Global scenarios for nuclear energy

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Introduction

The fossil resources of the Earth are unevenly distributed over the territories of countries. In the 21st century, in the conditions of climate change and the depletion of resources, the struggle for access to world energy markets will intensify [4, 5].

At the same time, nuclear energy is considered the most promising type of energy production, since it is considered as a “technological resource” rather than a natural resource; it does not depend on the geographical location of the country

Atomic energy is the low-carbon technology that is already available today. Instead of betting on technologies that have not yet proved their advantages either from a technical or financial point of view, they should first of all promote those nuclear technologies that have already demonstrated their effectiveness

International Nuclear Energy Development Projects

In recent years, international organizations and national institutes, including the IAEA, the Atomic Energy Agency at the OECD (OECD / NEA), the International Energy Agency, the Massachusetts Institute of Technology (MIT) and a number of other reputable organizations, have carried out studies on the development of the future global energy industry, which have shown that nuclear energy is a part of sustainable energy development.

Since 2000, several international projects have been created, within the framework of which medium- and long-term prospects for the development of nuclear power have been considered. Among such initiatives are well-known and fairly large-scale projects :

- Generation IV Program * (Generation IV) , initiated by the United States,
- The IAEA International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)

GLOBAL NUCLEAR ENERGY DEMAND SCENARIOS ((INPRO STUDY)

- The LOW growth scenario is consistent with nuclear energy maintaining its current (as of 2007) share of electricity generation (about 14% of global electricity supply);
- The MODERATE growth scenario is consistent with nuclear energy increasing its share of electricity generation, by displacing other energy sources such as fossil fuels
- HIGH growth scenario is consistent with nuclear energy being used on a large scale for both electricity generation and non-electric applications.

