A Power Plant (6)

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The Economics of Energy Corporations (2)

Outline of the course

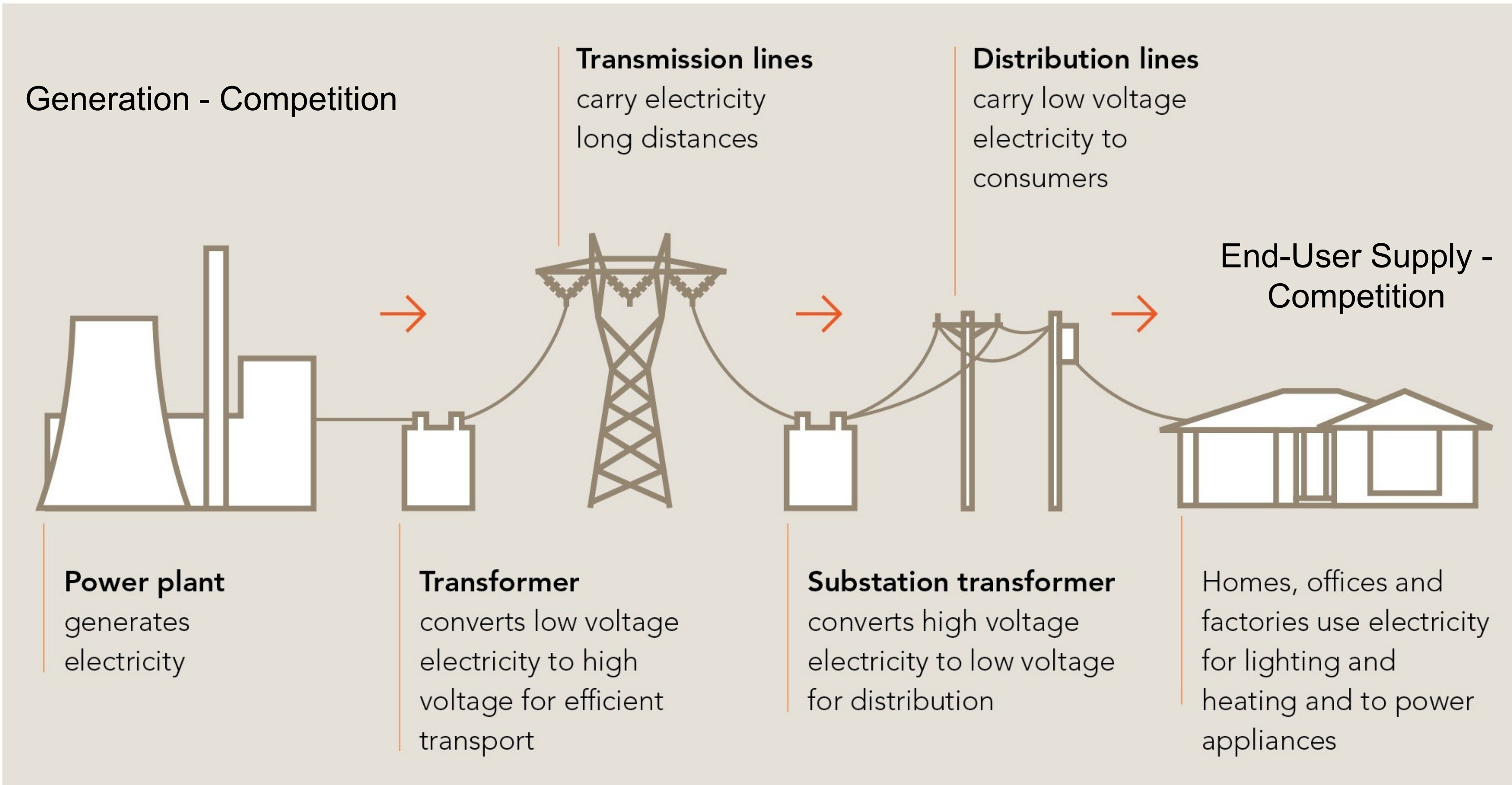
Overall objective – understand how senior management use economic models to make investment decisions

1. Introduction to key themes in the global energy market
2. Introduction to financial modelling as a management tool
    1. Understanding some key concepts
3. Starting two models for an oil and a gas field – revenues and prices
4. Inputting the costs – capital expenditure
5. Operating costs and paying the government
6. **A power plant – a buyer and seller of energy**
7. Calculating a discounted cashflow
    1. Why is it important
    2. How is it used to make decisions
8. Testing the investment decisions: running some numbers under different assumptions
9. Answering your questions

