



Rolls-Royce

Nuclear New Build Industrial Challenges – A Rolls-Royce Perspective

John Molyneux

February 2012



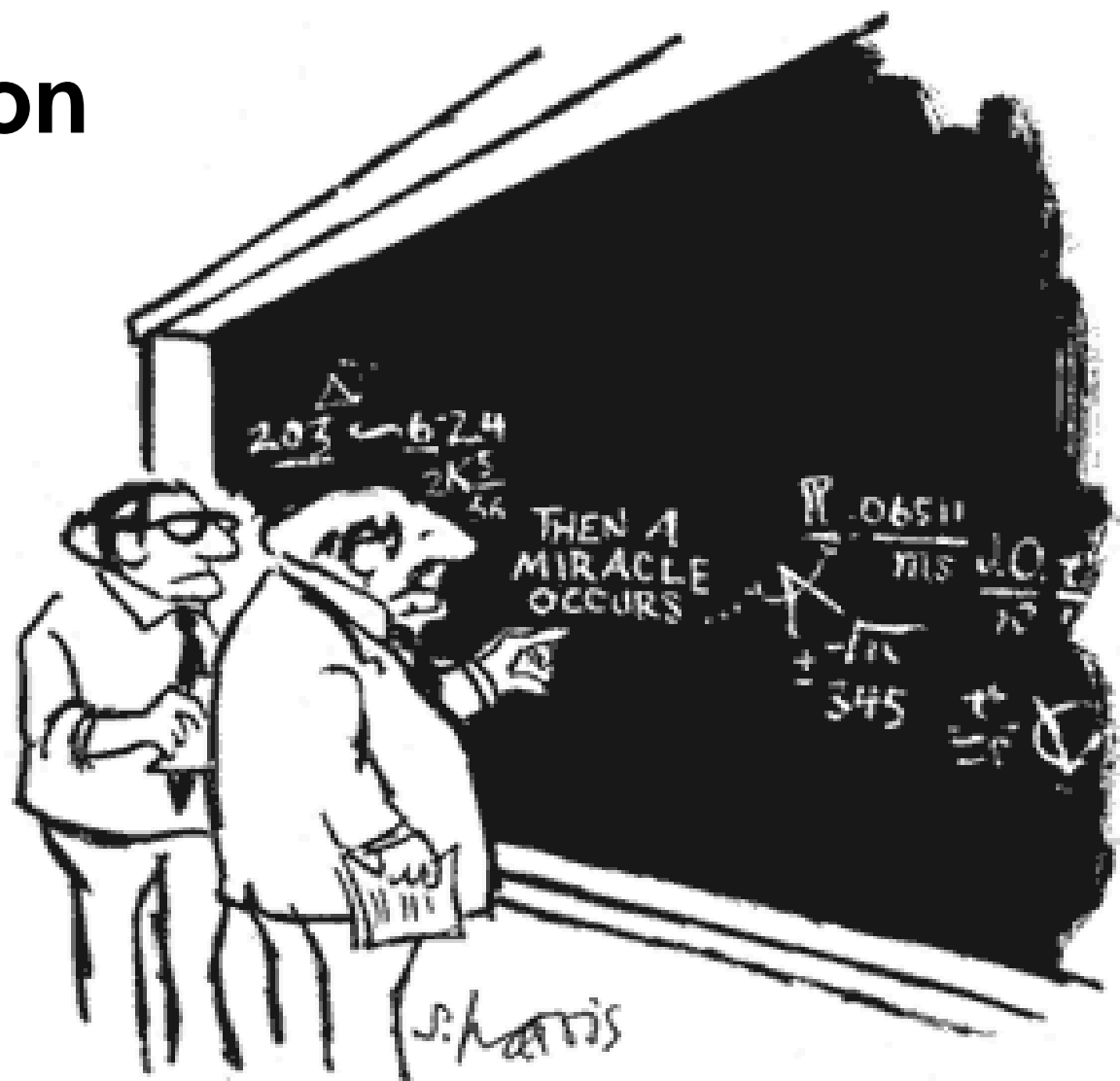
Agenda

- **Introduction**
- **The Uniqueness of Nuclear Power**
- **The Market**
- **The Technology**
- **The Challenges – for People**
- **The Challenges – for Manufacturing**
- **The Challenges for Rolls-Royce**



So What is so Special about Nuclear?

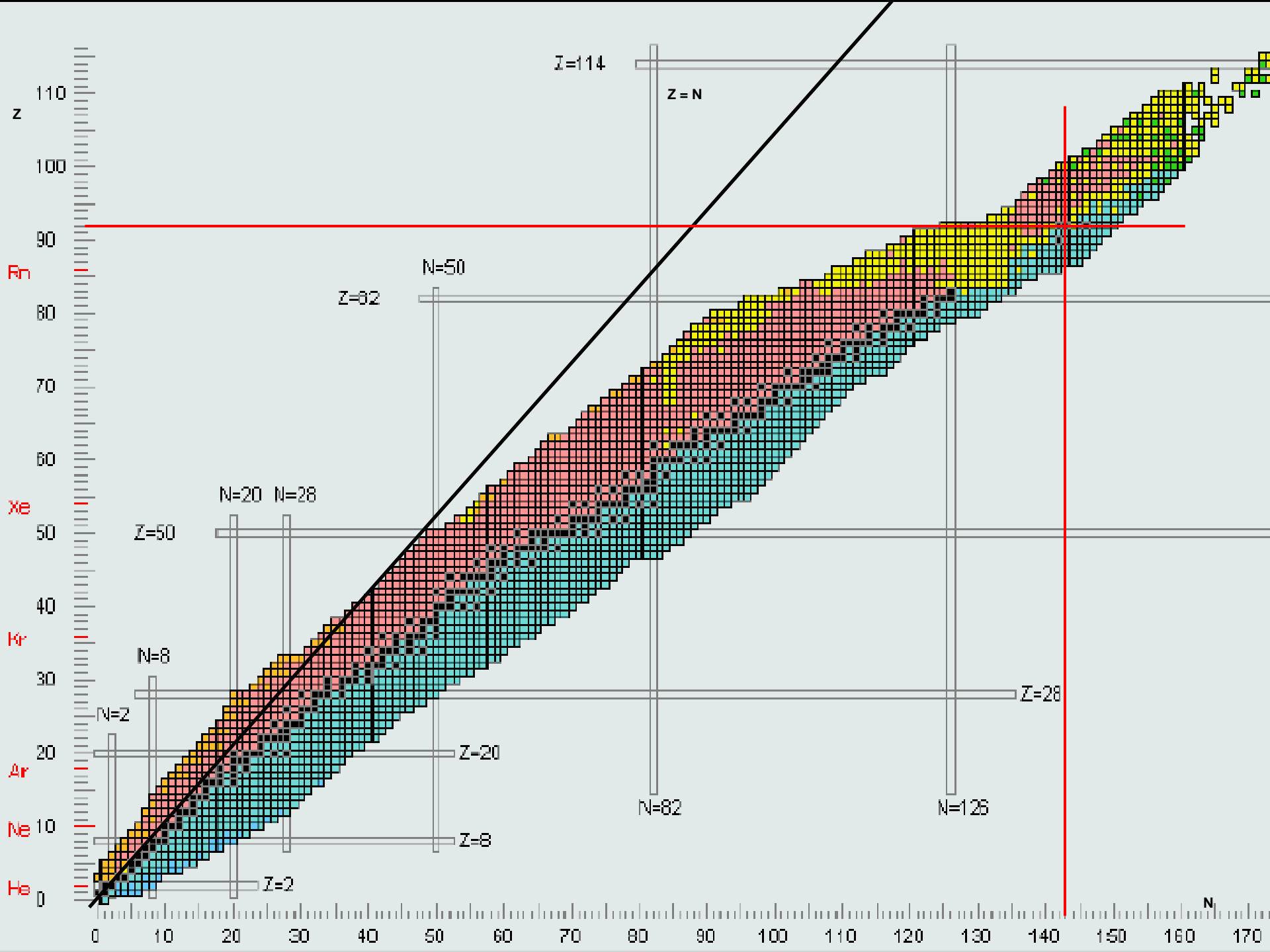
The common perception of nuclear physics...



