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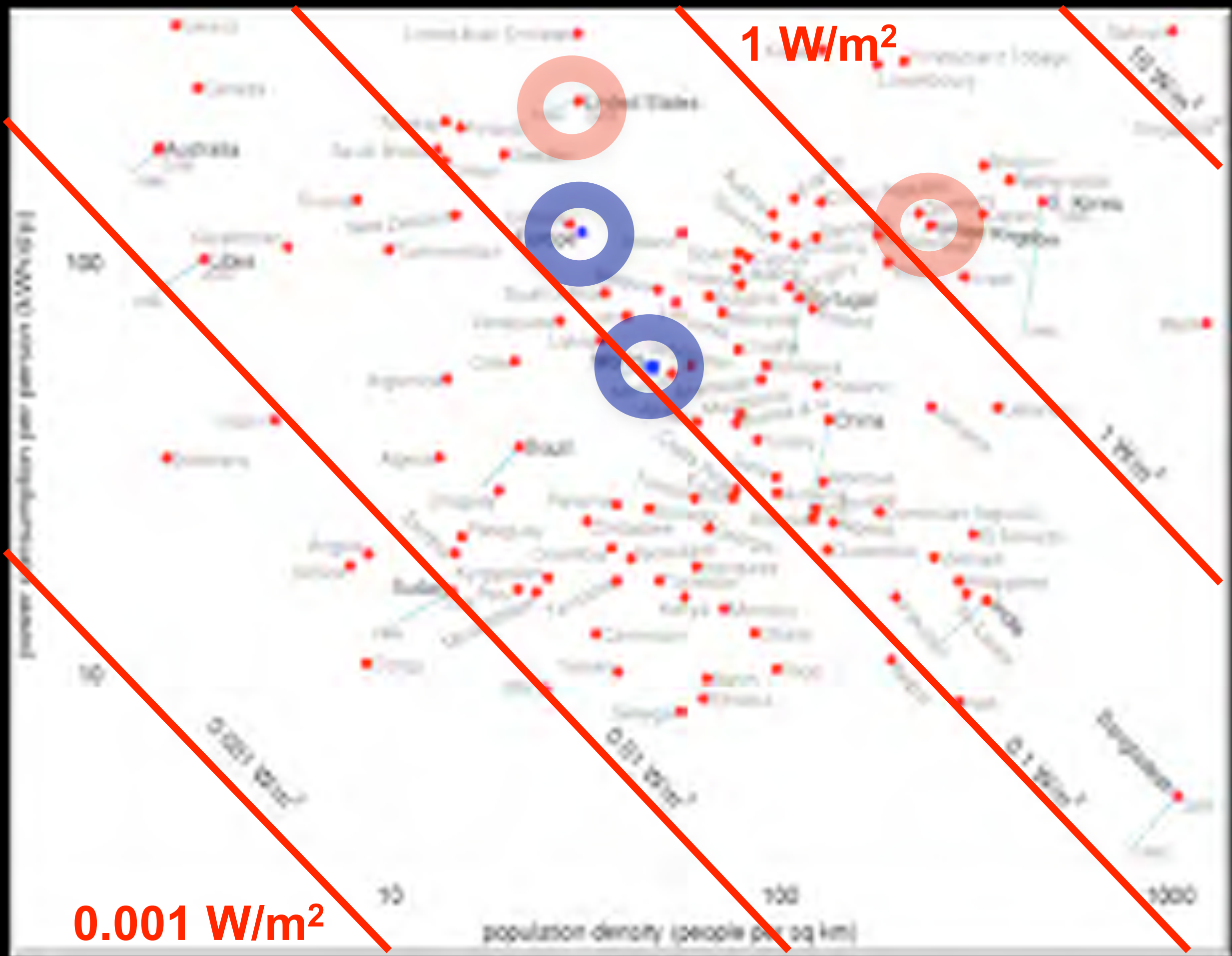
Birmingham Centre for Nuclear Education and Research

Martin Freer
M.Freer@bham.ac.uk

The Energy Challenge

Power consumption/person



Population density

Average power output per unit area

Wind	2-3 W/m²
Tidal	3-6 W/m²
Solar	5 W/m²
Hydro	11 W/m²

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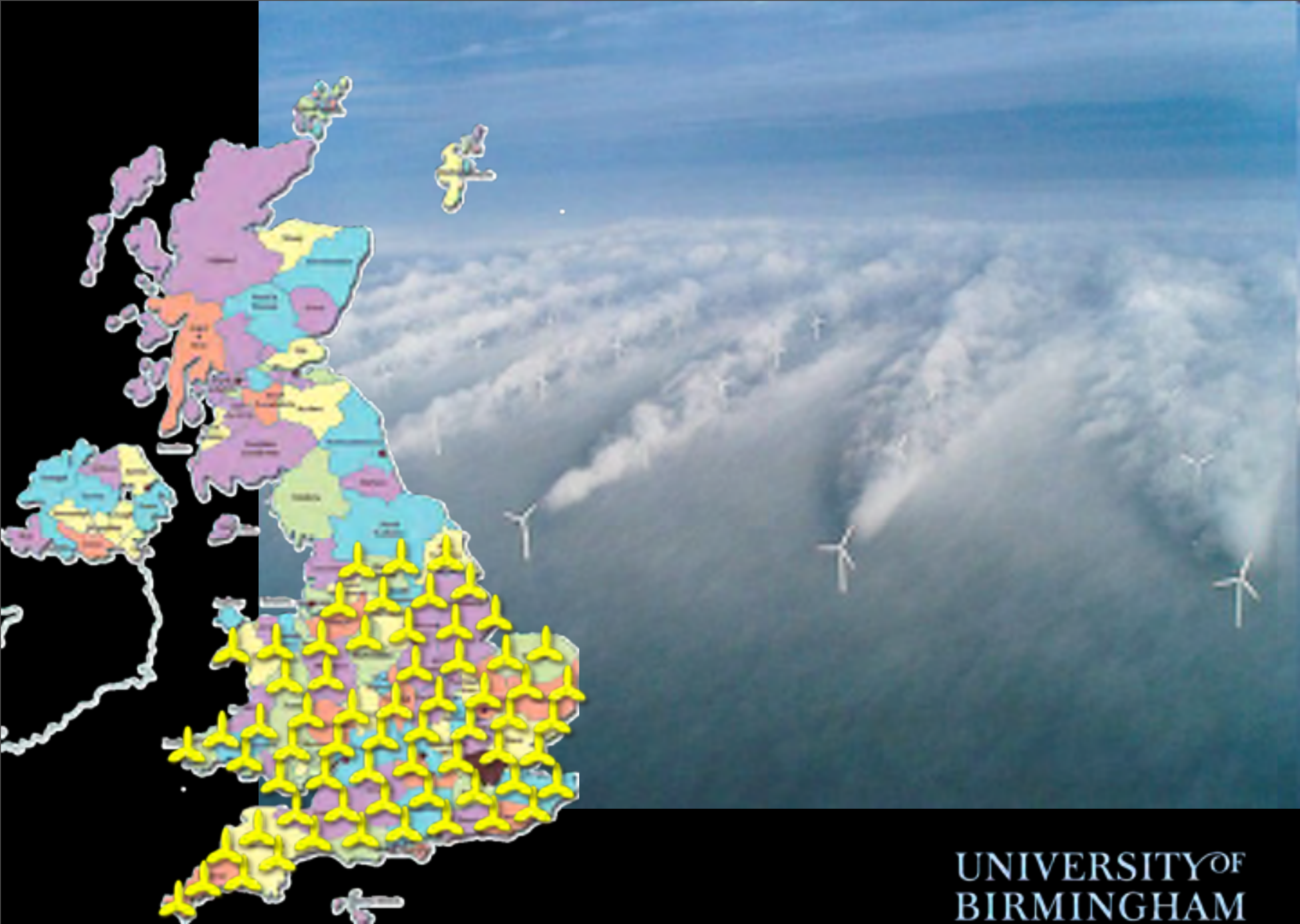

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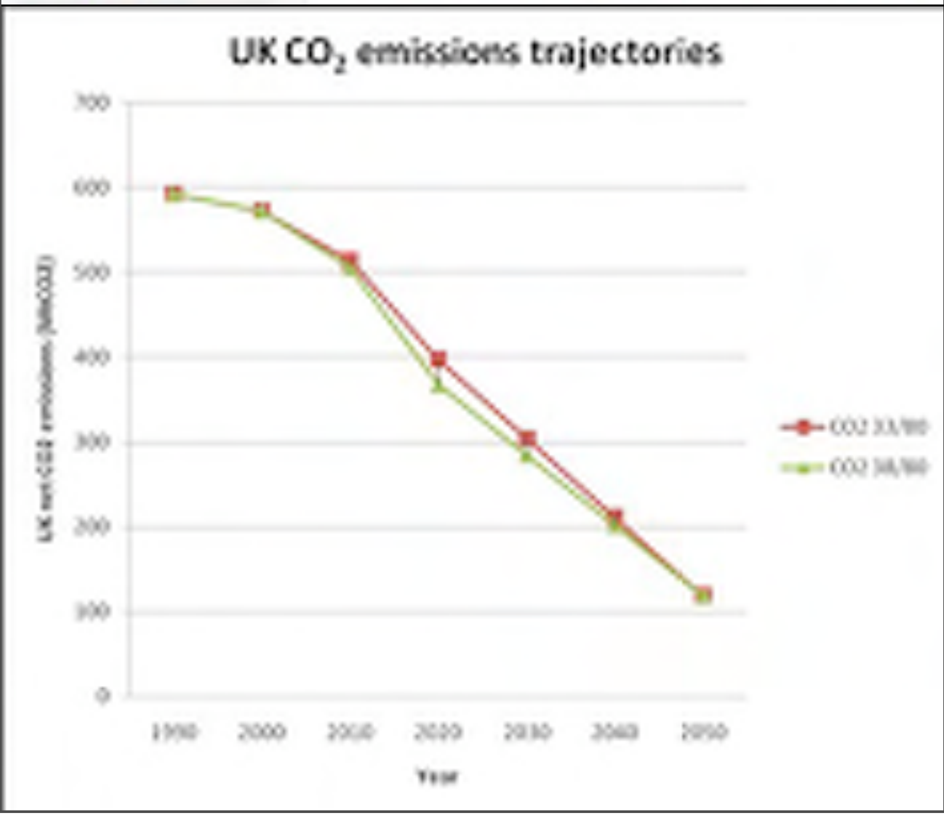
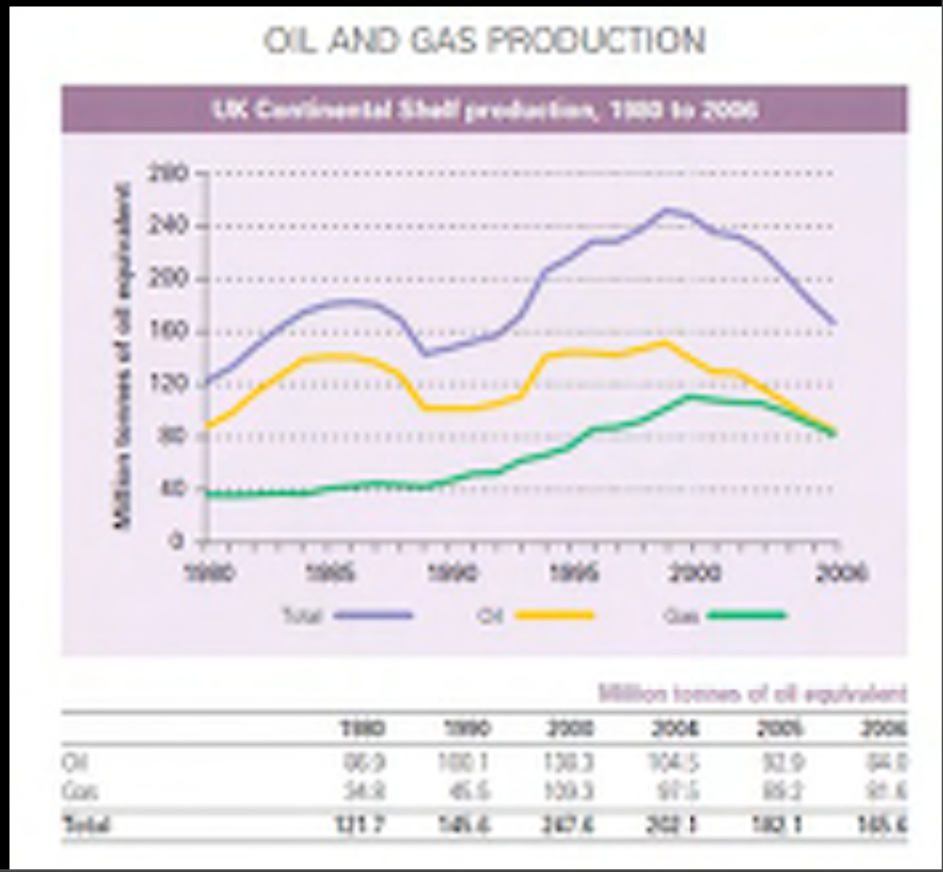
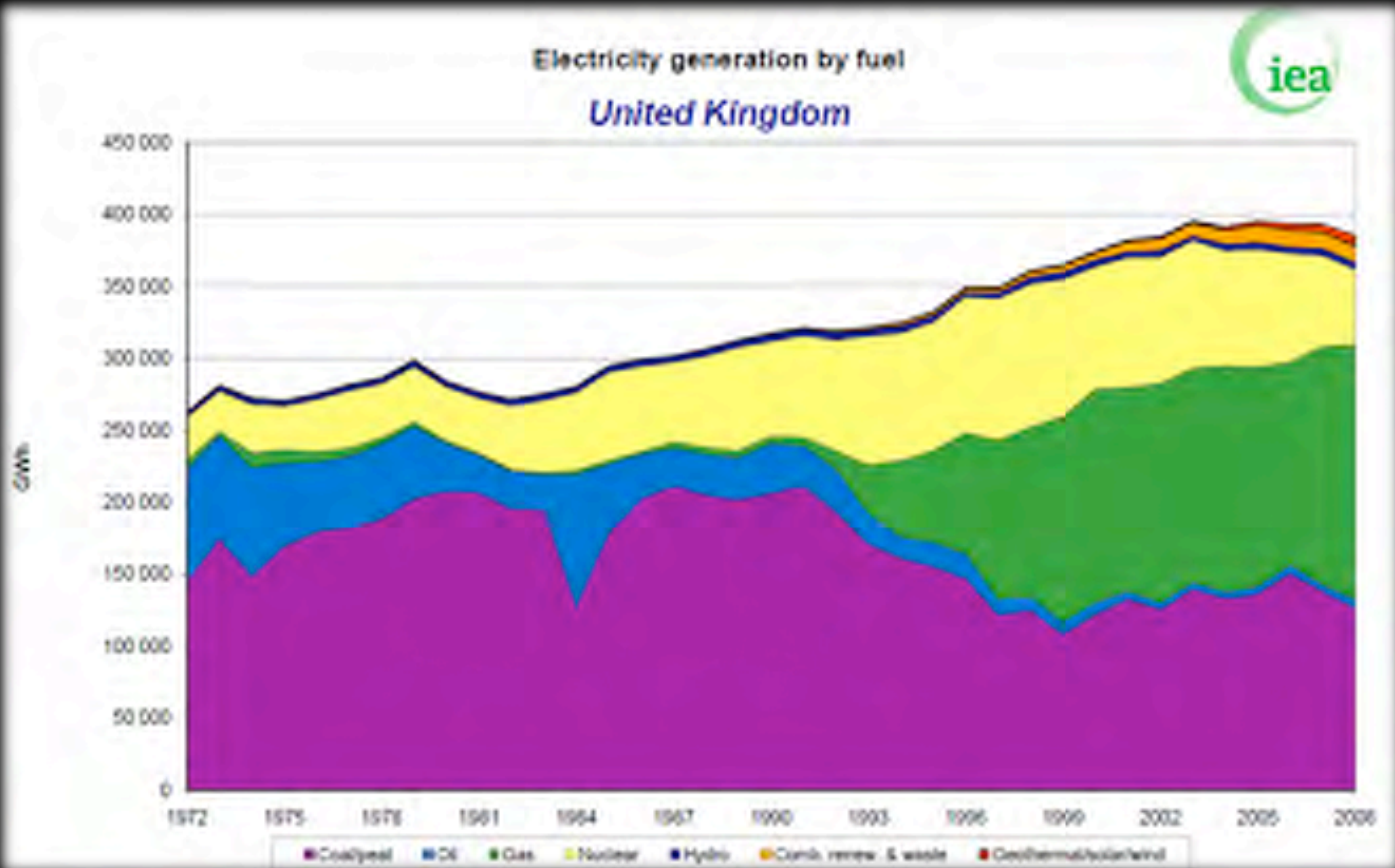
The Pressures







