Energy and Nuclear Energy Development Policy in China

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I. Energy Issue of China

- Current Status
- Future Energy Demand
- Problems and Challenges
- Development Strategy

Current Status:

China has become the 2nd largest country of both energy production and consumption since 2004

- Primary energy production：1.845 bln TEC，2nd in the world
  - coal: 1.958 bln tons , 1st in the world
  - crude oil: 167 mln tons, 5th in the world
  - electric power: capacity of 440 GWe, 2nd in the world
  - Nuclear power, ~7GWe, 1.7% of total capacity
- Primary energy consumption: 1.97 bin TEC, 2nd in the world
  - coal: 66%
  - Crude oil: 22.5%
  - Natural gas: 2.7%
  - hydropower: 7.1%
  - Nuclear power: ～1%

comparison of per capita energy consumption of different countries in 2004

China	1.08 (ton oil equivalence)
World average	1.63
The USA	8.02
Japan	4.03
The Great Britain	3.82

- Future development goal of China:
  - Building a well-off society in 2020 i**n an all-round way, and which will benefit well over one billion people**
- Challenges in China's future development:
  - **Gap of infrastructure**
  - **Bottle-neck restriction in energy and other natural resources**
  - **Environment burden**

The general principle of China's energy policy is self-reliance

- The current status:
  - self-supply energy ~94%
  - the imported energy ~ 6%
- The imported from world traded crude oil:
  - China shares 6.31%
  - USA shares 26.9%,
  - Japan obtains 11.3%.
- The above ratio in world crude oil trade will not significantly change in next many years.

Future Energy demand of China:

- Primary energy demand in 2020
  - **forecast: 2.5 - 3.3 b tCE**
  - **Average: 2.9 b tCE**
- Scenario of the development of China's economy in the time span from 2000-2020
  - **GDP: 4 times**
  - **Energy demand: 2 times**
  - **Energy consumption per capita : 1.0 tCE→ 2.0 tCE**

Energy mix in 2020

- Coal: 2.1 -2.9 billion tons, about 60% of the primary energy use
- Oil demand: 400-450 m tons
- Natural gas: 160-200 b m^3
- Installed capacity: 860-950 GW
  - **Hydropower: 200-240 GWe.**
  - **Nuclear Power: ~40GWe**

Problems and challenges:

- Gap between supply and demand of the primary energy, especially the crude oil
  - Crude oil demand: ~450 m tons in 2020,
  - 60% might rely on imported oil if no other solutions were going to be found.
- Low efficiency in energy utilization
- Severe environmental pollution

Severe environmental pollution

- Emissions from coal combustion:
  - **70% CO_2 (2nd in the world)**
  - **90% SO_2 (1st)**
  - **67% NO_x**
- If no mitigation measures prior to 2020, the emission figure could be:
  - **SO_2: 40 m tons**
  - **NO_x: 35 m tons**

development strategy:

- Priority in energy saving
- Security in energy supply
- Optimal composition in energy consumption
- Environmental friendly technology

II. nuclear energy in China

- Current status of nuclear energy in China
- Promoting the development of PWR
- Roadmap from PWR to FBR
- R&D of HTGR to VTHR for hydrogen production

Nuclear power in China

- Starting in 1980's
- *Qinshan Nuclear Power Plant*
  - **Commissioning in 1991**
  - **Self-reliance**
- *Daya Bay Nuclear Power Plant*
  - **Commissioning in 1994**
  - **International cooperation**
- By July 2004
  - **9 units in operation, 7.01 GW**
- In 2005
  - **Nuclear installed capacity: 9.13 GW.**

NPPs in operation or under construction in China

Name	Type	Status	Location	Net(Mwe)	Gross(Mwe)	Connected
DAYA BAY-1	PWR	Operational	GUANGDONG	944	984	1993/08/31
DAYA BAY-2	PWR	Operational	GUANGDONG	944	984	1994/02/27
LINAO-1	PWR	Operational	GUANGDONG	938	990	2002/02/26
LINAO-2	PWR	Operational	GUANGDONG	938	990	2002/12/15
QINSHAN-1	PWR	Operational	ZHEJIANG	279	300	1991/12/15
QINSHAN2-1	PWR	Operational	ZHEJIANG	610	642	2002/02/06
QINSHAN2-2	PWR	Constructing	ZHEJIANG	610	642	2004/03/01
QINSHAN3-1	PHWR	Operational	ZHEJIANG	665	728	2002/11/19
QINSHAN3-2	PHWR	Operational	ZHEJIANG	665	728	2003/06/12
TIANWAN-1	WWER	Constructing	JIANGSU	1000	1060	2006
TIANWAN-2	WWER	Constructing	JIANGSU	1000	1060	2006

Promoting PWR

- Nuclear power of China in 2020: ~40 GW
- Guidelines
  - **Cooperating with international partners with China playing the major role**
  - **importing technology and promoting localization**
- Emphases are placed on:
  - **Uniform technology**
  - **Advanced technology**
  - **Safety and economy**

Recent development

- 2 PWR nuclear power stations approved
  - ***Sanmen* (2× 1,000 MW) in Zhejing**
  - ***Lingao* (2× 1,000 MW) in Guangdong**
- 2 expansion projects under review
  - ***Yangjiang* in Guangdong**
  - ***Qinshan II* in Zhejiang**

