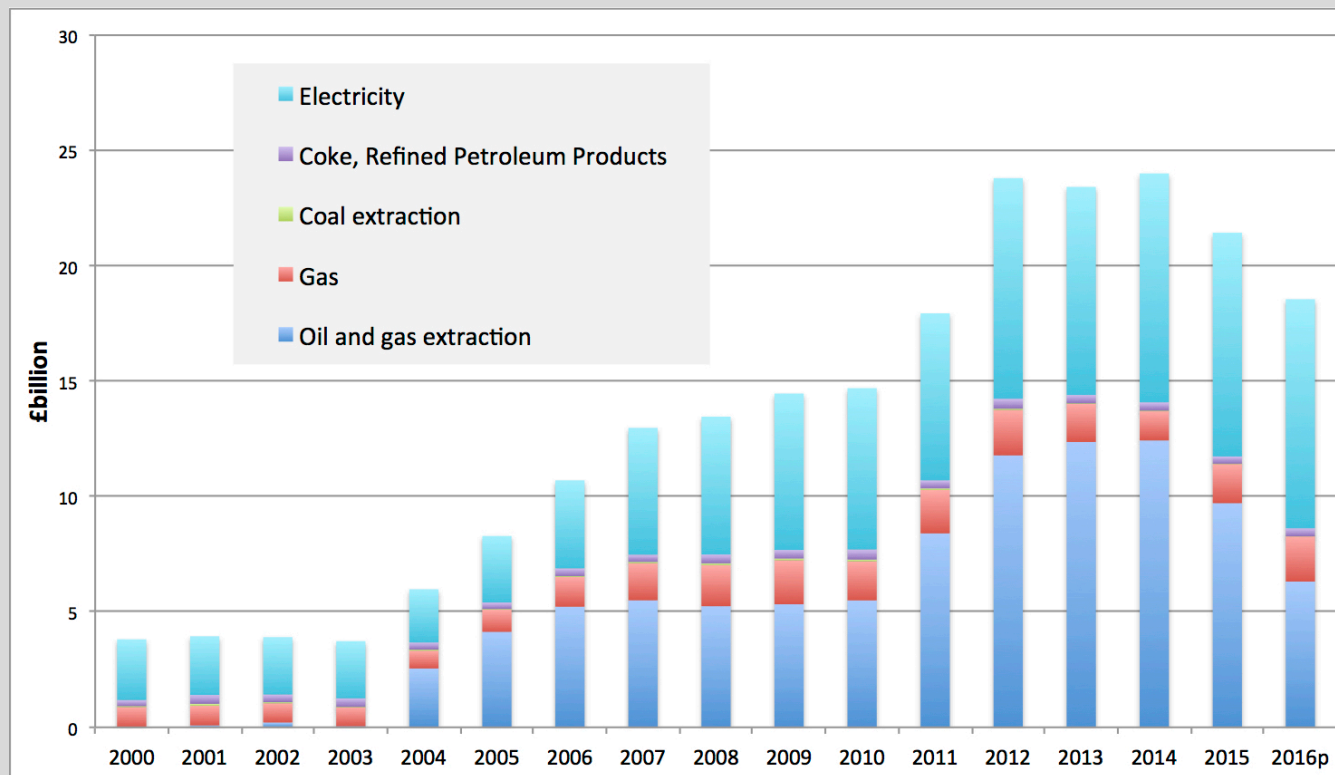
Source: BM Reports; chart by REF, see [www.ref.org.uk](http://www.ref.org.uk).

# Overheated Renewable Electricity Sector, But cooling off...

- 30.8 GW of operational capacity
  - Biomass (3.9 GW); Solar (8. GW [+ 4 GW of capacity outside the permitting system]); Waste (1.1 GW); Offshore wind (5.9 GW); Onshore wind (11.2)
    - **Generating approx. 80 TWh per year**
    - **Subsidies now total £6 billion per year**
- 28.9 GW of capacity under or awaiting construction
  - 16.6 GW offshore wind
  - 2.4 GW solar
  - 5.3 GW onshore wind
  - 3.1 GW biomass
  - 1 GW waste
- Total Consented capacity 59.8 GW
  - Output of consented capacity = approx 161 TWh
  - 47% in excess of 110 TWh target for electricity in 2020
  - Treasury budget for subsidies (Levy Control Framework) likely to be breached
- Only 5 GW of capacity seeking consent:
  - Onshore wind (4.3 GW), almost all in Scotland...
  - Offshore wind (0 GW)
  - 300 MW solar, 300 MW marine...

