Development of Civil Nuclear Power In China

Winter SAMM
Nov 2025

world nuclear transport institute

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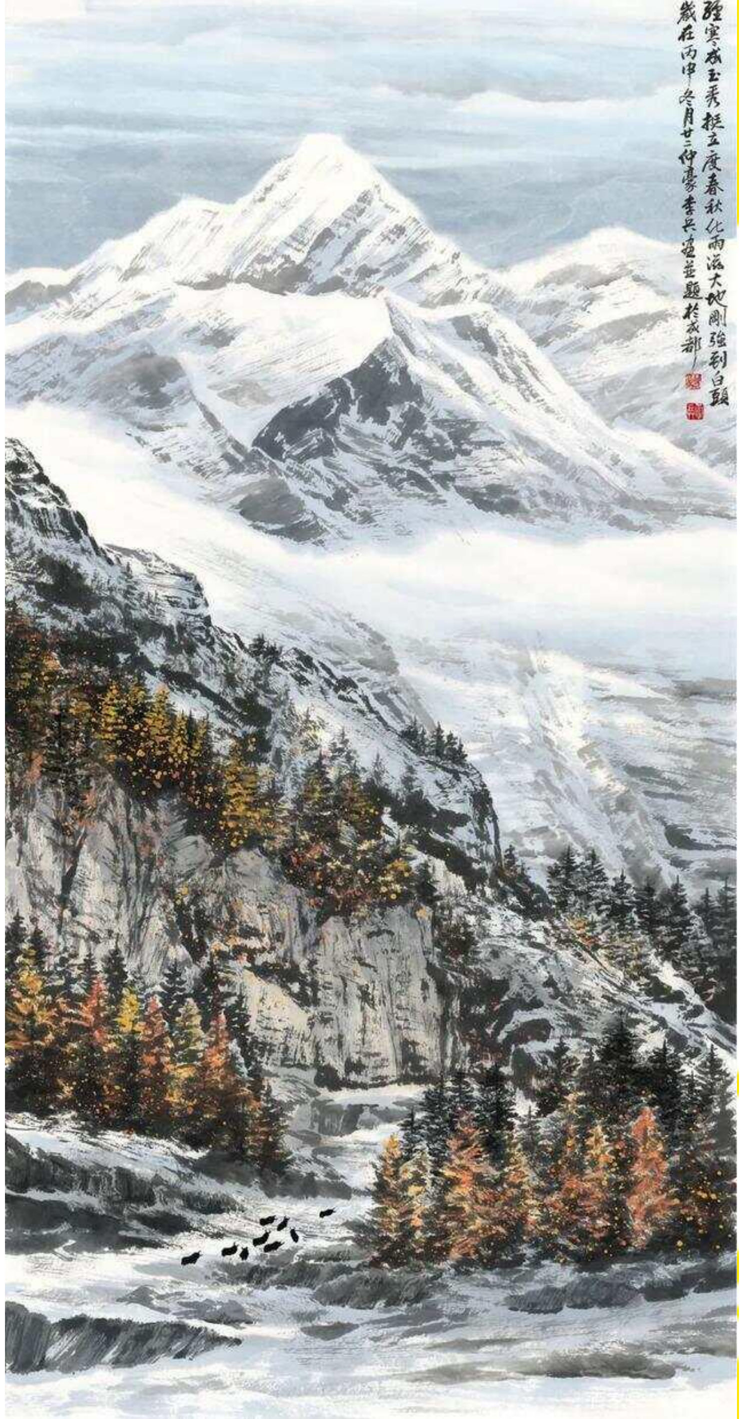


Global Picture of China's Nuclear Program

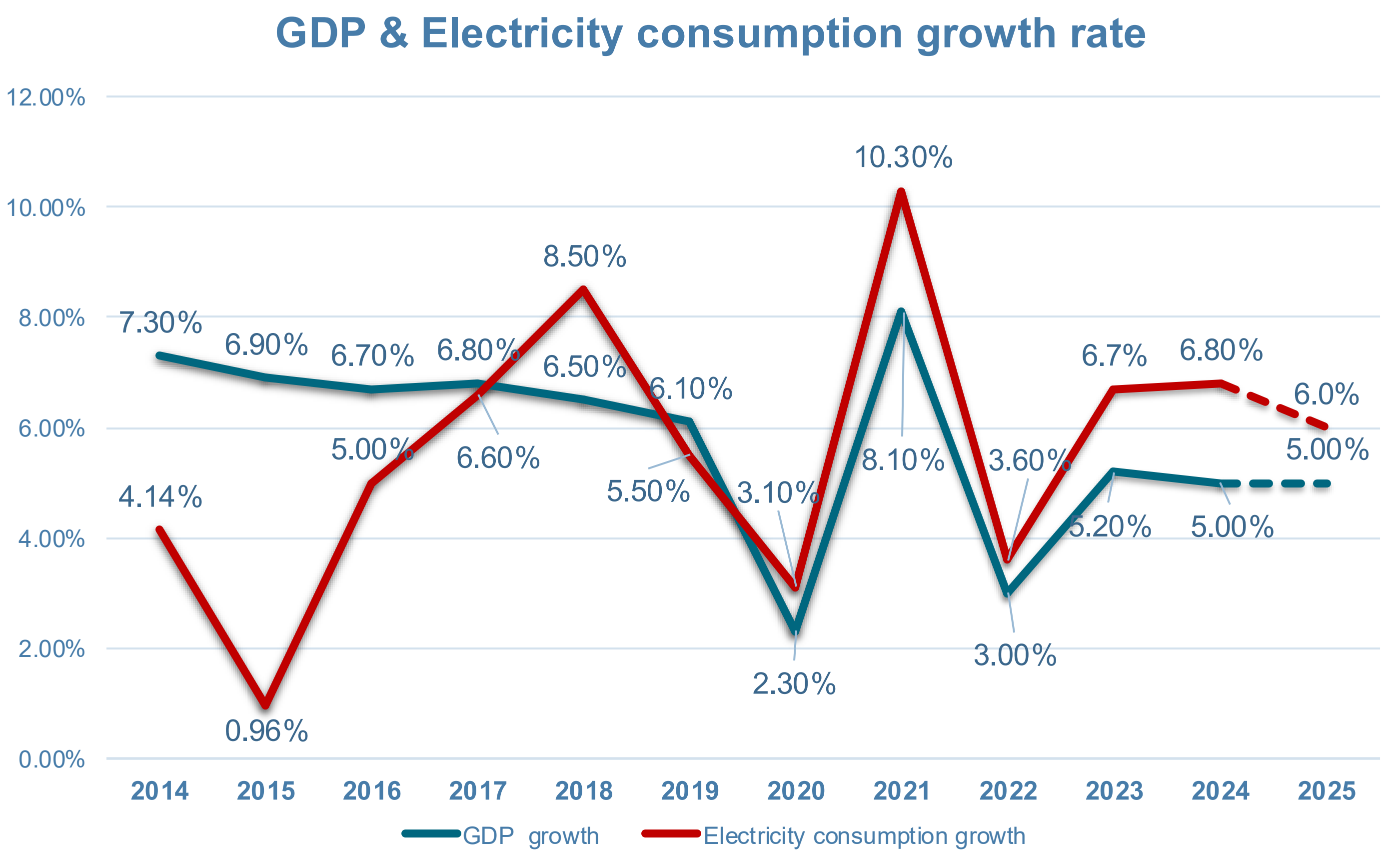
- **China aims to reach carbon peak by 2030 and carbon neutral by 2060, this is supported by a well structured and well planned clean energy development program in the decades to come. In this program, nuclear power has an important role to play;**

