Marketing Update

China

WNTI SAMM
2025.2

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01

General Context

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Key points about the market context in China in 2024
-- *Very dynamic nuclear market*

- **Better economical context**
  - → 5.2% growth of GDP achieved in 2023, and 5% GDP expected in 2024 (forecast confirmed by the IMF experts),

- **In line with the 14th Five Year Plan, the Chinese government is acting "actively and orderly" to develop the nuclear industry:**
  - → 56 reactors in operation, and 37 new approved reactor projects (in construction or in progress to pass FCD),
  - → The Nuclear installed base will be around 100 GWe by 2030, becoming the first nuclear fleet in the world,
  - → New projects combining Nuclear and Renewable generation,
  - → Inland reactor projects still forbidden but the use of nuclear energy to produce heat and vapor could open the way in the near future.

- **China is launching new investments to add conversion and enrichment capacities to support the ramping up NPP fleet.**

- **China is very active on the field of SMR/AMR development technology but no significant move on the deployment of the closed fuel cycle (back end)**

- **On non-nuclear side,**
  - → Still massive investments in the renewable energy (+293 GWe for Solar and Wind installed based in 2023!),

Reactors map in China (Sep. 2024)

Status	Number	GWe
Operation	56	58.3
Construction	31	36.4
Big Road Tickets	**17**	**20.3**
Small Road Tickets	6	7.2

Big RT: State Council approval

Small RT: NDRC approval

	CGN	CNNC	SPIC	Huaneng
Operation	**25 reactors** - 4 x M310 - 14 x CPR1000 - 3 x ACPR1000 - 2 x EPR 1750 - 2 x HPR1000	**25 reactors** - 1 x CNP300 - 6 x CNP600 - 2 x CANDU728 - 6 x CNP1000 - 4 x VVER1200 - 2 x AP1000 - 2 x ACPR1000 - 2 x HPR1000	**5 reactors** - 2 x CPR1000 - 2 x AP1000 - 1 x ACPR1000	**1 reactor** - 1 x HTR200
Construction	**7 reactors** - 7 x HPR1000	**15 reactors** - 4 x HPR1000 - 2 x CFR600 - 4 x VVER1200 - 1 x ACP100 - 4 x CAP1000	**6 reactors** - 2 x CAP1400 - 4 x CAP1000	**3 reactors** - 3 x HPR1000

*Source: IAEA, CNEA,
*Power in MWe, gross

Hongyanhe 4x1119 CPR1000 (CGN/SPIC)
1x1119 ACPR1000 (CGN)
1x1119 ACPR1000 (SPIC)

Xudapu 2x1274 VVER (CNNC)
2x1291 CAP1000 (CNNC)

Zhaoyuan 2x1200 HPR1000 (CGN)

Xuwei 2x1200 HPR1000 (CNNC)
1x660 HTR600 (CNNC)

Fangchenggang 2x1086 CPR1000 (CGN)
2x1180 HPR1000 (CGN)

Bailong 2x1250 CAP1000 (SPIC)

Changjiang 2x650 CNP600 (CNNC)
2x1200 HPR1000 (Huaneng/CNNC)
1x125 ACP100 (CNNC)

Yangjiang 4x1086 CPR1000 (CGN)
2x1086 ACPR1000 (CGN)

Haiyang 2x1250 AP1000 (SPIC)
2x1251 CAP1000 (SPIC)

Shidaowan 1x211 HTR200 (SPIC/Huaneng)
2x1534 CAP1400 (SPIC)
1x1200 HPR1000 (Huaneng)
1x1200 HPR1000 (Huaneng)
2x1200 HPR1000 (Huaneng)

Tianwan 2x1060 VVER (CNNC)
2x1126 VVER (CNNC)
2x1118 ACPR1000 (CNNC)
2x1265 VVER (CNNC)

Qinshan 1x330 CNP300 (CNNC)
2x650 CNP600 (CNNC)
2x660 CNP600 (CNNC)
2x728 CANDU (CNNC)