http://2050-calculator-tool.decc.gov.uk/pathways

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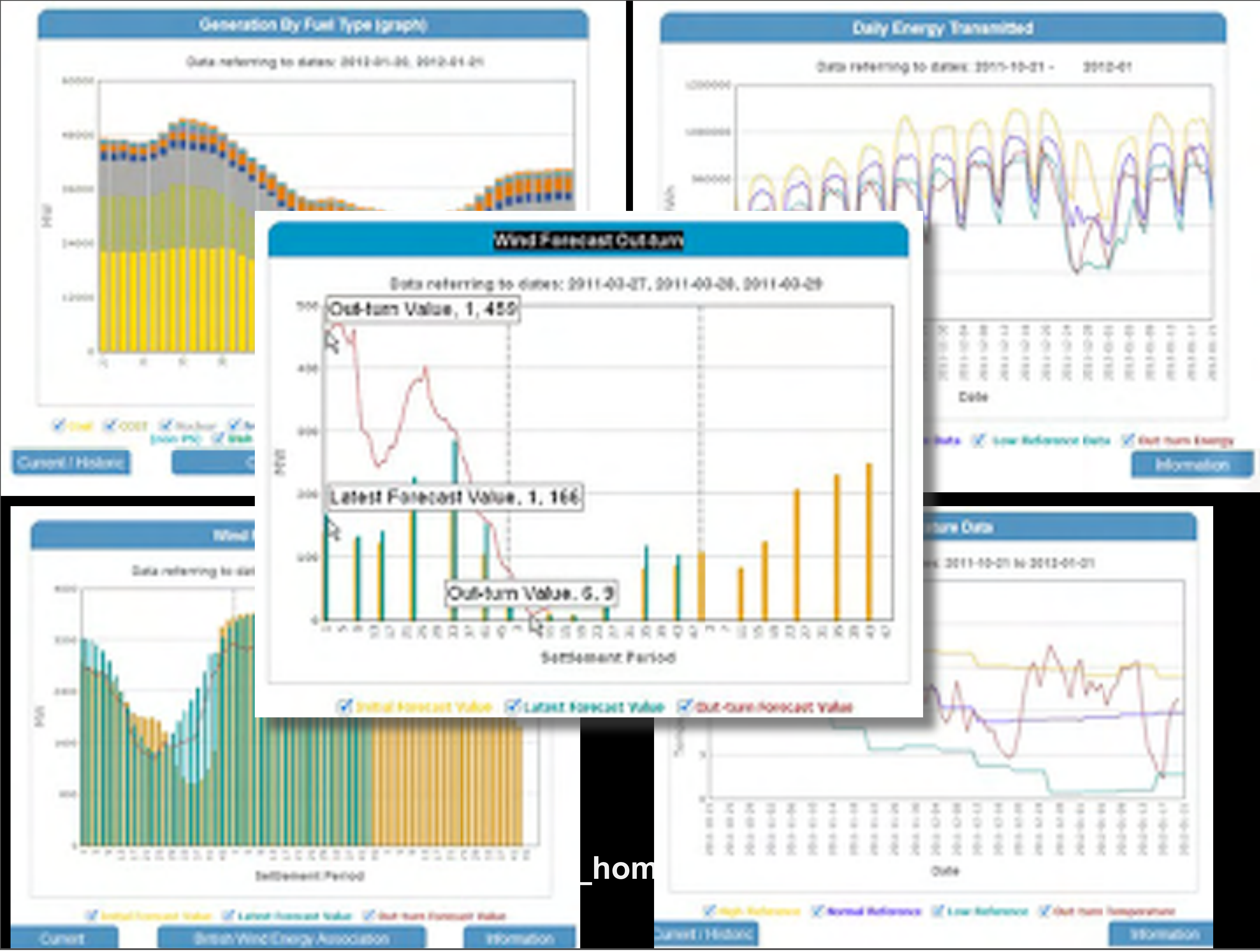
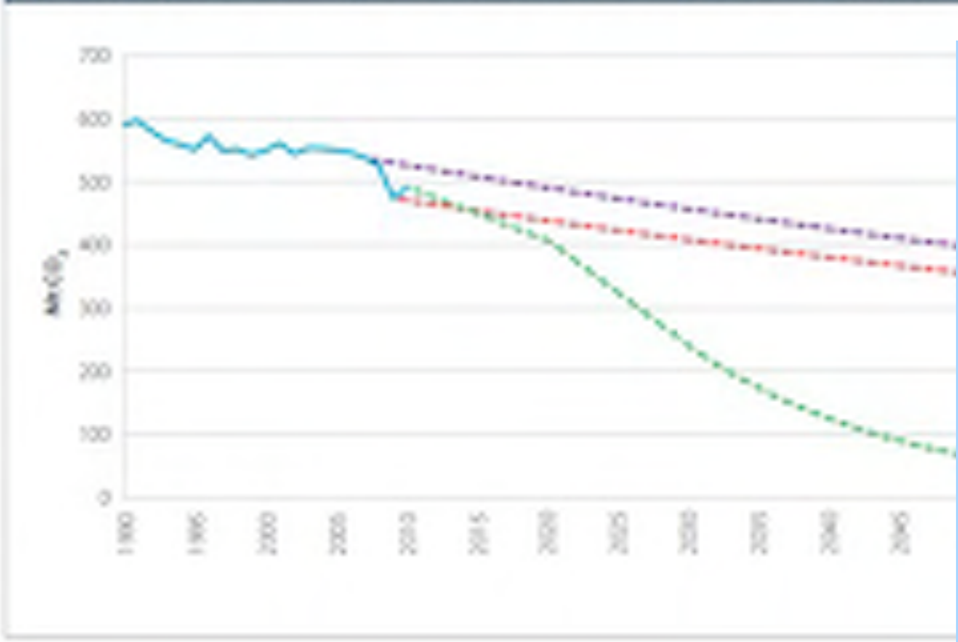

Generation By Fuel Type (graph)
Daily Energy Transmitted
Wind Forecast Out-turn
Data referring to dates: 2011-03-27, 2011-03-28, 2011-03-29
Out-turn Value, 1, 459
Latest Forecast Value, 1, 166
Out-turn Value, 6, 9
Settlement Period
Initial Forecast Value
Latest Forecast Value
Out-turn Forecast Value
Current / Historic
Information
British Wind Energy Association
Current
_hom

Committee on Climate Change

Independent advisors to the UK Government on tackling and preparing for climate change

Figure 3: CO_2 emissions under pre-recession trend versus required reductions (1990-2050)



Illustrative 2030 scenario. We set out an illustrative scenario in which commitments on support for offshore wind and marine through the 2020s are broadly in line with planned investment and supply chain capacity to 2020. Together with ongoing investment in onshore wind, this would result in a 2030 renewable generation share of around 40% (185 TWh). **Sector decarbonisation would then require a nuclear share of around 40%** and a CCS share of 15%, along with up to 10% of generation from unabated gas.

The Renewable Energy Review

May 2011

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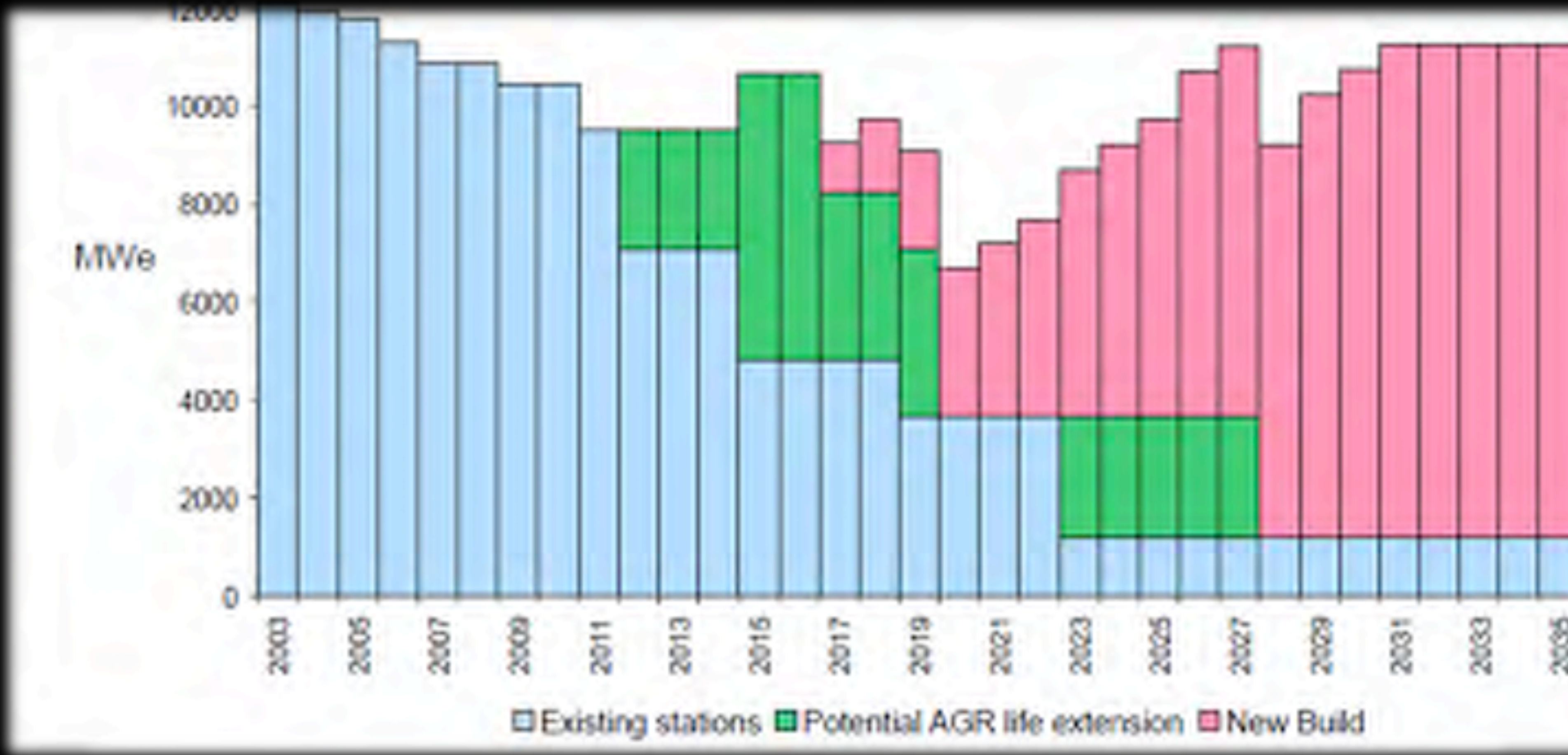

