The Role of Nuclear Energy in the UK

The Nuclear Energy (SME) Industry Perspective

Dr John Taylor

DBD Ltd

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- The industry's development
- The 'dash for gas'

Present:

- Competition, reactor options
- Current challenges

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Past: Nuclear Industry's Development

- UK Science and Technology (S&T) was paramount in developing the UK independent nuclear deterrent
- Objective - produce plutonium for the deterrent
- 1950 -51 Windscale 'Piles' became operational
- UK S&T rapidly developed independent reactor designs and a fuel cycle

Past: Nuclear Industry's Development

- The cost of nuclear power (per MW-hr) was a ¼ to ½ from coal – a low cost energy mix was required
- Calder Hall Magnox station launches the UK nuclear programme
- *Visionary* - based on UK world leading S&T driven by Government/UKAEA

Past: Nuclear Industry's Development

1953 – Calder Hall Magnox Power Station

Past: Nuclear Industry's Development

A Historic Picture of the Windscale Site Circa 1957

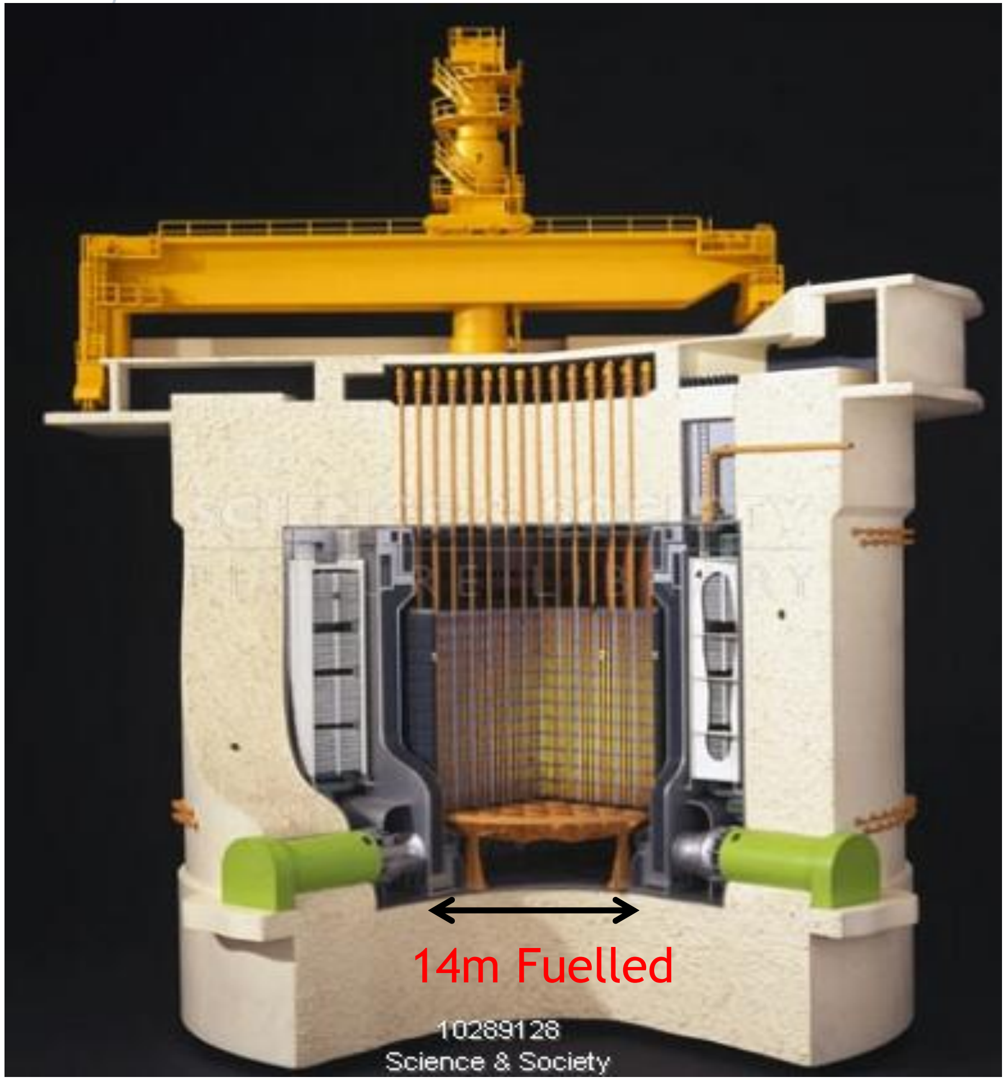
Past: Nuclear Industry's Development

- 1956 – 1995
  - 26 Magnox Stations , UK S&T
  - 14 AGR units, UK S&T
  - Peak contribution to electricity production in 1990's, 25%

