Costs of Offshore Wind Presentation

Costs of Offshore Wind

R Camilla Thomson and G P Harrison

Institute for Energy Systems, School of Engineering, University of Edinburgh

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Photograph by Andy Dingley via Wikimedia Commons

Introduction

- Understanding the economics of offshore wind is essential, but there is a diversity of views.
- Types of cost:
    - CAPEX – typically high for renewables;
    - OPEX – typically high for fossil/nuclear;
    - Decommissioning – typically high for nuclear.
- Levelised cost of energy (LCOE) avoids limitations of looking at only one of the above.
- System costs are usually excluded from LCOE, but include:
    - Costs of balancing the system to cope with variable output
    - Costs of providing ‘backup’;
    - Cost of additional transmission and associated losses.

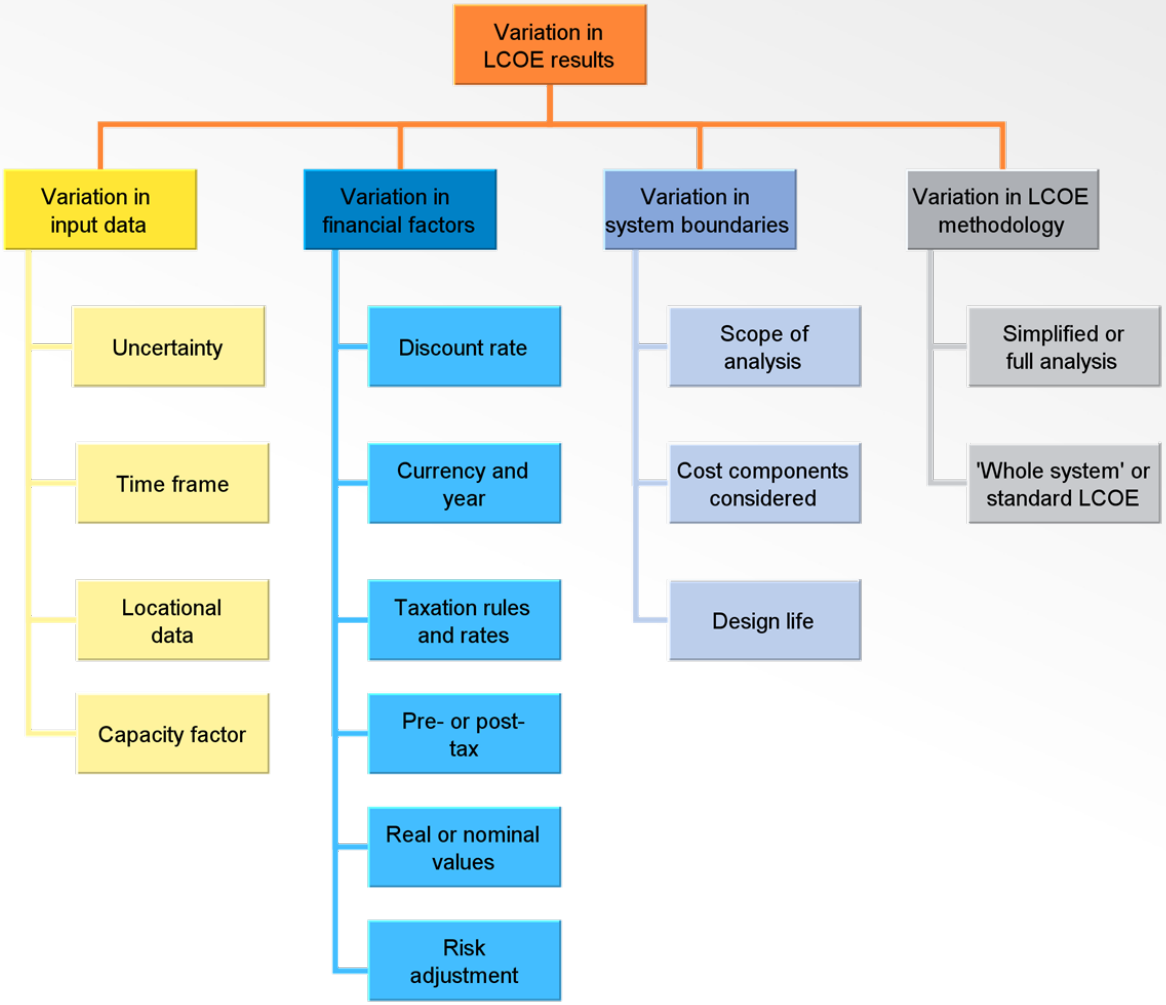
LCOE – IEA method

$$\mathrm{LCOE} = \frac{\sum_{t}^{T} \frac{C_t + O_t + F_t + D_t}{(1+r)^t}}{\sum_{t}^{T} \frac{E_t}{(1+r)^t}}$$

