Status and Prospects of FBR and Nuclear Fuel Cycle in China

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Status of NPP in China Mainland

Site	Capacity/Type	Grid Date
Qinshan I	300MW/PWR	1991.12.15
Daya Bay -1	900MW/PWR	1993.08.31
-2	900MW/PWR	1994.02.07
QinshanII-1	600MW/PWR	2002.02.01
-2	600MW/PWR	2004.03.11
Lingao -1	984MW/PWR	2002.04.05
-2	984MW/PWR	2002.12.15
QinshanIII-1	700MW/PHWR	2002.11.10
-2	700MW/PHWR	2003.06.12
Tianwan -1	1000MW/PWR	2004.12
-2	1000MW/PWR	2005.12

Near-Term Program : 2005～2006

- **Extension of Qinshan** Ⅱ:units 3&4
  2×650MWe, will start construction next year
- **Extension of Lingao :units 3&4**
  2×900MWe, will start construction next year

Mid-Term Program : 2007～2015

- **Tianwan site:** PWR
  6×1000～1500MW
- **Sanmen site:** PWR
  6×1000～1500MW
- **Yangjiang site:** PWR

6×1000～1500MW

• **Up to 2020:** Capacity for NPP will be 40 GWe

Long-Term Program : 2020～2050

40 GWe in 2020

240 GWe in 2050

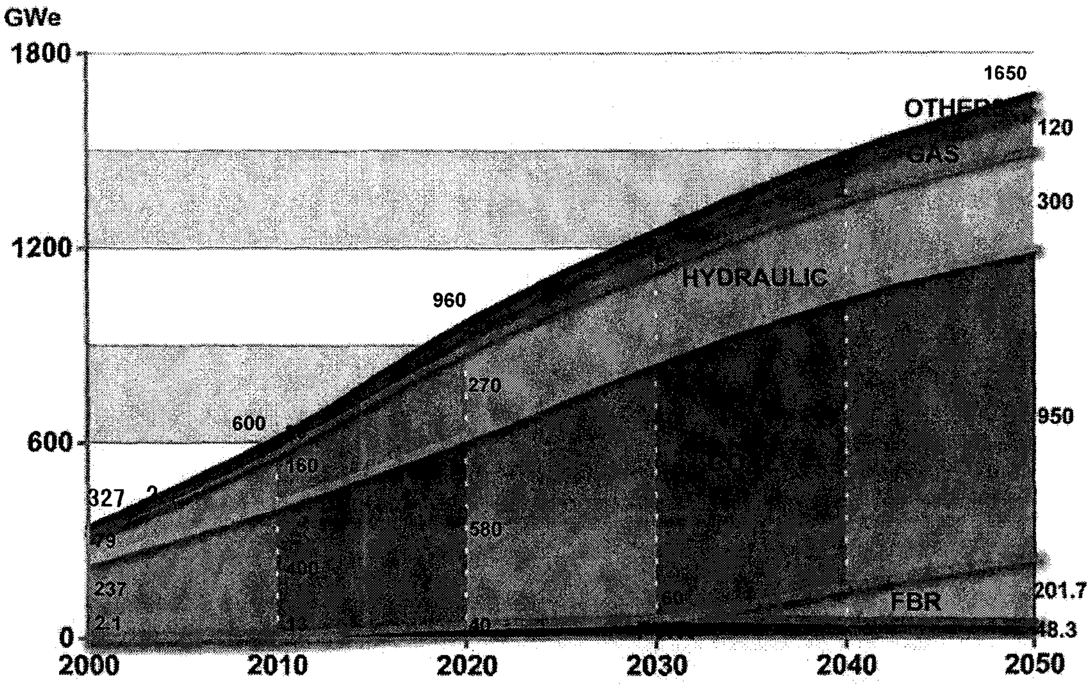
Impossible to use only PWRs due to Uranium resources limited