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

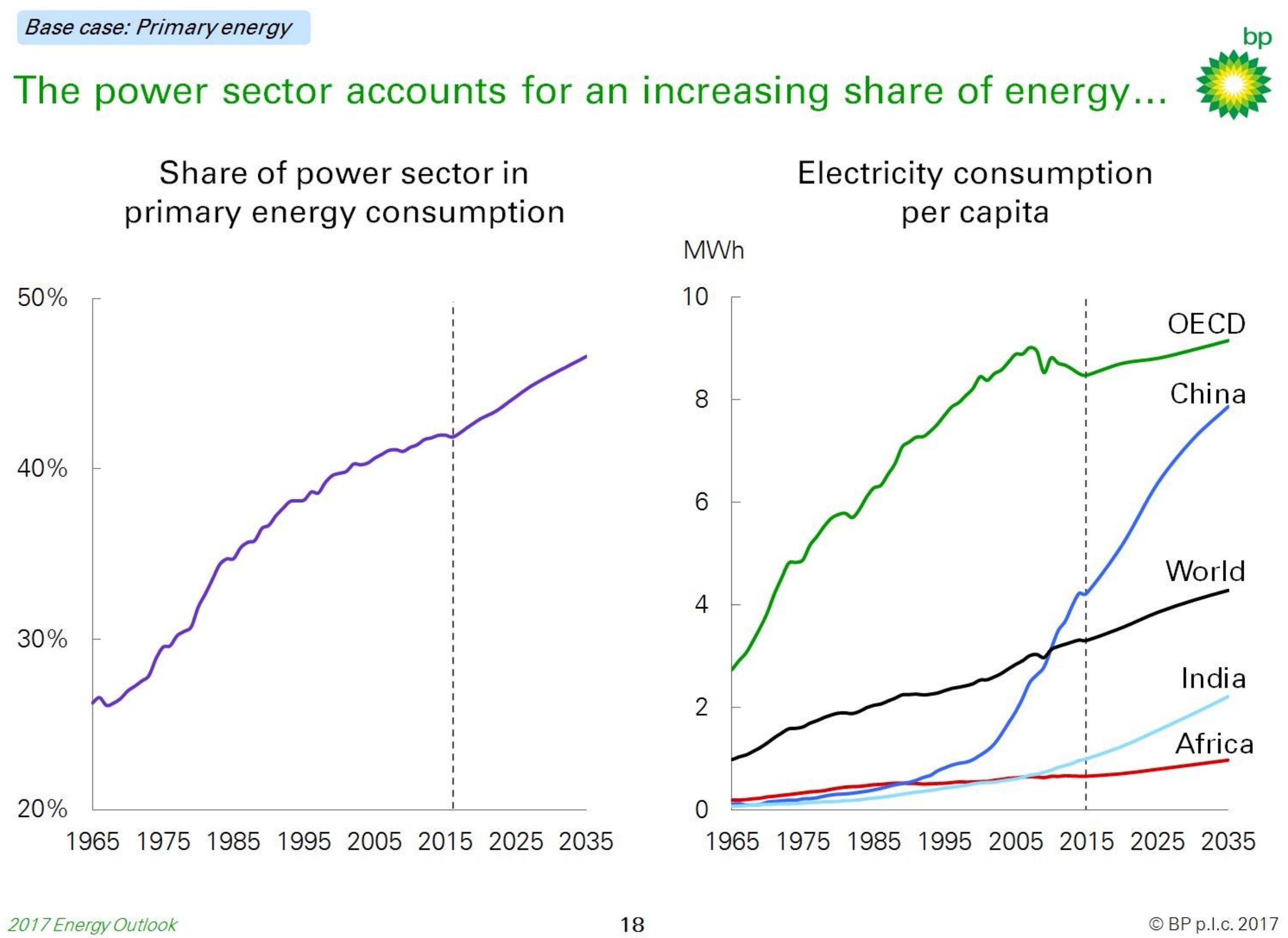


TRANSPORT OF ELECTRICITY

Transmission and Distribution – Regulated

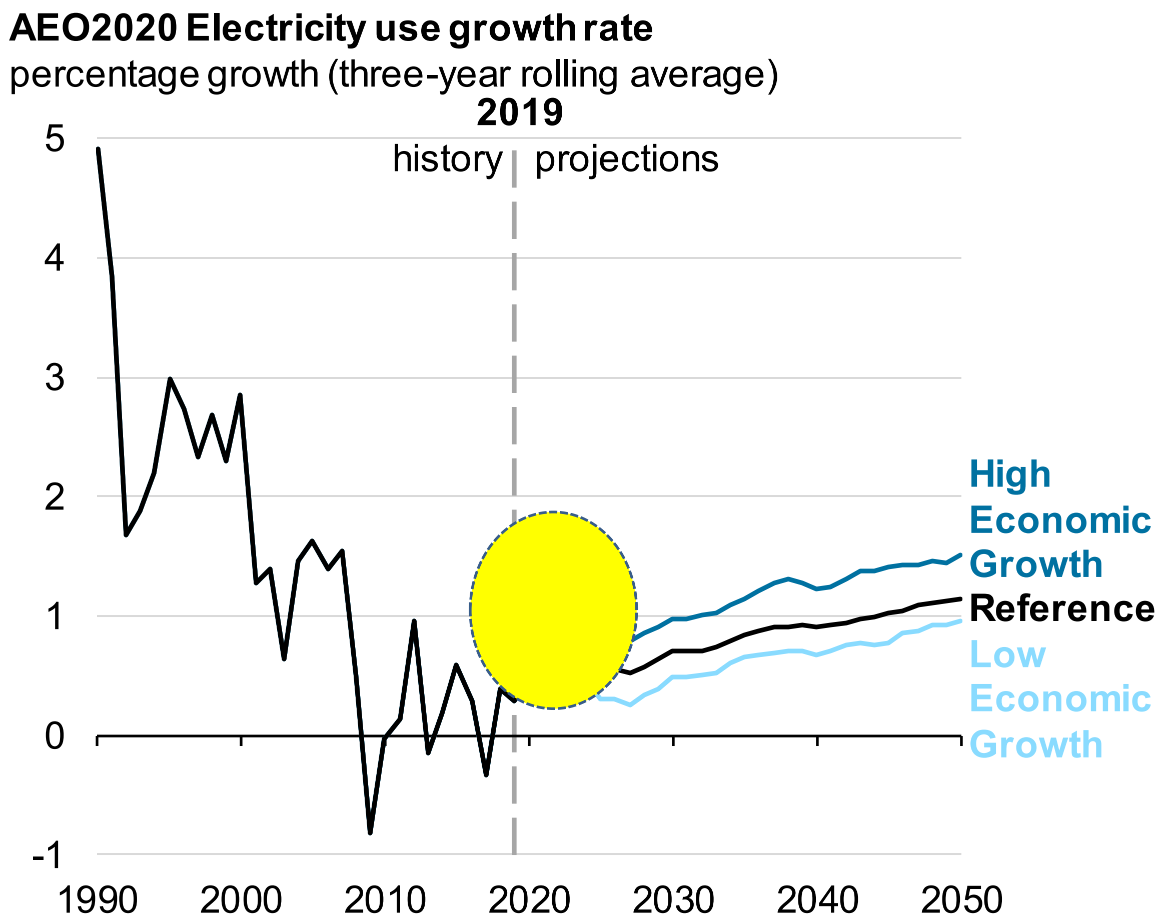
- Electricity sector is a mixture of regulated and unregulated segments
- As renewable energy is introduced, and as demand patterns change, the complexity for energy companies in all parts of the chain increases

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?

US electricity consumption forecast

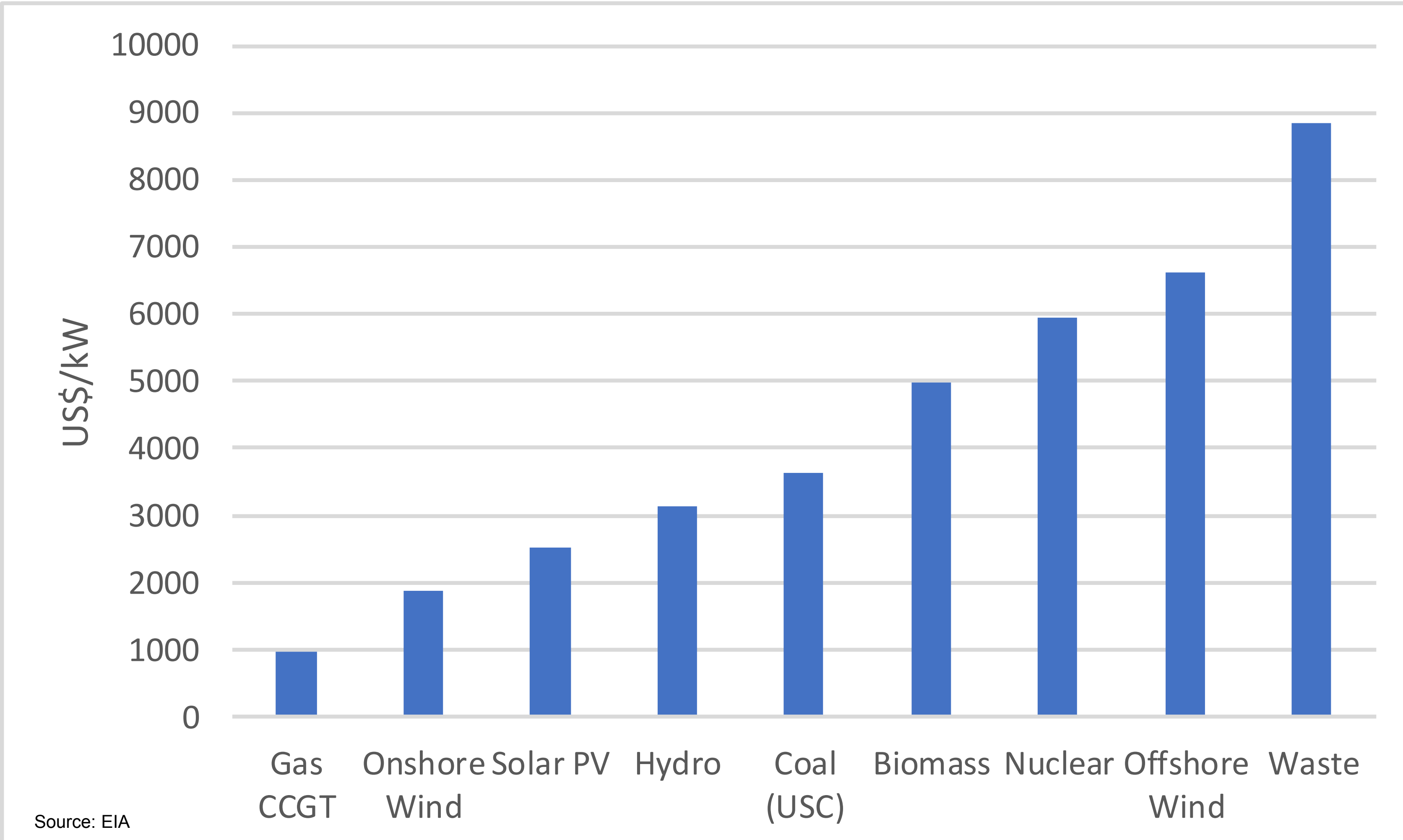


- Covid-19 impact and recovery followed by steady growth

Key Economic Concerns

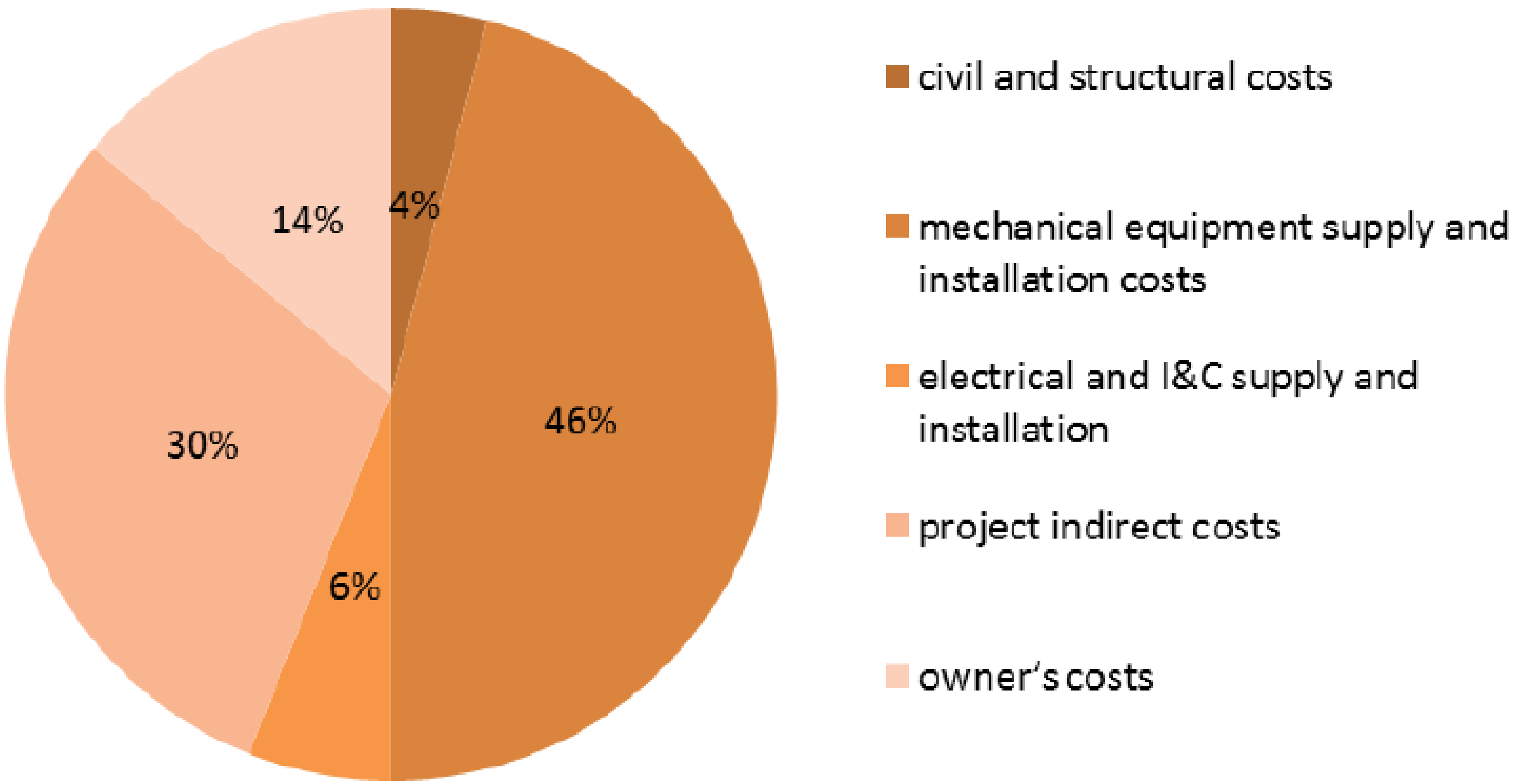
- Capital and operating costs – but these are largely fixed
- Electricity prices
- Input price of gas
- Carbon price
- Capacity utilisation

