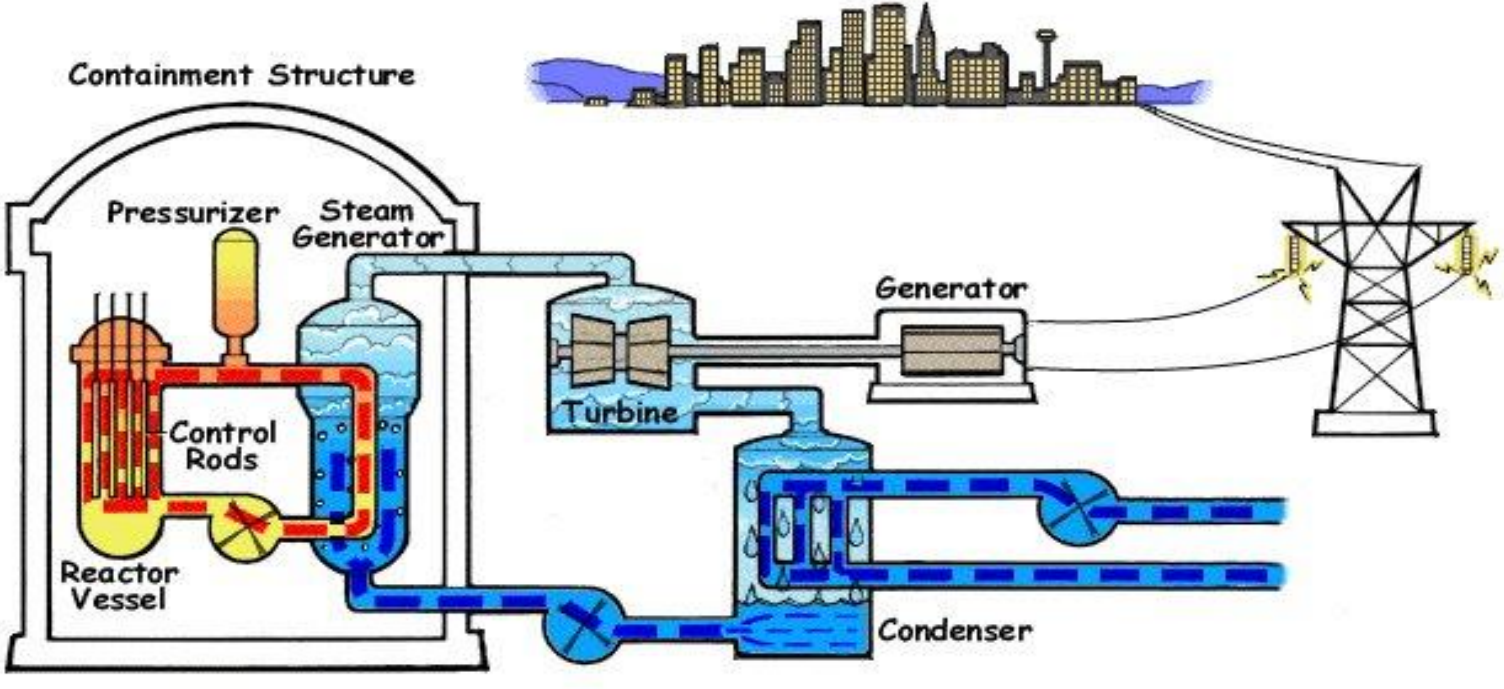
Bradwell Power Station Plans

Proposals for a new
Pressurised Water Reactor
Nuclear Power Station
At Bradwell in Essex

Bradwell Power Station Planning



- The proposal is for CGN (Largely State owned China General Nuclear Company) to design and build a new Pressurized Water Reactor (PWR) of the type Hualong One at Bradwell jointly with (Largely State owned EDF of France). It is envisaged that CGN will put up 65% of the capital and EDF 35%.

- The financing is somewhat analogous to the Private Finance Initiative (or on a household scale to Hire Purchase). Basically this saves on the immediate borrowing requirement of the government, in the light of the aim to reduce National Debt, but the cost eventually falls on the consumer one way or another.

- The design is intended to be proof against an airplane crash.

- In the Hualong One (also known as Hualong 1 and HPR1000) type of reactor the energetic neutron beams from decaying Uranium are stopped and give up their energy to plain water under pressure, heating the water. This heat is then used

to heat water in a second circuit, generating steam. This in turn is used to turn the coiled wire in a magnetic field that generates the alternating electric current to feed the national grid.