Nuclear Electricity Capacity Growth by Matched PWR-FBR

Year	PWRs (GWe)	U Requirement Accumulated (103t)	PWR+FBR (GWe)
2005	8.5	5.5	8.5
2010	16.3	16.5	16.3
2020	32	54.9	32
2030	50	117.5	77
2040	47.9	186.0	160
2050	33.7	246.4	386

Assuming:

- capacity increases linearly
- LFBR deployed at 2030 with closed fuel cycle



Electric Capacity Development Envisaged In China

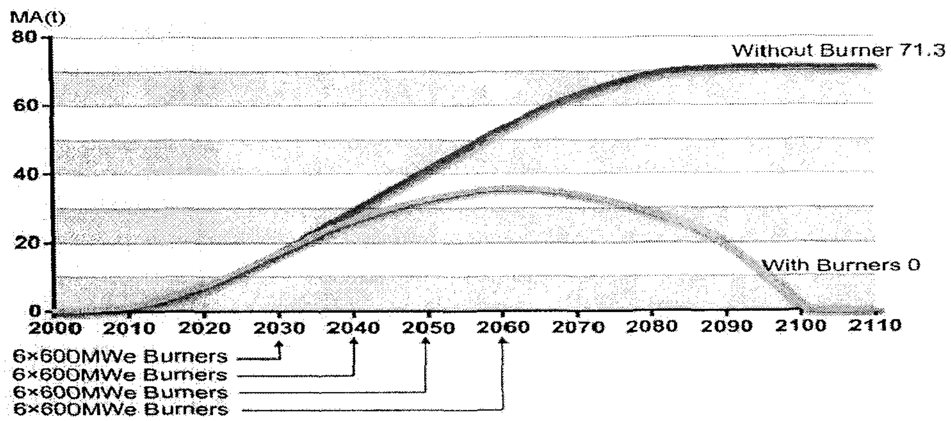
P&T strategy

Estimated MA and LLFP Accumulation from PWRs

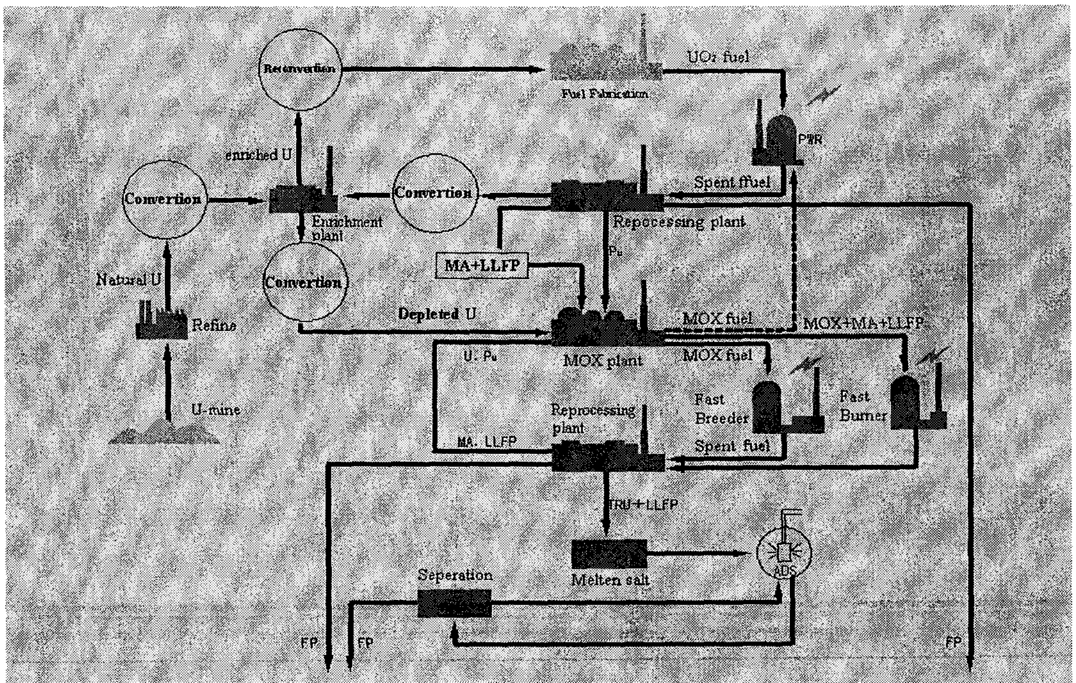
Year	PWRs(GWe)	MA(t)	LLFP(t)
2005	8.5	0.6	1.0
2010	16.3	2.0	3.2
2020	32	7.0	11.2
2030	50	15.4	24.7
2040	47.9	25.0	40.5
2050	33.7	34.0	54.0