Study results

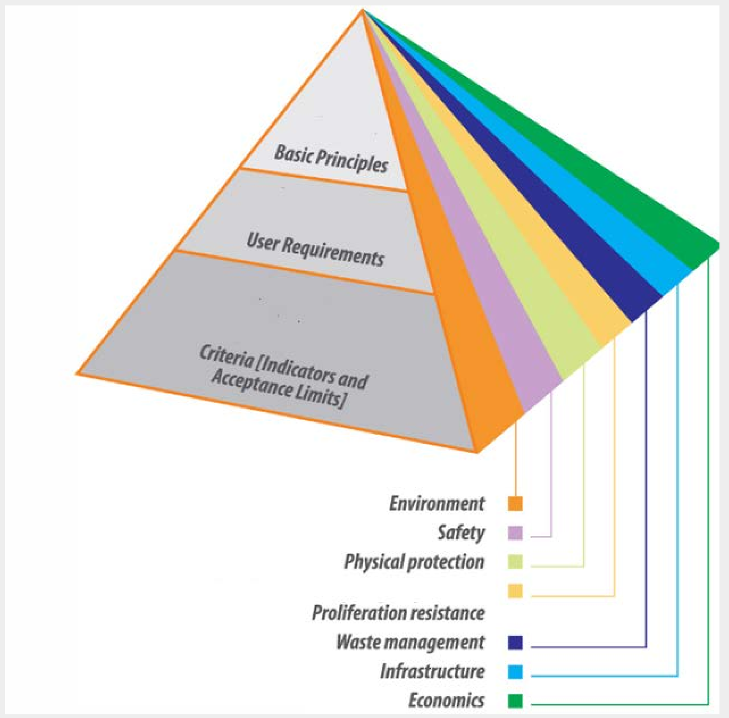

Fig. 1. The structure of the INPRO methodology

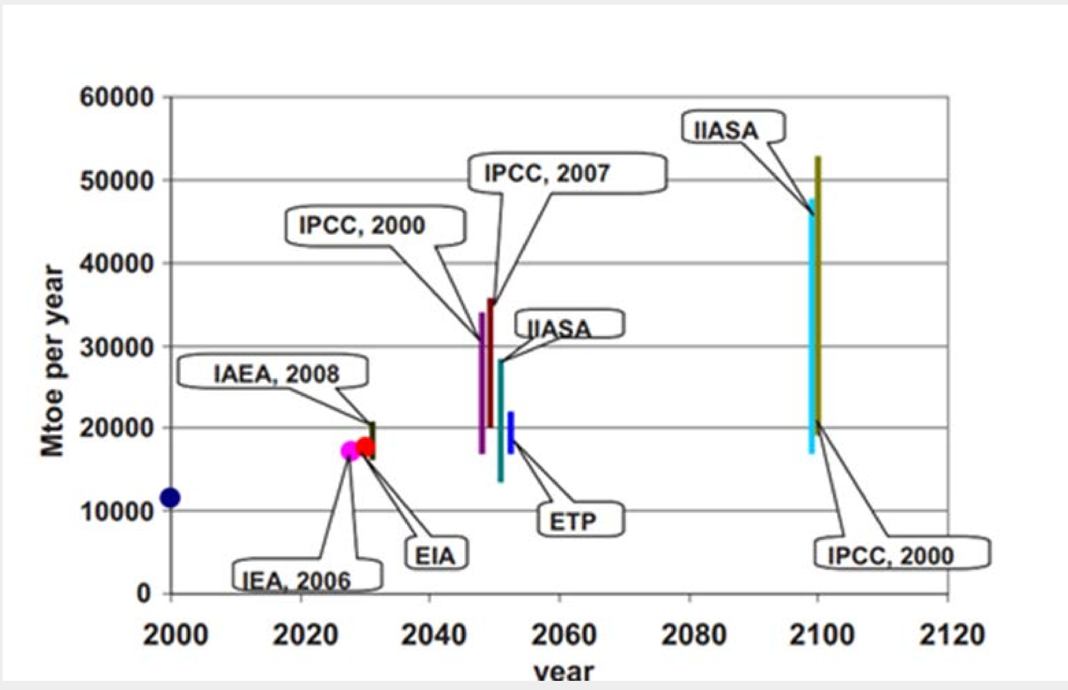

Fig. 2. Scenarios of global primary energy consumption in the twenty-first century (IPCC = International Panel of Climate Change, UN; IIASA = International Institute for Applied Systems Analysis; EIA = Energy Information Agency, DOE; ETP = Energy Technology Perspective, OECD).

Reactor type	Characteristics of thermal reactors
WCR	Corresponds to present day LWR
WCR-M	Represents a modernized LWR with higher fuel burnup and higher thermodynamic cycle efficiency
SMR	A small PWR having a somewhat higher specific consumption of natural Ua compared with LWR; which could turn out to be better adapted to specific regional conditions
HTR	A high temperature reactor operating on uranium fuel.(high temperature heat applications, including H2 production).
HTR (U3)	A high temperature reactor similar to the HTR, but using Th as a fertile and U-233 as fissile material.
	Characteristics of fast reactors
FBR-C	A liquid metal cooled fast reactor design with a breeding ratio close to one
FBR-S	An advanced sodium cooled fast reactor design featuring a higher core power density The overall breeding ratio is 1.4.
FBR-A	A fast reactor with fuel breeding ratio of 1.6.
FBR-A	(Th) A fast reactor similar to FBR-A, but containing Th-232 in the radial blanket, where the breeding of U-233 takes place.

