UNIVERSITY OF CAMBRIDGE

Nuclear Subsidies Then and Now

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Historical Subsidies for Nuclear Energy

Type of Subsidy:	Example/Comment
• Market/Price	• Prior to 1990, there was no electricity market; • CEGB as a monopoly could recover its costs through the prices it charged; • When Nuclear was privatised NFFO ~£10/MWh top-up for nuclear;
• Construction Risk	• CEGB Government owned & backed by Treasury guarantee – either to fund, or to borrow;
• Waste & Decommission	• Waste charges paid to BNFL on usage basis; • B Energy accrued fund for decommissioning cost, fund was lost on re-acquisition, again accruing from 2002;
• Research & Development	• UKAEA R&D for fast reactors £200m pa until 1992 – no commercial designs - technology unused.

New Build & No Subsidies

- Once the **need for** new nuclear was accepted, the history of nuclear cost over-runs and subsidy led to Government policy of:

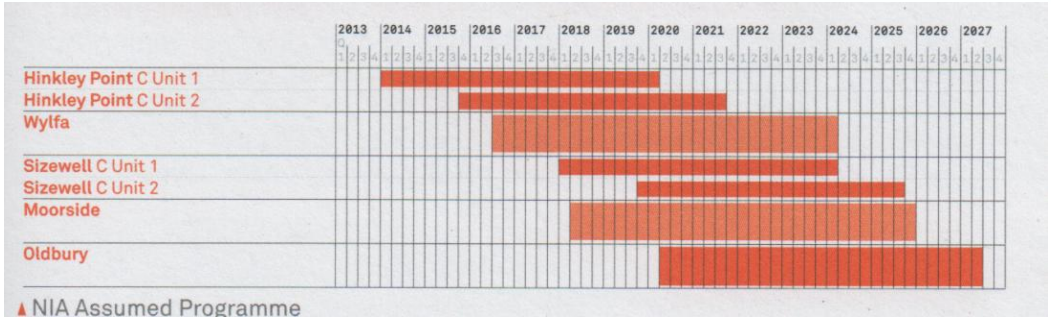
  Private sector investment with **no public** subsidy

  Full **provision for waste and decommissioning** costs in a segregated fund, with guarantees by the investor/operator

Government's position was subsequently modified to 'no special subsidy' for nuclear – which is the basis of EMR.

UK Nuclear Plans

- **Current nuclear generation**
  ~9GWe ~**15% of UK supply**
- Plans for **15GWe new** by 2030



- **EDF Energy** plans for four **EPR** systems – two twins:
  Hinkley Pt C, Sizewell C, a total of **6.4 GWe**
- **Horizon Nuclear Power** (bought by Hitachi)
  Five **ABWR** - yet to be licensed in UK
  Sites at Wylfa and Oldbury with outline plans for
  6 GWe of nuclear generation;
- **NuGen** (JV between: GDF Suez & Toshiba)
  Three Westinghouse **AP1000** part way through licensing;
  Option on a site near Sellafiield at Moorside – **3.3 GWe**

Nuclear Costs in the UK

- **2006 Energy Review** suggested mature new nuclear could be built in 5-6 years with unit overnight capital costs ~£1,200/kWe
- When **inflated** to current values (2013) overnight capital costs: £1,600/kWe,

  or, with project interest: £2,162/kWe

  would require a life-time levelised price of: **£70/MWh** @ 9% project discount rate

- Press reports that **Hinkley C**, which includes significant first-of-class costs,

