Nuclear Power – Putting the Costs and Financing in Perspective

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Competitiveness of Nuclear Power

Countries are increasingly seeing nuclear power as providing a low carbon and secure source of electricity supply.

But the 'nuclear renaissance' has been slow for a number of reasons:

- Financing remains a key issue for all countries, given the decreasing 'risk appetite' of investors
- The competitiveness of nuclear is dependent on many variables, some of which are hard to control
- High barriers to entry remain especially for newcomer countries e.g. HR development, industrial capacity etc
- Governments have been slow to confirm price signals for carbon emissions
- Technological developments have been slower than expected
- Public confidence is still low in many countries and remains a key obstacle to rapid deployment

This paper will consider some conclusions from 2 recent NEA studies on financing and electricity costs as a way to clarify the influence of some of these factors.

Special Challenges in Constructing Nuclear Power Plants

In 2008, NEA released a study, ***The Financing of Nuclear Power Plants that*** identified a number of challenges to the financing of nuclear power plants:

- The high capital cost and technical complexity of NPPs , which present relatively high risks during both construction and operation.
- The strong dependence of levelised cost of electricity on the discount rate for finance.
- The relatively long period required to recoup investments or repay loans for NPP construction, which increases the risk from electricity market uncertainties.
- The often controversial nature of nuclear projects, which gives rise to additional political and regulatory risks.
- The need for clear solutions and financing schemes for radioactive waste management and decommissioning.

Addressing these challenges is crucial for access to financing at competitive rates.

Challenges to Financing

The Financing of Nuclear Power Plants identified a number of specific issues that will require addressing for more rapid deployment of nuclear power plants:

a. Political & policy support – longer term commitments and consensus
b. Nuclear licensing & regulation – reducing approval uncertainties
c. Nuclear liability & insurance – agreement on legal framework
d. Construction & supply chain risks – especially in deregulated markets
e. Electricity market conditions – longer term pricing arrangements, regulation
f. Plant operating performance – costs and availability levels
g. Nuclear fuel supply
h. Managing HLW waste & decommissioning

Dealing with Risks

Financial risk can occur at the planning, construction, operation and back end stages:

1. Planning risks are associated with choice of site and approval processes, but the outlays are 'relatively' small at that stage.
2. Financial risks due to **delays during construction** are the most significant for investors
3. Operational risks are related to electricity market pricing and reactor availability factors
4. Back end risks for waste and decommissioning costs are often cited as a major issue, but financially this should be manageable through operational tariffs

Dealing with Construction Risks

Risks during the construction period remains the biggest challenge:

1. **Construction delays** can arise from many sources and seem difficult to control in many countries – improvements in construction times are vital e.g. Korea 4-5 years versus 6-8 years (and more) in other OECD countries
2. Some risks can be shared with other parties (vendors, owners, operators, customers, venture capital…)
3. **Substantial amounts of residual risk** likely to remain with NPP owners
4. Current designs are **evolutionary**, but some **FOAK** risks remain for early projects
5. Pure **project financing** ("merchant power plants") remains unlikely due to technical and political complexity
6. Major financial institutions (eg World Bank) do not provide finance for nuclear construction

A Large Investment for Utilities

a. In many countries, NPP investment may be too large for most private sector utilities given their market capitalisation (a twin unit NPP could cost more than US$10 billion);

b. An issue, in particular for US utilities; some European utilities may be better able to finance NPPs but risks for credit rating remain.

Utility (US)	Market Cap. (USD billion)
Exelon	30
FPL Group	22
Southern	22
Dominion	18
Duke Energy	17
PSEG	16
Entergy	14
PG&E	13

Utility (Europe)	Market Cap. (USD billion)
EDF	88
GDF-Suez	82
E.ON	65
RWE	42
ENEL	35

Dealing with Construction Risks

Innovative strategies are needed to overcome these issues. Some of these may be:

1. **Government actions to lower the cost of financing** – loan guarantees or export credits
2. Risk sharing among a consortium of users e.g. Finnish case
3. More clearly identifying the nature of the risks and the group most appropriate to carry this risk
4. Major financial institutions (eg World Bank) reversing their positions on financing nuclear construction
5. Financing through equity partners, including from overseas companies
6. Consideration of small and medium sized reactors to lower the capital hurdle

