Feasibility Study on Sino-British Cooperation in Nuclear Facility Decommissioning, Waste Management and Transportation

China Nuclear Energy Association (CNEA)

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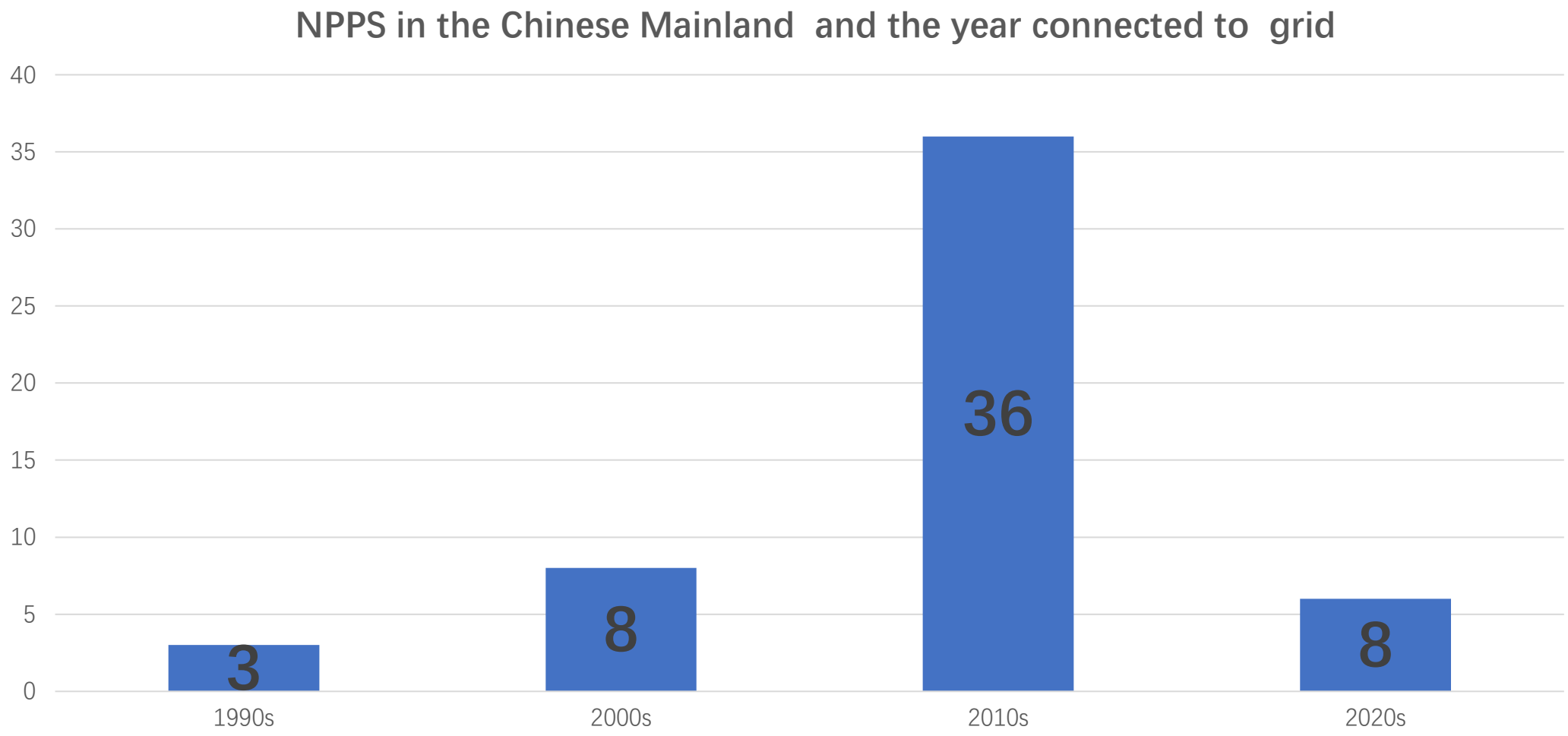
I. Nuclear Facility Decommissioning

- As of June 2022, in Chinese mainland :

54 operating units

24 nuclear power units under construction and approved

I. Nuclear Facility Decommissioning



I. Nuclear Facility Decommissioning

- At present, there is not NPP in Chinese mainland scheduled to decommission in near future;
- It is estimated that there will be 7 units to enter the stage of decommissioning or decommissioning preparation till 2050, including Qinshan NPP unit 1, Daya Bay NPPs, Lingao NPP Phase I, and Lingao NPP Phase II.