Capital cost comparison



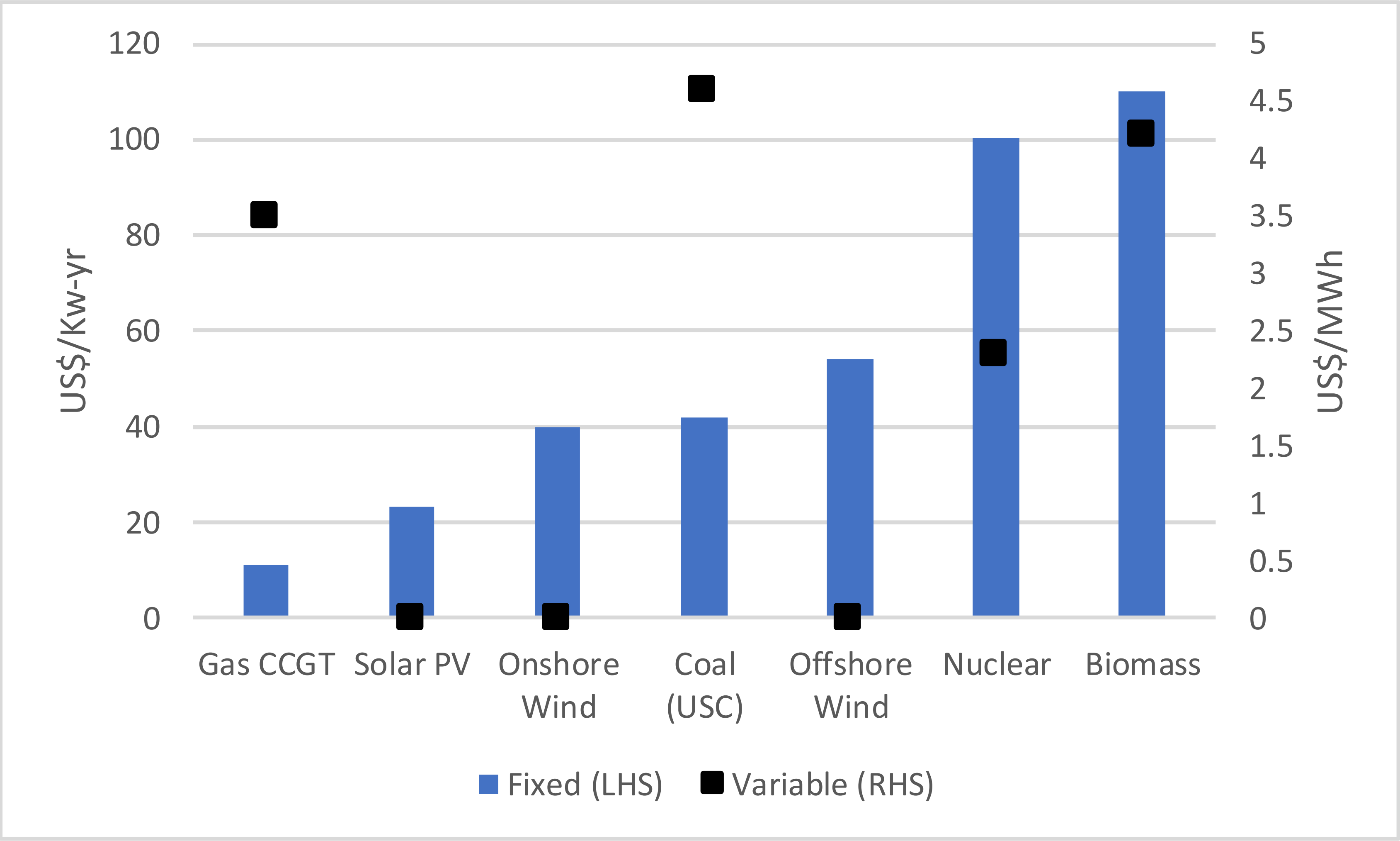
- Gas looks very cheap compared to alternatives on a capital cost basis

Breakdown of costs for CCGT



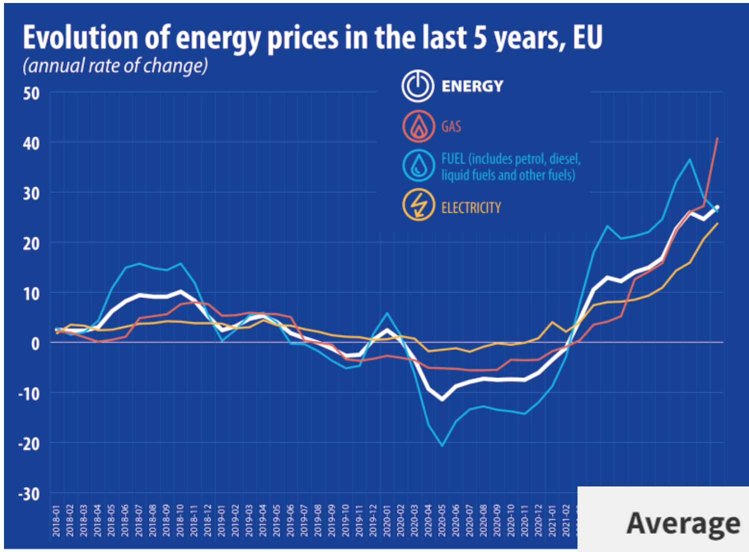
- Different contractors for each element, can costs will vary by region and level of competition

Operating cost comparison

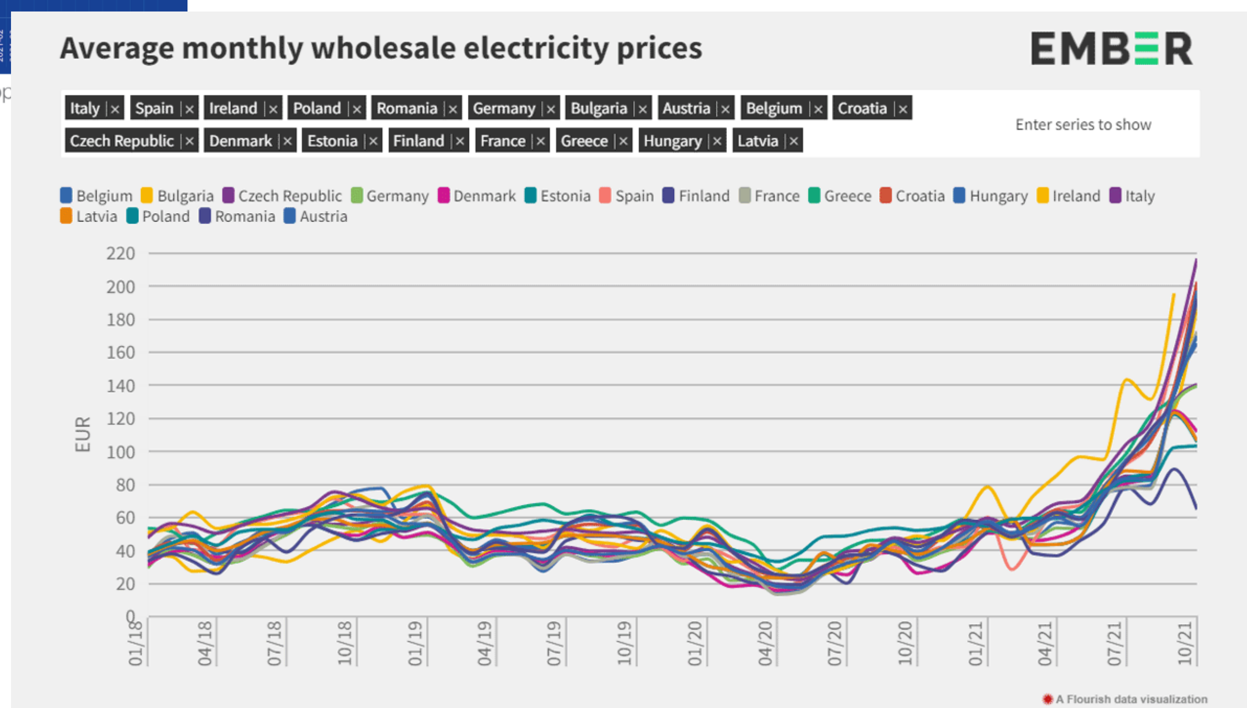


- Note difference between fixed and variable costs – renewables have no variable opex