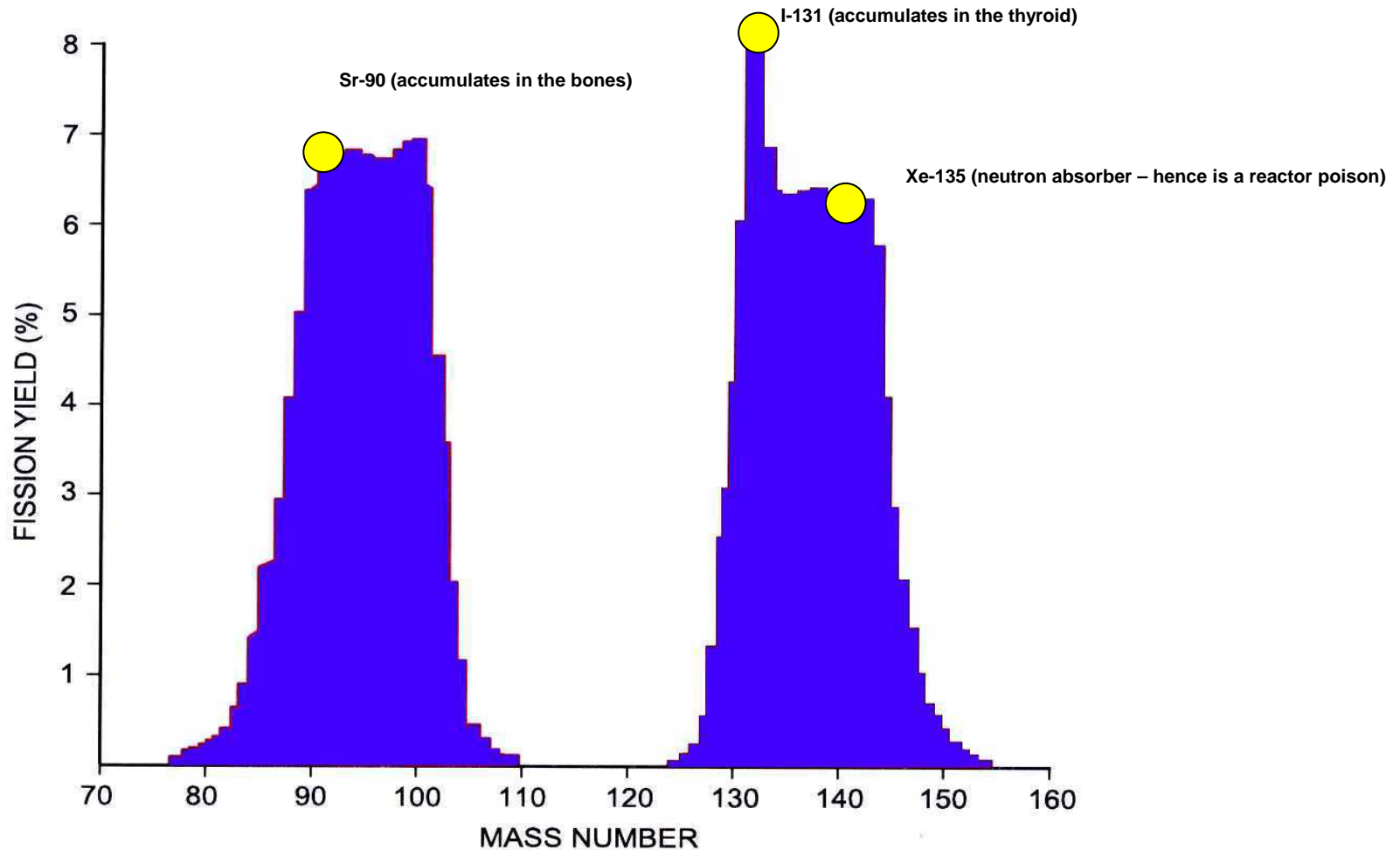
"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

How much heat from fission?

- Remember Einstein...?
- $E = mc^2$
- Burning oxygen and carbon releases around 4.02 eV of energy per carbon atom
- Splitting one uranium atom releases about 2,000,000 eV of energy
- We need to capture that heat, use it to boil water for steam, and drive a turbine



Fission Product Yield Curve



Fission Product Yields for U-235

3 Nuclear Issues

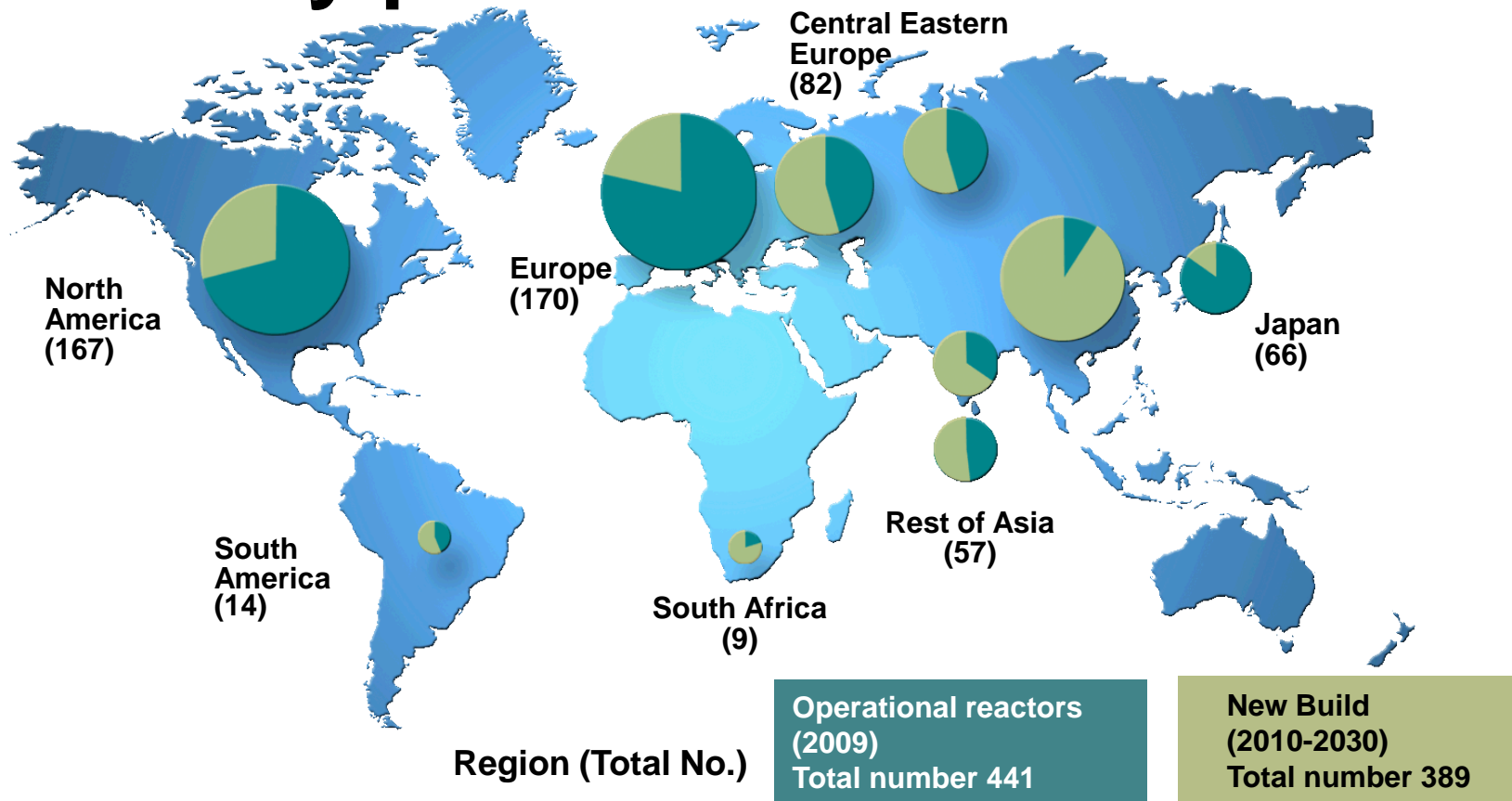
- **Criticality**
- **Heat Removal**
- **The Legacy of Waste**



We have to think Globally...