- 'Large' integrated entities, Government, CEGB, TNPG, NNC

- Beyond 2014
  - Magnox — all closed by 2015
  - AGR — all closed by 2023
  - Sizewell B PWR — closure 2035

Past: Nuclear Industry’s Development

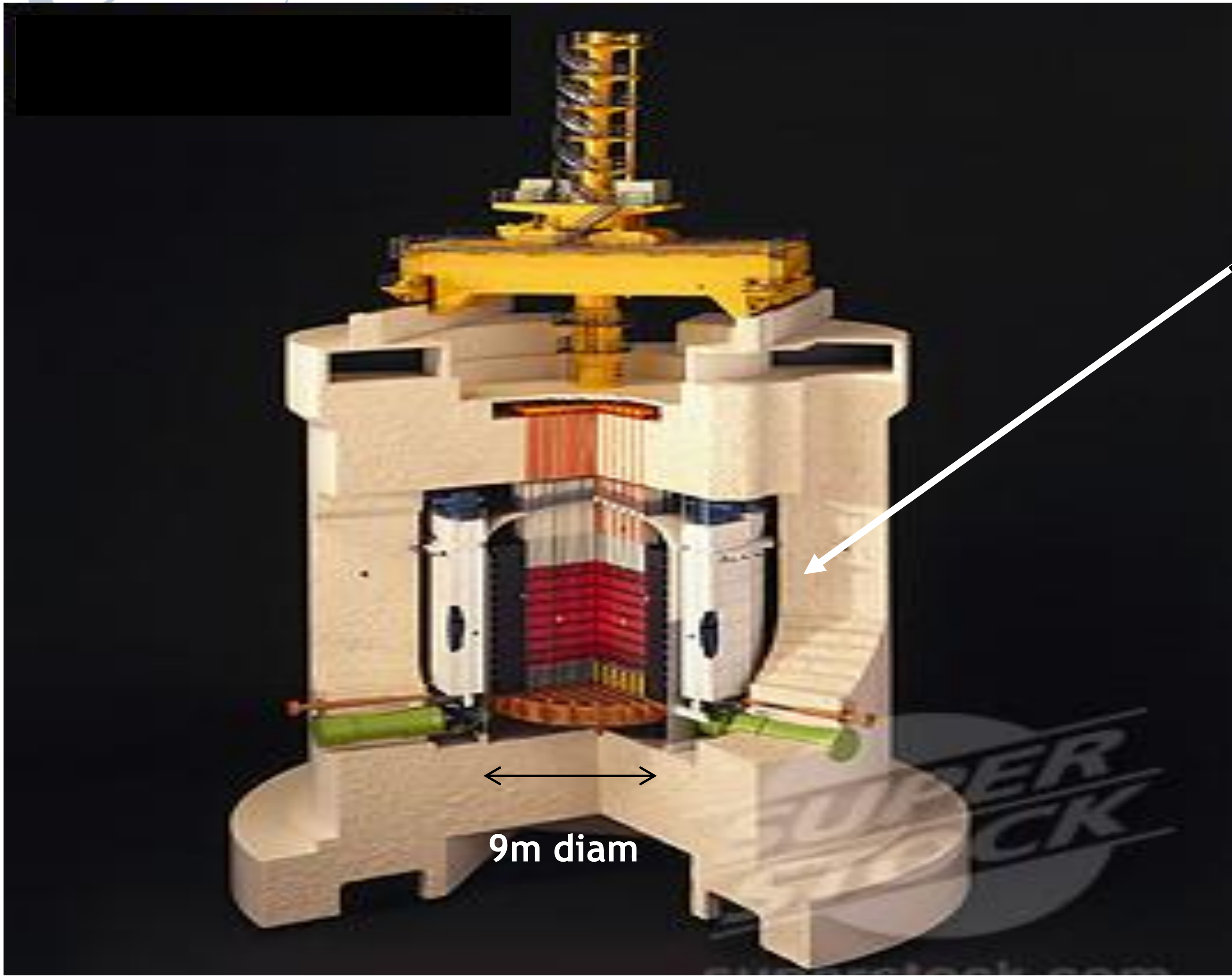


9m high fuelled core

(14m including reflectors)

