THE OXFORD INSTITUTE FOR ENERGY STUDIES

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UNIVERSITY OF OXFORD

CCGT Power Station

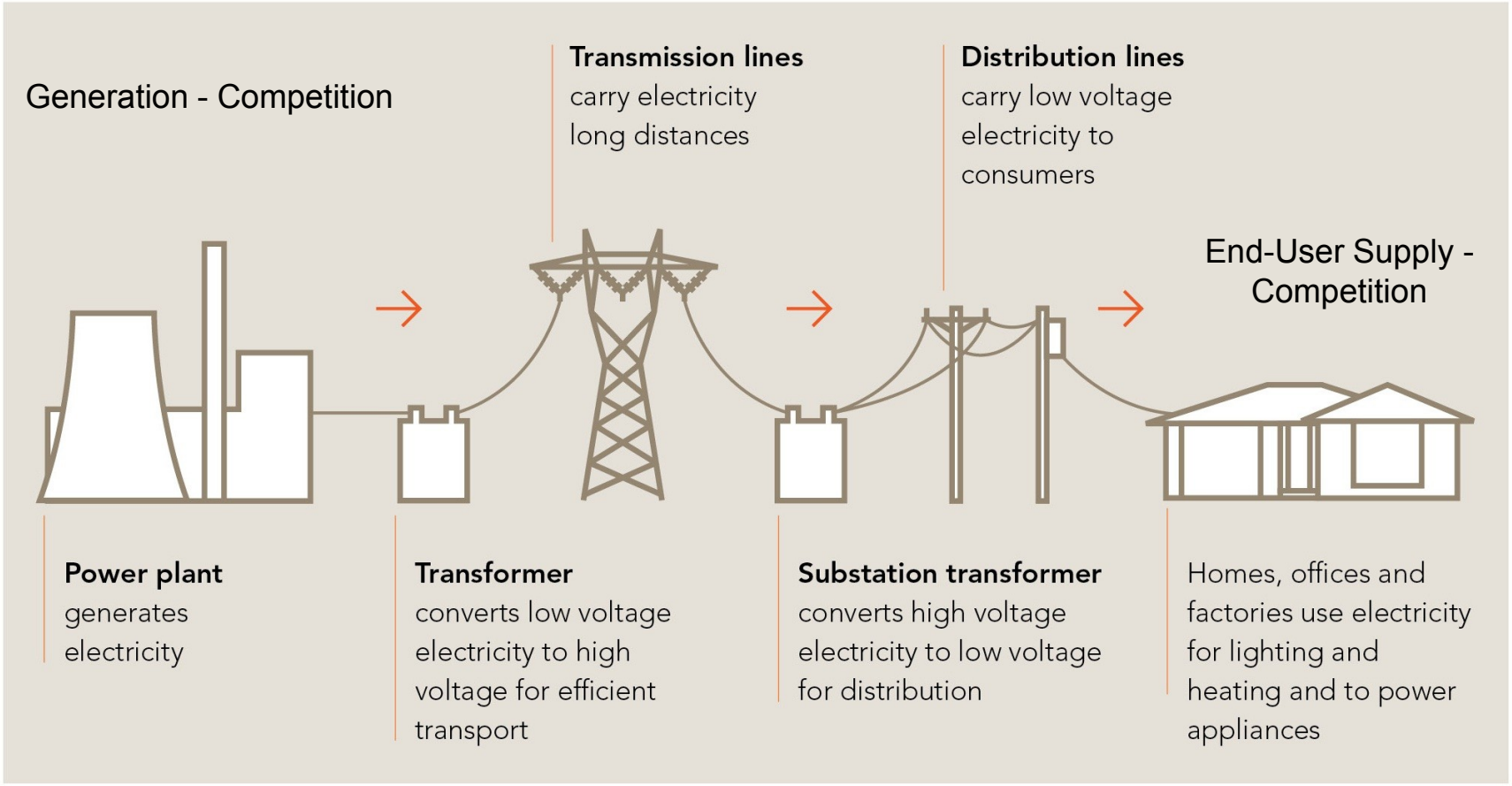
April 2019

The Economics of Energy Corporations (2)

A Key Consumer of Gas

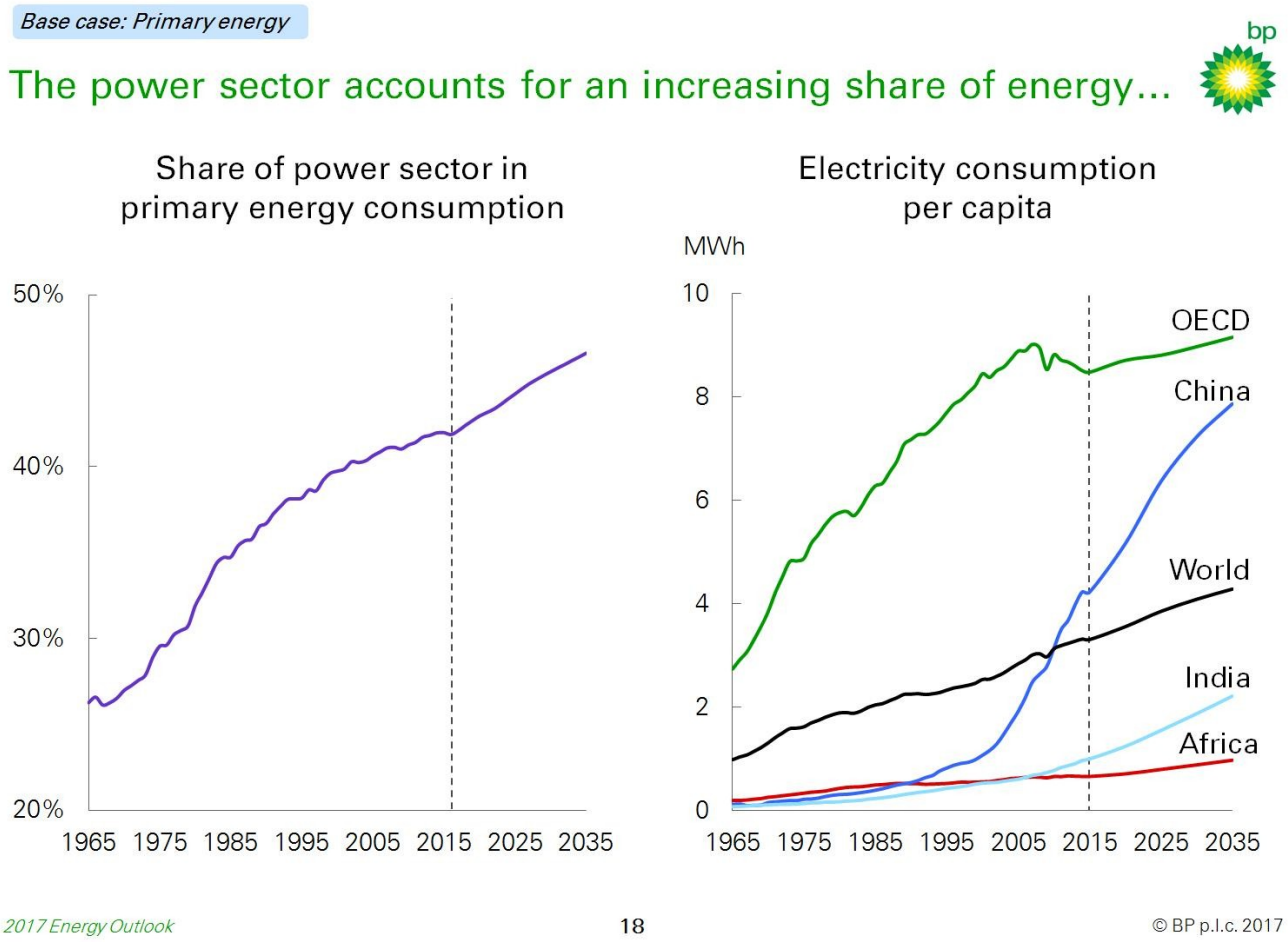
- Power sector accounts for a huge share of gas demand in many regions
- Provides base load power on which other demand is built
- Combined-cycle gas turbines (CCGT) are relatively cheap and efficient, and also provide vital flexibility
- The economics are based on low capital and operating costs and the price of the key input – gas supply
- It is also very important to consider how much the plants run – the more they operate the better their commercial outcome

