中广核 CGN

善用自然的能量
Natural Energy Powering Nature

THE SPENT FUEL STORAGE AND TRANSPORTATION OF CHINA—— CHALLENGES AND RECOMMENDATIONS

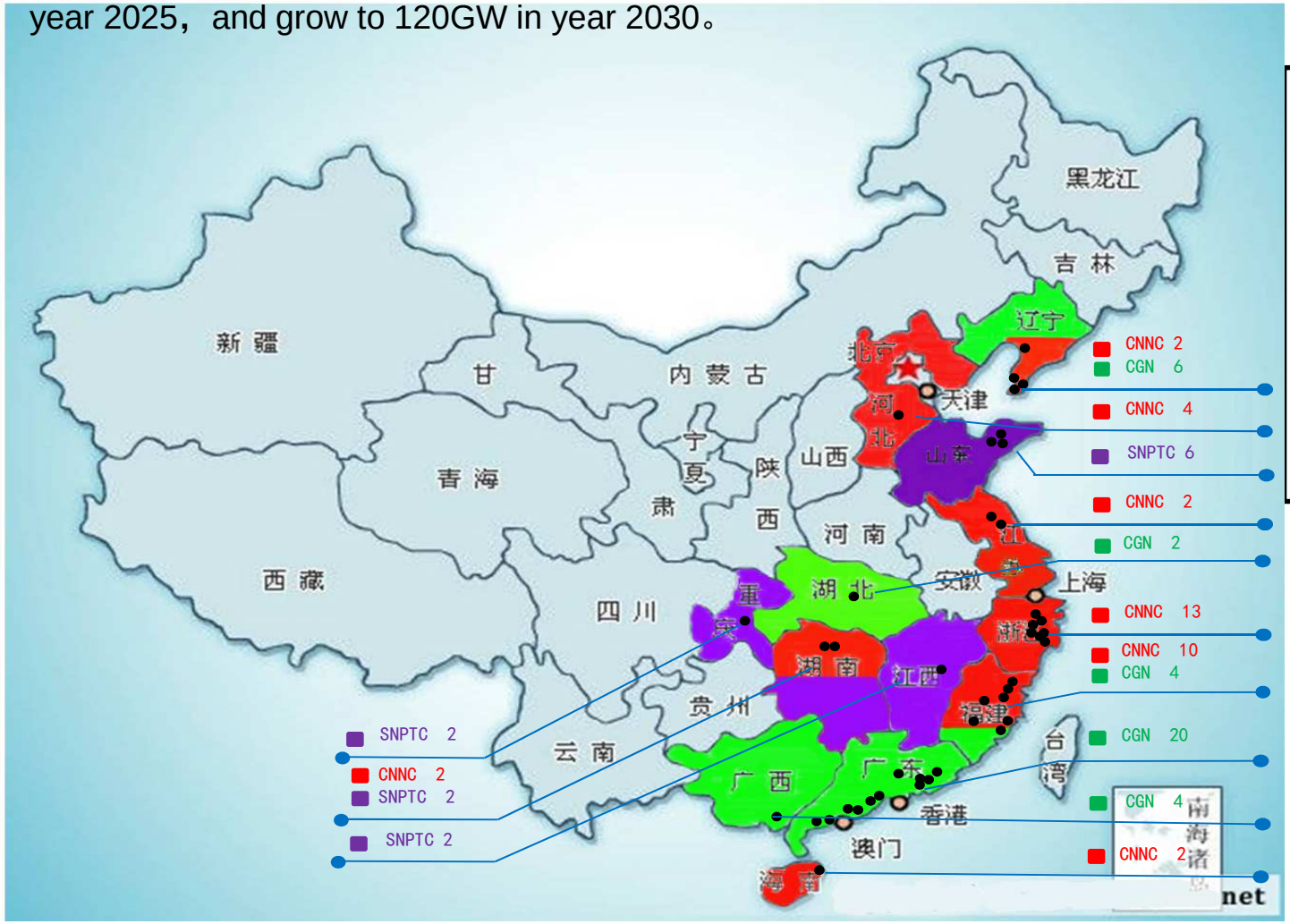
China General Nuclear Power Corporation

November 2015

Content

1. Nuclear Power Situation of China

Mid & Long-term nuclear development plan of China：In year 2020, nuclear capacity in operation will be 58 GW， under construction will be 30 GW. This date will grow to 90GW and 30-40 GW in year 2025，and grow to 120GW in year 2030。



There are 83 reactors presently in China，（in operation+ under construction+ approved ），of which, CNNC is 35，CGN is 36 and SNPTC is 12.