- **China walks the talk in the past decade, with now 58 reactors in operation, 32 in construction, 24 new additional units already validated;**
  - ✓ On the way to become by 2032 the world's leading civil nuclear player.
  - ✓ Already world leading capacity to build on time and on budget (thanks to efficient civil work and supply chain organization).

- **In front end part of nuclear fuel cycle, the challenge to ensure the supply of uranium, conversion&enrichment and fuels is huge therefore Chinese utilities have been making every efforts in securing uranium supply and in building con/en/fuel capacities;**

- **In the back-end, capabilities are a bit fallen behind but China has been very consistent in close-cycle strategy which has been recognized as a National Strategy since more than 15 years;**

In a very difficult economic situation, the GDP growth in 2024 reached 5.0%, it is in the expectation of IMF and other institutions.

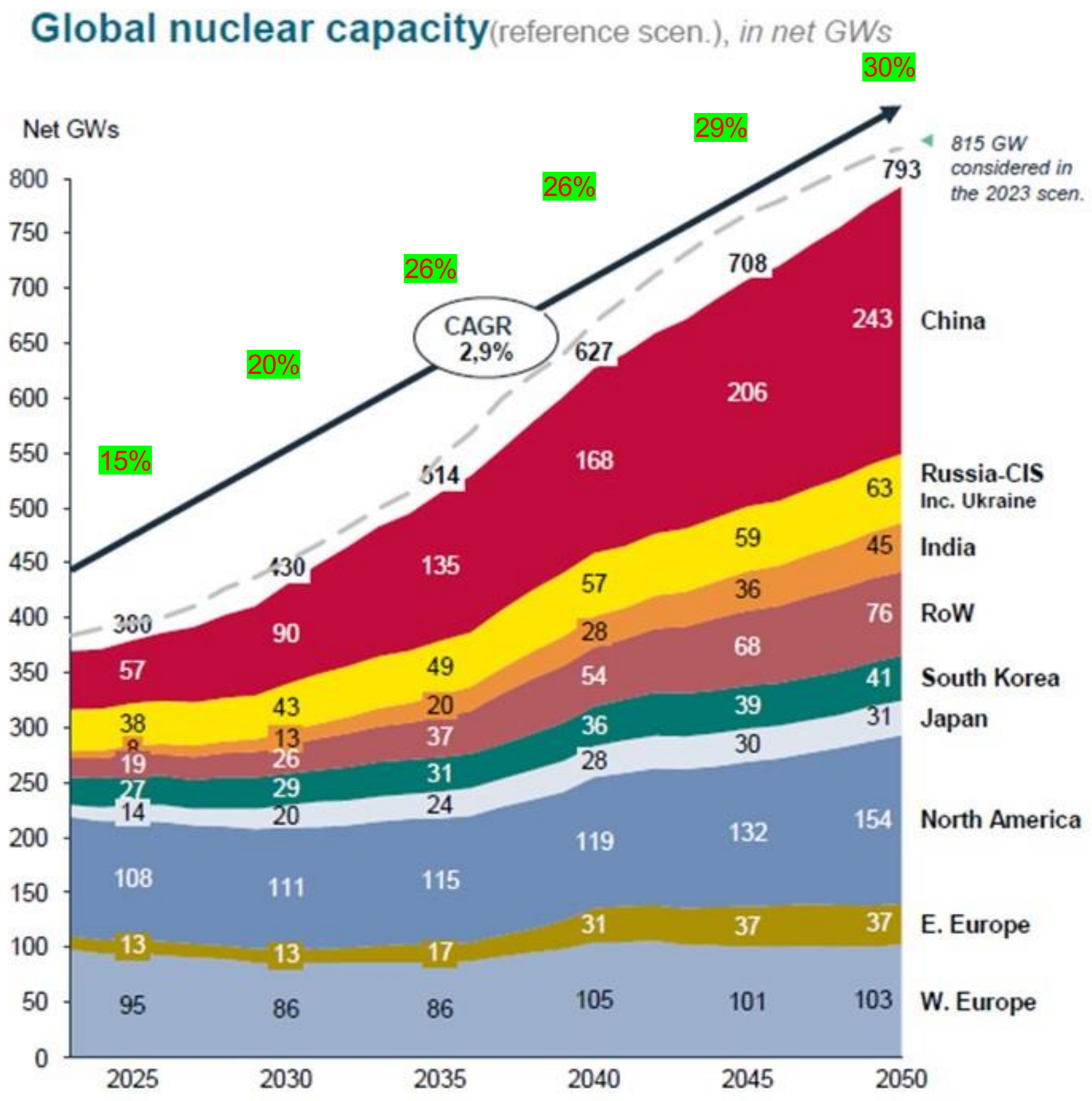


→**2024 GDP growth reached +5.0%**

→**The electricity consumption in China has increased by +6.8% in 2024, in line with the GDP Growth.**

→**2025 GPD growth is set at 5.0% in the Government Work Report during the Liang Hui in March 2025 and the electricity consumption will increase 6.0%.**

Chinese reactor scenario



- **10 new reactors** were approved by the State Council in April 2025, the 4th consecutive year that the number of new approved reactors attains 10.
- A dynamic scenario reactor + **7 GWe/year** for the next 25 years.
- The Nuclear installed base will reach **104 GWe** (gross) by 2030, becoming the first nuclear fleet in the world
- A **nuclear capacity** from 15% in 2025 (57 GWe) up to 30% in 2050 (243 GWe), compared to the worldwide nuclear installed capacity.
- **Enough sites for NPP in China**:
  228 GWe on coastal sites in operation, construction, already proposed or identified
  + 241 GWe Inland already proposed or identified.
- An announced transition to **RNR**s that would start by 2040, with 40 GWe in 2050.
- **Share of nuclear power generation** in electricity production (**5%** in 2024, target **15%** in 2060).