Where:

- *C* is the capital cost (£);
- *O* is operations and maintenance (O&M) cost (£);
- *F* is fuel cost (£);
- *D* is the decommissioning cost (£);
- *E* is the electricity produced (MWh);
- *r* is the discount rate (%);
- *t* is the year in which a cost occurs during the project lifetime *T*.

Sources of variation



LCOE – Full cash flow method

$$\mathrm{LCOE} = \frac{e \times C + \sum_{t=1}^{T} \frac{(1-Tax) \times (O_t + F_t + D_t) - Tax \times (Int_t + Dep_t)}{(1+r_e)^t}}{\sum_{t=1}^{T} \frac{E_t (1-Tax)}{(1+r_e)^t}}$$

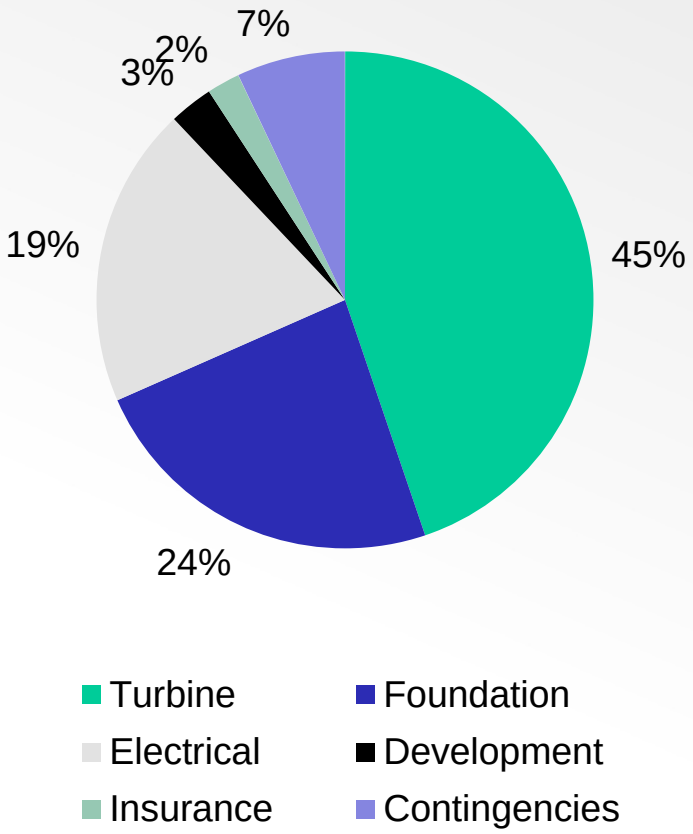
Where:

- *e* is the proportion of the project funded by equity;
- r_e is the return on equity;
- *Tax* is the tax rate;
- *Int* is the interest paid on the loan;
- *Dep* is depreciation.