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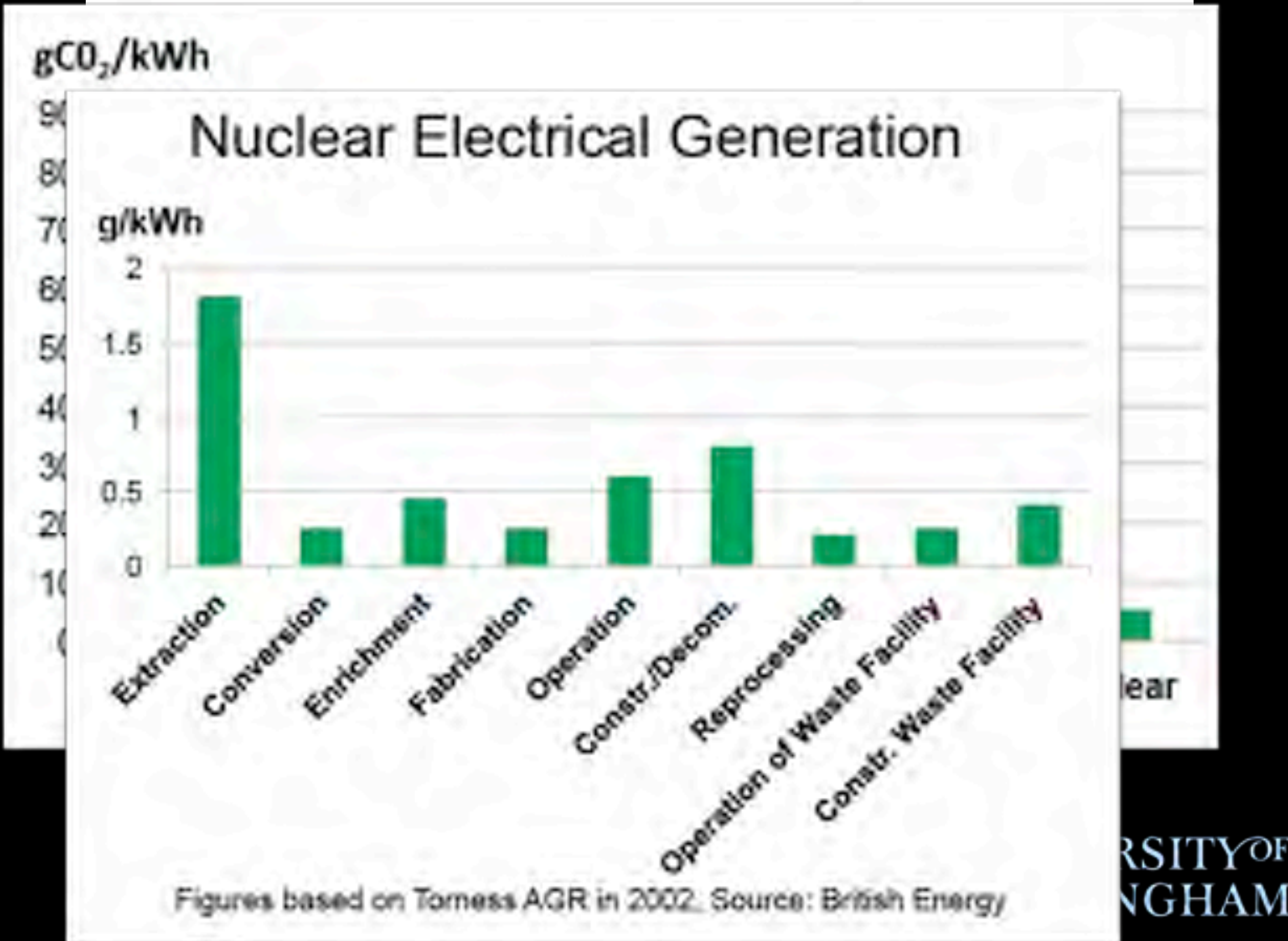
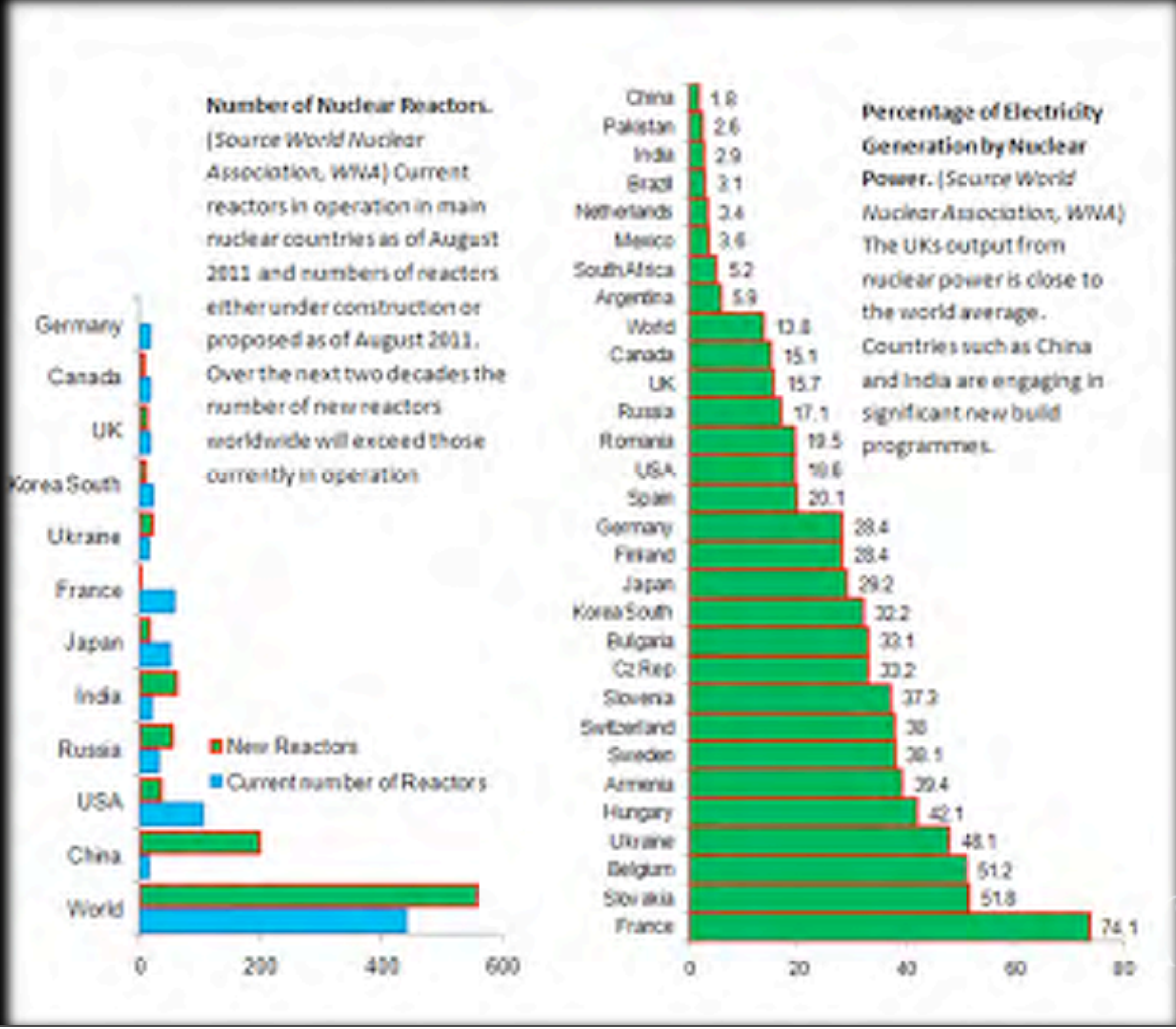
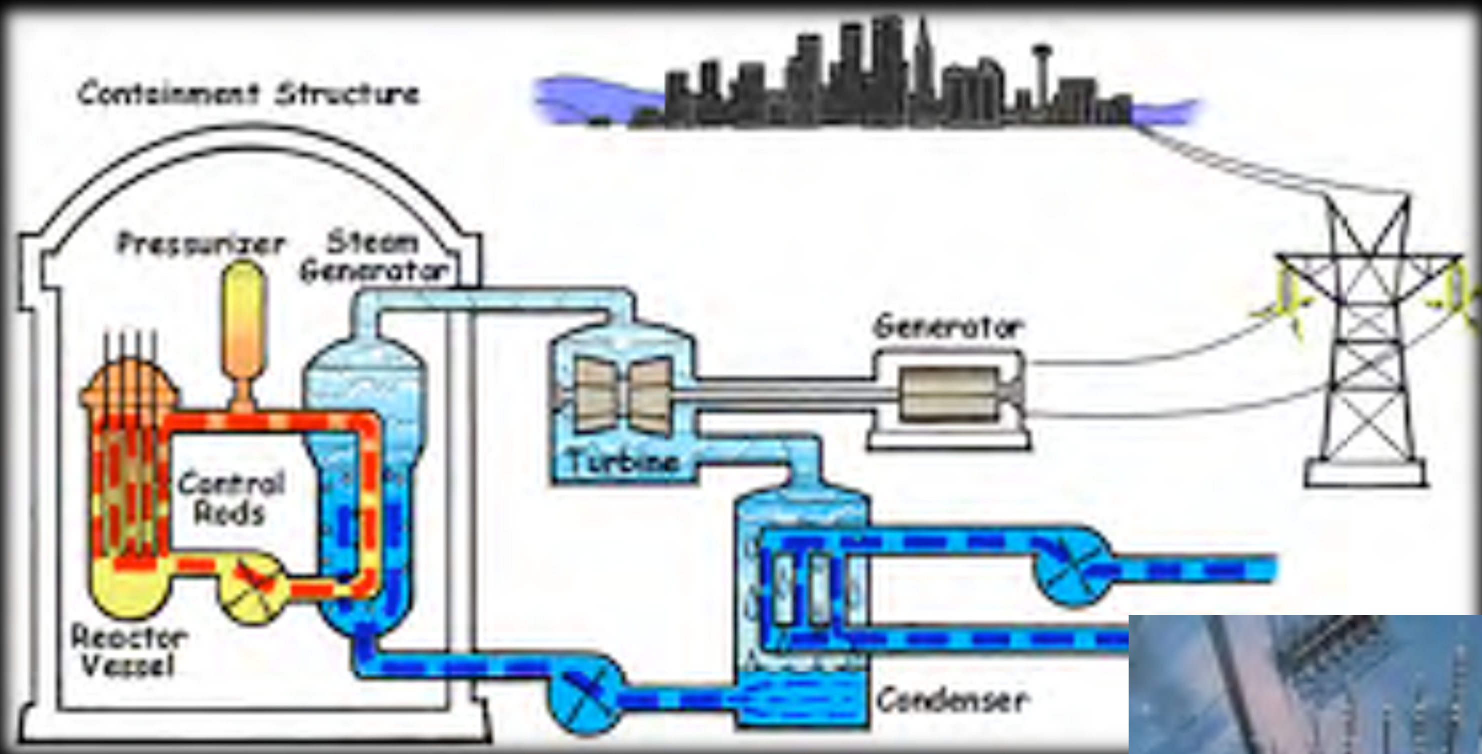
Carbon Footprint