EDF and CGN UK Projects

Source: CGN,UK

Hinkley Point C (HPC)

- The largest UK nuclear power project for 20 years
- It will meet 7% of UK's power demand after construction
- Technology: EPR

Shareholding:
EDF: 66.5%
CGN: 33.5%

Sizewell C (SZC)

Technology: EPR

Shareholding:
EDF: 80%
CGN: 20%

Bradwell B (BRB)

- Proposed a breakthrough export of China's proprietary nuclear technology to western developed countries.
- Reference power station: Guangxi Fangchenggang Nuclear Power Station Phase II Project
- Technology: HPR1000 (proposed)

Shareholding:
CGN: 66.5%
EDF: 33.5%

Source: Wikipedia

Électricité de France S.A. (**EDF**; ***Electricity of France***) is a French electric utility company, largely owned by the French state. Headquartered in Paris, with €65.2 billion in revenues in 2010, EDF operates a diverse portfolio of 120+ gigawatts of generation capacity in Europe, South America, North America, Asia, the Middle East and Africa.In 2009, EDF was the world's largest producer of

electricity. In 2011, it produced 22% of the European Union's electricity, primarily from nuclear power:

nuclear: 64.3%;

renewable energy: 12.3% (includes 4.6% hydroelectricity);

gas: 8.6%;

coal: 14.5%;

other: 0.3%.

Its 58 active nuclear reactors (in France) are spread out over 20 sites (nuclear power plants). They comprise 34 reactors of 900 Me, 20 reactors of 1300 MW, and 4 reactors of 1450 MW, all PWRs

Source: Wikipedia

China General Nuclear Power Group (CGN) (Chinese: 中国广核集团), formerly China Guangdong Nuclear

Power Group (Chinese: 中国广东核电集团), is a major energy corporation under the SASAC of the State Council.

CGN has operating nuclear plants at Daya Bay Nuclear Power Plant, Ling Ao Nuclear Power Plant, Hongyanhe Nuclear Power Plant and Ningde Nuclear Power Plant, with five new nuclear power stations under construction and another 2 planned.

CGN operates in other emerging energy industries like wind energy and solar energy, as well as more traditional industries like hydroelectricity.

As of 2014 CGN operates power generation plant of the capacity: nuclear 8.3 GW, wind 4.7 GW, hydro 4.0 GW and solar 600 MW.

Source: World Nuclear news

Some History

- CGNPC was established in 1994 and was 45% owned by the provincial government, 45% by China National Nuclear Corporation (CNNC) and 10% by China Power Investment Corp (CPI). It was under the supervision of the State-owned Assets Supervision and Administration Commission (SASAC) of the State Council.

- In September 2012 a change in CGNPC's ownership structure was approved with SASAC itself taking an 82% stake in the company and the provincial government's and CNNC's holdings dropping to 10% and 8%, respectively.

- The group now comprises some 20 companies with gross assets in August 2012 of $40.3 billion

and net assets of $10.8 billion. China Guangdong Nuclear Power Holding Company leads this group, which is responsible for the Daya Bay, Ling Ao, Yangjiang, Hongyanhe and Ningde power stations, as well as further projects in the province and outside it.

- CGNPC currently has seven nuclear power reactors in operation (six within Guangdong province) with a combined capacity of 7.2 GWe, accounting for 53% of China's installed nuclear capacity. In addition, it has 15 reactors under construction with a combined capacity of 17.8 GWe, only eight of which are within Guangdong.

- According to its strategic plan, CGNPC aims to have some 90 GWe of installed clean energy generating capacity by 2020, when it will supply some 420 TWh of electricity to the grid annually.

- (Data appertaining to May 2013)