The Electricity Sector Value Chain



- Electricity sector is a mixture of regulated and unregulated segments
- As renewable energy is introduced, and as demand patterns change, the complexity for energy companies in all parts of the chain increases

Electricity consumption is set to rise

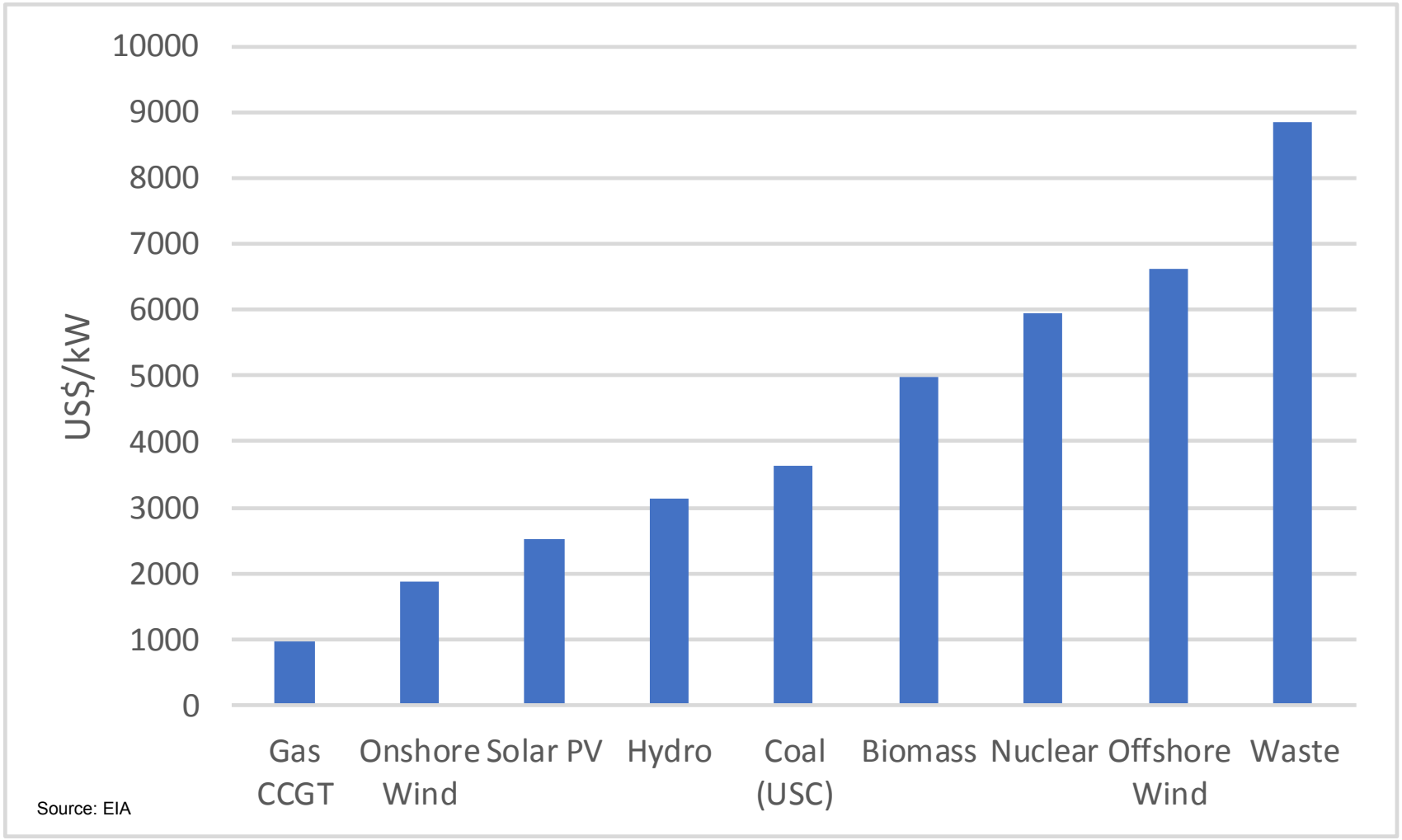


- Electricity demand is likely to rise as part of a decarbonisation strategy
- As a result, the focus of the energy economy will be on how power stations are fuelled, with the assumption that renewables will grow
- Key question for fossil fuels – how fast will the decline be?

Key Economic Concerns

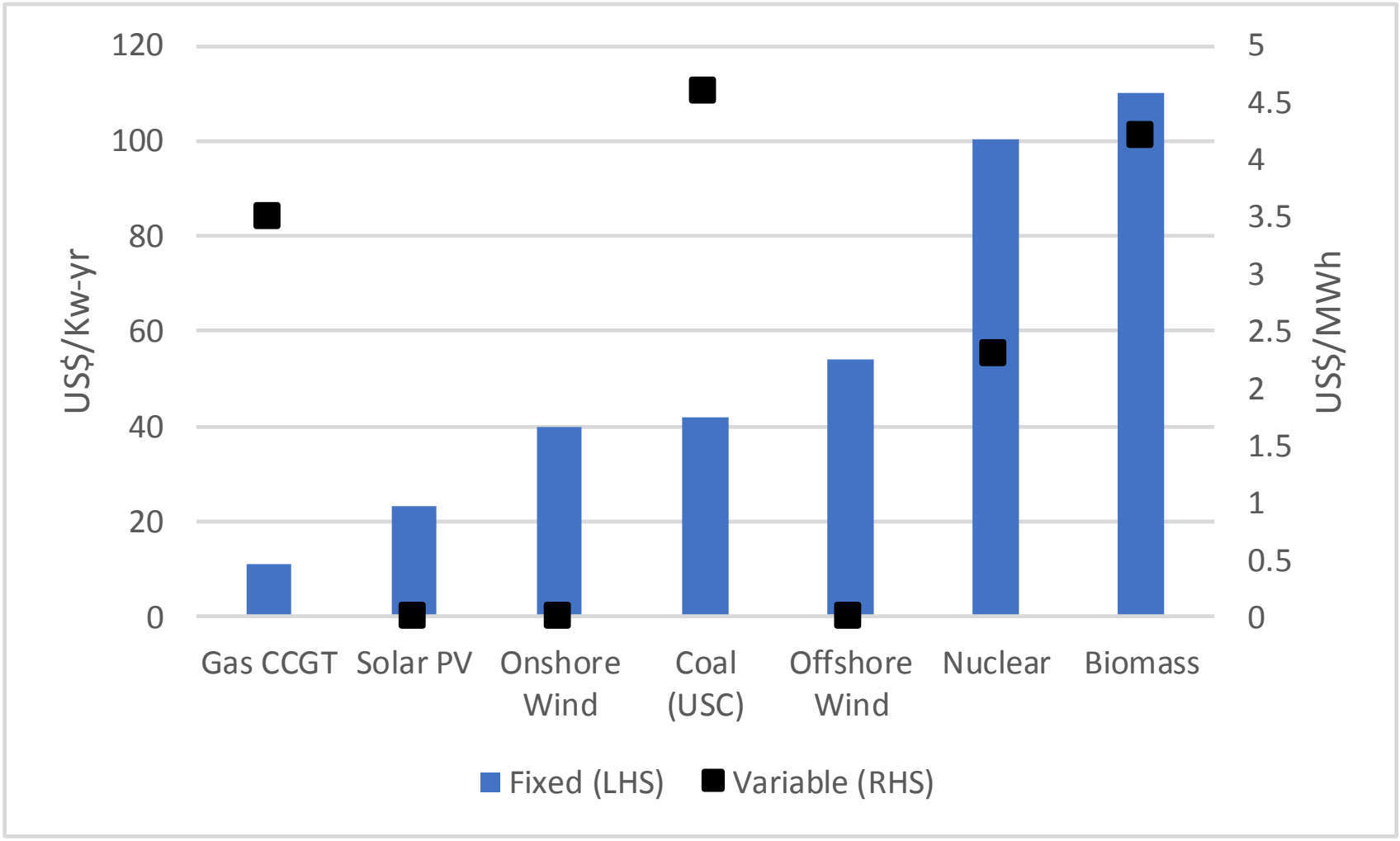
- Capital and operating costs – but these are largely fixed
- Electricity prices
- Input price of gas
- Carbon price
- Capacity utilisation