SanAo 2x1210 HPR1000 (CGN)
2x1210 HPR1000 (CGN)

Sanmen 2x1251 AP1000 (CNNC)
2x1251 CAP1000 (CNNC)

Jinqimen 2x1200 HPR1000(CNNC)

Xiapu 2x682 CFR600 (CNNC)
4x1200 HPR1000 (Huaneng)

Ningde 4x1089 CPR1000 (CGN)
1X1200 HPR1000 (CGN)
1X1200 HPR1000 (CGN)

Fuqing 4x1089 CNP1000 (CNNC)
2x1150 HPR1000 (CNNC)

Zhangzhou 4x1212 HPR1000 (CNNC)

Lufeng 2x1200 HPR1000 (CGN)
2X1250 CAP1000 (CGN)

Daya Bay 2x984 M310 (CGN)

Ling'Ao 2x990 M310 (CGN)
2x1086 CPR1000 (CGN)

Taipingling 2x1200 HPR1000 (CGN)
2x1200 HPR1000 (CGN)

Lianjiang 2x1250 CAP1000 (SPIC)

Taishan 2x1750 EPR (CGN)

Status 2023 - 2024

2023 (FCD = first concrete date, COD = connection to grid date)

- In 2023, 10 units were approved (big road tickets) by the State Council
- 5 FCD reached in 2023
- 2 COD reached in 2023