Source DCS Marketing

Reactors map in China (June 2025)

Chinese fleet status:
- 58 reactors in **Operation**
- + 32 **in construction**
- + 24 **approved**

127 GWe

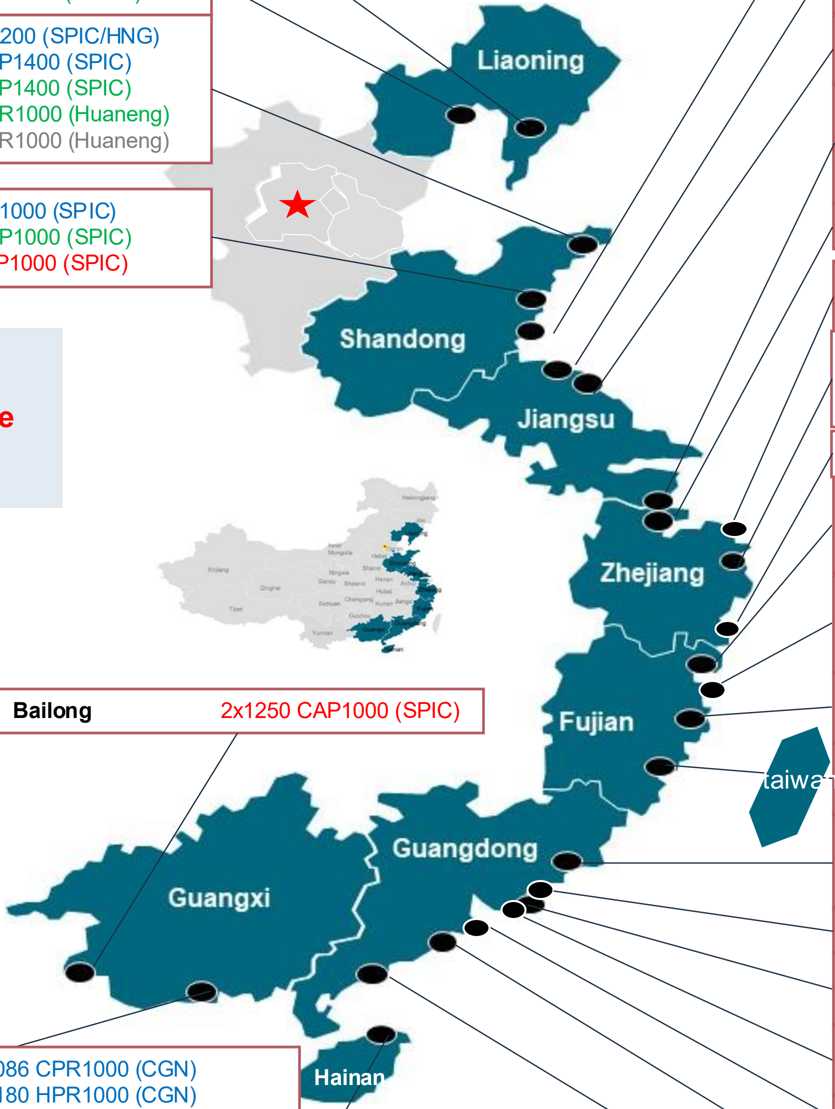
Standardization of Chinese reactor technologies:
- **Hualong**: 5 in operation + 14 in construction + 19 approved = **45 GWe**
- **CAP1000/1400** : 1 in operation + 10 in construction + 5 approved = **21 Gwe**

About VVER : 4 in operation + 4 in construction + 0 approved

	CGN	CNNC	SPIC	Huaneng
Operation	**25 reactors** - 4 x M310 - 14 x CPR1000 - 3 x ACPR1000 - 2 x EPR1750 - 2 x HPR1000	**26 reactors** - 1 x CNP300 - 6 x CNP600 - 2 x CANDU728 - 6 x CNP1000 - 4 x VVER1200 - 2 x AP1000 - 2 x ACPR1000 - 3 x HPR1000	**6 reactors** - 2 x CPR1000 - 2 x AP1000 - 1 x ACPR1000 - 1 x CAP1400	**1 reactor** - 1 x HTR200
Construction	**9 reactors** - 8 x HPR1000 - 1 x CAP1000	**14 reactors** - 3 x HPR1000 - 2 x CFR600 - 4 x VVER1200 - 1 x ACP100 - 4 x CAP1000	**5 reactors** - 1 x CAP1400 - 4 x CAP1000	**4 reactors** - 4 x HPR1000