Capital cost comparison



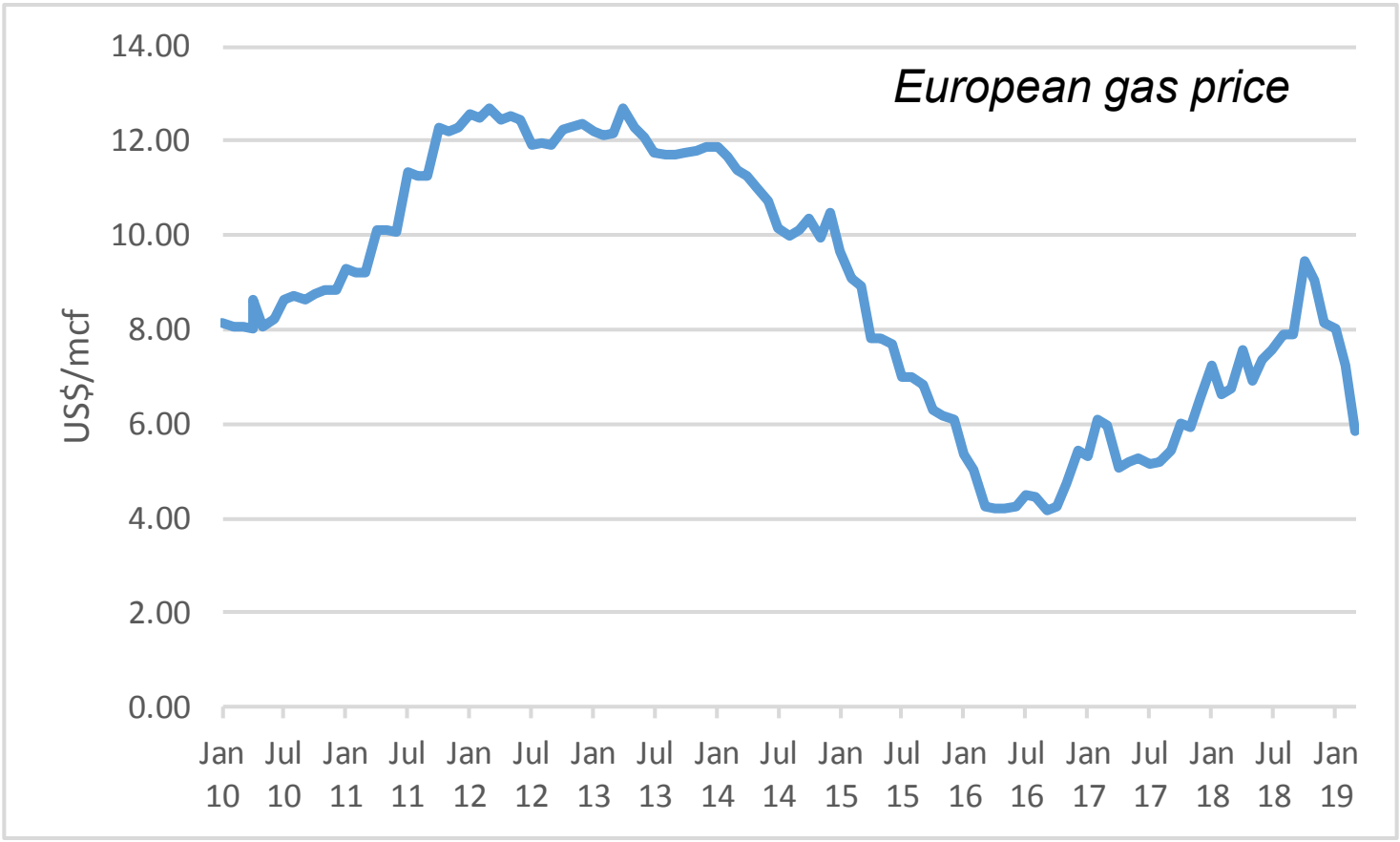
- Gas looks very cheap compared to alternatives on a capital cost basis

Operating cost comparison



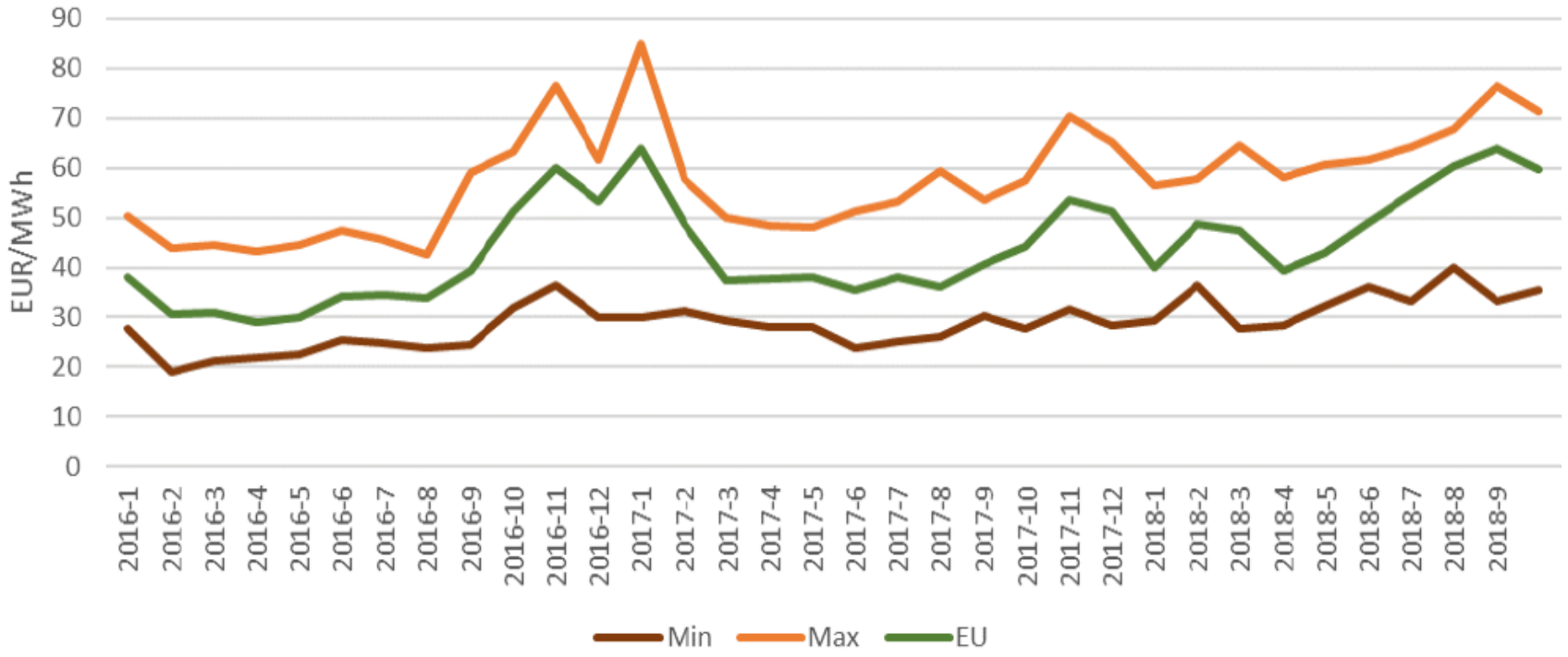
- Note difference between fixed and variable costs – renewables have no variable opex