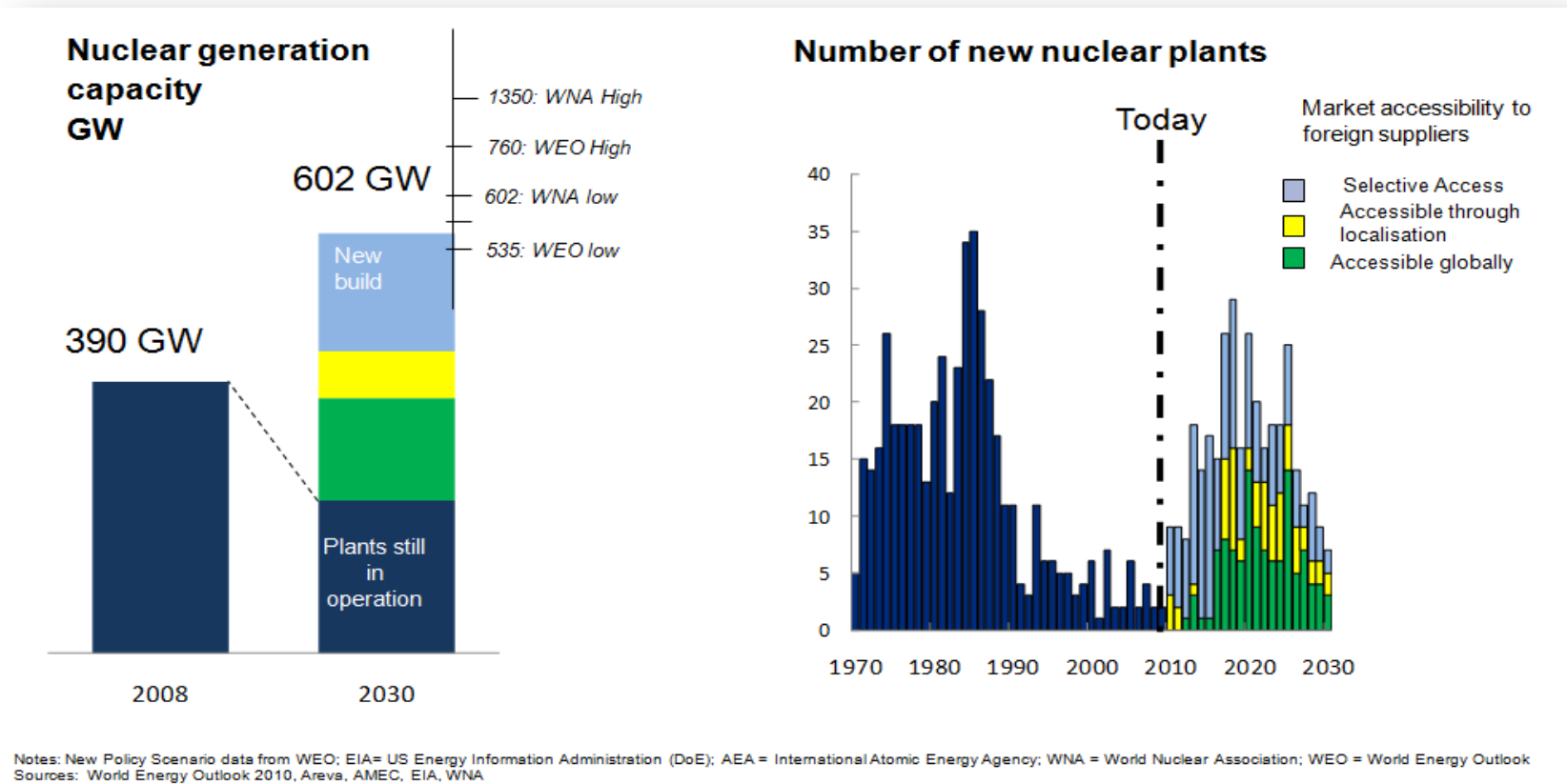
....and economically

Today nuclear power accounts for 14% of the world's electricity production



The global nuclear renaissance

● Once in a generation opportunity

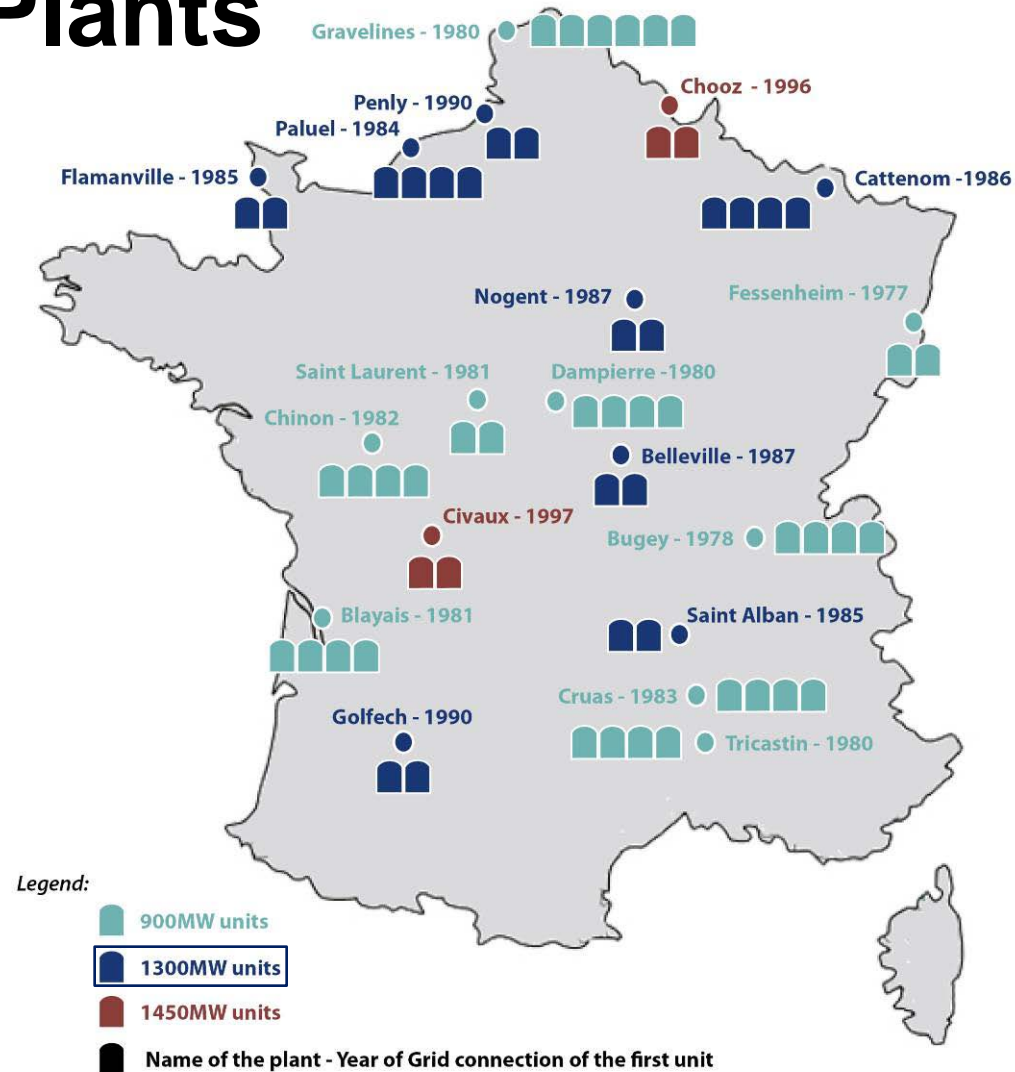






French Nuclear Plants

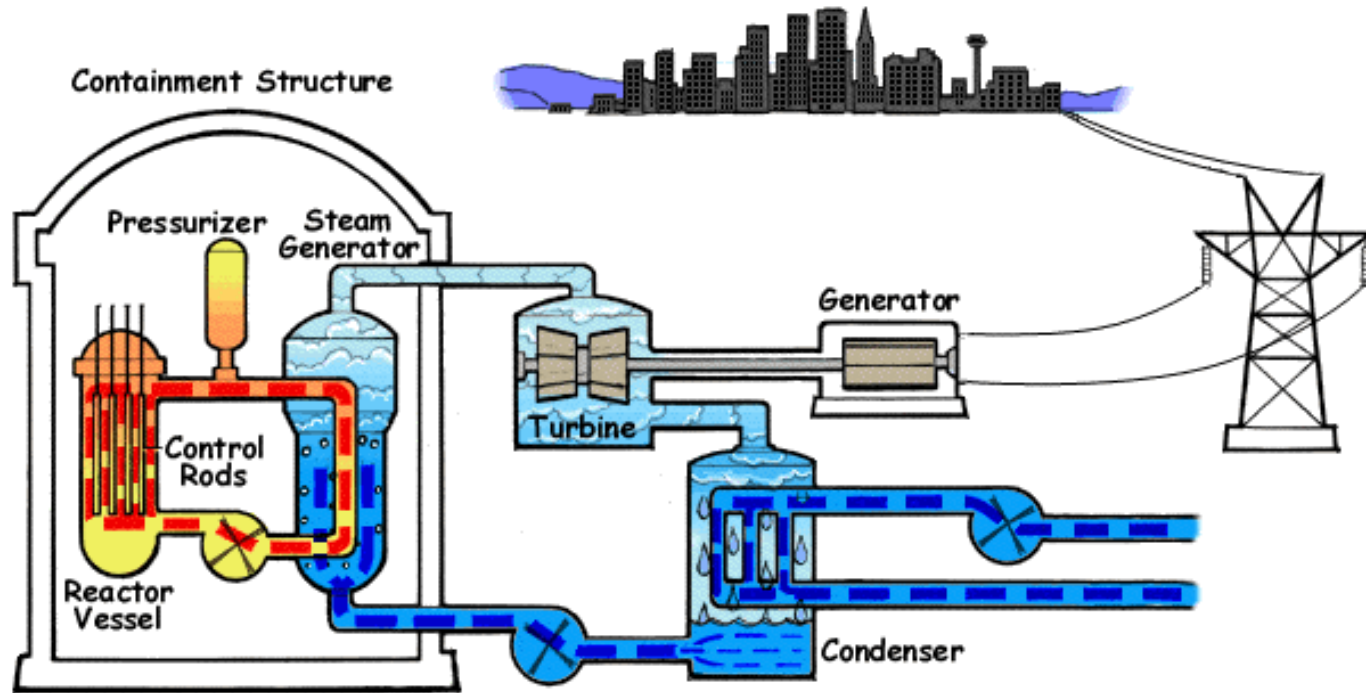
- France has had a pro Nuclear policy since the 1970's
- The Result is a large dependence on Nuclear Power...
- ... and a large industrial base very capable of delivering to the requirements





Nuclear Reactor Plant Types that will appear in the UK

Pressurised Water Reactors



- ☺ Design & operation well understood: **LOWER TECHNICAL RISK**
- ☺ Light water is low cost coolant
- ☺ High power density: small RPV
- ☺ Self-regulating and load-following capability (-ve temp coefficient of reactivity)

- ☹ High-pressure: LOCA prone
- ☹ Cost of enriched fuel
- ☹ No on-load refuelling
- ☹ Efficiency low (~35%)