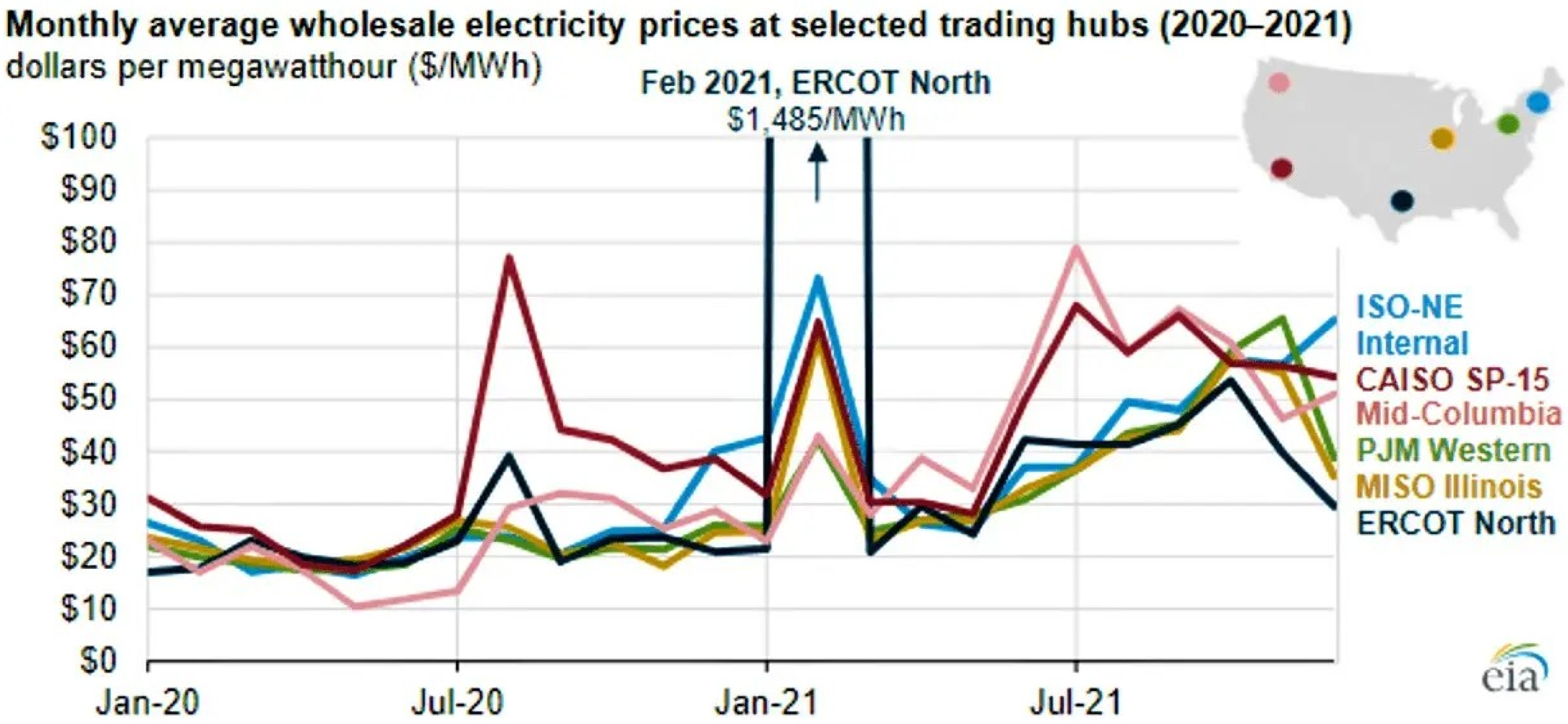
European electricity price is on the rise