2. Demand of Spent Fuel Storage and Transport

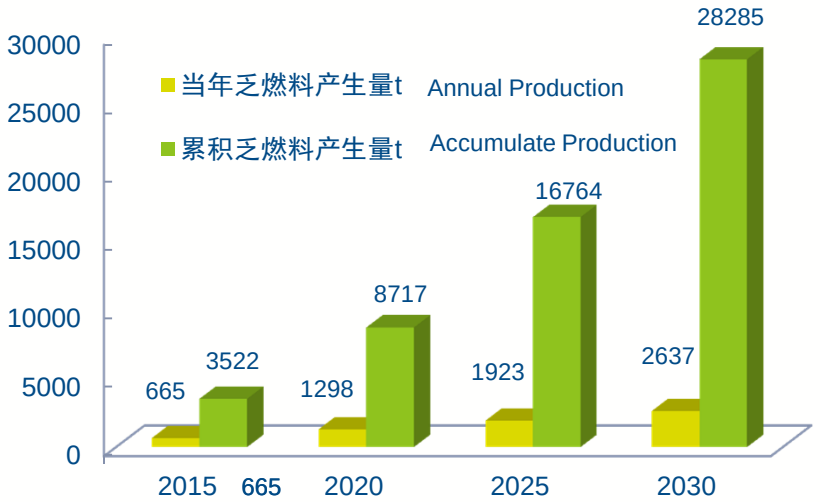
Storage and Transport Demand of China

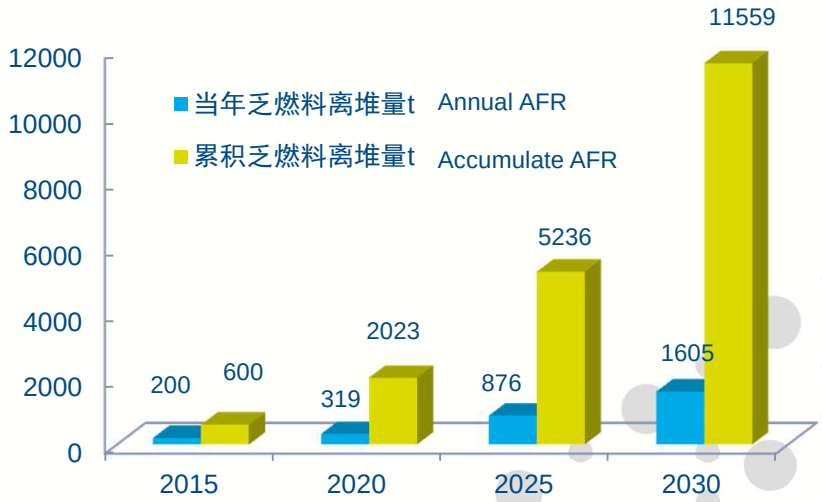
Year	Annual production/t	Accumulating production/t	Annual AFR /t	Accumulating AFR /t	Annual transfer/t	Accumulating transfer/t
2015	665	3522	200	600	188	456
2020	1298	8718	319	2023	262	1594
2025	1923	16764	876	5236	819	4522
2030	2637	28285	1605	11559	1503	10560

Note：
1）Calculated base: In year 2015, nuclear power capacity in operation is 46GW. In year 2020, capacity in operation is 58GW, under construction is 30GW. In year 2030, capacity in operation is 120GW.
2）Spent fuel will be transferred away from reactor pool after cooling 8 years .
3）Qinshan 3th and Sanmin Fast Reactor are not included.
4）SF transport of Qinshan 1st and Tianwan Reacor are not included。

2. Demand of Spent Fuel Storage and Transport

Storage and Transport Demand of China





The spent fuel production, away-from-reactor and transport demand have a step growth.

2. Demand of Spent Fuel Storage and Transport

Significant Growth of CGN SF transfer demand

- As originally planned, beginning in Year 2016, SNF demanded to be transferred away from Daya Bay is 3~4 times of current number.
- In Year 2018 , SNF pool newly built in 404 will reach its own storage limit, if no other interim storage solutions or storage location is developed, Reactor 1 & 2 of Daya Bay will face the danger that there is no storage slot for newly unloaded SNF.