# Renewables Capital Investment

- Investment in renewables since 2010: £52 billion.
- 36% of *total energy sector* capital formation
- 83% of electricity sector investment

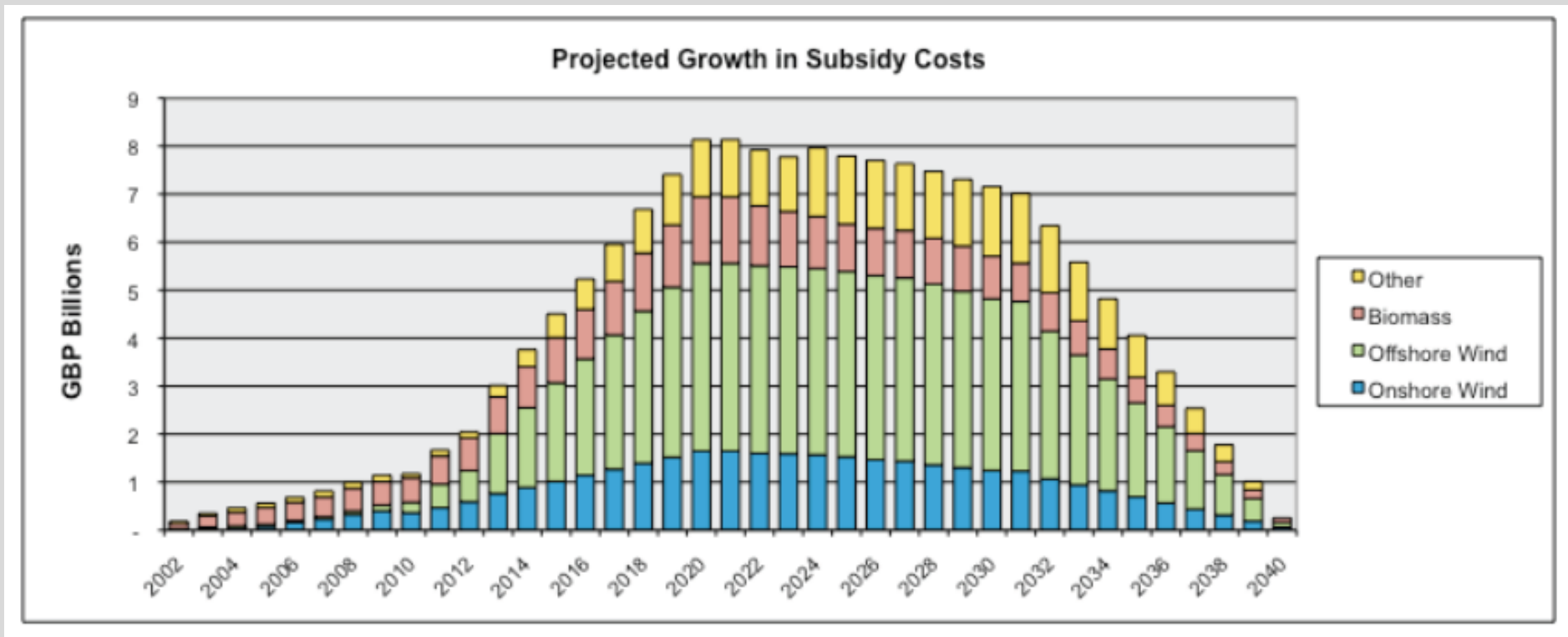


Source: Department of Business, Energy and Industrial Strategy (2017). Chart by author.

# Renewable Electricity

## Cumulative Subsidy 2002–2040

- Assumptions: Current subsidy levels; no new capacity after 2020; DECC technology pipeline projections
- Cumulative subsidy Cost 2002–2040: ca £162bn



Source: REF. Based on DECC's pipeline projections in *Renewable Energy Roadmap 2013*.

# DECC: 2020 Electricity Price Policy Impacts

- Overshoot would exacerbate already severe price impacts.
- Even if within Levy Control Framework...
- Domestic Households
  - Low fossil price scenario: + £55/MWh (+ 42%)
- Medium Sized Businesses
  - Low fossil price scenario: + £53/MWh (+77%)
- Even in DECC's High Fossil Price scenario prices rise by 30% to 45% due to climate and other policies

Source: DECC, *Estimated Impacts of Energy & Climate Policies on Prices and Bills* (2014)