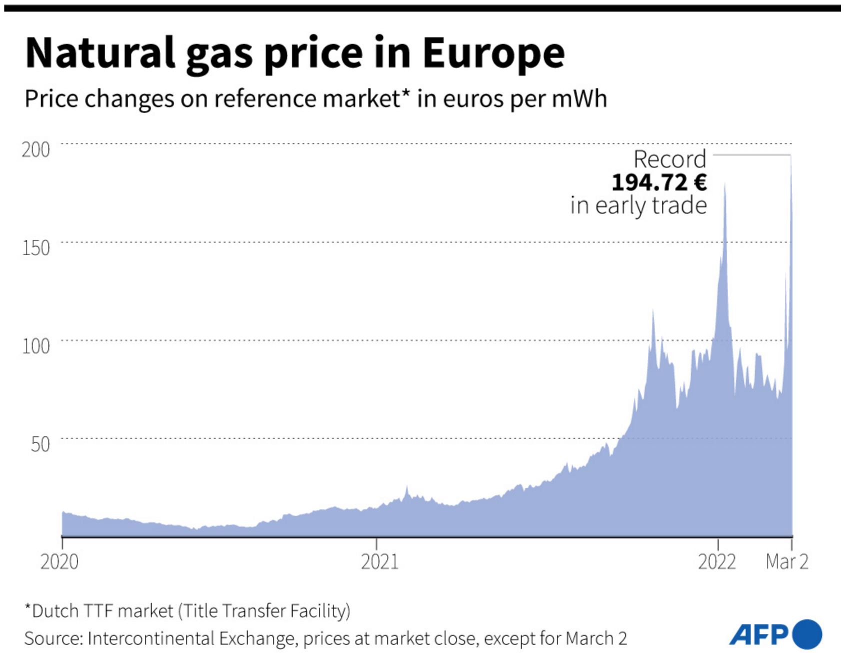
ec.europ

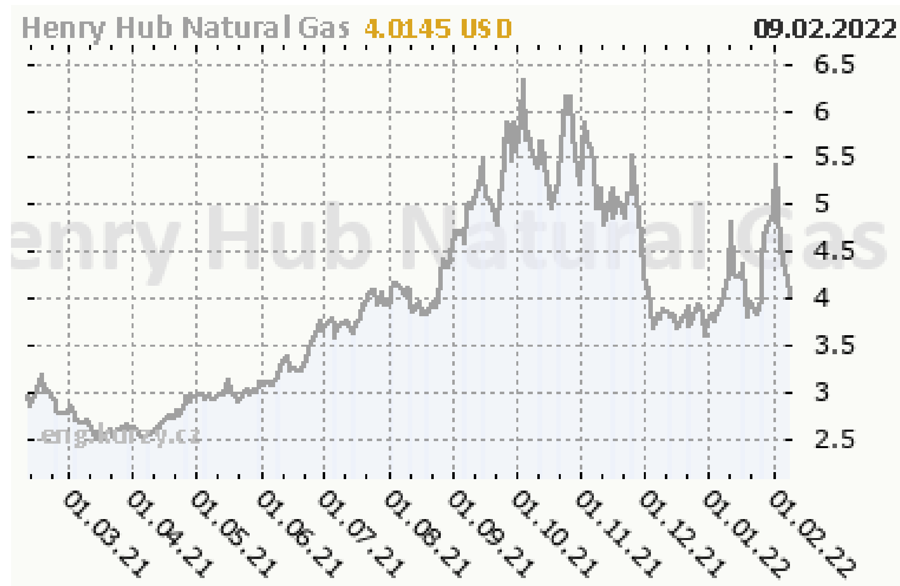


US electricity price already quite volatile



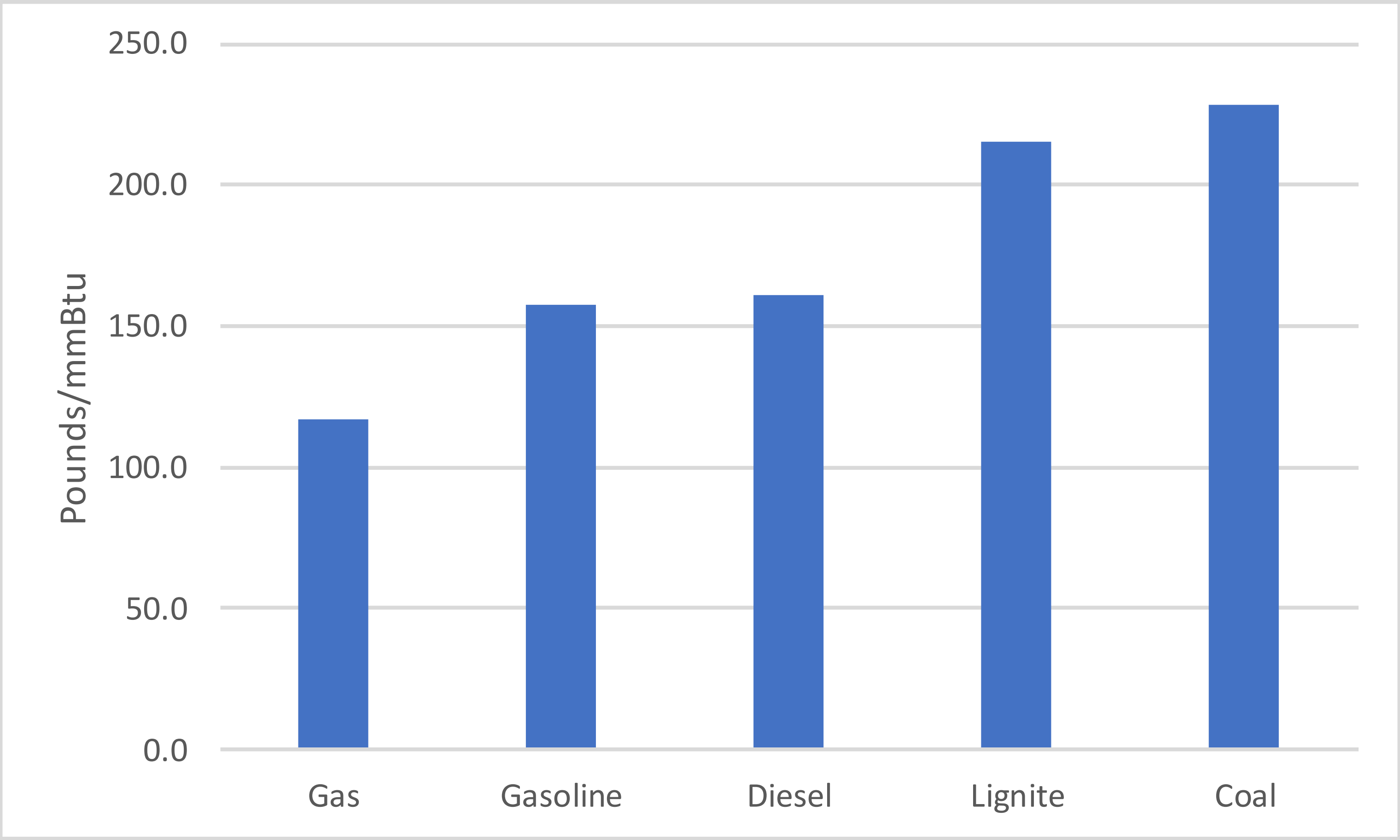
Gas input price is a key driver





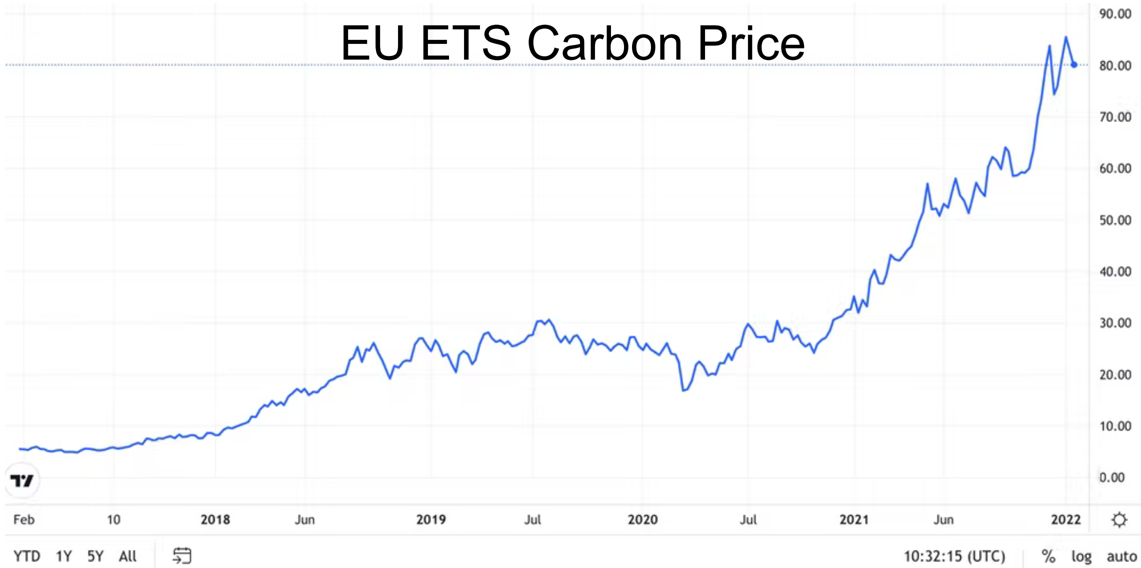
- European gas price has been as high as €195/MWh, but now at €120/MWh ($40/mmbtu)
- US gas price has also risen sharply, but remains at much lower levels of c.$5.50/mmbtu

Carbon output by fuel



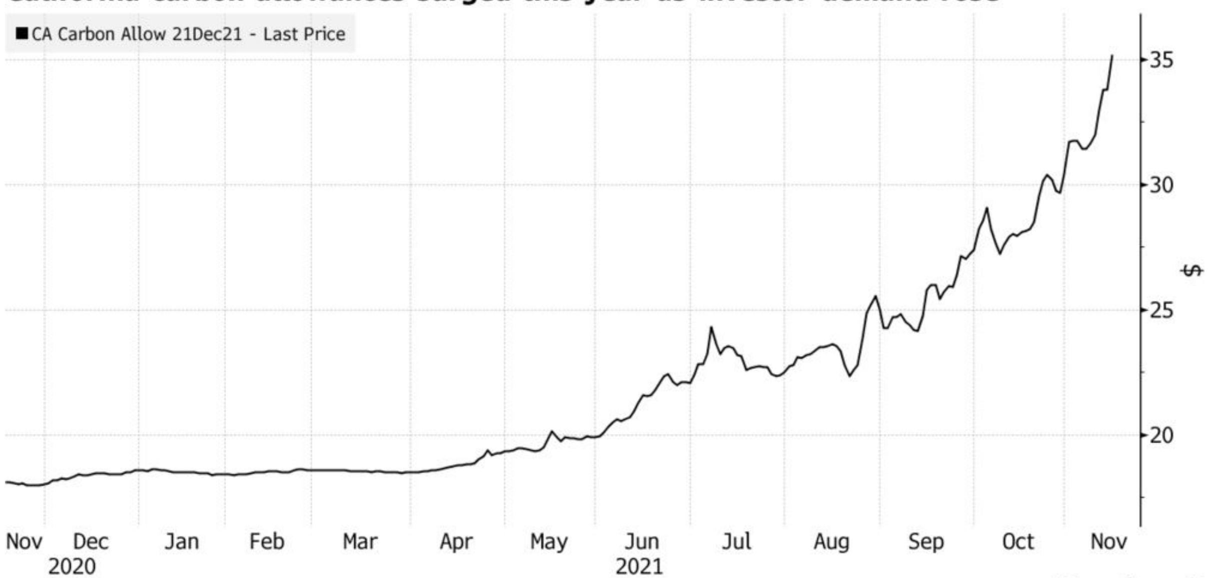
- Coal emits roughly twice as much carbon as natural gas