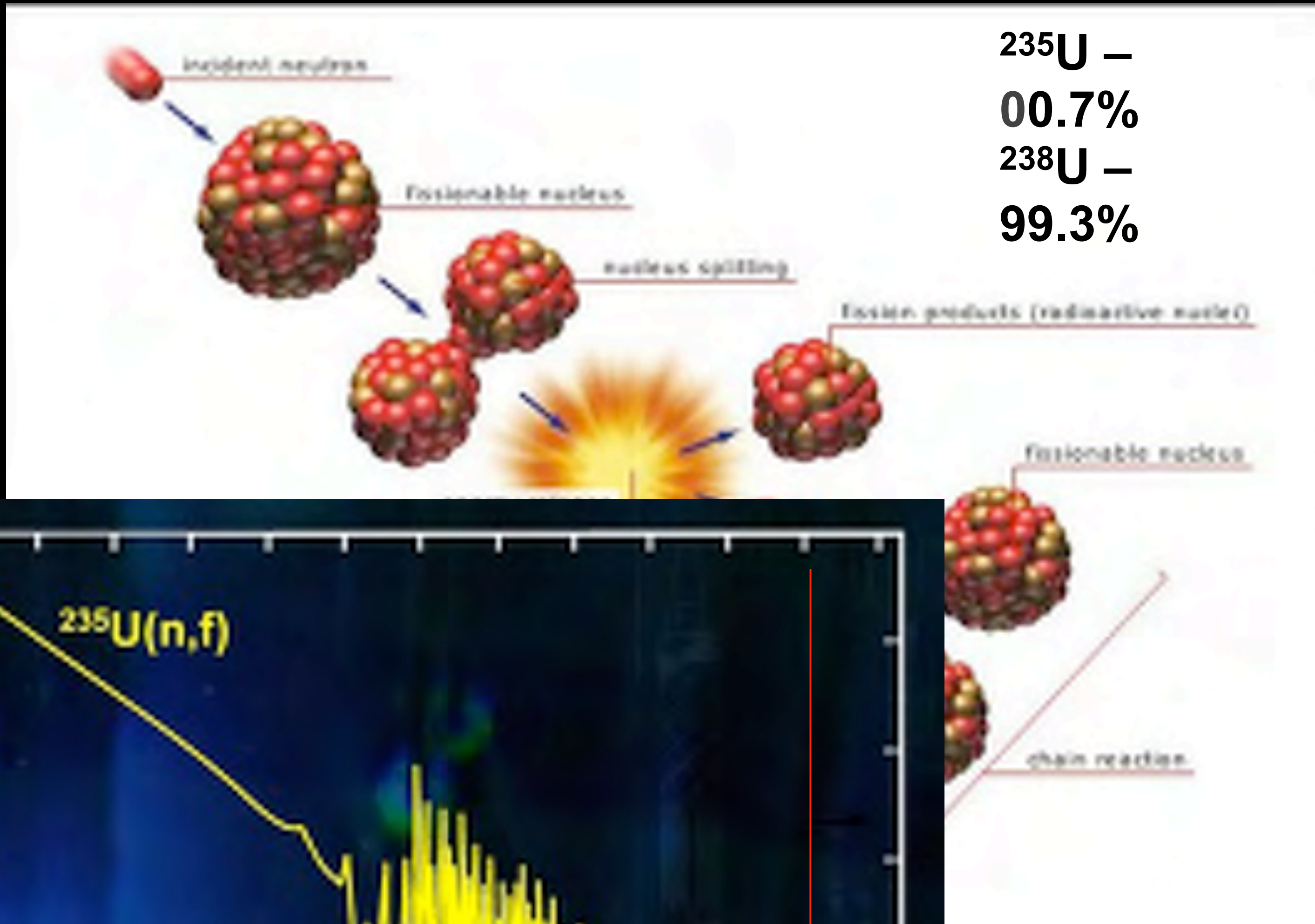
Saturday, 28 January 2012

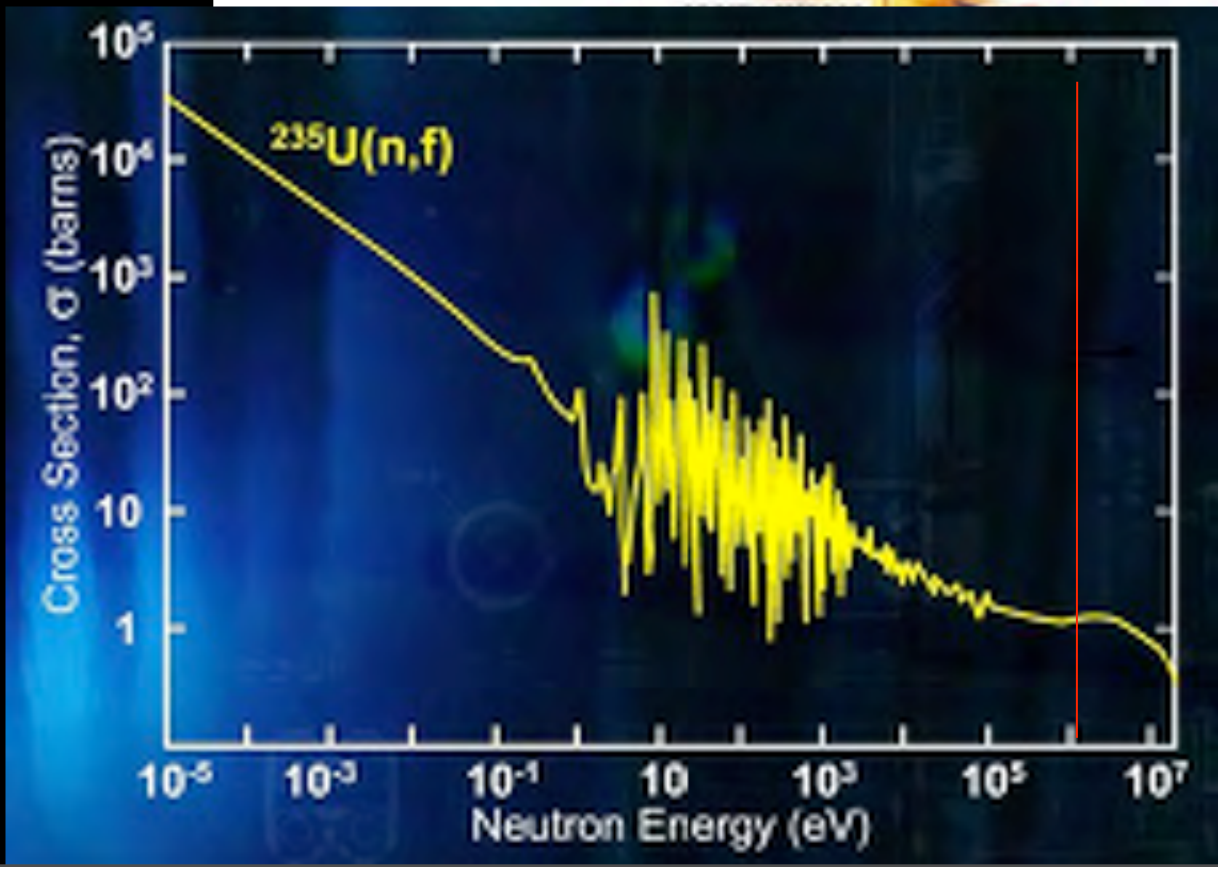

Number of Nuclear Reactors.
(Source World Nuclear Association, WNA) Current reactors in operation in main nuclear countries as of August 2011 and numbers of reactors either under construction or proposed as of August 2011. Over the next two decades the number of new reactors worldwide will exceed those currently in operation
Germany
Canada
UK
Korea South
Ukraine
France
Japan
India
Russia
USA
China
World
New Reactors
Current number of Reactors
0
200
400
600
Percentage of Electricity Generation by Nuclear Power. (Source World Nuclear Association, WNA) The UKs output from nuclear power is close to the world average. Countries such as China and India are engaging in significant new build programmes.
China 1.8
Pakistan 2.6
India 2.9
Brazil 3.1
Netherlands 3.4
Mexico 3.6
South Africa 5.2
Argentina 5.9
World 13.8
Canada 15.1
UK 15.7
Russia 17.1
Romania 19.5
USA 19.6
Spain 20.1
Germany 28.4
Finland 28.4
Japan 29.2
Korea South 32.2
Bulgaria 33.1
Cz Rep 33.2
Slovenia 37.3
Switzerland 38
Sweden 38.1
Armenia 39.4
Hungary 42.1
Ukraine 48.1
Belgium 51.2
Slovakia 51.8
France 74.1
0
20
40
60
80

Pressurised Water Reactor (PWR)



^{235}U – 00.7%
^{238}U – 99.3%





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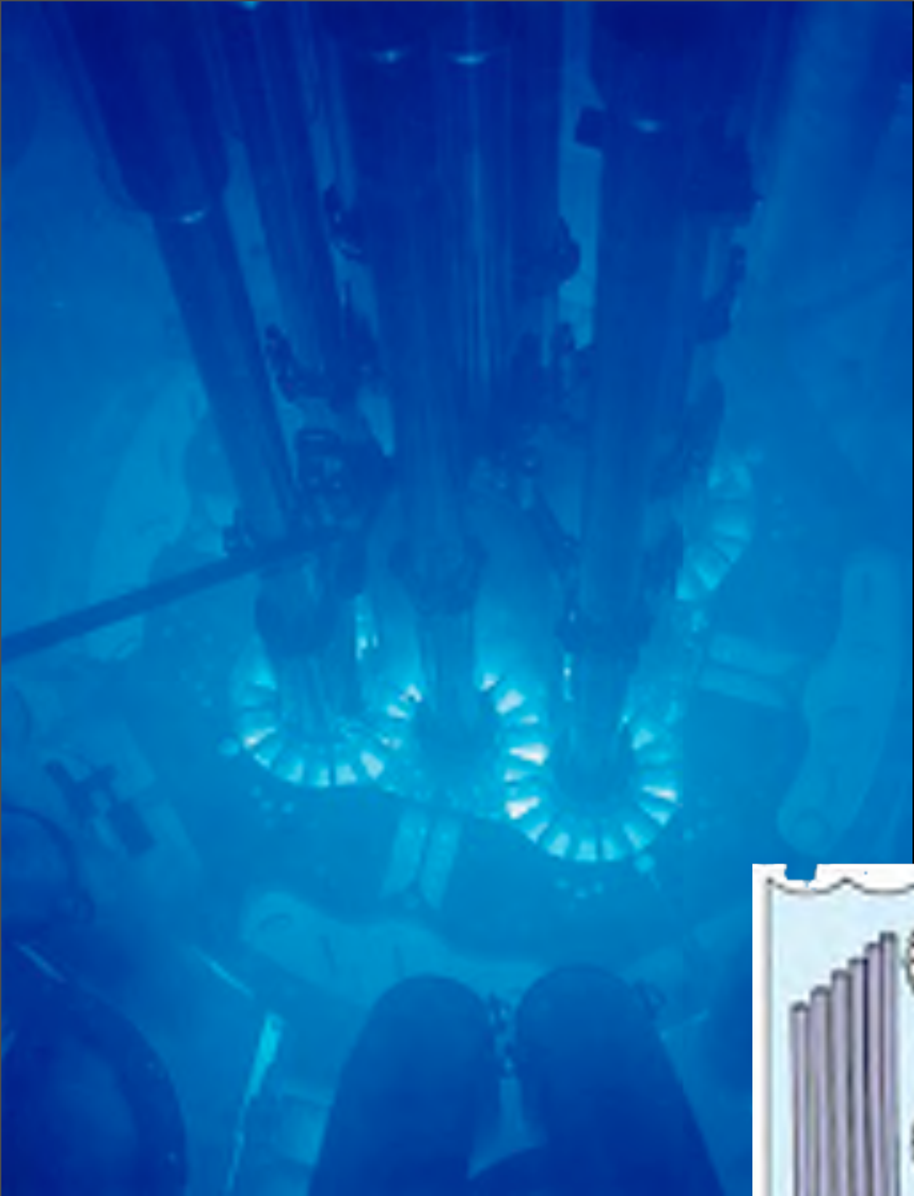
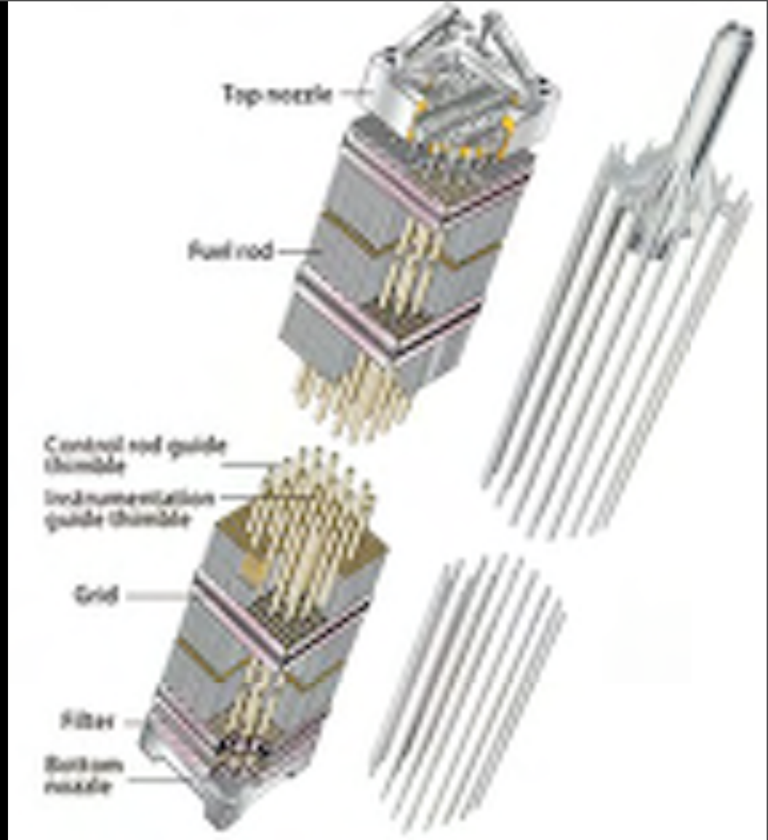
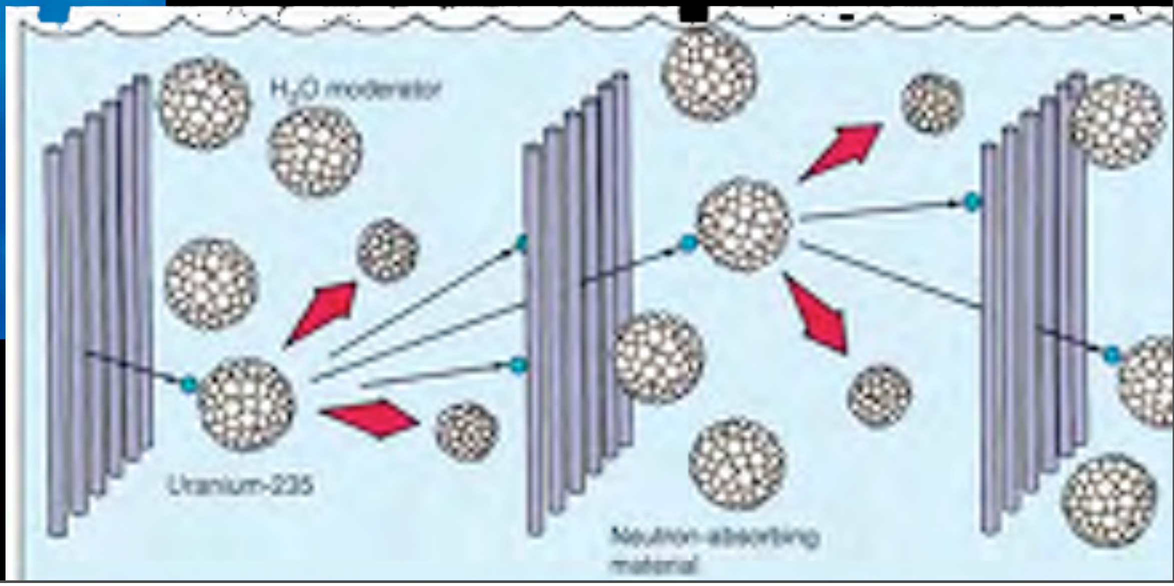
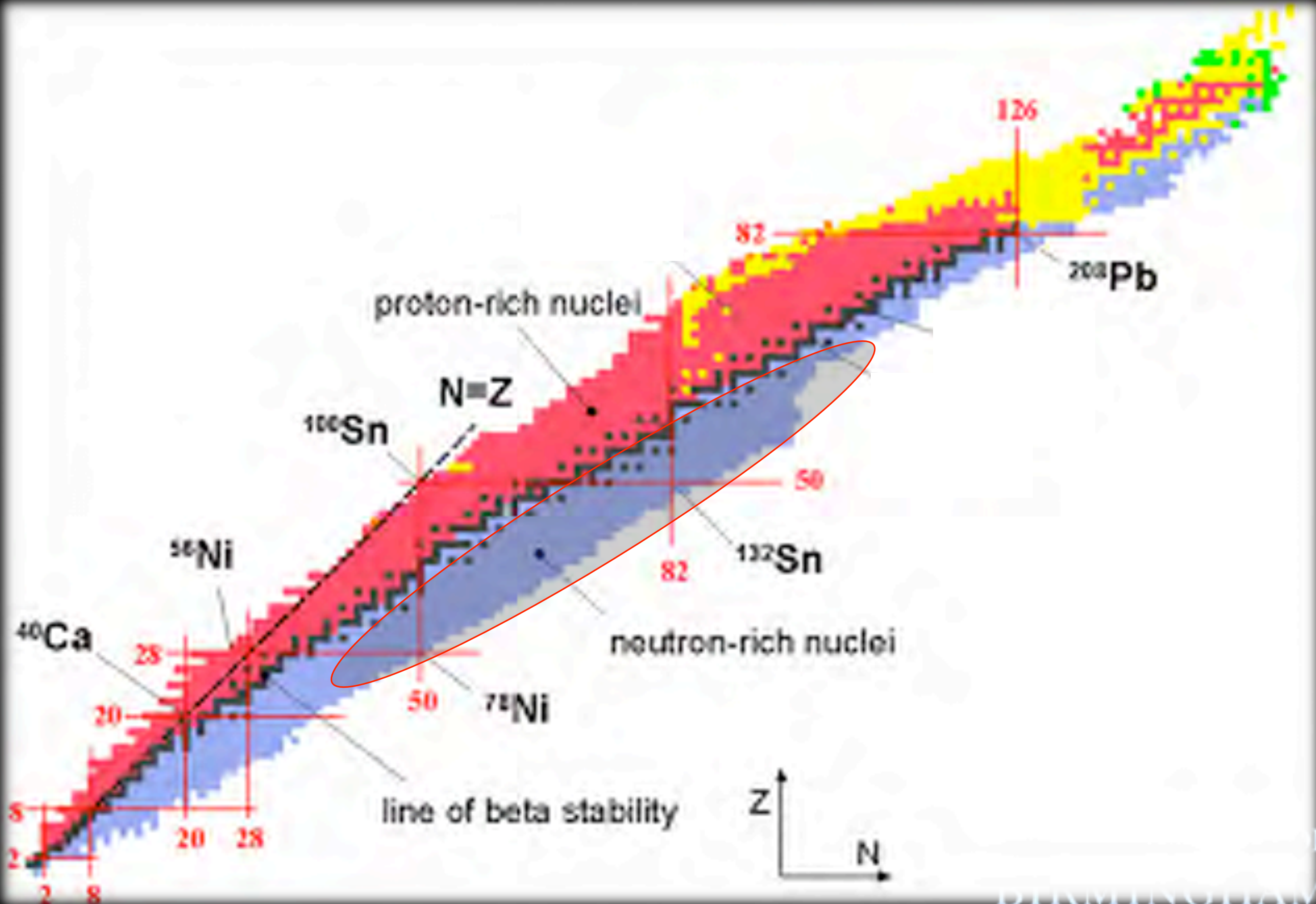