Power in MWe, gross

Source Orano China Marketing

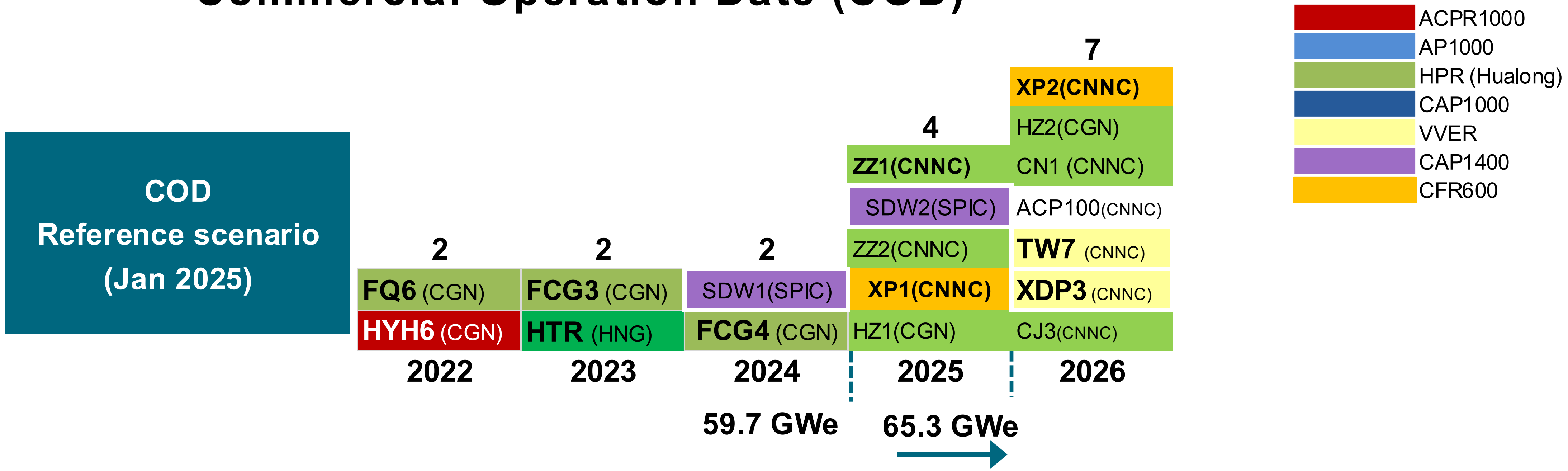


Hongyanhe	4x1119 CPR1000 (CGN/SPIC) 1x1119 ACPR1000 (CGN) 1x1119 ACPR1000 (SPIC)
Xudapu	2x1274 VVER (CNNC) 2x1291 CAP1000 (CNNC)
Shidaowan	1x211 HTR200 (SPIC/HNG) 1x1534 CAP1400 (SPIC) 1x1534 CAP1400 (SPIC) 2x1200 HPR1000 (Huaneng) 2x1200 HPR1000 (Huaneng)
Haiyang	2x1250 AP1000 (SPIC) 2x1251 CAP1000 (SPIC) 2x1251 CAP1000 (SPIC)
Bailong	2x1250 CAP1000 (SPIC)
Fangchenggang	2x1086 CPR1000 (CGN) 2x1180 HPR1000 (CGN) 2x11200 HPR1000 (CGN)
Changjiang	2x650 CNP600 (CNNC) 2x1200 HPR1000 (HNG/CNNC) 1x125 ACP100 (CNNC)
Zhaoyuan	2x1200 HPR1000 (CGN)
Tianwan	2x1060 VVER (CNNC) 2x1126 VVER (CNNC) 2x1118 ACPR1000 (CNNC) 2x1265 VVER (CNNC)
Xuwei	2x1200 HPR1000 (CNNC) 1x660 HTR600 (CNNC)
Qinshan	1x330 CNP300 (CNNC) 2x650 CNP600 (CNNC) 2x660 CNP600 (CNNC) 2x728 CANDU (CNNC)
Fangjiashan	2x1089 CNP1000 (CNNC)
San'Ao	2x1210 HPR1000 (CGN) 2x1210 HPR1000 (CGN)
Sanmen	2x1251 AP1000 (CNNC) 2x1251 CAP1000 (CNNC) 2x1200 HPR000 (CNNC)
Jinqimen	2x1200 HPR1000(CNNC)
Xiapu	2x682 CFR600 (CNNC) 2x1200 HPR1000 (Huaneng) 2x1200 HPR1000 (Huaneng)
Ningde	4x1089 CPR1000 (CGN) 1X1200 HPR1000 (CGN) 1X1200 HPR1000 (CGN)
Fuqing	4x1089 CNP1000 (CNNC) 2x1150 HPR1000 (CNNC)
Zhangzhou	1x1212 HPR1000 (CNNC) 3x1212 HPR1000 (CNNC)
Lufeng	2x1200 HPR1000 (CGN) 1x1250 CAP1000 (CGN) 1X1250 CAP1000 (CGN)
Daya Bay	2x984 M310 (CGN)
Ling'Ao	2x990 M310 (CGN) 2x1086 CPR1000 (CGN)
Taipingling	3x1200 HPR1000 (CGN) 1x1200 HPR1000 (CGN)
Lianjiang	2x1250 CAP1000 (SPIC)
Taishan	2x1750 EPR (CGN) 2x1200 HPR1000 (CGN)
Yangjiang	4x1086 CPR1000 (CGN) 2x1086 ACPR1000 (CGN)

2024 nuclear power capacity factor (91.5%)

A total installed capacity of 59.7 GWe in 2024 and it is expected to reach 65.3 GWe by the end of 14th FYP in 2025

Commercial Operation Date (COD)



Note: In Dec 2024,NEA has adjusted the previous objective from 70 GWe to 65 GWe by the end of 2025, this objective will be reached without any problem according to our scenario here.

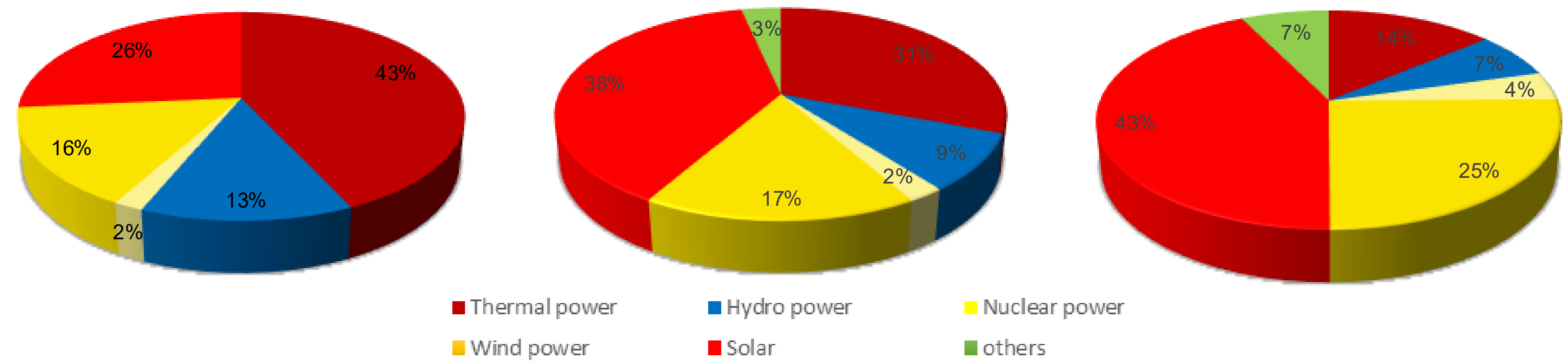
Energy mix

Renewable energies increase rapidly in recent years and the goal of 1200 GWe for Solar and wind has been achieved in 2024, 6 years earlier than goal set before.

Commitment of carbon neutrality of Chinese President XI Jinping calls for important roles of renewable and nuclear in energy's mix in the years to come

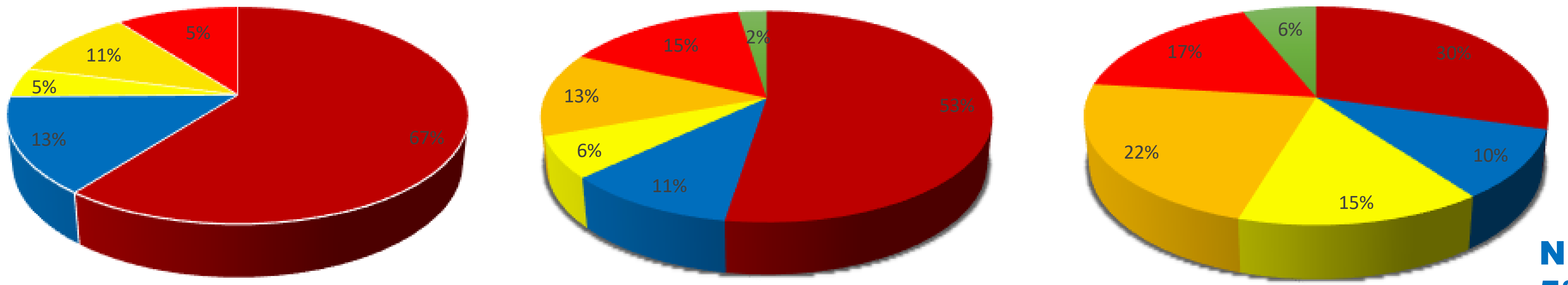
Installed capacity

2024 (3,349 GWe) | 2030 (4,700 GWe) | 2060 (7,940GWe)