Power Stations	Units	2013	2014	2015	2016	2017	2018	2019	2020
Daya Bay	1#	78(Trans)	52	26	78	78	78	104	52
	2#	26(Trans)	52	78	78	26	78	52	52
Lingao Ⅰ	1#	0	0	0	78	52	78	52	78
	2#	0	0	0	52	78	52	78	52
Lingao Ⅱ	1#							52	52
	2#								52
Every year		**104**	**104**	**104**	**286**	**234**	**286**	**338**	**338**
Added			**208**	**312**	**598**	**832**	**1118**	**1456**	**1794**

2. Demand of Spent Fuel Storage and Transport

CGN higher burn-up SNF out-transfer demand

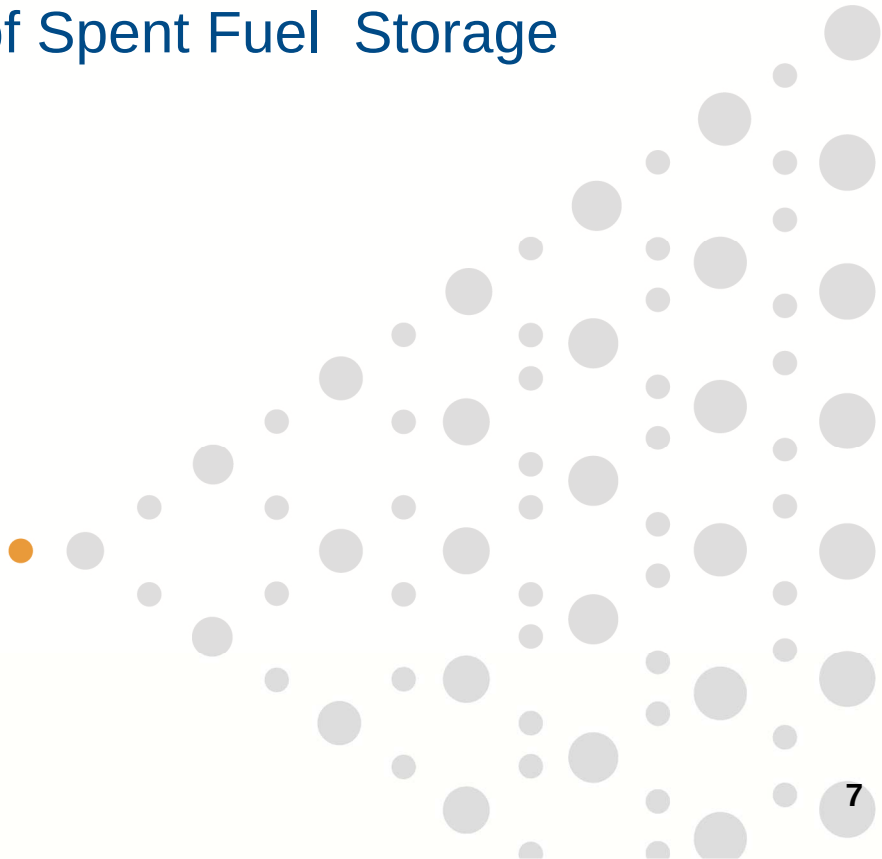
- Beginning from 2016, the SNF to be transferred away from Daya Bay will be of burn-up higher than 45000 MWd/tU, which also undergoes cooling time less than 8 years in SNF pool .
- In another word, the burn-up and cooling parameters of SNF to be transferred away is over the authorized limit of the current containers.

