



# Levelised Costs of Power Generation

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Dr. Nick F Frydas

# Contents

- What are levelised costs?

*“Levelised cost of generation is the discounted lifetime cost of owning and operating a generation asset expressed on a per unit of output basis (£/MWh). - Busbar Cost – No externalities except Carbon Price*

- Recent trends in EPC prices

- Build up of EPC and overnight capex costs

- Base case assumptions

- Outlook for levelised costs

# Who is Mott MacDonald?

## **One of the world's largest management, engineering and development consultancies**

*active in power, oil & gas, water, transport, buildings, communication, education, health etc.*

*Leading capability in power covering renewables, thermal and nuclear*

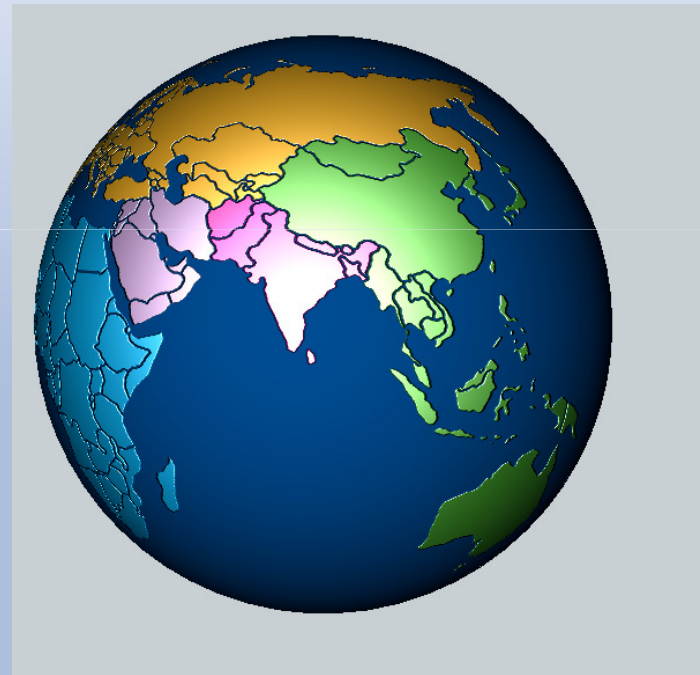
*We work in over 140 countries*

*From 200 permanent offices*

*On some 16,000 projects*

*Over 14,000 staff*

*Turnover of ~ \$1.5bn*



# Power Sector – Our Services

*Project initiation & development*



*Design & construction*

*Commissioning & operation*

# Drivers of Levelised Costs

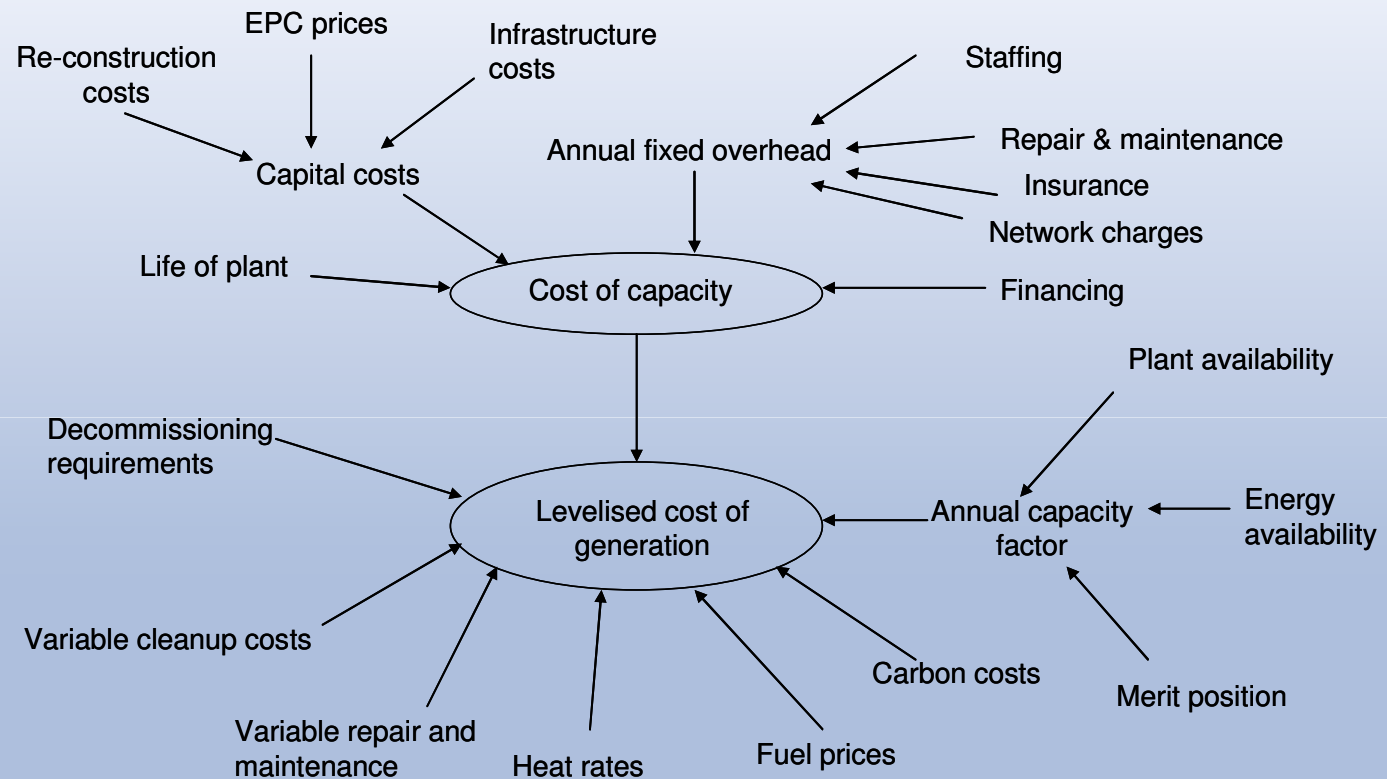
Main components of costs comprise:

A. **Investment costs**

B. **Fixed costs**

C. **Variable Operating Costs**

(including Fuel / Carbon)