Generation capacity

2024 (9,418 TWh) | 2030 (12,380 TWh) | 2060 (16,520 TWh)



Nuclear: from 5% to 15%

Thermal power | Hydro power | Nuclear power
Wind power | Solar | others

Sources: CNEA
NEA, CEC

OPI1 : DIFFUSION LIMITEE / RESTRICTED

A few highlights of China's Nuclear Power Industry

- **Operational Safety**: In 2023, 33 units out of 54 units had WANO Index 100. Average WANO Index is one of the leading country;
- **Operational Efficiency**: Average utilization hours reached 7661h in 2024; Average capacity factor reached 91.5%;
- **Construction capacity**: 32 units under construction mainly driven by HPR1000 (14 units) and CAP1000/1400 (10 units);
- **Construction schedule**: for Gen II 1000MW power reactors, the construction are under 60 months, some under 58 months; For Gen III, it is on the way to optimize construction duration and therefore economic performances;
- **Fuel cycle**:
  - ✓ **Fuel supply**: 1000tU/y of AFA3G fuel, 400tU/y of AP1000 fuel, 200tU/y of CANDU fuel and 30tU/y of HTR fuel
  - ✓ **Spent fuel management**: cumulative generation of spent fuel reached 11,000tHM by the end of 2024, 10,000tHM are stored in reactor pools or on-site dry storage systems;
- **Waste disposal**:
  - ✓ 3 ILW and LLW disposal sites have been built
  - ✓ In total 1,280,000 m^3 nominal storage capacity

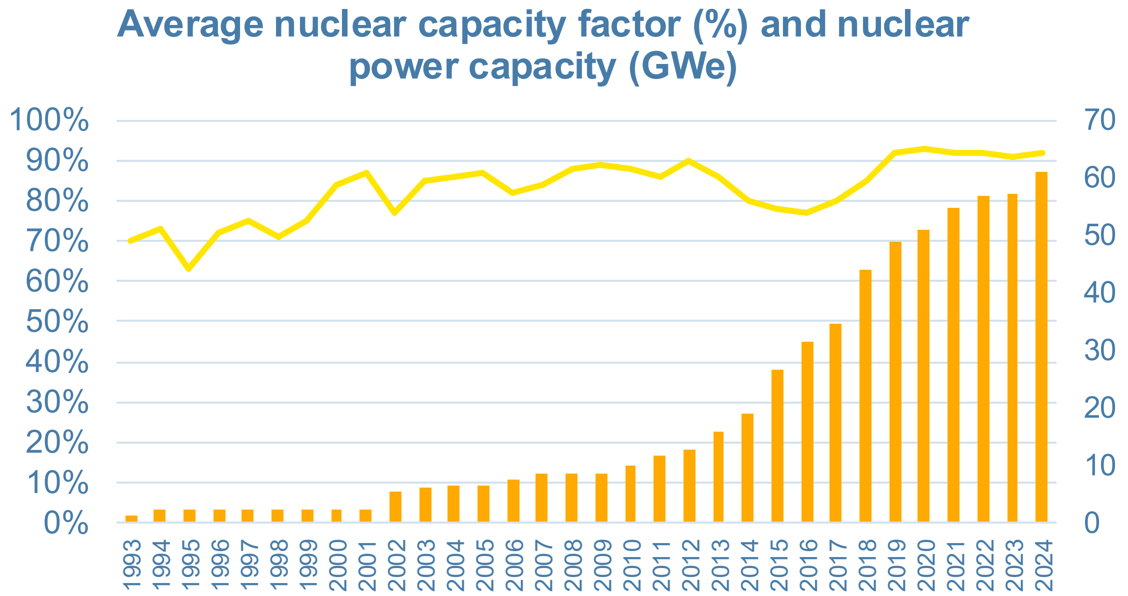
Nuclear energy in China (fast construction, high-capacity factor)

FCD to COD for Hualong: 5.5 years up to 7.5 years

Model	Average (months)	Range (months)	Reactors in operation	Reactors in construction
HPR1000	80	68 to 89	5	13
ACPR1000	68	57 to 83	6	0
VVER	62	62 to 63	4	4
AP1000	108	103 to 113	4	0
EPR	110	108 to 112	2	0
CAP1000	-	-	4	9
CAP1400	-	-	1	1
HTR	132	132	1	0
CFR600	-		0	2
ACP100	-		0	1

Excluding older models (CNP300, 600 and 1000, CANDU, M310, CPR1000)

2024 capacity factor: 91.5%



Main Players

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CGN, CNNC, SPIC and Huaneng – four players

CNNC

- Total installed capacity: **53 GWe**
- Including **25 GWe** from nuclear
- Revenues 2024: **20.5 bn€**

- By the end of Jan 2025, 26 reactors in operation (25 GWe) and 16 under construction (17.6GWe),
- Nuclear electricity production in 2024: 183.1TWh.
- 3 new reactors were approved in 2024

CGN

- Total installed capacity: **>110 GWe**
- Including **32 GWe** from nuclear
- Revenues 2024: **37.1 bn€**

- By the end of 2024, 28 reactors (3 reactors with SPIC) in operation (31.7 GWe) and 7 under construction (8.4 GWe),
- Nuclear electricity production in 2024: 242.2 TWh.
- 6 new reactors were approved in 2024.

SPIC

- Total installed capacity: **249 GWe**
- Including **7.3 GWe** from nuclear
- Revenues 2024: **52.7 bn€**

- By the end of 2024, 6 reactors in operation (7.3 GWe, including 3 with CGN), 5 reactors under construction (6.65GWe),
- nuclear electricity production in 2024: 44TWh. 2 new reactors were approved in 2024

CHINA HUANENG

- Total installed capacity: **252 GWe**
- Including **0.2 GWe** from nuclear
- Revenues 2024: **53.5 bn€**

- Shidaowan HTR is in commercial operation in Dec 2023.
- By the end of 2024, 3 reactors are under construction (3.6 GWe),
- 2 new reactors were approved in 2023, no in 2024.
- Nuclear installed capacity: 0.2 GWe .