Carbon prices vary widely between EU and US



Carbon Cost

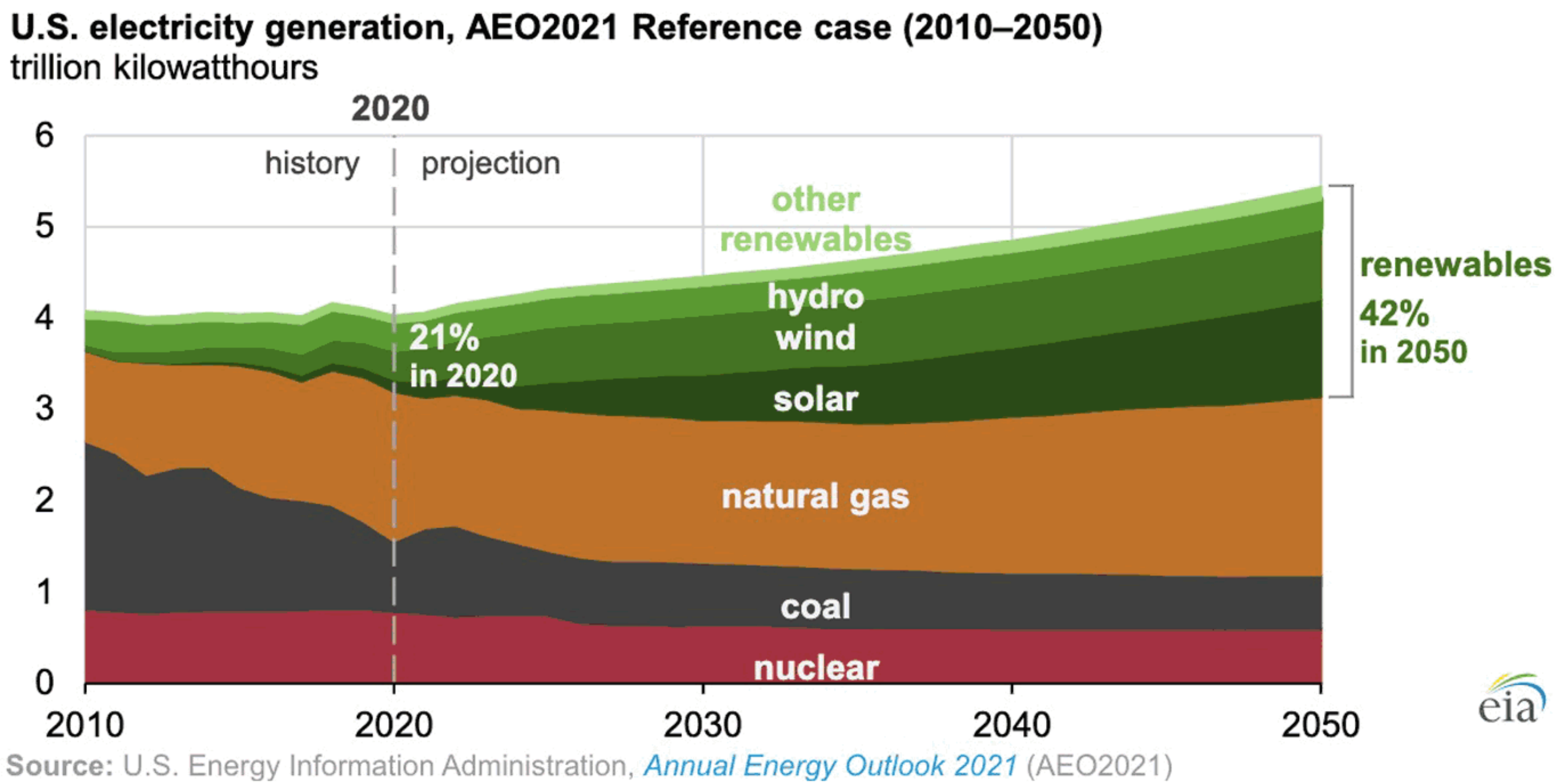
California carbon allowances surged this year as investor demand rose