- DECC has published no new estimates since 2014

# CO<sub>2</sub> Abatement Cost & Social Cost of Carbon

Marten 2011: SCC = \$0 – \$206 t / CO<sub>2</sub>

Stern Review: SCC = \$29 / tCO<sub>2</sub>

	Cost per tonne CO <sub>2</sub>
Roof mounted solar PV	\$380 – \$1,450
Free-standing solar PV	\$228
Small onshore wind (<500 kW)	\$608
Large onshore wind (> 1 MW)	\$137
Offshore wind	\$274
Dedicated biomass	\$198
Hydro	\$0 - \$137 – \$684
Anaerobic digestion	\$274 – \$380
Incinerated municipal biomass	\$0

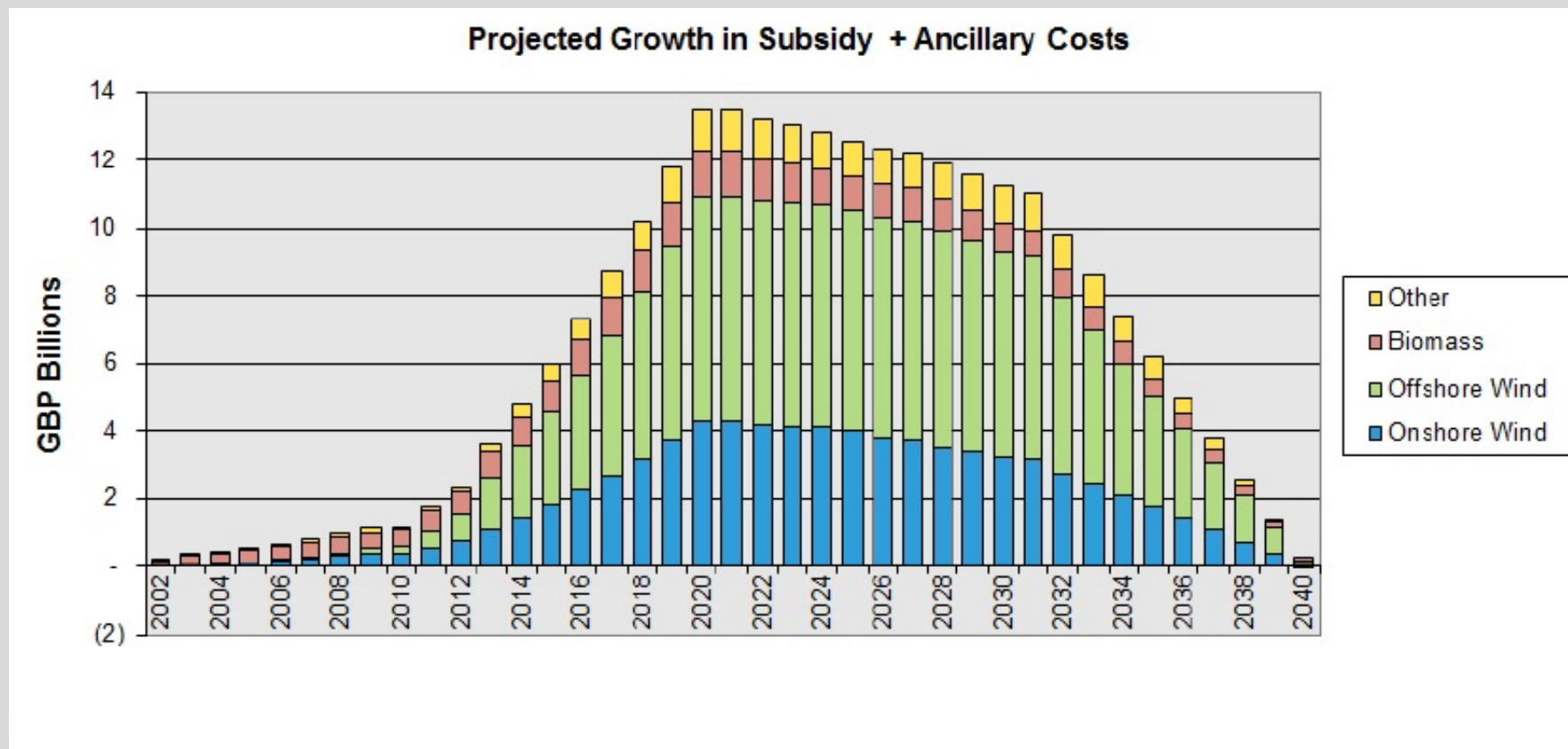
Source: Ofgem, DECC. Calculations and chart by REF.

Marten, Alex L. (2011). Transient Temperature Response Modeling in IAMs. Economics E-Journal 5: 2011–18.