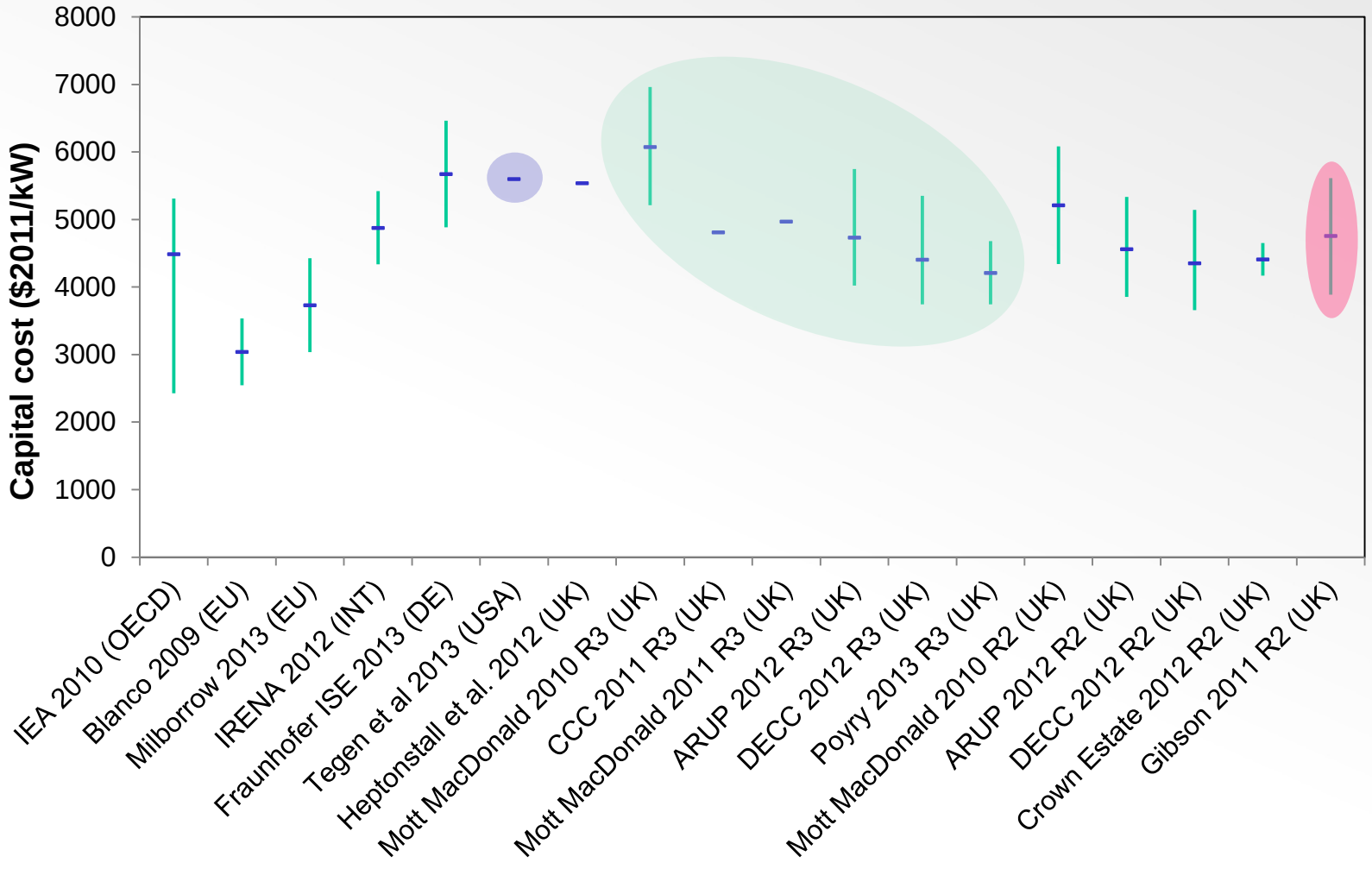
Capital Cost

- 60 to 80% of total life cycle costs
- Largest proportion due to labour costs
  - Particularly manufacture of carbon and glass-fibre rotors
- Significant fluctuations due to commodity prices, year, site conditions, etc.

Typical breakdown of costs
(Source: MottMacdonald, 2011)