New NEA Study

Projected Costs of Generating Electricity: 2010 Edition

Published on 25 March 2010 – it is the **7th Edition** in the series of Joint IEA/NEA studies (since 1983)

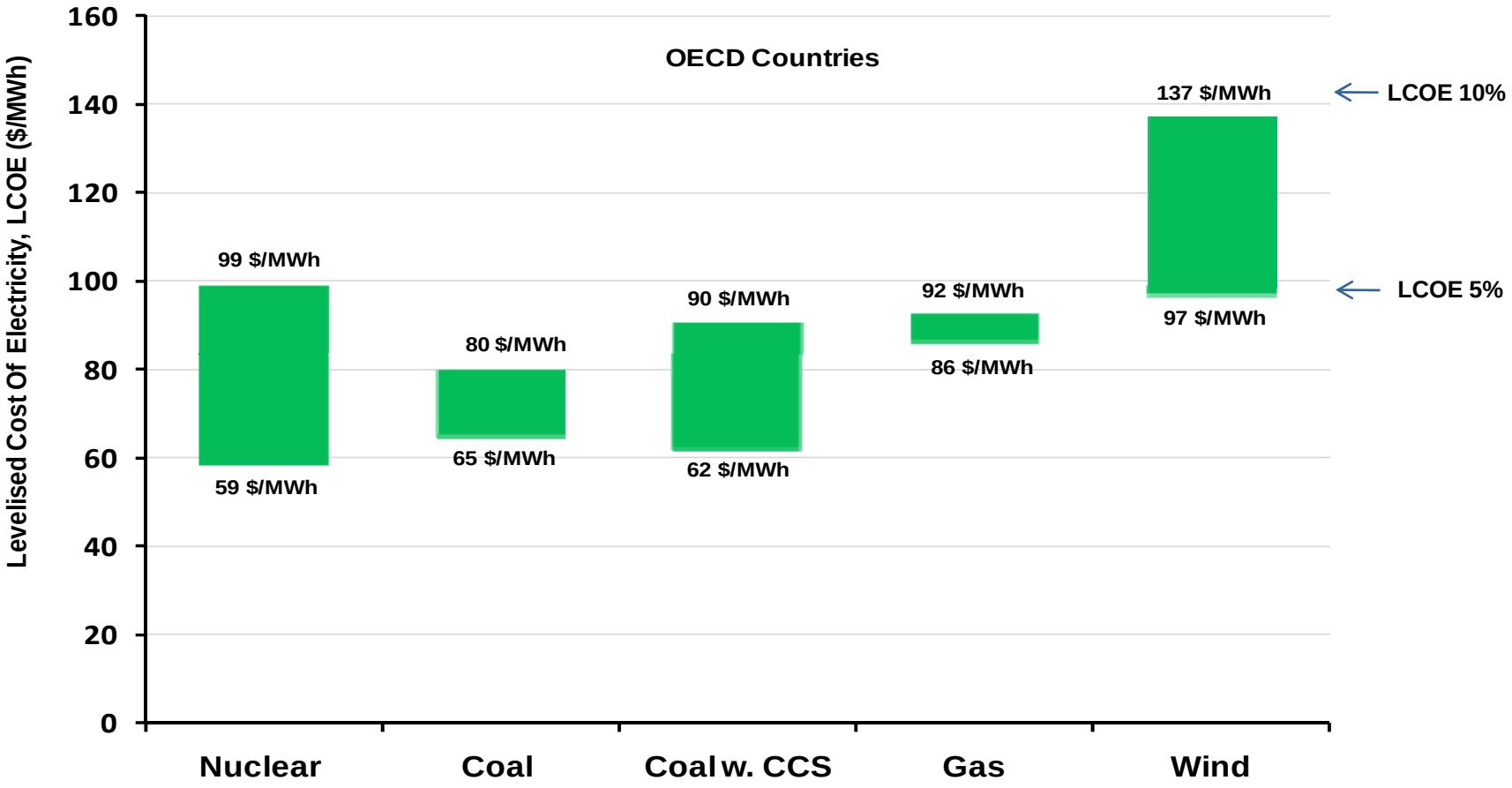
a. Presents **baseload power generation costs** for 190 power plants with different technologies in 21 countries (date of commissioning 2015);
b. The study assumes, for the first time, a **CO2 price of 30 USD/tonne** and long-term fossil fuel prices based on ***WEO 2009***.
c. The cost of electricity will depend on a number of key parameters, in particular the cost of raising finance and the price of carbon.