# Subsidy + Wind Integration Costs

Total Cost 2002–2040: ca. £256bn

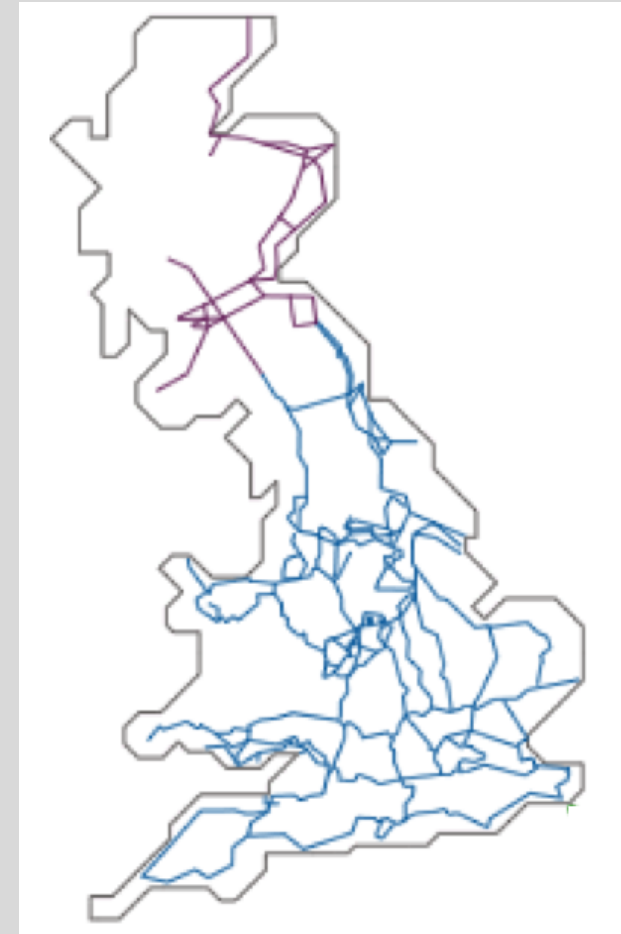
Could be higher with solar costs



Source: REF. Based on DECC Pipeline projections.  
Ancillary costs based on Colin Gibson for IESIS (2011).

# Further Problems: Integration Problems: *Constraint Payments to Wind Power*

- Total 2010 to 28 Nov. 2017: £377m
  - £82m in 2016
  - £99.6m in 2017 so far...
- **Almost all in Scotland**
  - **But offshore wind increasingly constrained off**
- Average price in 2017 to reduce generation: **£70/MWh**
  - **Nearly double the lost income**
- **Overall system balancing costs have risen sharply**
  - **2001/2002: £300m**
  - **2016/2017: £1.2 billion**



The UK HV Network  
Source: National Grid



# Constraint Payments to Scottish Wind: Further Reading

- John Constable & Matt Ridley, “The Scottish Wind-power Racket” (August 2017)
- <https://capx.co/the-scottish-wind-power-racket/>
- Describes perverse incentive to build wind power in Scotland behind grid constraints



10 August 2017

## The Scottish wind-power racket

By John Constable and Matt Ridley

Whitelee, in Scotland, is Europe's largest onshore wind farm. Photo: Jeff J Mitchell / Getty

Share

- Wind farm owners in Scotland are making out like bandits
- Since 2010, we've paid £328m to wind farms not to generate - most of them in Scotland
- Westminster must stop Holyrood from consenting new wind farms and extensions

# But is it all worthwhile?

- “Subsidy free solar comes to the UK”

*Department of Business, Energy, and Industrial Strategy (BEIS), 26  
September 2017*

- Offshore Wind: “Costs Halve”!

*All UK newspapers, 11 September 2017*

*However, claims do not stand up to scrutiny...*

# Clayhill Solar Farm: Opened *26.09.17*



# Clayhill *Battery* System (+ Solar)

- 10 MW Solar PV + 5 BYD Batteries: 6 MW peak & 6 MWh storage
  - Shares grid connection with nearby 4.75 MW, subsidised solar farm
- Clayhill will be contracted on a retainer in the Capacity Market to provide balancing services
- Project is not a subsidy free solar system, but battery providing rapid response power, and using onsite solar as *one* of its charging options
- Clayhill is **not** an indicator of broader prospects for solar energy generation:
  - “Steve Shine, chairman of Anesco, which owns Clayhill, said that solar farms were still not economically viable but that the company was developing another five farms with batteries.”  
*The Times* 26.09.17
  - “‘It [the Clayhill project] wouldn’t pay with solar by itself at the moment . . . it needs the storage as well,’ said Mr Shine.”
  - “government shouldn’t then assume the industry is away — it isn’t [...] It is only going to be exceptional projects [that are built subsidy free] [...] Government subsidies would still be required to support the majority of solar projects in future [...] a spokeswoman for the Solar Trade Association said.”