Summary of CAPEX estimates

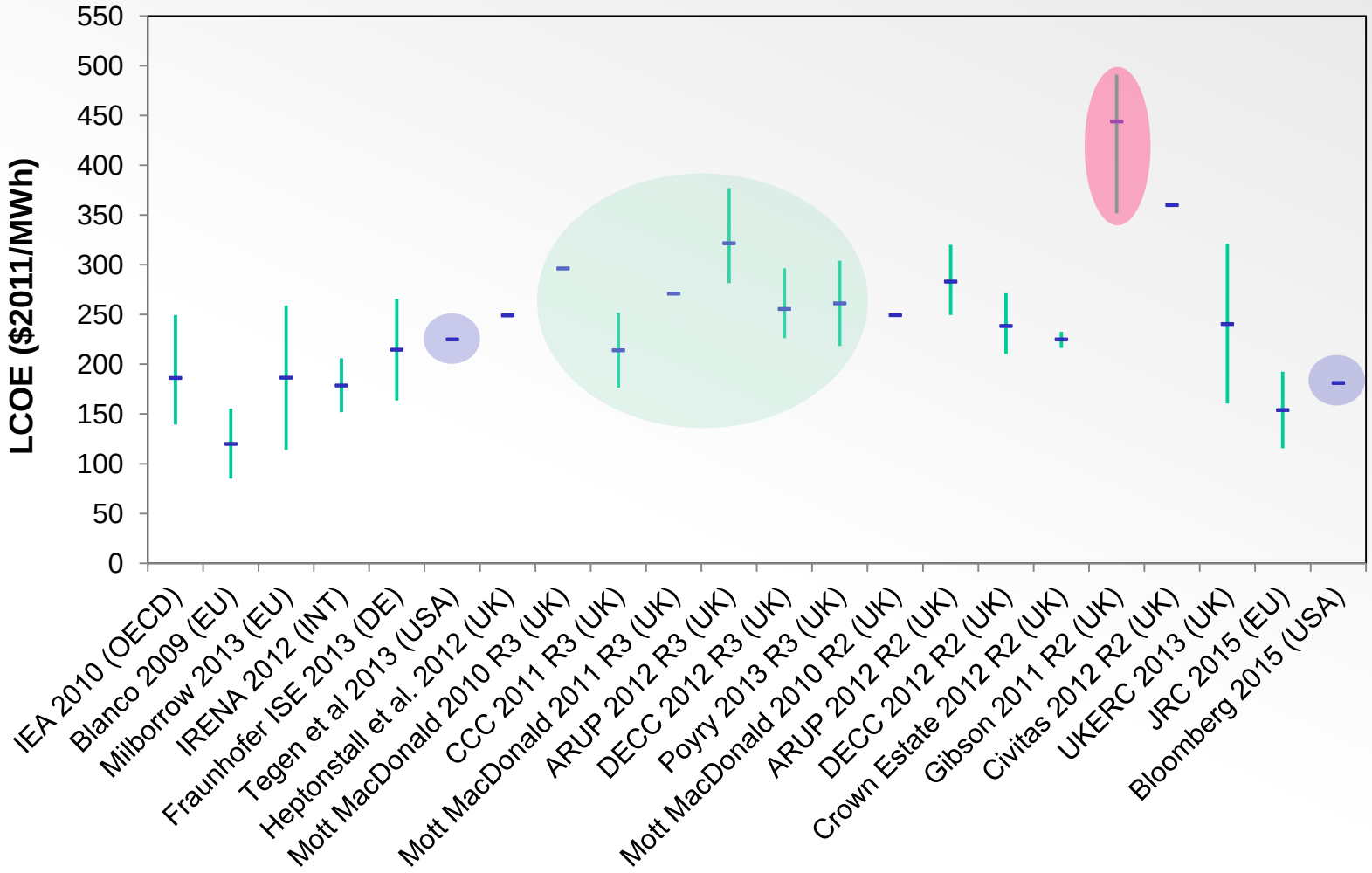


OPEX & Decommissioning

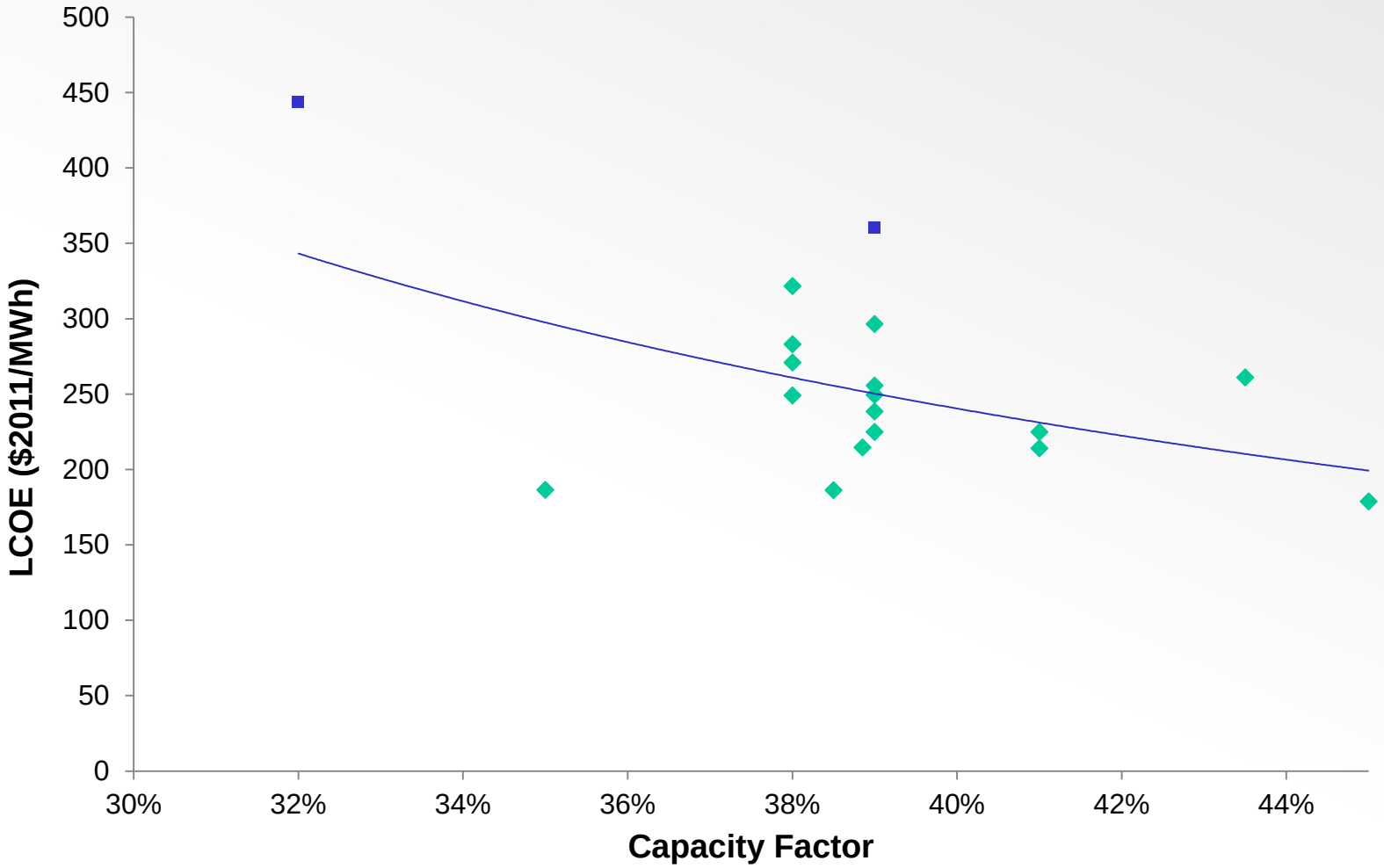
- Operating cost is less significant than capital cost
- Typically expressed as fixed and/or variable components:
  - Fixed annual cost as proportion of capital cost (%)
  - Fixed annual cost per unit of capacity (£/kW/yr)
  - Variable/levelised cost per unit production (£/MWh)
- 16 to 35% of LCOE
- Higher more recently
  - Greater experience and recognition of challenge
  - Further offshore and deeper

- Decommissioning costs are largely neglected:
  - Discounted value low
  - Costs assumed equivalent to salvage value