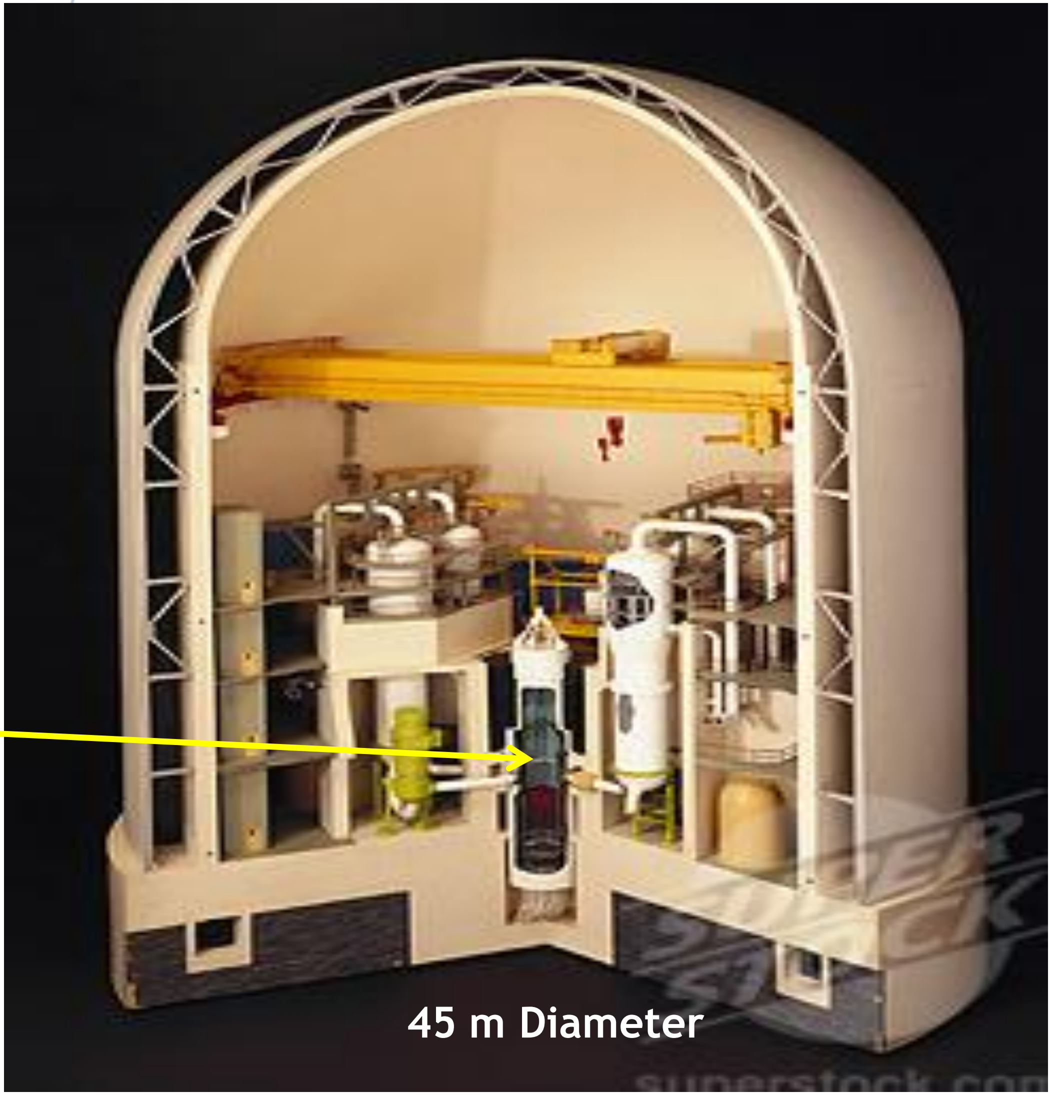
Carbon Dioxide Cooled Magnox Reactor Core

Past: Nuclear Industry’s Development



Torness AGR Carbon Dioxide Cooled Reactor ~ 680 MW (e)

Past: Nuclear Industry’s Development



65m High

Core:
4m high
4m diam.

Sizewell B PWR 1250 MW(e)

Past: Nuclear Industry's Development

- 1995, 25% nuclear ~12 GW(e)/year
  (~40 GW(e) from coal, gas, minimal renewable)

- CO_2 savings, 70million tonnes or 15% of UK annual discharge

- By 2023 nuclear will make no contribution to CO_2 reduction

Past: 'The Dash for Gas'

- Government withdraws from nuclear - 1980's
- Electricity production privatised – a new vision
- Gas generation capacity rises - 5% to 28% per/y
- Last nuclear plant Sizewell B PWR
- If Hinkley 'C' comes on line - a gap of 28 years.