CNNC Activities

BACK END

Competences are being built

Decommissioning

Not applicable yet

Recycling

Leading the development

Storage & Logistics

Leading the domestics transport of fuel cycle, leading the multi-model transport system of spent fuel

REACTORS & SERVICES

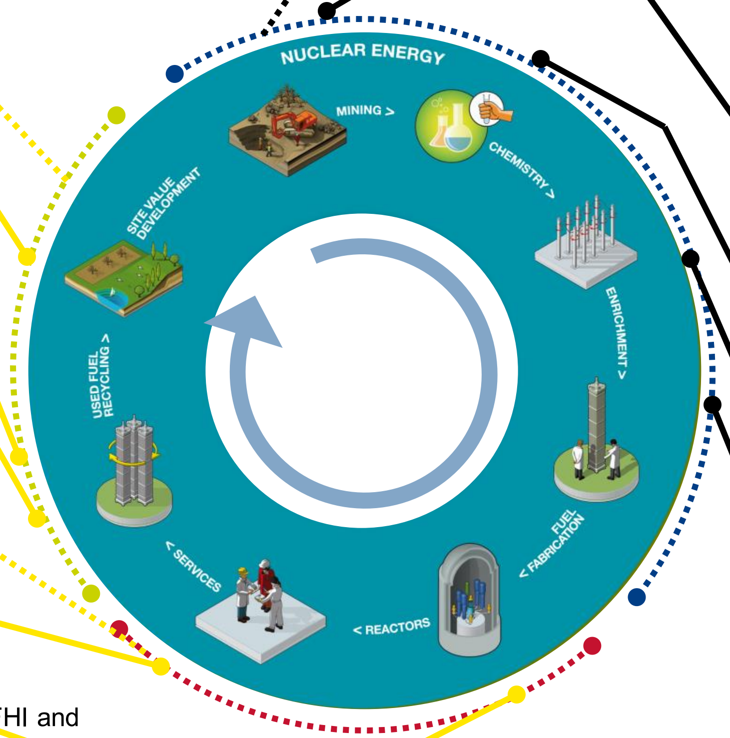
Lot of in-house activities

Reactors Services

Operations management by CNNP

Reactors New Builds

Heavy Components: outsourced to DEC, SEC, CFHI and HEC
Strong position in SMR and innovation projects (ACP, CFR)



MINING & FRONT END

Unique position

Mining

Sole U_3O_8 producer domestically in China
Successful overseas acquisitions

Chemistry

The only converter in China

Enrichment

The only enricher in China

Fuel

The only fuel maker in China

CGN Activities

BACK END

Follower

Decommissioning

Not applicable yet

Recycling

Will be developed under CNNC leadership

Storage & Logistics

Self-competence in U3O8 trpt while rely on CNNC in other sectors

REACTORS & SERVICES

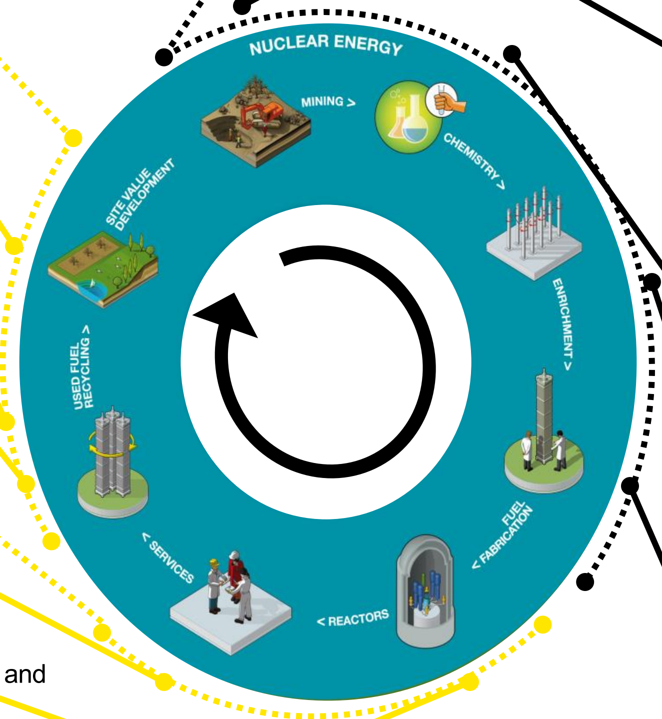
Lot of in-house activities

Reactors Services

Operations: in-house (DNMC for DB/LA)
Services: mainly in-house, via CNOC

Reactors New Builds

Heavy Components: outsourced to DEC, SEC, CFHI and HEC
Largest fleet in operation + under construction in China



MINING & FRONT END

Active oversea activities

Mining

No projects domestically in China
Successful overseas acquisitions and procurements

Chemistry

Relies on CNNC

Enrichment

Relies on CNNC, but looking for diversification thru ULBA-FA

30% of Daya Bay reload and SWU for Taishan EPR is not supplied by CNNC

Fuel

Mainly relies on CNNC
ULBA-FA ~ 200tU/year

SMR and Gen IV

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SMR and Advanced reactors in China

China views SMRs & ARs as part of energy security strategy, decarbonization goals and export-ready nuclear technology. SMRs are also considered as support for Off-grid, industrial use, desalination and hydrogen production for remote regions.