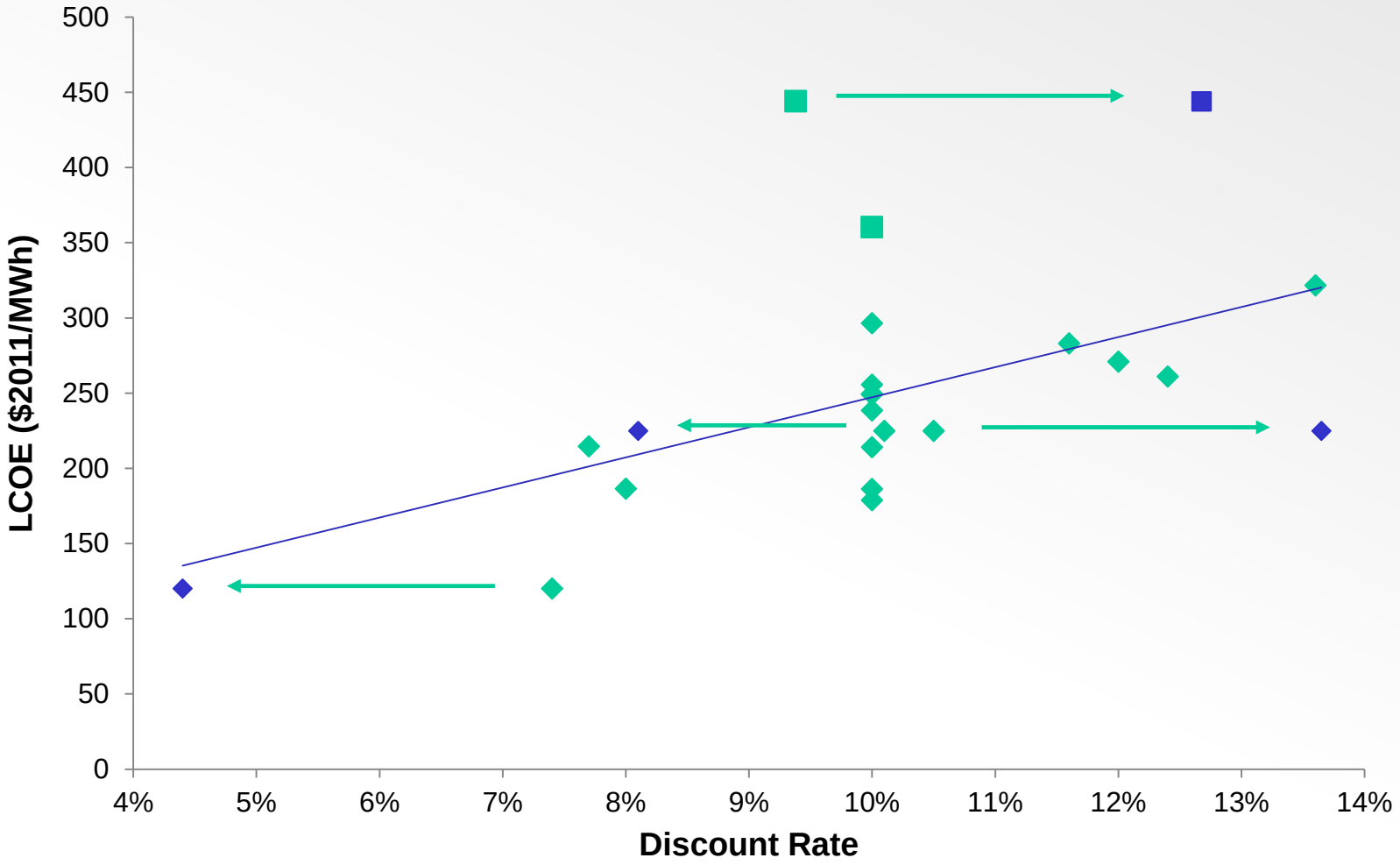
Summary of LCOE estimates



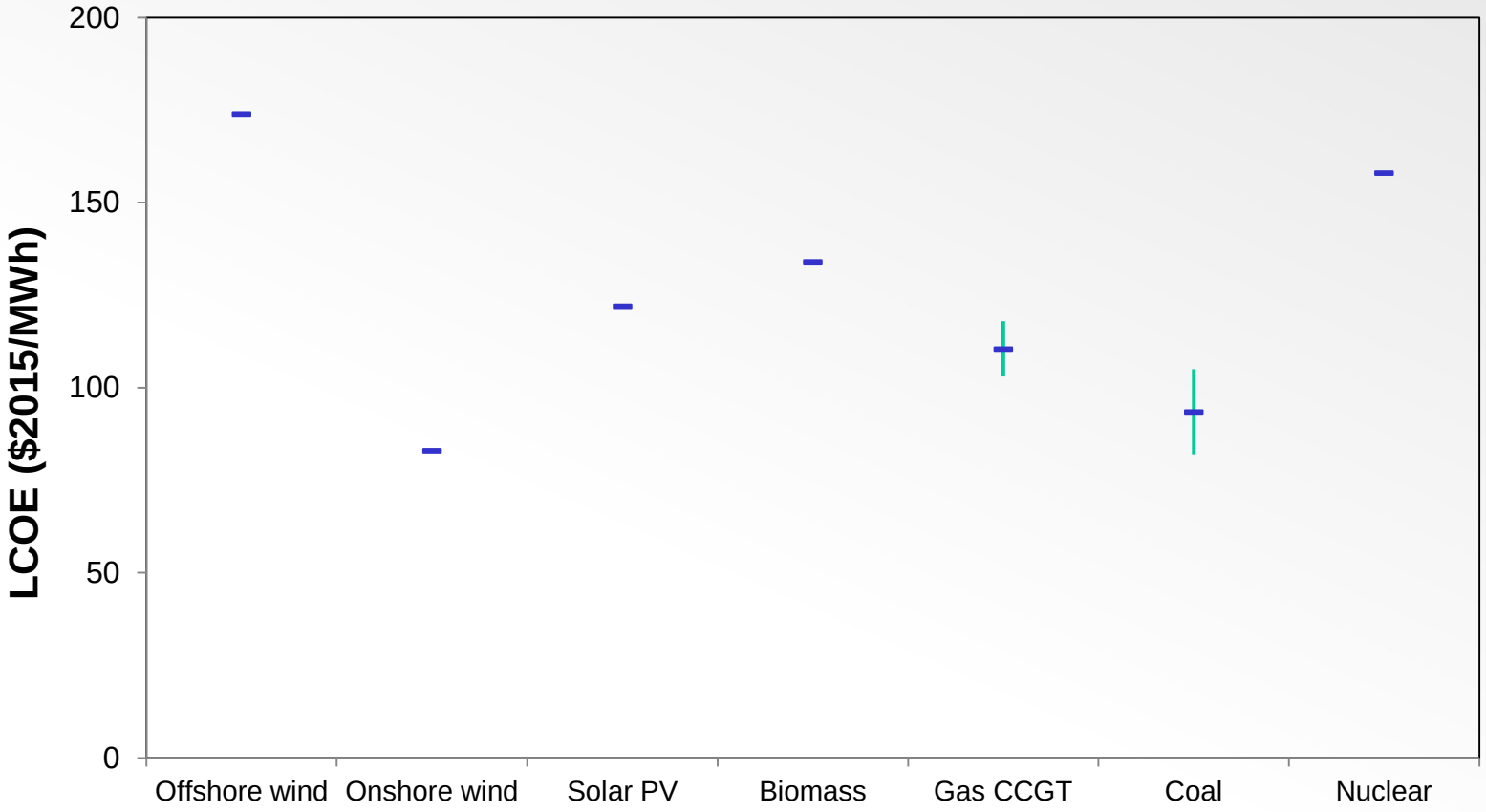
Sensitivity to Capacity Factor



Sensitivity to Discount Rate



Comparison with other technologies



Source: Bloomberg New Energy Finance, 2015. Wind and solar boost cost-competitiveness versus fossil fuels, Press Release, October.