# Levelised Cost - Main Components

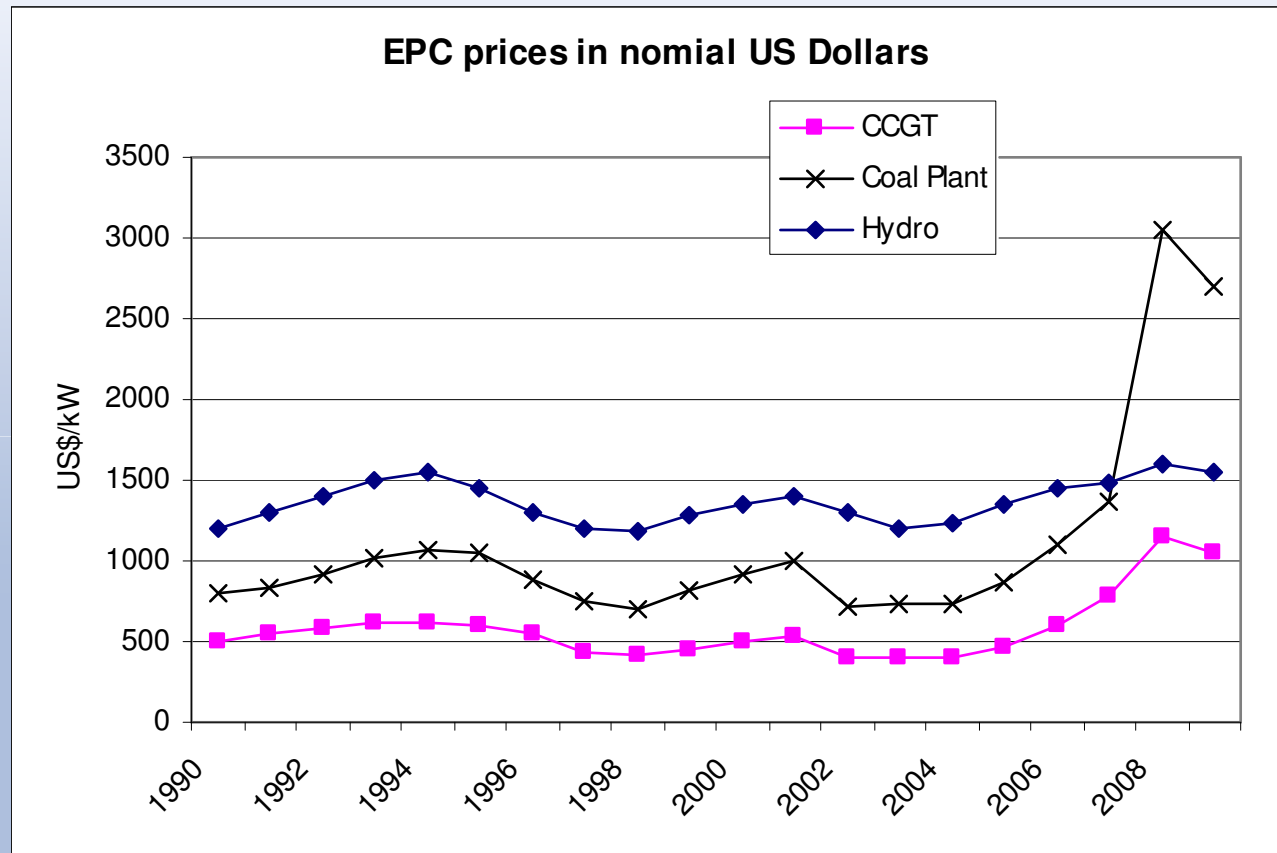
- Pre-construction costs
- Capex including financing costs
- Annual overheads of plant (excludes central HQ overheads)
- Variable non-fuel opex (var. O&M, ash disposal, etc.)
- Fuel and carbon
- CO2 transport and disposal
- Decommissioning

# Technologies

Mainly looking “baseload” and >10MW

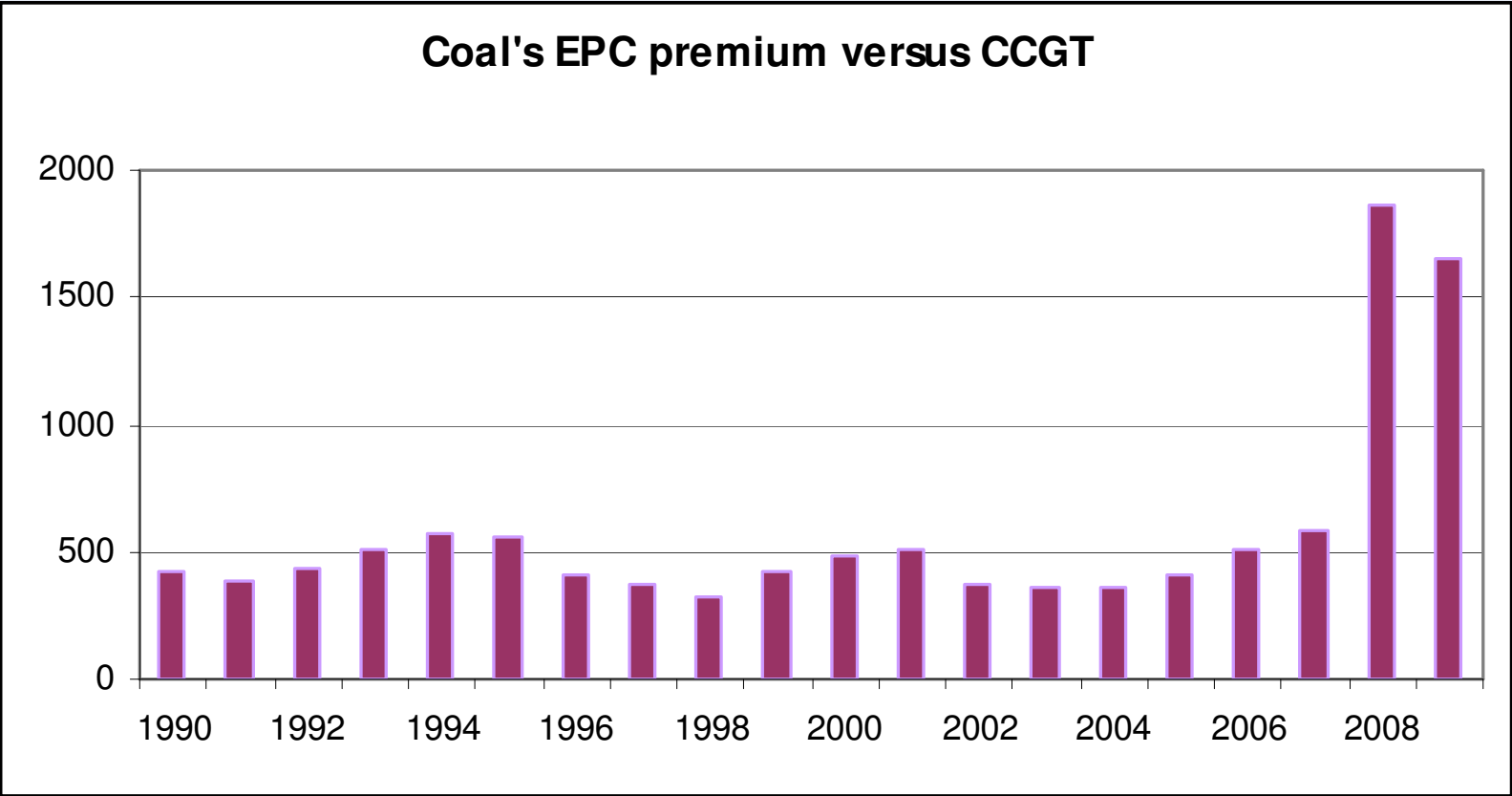
- CCGT, ASC Coal, IGCC + CCS variants
- Nuclear – EPR/AP1000
- Wind – on and offshore
- Biomass combustion 50MW/ 300MW
- Gas and biomass fired CHP
- Bio-methane (LFG, Sewage, AD of agri wastes)
- Hydro reservoir +PSP

# Representative EPC prices: 1990-2009





# Coal has developed a huge premium versus CCGT



# Drivers of EPC price increases

- High and uncertain commodity prices
- Bottlenecks in supply chain
- Full order books for main OEMs and/or EPC contractors, both of which seen shortage of skilled workers/managers
- Vendors and EPC contractors factoring in contingency margins/ excess profit
- US Dollar depreciation versus the Yen and Euro

## Other drivers of EPC costs

- Hardware/process complexity
- Economies of scale
- Maturity of technology
- Jurisdictional risk

# EPC options and costs by fuel type

Nuclear					
Demanding biomass waste					
Sewage gas					
MSW					
Woody biomass					
Easy biomass waste					
Coal					
HFO					
Landfill gas					
Diesel					
Natural gas					
	Industrial GT	Gas engine	Aero GT	Large boiler ST	Small boiler ST