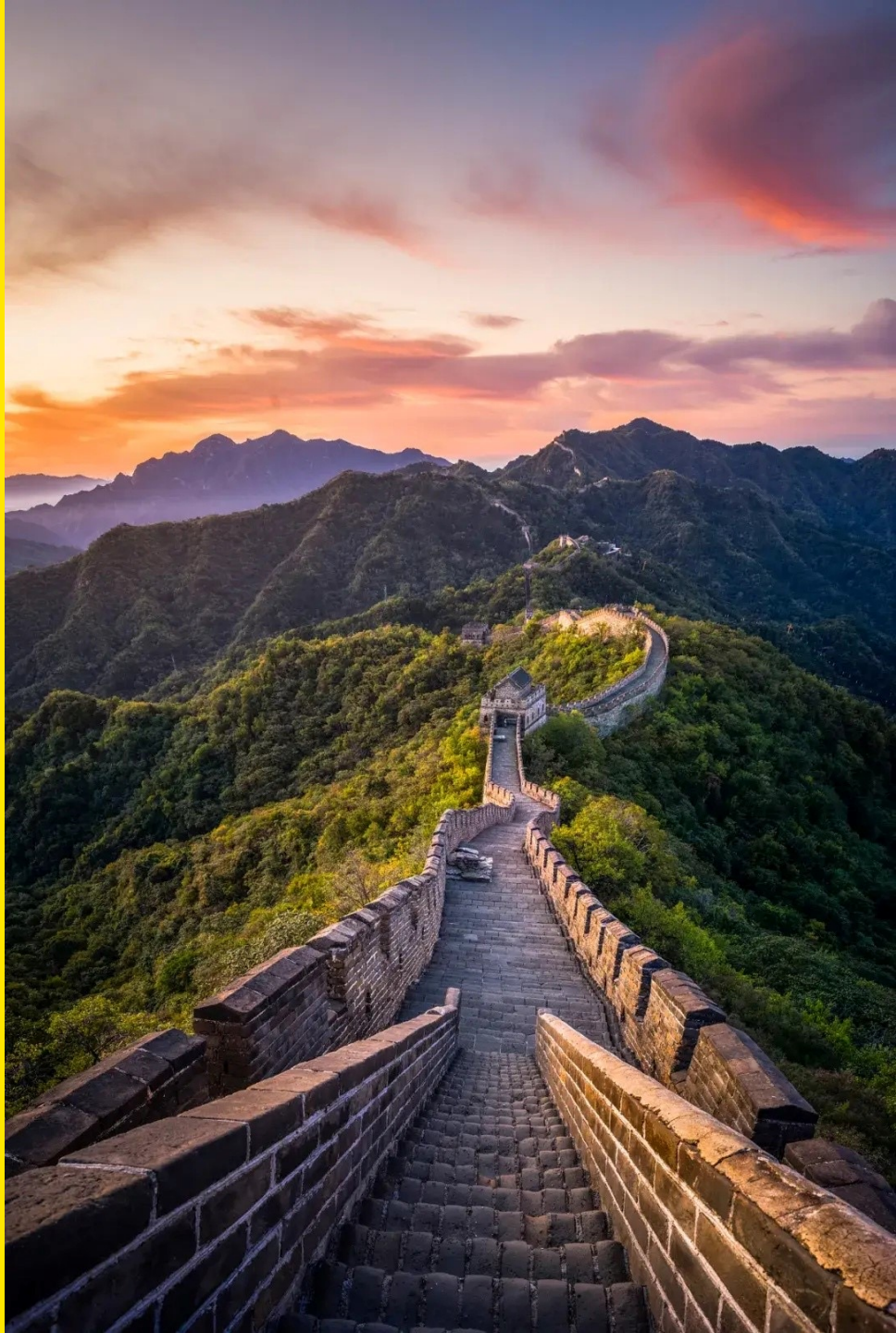
2024

- It was expected that 6-12 units will be approved by the State Council
  In 2024:
  - 2 Small road tickets from NDRC
  - 11 projects already approved
- 6-8 FCD are expected in 2024
- 3 COD are expected in 2024

Notes:
CHN: China Huaneng Group