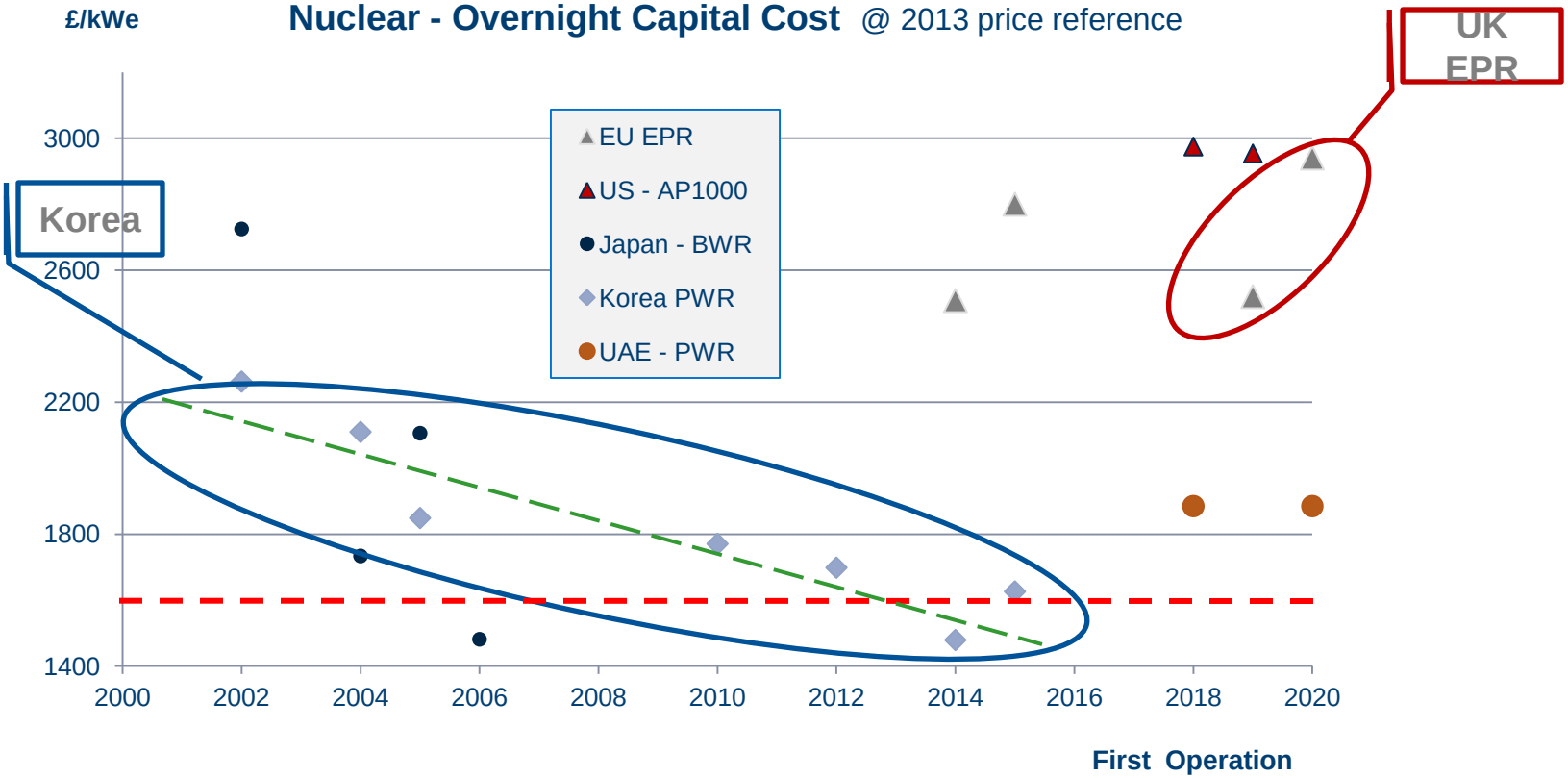
  will have overnight capital costs of: ~£3,000/kW

  adding project interest over a 9-10 year build period: £5,000/kWh

  requires unit generation prices of: **£92/MWh** (£86/MWh)

Nuclear Capital Costs

Actual & estimated costs are much higher than Energy Review 2006



Sources

'Future of Nuclear Power 2009' MIT - restated to UK £s in 2013 plus recent public data – US, UAE etc

Energy Review central cost estimate - restated to 2013.

How did we get here?