## Indicative build-up of nuclear plant costs: \$/kW

### FOAK build up

<b>Cost to build</b>	<b>3500</b>
FOAK premium	700
Contractor's normal profit	300
OEM's risk premium	250
<b>Headline EPC price</b>	<b>4750</b>
Owners allowed contingency	750
Unallocated over-runs	500
<b>Total overnight EPC cost</b>	<b>6000</b>

# Nuclear cost build-up – endpoint?

## NOAK build up

<b>Cost to build</b>	<b>3500</b>
Bulk discount/ supply chain upgrade	-300
FOAK premium	0
Contractor's normal profit	100
OEM's risk premium	100
<b>Headline EPC price</b>	<b>3400</b>
Owners allowed contingency	200
Unallocated over-runs	0
<b>Total overnight EPC cost</b>	<b>3600</b>

## Fixed opex

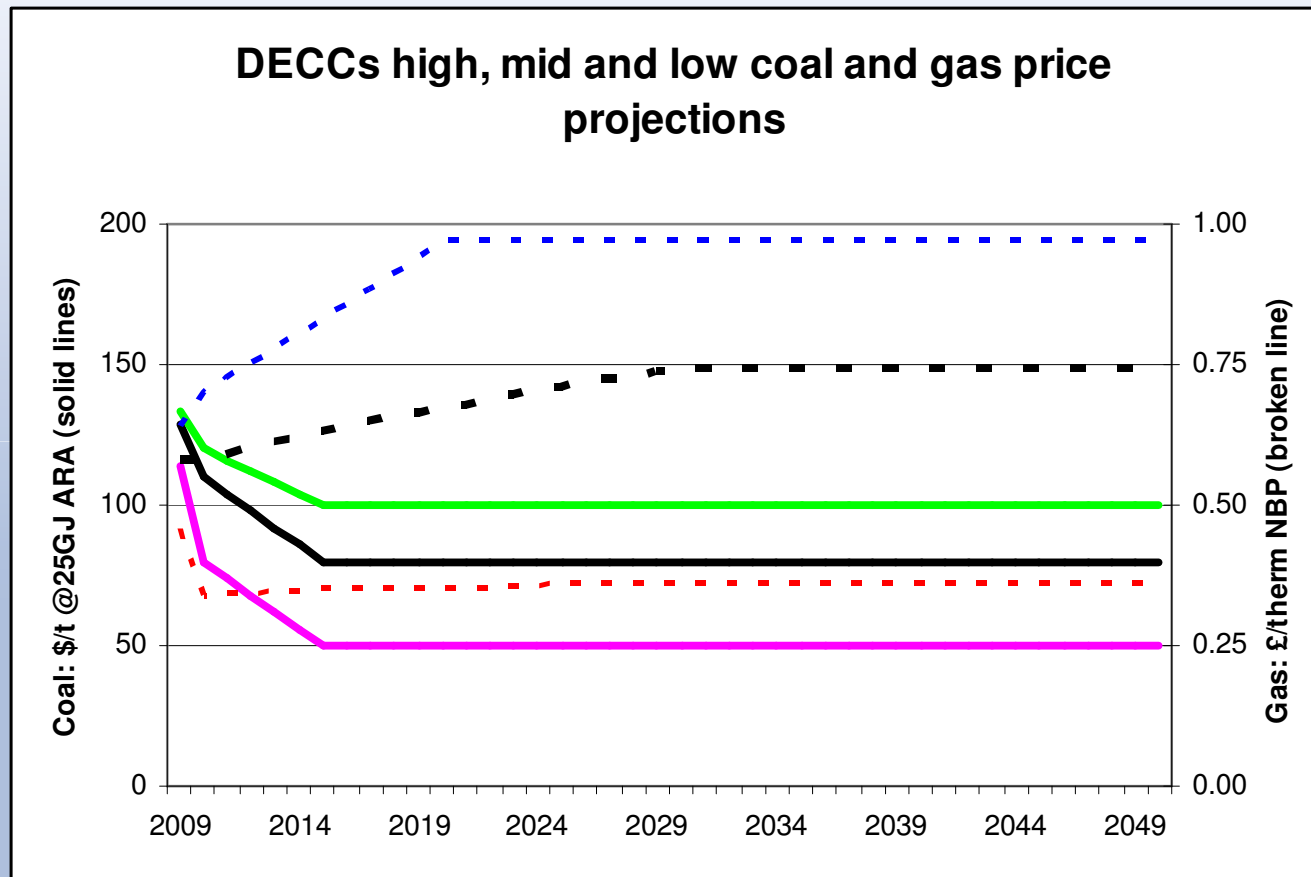
- What drives fixed opex? Core operating and maintenance linked to specific capex cost (EPC costs) – Insurance also?
- Some items like TNUoS and rates linked to MW
- Seems to have risen with EPC prices
- Varies between 1.5% and 8% of capex

# Base Case Assumptions

- Discount rate: 10%
- Used economic plant lives rather than loan terms
- Fuel prices taken from DECC projections – all scenarios higher than pre-2005 average
- Carbon prices - MM central case £32/t
- General EPC prices – softening in medium term, then level