*Financial Times*, 26.09.17

# Offshore Wind: “Costs Halve”

- Feed-in Tariffs with Contracts for Difference Auction
  - Round 1 (2015): £114 – £150/MWh (2012 prices)
  - Round 2 (2017): £57.50 – £74.75/MWh (2012 prices)
    - *Daily Telegraph*
      - ‘Offshore wind to power £17.5bn investment boom as costs halve’
    - BBC
      - ‘Offshore wind power cheaper than new nuclear’
    - *The Times*
      - ‘Winds of Change: The price of renewable energy is falling faster than anyone dared hope’
    - *Daily Telegraph*
      - ‘Wind could make Britain an energy superpower to rival Arabia’
    - Cornwall Energy:
      - ‘Paradigm Shift: Offshore wind blows hole in opposition to renewables’.

# Are Offshore Wind Costs Really Falling?

- Published 25.09.17
- Statistical analysis of capex and other data for 86 offshore wind farms
- Available from:  
<https://www.thegwppf.org>



# Offshore Wind Capital Cost and Water Depth

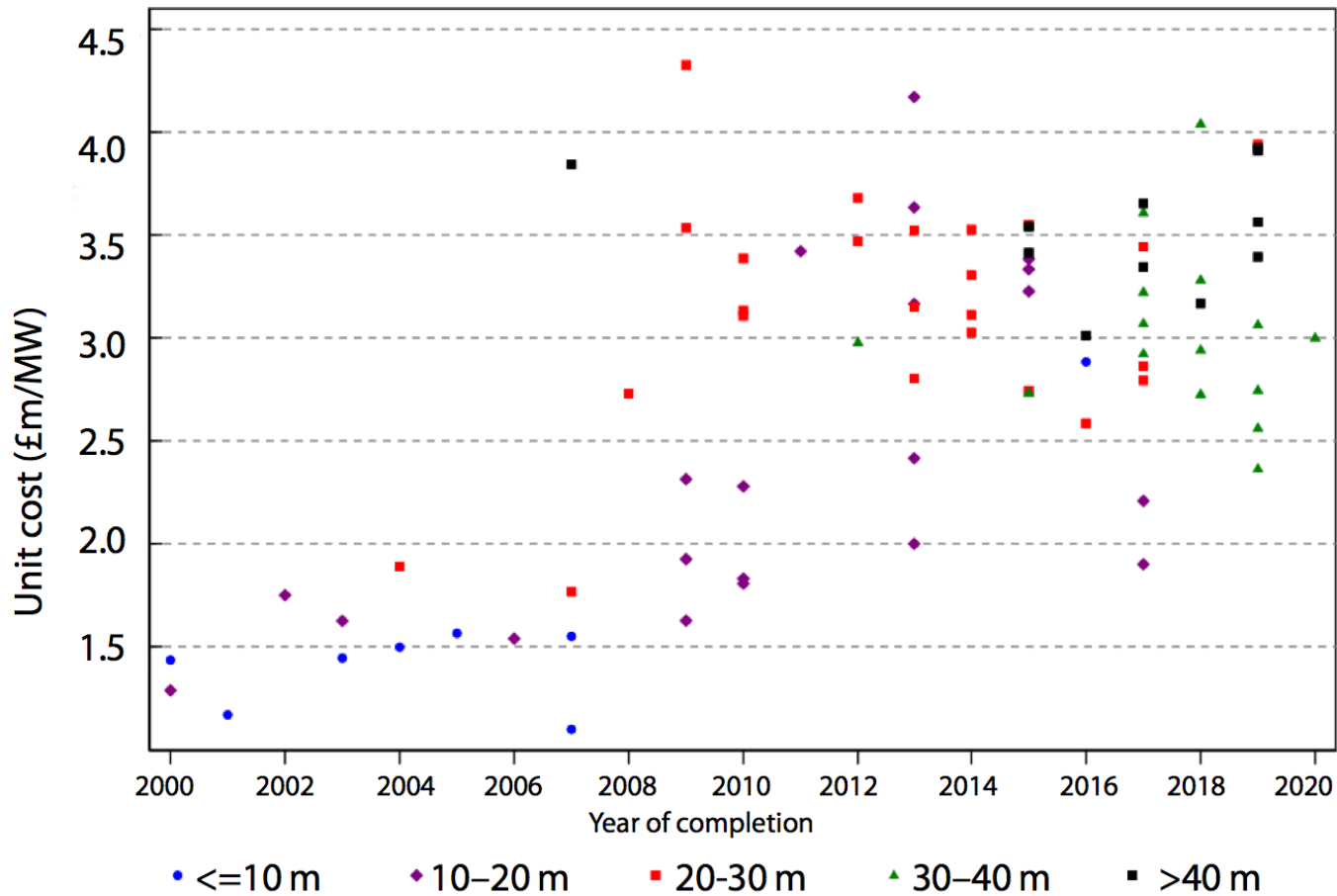


Figure 1: Wind farm capital cost and water depth, 2000–2020.  
£/MW, 2012 prices.

Yes, some technological progress...  
Costs falling at 4% per year since 2013

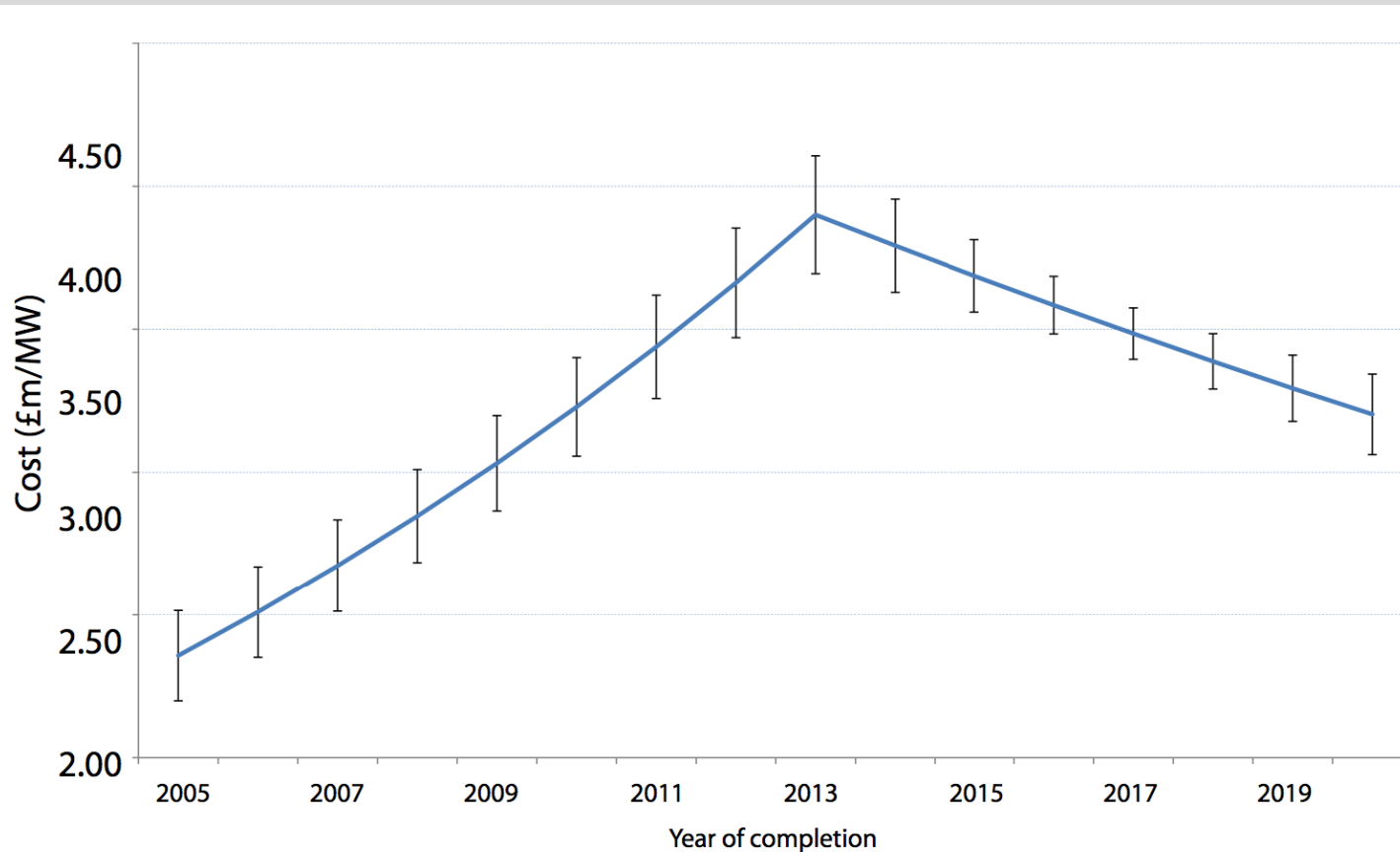


Figure 2: Evolution of standardised unit costs for wind farms over time.