I. Nuclear Facility Decommissioning

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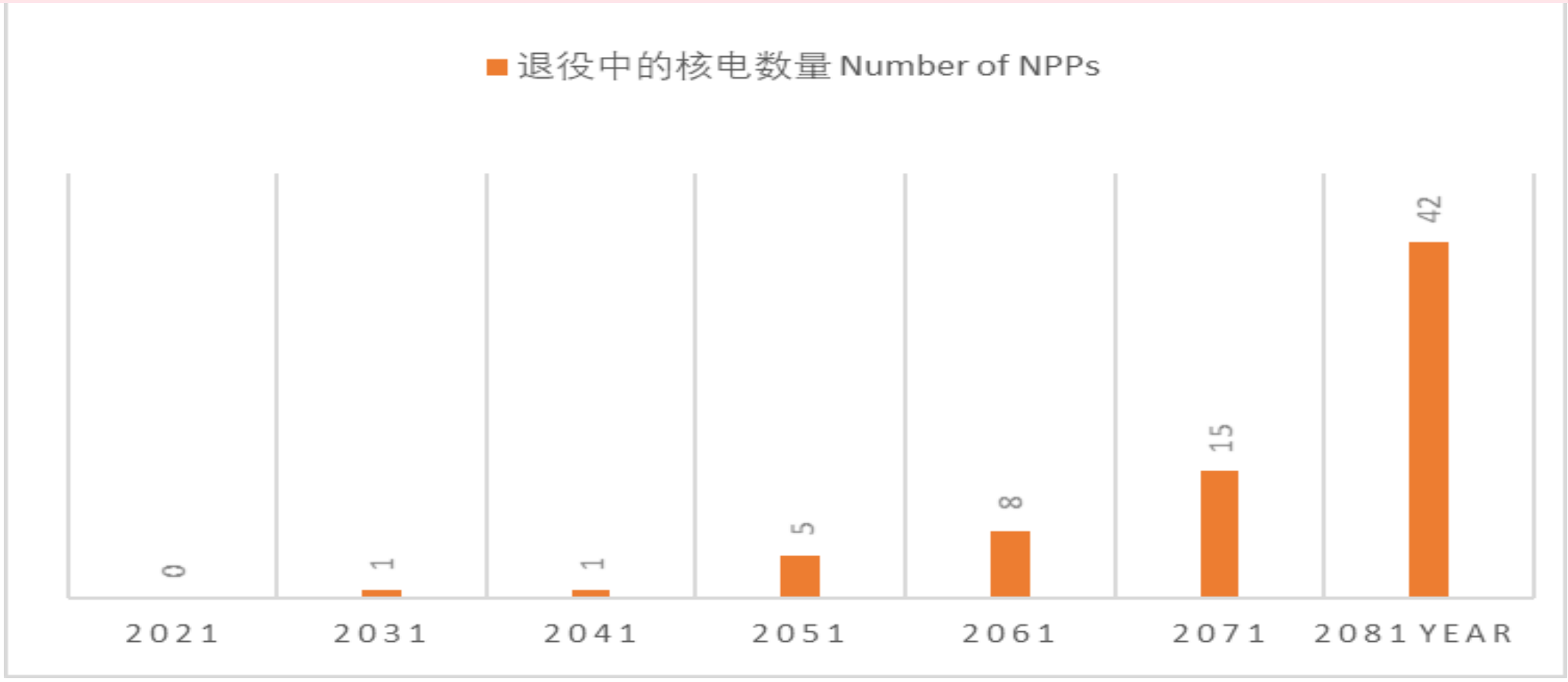
The expected year beginning decommission and the NPPs Number in the Chinese mainland



I. Nuclear Facility Decommissioning

- In September 2021, in accordance with the relevant requirements of the "Nuclear Safety Law of the People's Republic of China" and the "Regulations of the People's Republic of China on the Safety Supervision and Administration of Civilian Nuclear Facilities", after strict technical transformation and review, the National Nuclear Safety Administration approved the extended operation of Qinshan NPP Unit 1until July 30, 2041.
- According to the operation of the power station and technological progress, the other 6 units may apply for extension. At present, Qinshan NPP Unit 1 and Daya Bay NPPs have been proposed decommissioning strategy, and are been studied the overall plan for NPP decommissioning.