Units		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	Initial enrichment (%)	≤4.45									
1#	Cooling time (year)	10	9	9	8	<8	<8	<8	<8	<8	<8
	Burn-up (MWD/TU)	<45000			>45000						
2#	Cooling time (year)	9	9, 8	9, 8	<8	<8	<8	<8	<8	<8	<8
	Burn-up (MWD/TU)		>45000								

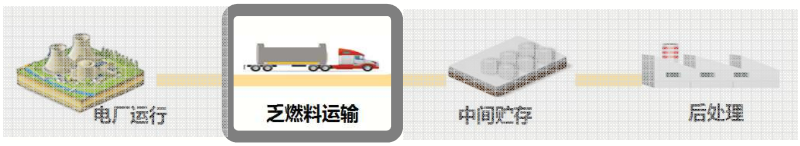
01. Demand of Spent Fuel Storage and Transportation

02. Situation and Challenges of Spent Fuel Storage and Transportation

03. Suggestions



1 Situation of Spent Fuel Storage and Transport



Limited transport capacity

Transport capacity is limited. Transportation capability buildup is linked to many issues, such as container, transport method, rout, time window, etc. It is a system engineering。

■ **Limited transport capacity**

- 2 containers ONLY for AFA-3G FA.
- Subjected to weather conditions, like snow, frost and typhoon. Average capacity now is twice a year, or 104 FAs per year.

■ **Limited transport methods, Long distance, High risk**

- Road transport ONLY.
- ~3000 km, ~3 months one way.
- high risk

■ **Disadvantage in cost**

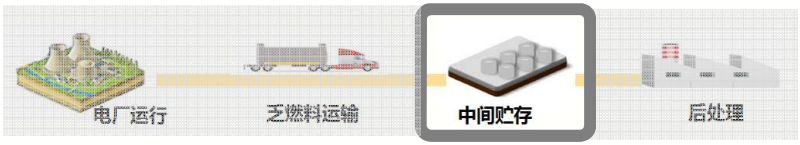
——International transport cost is 50-70 dollars/kgHM；（dates from OECD、BCG reports）

——Domestic transport cost is 180 dollars/kgHM.

■ **Vulnerable to big social events**

- Such as vital meeting and festival, during which time, SNF transport experienced disturbance in the past.
- High social concern

1 Situation of Spent Fuel Storage and Transport

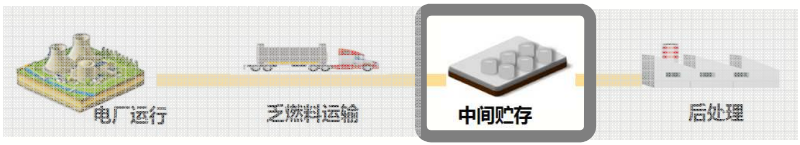


Single mode and insufficient storage capacity

Currently, 2 ways to store the SF in China: 1) In SF pool in reactors; 2) In SF pool in 404 Facility. Latter is the only facility for spent fuel interim storage.

SF pool	Capacity (t)	hack	B1	B2	remark
Daya Bay	500	864	432	432	Full
Qinshan 1st		216	108	108	Reserved, not received
404 Expanded Pool	800	——	(400T)	(400T)	Operating time unknown