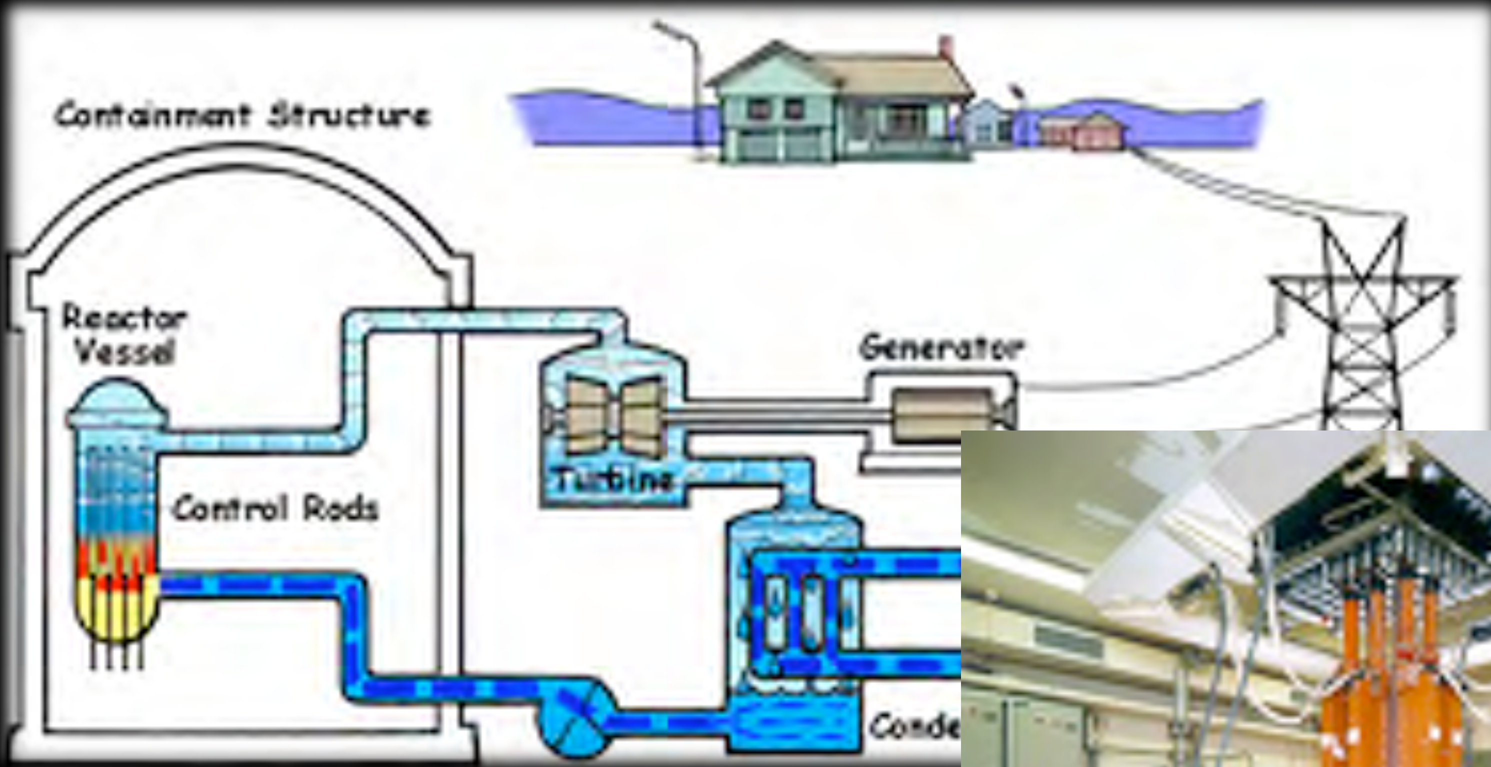
Top nozzle
Fuel rod
Control rod guide thimble
Instrumentation guide thimble
Grid
Filter
Bottom nozzle



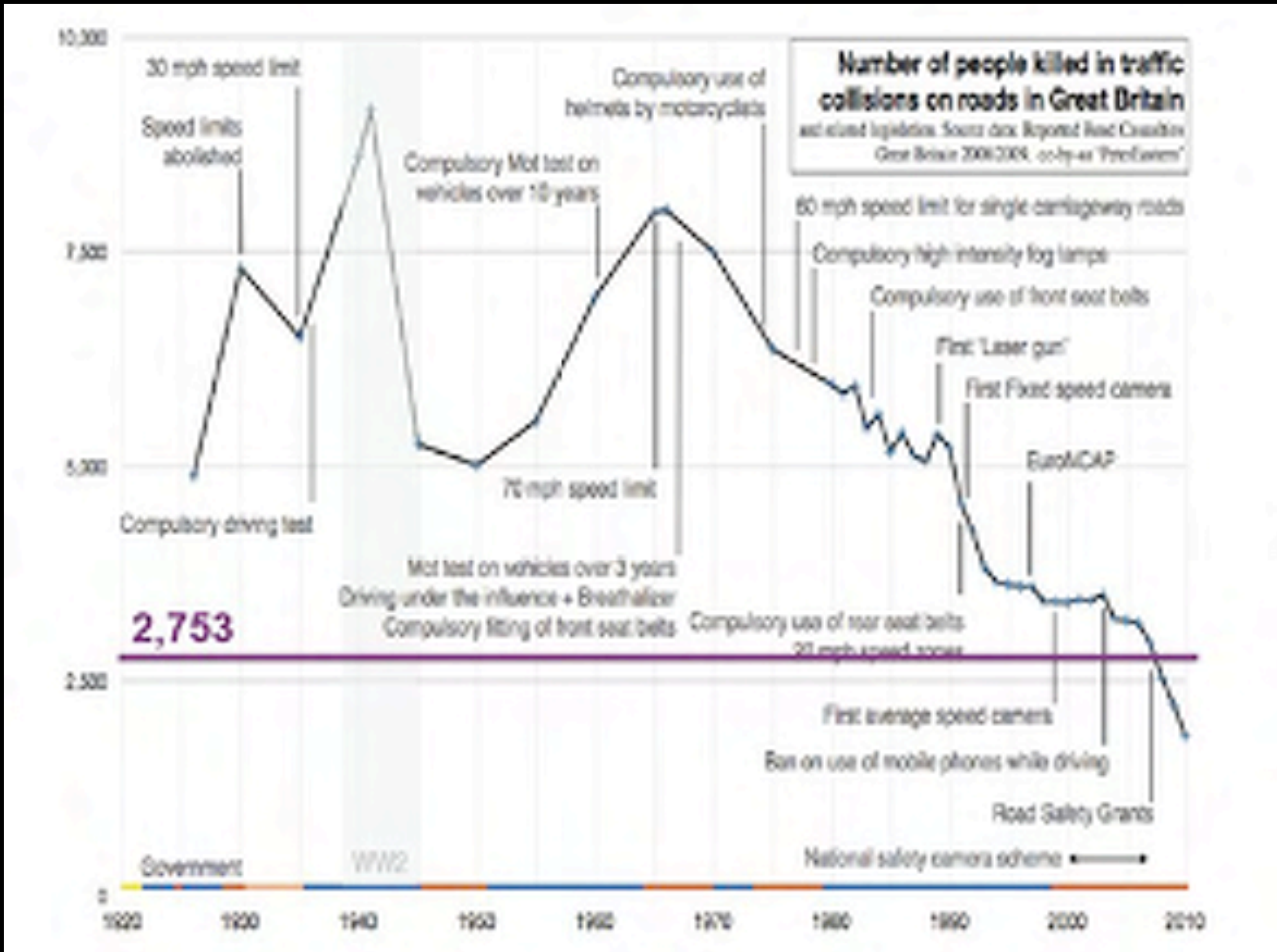
H_2O moderator
Uranium-235
Neutron-absorbing material

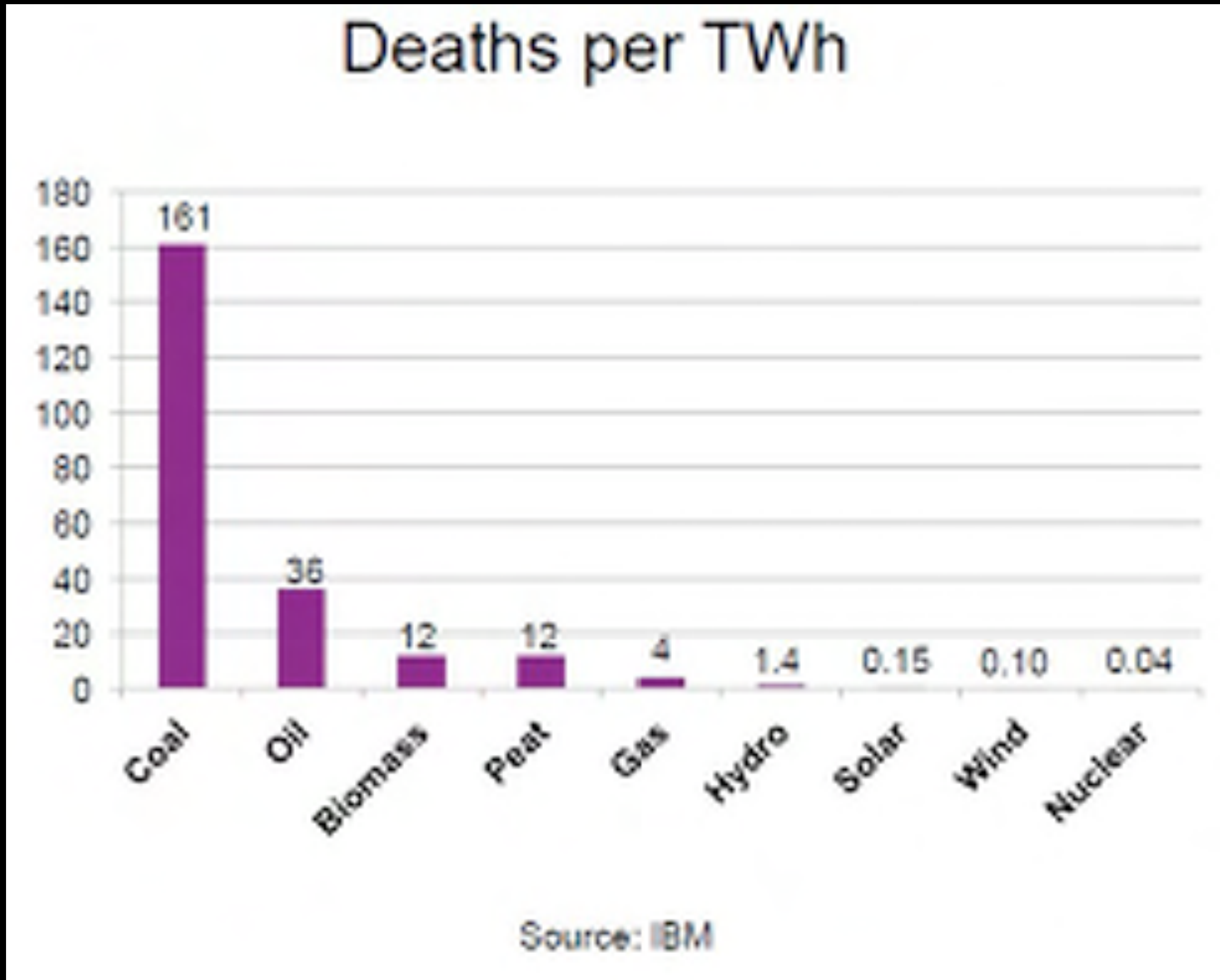

126
82
^{208}Pb
proton-rich nuclei
N=Z
^{100}Sn
50
^{132}Sn
82
^{56}Ni
neutron-rich nuclei
^{40}Ca
28
20
^{78}Ni
50
8
2
20
28
line of beta stability
Z
N
2
8

Boiling Water Reactor (BWR)