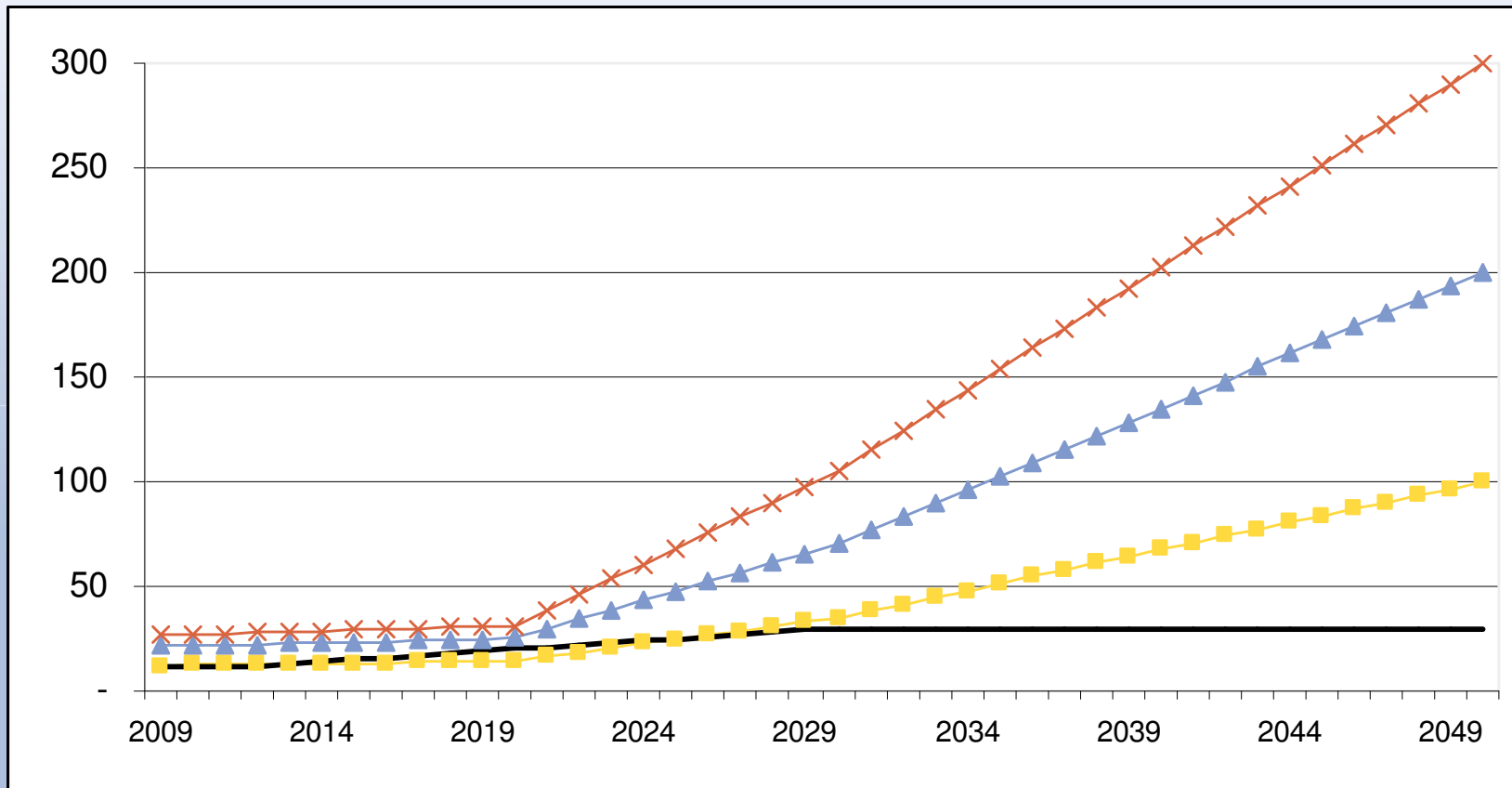


# Fuel prices



*Mid case has coal at £2.25/GJ (\$80/t) versus gas at £7.70/GJ (73ppt).*

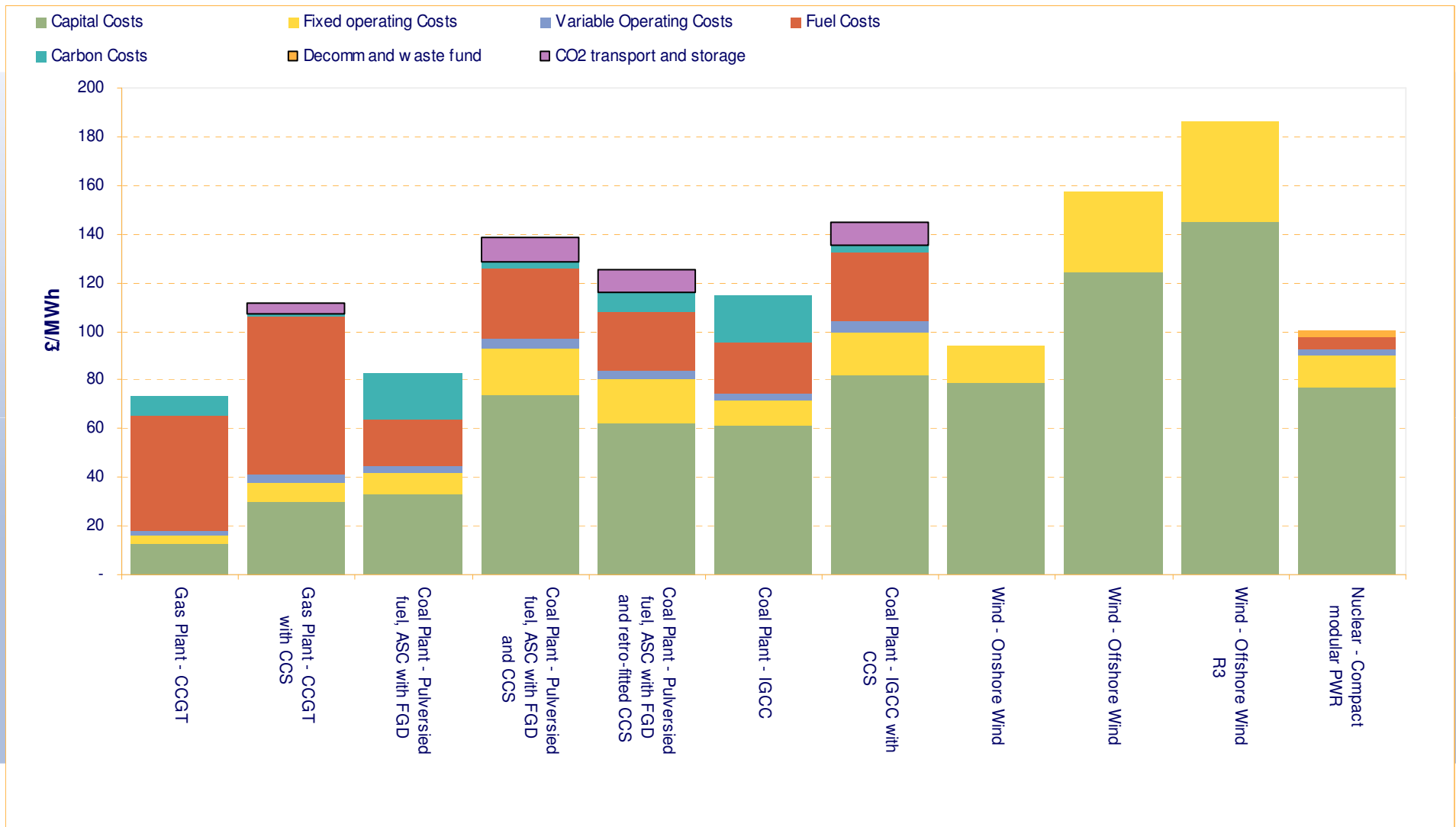
# Carbon prices: £/tCO<sub>2</sub>, DECC versus MM