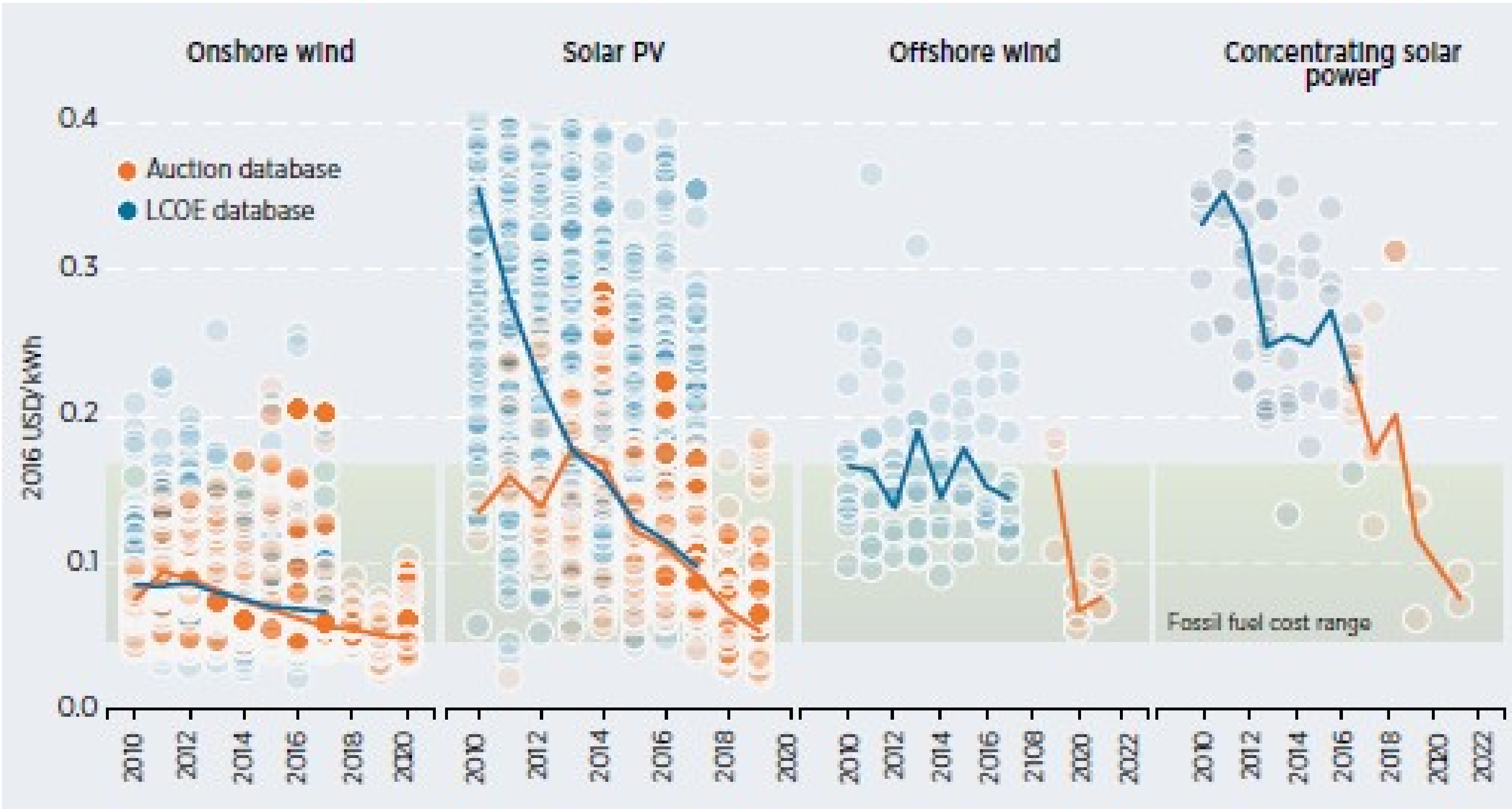
Source: ICE

Bloomberg

The outlook for renewables has increased significantly

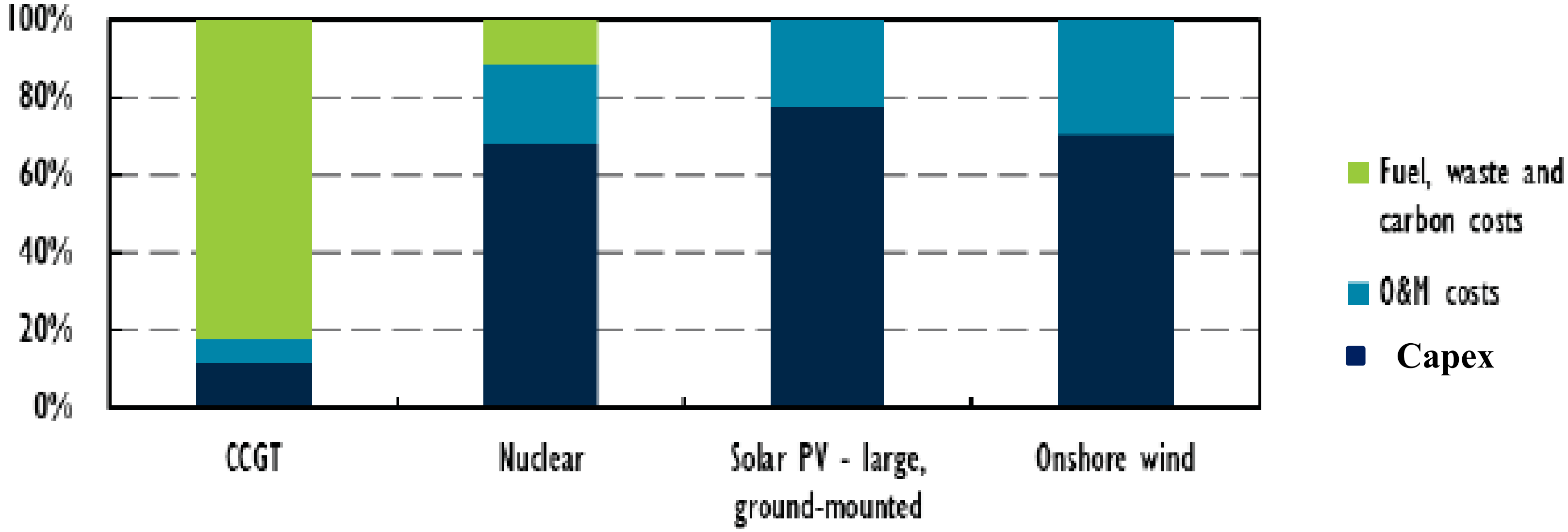


Outlook for costs based on auctions



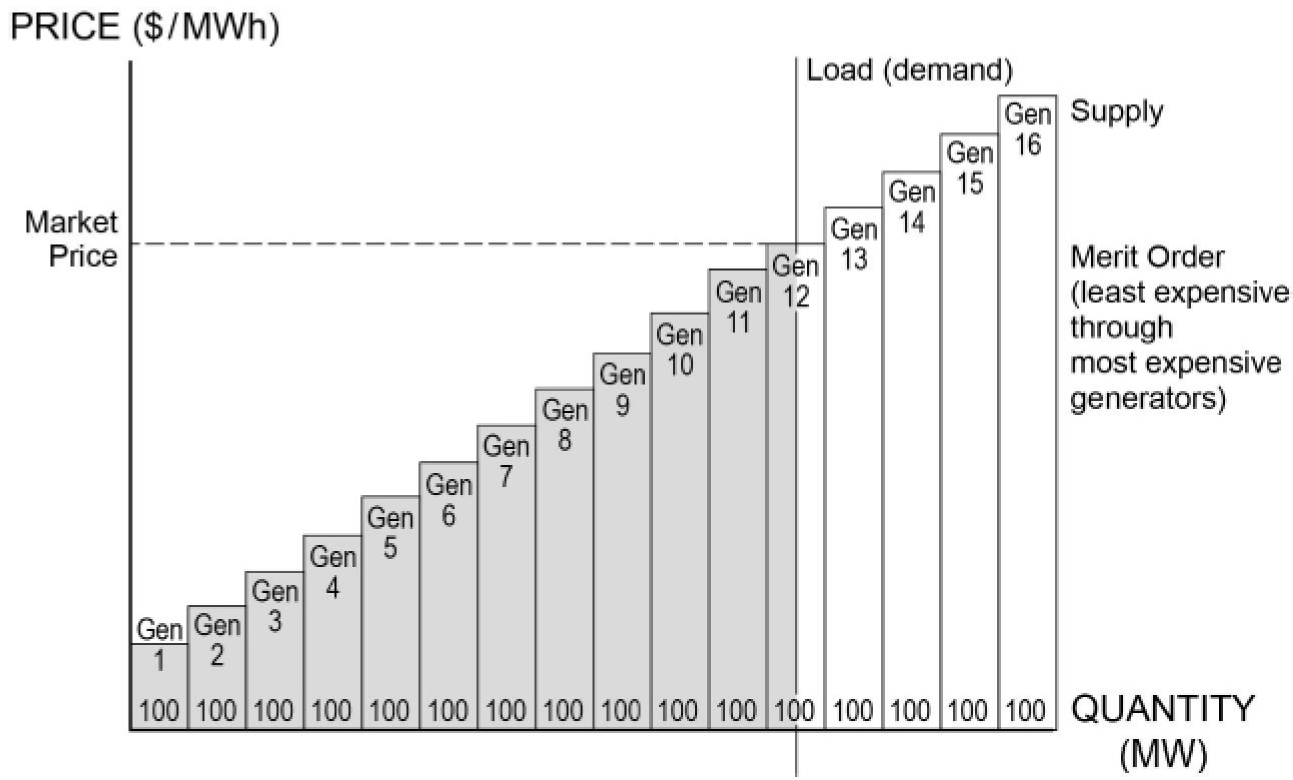
- The cost of renewable energy is falling fast, and is getting very close to the range of fossil fuel generation
- Once subsidies are no longer required, a tipping point could be reached
- Key question revolves around the cost of intermittency and the need to provide back-up capacity

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

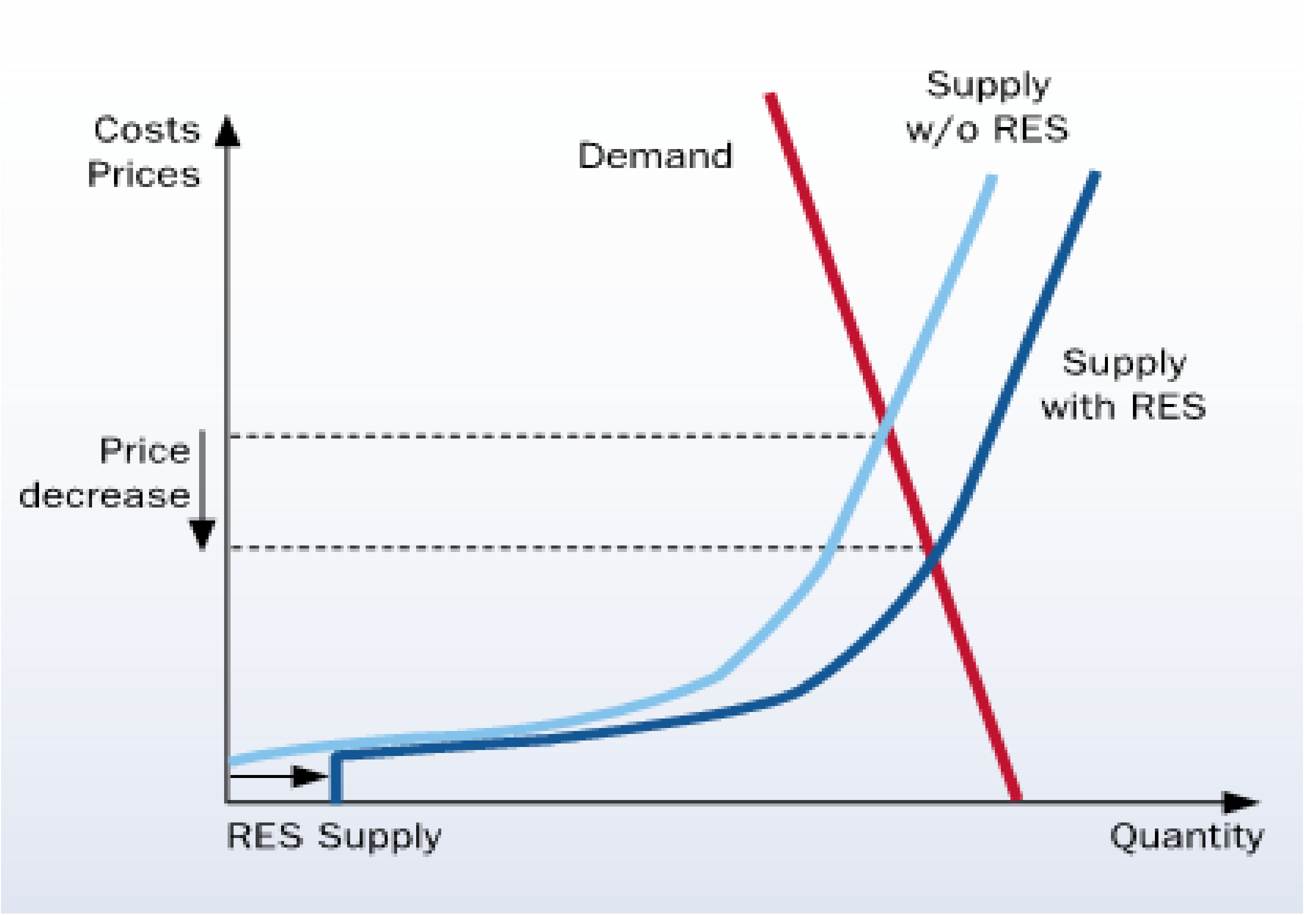
Stylised merit order for power generation