Fast burner : rather realistic

- safe • with good dynamic properties
- large support ratio: 4 for FBR
  10 for ADS



MA Transmutation Strategy



Closed Fuel Cycle Envisaged

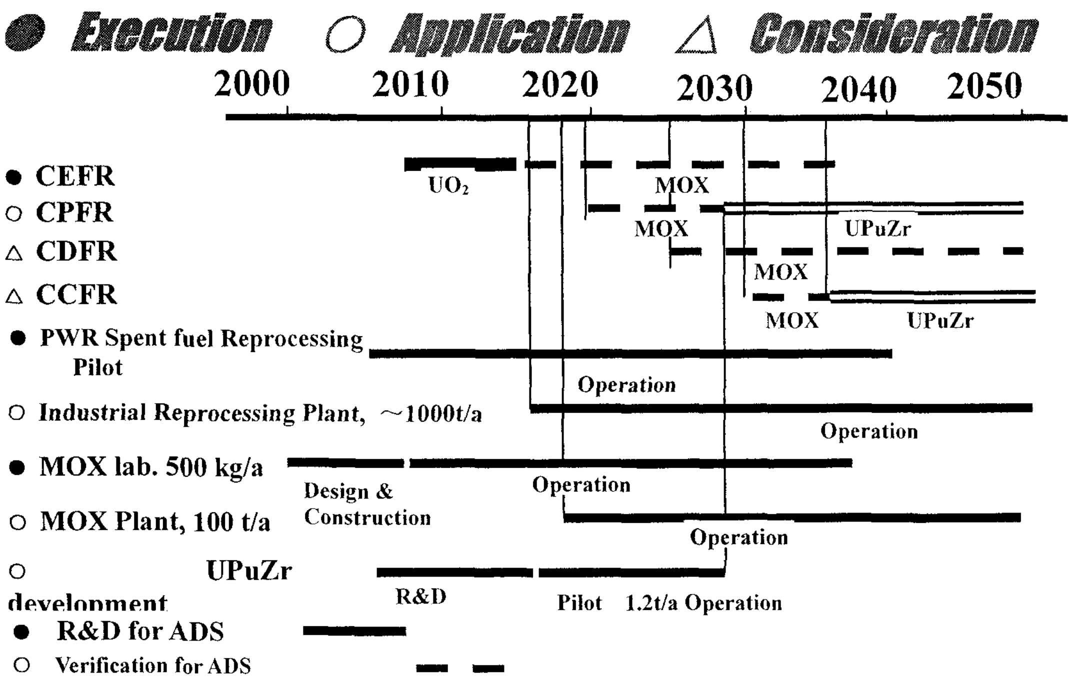
Some Technical Selections: Breeding, P&T strategy

- PWR spent fuel reprocessing pilot
  - Matured process PUREX
    UO_3 or U_3O_8 and PuO_2 as Products
  - HLW temporarily stored
    to wait suitable extraction process for MA
    under development in CIAE and Tsinghua U
- FBR MOX spent fuel reprocessing
- Molten salt technology

Development for Breeder and Burner with large support ratio

- R&D work for ADS system as Burner, in CIAE
- Development of FBR as Breeder and Burner, in CIAE
- 500 kg MOX Laboratory
  — mechanical mixing of U and Pu oxide powders
  and sintering process
- UPuZr development