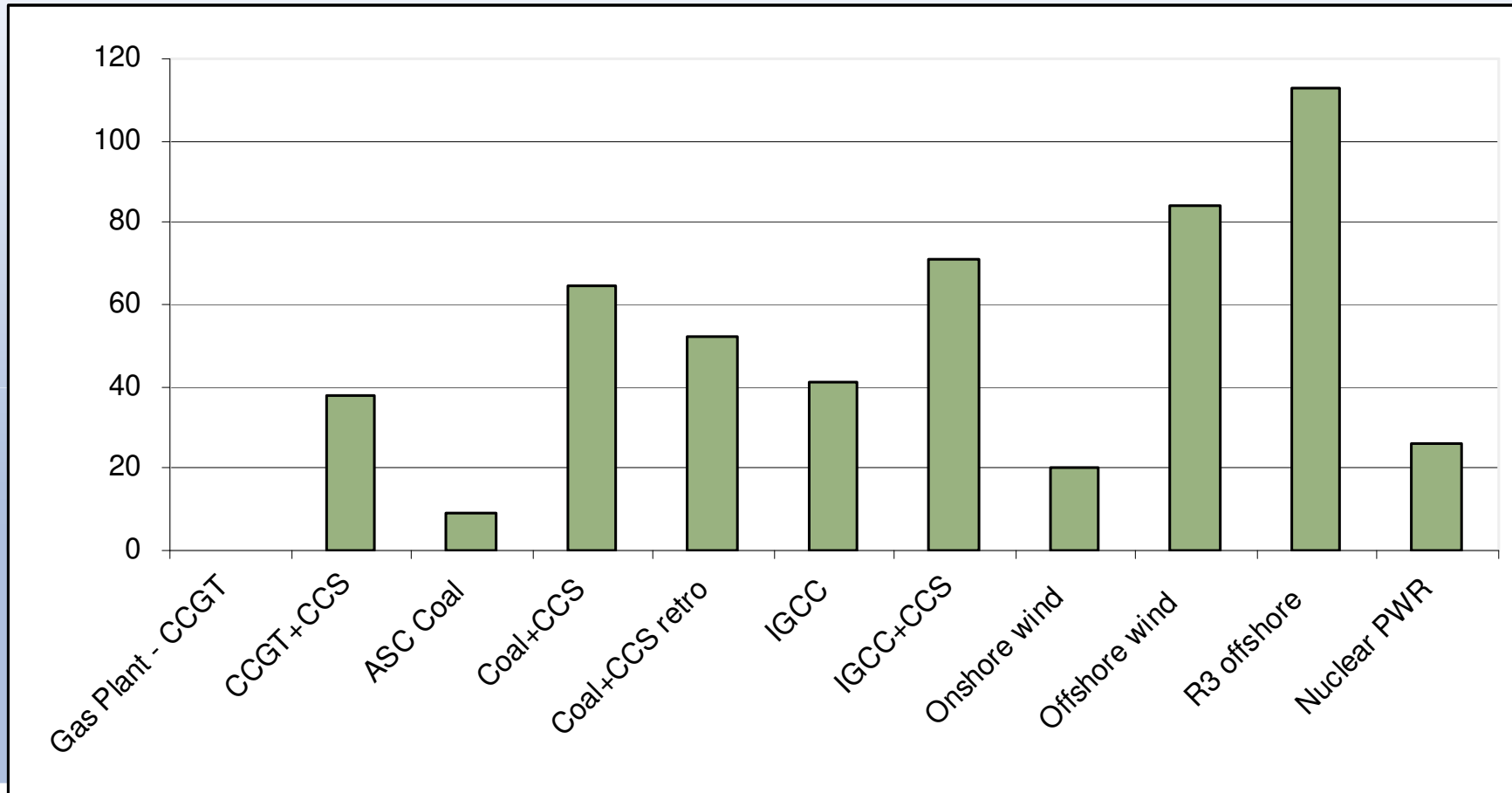
# Base Case Results

- ASC Coal and CCGT are lowest cost of main technologies excluding carbon, at £62/MWh
- Adding carbon at average price of €32/t makes **CCGT least cost, at £74/MWh** versus £82/MWh for coal (£108/MWh)
- CCGT+CCS and least cost coal+CCS costs £104-115/MWh, well above nuclear at under £99/MWh – In the longer term nuclear becomes the Least Cost Option at **£67/MWh**
- On-shore wind sits between ASC coal and nuclear at £94/MWh, while offshore wind well over CCS options at £157-185/MWh (£110-125/MWh)
- Biomass CHP with 50% steam credit < £70/MWh (£102/MWh)
- LFG/SG < £60/MWh

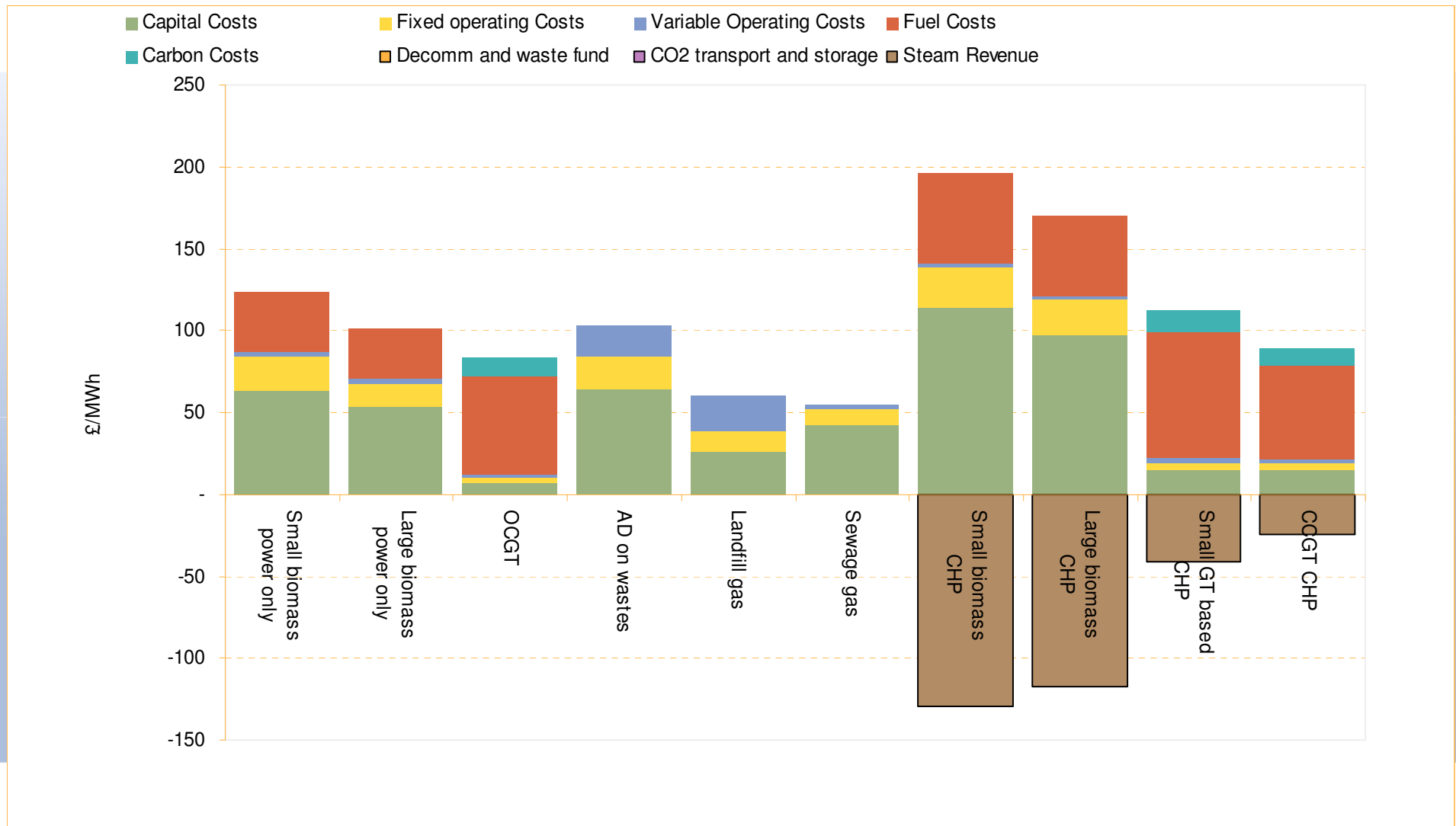
# LEC main technologies, Base case – 2009 start