- 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

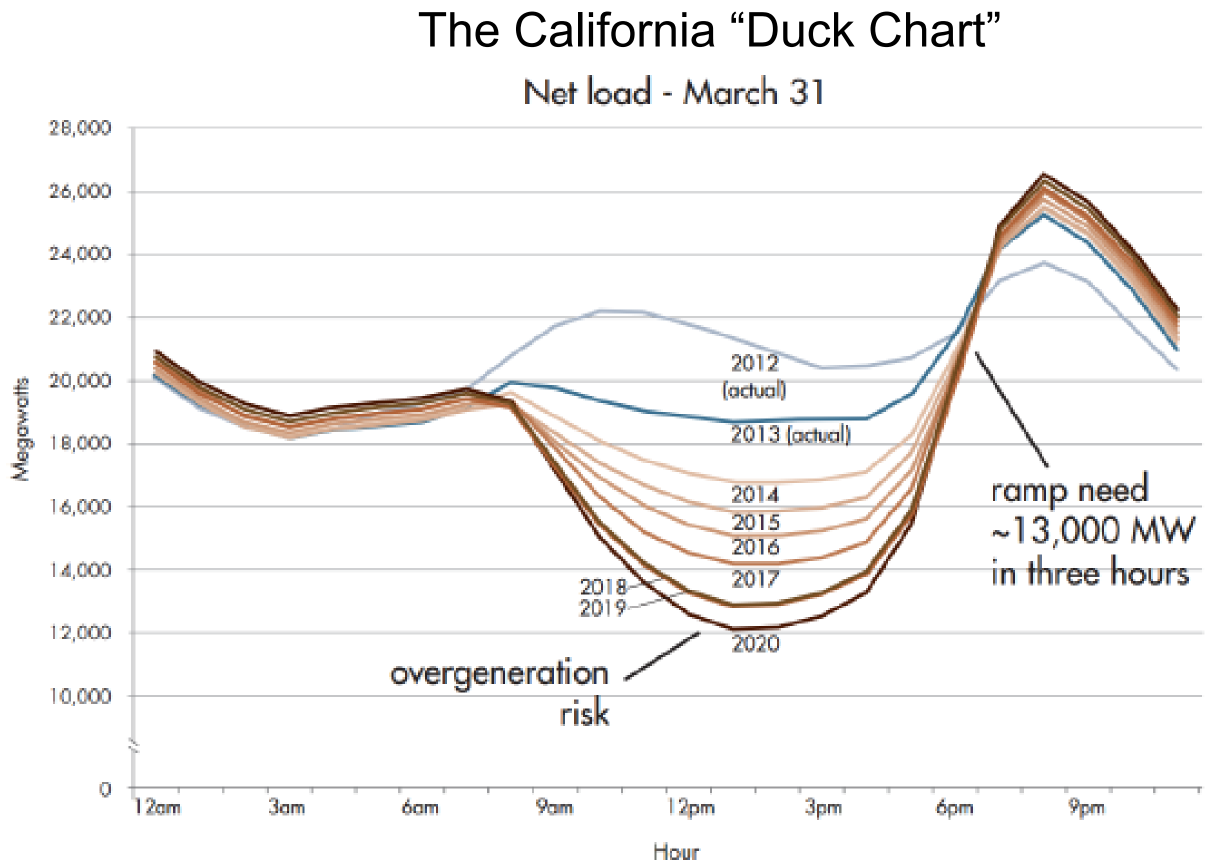
Renewables and the merit order effect

Introduction of renewables alters supply curve



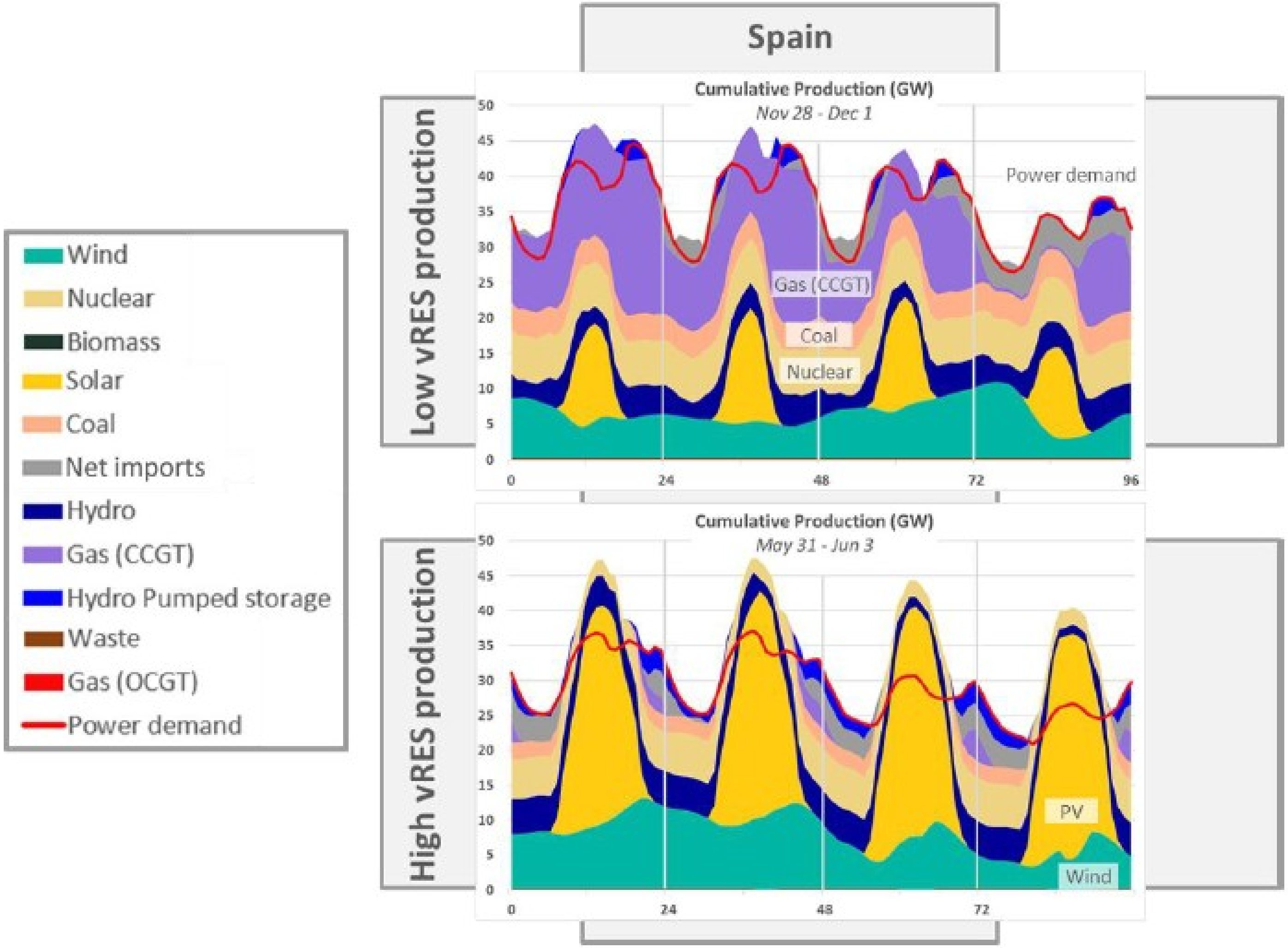
- Renewable energy has guaranteed dispatch, and so moves all higher cost supply out
- The wholesale price declines as demand is satisfied at a lower level

Renewables create over-generation risk



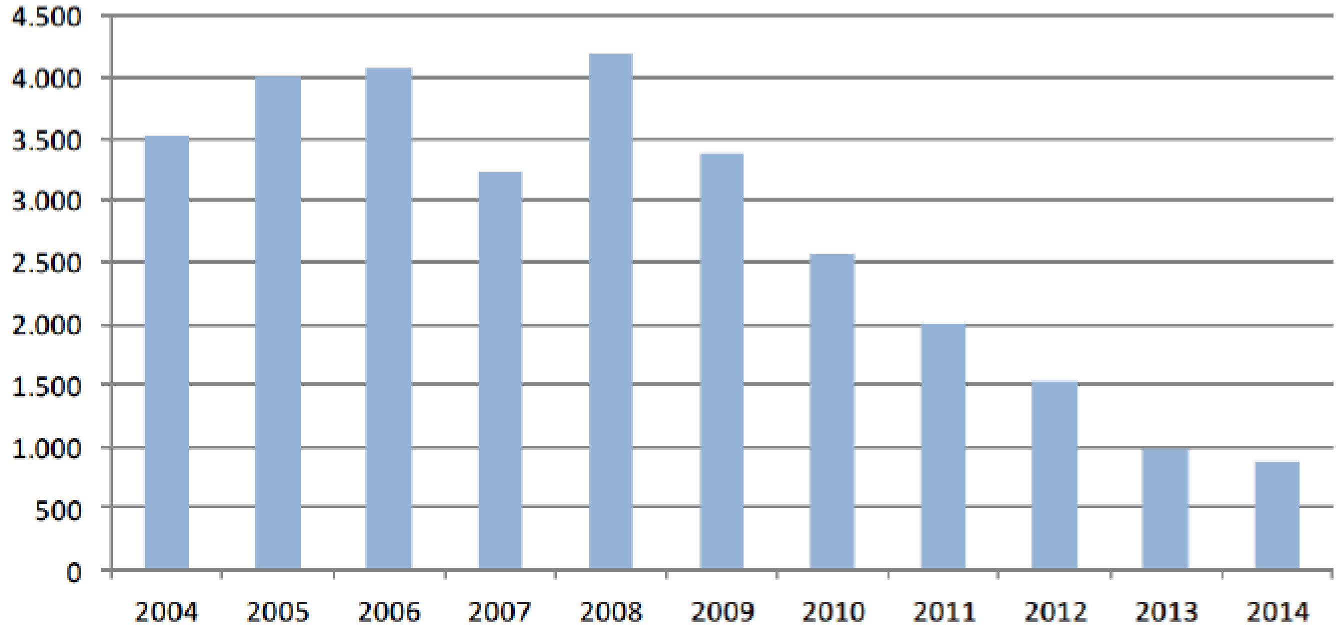
- Net load (total electricity demand less generation from wind and solar PV) varies dramatically according to weather
- As renewable generation increases, so low point gets lower, increasing the risk of having too much base load capacity
- In a worst case scenario curtailment is required, undermining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

Key Questions

- What is electricity demand likely to be?
- How much of it will be satisfied by renewable energy?
- What will this do to the electricity price?
- What will this do to utilisation of hydrocarbon-fuelled power stations?

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$4/mcf; carbon price $35 per tonne
- Electricity price - $55/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 – 3%
- Tax rate – 20%
- Debt:Equity split – 60:40

Let’s change the model

- Capacity – 900MW, efficiency 54%
- Capital Cost – US$978/kW (construction time 3 years)
- Fixed Cost – US$11/kW
- Variable Costs – US$3.5/MWh
- Assumed utilisation – 70% for 20 years production life
- Gas price – US$2/mcf; carbon price $30 per tonne
- Electricity price - $40/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 – 0.70
- Company interest rate – 4%
- Tax rate – 20%
- Debt:Equity split – 70:30

Let’s make some forecasts!

- Base case
- Upside case
- Downside case
- Disaster (worst) case
- Does the investment need to work in all of these scenarios?

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