Past & Present: 'The Dash for Gas'

Implication for UK nuclear engineering, science and technology – the SME perspective

- University science and engineering graduates intake reduced
- University courses closed London, Salford, Manchester etc
- Industry experts aging and leave the industry
- Corporate knowledge declining rapidly
- World class Integrated S&E teams delivering a national vision is lost - design house/privatisation arises – different vision(s)

The Present: Rising demand for S&T Resources

Reactor design – UK has limited capability however;

- New reactor design – must be understood the ‘intelligent customer’- a regulatory demand
- Decommissioning of old reactors increasing
- Defence work – new facilities design, refurbishment, decommissioning
- Sellafield, Capenhurst, Springfields – new facilities design, refurbishment, decommissioning
- Waste Management and materials transport demands
- Demand for increasing independent expert advise e.g. DBD

The Present: Resource Map – The Industry's SME Perspective

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Safe plant – Yes
at a higher cost and behind schedule

Rising costs - resource factor

High Demand

Consequence - repeat, work, again and again

Engineers Resources

Few 'corporate' teams

'Classical' engineering judgement lost – Universities limited experience

Limited engineering and safety function integration

Reduction in nuclear engineers knowledge (20 years)

Agency engineers, where is the vision and mission for UK plc?

The Future: Reactor 'Competition' and Options

- 2006 energy paper, nuclear option revised
- 2008 Energy Act enshrines CO_2 reduction into law
- UK no longer has the capability to design or offer a large scale nuclear power plant

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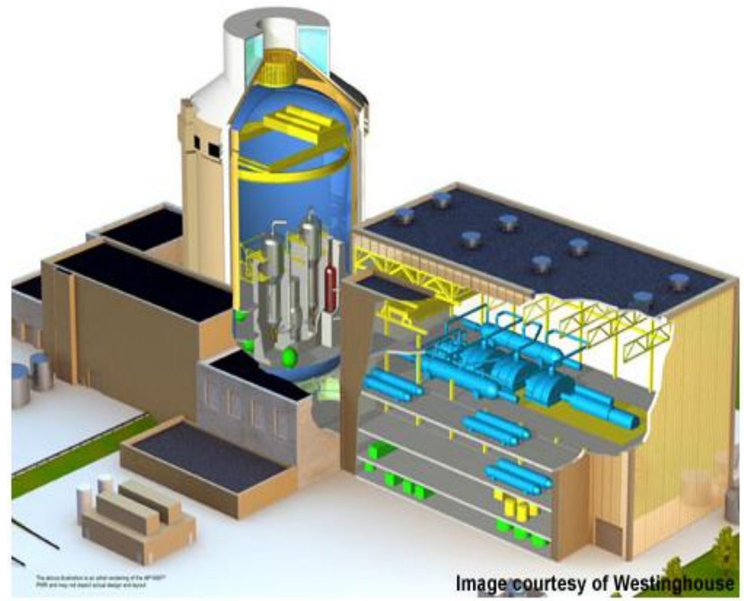
- Overseas Private Companies designs will have to meet Govt. 19GW(e) nuclear target by 2030
- This give 30% /y CO_2 reduction
- Available designs:
  - Large Power reactors 1000 MW(e), 500 MW(e)
  - Small to medium size reactors 35 MW(e), 225 MW(e)

The Future: Reactor Types ~ 1000MW(e)

European PWR 1650 MW(e)

Computer generated view of an EPR power plant

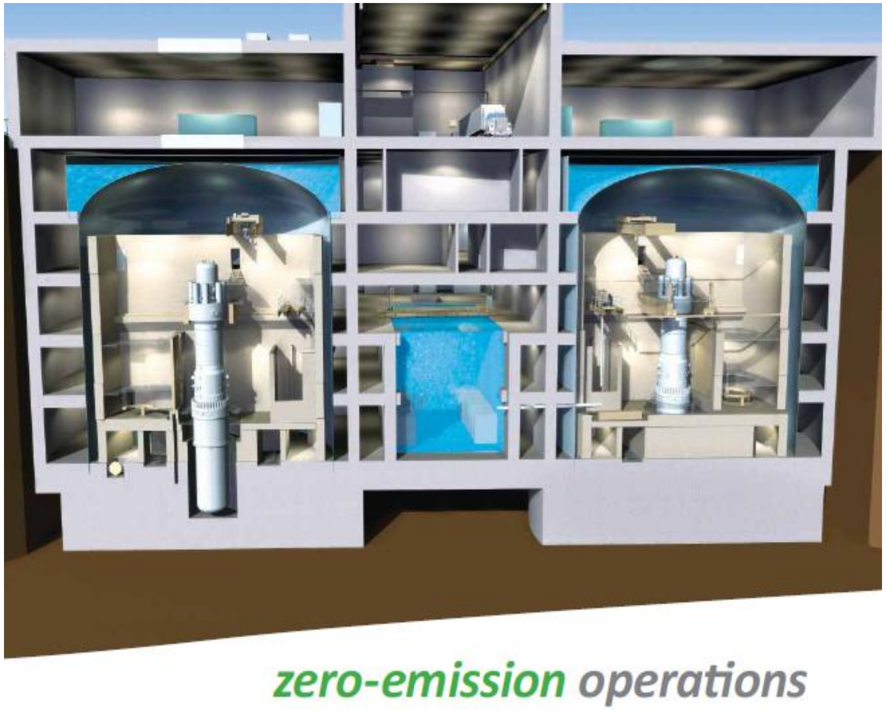
Westinghouse AP1000 MW(e)