HPR: Hualong Pressurized reactor

02

Assumptions link to carbon peak & carbon neutral strategy



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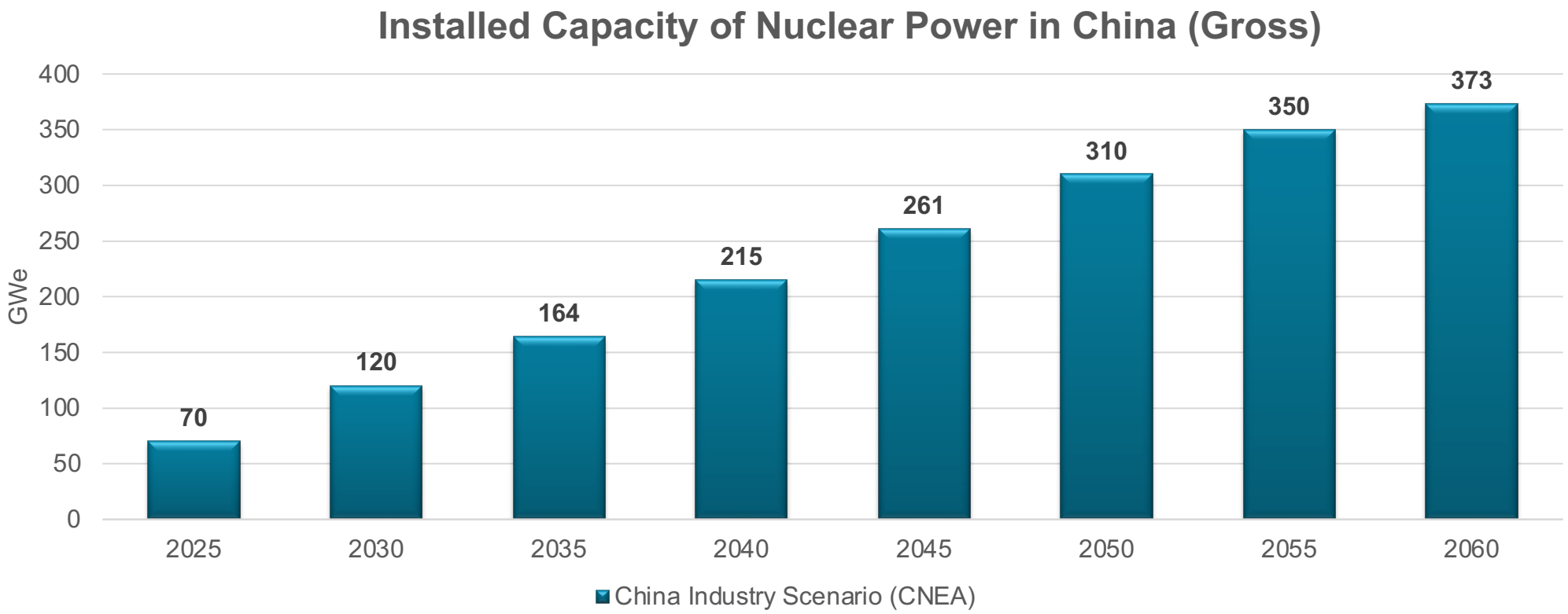
Estimation of Installed Capacity of Nuclear Power Development in China 2025-2060