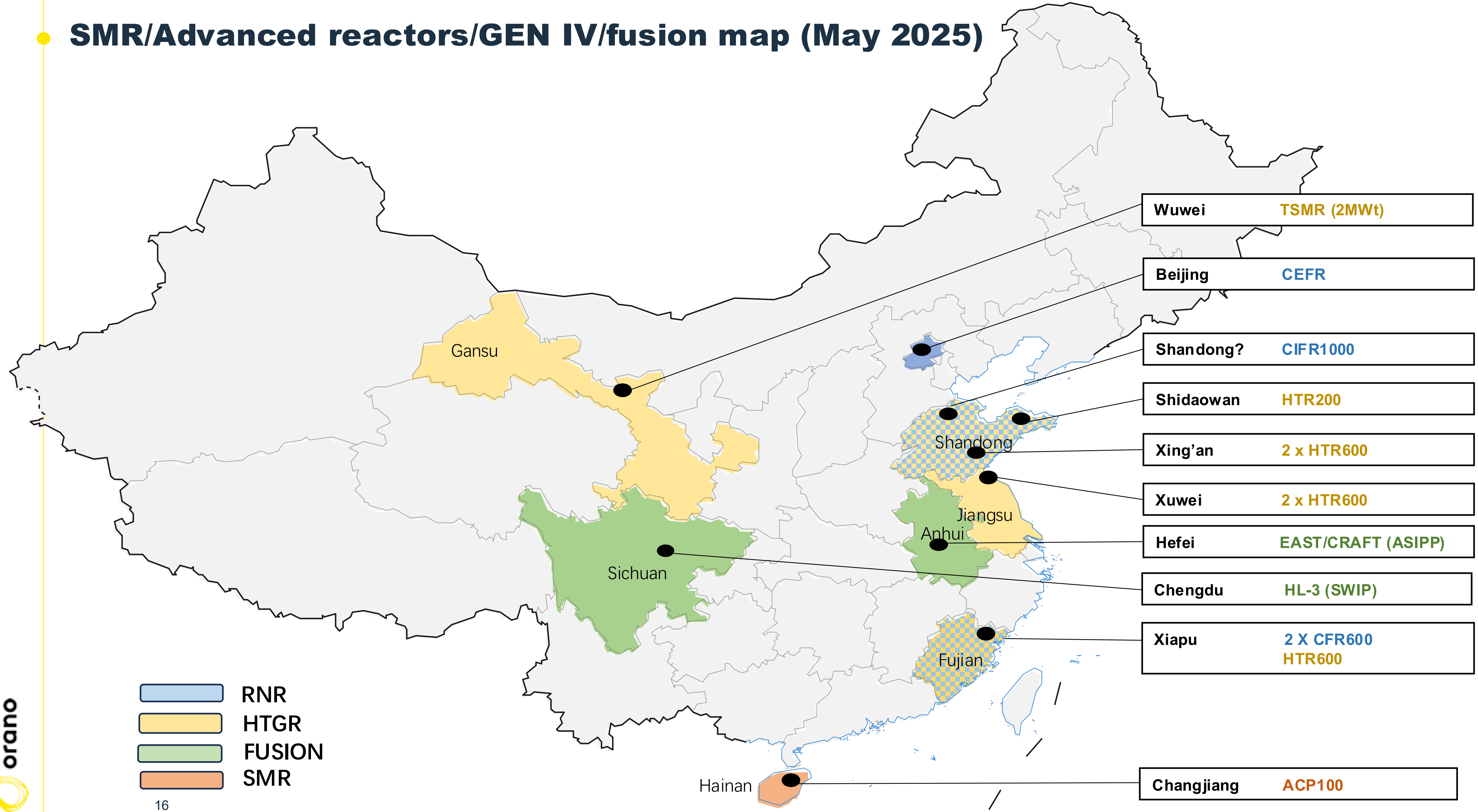
SMR Status	Developer	Technology	Status
ACP100	CNNC	PWR	Under construction since 2021
Yanlong	CIAE *(CNNC)*	Pool-type reactor	Demo built (tested in Beijing for urban heating
CARR	CIAE *(CNNC)*	Research & multi-purpose reactor	Operational – support R&D for other SMRs
SCWR	NPIC *(CNNC)*	High-Efficiency Super Critical Water Reactor	Early R&D stage

High Temperature Reactor Projects in China

- Currently an HTR-PM (200 MWe) is under operation in China as a commercial demo.
- One HTR-600 is approved at Xuwei site. Other projects for HTR-600 for Xiapu & Xin'An.
- **Market application:** industrial process heat, district heating, potentially off-grid applications (remote industrial parks…).
- **TRISO Fuel:** domestic TRISO line operational at the CNNC Baotou plant.
- Regarding the **spent fuel**, on-site dry storage in pits is chosen, with no reprocessing planned.

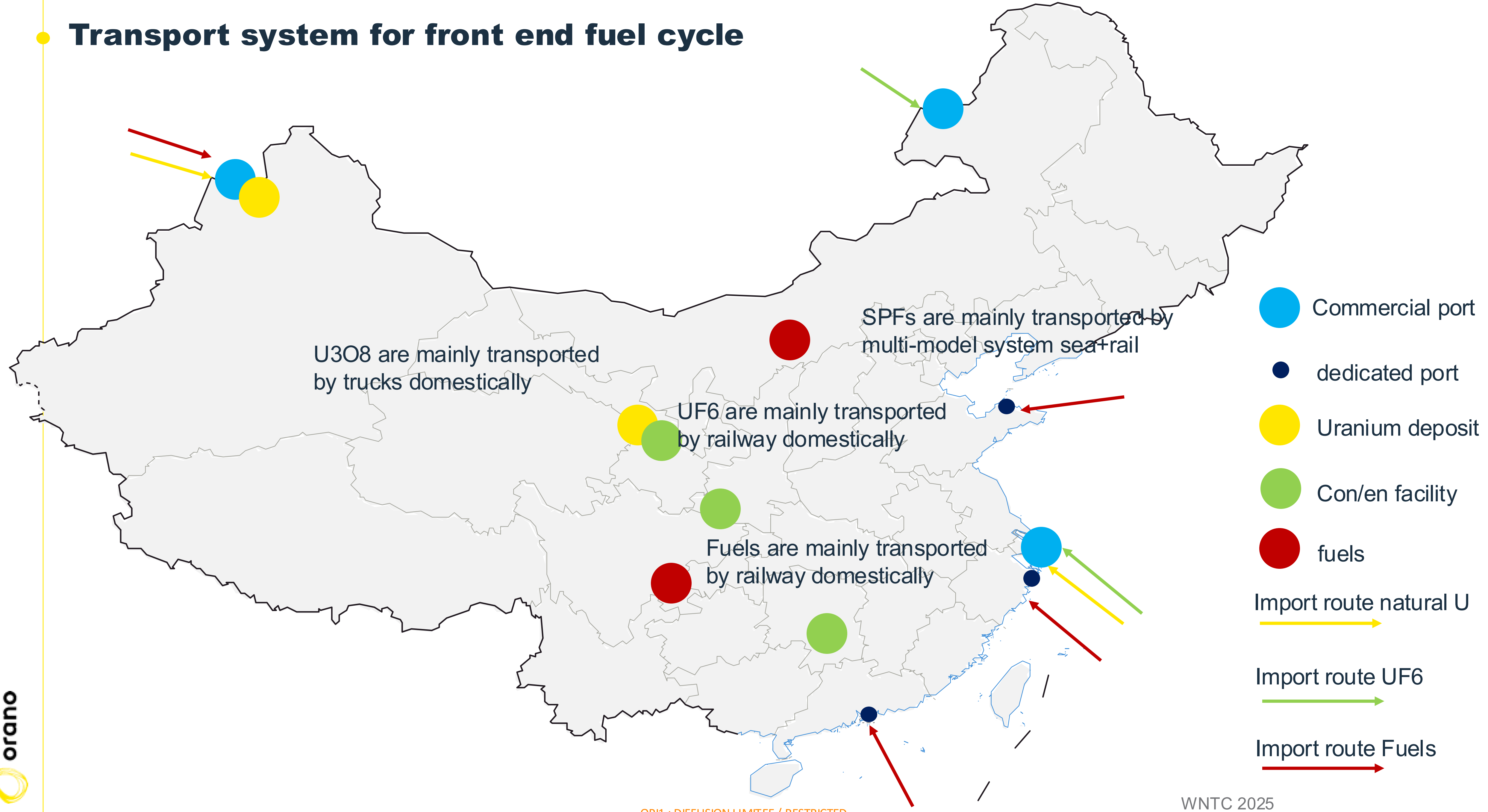
AR Status	Developer	Technology	Status
CFR-600	CNNC	Sodium-cooled Fast Reactor (SFR)	2 units under construction *(unit 1 might run at low power as of mid-2023)*
CFR-1000	CNNC	Sodium-cooled Fast Reactor (SFR) – MOX fuel	In design phase
CiFR-1200	CNNC	Sodium-cooled Fast Reactor (SFR) – metal fuel	In design phase
MSR TMSR-LF1	SINAP	Thorium Molten Salt Reactor	Experimental reactor built in Gansu *(first criticality in 2022)*
Lead-cooled Fast Reactor (LFR)	INET & CAS	Lead-bismuth cooled reactor	Concept stage *(funding ongoing)*
HTR-PM	Tsinghua Univ. & Huaneng	High Temperature Gas Cooled	Commissioned (world's first modular HTGR)