SASAC

State-owned Assets Supervision and Administration Commission

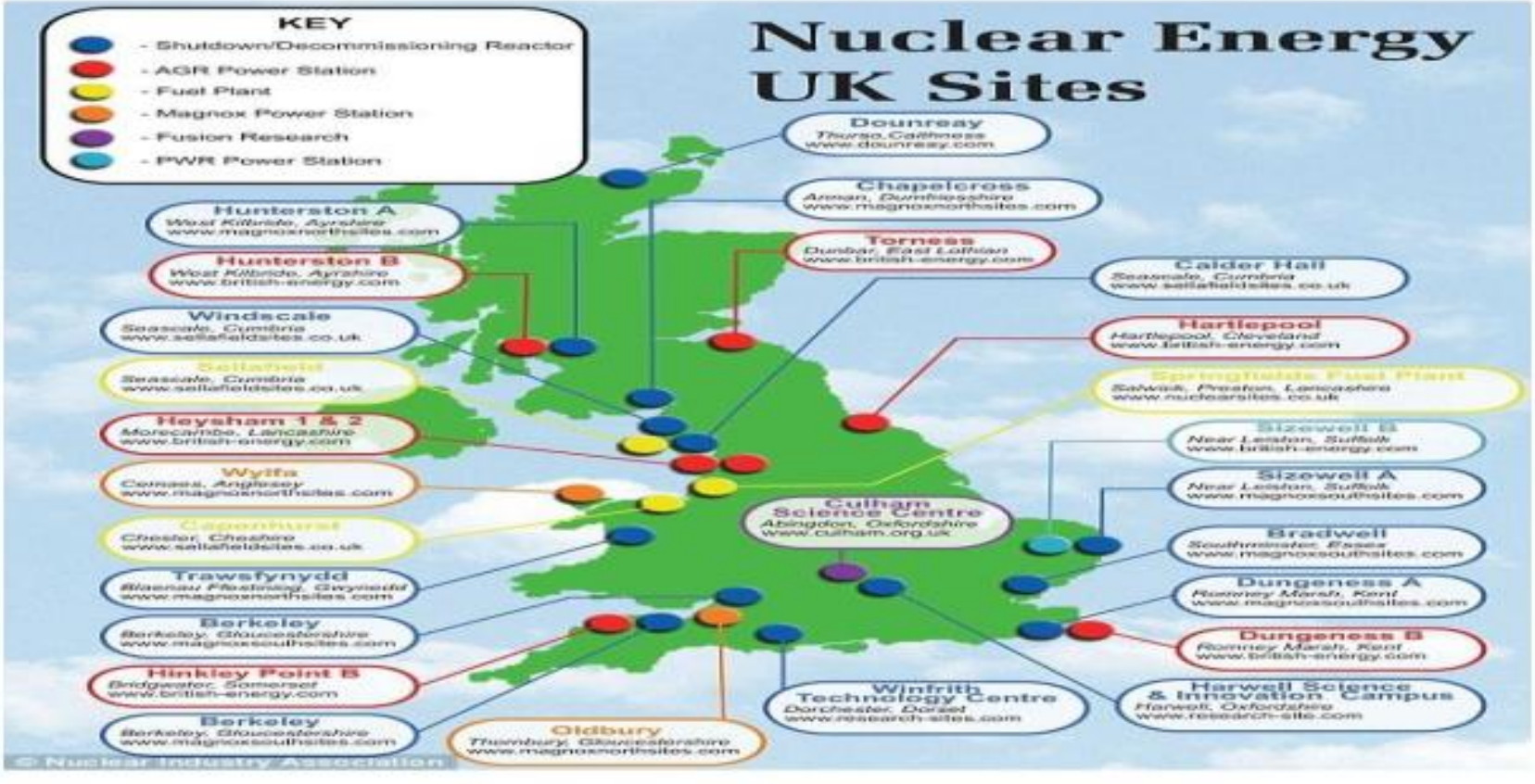
- The State-owned Assets Supervision and Administration Commission of the State Council (SASAC) is a special commission of the People's Republic of China, directly under the State Council.

- It was founded in 2003 through the consolidation of various other industry-specific ministries.

- As part of economic reform, nearly half of state-owned enterprises were sold off in the form of stocks.
- SASAC is responsible for managing the remaining SOEs, including appointing top executives and approving any mergers or sales of stock or assets,

as well as drafting laws related to state-owned enterprises.

- As of 2017, its companies had a combined revenue of more than 23.4 trillion yuan (US$3.6 trillion) and an estimated stock value of 50 trillion yuan (US$7.6 trillion),making it the largest economic entity in the world.