I. Nuclear Facility Decommissioning

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No.	Facility name	Type	Thermal power (kW)	State	start time	retirement time
1	Venus-1	Subcritical device	0.00	Operating	2005.7	
2	China Advanced Research Reactor	Pool-type reactor	60000.00	Operating	2010.5	2040.5
3	China Experimental Fast Reactor	Fast reactor	65000.00	Operating	2011.7	2041.7
4	Medical Micro reactor	Micro reactor	30.00	Operating		
5	swimming pool reactor	Pool-type reactor	3500.00	Operating	1964.12	2032
6	Micro reactor	Micro reactor	27.00	Operating	1984.3	2036.2
7	zero power critical reactor	Fast reactor	0.050	life extension	2000.6	
8	heavy water research reactor	heavy water reactor	15000.00	in retirement	1958.6	2007.12
9	high flux engineering reactor	Pool-type reactor	125000.00	Operating	1981.12	2030
10	pulse reactor	Pool type, uranium hydrogen zirconium nuclear fuel	1000.00	Operating	1990.7	2035
11	Zero Power High Flux Reactor	Standard assembly	0.00	Operating	1982.10	2050
12	Reactor in Minjiang	Pool-type reactor	5000.00	Operating	1992.12	2050
13	NPIC Zero Power Reactor	Standard assembly	0.00	Permanently closed	1966.1	1984
14	Mianyang Research Reactor	Pool-type reactor	20000.00	Operating		
15	Micro reactor in Shenzhen	Micro reactor	30.00	to be decommissioned	1988.11	
16	10 MW HTGR	HTGR	10000.00	Operating	2003.1	
17	5 MW low temperature reactor	Thermal Protection	5000.00	Operating	1989.11	
18	ESR-901	Pooled - Dual Core	1000.00	Closed		

I. Nuclear Facility Decommissioning

◆ China’s nuclear facilities decommissioning emphasizes the whole-process management, clarifies the concept of “facilitating decommissioning”, and the decommissioning activities should be considered from the engineering design stage.

◆ The decommissioning strategy of China's nuclear facilities has also been adjusted based on IAEA’s strategy, the initial three decommissioning strategies of immediate dismantling, delayed dismantling and in-situ burial has been changed into immediate dismantling and delayed dismantling.

I. Nuclear Facility Decommissioning

The decommissioning governance technology capability in China:

- Since the late 1980s, China has carried out comprehensive decommissioning work for most of the old nuclear facilities. For over 30 years, China has successfully implemented a number of decommissioning;
- Established treatment and conditioning facilities for different wastes, and mastered treatment technology for different types of waste;
- Established extremely low-level waste landfill, medium and low-level radioactive waste near-surface disposal sites, and formed a complete radioactive waste treatment and disposal capacity.
- Basically established a scientific research capability system that meets the actual needs of China's nuclear facilities decommissioning.

I. Nuclear Facility Decommissioning

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Potential cooperation aspects for decommissioning

NPPs decommissioning

- Research on decommissioning strategies and plans
- Source term estimation
- Decommissioning cost estimates
- Decommissioning Digital Simulation

Special technology and equipment

- Waste treatment technology
- Source item investigation
- Cutting and dismantling technology
- Decontamination technology

I. Nuclear Facility Decommissioning

◆ After more than 30 years of decommissioning remediation engineering practice and scientific research, China has established a complete and systematic decommissioning professional system, and has cultivated a group of professional talents for decommissioning treatment technology R&D, design and engineering implementation.

◆ In response to the UK's technical needs for decommissioning treatment, China could give full play to its own advantages, participate in engineering and scientific research projects in the field of decommissioning treatment in UK in various forms such as engineering design, project implementation, equipment supply, technology output, and joint R&D.

◆ China and UK could also give full play to their own advantages and join forces to jointly find potential opportunities for decommissioning and treatment of nuclear facilities in the world, and form a consortium to jointly bid for decommissioning and treatment projects in other countries.