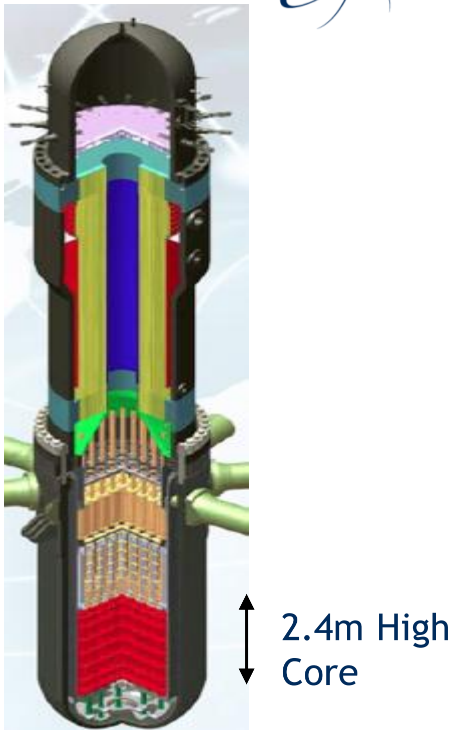
The Westinghouse AP1000 uses 50% fewer valves than reactors that produce the same amount of power.

- Base load high power output reactors
- Plant are currently being built in Finland and China
- “Off the shelf designs” – Require UK regulatory approval and licences

The Future: Small to Medium Size Reactor (SMR) > 35 Mw(e) to 350Mw(e)



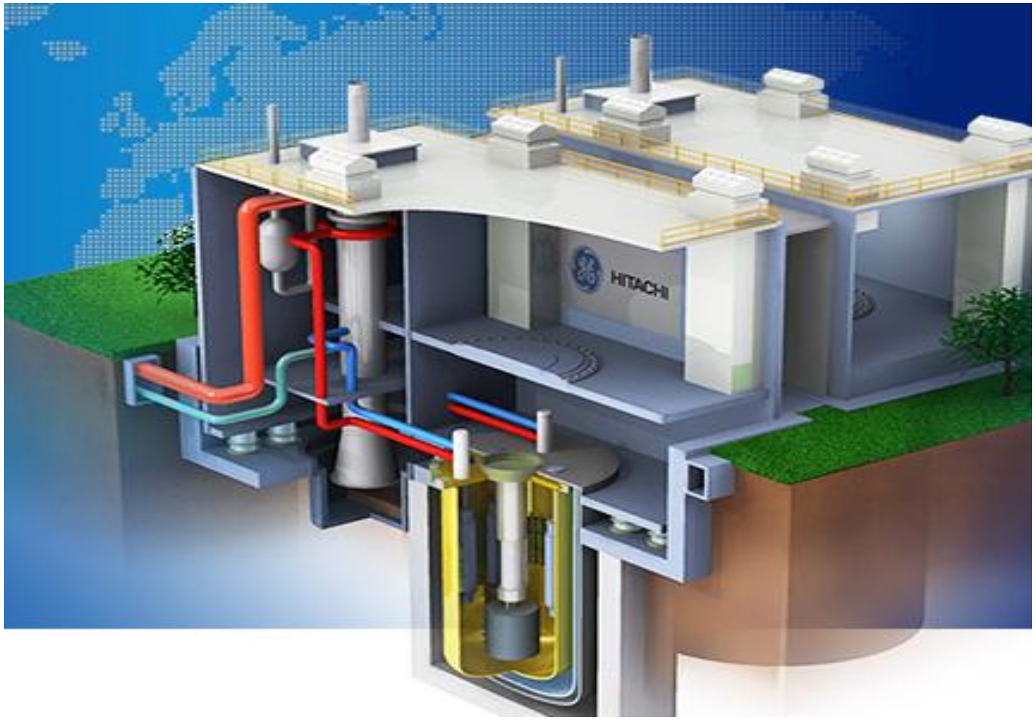
Babcock and Wilcox 2 X 150MW(e) PWR's



Westinghouse 225 MW(e) PWR

- Base load local area power only e.g. Trawsfynydd, or Cumbria
- Potential large overseas market, low cost re 1000 MW(e)
- Some additional design work required
- "Off the shelf designs" – Require UK regulatory approval and licences