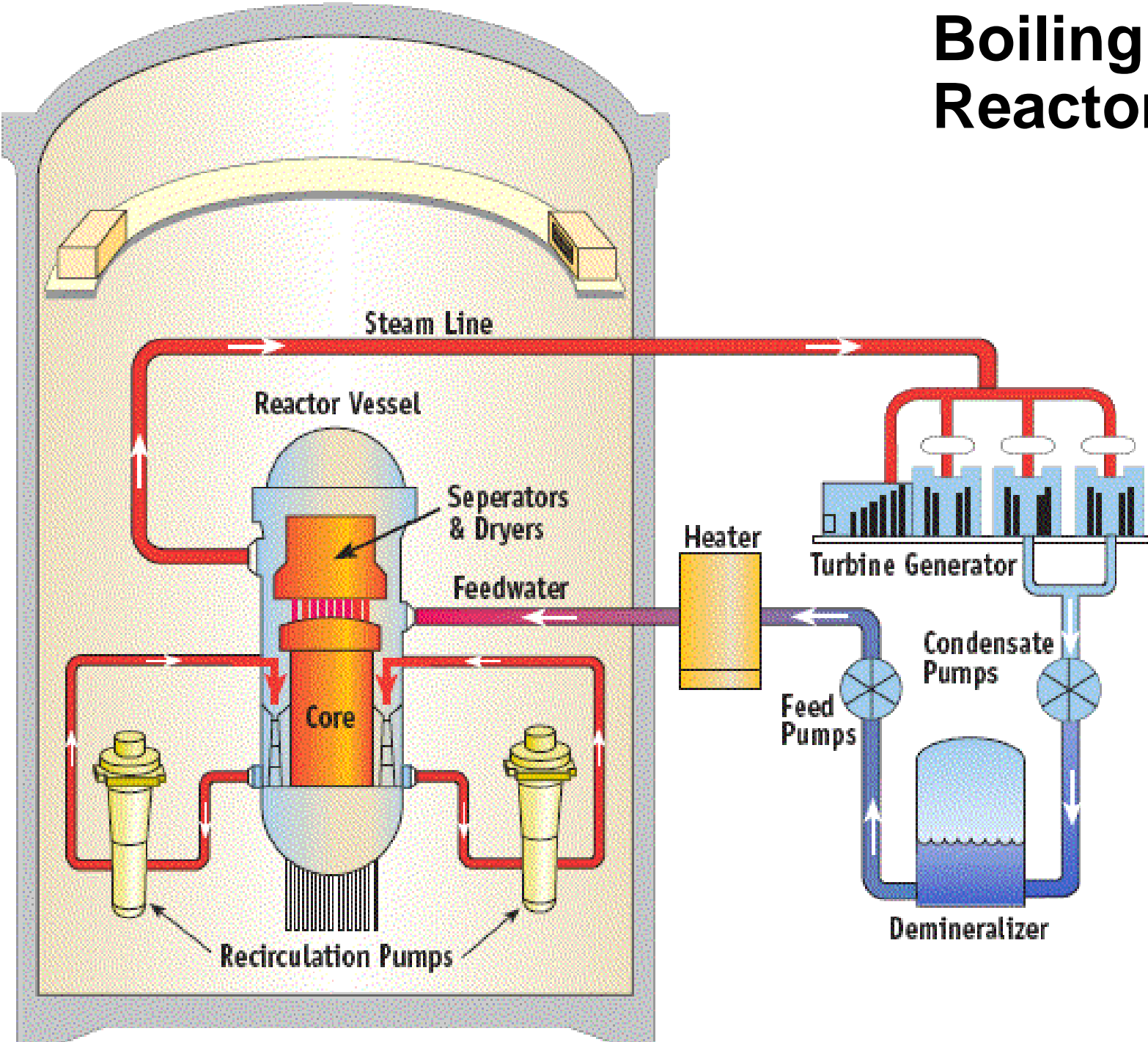
Areva EPR



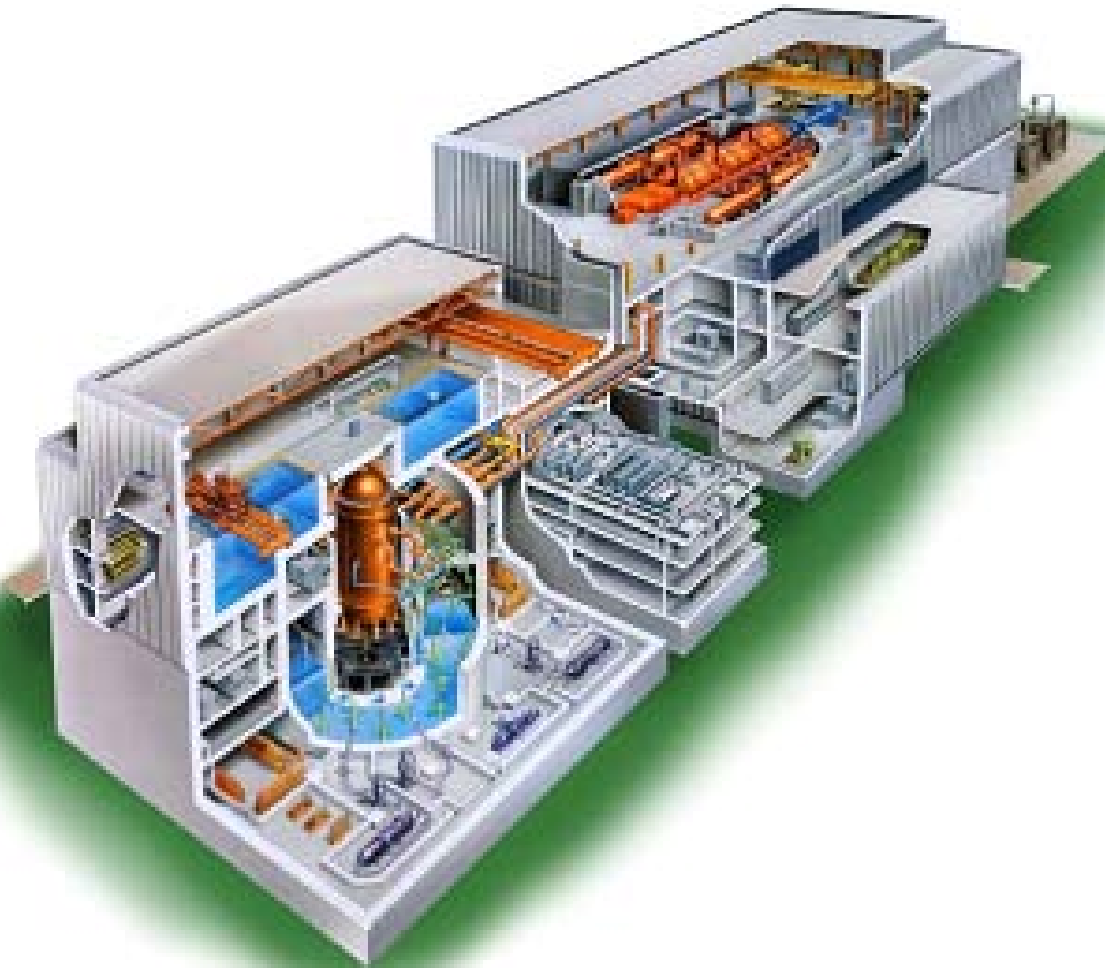
(Evolutionary Pressurised Reactor)

- 4-loop, one pump per loop PWR based on earlier French plant designs
- 1.6 GW electrical output
- Active safety systems arranged in 4 separate safety trains.
- Plants currently under construction in China, Finland and France