Content

Projected Costs of Generating Electricity: 2010 Edition

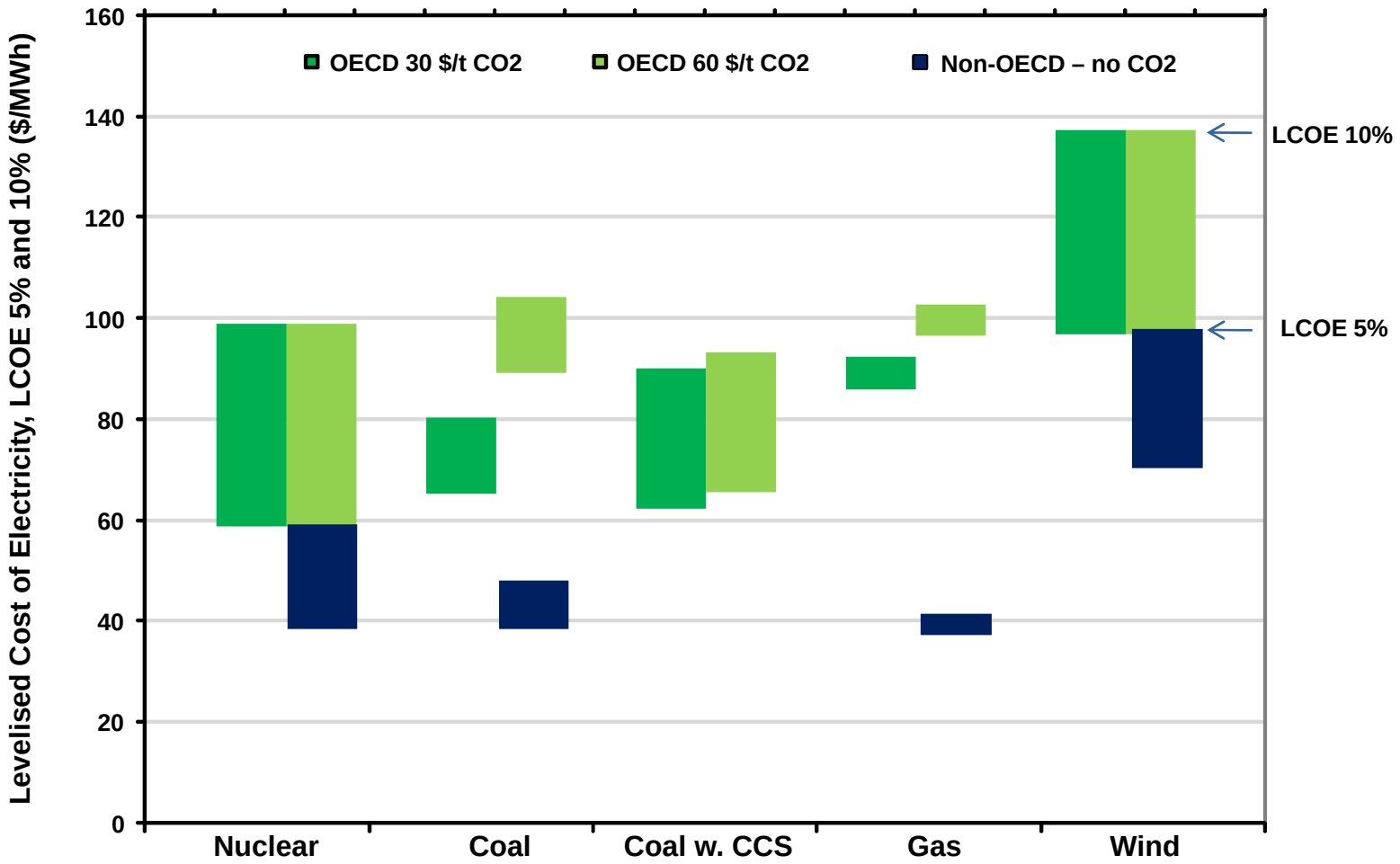
1. Data from **17 OECD** and **4 non-OECD** countries (Brazil, China, Russia, South Africa), including a wide range of technologies:
   - **Nuclear**: 20 light water reactors
   - **Gas**: 25 plants of which 22 CCGTs
   - **Coal**: 34 plants of which 22 SC/USC
   - **Carbon capture**: 14 coal-fired and 2 gas-fired plants with CC(S)
   - **Renewables**: 72 plants, of which 18 **onshore wind**, 8 **offshore wind**, 17 **solar PV**, 3 **solar thermal**, 14 **hydro**, 3 **geothermal**, 3 **biogas**, 3 **biomass**, 1 **tidal** and 2 **wave**
   - **CHP**: 20 plants, of which 13 gas, 3 coal, 3 biomass, 1 biogas and municipal waste
2. Extensive range of **sensitivity analyses** to changes in key cost parameters (interest rate, fossil fuel and CO2 prices, construction costs, lead times, lifetimes, load factors) based on "Median Case"