Nuclear Energy
UK Sites
KEY
- Shutdown/Decommissioning Reactor
- AGR Power Station
- Fuel Plant
- Magnox Power Station
- Fusion Research
- PWR Power Station
Dounreay
Thurso, Caithness
www.dounreay.com
Chapelcross
Annan, Dumfriesshire
www.magnoxnorthsites.com
Torness
Dunbar, East Lothian
www.british-energy.com
Hunterston A
West Kilbride, Ayrshire
www.magnoxnorthsites.com
Hunterston B
West Kilbride, Ayrshire
www.british-energy.com
Calder Hall
Seascale, Cumbria
www.sellafieldsites.co.uk
Windscale
Seascale, Cumbria
www.sellafieldsites.co.uk
Hartlepool
Hartlepool, Cleveland
www.british-energy.com
Sellafield
Seascale, Cumbria
www.sellafieldsites.co.uk
Springfields Fuel Plant
Salwick, Preston, Lancashire
www.nuclearsites.co.uk
Heysham 1 & 2
Morecambe, Lancashire
www.british-energy.com
Sizewell B
Near Leiston, Suffolk
www.british-energy.com
Wylfa
Cemaes, Anglesey
www.magnoxnorthsites.com
Sizewell A
Near Leiston, Suffolk
www.magnoxsouthsites.com
Culham Science Centre
Abingdon, Oxfordshire
www.culham.org.uk
Capenhurst
Chester, Cheshire
www.sellafieldsites.co.uk
Bradwell
Southminster, Essex
www.magnoxsouthsites.com
Trawsfynydd
Blaenau Ffestiniog, Gwynedd
www.magnoxnorthsites.com
Dungeness A
Romney Marsh, Kent
www.magnoxsouthsites.com
Berkeley
Berkeley, Gloucestershire
www.magnoxsouthsites.com
Dungeness B
Romney Marsh, Kent
www.british-energy.com
Hinkley Point B
Bridgwater, Somerset
www.british-energy.com
Winfrith Technology Centre
Dorchester, Dorset
www.research-sites.com
Harwell Science & Innovation Campus
Harwell, Oxfordshire
www.research-site.com
Berkeley
Berkeley, Gloucestershire
www.magnoxsouthsites.com
Oldbury
Thornbury, Gloucestershire
www.magnoxnorthsites.com
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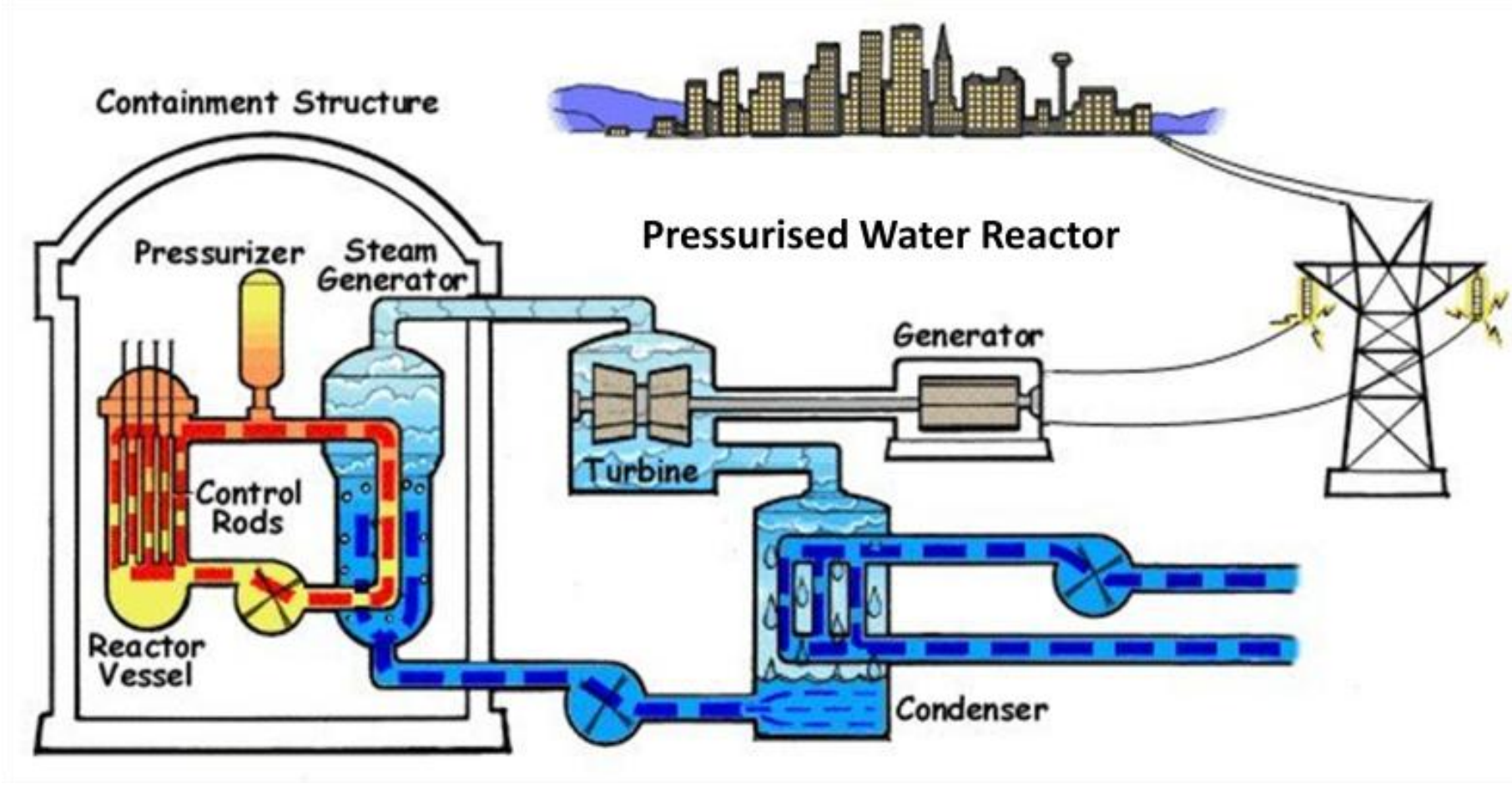

Containment Structure
Pressurised Water Reactor
Pressurizer
Steam Generator
Generator
Turbine
Control Rods
Reactor Vessel
Condenser

Nuclear v Conventional Power Stations

The only distinction between a conventional (coal or gas powered) electricity generating plant and a Nuclear Powered Generating Plant is the source of heat.

In a Nuclear Power plant the heat is supplied by a radioactive substance, usually Uranium.

As this gradually disintegrates (splits into other elemental substances) it emits high velocity neutrons (a heavy constituent of the nucleus of an atom)

When these energetic particles are stopped by a Moderator heat is given up.

This heat is the used to generate steam, just as in a conventional power station.

The steam then is used to turn a turbine.

This then generates alternating current by the turning of large metal coils in an intense magnetic field (essentially in the same way as a bicycle dynamo).

One of the major differences between Nuclear Power Stations is in the moderator.

At Bradwell the first power station was a magnox reactor. The name magnox comes from the magnesium-aluminium alloy used to clad the fuel rods inside the reactor. The moderator was graphite.

The Hualong One type of reactor that is proposed for development at Bradwell uses Pressurized Water as a Moderator. It is thus known as a PWR reactor.

Most reactors world-wide are now PWR reactors.