Boiling Water Reactor



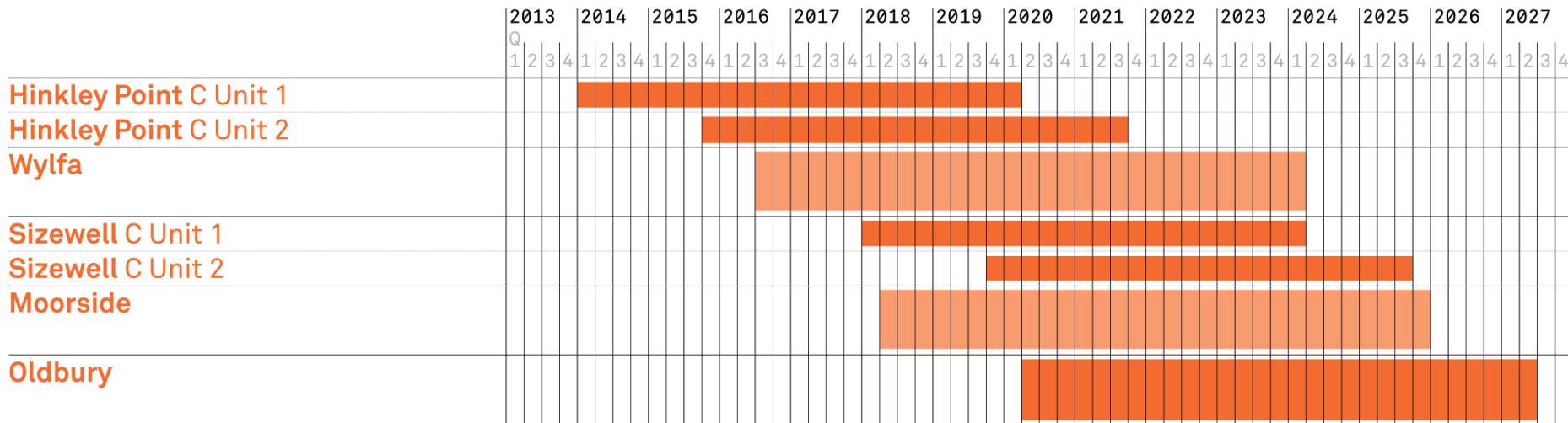
The Hitachi GE ABWR



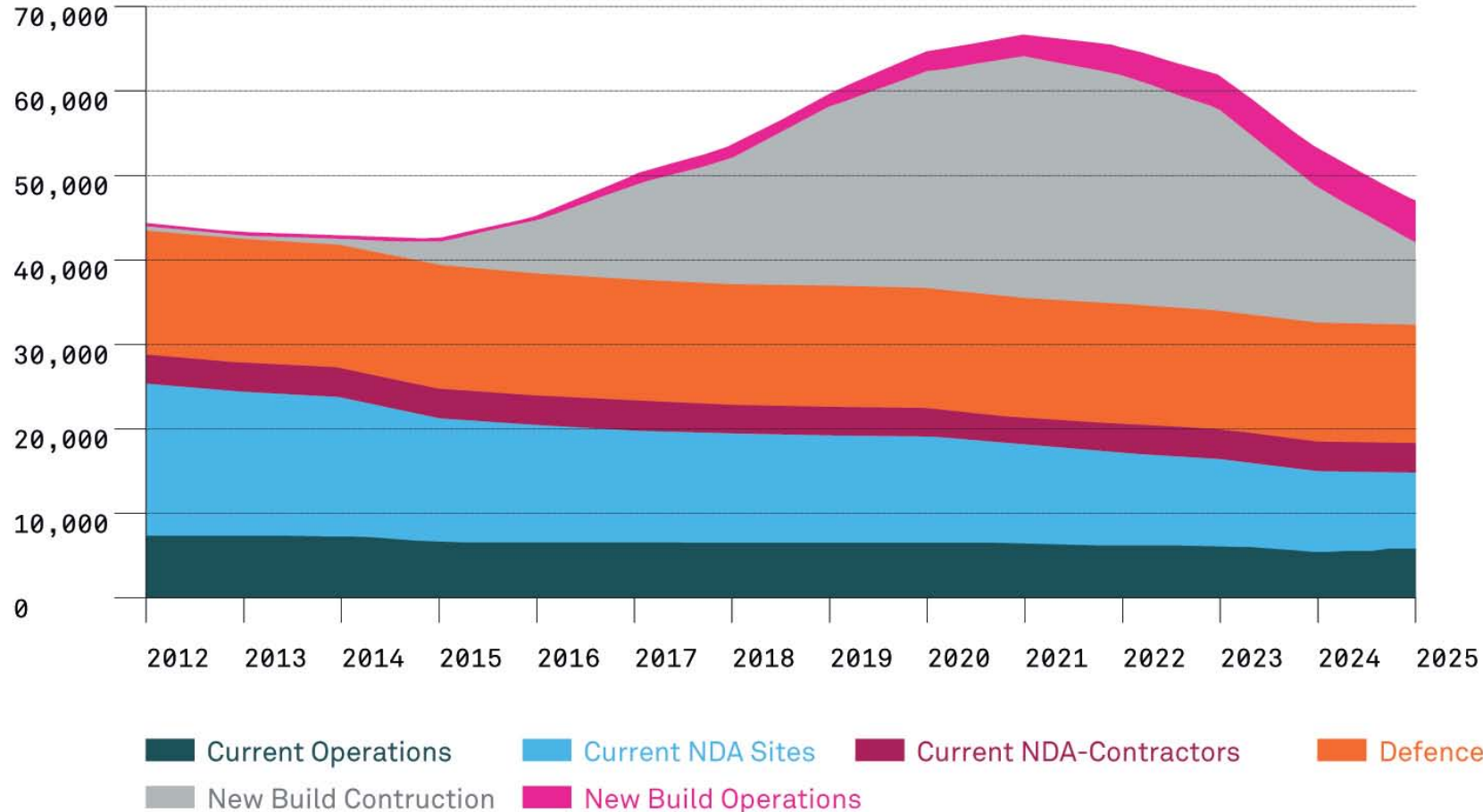


Nuclear Industry Demographic Challenges

NIA assumed programme



Nuclear industry employment with new build





The Prize is Jobs created by 16GWe new build

- **Over 600,000 man years of high quality work from now into the next century:-**
 - **5000 jobs per year over a 20 year construction period**
 - **7000 permanent jobs operating and servicing the new stations for their 60 year lifetime**
 - **5000 jobs per year over the main decommissioning period of 20 years**
- **Over 26,000 jobs at peak of construction period:-**
 - **7,000 manufacturing**
 - **10,000 civil engineering & construction**
 - **8,000 mechanical installation**
 - **3,000 electrical installation**



Twin challenges

- **Successfully deliver new power stations on time and on budget**
- **UK industry wins large share of the work**
 - **Capability**
 - **Capacity**
 - **Competitiveness**



Manufacturing Challenges

A Global Network of Manufacturing Research Centres



CCAM (Commonwealth Centre for Adv. Manuf.)

- Location – Crosspointe, Virginia USA
- Opens – 2013
- Subject – Surface Engineering, Manuf. Systems



Process Technology Research Centre

- Location -Singapore
- Opens – September 2011
- Subject – Surface Finishing



NCC (National Composites Centre)

- Location - Bristol UK
- Opens – May 2011
- Subject – Composites



AMRC (Advanced Manufacturing Research Centre)

- Location – Sheffield-Rotherham UK
- Opened - 2008
- Subject – Machining and Measurement



MTC (Manufacturing Technology Centre)

- Location - Ansty UK
- Opens – May 2011
- Subject – Automation, Fixturing, Joining, NNS



AFRC (Advanced Forming Research Centre)

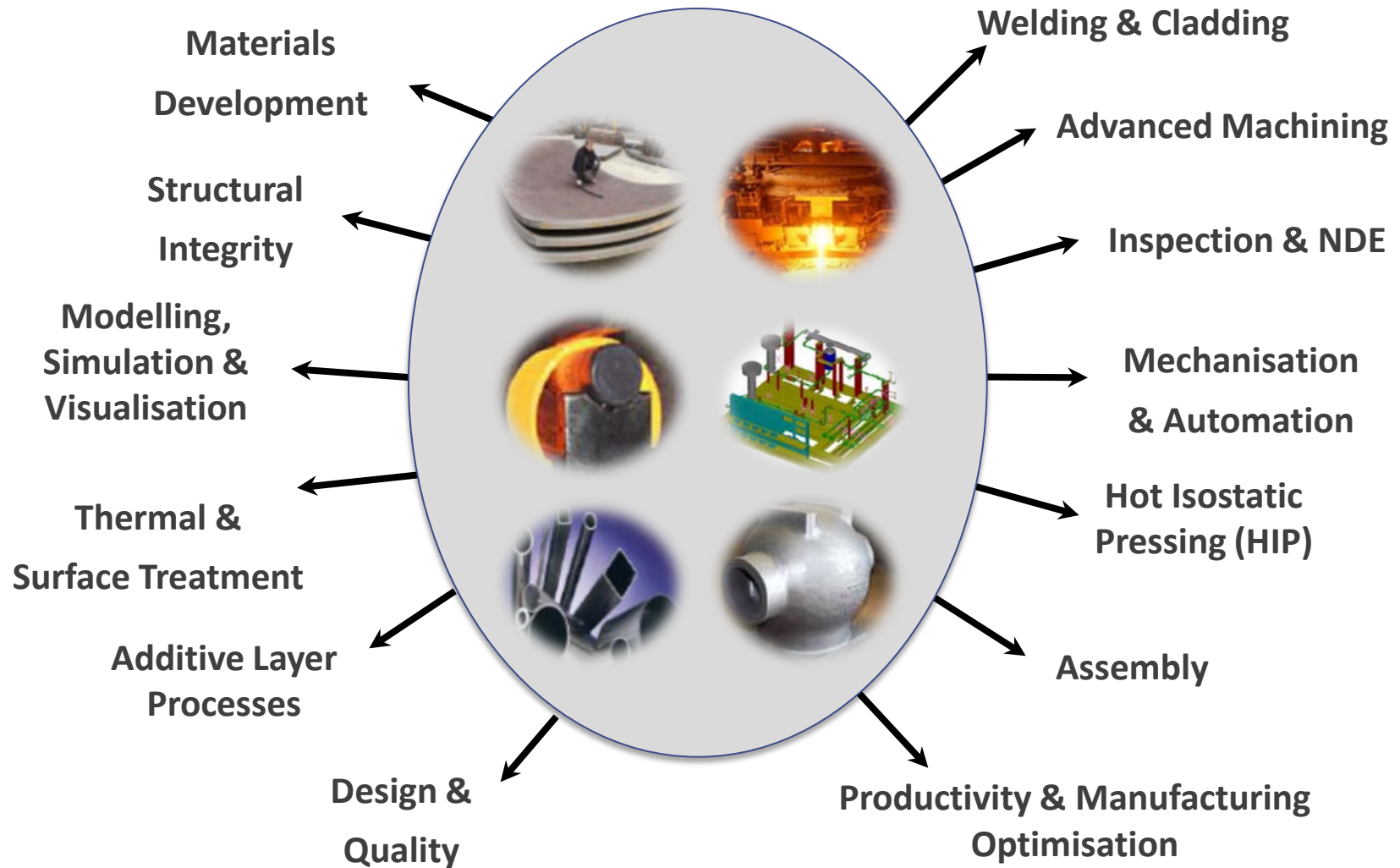
- Location – Glasgow UK
- Opened - 2010
- Subject – Forming & Forging



NAMRC (Nuclear Adv Manufacturing Research Centre)