Stepping into Generation III

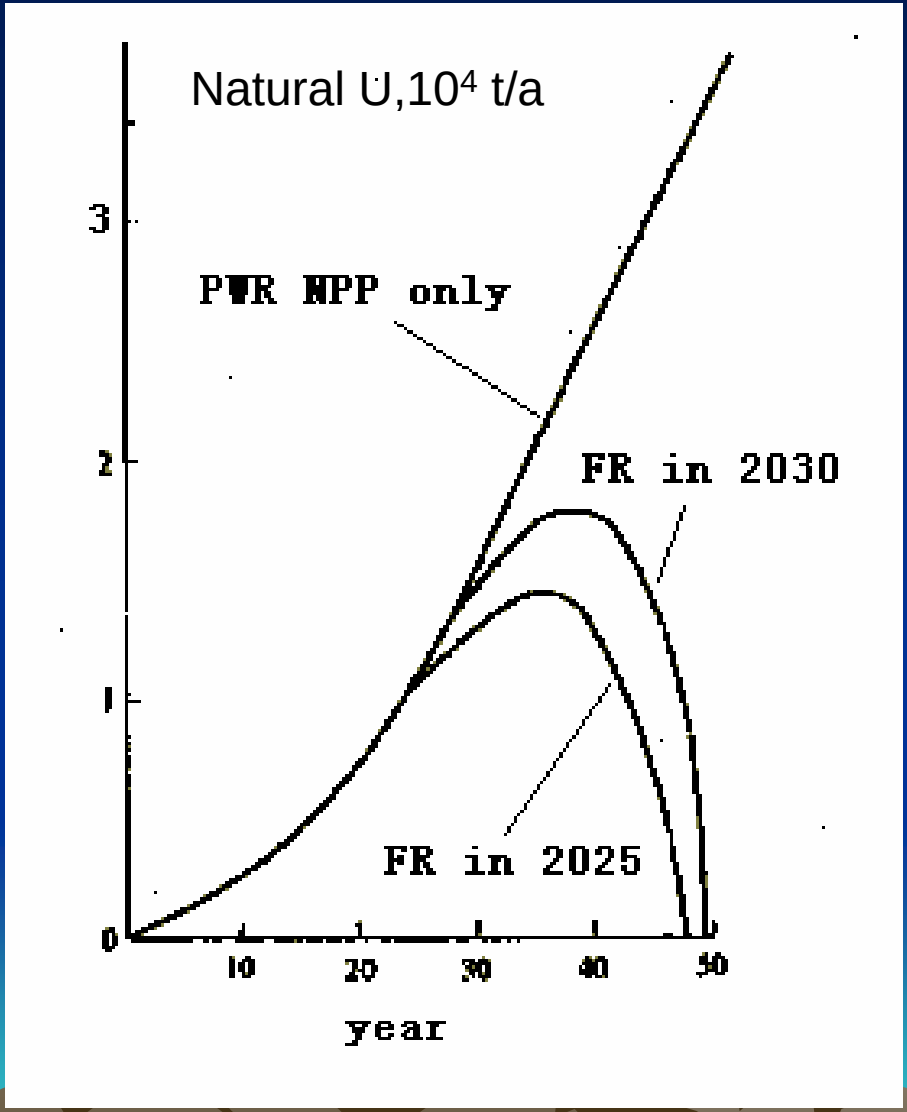
- Core meltdown < 1.0×10^{-5}/R·a
- Large radioactive materials release < 1.0×10^{-6}/R·a
- Competitive with gas combined cycle in economics
- AP1000, EPR and VVER-1000 are under bidding process

Roadmap from PWR to FBR :

- Two crucial questions must be answered:
  - do we make mature technology ready for large scale expansion of nuclear energy?
  - what must now be done to accelerate the nuclear renaissance?

- **Supported by National High-Tech Program since mid-1980's, a 65MWth sodium-cooled test fast reactor and a 10MWth experimental HTGR have been constructed in China, the former is going to be completed in 2007 in CIAE and the latter has been in test operation since 2003.**

Sustainable nuclear energy from PWR to FBR



If China were not taking into account the development of fast spectrum reactors, the natural uranium demand per year would increase drastically with the rapid expansion of PWR NPPs and would reach 37000t/a in 2050, which is un-bearable to Chinese natural uranium resources.

R&D of HTGR in China

- Modular high temperature gas-cooled test reactor of 10MWth (HTR-10) has been successful in all aspects as a test reactor project.
- Before 2015: 200MWe modular HTGR steam-turbine demonstration power plant is on schedule
- Further R&D on electric power generation with direct helium turbine and VHTR for hydrogen production are also underway or under consideration.

Conclusions:

- This presentation claims that China must strengthen R&D activities to develop both FBR and VHTR technologies to fulfill the sustainable energy strategy based on self-reliance principle

- By further combining the achievements in
  - fuel cell technology for vehicles in transportation,
  - nuclear energy technology, i.e., PWR to FBR and HTGR to VHTR, then to Fusion Energy
  - renewable and hydrogen energy technologies,

  a bright road towards China's future sustainable energy strategy will be paved.