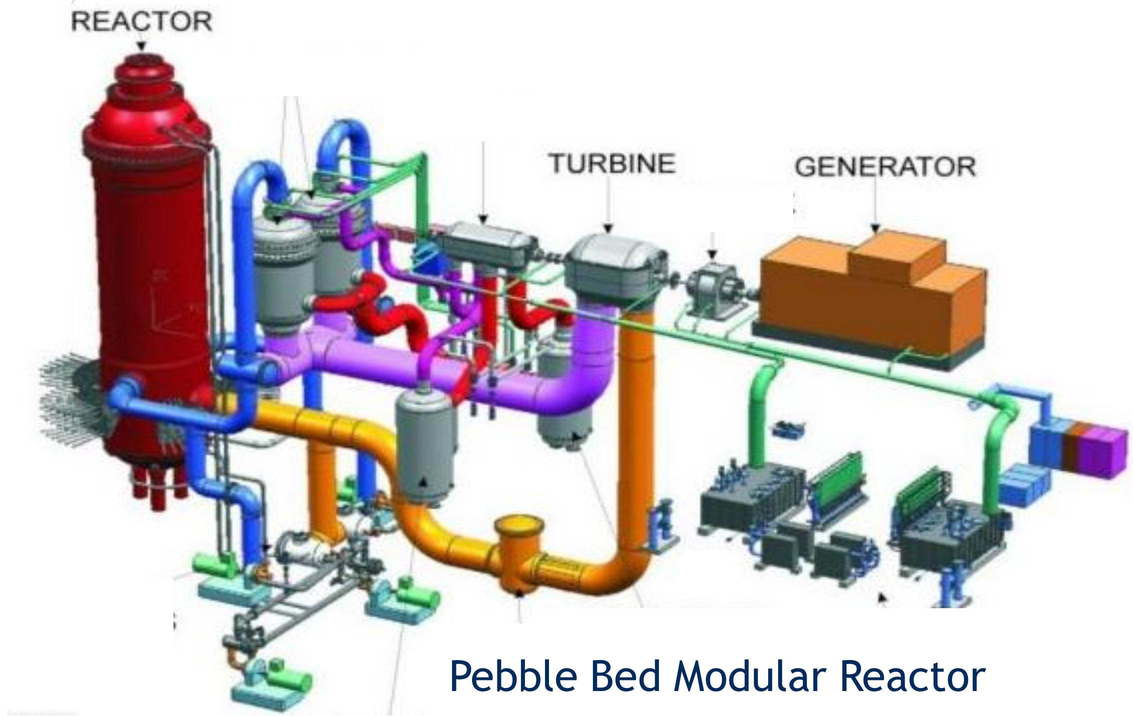
The Future: Small to Medium Size Reactor (SMR)



GE Hitachi PRISM (Fast Reactor) 311 MW(e)

- Primarily plutonium burning reactors to reduce the stock, using mixed oxide fuel
- At a high level of design – require UK regulatory approval and licences

The Future: Small to Medium Size Reactor (SMR)



Pebble Bed Modular Reactor

- Two have operated in Germany
- Typical power 195MW(e) – helium cooled, inherently safe
- Key feature high outlet temperature 900°C
- Ideal for hydrogen production
- Required: Further reactor design work; fuel manufacturing process; UK regulatory approval required

Legacy Issues – A Challenge for the industry

- Public perception of safety – reactors and wastes
- Reprocessing facilities to be decommissioned producing legacy waste – a complex task
- Legacy of plutonium (an energy asset)
- HLW legacy – fission products and long lived isotopes, a public concern

