

A study of the business case for Natural Gas Combined Cycle Power Plant with Carbon Capture and Storage in the UK

Name: Richard Harrap

1. INTRODUCTION:

- Carbon Capture and Storage (CCS) offers a way to reduce CO₂ emissions and meet targets whilst reducing total electrical system costs
- As intermittent renewables increasingly enter the power grid the issue of 'missing money' for the remaining generators is worsened
- UK CCS competition is entering the commercial negotiation phase with Government over the Contract for Difference strike price

2. RESEARCH QUESTIONS:

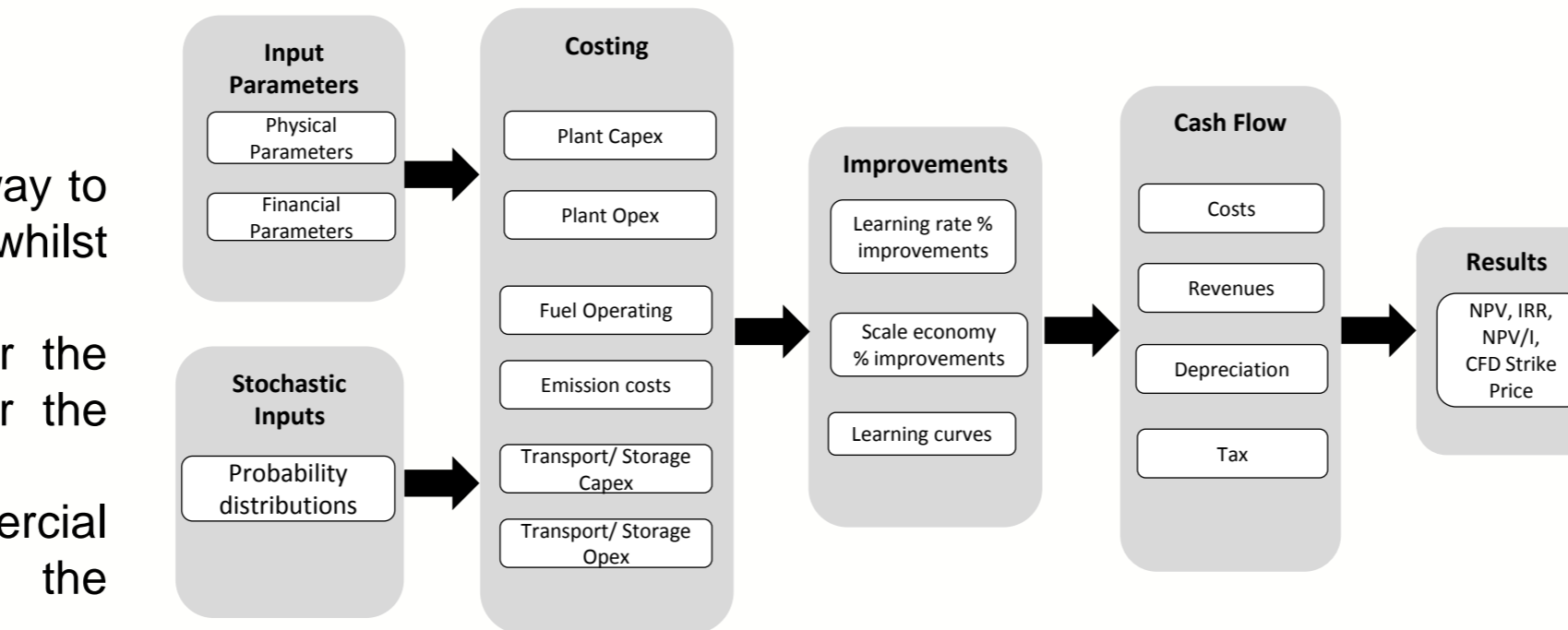
- What CFD strike price will be required for the first commercial NGCC CCS plants and how will the strike price reduce in the future?
- What role could NGCC CCS have in power generation for providing low carbon base load and/or balancing supply?
- How could energy market designs or policies help improve the business case?