II. Waste Management

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01

In order to meet the management requirements of minimizing radioactive waste, the radioactive waste treatment of NPPs in the Chinese mainland has carried out a lot of engineering practice and research in terms of reducing waste source items, introducing advanced technologies and centralized treatment models, and has achieved fruitful results. At the same time, China is also making some progress in promoting the construction of a centralized disposal site for low- and medium-level radioactive waste in NPPs.

02

China also has some outstanding problems in the management of radioactive waste, and the development of China's third-generation NPPs has put forward higher requirements for waste minimization.
As UK has advanced technology and management experience in the treatment and disposal of radioactive waste in NPPs, China and UK could explore cooperation on the premise of meeting the requirements of China's laws and policies.

II. Waste Management

As of December 31, 2019,

69 radioactive waste treatment and storage facilities built for NPPs;

11 radioactive waste treatment and storage facilities for research reactor;

14 radioactive waste treatment and storage facilities for nuclear fuel cycle facility;

3 low- and intermediate-level solid waste disposal sites have been put into operation.

II. Waste Management

In terms of spent fuel cycle treatment, China is also actively promoting commercial reprocessing plant projects. Higher requirements are put forward for the detection, classification, treatment, decontamination and control of radioactive waste, intelligent level, etc., and some technologies (such as waste gas removal C-14 technology, waste liquid tritium removal technology, steam cracking, etc.) have not yet mature engineering applications in the Chinese mainland.

There is still some room for improvement in the overall comprehensive treatment strategy of waste minimization and the analysis of costs and benefits of China's NPPs, and British enterprises could provide corresponding technical services to Chinese NPPs with the help of corresponding operating experience and professional software.

II. Waste Management

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01	The solid waste treatment of units 3 and 4 of the Xudapu Nuclear Power Project in the bidding process;
02	In the future, there will be a number of nuclear power projects such as Zhejiang Jinqimen Nuclear Power Project, Lianyungang Nuclear Energy Heating Project, Huaneng Xiapu Nuclear Power and so on, which are planned to use open tendering (domestic or international) for equipment procurement, and can also pay attention to possible nuclear power technical transformation projects in the future.
03	The underground laboratory of high-level radioactive waste disposal in China will welcome cooperation and participation from abroad for the scientific research projects.

II. Waste Management

The underground laboratory of high-level radioactive waste disposal in China will carry out the following scientific research projects, British enterprises and research institutions have the opportunity to participate in these aspects of research work:

(1) "Research on the Deep Geological Environment of Underground Laboratory Sites"

(2) "Study on Hydrogeological Characteristics of Underground Laboratory Sites"

(3) "Study on the Mechanical Properties and Long-term Stability of Deep Surrounding Rock in Underground Laboratory"

(4) "Long-term Monitoring and Impact Study of Underground Laboratory Site Environment"

(5) Research on Key Technologies for Deep Rock Mass Excavation in Underground Laboratory

(6) "Research on Mechanical Excavation Equipment for Disposal Pits"

(7) "Research on the Structural Layout and Disposal Concept of The Underground Laboratory Demonstration Disposal Roadway"

(8) "Research on in-situ test and installation technology of buffer materials under underground laboratory conditions"

(9) "Study on the Release and Migration Behavior of Nuclides under Deep Surrounding Rock Conditions"