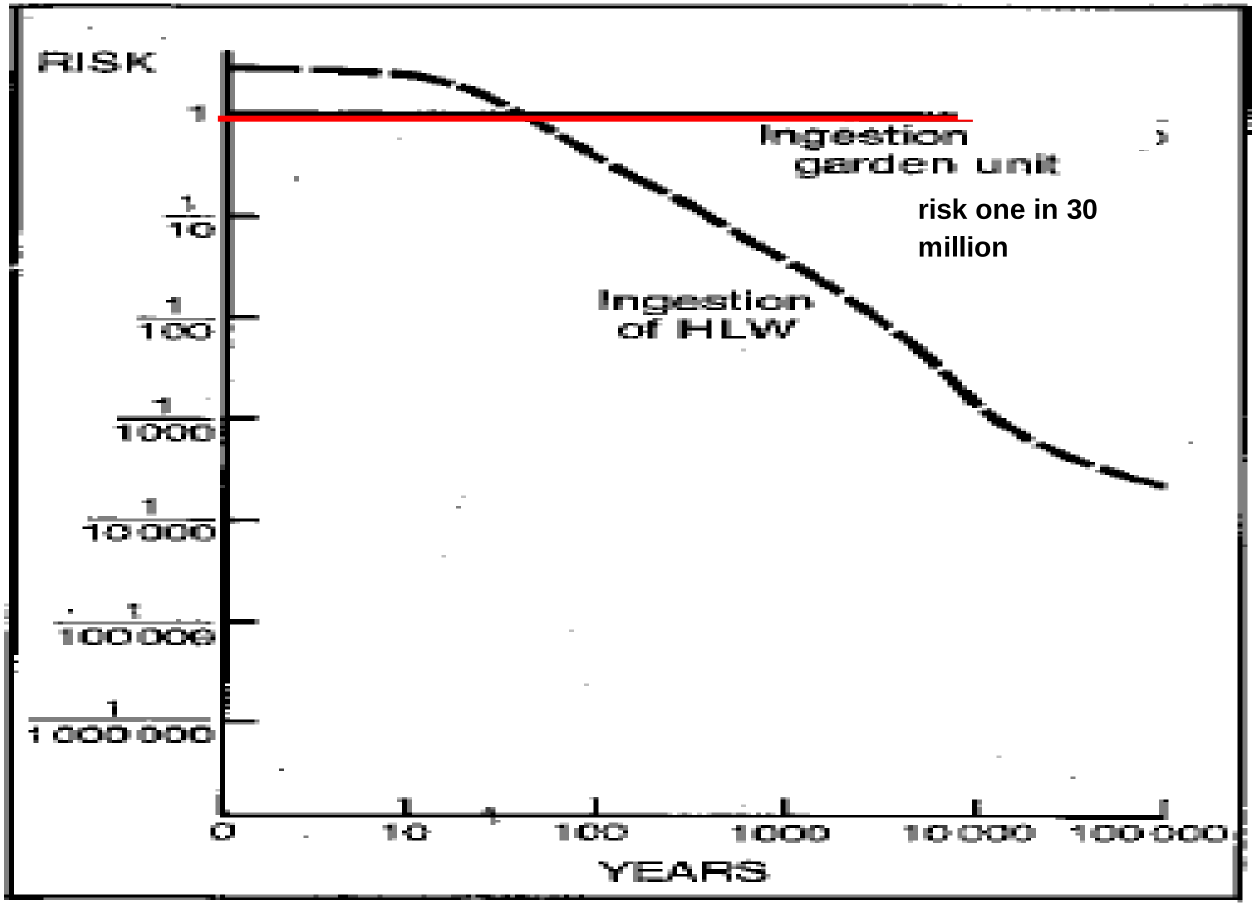
Legacy Issues – A Challenge for the Industry

Deep repository safety:

- A garden contains* approximately:
  - 250kg of radioactive potassium (K40)
  - 2.5t of radioactive thorium (Th232)
  - 800kg of uranium (mainly uranium 238)
- If all consumed from food, water, and inhalation it would be fatal – your risk is however, 1 in 30 million per year
- So what are the risks from a repository?

* To a depth of 300m and 40m by 10m.

Legacy Issues – A Challenge for the Industry



Ref. ATOM UKAEA No. 356 Lord Marshall

- The risk from an engineered repository is negligible
- The concern regarding legacy material safety is misplaced