Authors' dataset.<sup>7</sup> Calculations by the authors.



...but offset by deeper water

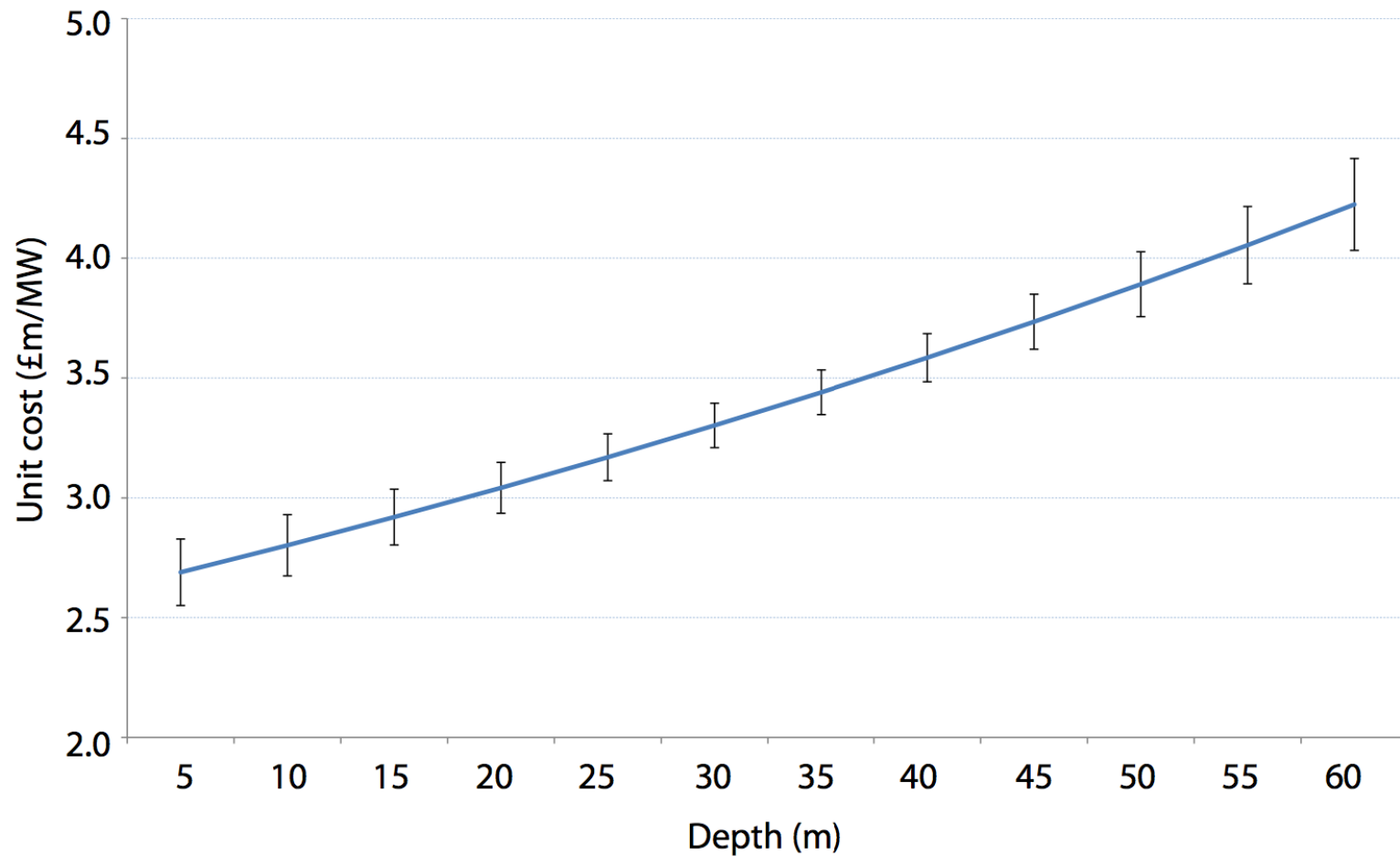


Figure 3: Standardised unit costs vs depth for wind farms in 2016.