1 Situation of Spent Fuel Storage and Transport



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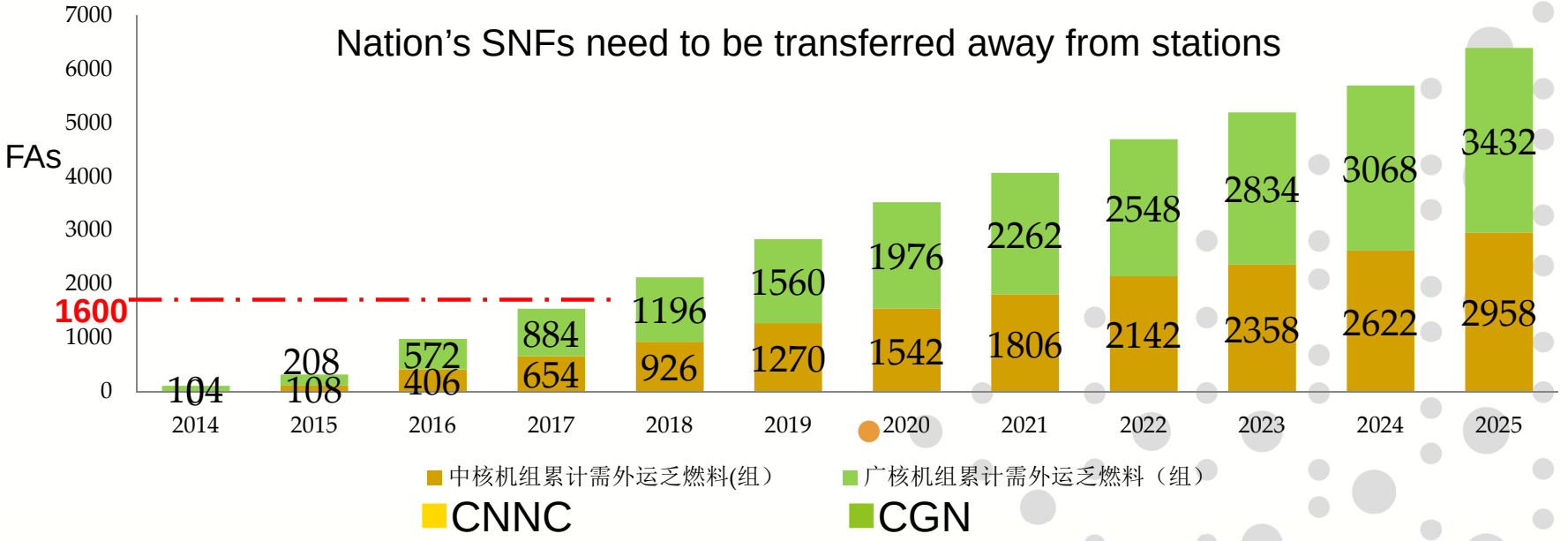
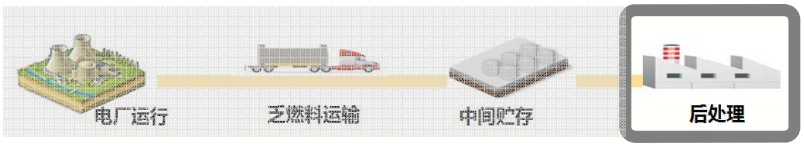
Single mode and insufficient storage capacity



Where to transfer and store the SNF in 2018?

1 Situation of Spent Fuel Storage and Transport



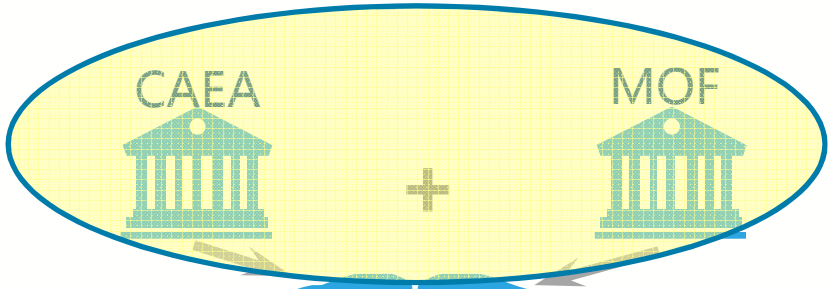
Uncertain issues of 800-ton SF reprocessing facility

Series of issues are not clear yet for the proposed 800-ton SF reprocessing facility, such as location, construction schedule and overall cost, etc.

Since series of issues are not clear yet for the proposed 800-ton SF reprocessing facility, such as location, construction schedule and overall cost, the auxiliary SF storage facility cannot be planned and constructed yet. This poses serious problem for SNF transfer and storage.

1 Situation of Spent Fuel Storage and Transport

China SF disposal fund –regulated by government



Set rule, manage fund and projects

"Temporary management measures of China SF disposal fund"

China SF disposal fund

"Project management measures of China SF disposal fund"

Demander

Fund payer, SF storage/ transport demander

Service Provider

SF transport

SF storage

SF reprocess

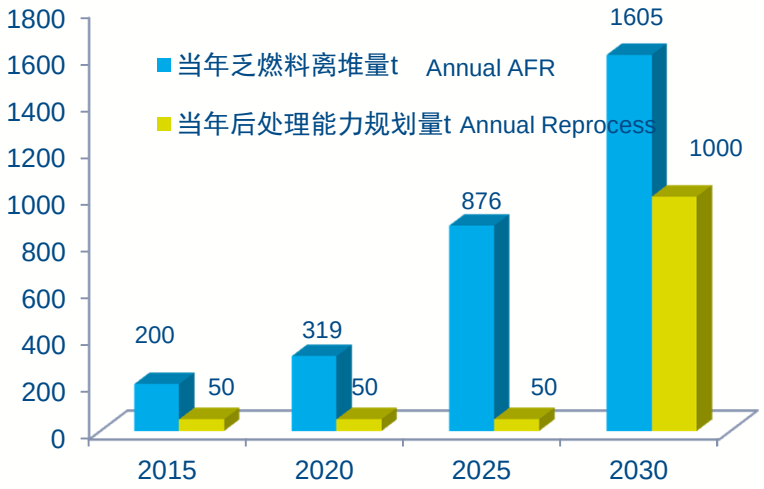
Capacity construction and project execution