A Thought Experiment - Nuclear Energy Impacting on CO_2 Emission - visionary

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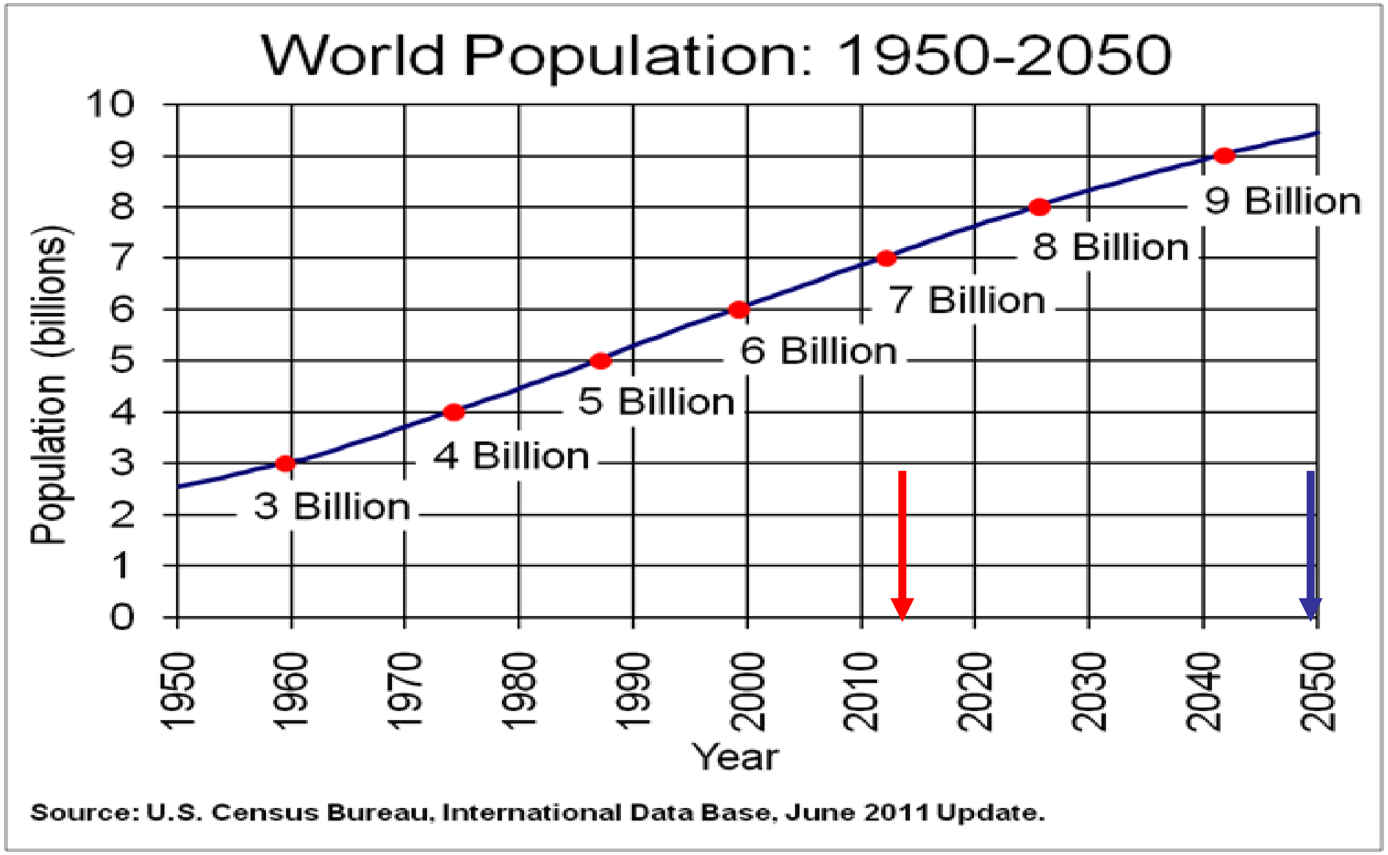
Current CO_2 Distribution	Low Carbon Energy Solution with Nuclear Power
38% From Power Production	Using PWR plant CO_2 = Zero
25% From Transport	High Temperature gas reactors plus magnesium nano particle storage technology for hydrogen production. Transport CO_2 ~ Zero
16% From Residential	Switch from gas to cheap nuclear powered electricity Residential CO_2 ~ Zero

Savings – 69% CO_2 of UK discharge

Savings – about 324 million tons CO_2 saved by nuclear power

Finally – Global Population and Energy Demand

Where will the energy come from for twice the worlds current population in ~ 30 years? SME industry perspective – UK must be engaged



Summary – The industry's SME Perspective

Industry grew from the 1950's/1960's with a mission/vision

Challenges:

- Dash for gas weakened the technical skills base
- Reactor designs are now overseas – UK has limited capability
- Declining 'knowledgeable' UK skills
- Driving repeat work putting pressure on schedules
- 'Classical' engineering judgement replaced – 'qwerty' decisions
- Being the 'intelligent customer' is now very demanding for new licensees

Summary – The industry's SME Perspective

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The Future

- Resources *are* coming through
- Graduates *are* of high calibre and resourceful
- Strong support from the 'retired corporate' knowledge
- SME's providing flexible and essential knowledge
- UK has a variety of plant options
- National and international nuclear scene is optimistic and UK has to engage
- Nuclear power could theoretically reduce the UK carbon footprint ~ 70%
- Concerns about legacy waste in a repository are technically ill founded.

Thank you for your time

Close