- Last nuclear station constructed in early 1990s – Sizewell B;
- Nuclear industry closed down 1995-2005 with focus on first: ‘dash for gas’ and then: investment in renewables:
  - Fast reactor programme cancelled and nuclear R&D reduced to almost zero;
  - No new nuclear forseeable – Energy White paper 2003;
  - BNFL broken-up & decision taken to close down fuel reprocessing;
- Low confidence that UK could build nuclear stations to time and cost – mainly due to experience of AGR programme and of CEGB;
- Hence Government have focused on:

1. **Low-risk reactors designs** – water reactors;
2. Owners that have the track record and can **shoulder the financial risks**.

Private Sector Risk

- Transfer of the project risk to private sector has crystallised significant financial requirements not previously visible:
  - **Project delivery risk** – both cost (uncertainty of new designs) and timescale;

    - interest during construction over 10 years adds up to 50% to investment
  - **Waste & Decommissioning** cost/provisions;
  - Scale and risk of **financing** of such large projects:

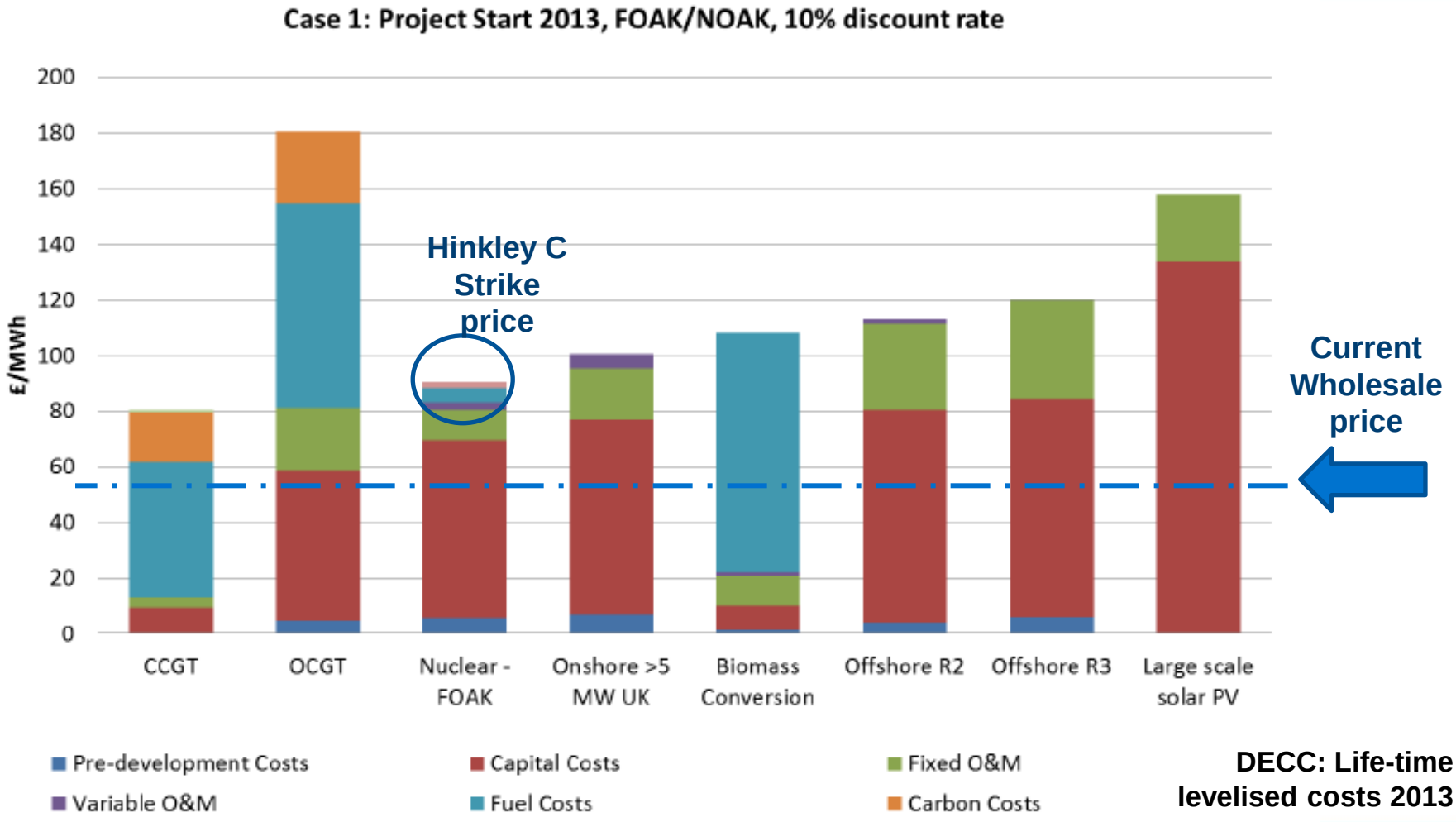
    – EDF committed to £30bn nuclear investment in UK c/f market cap £47bn!