3. SCOPE OF STUDY:

- 500MW commercial combined cycle gas power plant
- Offshore storage of CO₂ in depleted gas field
- 3 year construction, 30 year operation
- 10% discount rate, 0.3 NPV/Capex hurdle rate

4. BASE YEAR (2015) MODEL:

- Used detailed NGCC CCS plant costing data from US and UK state-of-the-art proposals
- CFD strike price found to be **£134/MWh**
- Over **50%** costs from capex for plant, pipelines and storage



5. MODEL VALIDATION:

- Sensitivity analysis of 6 key variables with literature comparison of financial metric results
- CFD strike price and gas price found to have most significant impact

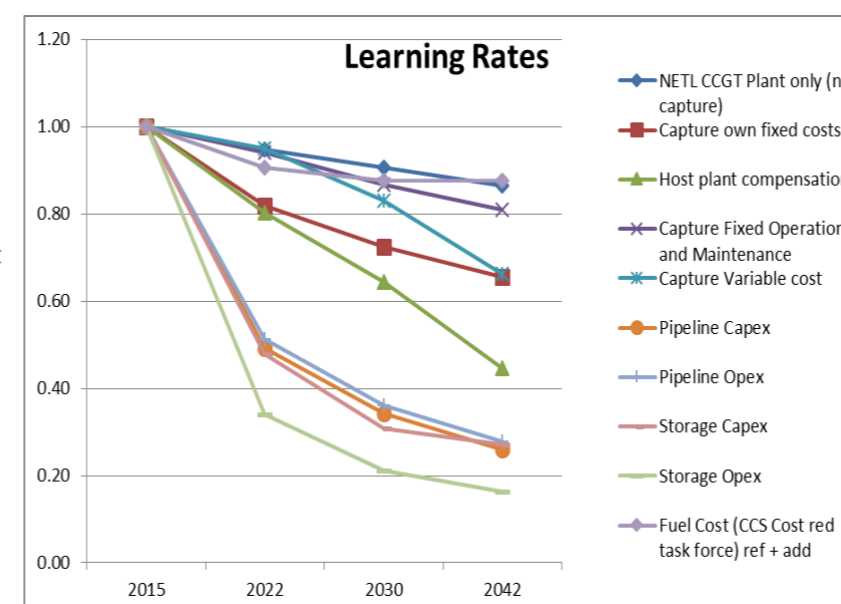
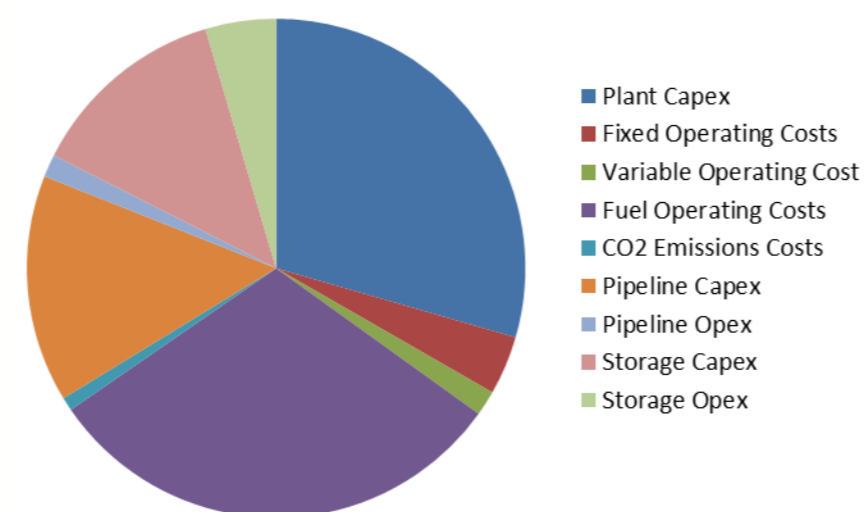
6. UNCERTAINTY ANALYSIS:

- Investigation of distribution of the uncertainty of 6 key variables and the combined output NPV uncertainty
- High level of uncertainty with 26% probability of negative NPV

7. LEARNING AND SCALE ECONOMIES:

- Bottom-up engineering approach taken with check from learning curve approach
- Projections for 2022, 2030, and 2040 (**£81/MWh**)