☞ **Extension of 20 years has been considered in this scenario**

52% of the installed capacity is non-fossil origin at the end of 2023

Electricity Installed base Gwe (in gross)	Installed capacity Jan-Dec 2023 (GWe)	2023 Increasing rate vs 2022	2022 Increasing rate vs 2021	Remark
Thermal	1390	+4.1%	+2.7%	China continues to increase its installed capacity in 2023 and non fossil energy accounts for 1530 GWe (52%). In 2023, the Renewable installed capacity has increased by +293 GWe (Wind +76 GWe, Solar +217 GWe). **China most likely will reach CO2 Pic emission before 2030; and deploy its low carbon installed capacity to reach carbon neutrality by 2060 as set by XI Jinping.**
Hydraulic	422	+1.8%	+5.9%	
Wind	441	+20.7%	+10.9%	
Solar	610	+55.2%	+28%	
Nuclear	57	+2.4%	+5.7%	
Total	**2920**	**+13.9%**	**+7.7%**	

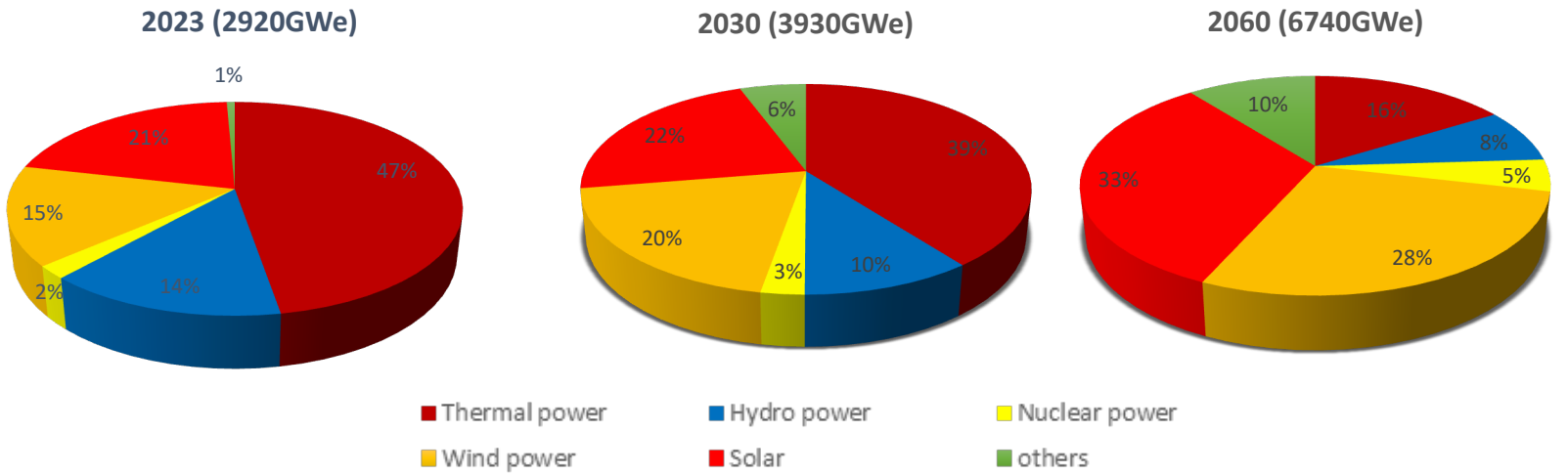
Source NEA and CEC May 2024

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

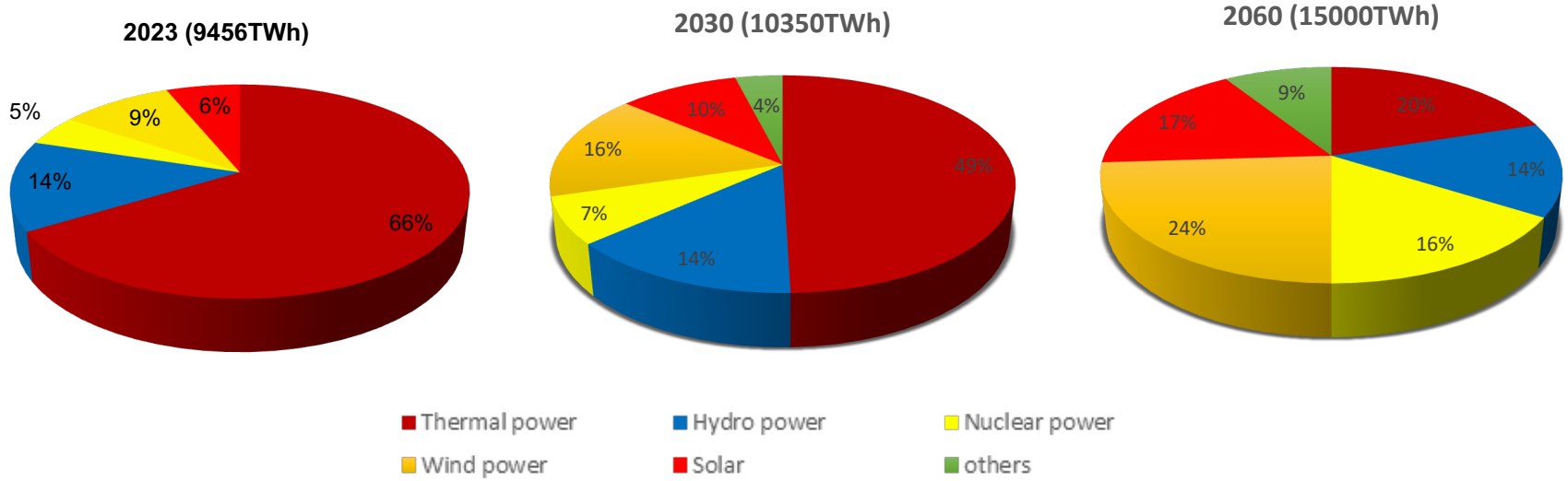
Fossil energies to be around 20% or less by end of 2060!

Sources: CEC, NEA, CNEA

Installed capacity



Generation capacity



03

SMR and Innovations

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Active SMR & AMR's technology development in China

SMR in China is subject to expansion but which will remain not in domain position by 2030

HTR-PM

The HTR-PM is a high-temperature gas-cooled reactor (HTGR) lead by Huaneng composed of two reactors based in Shidao Bay NPP in Shandong province.

- 2012: construction start
- 12/2021: reactor one was connected to the grid and began producing power
- 12/2022: 2 modules are coupled and connected to the grid
- 12/2023: official operation (COD) has been announced on Dec 06, 2023.
- Expected new projects of HTR 600 have been announced by Fujian and Guangdong provinces (no State Council authorization yet).

CFR600

The CFR600 is a sodium-cooled pool-type fast-neutron reactor under construction in Fujian province. It's a GEN-IV demonstration project by CNNC.

