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NUCLEAR FISSION AND FUSION: RIVALS OR COMPANIONS?

Both the nuclear fission and fusion were discovered in the thirties of the last century. Why now 75 years later the resulting utilization of nuclear power is so different for these two roads? In principle in the future the potential amount of energy produced by fusion can greatly outweigh the fission. Unfortunately the fusion is a much thornier path. All fusion devices developed so far have used much more energy than produced. The latest design the International Thermonuclear Experimental Reactor (ITER) is supposed to be able to generate an equal amount of energy to that required to sustain the reaction. However this is expected to happen after 15–20 years. Even if this will take place, fission and fusion will become the companions rather than the rivals.

1. TWO PATHS OF OBTAINING NUCLEAR ENERGY

a) Nuclear fission is the splitting of a heavy atom into two or more parts, releasing huge amounts of energy

$$^{235}U + n \rightarrow {}^{236}U \rightarrow 2n + {}^{92}Sr + {}^{140}Xe$$

b) Nuclear fusion involves bombarding hydrogen atoms together to form helium and neutron.

$$D + T \rightarrow {}^{4}He + n$$

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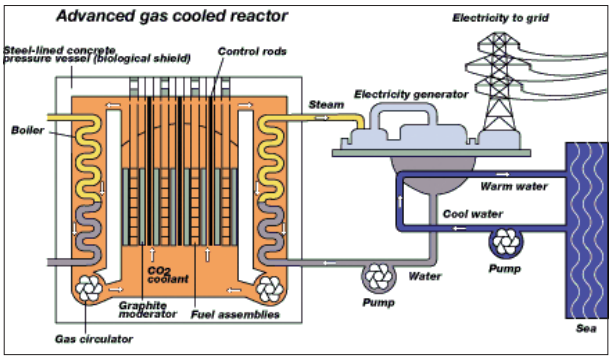
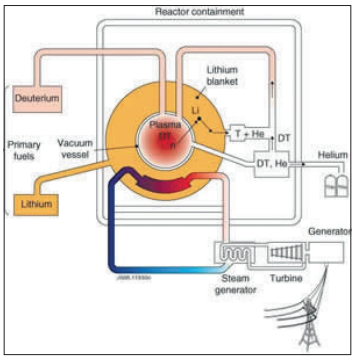


Fission power plant



Fusion power plant

2. HISTORY

Military applications.

Two atomic bombs (*fission!*) were dropped on Japan's cities: Hiroshima, 6. August 1945, Nagasaki, 9. August 1945. The first Soviet atomic bomb was test-exploded four years later on 29 August 1949. On November 1, 1952, the United States exploded the first hydrogen bomb (*fusion!*). The first Soviet test of a hydrogen bomb was on August 12, 1953

Civil applications.

The first commercial fission power plants began to produce electricity in 1954 in Obninsk (Russia) and 1956 in Calder Hall (United Kingdom). The first tokamak was built in 1956 in Moscow.

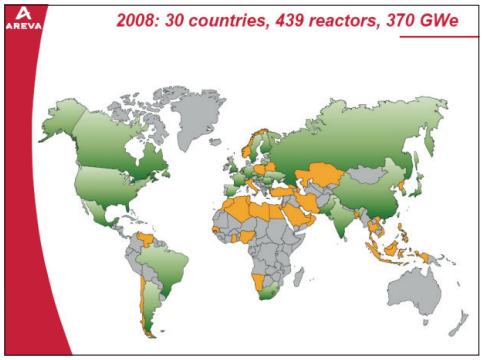
3. PRESENT STATUS

Fission

WNA May 2010

Nuclear Power 2009-10

Country	GWe	TWh	Units	%Elec
USA	101	797	104	20
France	63	392	58	75
Japan	47	263	54	29
Russia	23	153	32	18
S Korea	18	141	20	35
Germany	20	128	17	26
Canada	13	85	18	15
Ukraine	13	78	15	49
China	9	66	11	2
Spain	7	50	8	18
Sweden	9	50	10	35
WORLD	374	2 558	438	14