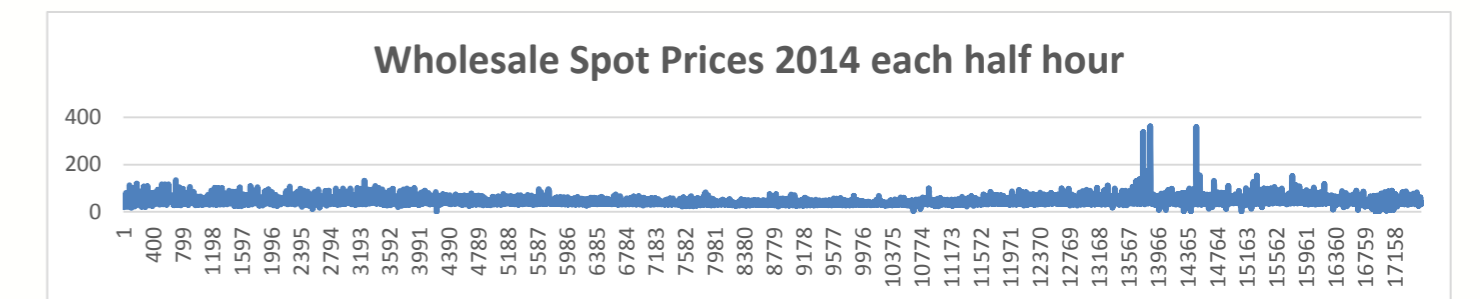
Cost breakdown for base case



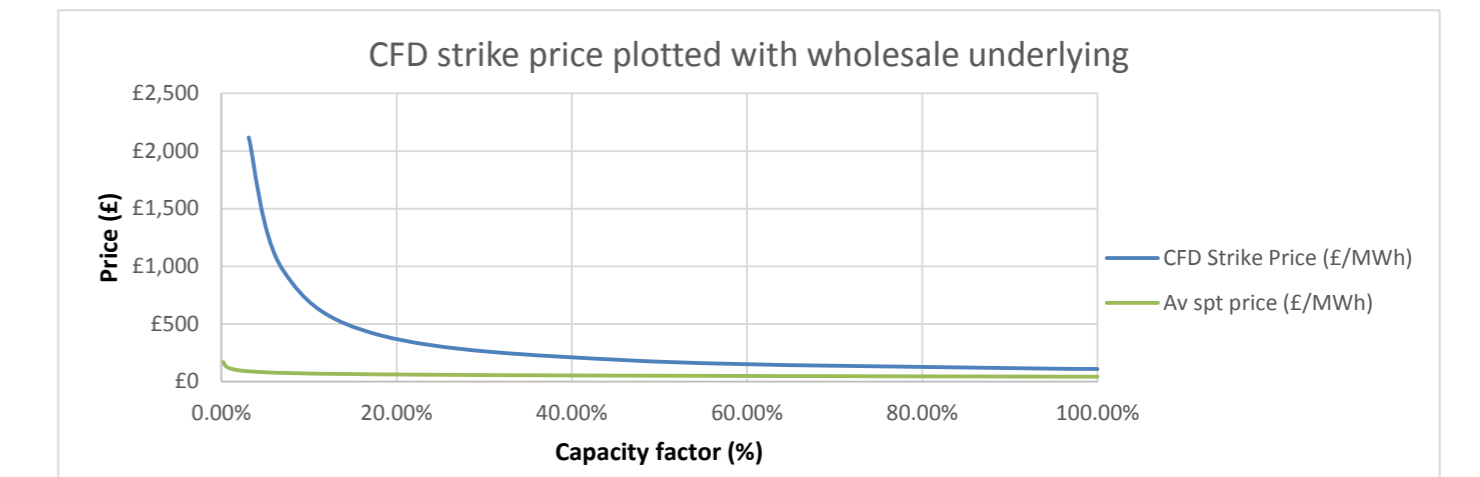
8. BASE LOAD VRS BLANCING:

- Capacity factor varied with threshold start up spot electricity price

Threshold start up price (£/MWh)	0	10	20	30	40	50	60	70
Capacity Factor (%)	100.00	99.76	99.28	92.47	46.92	18.28	7.01	3.13
Av spot price (£/MWh)	42.0	42.1	42.3	43.3	51.3	62.3	75.3	89.1
CFD Strike price (£/MWh)	£116	£116	£117	£122	£198	£438	£1,071	£2,346
Subsidy	£74	£74	£75	£79	£146	£376	£996	£2,256



- High capex relative to opex results in rapid erosion of business case as capacity factor reduces



9. MARKET DESIGN:

- Investigated alternatives such as capacity market with spot market sales and combining with Contracts for Difference
- Capacity market auction price for Dec 2014, £19.40/kW per year applied
- Application of capacity market with NGCC CCS and spot market sales found to be insufficient for positive NPV
- Small improvement in CFD possible with capacity market and CFDs i.e. from £134/MWh to £131/MWh

10. CONCLUSIONS:

- The required NGCC CCS strike price is projected to fall from the current £134/MWh to £81/MWh
- NGCC CCS is likely to be operated at base load unless there was a significant change to the capacity market structure