Gas price volatility



- 5-year average price = $7/mcf
- High-Low range = $12.68 - $4.16/mcf
- 2019 range – c.$4.50-6.00/mcf

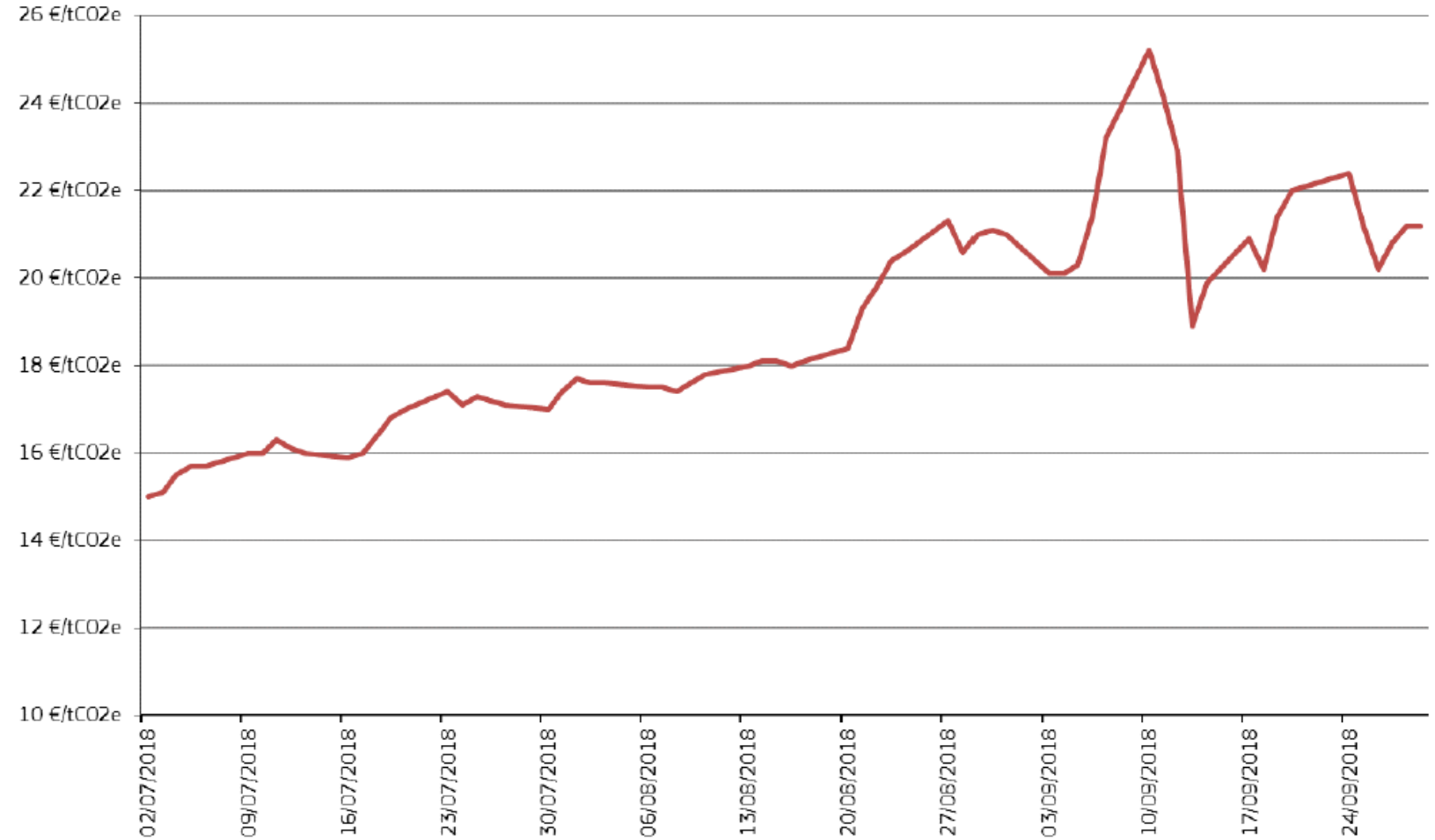
European Wholesale Electricity Price



Source: European Wholesale Power Exchanges

- Significant divergence across Europe, with seasonal volatility
- Average price for the EU since 2016 has been c.€50/MWh
- Current price is around €45 in Germany and €60 in the UK