- 2017: construction started
- 2019: Abandon of Terrapower cooperation due to US sanctions
- 2019: fuel will be supplied by Rosatom
- 2020: construction of the second CFR600 started
- Unit 1 has been in operation in 2023, but no official announcement on its COD yet, the official COD is expected in 2024;
- Operation of unit 2 is expected in 2026

ACP100

The ACP100 is a PWR technology developed by CNNC

- 2019: CNNC announced to build an ACP100 on Changjiang NPP site (Hainan island) by end-2019
- 07/2021: CNNC started the construction
- 10/2021: the containment vessel bottom of the first two units was installed
- 03/2023: civil work of inside structure of nuclear island is achieved
- The dome is put in place in Feb 2024 and its commercial operation is planned in 2026

TMSR

The TMSR is a 2 MWt prototype molten salt reactor currently under construction in Gansu province.

- 2018: NNSA approved the site selection
- 2020: NNSA delivered the construction license
- 2020: SINAP launch the construction
- 2021: SASTIND approved nuclear material license (fuel)
- 2022: SINAP is waiting for the operating license
- 07/2022: commissioning is in progress
- 05/2023: the first criticality was scheduled at the end of May 2023, no official announcement on its operation yet.

Next step announced on Fast Reactor Nuclear energy : CiFR 1000 program

- **Develop CiFR1000 nuclear energy system in about 10 years, as the main product for the large-scale development of Fast Neutron Reactor in China, with the following main characteristic:**
  - → **Electric power: 1200 MWe (4 primary loops and 4 secondary loops)**
  - → **Fuel type: Metal Fuel (U, Pu, TRU)**
  - → **Maximum burn-up: 120 000 MWd/tHM**
  - → **Refueling cycle: 12 months**
  - → **Design life: 60 years // Expected construction cycle: 60 months**

- **Program in 3 phases:**
  - **From 2021 to 2025: Research on key technologies**
    - ✓ **Complete standard preliminary design**
    - ✓ **Complete technical & economic feasibility study**
  - **From 2026 to 2030: Engineering verification**
    - ✓ **Complete all process validation**
    - ✓ **Completion of equipment and engineering validation tests**
  - **From 2031 to 2035**
    - ✓ **Complete the construction of the first CiFR 1000 demonstration project**

04

Main Player Information

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CGN, CNNC, SPIC and Huaneng – 2024 Key Facts

CNNC

- By the end of March 2024, 25 reactors in operation (23.8 GWe) and 13 under construction (13.9GWe),
- Nuclear electricity production in 2023: 209.9 TWh, 5.6%% more than 2022
- 4 new reactors were approved in 2023

CGN

- By the end of March 2024, 27 reactors (3 reactors with SPIC) in operation (30.5 GWe) and 7 under construction (8.4 GWe),
- Nuclear electricity production in 2023: 228.3 TWh.
- 4 new reactors were approved in 2023.

SPIC

- By the end of April 2024, 5 reactors in operation (5.9 GWe, including 3 with CGN), 6 reactors under construction (8.05GWe),
- nuclear electricity production in 2023: 21TWh. 2 new reactors were approved in 2023
- Total installed capacity: 239 GWe (by the end of Sep 2023)

Huaneng

- Shidaowan HTR is in commercial operation in Dec 2023.
- By the end of 2023, 2 reactors are under construction (2.4 GWe),
- 2 new reactors were approved in 2023
- Nuclear installed capacity: 0.2 GWe