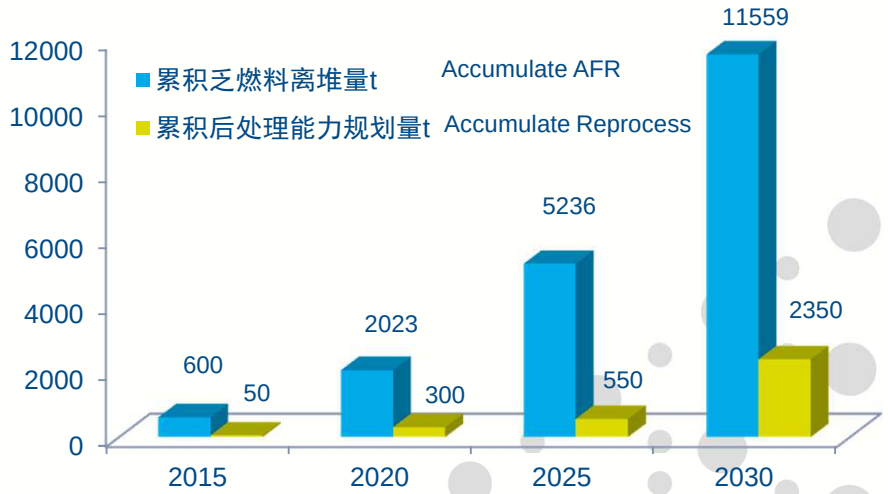
Consulter

Technical support

2. Challenges of SF Storage and Transport

Challenge 1：Reprocess capacity never catch up SF Away-From-Reactor demand

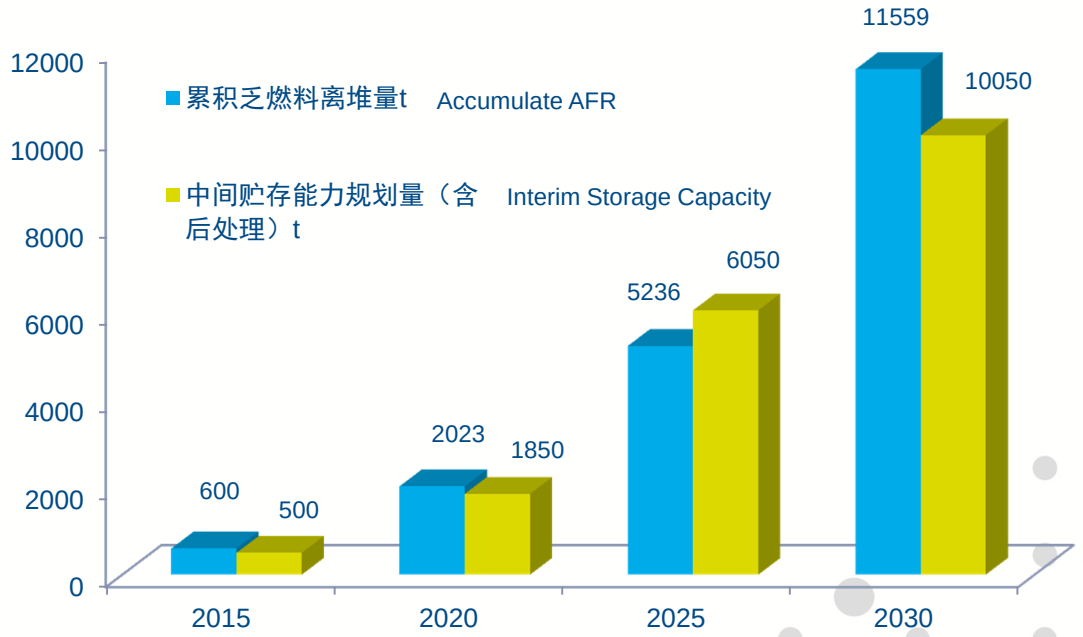




Reprocess capacity never catch up SF AFR demand. SF storage should be an indispensable link of China Nuclear Fuel Cycle.