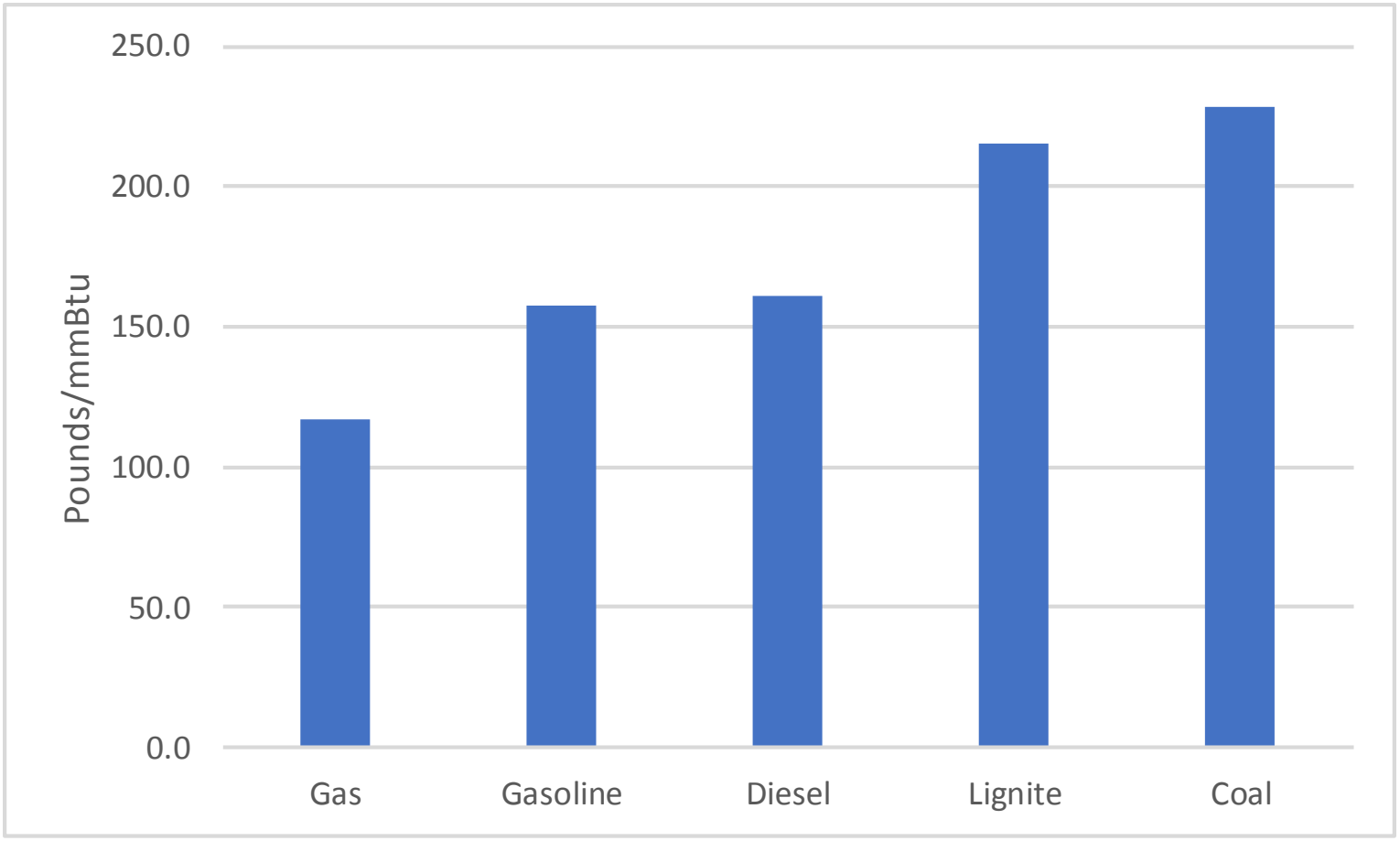
The European Carbon Price



Source: S&P Global Platts

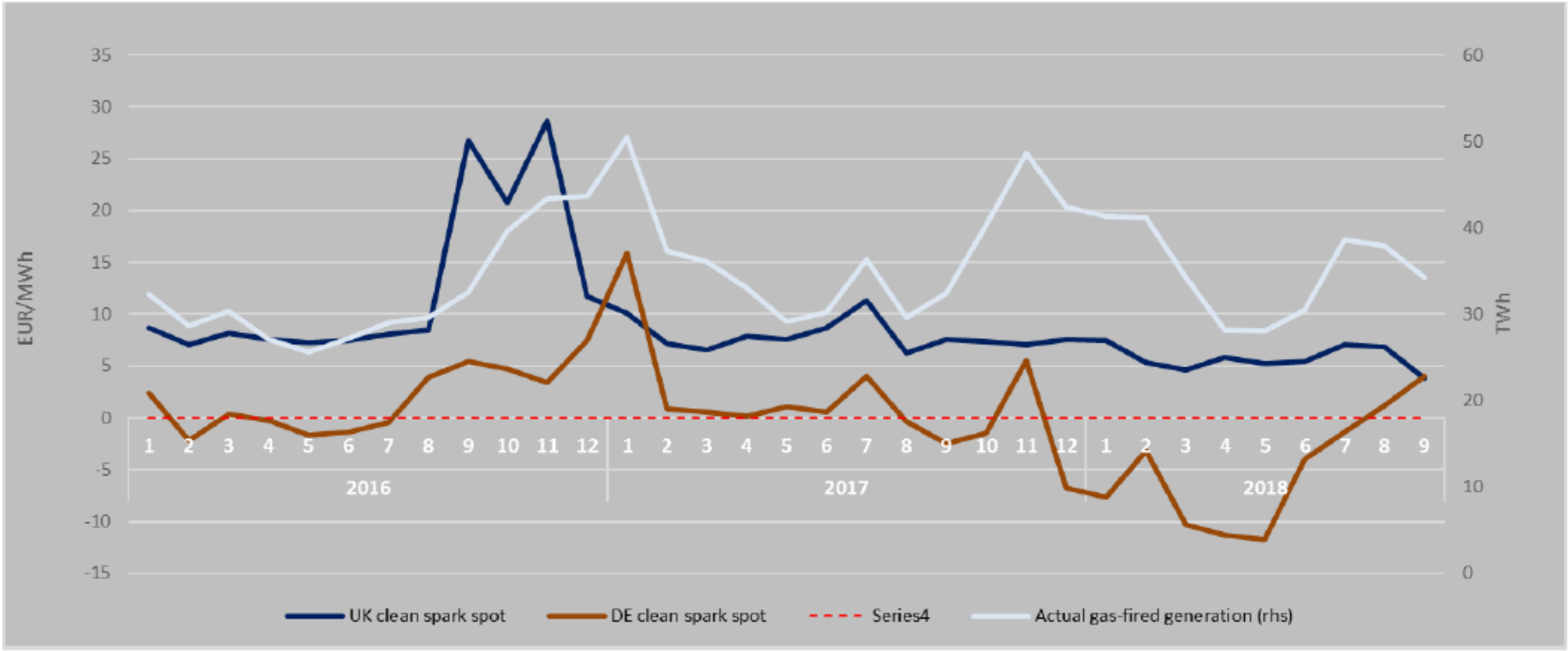
- Price per tonne of carbon emitted; UK adds an extra levy based on a carbon floor

Carbon output by fuel



- Coal emits roughly twice as much carbon as natural gas

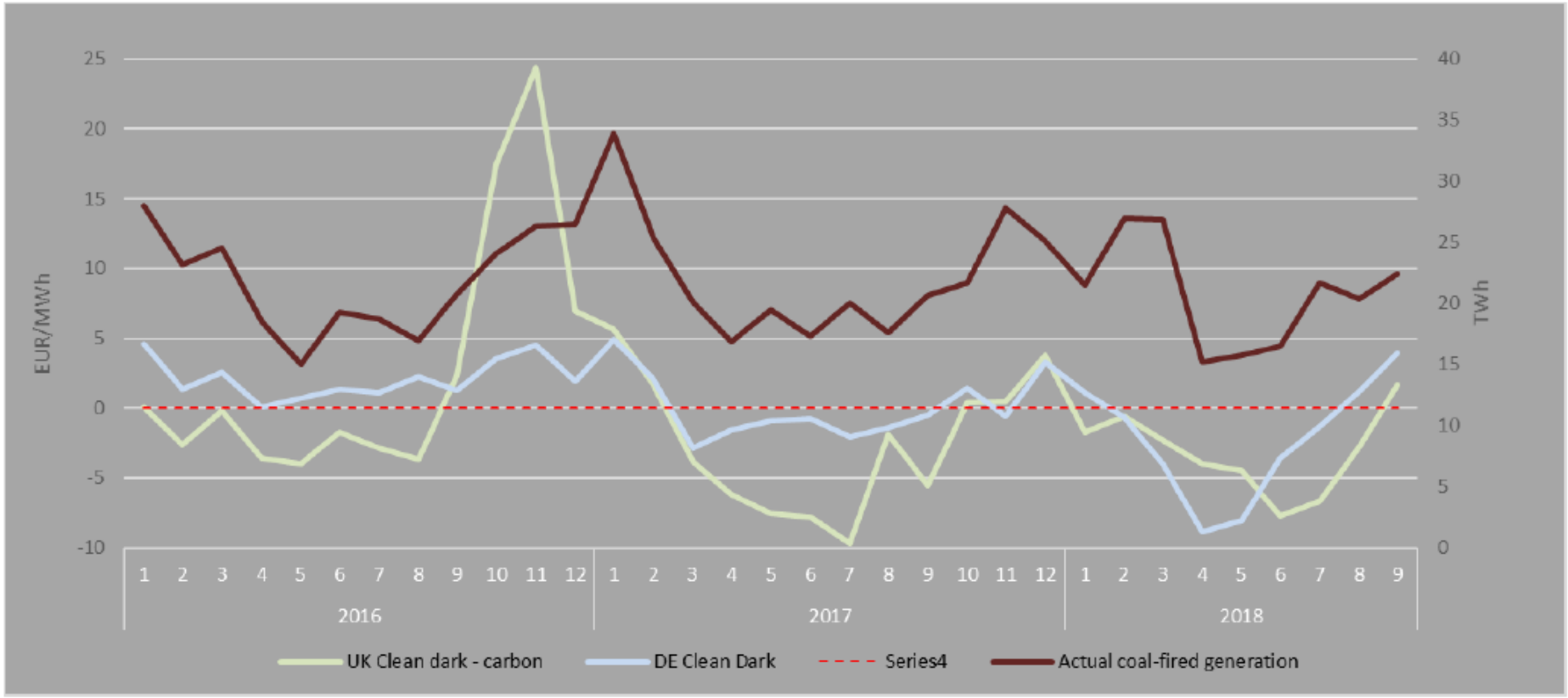
Spark Spread – Clean for Gas



Source: S&P Global Platts and ENTSO-E

- Gas-fired power generation was profitable in the UK for the entire period, but was loss-making in Germany for most of 2018