Issues/Risks





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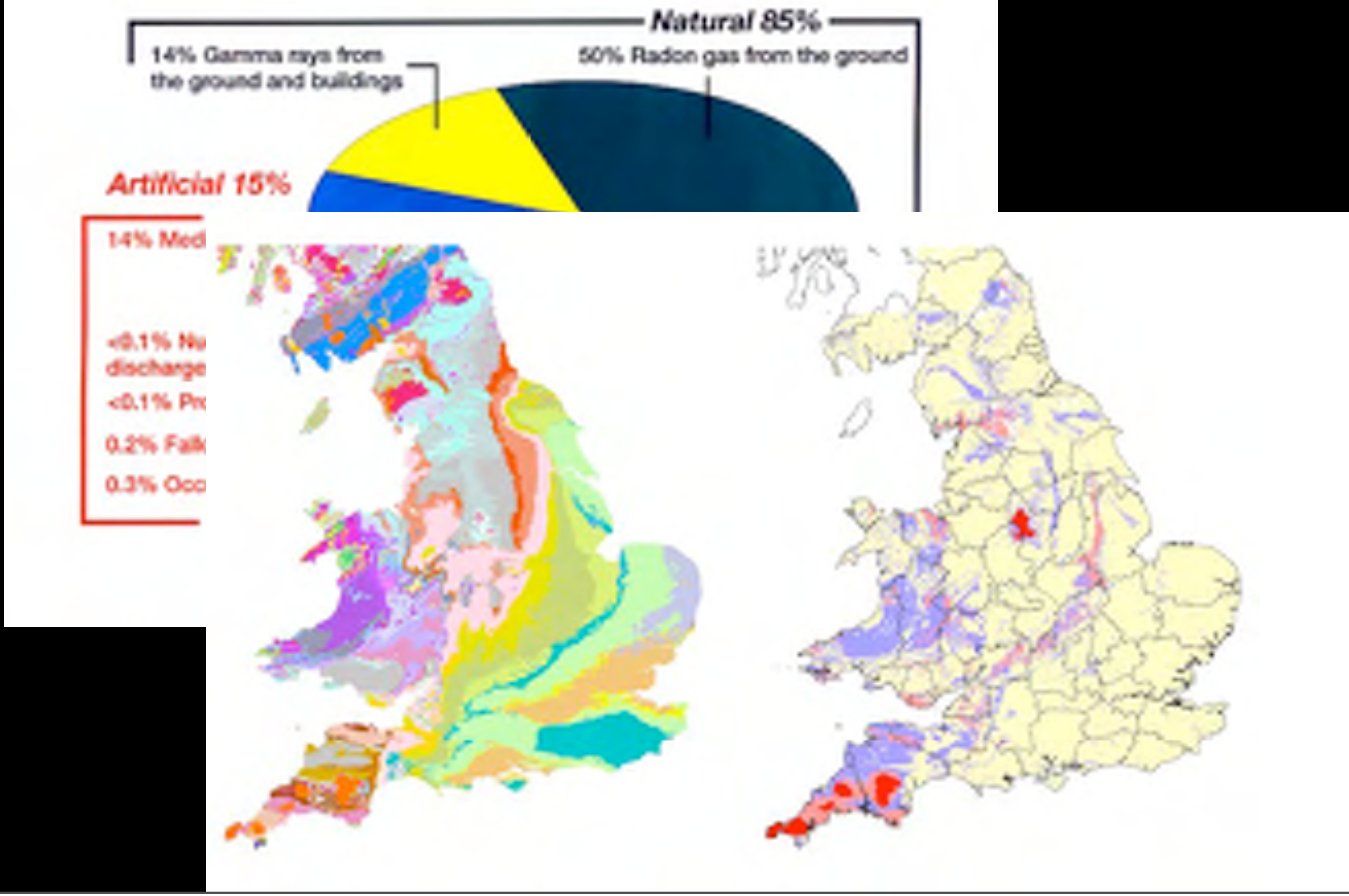
Average Annual UK Radiation Dose



UK New Build Programme

Westinghouse AP1000

Areva EPR

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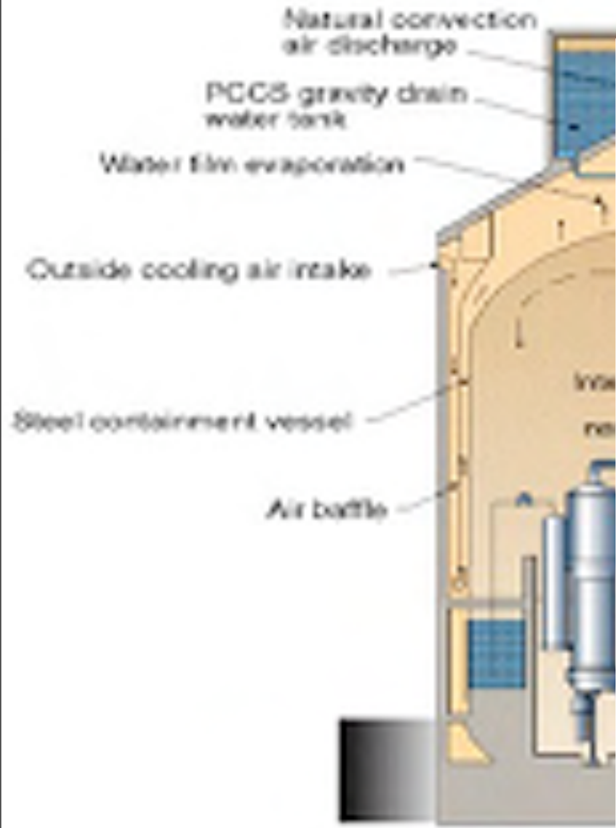
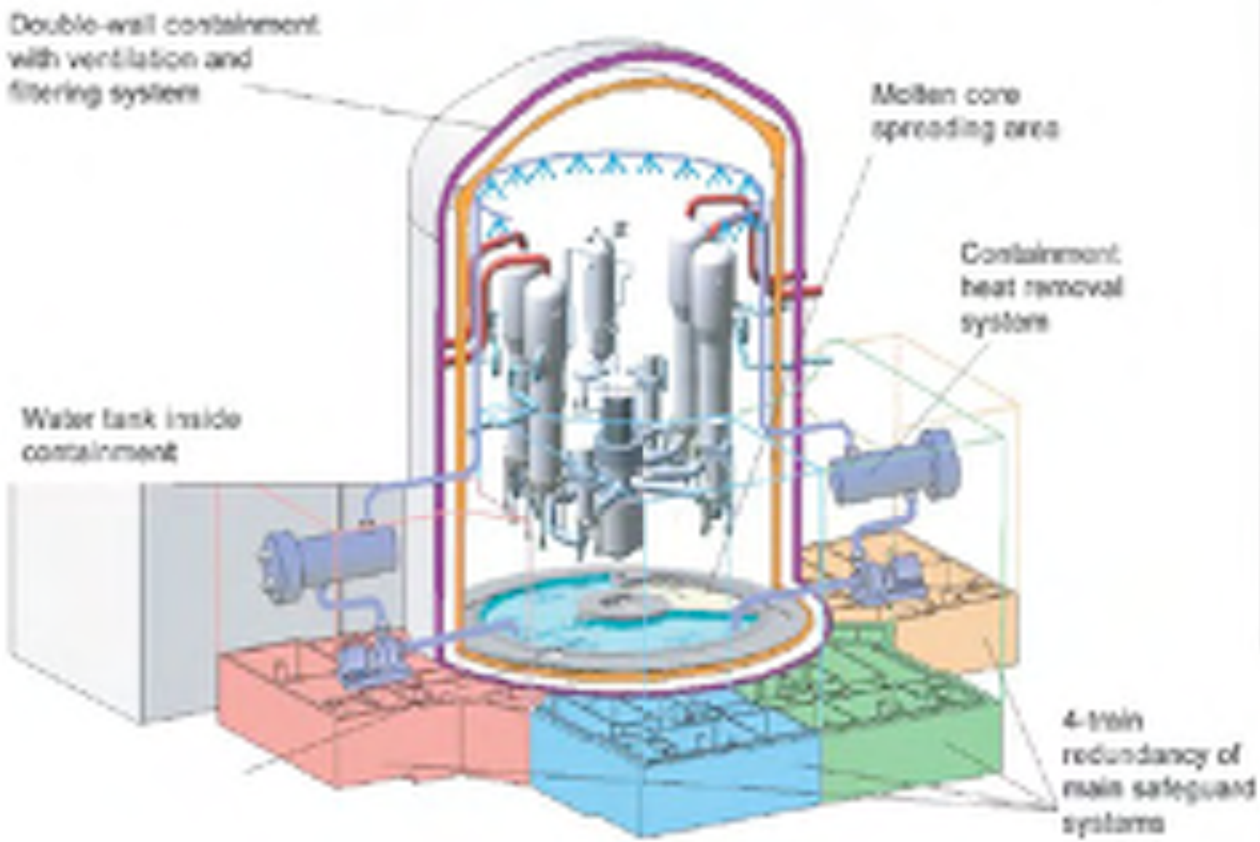
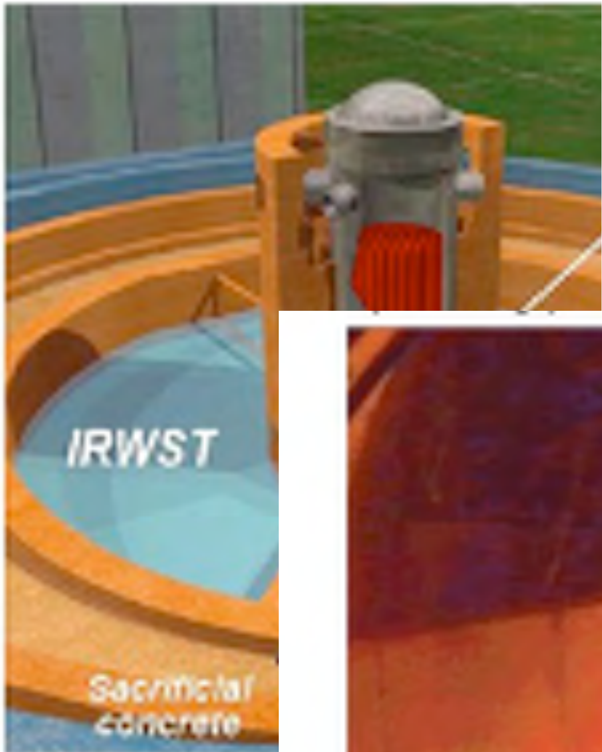
Passive Cooling



EPR Safety Systems



EPR Core Melt R



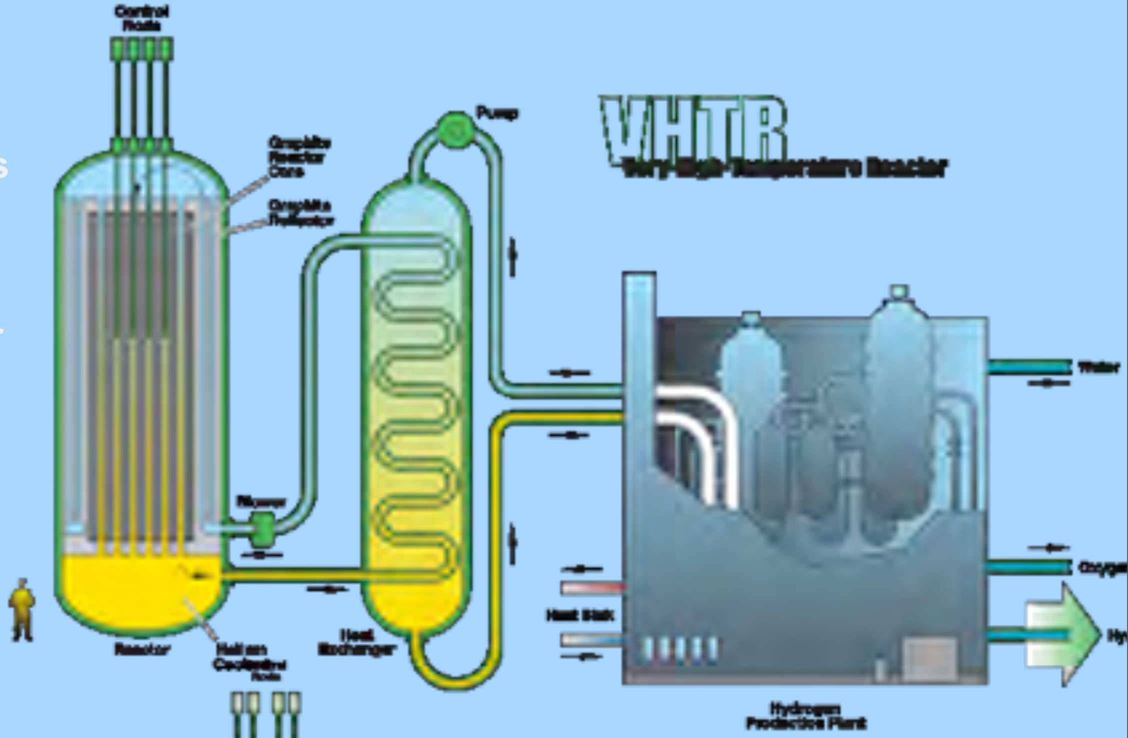
VULCANO (real UO_2 with some Zr O_2)