China targets new UK nuclear deal

The Chinese firm helping to build the Hinkley Point C nuclear power station is to submit a design for another UK site. The proposed Hualong-1 reactor at Bradwell would be the first Chinese-designed nuclear plant in the West

HUALONG-1: ***1,100MW pressurised water reactor***
China's first indigenous reactor. Design life 60 years

Reactor building: Double-wall structure. Reinforced concrete inner containment with steel lining. Reactor core has 177 fuel assemblies

Fuel building

Emergency diesel generator building

Gantry

Turbine hall

Electrical building

Access building

Nuclear waste building

Auxiliary building

Safeguard buildings: Two backup safety systems, separate from rest of plant, on opposite sides of reactor

Concrete shielding protects reactor, fuel building and electrical building from large commercial aircraft crash

UK NUCLEAR PLANTS

Torness
Hunterston
Hartlepool
Heysham
Sizewell
Dungeness

Bradwell: China could take lead role in developing Hualong-1 reactor with support of French energy giant EDF

Hinkley Point C: Chinese state firm CGN to fund one-third of nuclear plant, due for completion by 2025. France supplying reactor technology

Sources: ScienceDirect, World Nuclear Association

China’s Hualong One Clears First Hurdle in UK

Adapted from The Energy Collective

Before a new nuclear power station can be built and operated in the UK, the reactor design must go through the GDA (Generic Design Assessment) process .

The purpose of GDA is to determine whether the design meets the robust safety and security standards to make it suitable for use in the UK.

The operator must also obtain permission from regulators and Government in the form of:

Site license and relevant consent to begin nuclear-related construction from ONR. (The Office for Nuclear

Regulation is responsible for regulation of nuclear safety and security across the UK);

Environmental permits from Environment Agency or Natural Resources Wales (NRW);

Planning permission from the Department for Business, Energy and Industrial Strategy (BEIS).

Mike Finnerty, the ONR’s deputy chief inspector and director of the ONR’s new reactors division has stated: “I am satisfied that there are adequate project management and technical provisions in place to enter step two of the process and, as regulators, we can begin our technical assessment phase.”

CGN, which holds a one-third stake in the French-led Hinkley Point C EPR nuclear project, said it is confident that the HPR1000 will be approved by UK authorities for construction at Bradwell. The company hopes the GDA will be completed in less than five years.

The costs of the GDA, which have not been disclosed, will be paid by French nuclear operator EDF and CGN, which

have formed a joint venture called General Nuclear Systems Limited to develop the Bradwell plans.

They are also behind plans for Hinkley Point C in Somerset and Sizewell C in Suffolk.

EDF said the current reference plant for Bradwell B is CGN’s Fangchenggang Plant Unit 3 in China which started

construction in February 2017 and is reported to be on schedule.

The original reference design for the Hualong One is believed to be China’s Daya Bay reactor which is based on a French Framatone 900 MW unit.

Britain needs to fill an electricity supply gap in the next decade. Many of its nuclear plants are due to close by

2030 and the government plans to shut its coal plants by 2025 to help reduce carbon dioxide emissions.

Hualong One, Hualong-1, HPR1000

Sources: Wikipedia & CGN,UK

The **CPR-1000**, or **CPR1000**, (improved Chinese PWR) is a Generation III pressurized water reactor, based on the French 900 MW three cooling loop design imported in the 1990s, improved to have a net power output of 1,000 MW (1080 MW gross) and a 60-year design life.

The CPR-1000 is built and operated by the China General Nuclear Power Group (CGNPG), formerly known as China Guangdong Nuclear Power.

Progressively more Chinese manufactured components were used in the units; the second unit built had 70% of its equipment manufactured in China, with a 90% Chinese content target for later builds.

Source: CGN,UK

HPR1000 is one of the most widely-received Generation-III nuclear power models on the market.

It was developed through joint research and development by CGN and China National Nuclear Corporation (CNNC, and based on experience, breakthrough technologies, and excellent human resources accumulated through 30 years

of design, construction, and operation of nuclear power plants.


Source: CGN,UK

Advantages

It enjoys full proprietary intellectual property rights.

- It is of internationally advanced levels in terms of technological safety and has the economic advantage compared with other reactors and the former three generations of mainstream models

with a domestic benchmark construction cost of less than $2,500 per kilowatt.

- It has the competitive advantage in the industrial chain. Thanks to mature domestic equipment manufacturing systems and capacity strength, an advantage in “going global”, or reaching international markets, has been obtained through

supply chain formation. It is expected that 10 to 12 new units will be constructed every year and each of them will offer over 20,000 jobs.