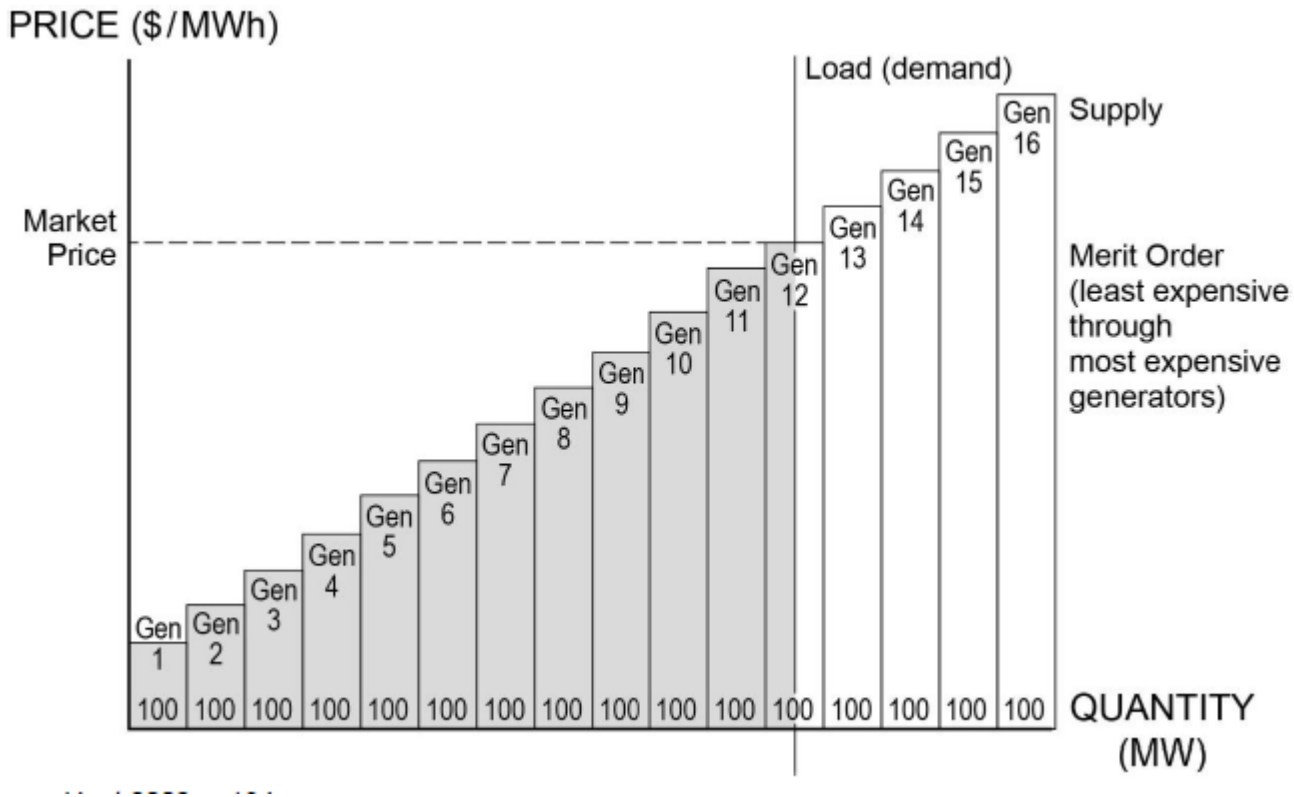
Spark Spread – Clean Dark for Coal



Source: S&P Global Platts and ENTSO-E

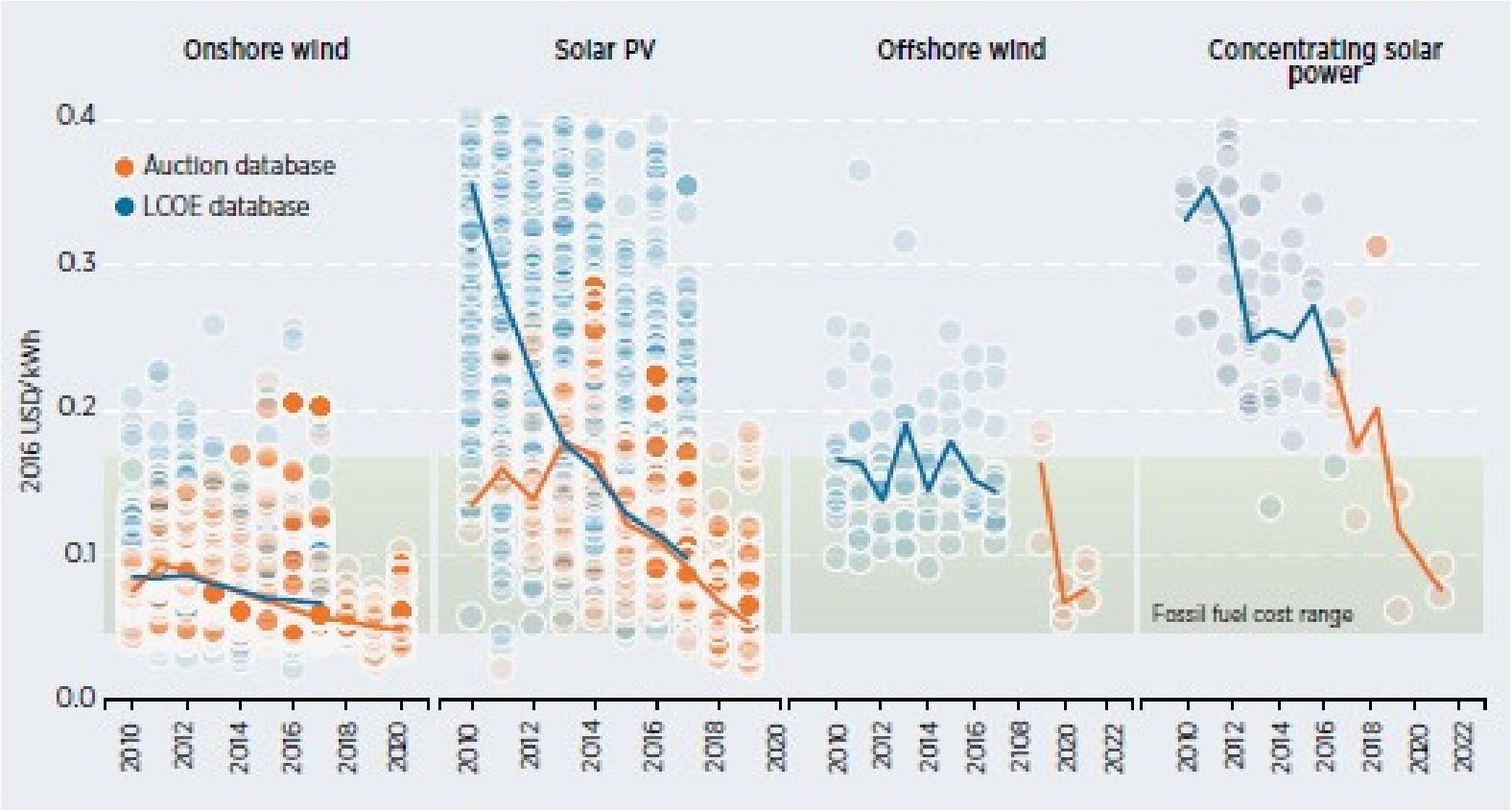
- Coal is hit harder by the carbon price and has been largely unprofitable since 2017