SMR/Advanced reactors/GEN IV/fusion map (May 2025)



Wrap – up Transport System

Transport system for front end fuel cycle



Main Competent Authorities involved in class 7 transport

CAEA	**Main missions of CAEA:** • Approve the projects of nuclear fuel installations • Carry out nuclear material control, nuclear export supervision and management • Deal with the exchange and cooperation in governments and international organizations, and to take part in IAEA and its activities in the name of the Chinese government
MOT	**Main missions of MOT:** • Regulate safe transport of class 7 materials with rail, road, air, water • Give administrative approval of certain dedicated transport routes of fuel cycle materials • Give authorization or license to transport carriers, in cooperation with local public security • Give authorization or license to ports for class 7 materials, in cooperation with environmental protection department • Give approvals (by local MSA) for vessel carrying class 7 materials
NNSA	**Main missions of NNSA:** • Formulate standards and regulations in classification/categorization of class 7 materials, package design and manufacturing and transport approval processes. • Supervise and approve/validate package design and manufacturing
Customs	**Main missions of China Customs:** • Give license for import or export of cargo with nuclides or radio active sources • Inspect the import and export of such cargo

Main References

- Orano China marketing report, Edition June 2025, Orano China
- Blue Book - China’s Nuclear Power Development, April 2025, China Nuclear Energy Association

Action plans

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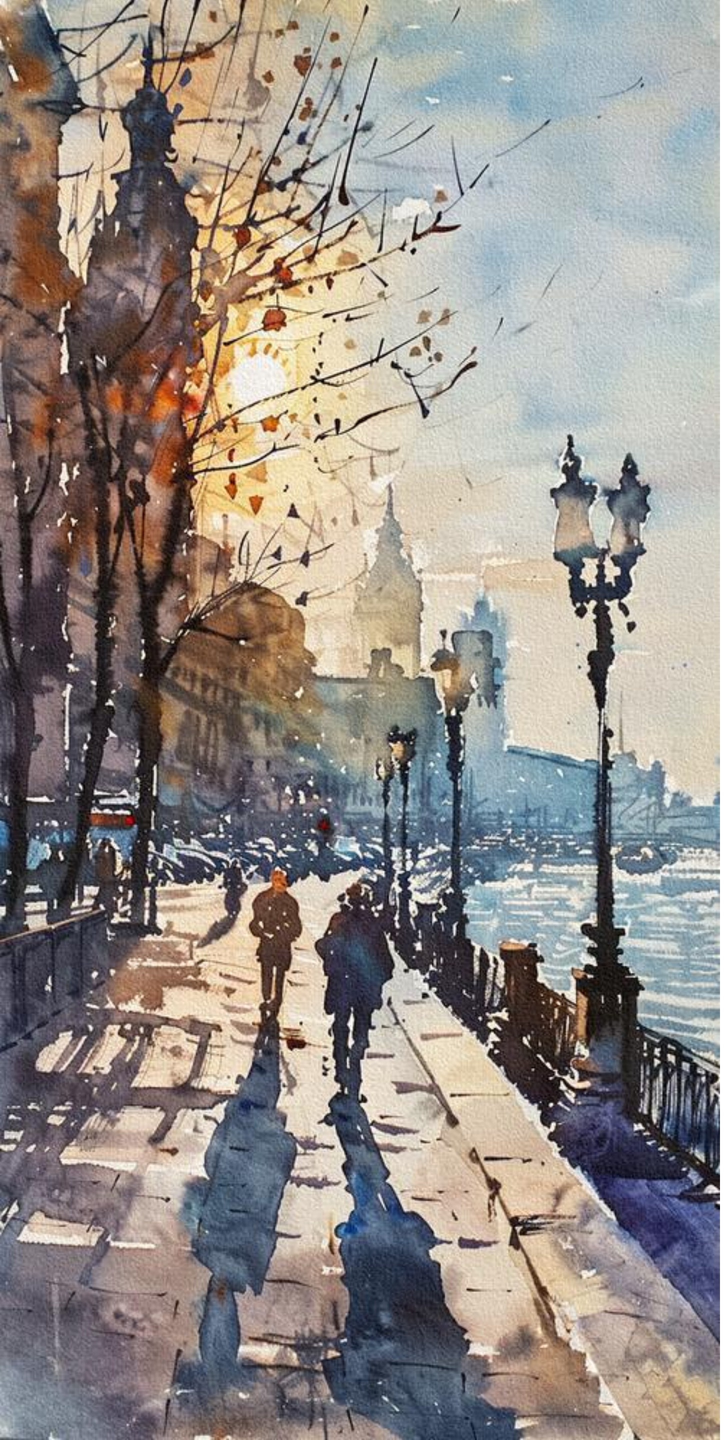
Recommendations - actions in China in line with strategic plan

- **Realize high level visit to the 3 members**
  - ✓ CNNC-CNEIC: the only UF6 and fuel supplier in China, serving one of the largest reactor fleet
  - ✓ CNNC-Everclean: the most capable transporter of spent fuel, operator of multi-model trpt system and waste deposit
  - ✓ CIMC: fabricator of 30B/48Y cylinders with sound reputation in this field

- **Maintain dialogue with potential members**
  - ✓ CNNC-CIRP: most capable institute in RAM package testing, transport safety evaluation and radiation protection
  - ✓ CGN-URC: the sole fuel cycle platform for CGN group, owner of Husab

- **Form partnership with CIRP in launching a joint WNTI training center in China**

- **Reconsider a dedicated China Workshop (following the ones in 2015, 2017 and 2019), with the support from or in cooperation with members and CNS or CNEA**



THANK YOU !

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