Interested technologies in the future

01

Removal and long-term storage of waste containing C-14 and Kr-85

02

Treatment of oily wastewater

03

Tritium removal

04

"near-zero" discharge of liquid effluents

05

medium-depth disposal of radioactive waste

06

waste resin plasma incineration

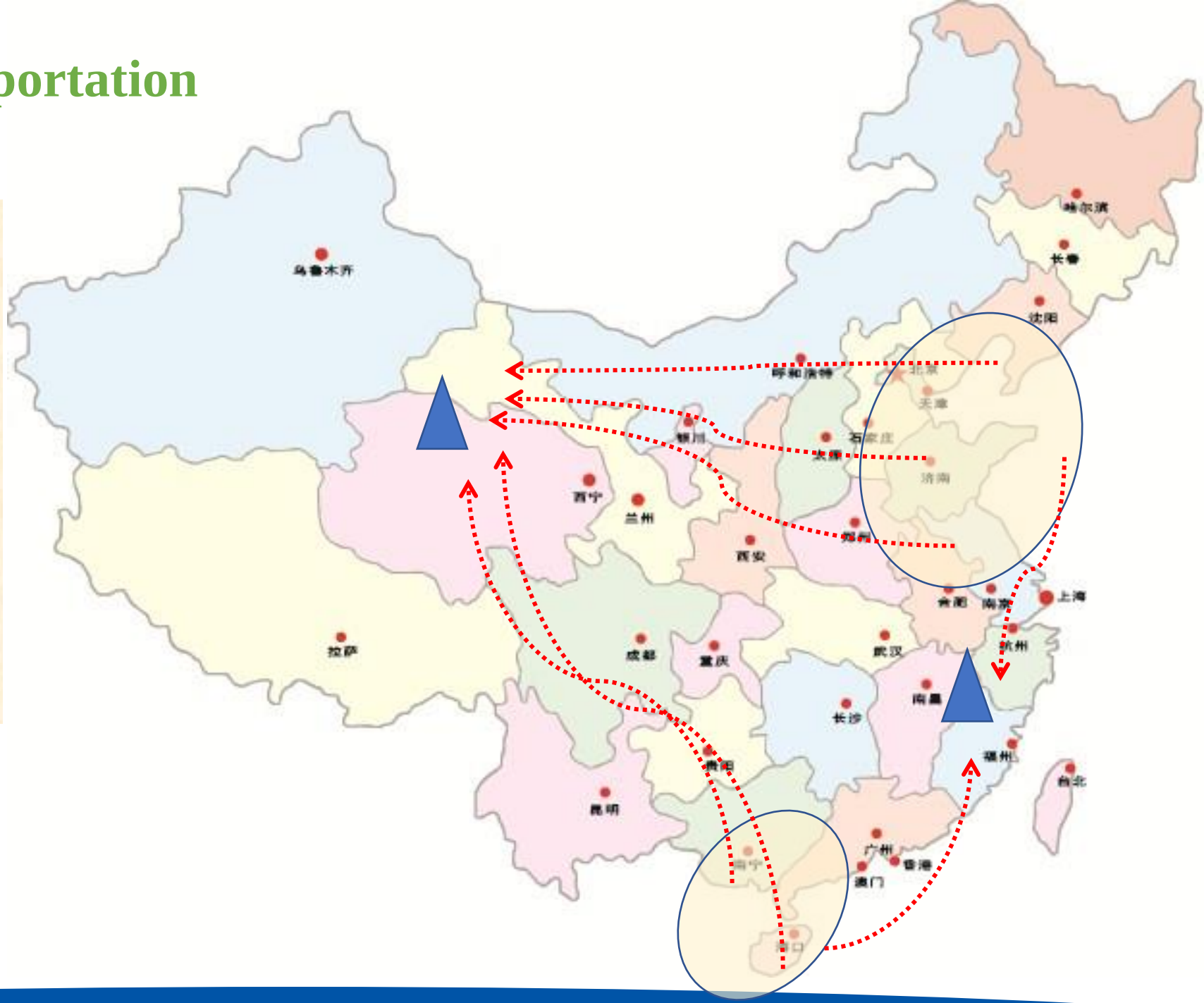
07

The minimization technology for radioactive waste

III. Spent Fuel Transportation

- Since the 1980s, the Chinese mainland has established the policy of closed-loop nuclear fuel cycle.

- According to the construction and operation of China's NPPs and the service life of NPPs, in the foreseeable future, the demand for spent fuel transportation in the Chinese mainland will continue to increase on a large scale.



- ✓ 3000-4000 km
- ✓ Road
- ✓ Sea
- ✓ Rail

III. Spent Fuel Transportation

Potential Cooperation in SF transportation

- Physical protection of spent fuel transportation；
- Emergency plans and responses；
- Development of spent fuel rail transport vehicles；
- Research and development of dual-use containers；
- Research and development of high level radioactive waste liquid transportation.

III. Spent Fuel Transportation

The potential projects in China's spent fuel transportation sector that may be open to foreign parties for bidding are:

- ◆ International transportation of radioactive materials such as spent fuel;
- ◆ Imports of package for the transport of radioactive materials such as spent fuel;
- ◆ Research on physical protection schemes for combined transportation of spent fuel by road-way, sea-way and rail-way;
- ◆ Research on the emergency plan for combined transportation of spent fuel by road-way, sea-way and rail-way;
- ◆ Development of spent fuel railway transport vehicles;
- ◆ Transport container maintenance process and equipment research, etc.


Thanks