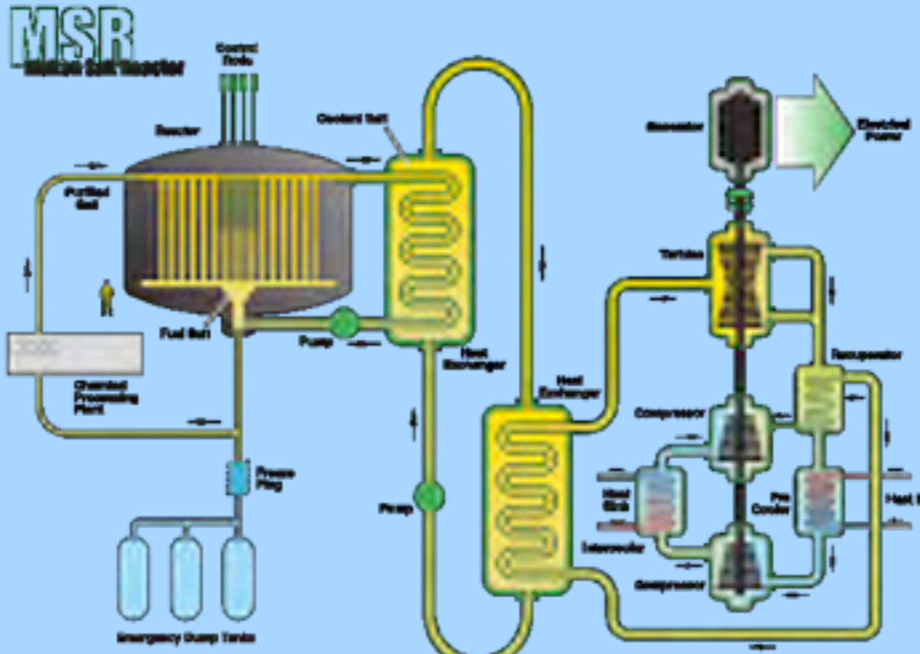
Future: Gen IV

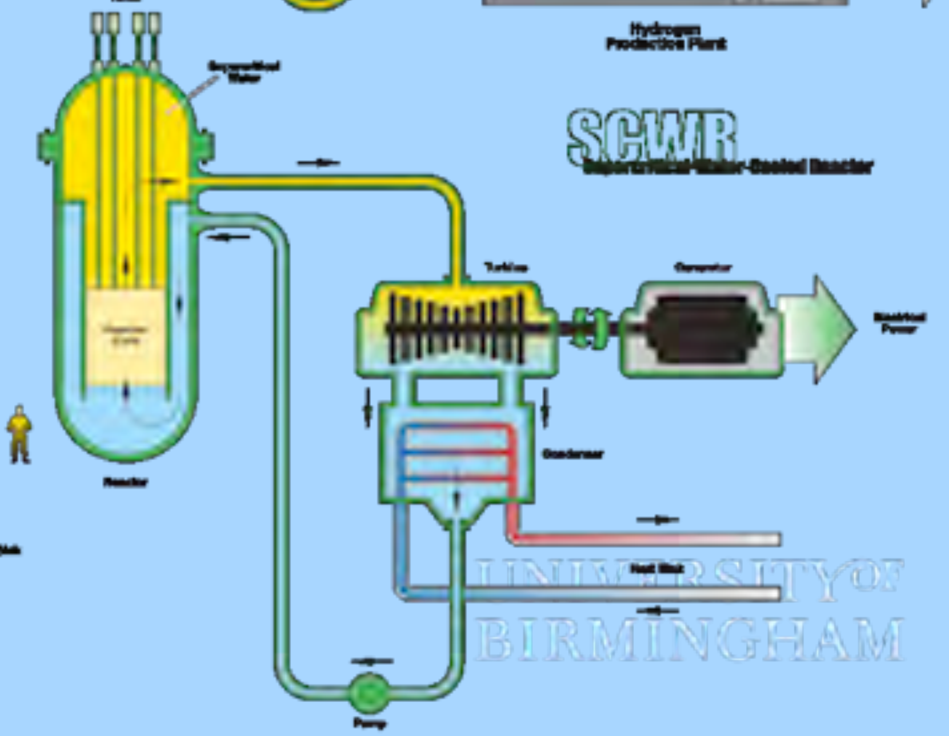
-Nuclear waste that lasts a few centuries instead of millennia
-100-300 times more energy yield from the same amount of nuclear fuel
-The ability to consume existing nuclear waste in the production of electricity
-Improved operating safety