Stylised merit order for power generation



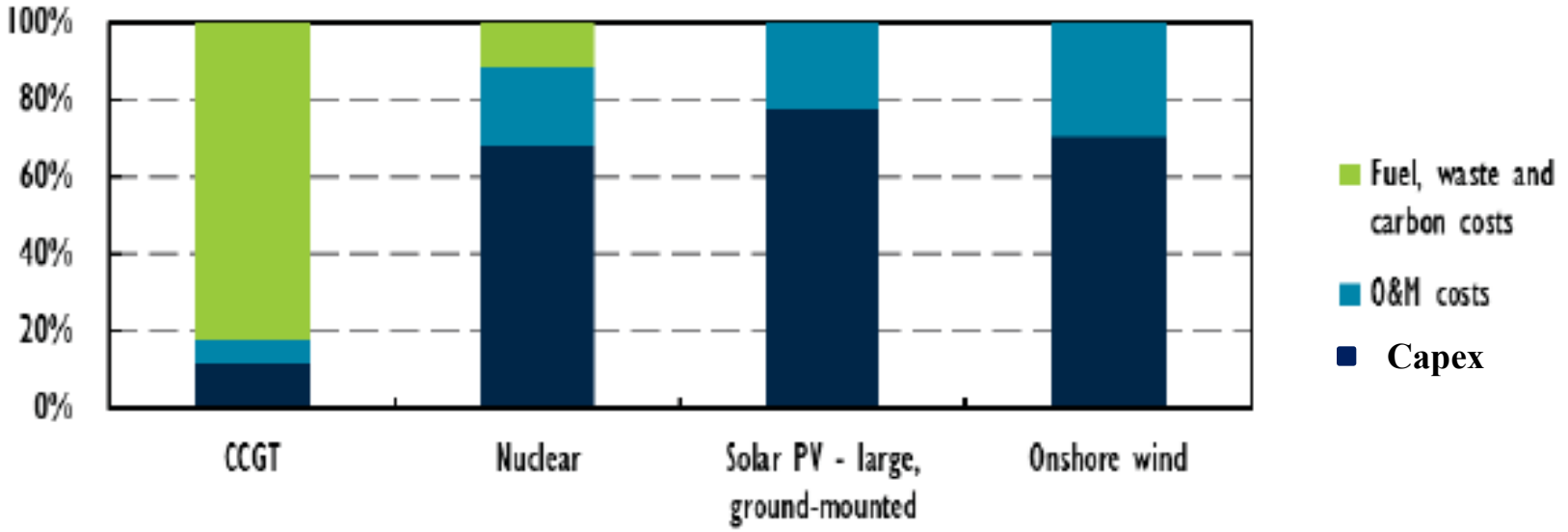
- Historically generating companies have competed on the basis of a merit order of generating costs
- The market price is set at the marginal price, which is paid to all power producers who are called upon to dispatch electricity

Outlook for costs based on auctions



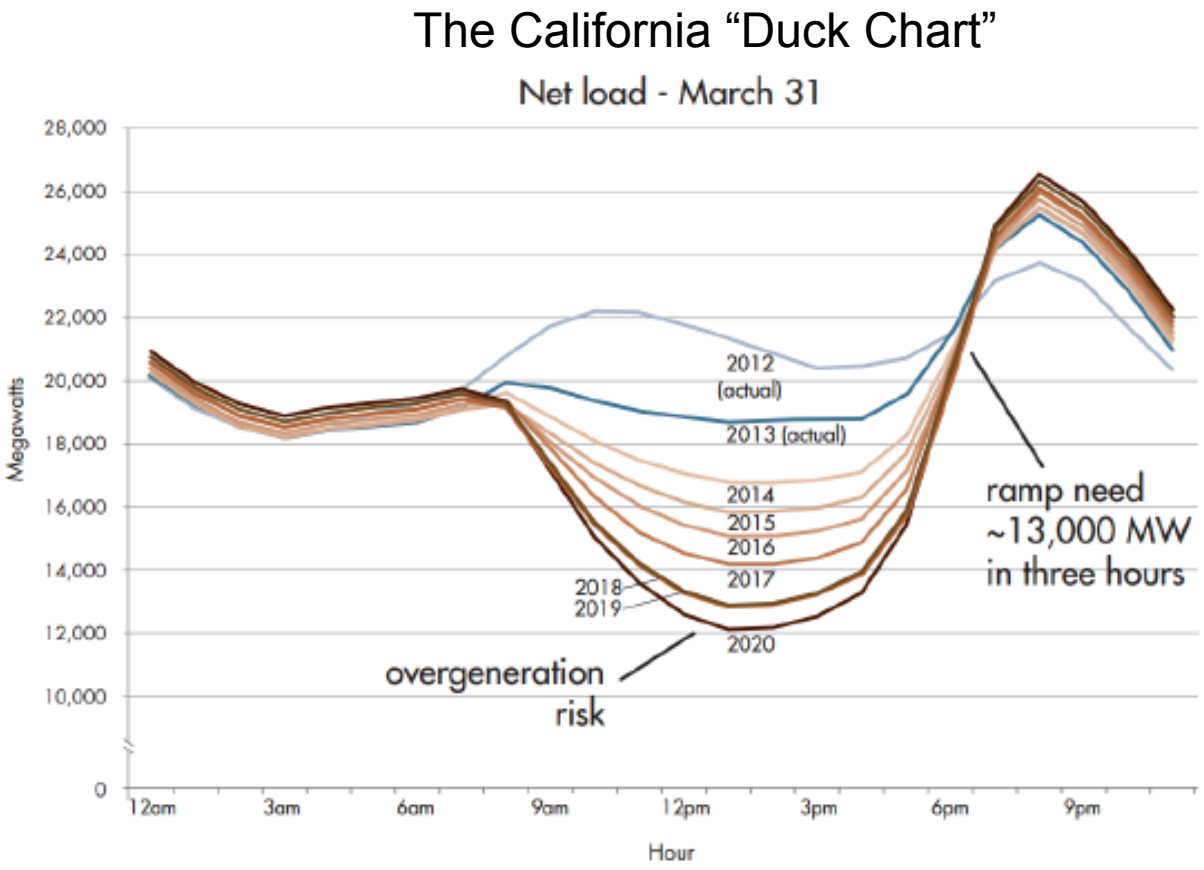
- The cost of renewable energy is falling fast, and is getting very close to the range of fossil fuel generation
- Once subsidies are no longer required, a tipping point could be reached
- Key question revolves around the cost of intermittency and the need to provide back-up capacity