    also, UK electricity market makes wholesale revenue highly uncertain.
- As a result, such nuclear projects are neither suitable for **private finance**, nor able to be **carried on the balance sheet** by even the largest corporations.

EMR for Nuclear

- Provides certainty of electricity pricing over the life of the project by means of **Contracts for Difference (CfD)**;
- **Loan guarantee** of ~60% of project cost make the project digestible for corporations – reduces the equity requirement;
- All projects will be **consortia** because of the scale of the investment;
- **Subsidies?**
  - Process is consistent/similar for **all low Carbon** energy sources;
  - **CfD** converts the owners business risk into a process of agreeing costs with Government – very similar to the regulated electricity markets in US;
  - **Loan Guarantee** – turns an equity risk into a loan risk;
  - **Performance risks** (construct**,** operate & decomm**)** remain with owner/operator.

Lifetime Levelised Costs & Subsidies



DECC: Life-time levelised costs 2013

Getting Ready for New Build

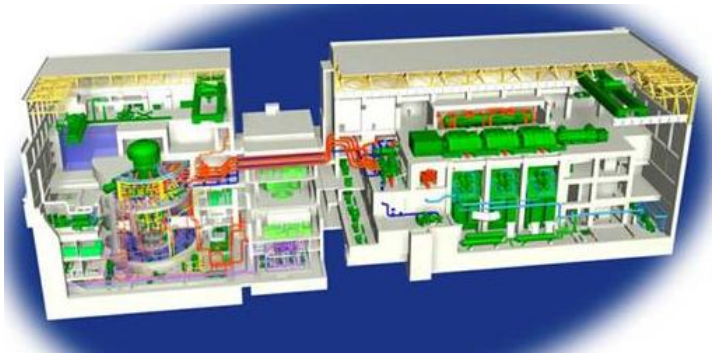
- Streamline safety regulation of new reactors:
  - New Generic design assessment process proven on EPR – one-stop-shop for regulation – via Office of Nuclear Regulation;
- Skills for new nuclear?
  - National Skills Academy for Nuclear – operating & sponsor of nuclear skills passport & nuclear apprenticeships;
  - Graduate courses: Birmingham, Manchester (part-time), Imperial & Cambridge – masters programmes, two doctoral training centres: Manchester & Imperial/Cambridge/OU:
- When will construction start?
  - Autumn 2014? after Energy Bill is passed & EU State Aid issue cleared;

Constructing the Stations

- It has been said that UK is capable of providing >66% of value of stations, in reality:
  - **OEM** (e.g. AREVA) Fuel, vessels and systems world-wide supply chain;
  - **Generator & HV** electrical plant Alstom, or Hitachi will supply;
  - **Constructio**n – JV UK company with foreign provider who has built before e.g. Laing O'Rourke/Bouygues selected for Hinkley C;
- UK firms also represented at the **next tier in supply chain**;
- EDF have conducted an extensive **supply chain qua**lification programme in UK;
- Government has invested a **Nuclear AMRC** at Sheffield – lower costs & improve UK manufacturing industry's competitiveness.

Scope for Cost Improvement & Price?

- Investment cost - **EPR** from £92/MWh
  - First of class capital costs ~10%
  - Construction schedule from 10 -> 8 years? £82-86/MWh
- **Re-financing** post construction could reduced required 'Strike price' by ~15% in the range £75-80/MWh



- Competition from lower cost designs **ABWR** – perhaps 20% cheaper

'Strike price' in the range £65-77/MWh

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