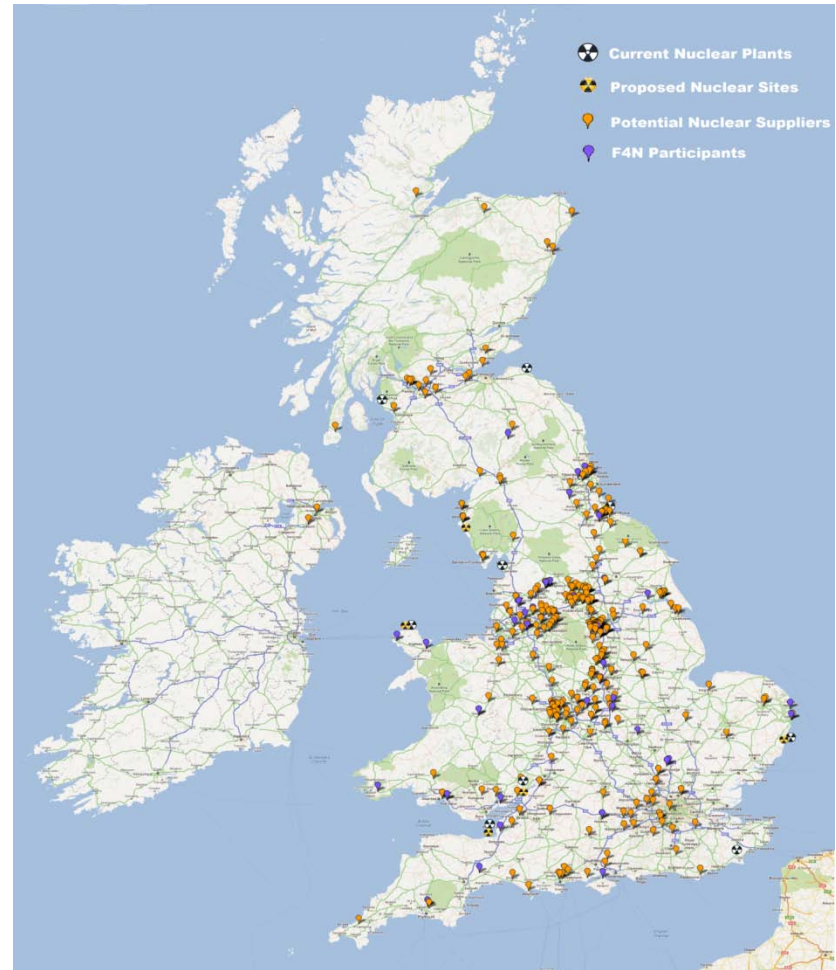
- Location – Sheffield-Rotherham UK
- Opens – September 2011
- Subject – Manuf. Technology, Training & Accreditation

Nuclear-AMRC will provide access to leading edge Manufacturing Technology



Nuclear – AMRC Supplier Identification

- **Approx. 500 companies identified**
- **Reduced to a target list of approx. 100~150 companies**
- **Mapped by region, components, etc.**





Challenges for Rolls-Royce...

... And our response so far



Our challenge

Power systems for -



Civil Aerospace



**Defence
Aerospace**



Marine

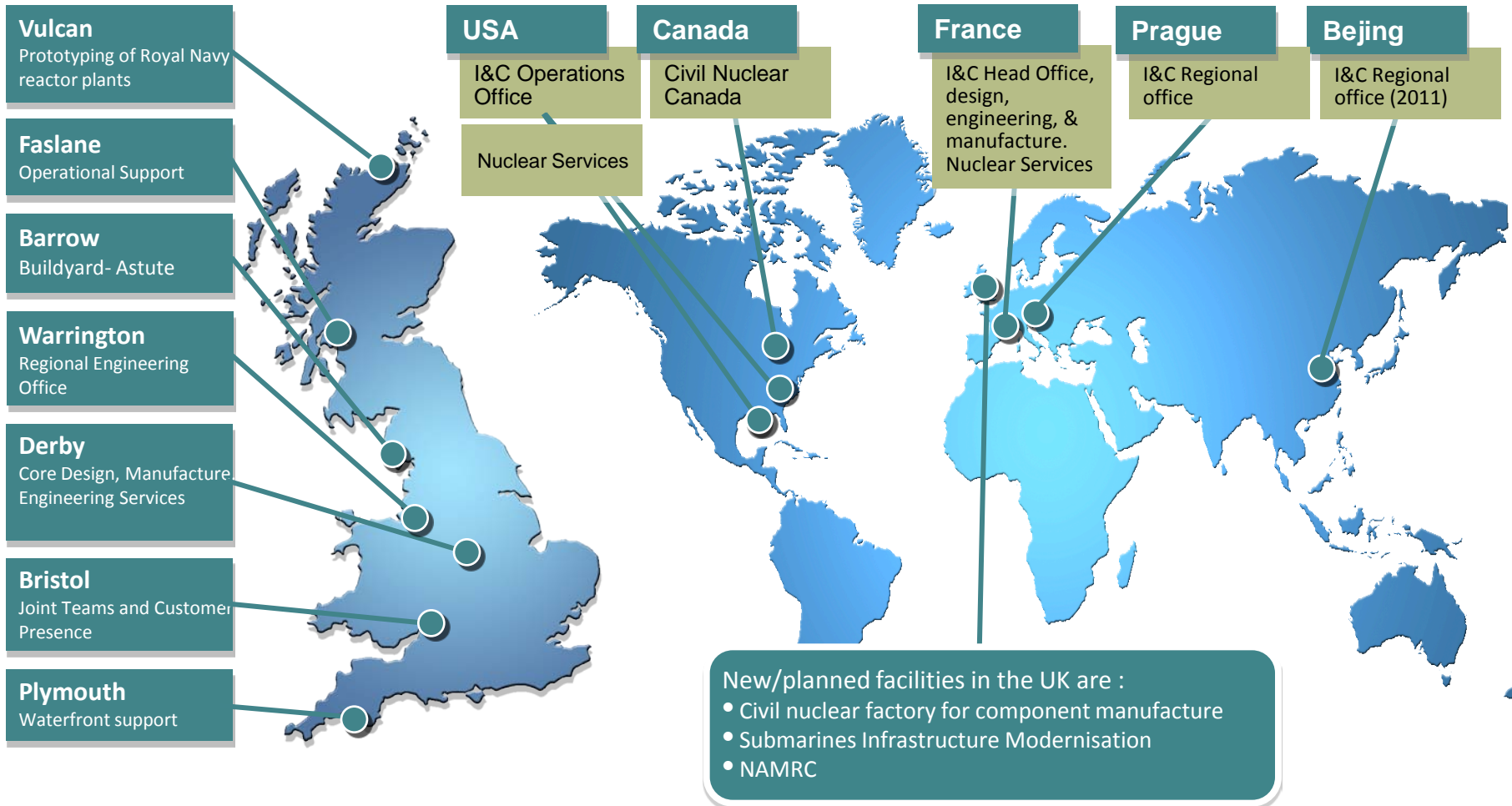


Energy



Nuclear

Nuclear Sector business locations



The Submarines business is a rare and valuable asset

Submarines

Bedrock capability

- Her Majesty's Government confirmed decision to proceed with Successor submarine
- Rolls-Royce PWR3 technology confirmed
- Site infrastructure investments ongoing:
 - Primary Components
 - Atlantic House
 - Core factory
- 1,000+ engineers with broad, rare capability



Business highly valued by HMG and provides critical national strategic function

New Build Delivery

- Capability:
 - Design of components for manufacture
 - Procurement specialist
 - Engineering support and programme management
- Proposed components manufacturing facility, Rotherham
- ASME N Certification



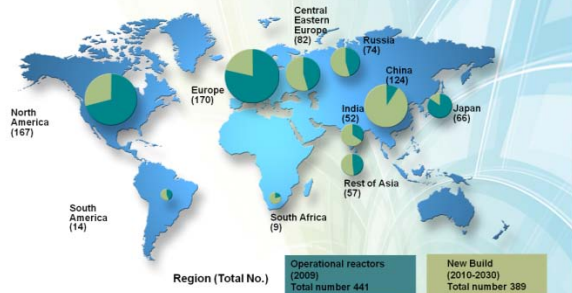
Our strategic logic

Nuclear revenue



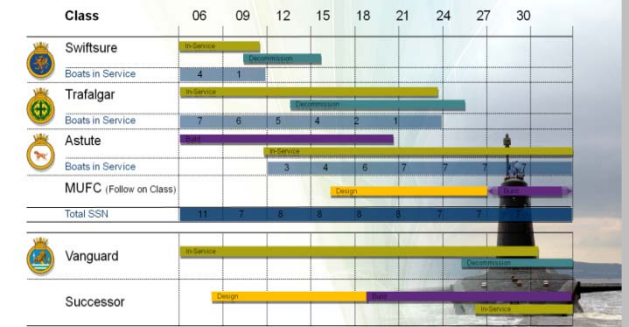
Emerging Civil Nuclear business

Today nuclear power accounts for 16% of the world's electricity production



Established Submarines business

And the UK's Submarine programme has a long term future of both new build and support of current fleet



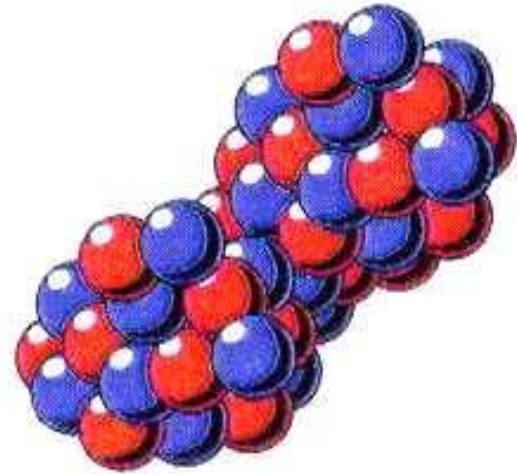
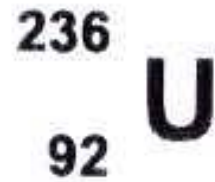


ANY QUESTIONS AT ALL...?