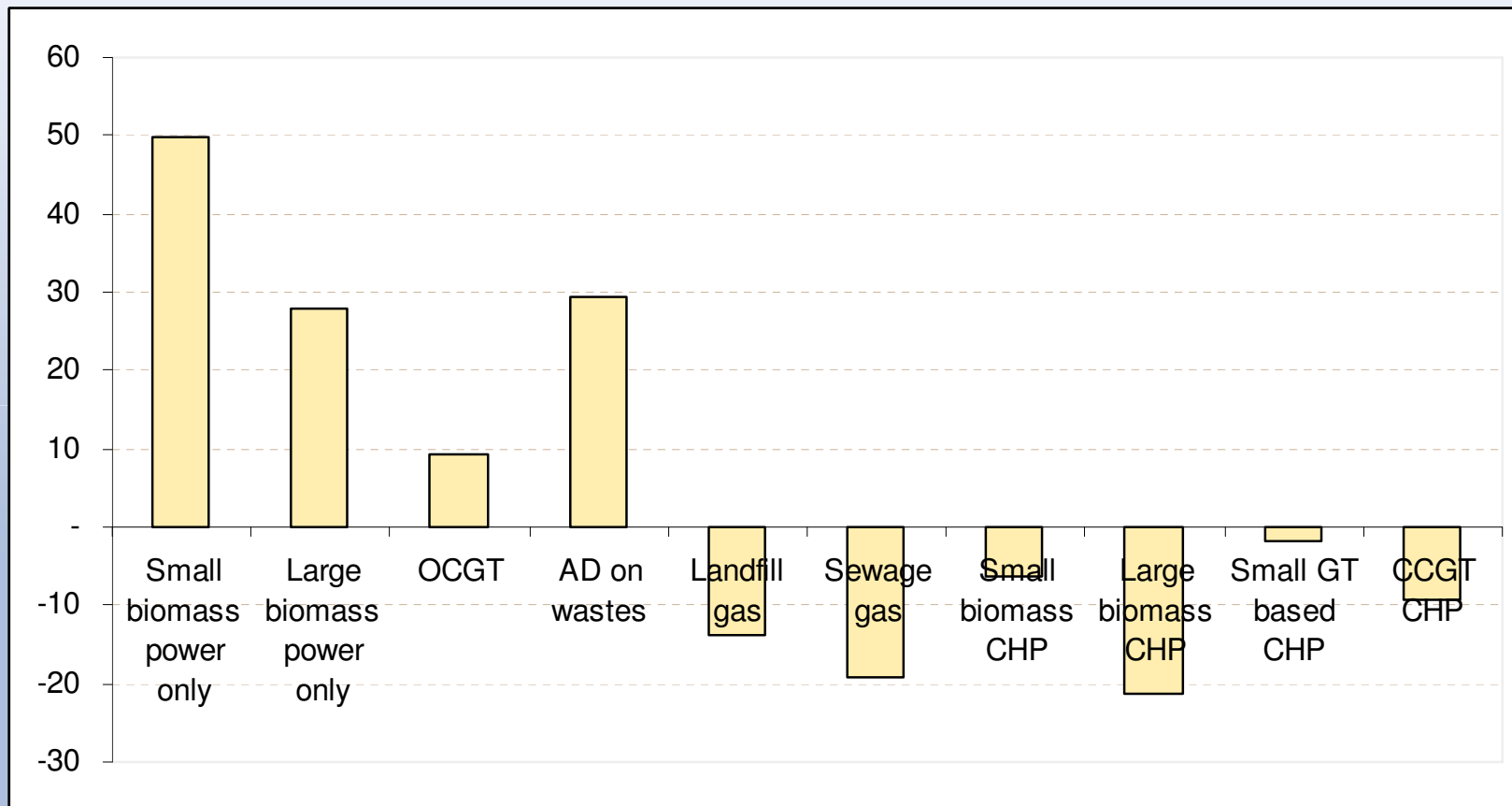
# LEC premium versus CCGT, main technologies, Base case – 2009 start



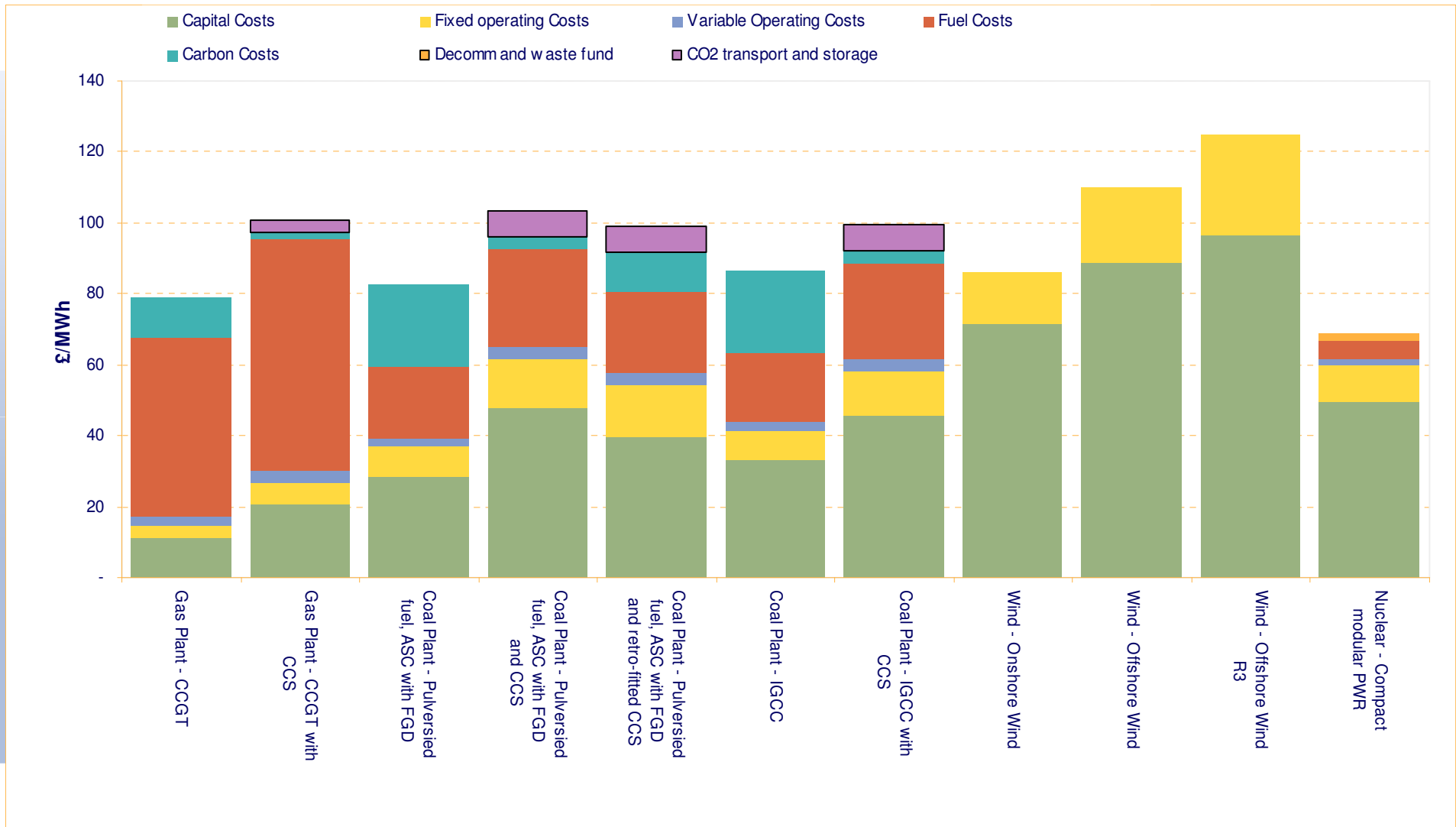
# LEC minor technologies, Base case – 2009 start