Source: CGN,UK

Features

Single Reactor Layout

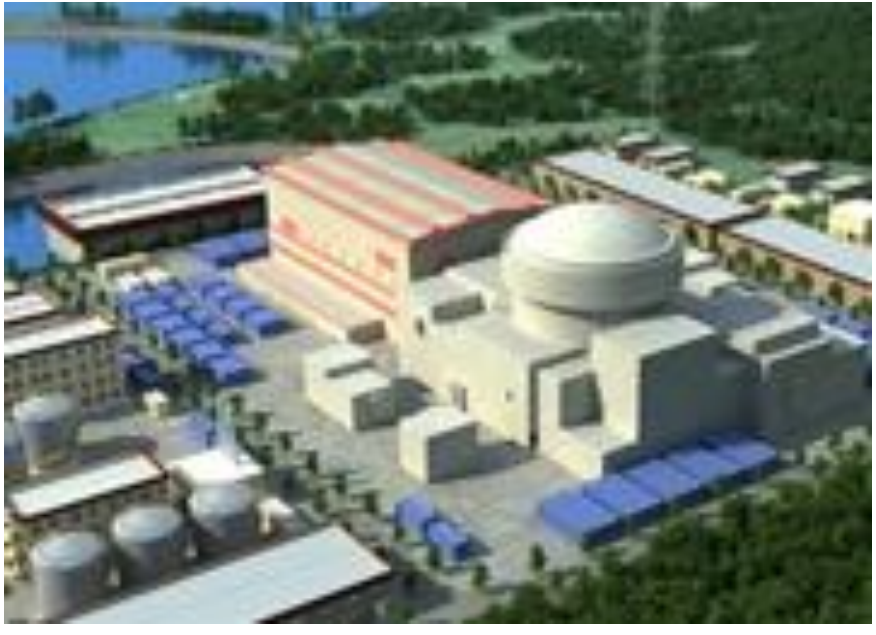
- Single reactor layout optimizes the buildings layout in nuclear island.
- Better physical isolation avoids common mode failure of safety systems.

- It is convenient for construction, operation and maintenance.

Source: CGN,UK

- The large volume improves safety in case of an beyond-design accident or severe accident.
- The annular space ventilation system is designed for double containment, minimizing the risk of releasing radioactive substances into the environment when accident occurs, and thus improving the safety of the power plant.

- The outer shell of the containment is able to withstand the crash of large commercial airplanes.



Source: CGN,UK

Three Safety Trains

- It has three physically isolated safety trains.
- It is of 3×100% redundant safety guarantee.
- The CDF is one order of magnitude lower than that of a two-train configuration scheme, so that it

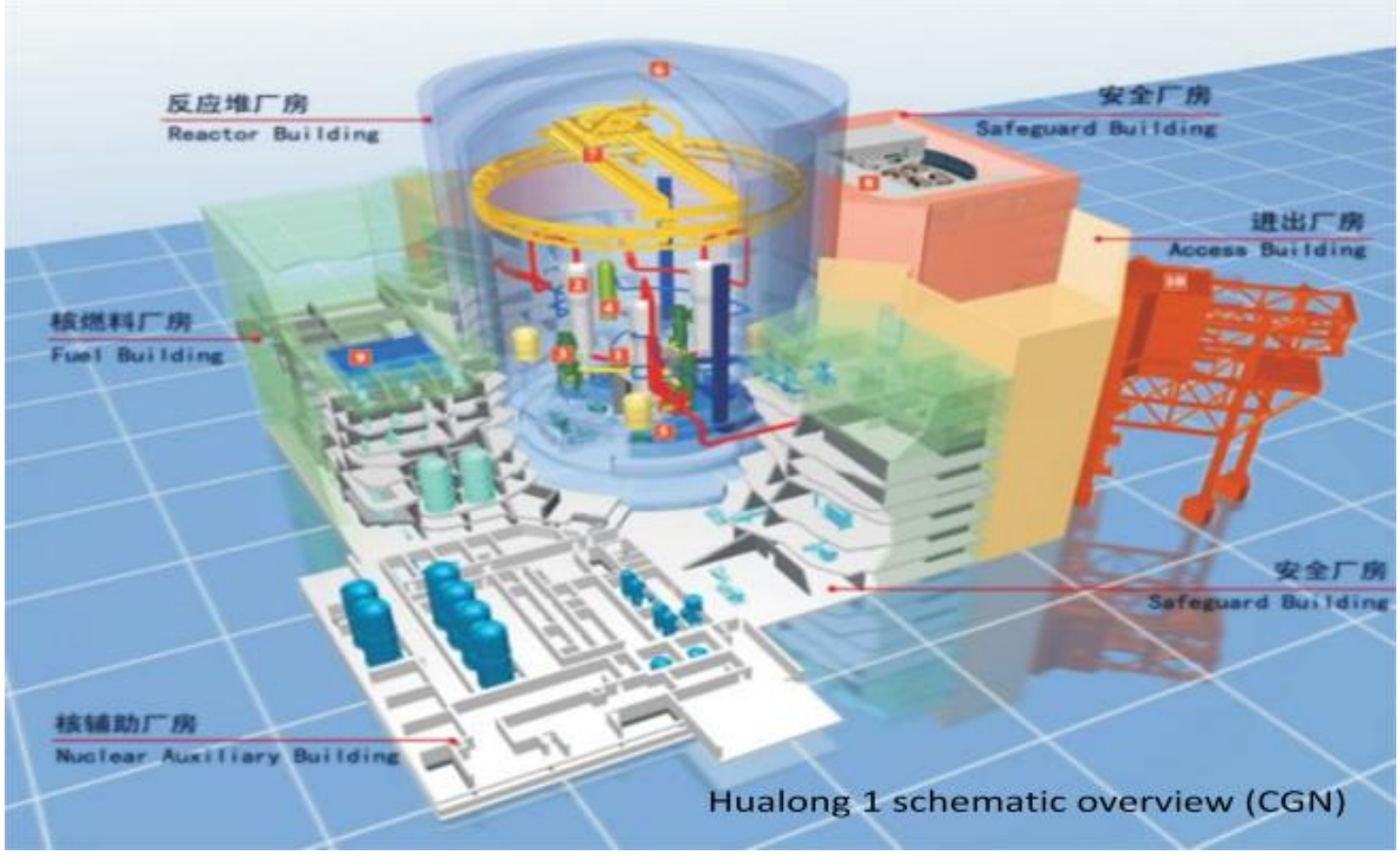
can better respond to both internal and external accidents.