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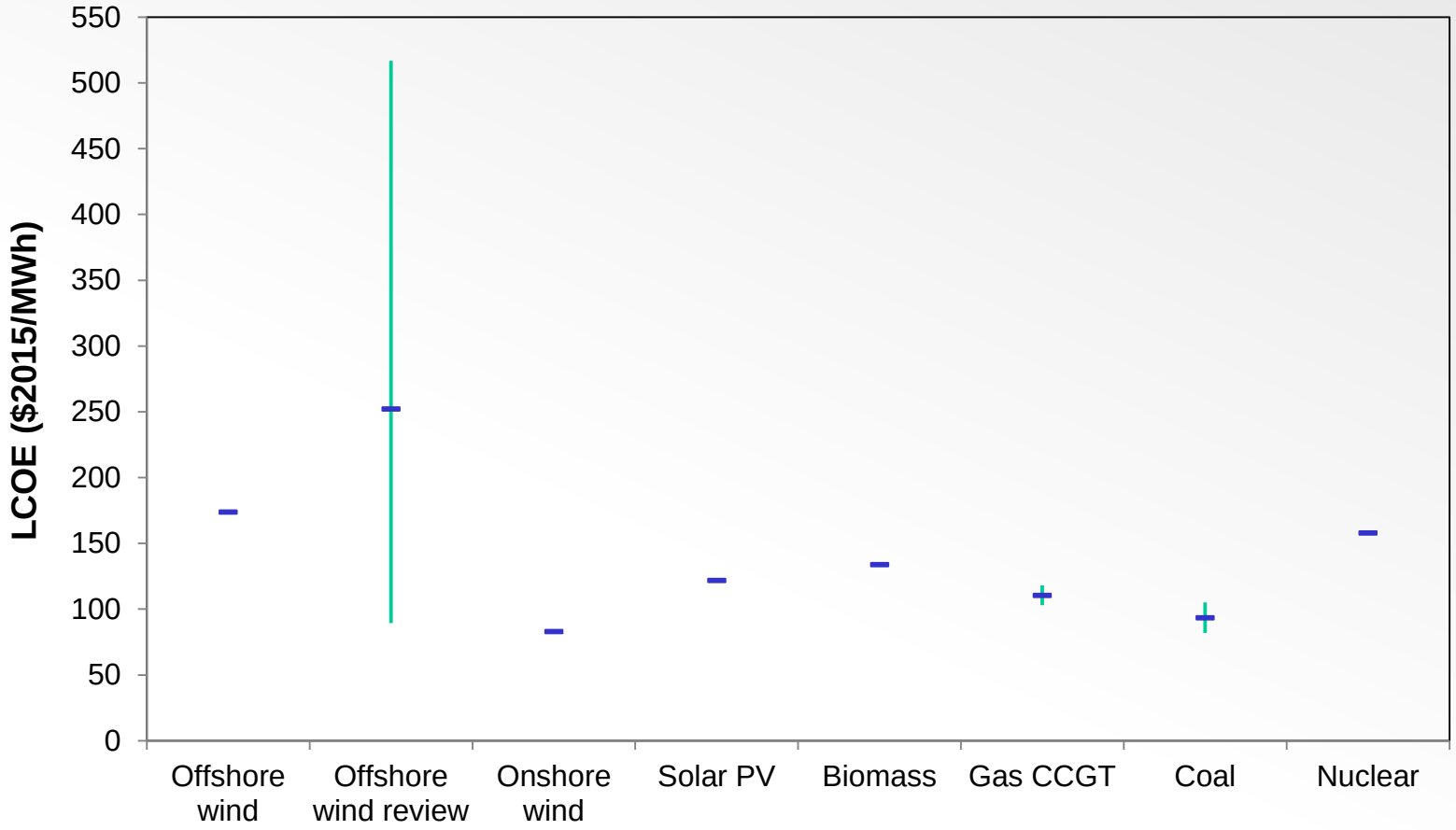

Source: Bloomberg New Energy Finance, 2015. Wind and solar boost cost-competitiveness versus fossil fuels, Press Release, October.

Outlook

- Bloomberg's findings support the established expectation that costs will come down and performance will increase with time.
- Two approaches for forecasting costs:
  - Technical engineering assessment
  - Extrapolation using experience curves
- Available literature suggests a generally downward cost trend for most technologies, despite move to more challenging sites, due to:
  - Erosion of 'market congestion' premiums
  - Larger turbines allowing new low-mass generator designs, fewer foundations for a given capacity and higher capacity factor
  - Larger farms allow sharing of infrastructure
  - Move to HVDC reducing number of subsea cables
  - Improvement in foundation design and manufacture
  - Improvements in installation and maintenance requirements and supplier capabilities

System Costs

Cost component	Range ($2011/MWh)
Balancing costs	3 – 11
Backup costs	0.3 – 0.8
Transmission costs	8 – 16
Total 'system' costs	**11 - 28**

- The impact of wind on other generators and the system is generally excluded from LCOE calculations
- There are suggestions that system costs of offshore wind increases the apparent cost by 30 to 45%
- System costs include:
  - Costs of balancing the system to cope with variable output
  - Costs of providing 'backup'; ensuring generation can meet demand
  - Cost of additional transmission and associated losses

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Cost component	Range ($2011/MWh)
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- There is no disagreement that such costs exist, but little agreement as to their value (IEA, 2010)
- Literature suggests that balancing costs are likely to be lower in larger markets
- Backup costs are overstated due to a partial understanding of the system
- Transmission costs are more challenging to estimate.

Conclusions

- There is scope for large variations in LCOE estimates for offshore wind power, most significantly from:
  - Capital cost of turbines
  - Capacity factor
  - Discount rate
- System costs are normally not considered, but where they're included they're often overestimated.
- System costs arising from accommodating wind do exist, but at relatively modest levels.
- Levelised costs for offshore wind are currently higher than other forms of low carbon generation; however, there are very substantial potential cost reduction opportunities.

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THOMSON, R. C. & HARRISON, G. P., 2014. "*Life cycle costs and carbon emissions of offshore wind power*". ClimateXchange.

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