2. Challenges of SF Storage and Transport

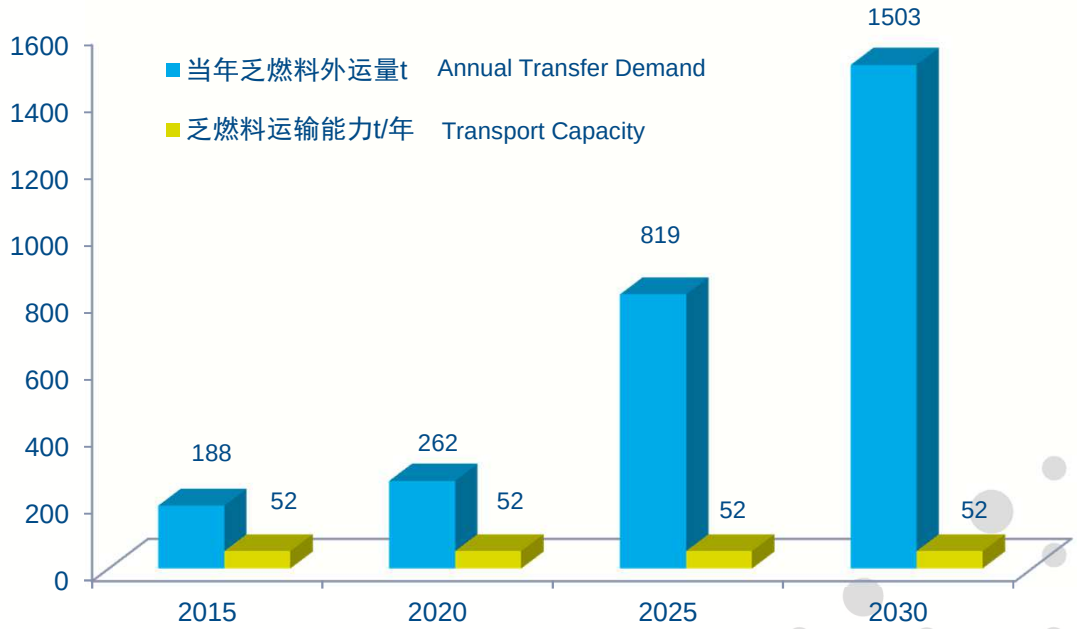
Challenge 2：SF storage capacity can’t meet AFR demand.



SF storage capacity can’t meet AFR demand. Dry storage should be an important supplement.

2. Challenges of SF Storage and Transport

Challenge 3：SF transport capacity is far less than out-transfer demand.



Only road transport and SF transport capacity is far less than out-transfer demand.

2. Challenges of SF Storage and Transport

Challenge 4：Uncertain issues of 800-ton SF reprocessing facility will bring risk for SF transport and storage.

2 times of transfer for SF

If SF from all reactors of China are transferred to Northwestern part of China, and the reprocessing plant is settled somewhere else. Consequent safety risk and disadvantage of increased overall cost during possible secondary transport, which will be in large scale and intensive.

01. Requirement of SF Storage and Transportation in China

02. Situation and Challenges of SF Storage and Transportation

03. Suggestions

1. Spent Fuel Storage and Transport

Suggestion 1：SF Interim Storage should be considered as an indispensable link of China Nuclear Fuel Cycle.

Suggestion 2：Besides reprocessing facility and matching pool, SF railway, seafaring, multi-mode transport system and SF regional storage facility should be demonstrated and constructed as soon as possible. Urgent demand for SF storage and transport (e.g. Daya Bay NPP) should be taken into account as a whole in advance .

Suggestion 3：Nuclear power demand, other than reprocessing demand, should be the major consideration of SF storage and transport capacity buildup. Capacity adapted to our nuclear power scale should be built.

2. Spent Fuel Reprocess

Suggestion 4：More relevant parties should be taken into reprocessing facility affairs under the leading of government. it also should strengthen evaluation , surveillance and top-level design of SF reprocessing for further development of China Nuclear Fuel Cycle.

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China General Nuclear Power Corporation would like to join with all relevant parties to work on back-end of nuclear fuel cycle of China, and to contribute to the sustained development of China nuclear power!