Main Conclusions: Median Case - Sensitivity to Cost of Financing



No technology has a clear overall advantage globally or even regionally.

Main Conclusions: Median Case - Sensitivity to CO2 cost



To bolster competitiveness of low-carbon technologies such as nuclear, renewables and CCS decisively, strong government action to lower the cost of financing and a significant CO2 price signal is needed.

Each technology has strengths and weaknesses

- **Nuclear** delivers significant amounts of low-carbon electricity at stable costs – but has to manage high amounts of capital at risk and is faced with perception issues regarding decommissioning, waste management and proliferation
- **Coal** is competitive in the absence of a sufficiently high carbon price – but this advantage is quickly reduced as CO_2 cost rises
- **Coal with Carbon Capture** may be a competitive low-carbon generation option – but has not yet been demonstrated at commercial scale for power plants
- **Gas** key advantages are its low capital cost, low CO_2 profile and high operational flexibility, which make it a low risk option – but costs highly depend on gas price levels which may make it not profitable as baseload power
- **Hydro** and, for the first time **onshore wind**, are shown to be competitive in cases where local conditions are favourable – but if not dispatchable, renewables cannot be used for baseload

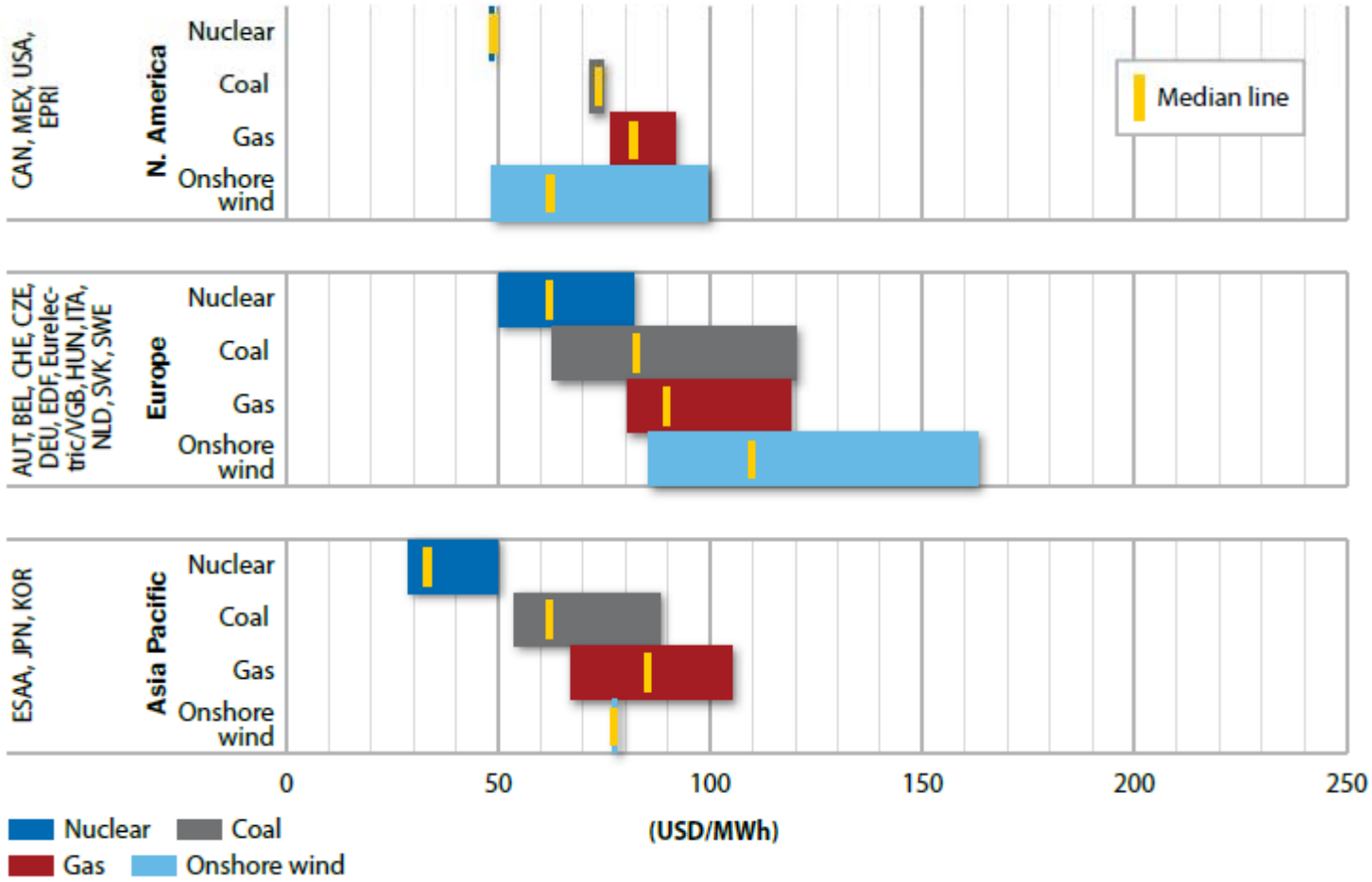
Basic Methodology of EGC Study

- In order to calculate LCOE per MWh all plants costs and revenues discounted or capitalised to the date of commissioning → **2015 (2020 for CCS)**
- Levelised average lifetime costs based on the equalization of discounted revenue and cost flows:

$$\textbf{LCOE} = \sum[(I_t + M_t + F_t)*(1+r)^{-t}] / \sum[E_t*(1+r)^{-t}]$$

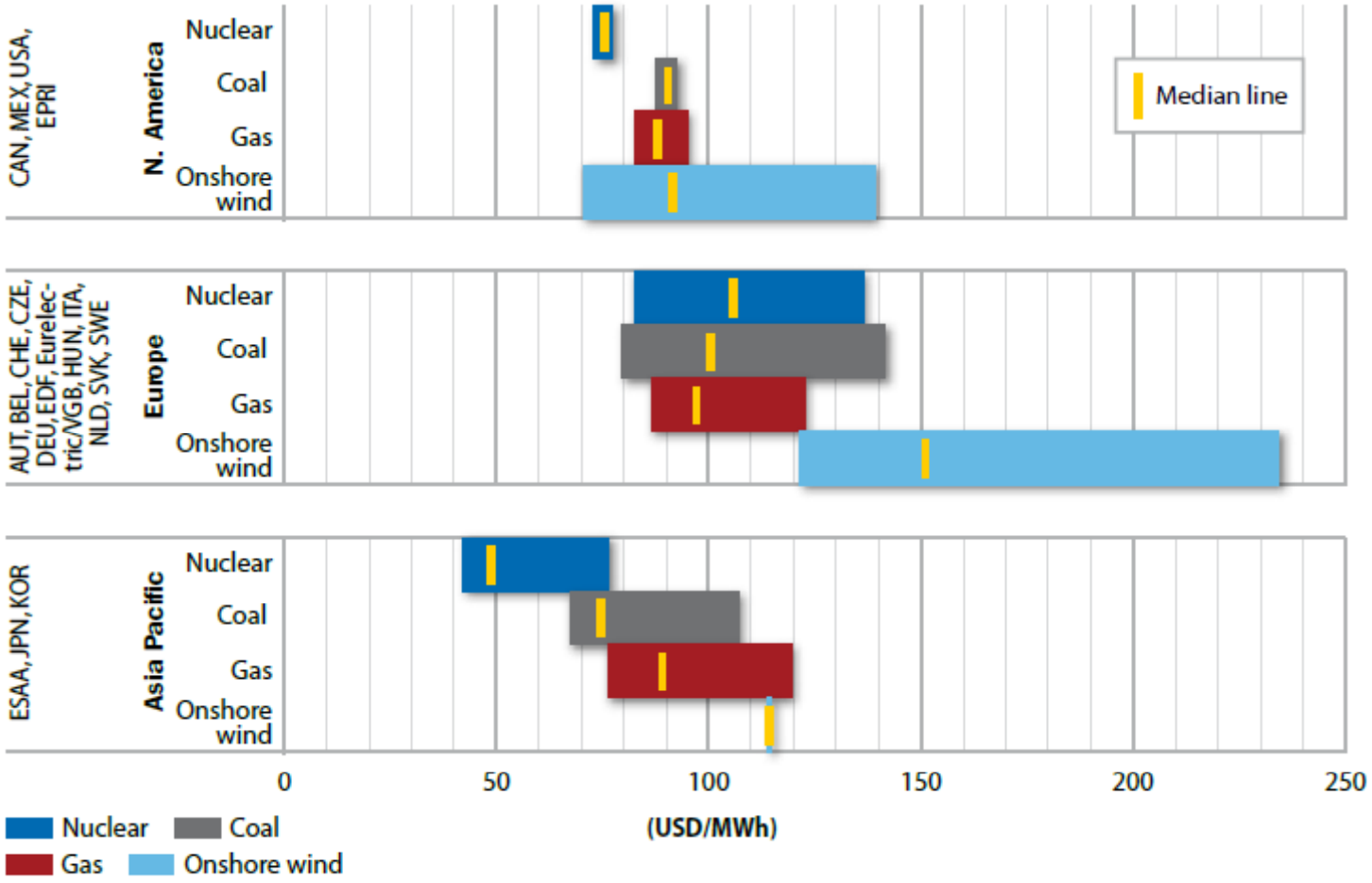
- Cost concept: **social resource cost** (no inclusion of technology-specific or solvency risk) rather than private investor financial cost (WACC).
- Two discount rates, 5% and 10% **real (net of inflation)**; in comparison long-term US corporate bonds have a **nominal** rate of around 7% (Spring 2010); equity investors would require higher rates of return.
- Plant-level cost of the production of **base-load** power (85% load-factor) for nuclear, coal, gas and of **renewables** (local load factor); no inclusion of system costs

Regional ranges of LCOE for nuclear, coal, gas and onshore wind plants at 5 % interest rate