Back Up

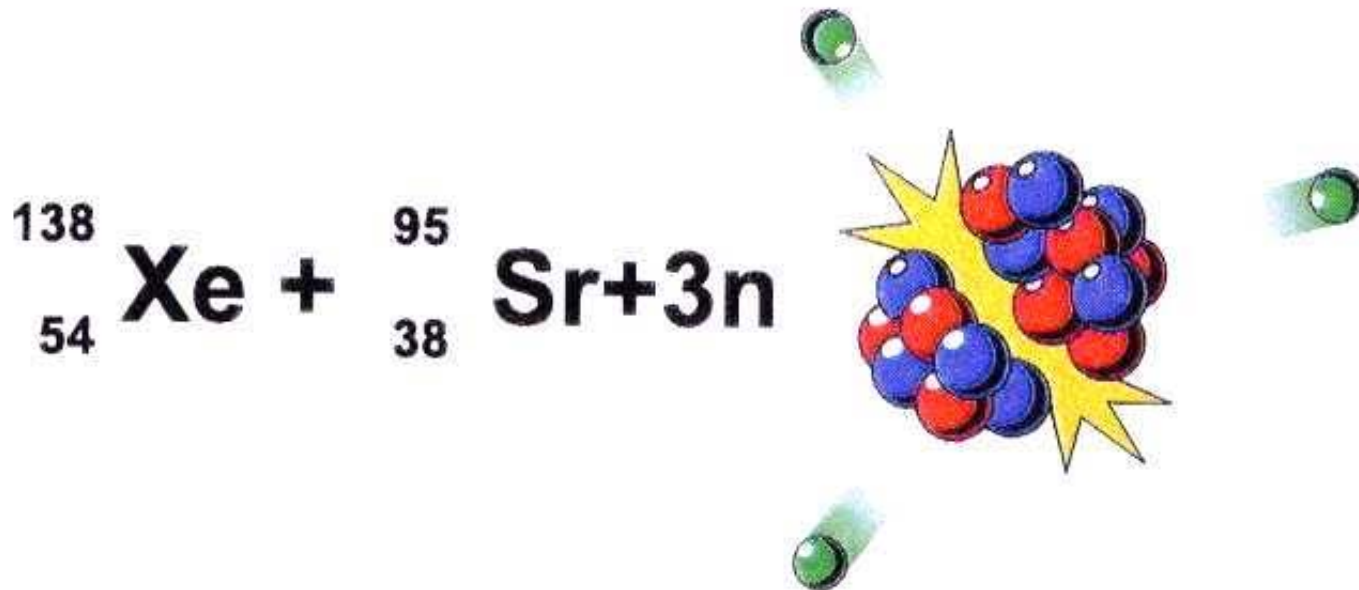
Fission



**Uranium-236 nucleus formed,
which is highly unstable**

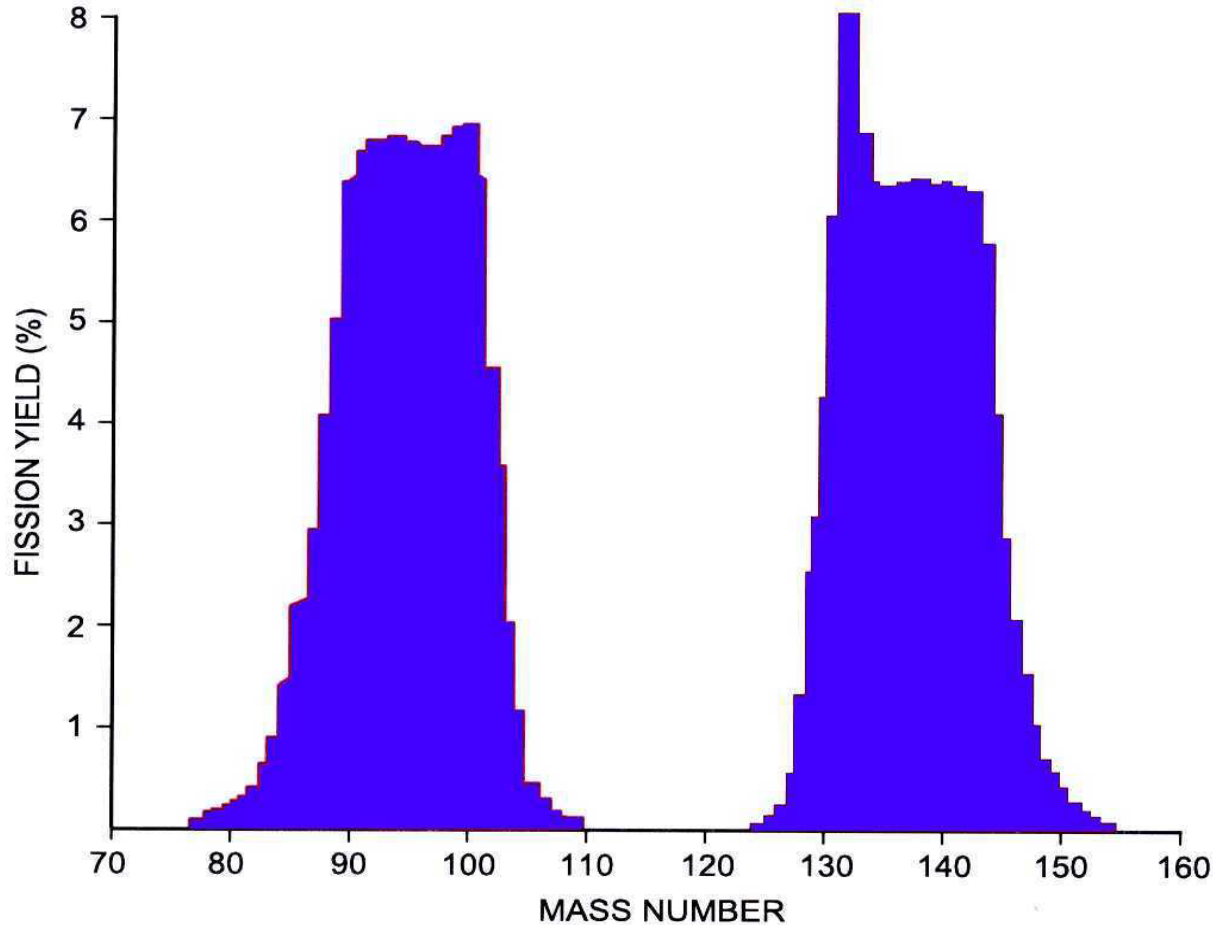
Fission

Uranium-236 nucleus splits, emitting more neutrons at high energy, and leaving behind two “fission products”



On average, about 2.5 free n's per fission

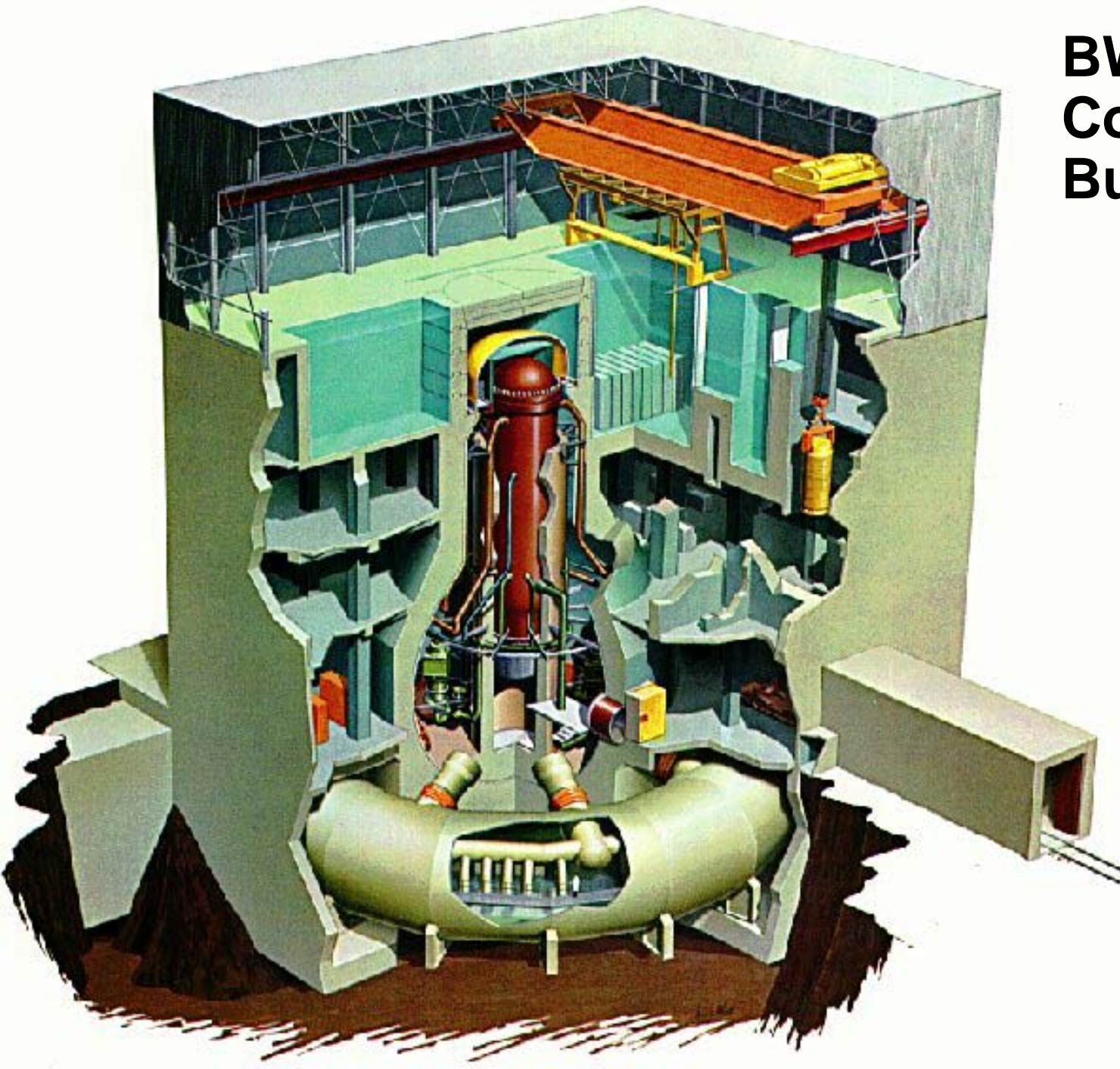
Fission Product Yield Curve



Why are we interested in this?