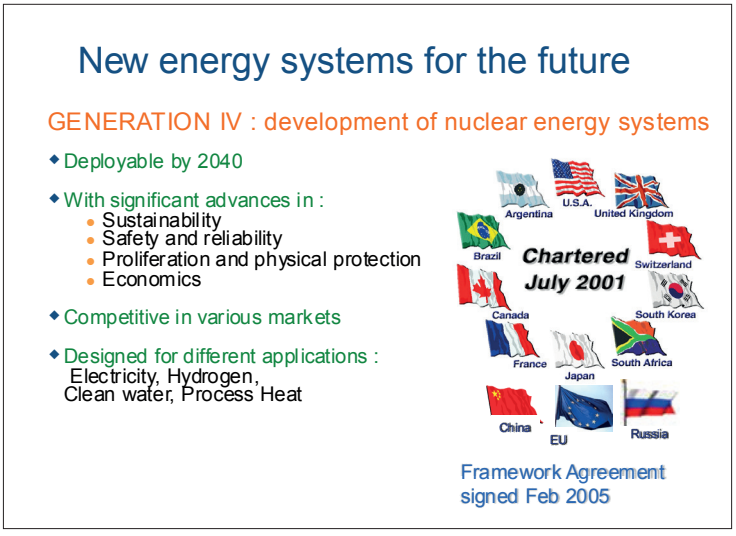
Green: existing power plants; yellow: showing interest; grey: no interest.

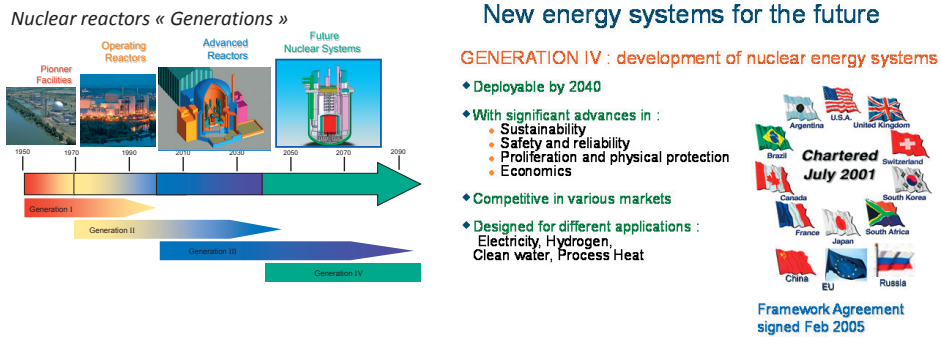
Fusion

Tokamak and Stellarator – two roads to nuclear fusion energy. Currently in operation 22 tokamaks and 9 stellarators. All these machines are purely research installations.

4. FUTURE

Fission





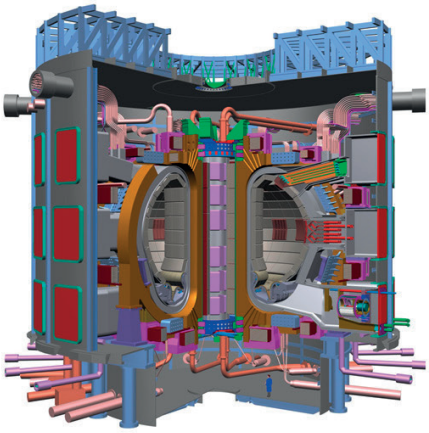
Fusion

Advantage: intrinsic safety (no chain reaction). *Disadvantage:* reactor far more complex than a fission reactor. It impossible to design small power reactors. *Uncertainty:* 2026 first DT plasma in ITER

Nuclear fission and fusion: rivals or companions? Companions!

Fission (very flexible and mobile): *Fusion* (stationary)
1) electricity production; 1) electricity production
2) heat production;

International Thermonuclear Experimental Reactor (ITER)



Nuclear fission and fusion: rivals or companions? Companions!

3) water desalination;
4) hydrogen production

Impact of Fukushima disaster on nuclear energy. Personal view.

Opponents of nuclear energy should remember:
1. past and future deaths of tens of thousands of coal miners all over the world;
2. deaths of people and sea animals and plants due to oil spills (BP, Gulf of Mexico);
3. destroyed natural landscapes;
4. air pollution;
5. climate changes;
6. etc…

Large fission power stations should be closed only after fusion power stations will generate electricity.

Bannt Deutschland die Atom-Hysterie?

Is Germany bewitched by the atom hysteria?
The concert hall must be immediately evacuated. My Geiger counter is on the alert.
die Geige = violin

Fear of radioactivity is more harmful than radioactivity itself!