Source: CGN,UK

Combination of Active and Passive

- It has the Secondary Side Passive Residual Heat Removal System. When the active feed-water system fails, the residual heat of the reactor core and stored heat in all equipment tied to the reactor coolant system can be removed via steam generators.

- It has the Passive Reactor Pit Injection System (IVR). When the severe accident like core melt-down occurs, it helps to maintain the integrity of the pressure vessel.



Hualong 1 schematic overview (CGN)

Technological Certifications of HPR1000

Source: CGN,UK

It is developed in accordance with China’s latest safety standard HAF102, and the requirements of the US’s Utility Requirements

Documents and Europe’s European Utility Requirement (EUR).

The standard combines the experience of the Fukushima nuclear accident and internationally advanced design ideas.

Currently, the EUR has agreed to accept its application for certification.

The process is expected to be launched in 2017 and takes about three years.

The CGN is preparing for the Generic Design Assessment (GDA).

How a nuclear reactor makes electricity

Several hundred fuel assemblies containing thousands of small pellets of ceramic uranium oxide fuel make up the core of a reactor.

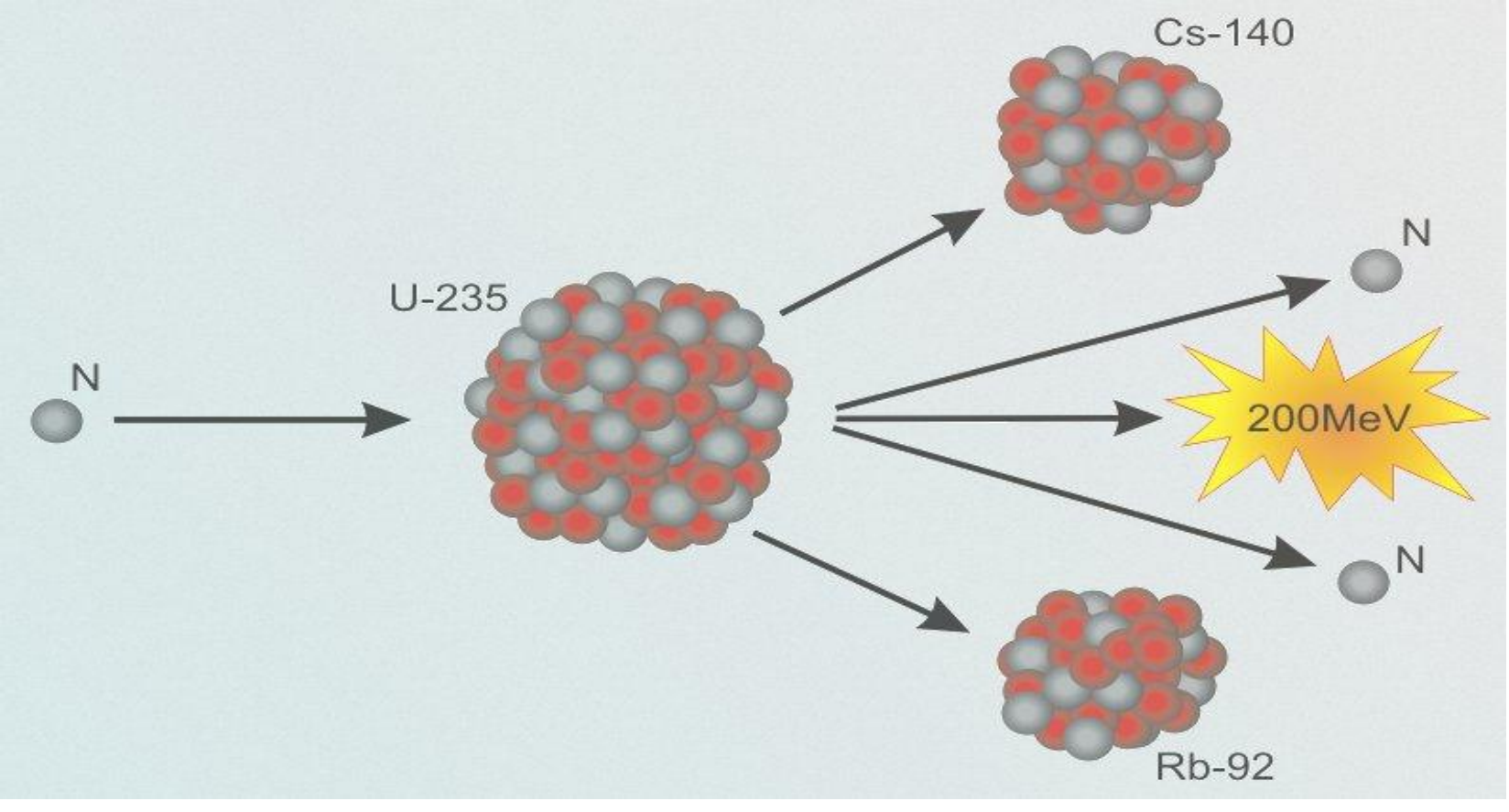
For a reactor with an output of 1000 megawatts (MW), the core would contain about 75 tonnes of enriched uranium.