Source: Authors' dataset.<sup>7</sup> Calculations by the authors.

# Industry Regards CfDs as *Options*...

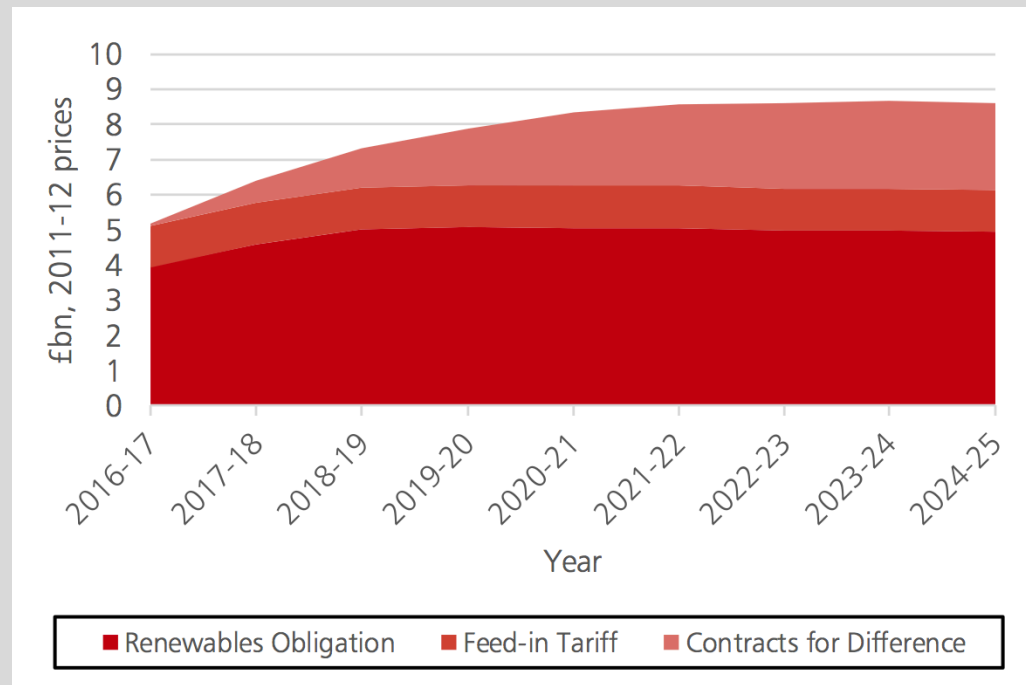
- CfD bid prices of £57.50 per MWh are not economic...
  - Price of about £120/MWh probably required...
- Why did companies bid so low?
- The CfD is a gamble on future wholesale prices and policy
  - High gas prices
  - Carbon price
- If wholesale prices rise, or a carbon price is introduced, developers will build and then abrogate the CfD contract.
- If wholesale prices do not rise, they will not build.
- In the meantime, they generate good PR, secure a market position and inhibit competition.

# UK Renewables 2002–2017: Summary

- UK electricity market now largely an administrative construction delivering renewables.
- Renewable generation deployment on a large scale dominating electricity sector capex.
- **Falling productivity of Electricity Supply Industry.**
- High annual and ongoing subsidy costs; High system costs; High emissions abatement costs.
- Solar still not economic; Offshore wind costs are **rising**.
- **Doubts about long term sustainability of policy...**
- **Autumn Budget has frozen annual costs to prevent**

# Autumn Budget 2017

- Except for £557m p.a. of promised CfDs, No new levies (subsidies) for low carbon technologies until total annual cost burden starts to fall (ca. 2025... or later).
- Current cost: £6.5 billion (2012 prices) per year (approx. 5% of global subsidies to renewables)



Low Carbon Levies Forecast 2016–2025: Source: Her Majesty's Treasury, *Control for Low Carbon Levies* (2017).

# Autumn Budget 2017: Questions

- £557m p.a. of CfD subsidies promised. Who will get these funds:
  - One nuclear station could take all
- What will cause decline in total cost of levies?
  - **Certain:** Expiry of existing subsidy entitlements under RO, FiT, CfD
  - **Uncertain:** High wholesale prices reducing the subsidy implicit in existing Contracts for Difference. Low prices look more likely...
- Will there be any new levies?
  - Very unlikely... carbon tax more probable...
  - No decision on levies or carbon tax has been taken... and need not be taken for eight years.
- Is the subsidy freeze compatible with the GHG emissions reductions targets?
  - Offshore wind with low CfD bids unlikely to be built... no new levies, no carbon tax...