Fuel Cycle Program and Consideration



Milestone for CEFR

2000. 5 Construction Permission Issued Construct Foundation Base
2001. 3 Construction Above Base
2002. 8 Main Building (57m) for Nuclear Island Completed

CEFR Main Design Parameters

Thermal Power	**MW**	**65**
Electric Power, net	**MW**	**20**
Reactor Core Height	**cm**	**45.0**
Diameter Equivalent	**cm**	**60.0**
Fuel/First Loading		**(Pu, U) O2 / UO2**
Pu, total	**kg**	**106.87**
Pu-239	**kg**	**65.76**
U-235 (enrichment)	**kg**	**92.33 (36%) / 236.7(64.4%)**
Linear Power max.	**W/cm**	**430**

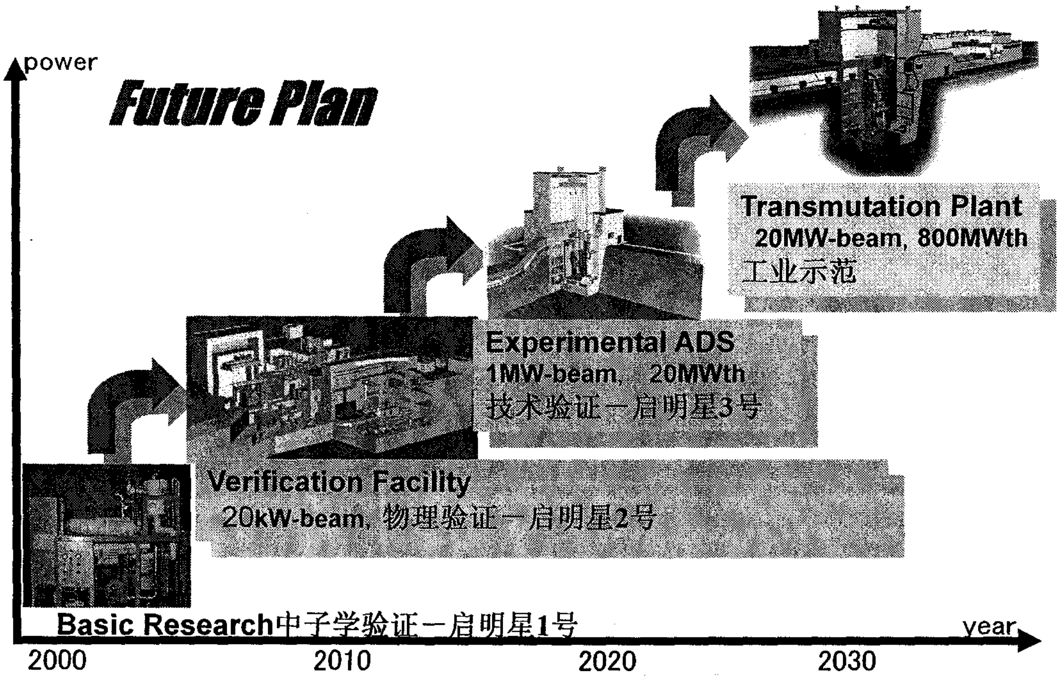
Recent Status of CEFR

90% components and systems ordered
400 components installed

70% non-sodium systems installed
Na systems only 20%

Future planning for CEFR
2005 : starting installation of Reactor Block
2005～2007: Pre-operation testing
2008.6～2008.7: Physics start-up and first criticality
2008.12: 40% full power incorporated to the grid

Progress in ADS Research
VENUS-I facility has been completed
Experiments are going on at VENUS-I
RFQ accelerator
founded
Energy: 3.5 MeV
Current: 50 mA
Duty Factor: >6%
ECR Ion Source
Energy 75keV
Current 67mA
Proton Ratio > 80%
Reliability 120h



Summary
The strategy for NPP development shows
a complicated fuel cycle structure including many new technologies

need expensive R&D, demonstration
The profits is still larger than expenses
due to a large scale utilization to nuclear energy