## LEC premium versus CGGT, Base case – 2009 start

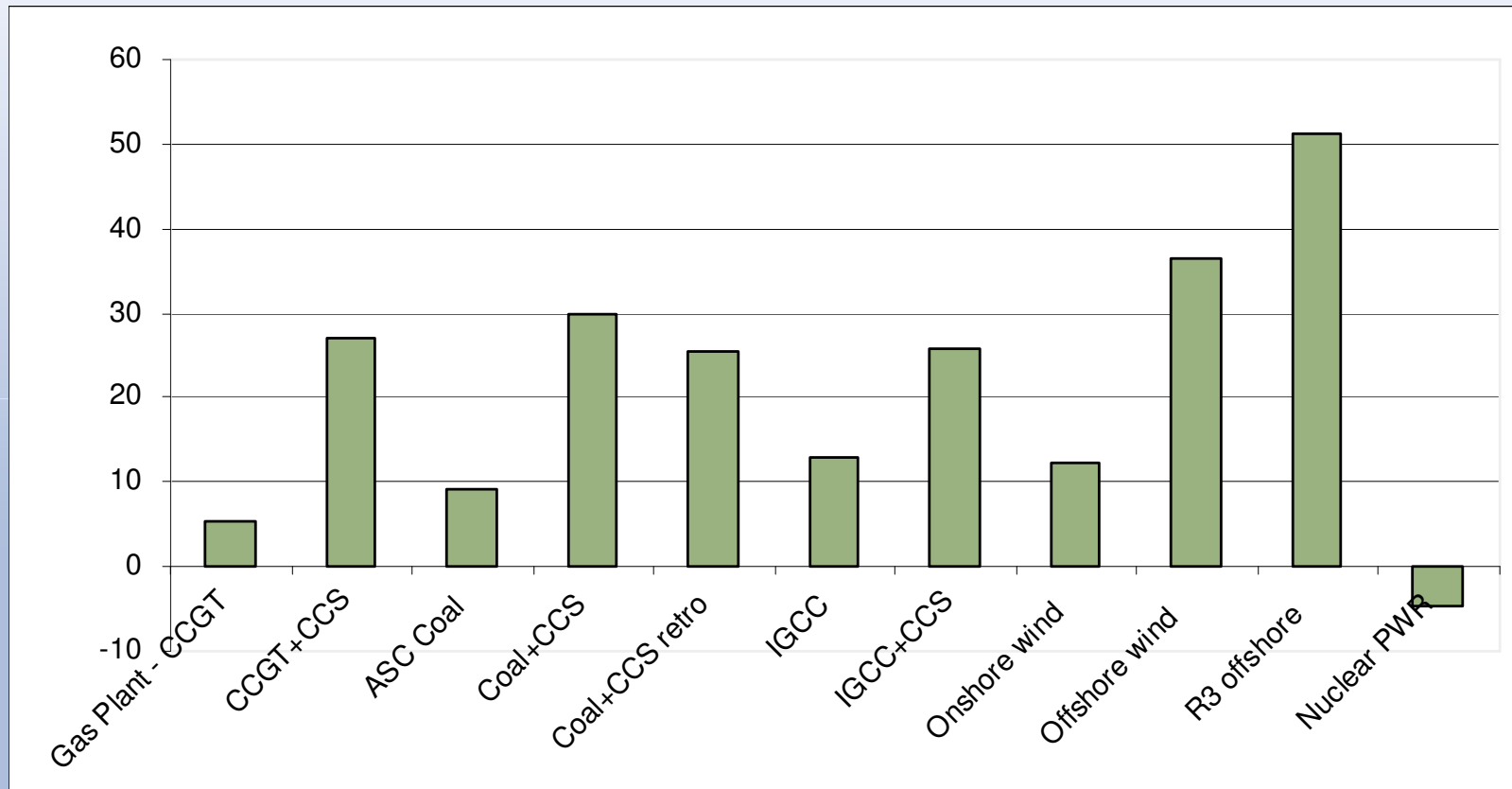


# LEC main technologies, project start 2020

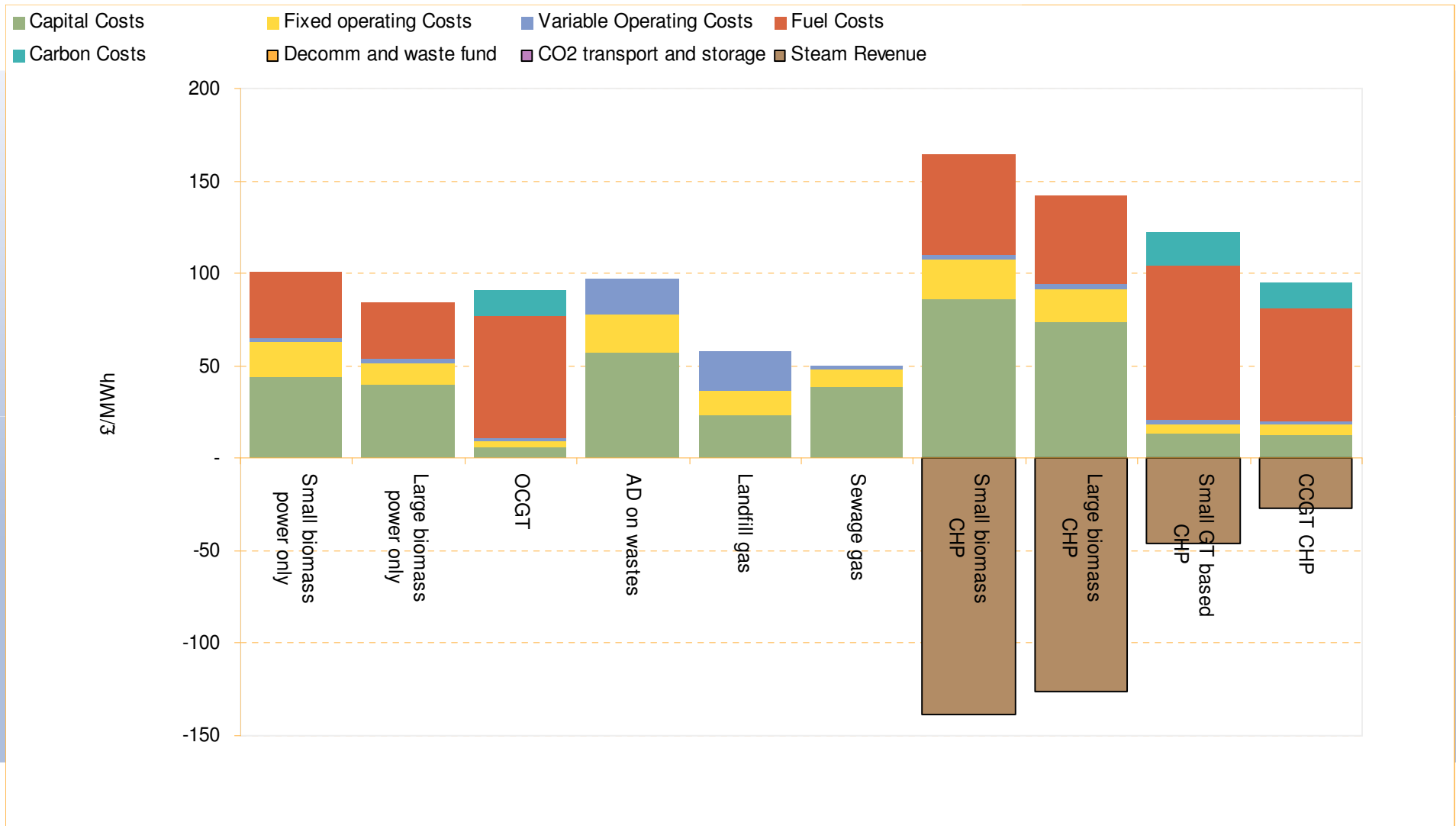




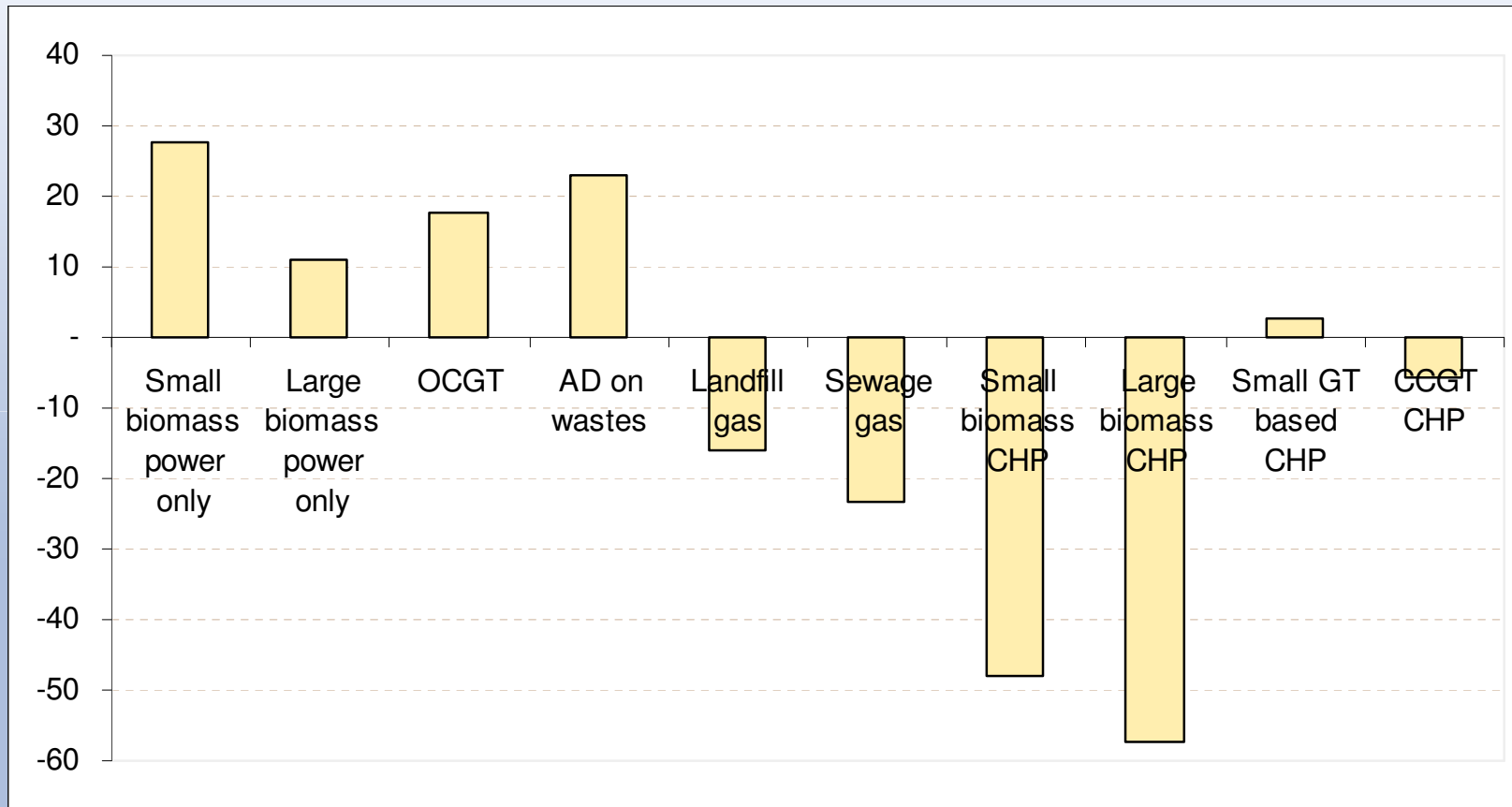
# LEC premium versus CCGT (2009), main technologies, project start 2020



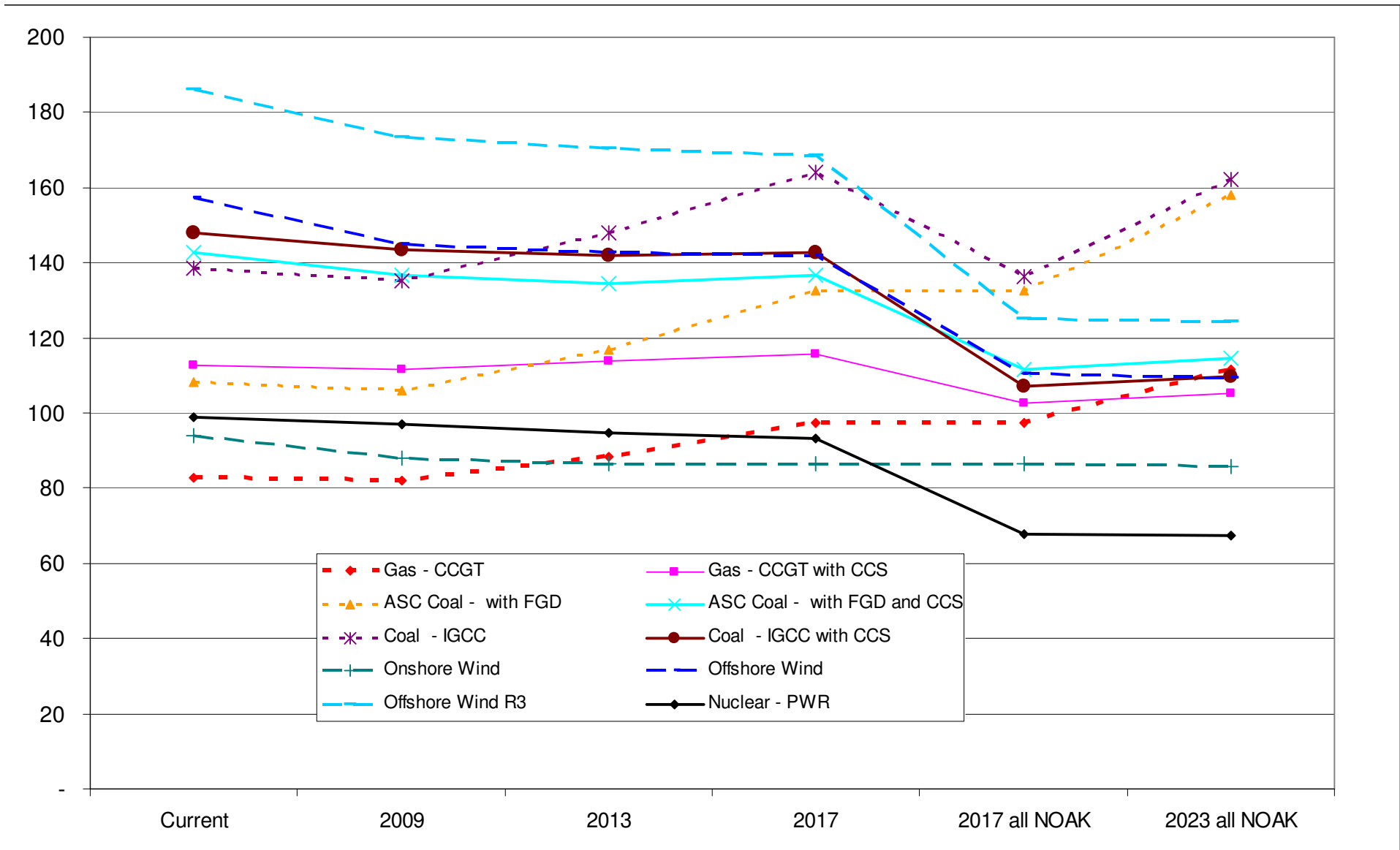
# LEC minor technologies, project start 2020



# LEC premium versus CCGT (2009), minor technologies, project start 2020



# Results using DECC assumptions – main technologies



# Conclusions

- Levelised costs for new plant will be higher than current prices
- CCGT will be the benchmark to beat in near to medium term – ASC coal £9/MWh above this, while nuclear and coal+CCS are £27-60/MWh above
- As nuclear, CCS and offshore wind move to NOAK status costs will fall markedly
- In longer term nuclear looks a good deal and should substantially undercut CCS and offshore wind, and could even be less than CCGT without CCS
- But high FOAK premium creates special funding challenge for first units, even assuming all benign regulatory and market environment