In the reactor core the uranium-235 isotope fissions or splits, producing a lot of heat in a continuous process called a chain reaction.

The process depends on the presence of a moderator such as water or graphite, and is fully controlled.

The moderator slows down the neutrons produced by fission of the uranium nuclei so that they go on to produce more fissions.

Some of the uranium-238 in the reactor core is turned into plutonium.


Cs-140
N
U-235
N
200MeV
N
Rb-92

Atomic Weapons and Atomic Fusion

- In an atomic bomb the fission material is condensed into such a small space that the chain reaction becomes uncontrollable. This is done by forcing together containers of condensed fission material with a conventional explosive (such as

TNT or nitro-glycerin) . The reaction stops when the material is exhausted.

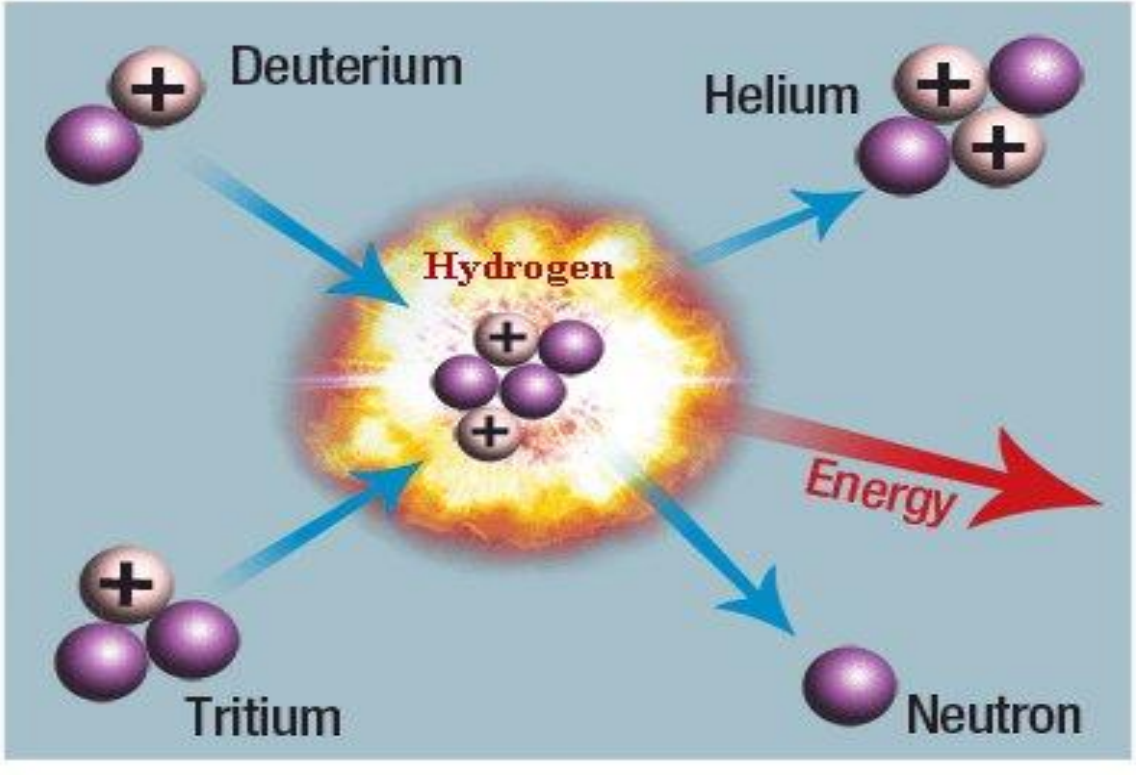
- A fusion hydrogen (thermonuclear) atomic bomb is set off by atomic fission bombs confined to instigate the fusion of hydrogen to helium, the same reaction as occurs to power the sun. The hydrogen is contained in a capsule within the

containing fission atomic bomb. This releases much more energy. Again the reaction stops when the material is exhausted.

- Attempts are currently being made to harness the fusion effect for the creation of electricity, but the problem of confining the reaction has yet to be solved, despite over 50 years of research.

- Once solved this would potentially produce practically limitless energy almost forever!

The Fusion Reaction in the Sun



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