Thermal Reactors

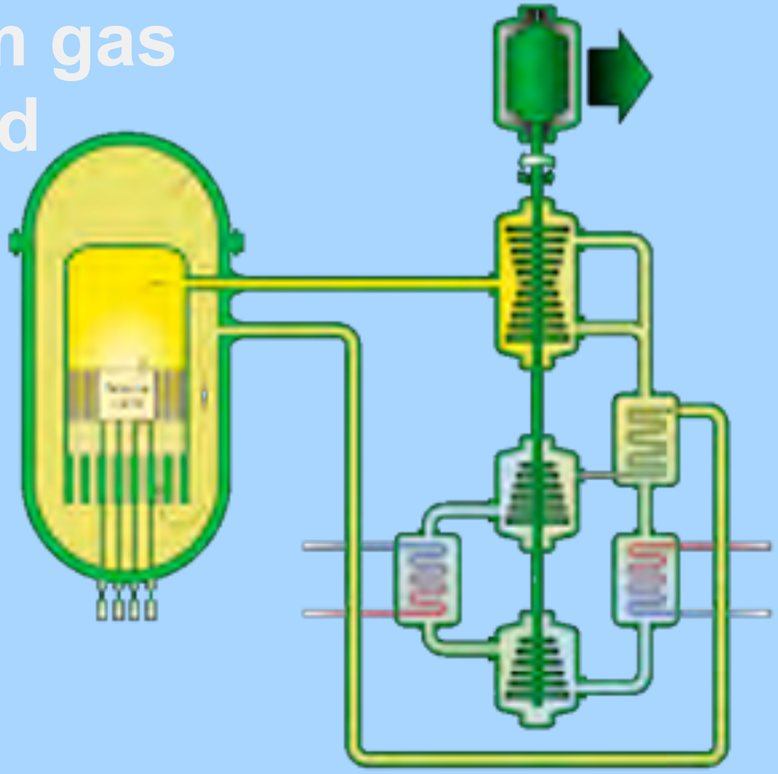
- Higher efficiency

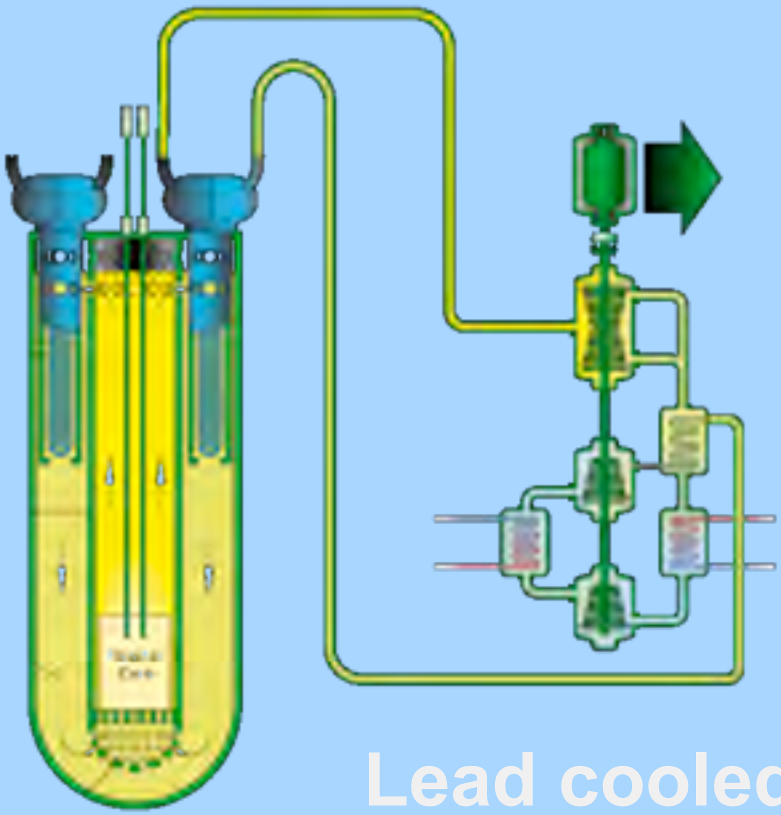


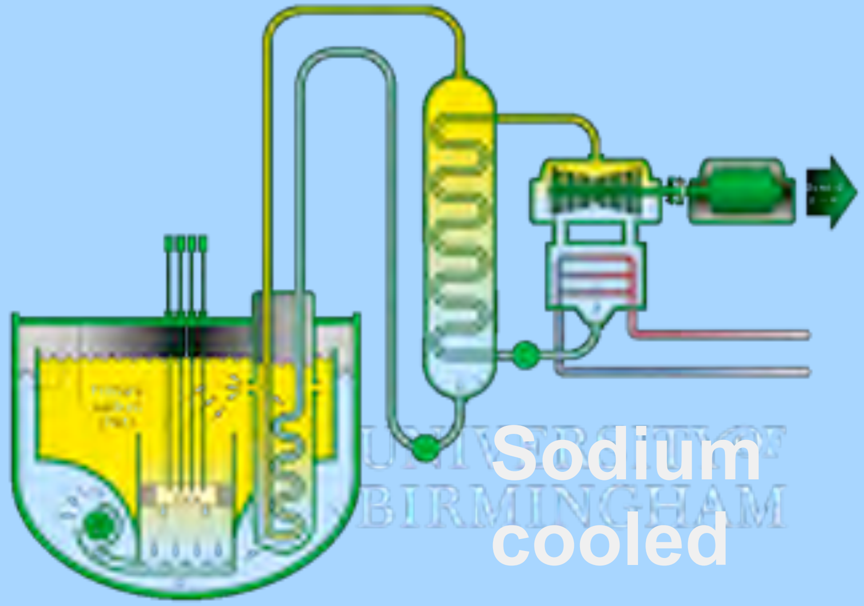




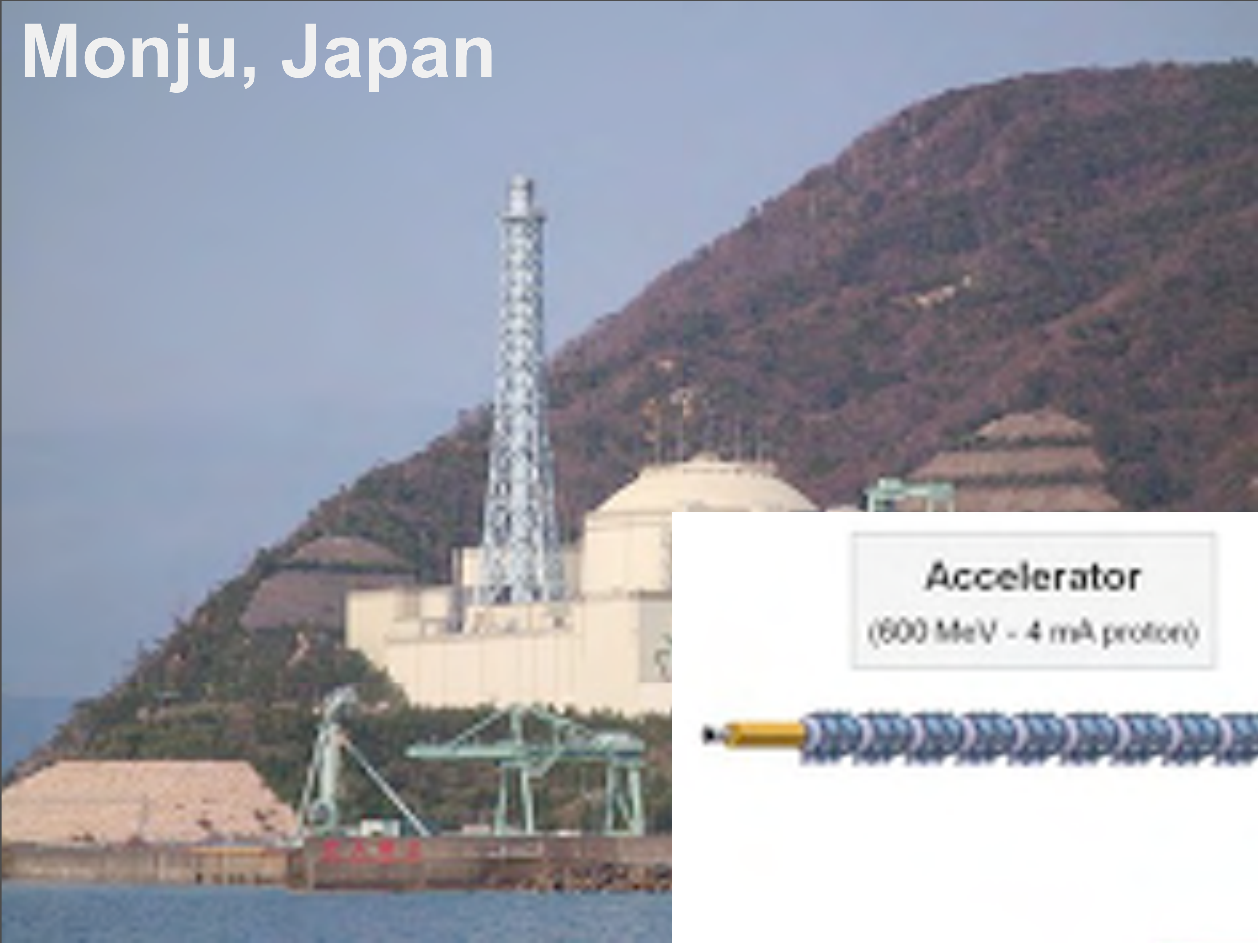
Future Fast Reactors

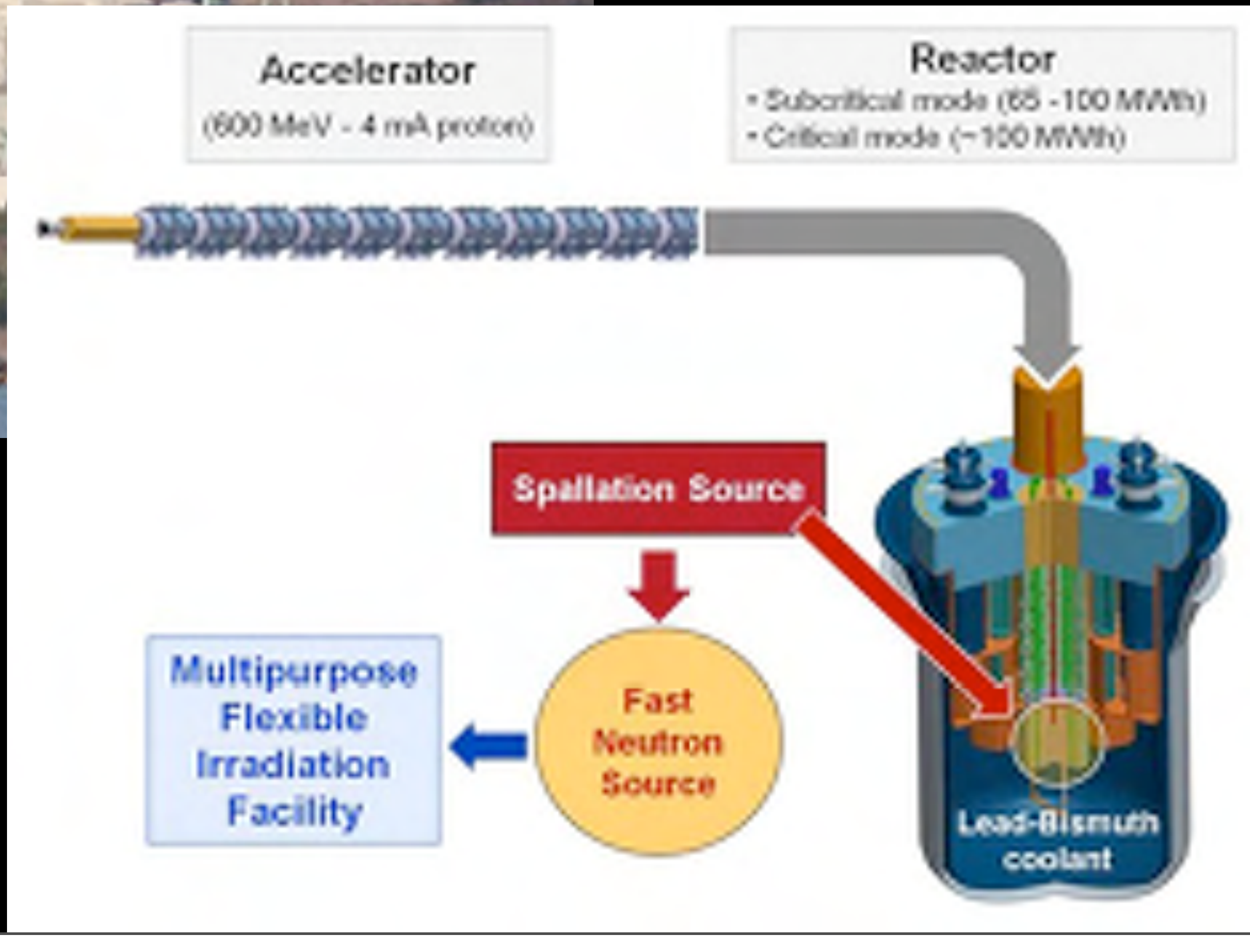






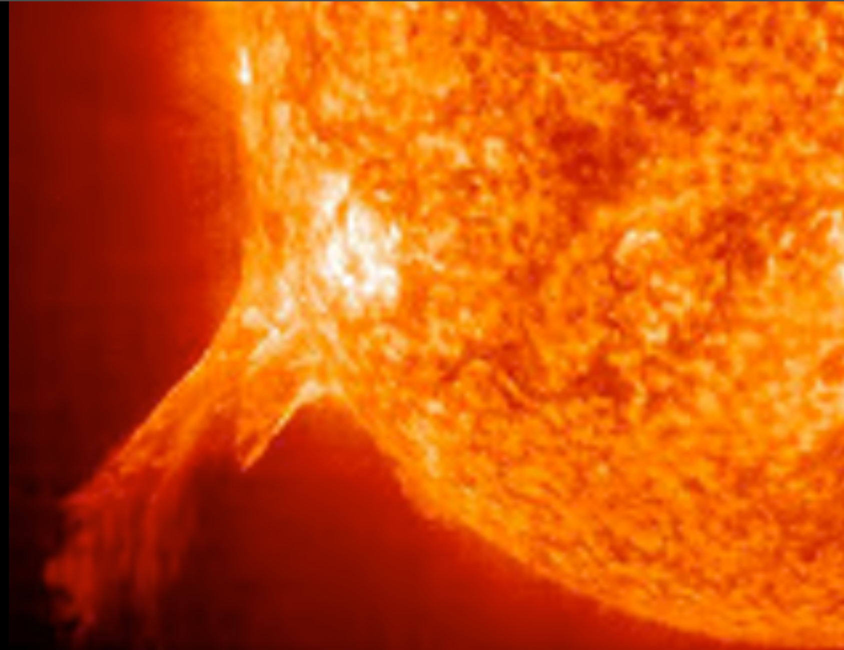
Monju, Japan





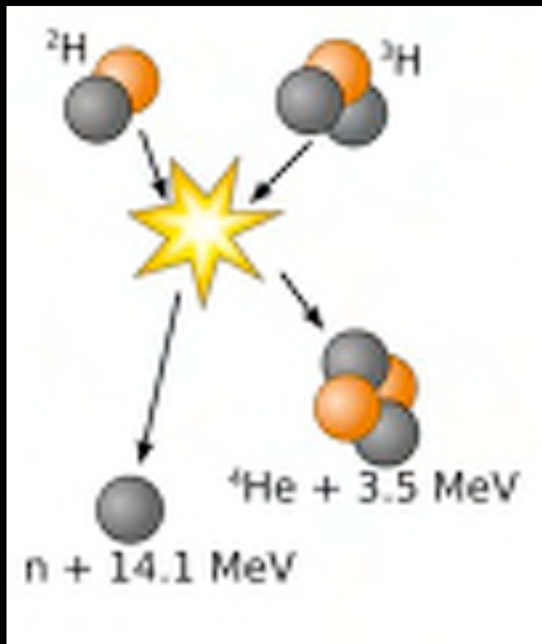
MYRRAH, Belgium

The future of nuclear power

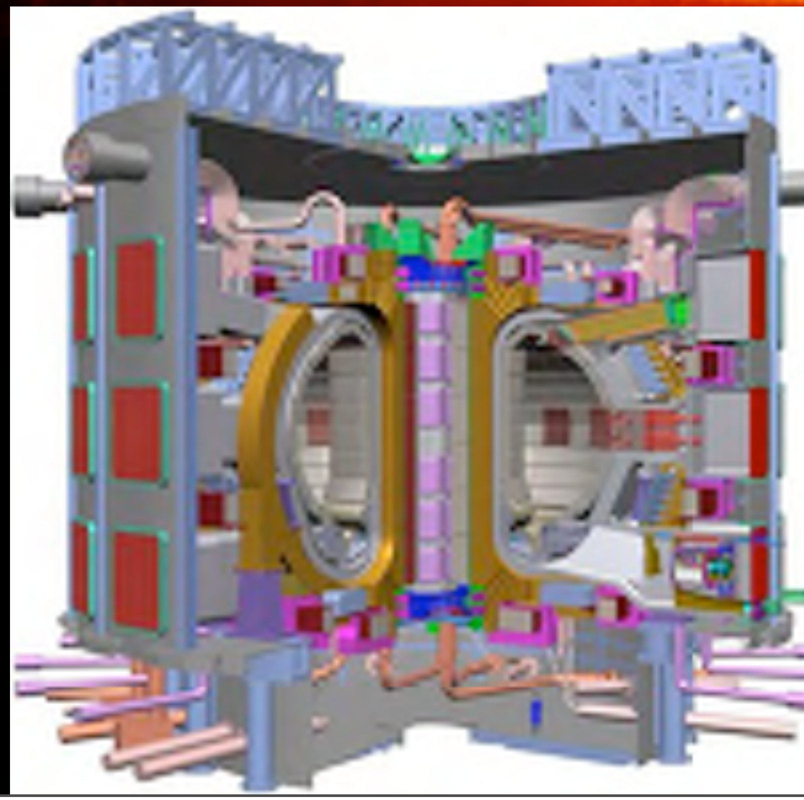


Fusion

Harnessing the power of the sun

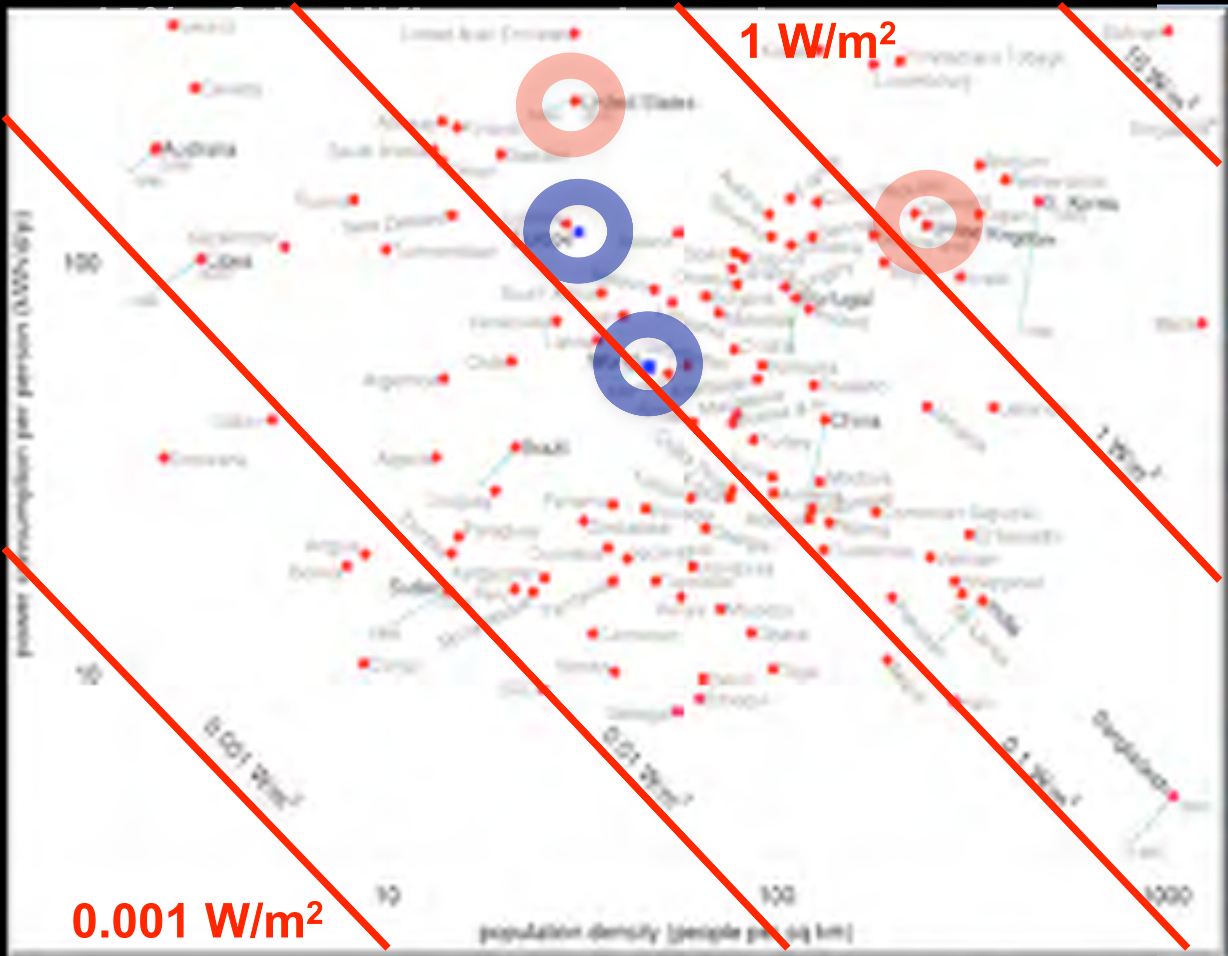


ITER is being built in France with UK expertise



UK Future Energy

Power consumption/person



Population density

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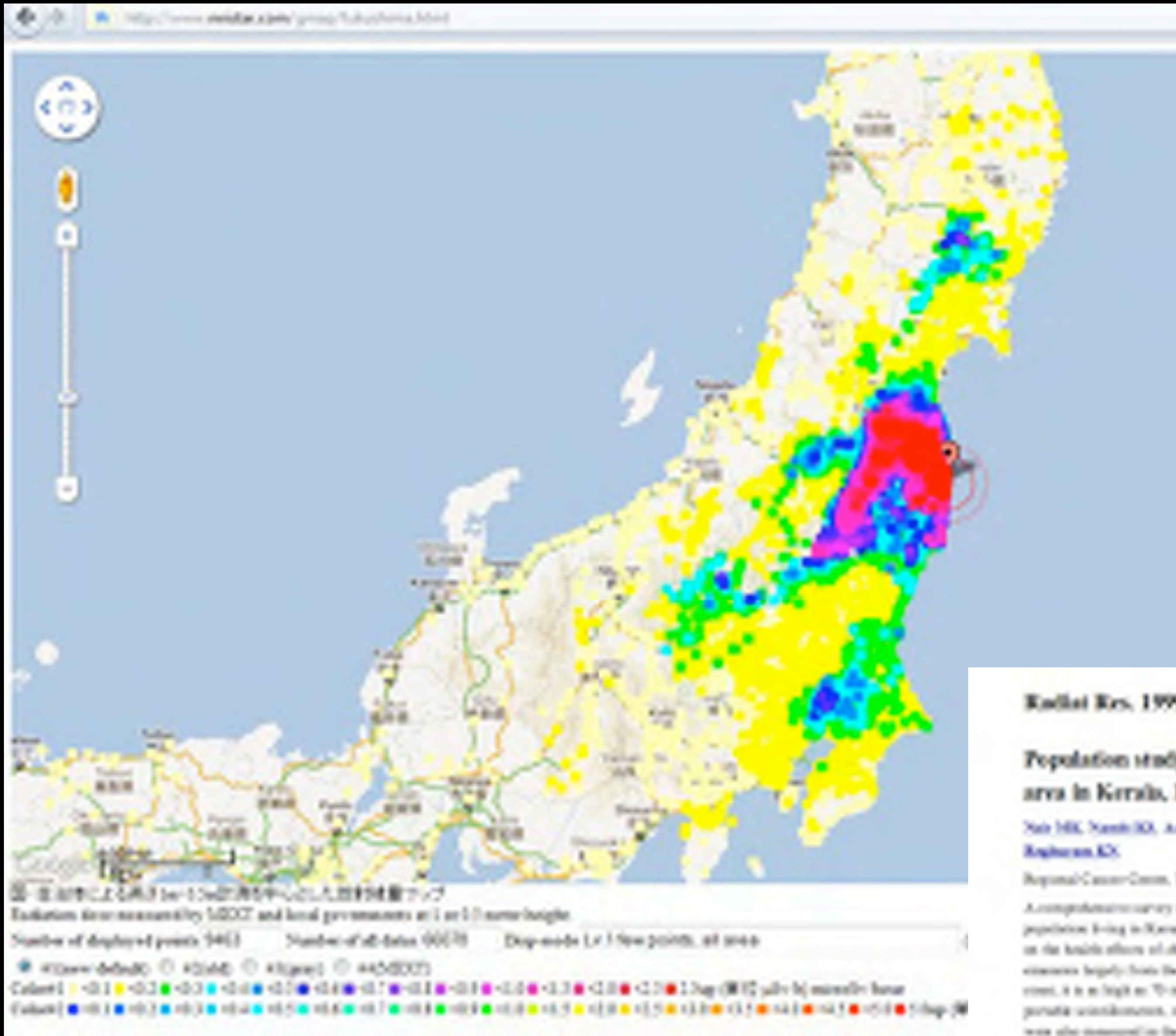

Radiat Res. 1999 Dec;152(6 Suppl):S145-8.

Population study in the high natural background radiation area in Kerala, India.

Nair MK, Nambi KS, Amma NS, Gangadharan P, Jayalekshmi P, Jayadevan S, Cherian V, Reghuram KN.

Regional Cancer Centre, Trivandrum 695 011, Kerala, India.