CNNC Activities

BACK END

Limited activities

Decommissioning

X

Recycling

Limited

Storage & Logistics

Limited, site by site

REACTORS & SERVICES

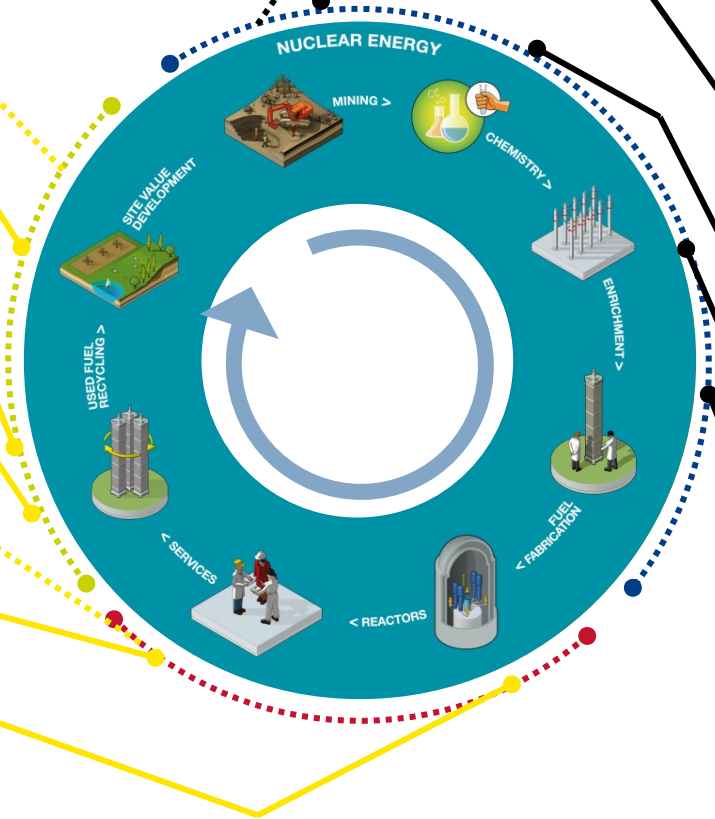
Lot of in-house activities

Reactors Services

√

Reactors New Builds

Project Mgt: √
Engineering: in-house, √
Heavy Components:√
Strong position in SMR and innovation projects



MINING & FRONT END

Very active, operator of domestic mines and fuel cycle facilities

Mining

√

Chemistry

√

Enrichment

√

Fuel

√

CGN Activities

BACK END

Limited activities

Decommissioning

X

Recycling

X

Storage & Logistics

Limited, site by site

REACTORS & SERVICES

Lot of in-house activities

Reactors Services

√

Reactors New Builds

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Engineering: in-house, √
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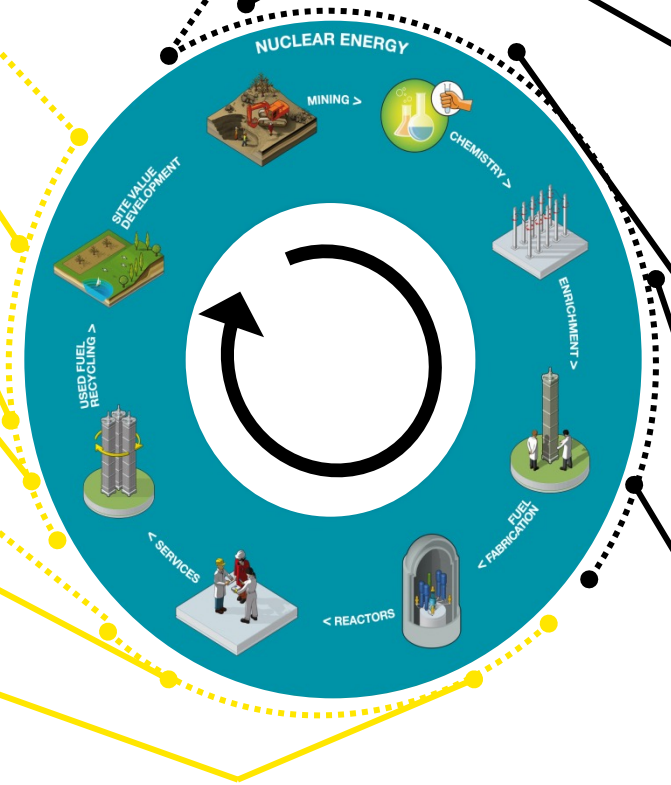

MINING & FRONT END

Active oversea activities

Mining

No projects domestically X
Overseas acquisitions (Husab) √

Chemistry

Relies on CNNC X

Enrichment

Relies on CNNC X

Fuel

Mainly relies on CNNC domestically X
Oversea facility ULBA-FA √