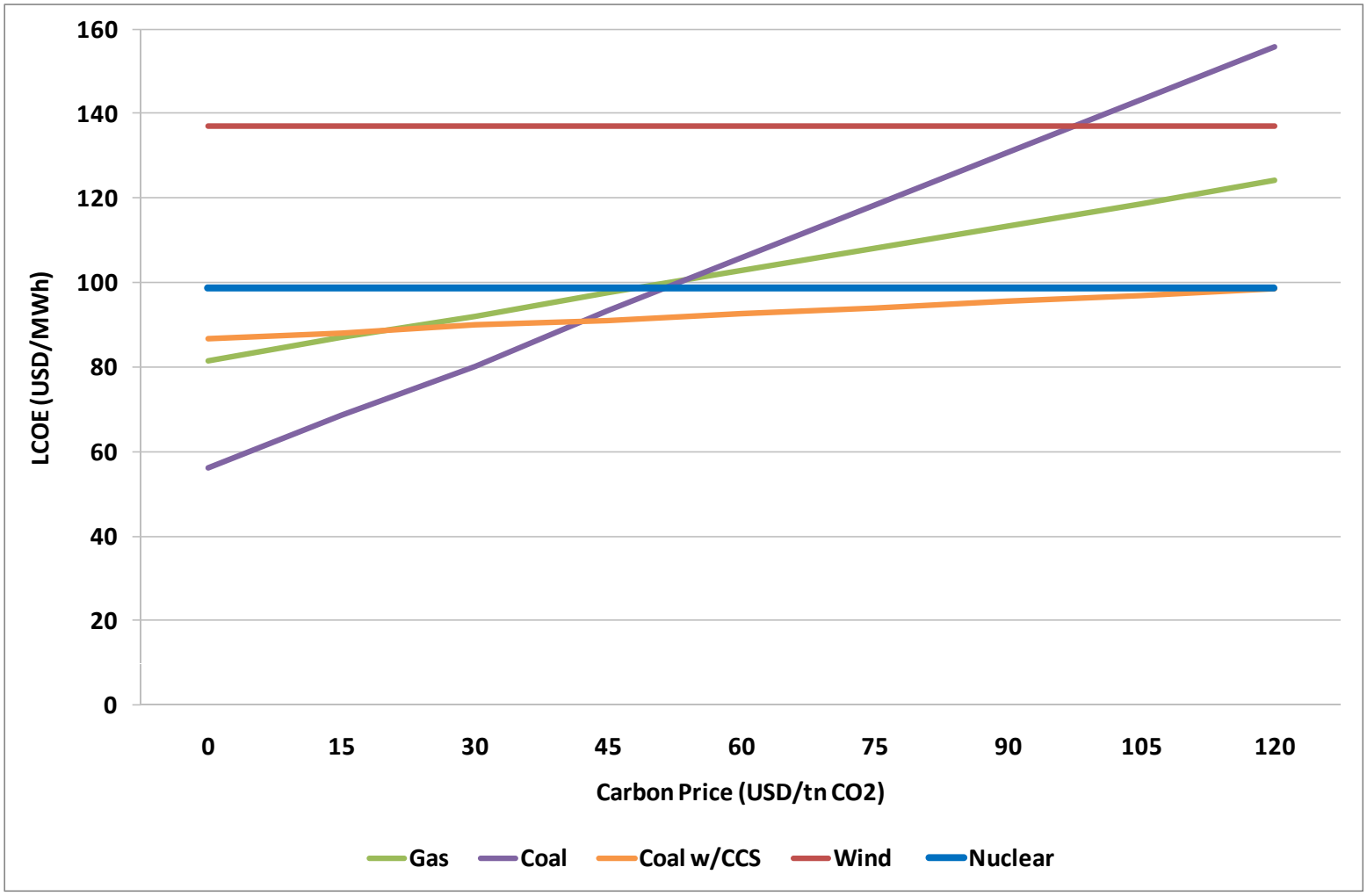
With financing costs at 5%, nuclear, followed by CC(S) – both capital-intensive, low-carbon technologies – are the most competitive solutions.

Regional ranges of LCOE for nuclear, coal, gas and onshore wind plants at 10 % interest rate



With financing costs at 10%, coal-fired generation, followed by coal with CC(S), and CCGTs are the cheapest sources of electricity.

The Sensitivity to Changes in Carbon Prices at a 10% Discount Rate



Key Messages from
Projected Costs of Generating Electricity

1. Looking at detailed country numbers, the study show large differences between countries; **national policies and local circumstances matter**.
2. Boundary issues such as **system costs** (which may be substantial especially for intermittent renewables) or specific financing issues must be assessed in a more qualitative manner. The study offers discussions of:
   a. Financing issues
   b. System Costs of Integrating Variable Renewables
   c. Prospects for Carbon Capture and Storage
   d. The Working of Electricity Markets
3. **At 5% per cent**, nuclear energy is an attractive option for baseload power generation in all three OECD regions.
4. **At 10% per cent**, nuclear energy remains a competitive option for baseload power generation in the United States and OECD Asia.
5. A **30 $/tonne CO2 price** is not enough to give a decisive advantage to low-carbon technologies in all circumstances – Government action remains key.

Key Government Actions

CONCLUSIONS

For successful NPP deployment, it requires;

1. Clear and sustained government **policy support**, as part of long-term national energy strategy; reducing the planning risks
2. Efficient & effective **regulatory systems**; e.g. actions to harmonise multi-lateral assessment processes and issue generic design approvals
3. Plan for **waste and spent fuel management**, with clear financial arrangements. Should not be a major financial hurdle
4. **Electricity market arrangements** (for instance, long-run contracts) adapted for long-term investments such as NPPs (high fixed costs)
5. Suitable **CO_2 pricing/trading** arrangements
6. Targeted measures to **reduce financing costs**. Possibly government **support to financing** (loan guarantees, export credits…)