Breakdown of levelised costs for different power technologies



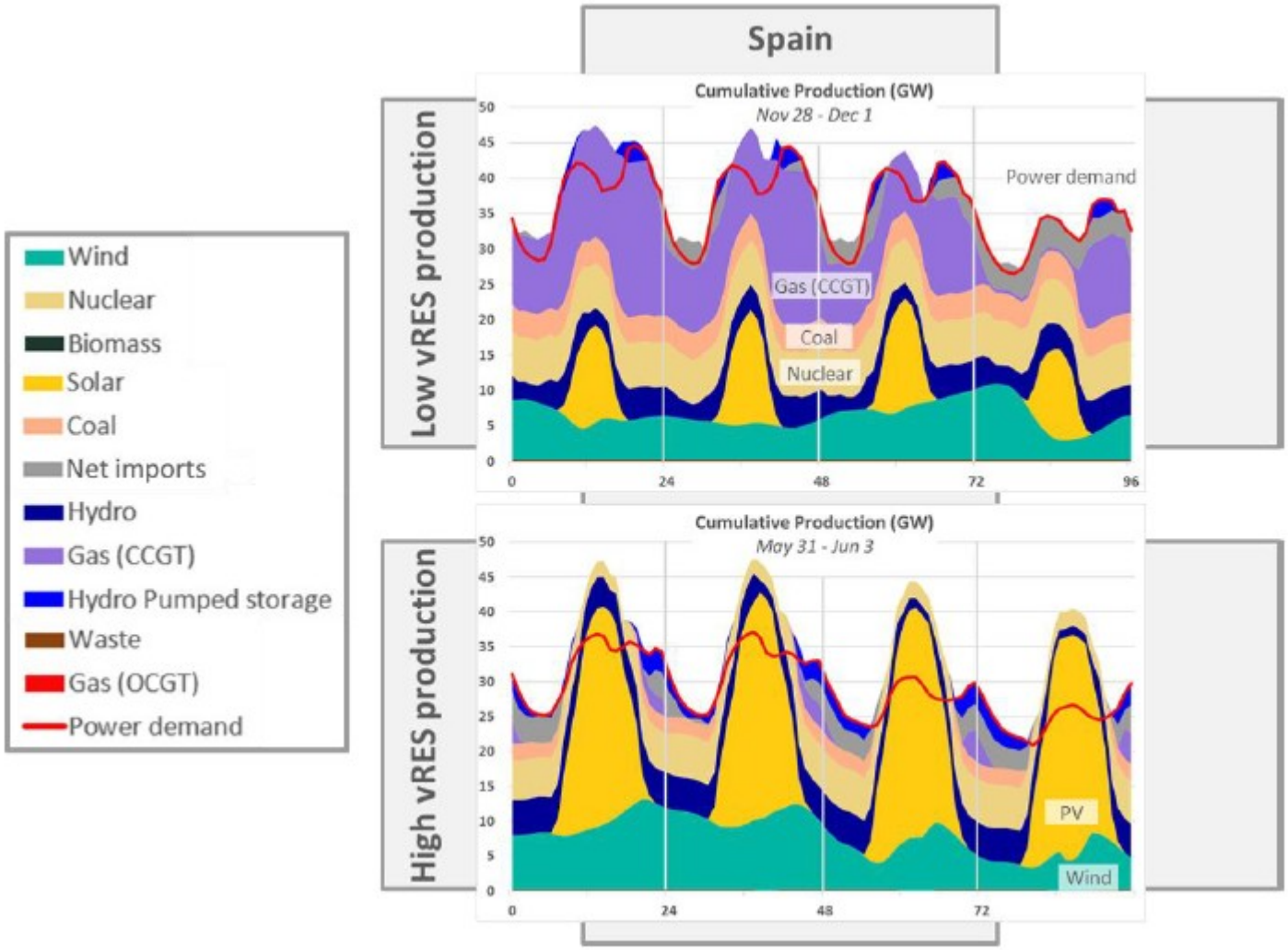
- The cost breakdown of renewables is very different from most fossil-fuel and nuclear technologies
- High capital costs necessitate government support via subsidies to ensure a rate of return for the developer
- Low operating costs mean that short run marginal costs are very low, so that a low price can be bid for dispatch
- Effectively, when the wind blows strongly or the sun shines brightly the price of excess renewable energy can be zero or even negative

Renewables create over-generation risk



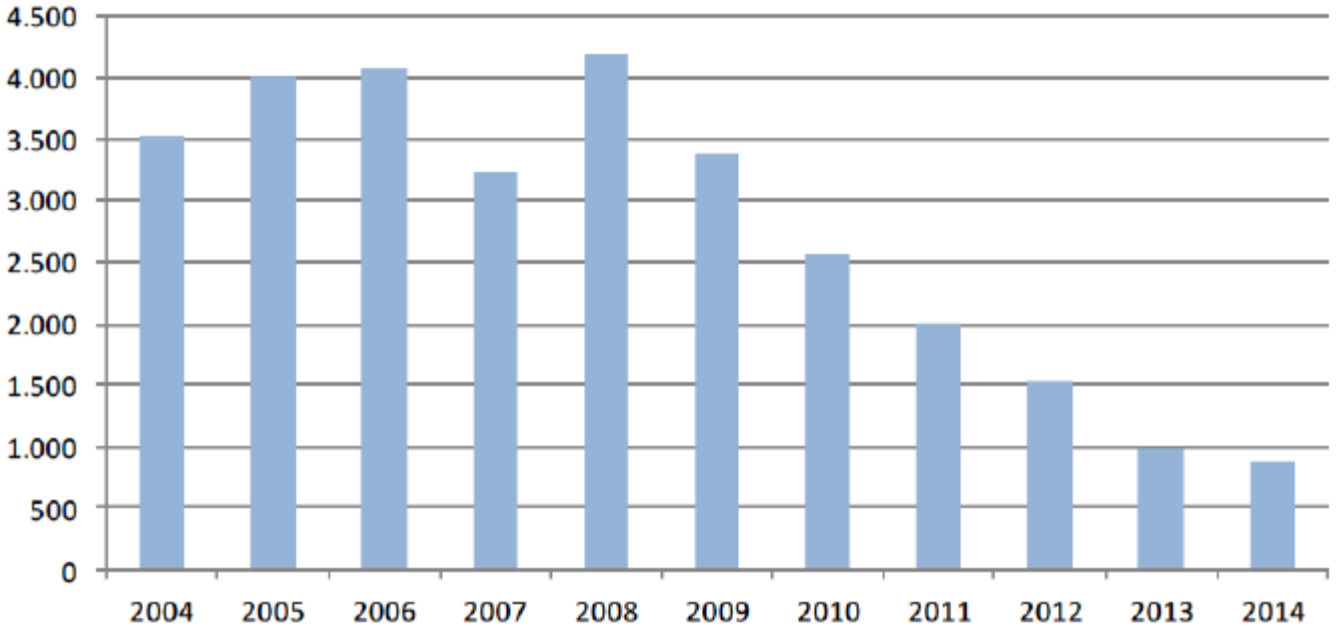
- Net load (total electricity demand less generation from wind and solar PV) varies dramatically according to weather
- As renewable generation increases, so low point gets lower, increasing the risk of having too much base load capacity
- In a worst case scenario curtailment is required, undermining project economics

The impact of renewables on fuel inputs for power generation



- Dramatic difference in fossil fuel use between seasons
- What incentives are needed to keep a fossil fuel plant open?

Hours of effective operation by Gas-Fired Plants in Spain



- The Spanish market provides a good example of the impact of renewables of fossil fuel generation
- Gas-fired plant utilisation has fallen to below 20% on average, and many station have been mothballed of shut down
- Low coal prices have also encouraged a renewables-coal mix, which has also been seen in Germany

Let’s build a model

- Capacity – 750MW, efficiency 54%
- Capital Cost – US$978/kW (construction time 3 years)
- Fixed Cost – US$11/kW
- Variable Costs – US$3.5/MWh
- Assumed utilisation – 85% for 20 years production life
- Gas price – US$5/mcf; carbon price $21 per tonne
- Electricity price - $50/MWh
- Project life – 20 years – straight line depreciation
- Tax rate – 20%

WACC assumptions

- Risk-free rate – 1.75%
- Equity market return – 10.53%
- Company Beta - 0.49
- Company interest rate – 4%
- Tax rate – 20%
- Debt:Equity split – 50:50