Fission Product Yields for U-235

BWR Containment Building



Rolls-Royce

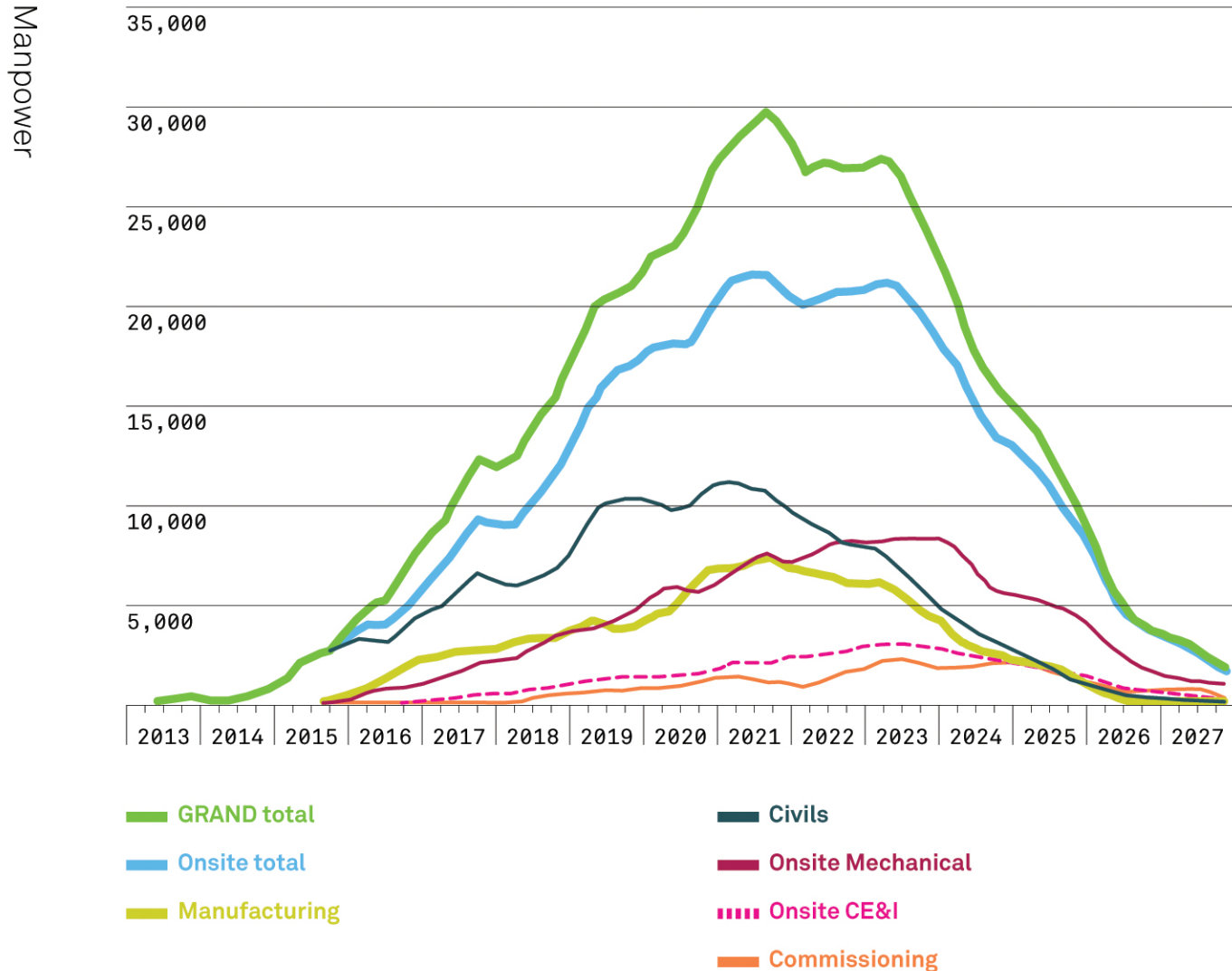


NIA UK Capability Study 2012

The 4 C's

- **Current UK capability**
- **Capacity requirements for multi-station programme**
- **Competitiveness**
- **Challenges for Government**

Workforce projection NIA assumed programme



“Fit for Nuclear” Programme Objectives

- Major objective of the Nuclear AMRC’s “Fit for Nuclear” Programme are:
 - To identify potentially nuclear capable UK-based companies, which manufacture products within the scope of supply of the UK’s Nuclear New Build Programme(s)
 - To support potential supply chain companies in closing capability gaps, through the development a programme of capability improvement activities
 - To match companies’ capability to the requirements of the utilities, the reactor vendors and their Tier 1s.



In July 2008, Rolls-Royce publicly announced the creation of a new business unit to address the civil nuclear market

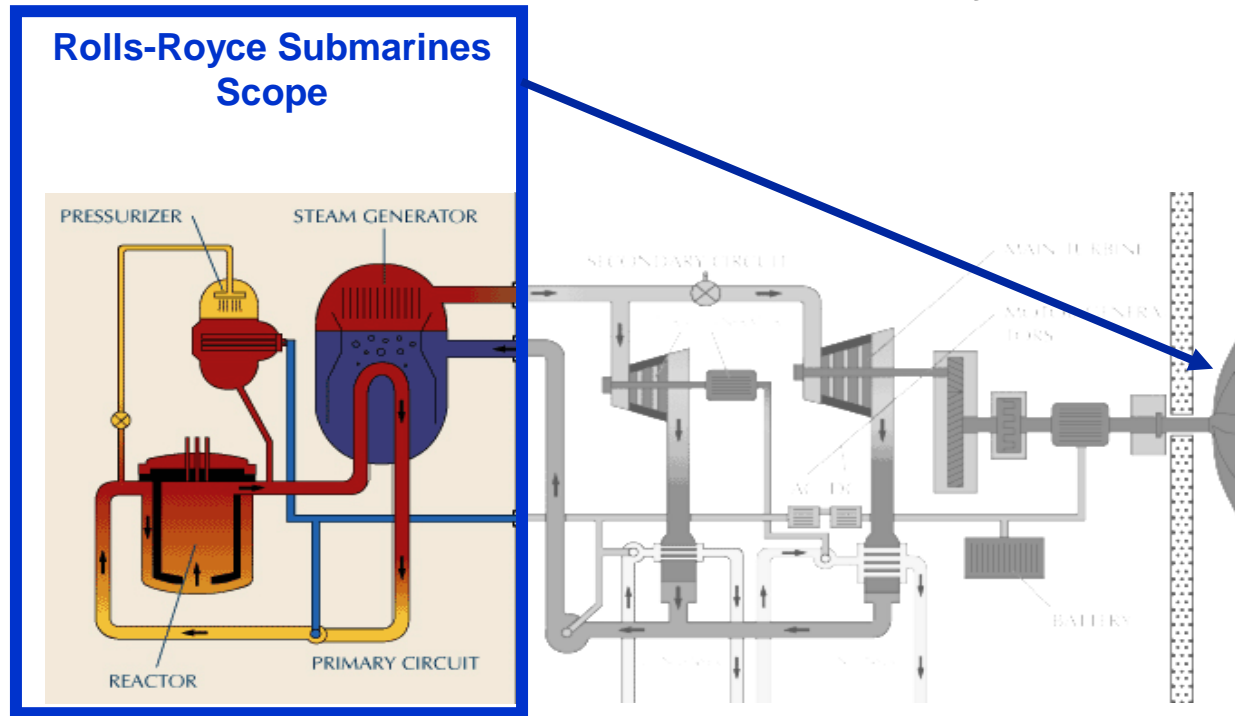
“Rolls-Royce has been involved in the UK’s nuclear industry for over 50 years. Our experience is directly applicable to all phases of new build programmes that are planned in the UK and globally, and also to the upgrade of existing plants. Our capability is unique in the UK and matched by only a handful of companies worldwide.

“The expansion of the civil nuclear market represents an exciting opportunity which builds on our extensive nuclear capabilities.”

Sir John Rose (former CEO)– July 2008

Rolls-Royce has a very broad role in the UK nuclear submarine programme

Nuclear submarine propulsion system



Nuclear island

(smaller than a civil nuclear island)