The mix technology future park of thermal and fast reactors

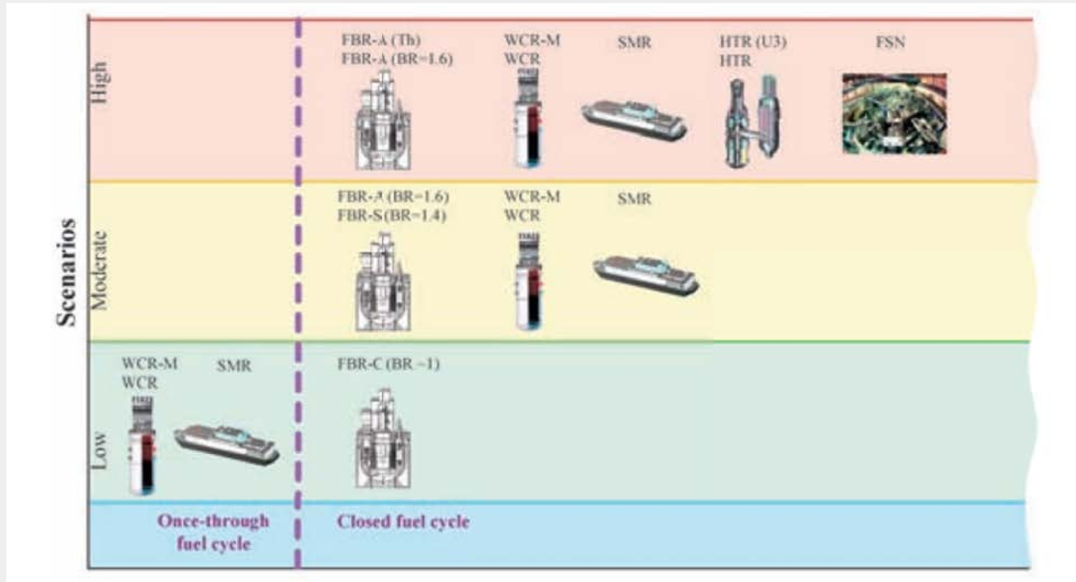

Fig. 3. World nuclear energy systems consisting of different reactor types for scenarios defined in the study (low, moderate, high). (LWR ≡ WCR)

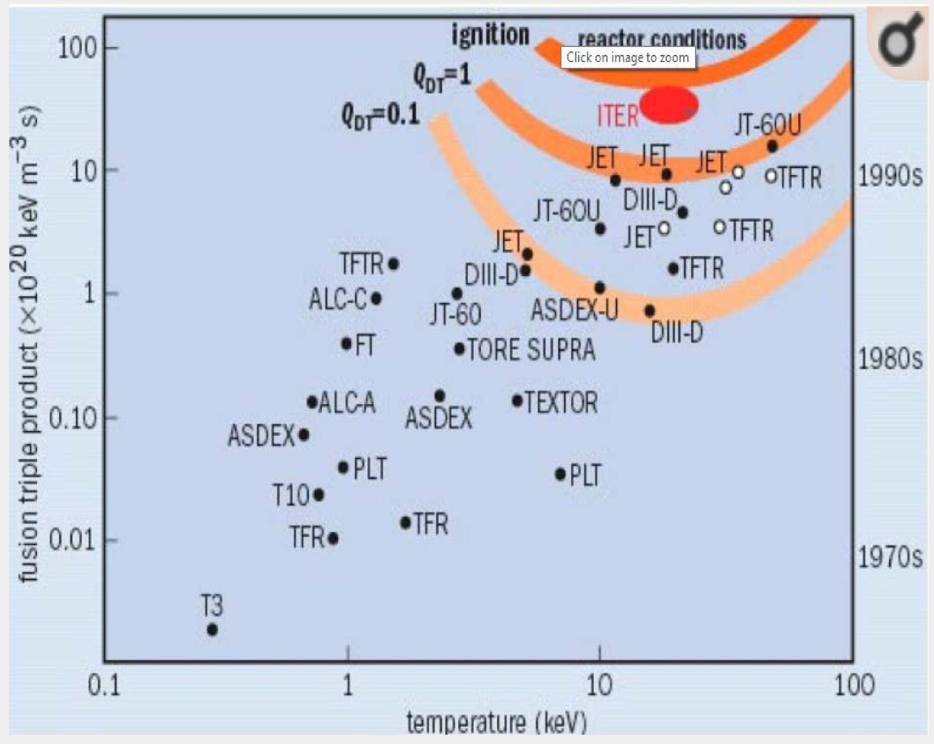

Fig. 4. Progress in fusion parameters .

Conclusion

- In the low growth scenario, thermal reactors are shown to be sufficient to satisfy demand until 2100 while not exceeding the postulated limit of natural uranium consumption (20 million Mg)
- In the moderate and high growth scenario, closing the fuel cycle and deploying fast reactors in combination with the continued deployment of thermal reactors could accommodate a large expansion of the role of nuclear power while keeping the uranium consumption within the limit of 20 million Mg,
- Fusion provides a long-term vision for an efficient energy production. The fusion option for a nuclear reactor for efficient production of electricity should be vigorously pursued on the international arena as well as within the European energy roadmap to reach a decision point which allows to critically assess this energy option

Recomindation

It is necessary to enhance global integrity and joint efforts in research in development advanced nuclear technology for future power sustainability and affordability