



# EXPANDING NUCLEAR CAPACITY: PRACTICE & SOLUTIONS

APERC Annual Conference 2025, May 29th, Tokyo



中国核工业集团有限公司  
China National Nuclear Corporation

WANG Mo CINIS, China National Nuclear Corporation

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# 01 GLOBAL TREND

## in developing nuclear energy

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# 02 KEY FACTORS

## impacting the expansion of capacity

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# 03 INTEGRATED SOLUTIONS

## to bring new capacity online

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مصاعفة إنتاج الطاقة النووية ثلاث مرات بحلول عام 2050  
الإمارات العربية المتحدة، ديسمبر 2023

TRIPLING NUCLEAR ENERGY BY 2050

United Arab Emirates, December 2023



GLOBAL TREND  
IN DEVELOPING NUCLEAR ENERGY

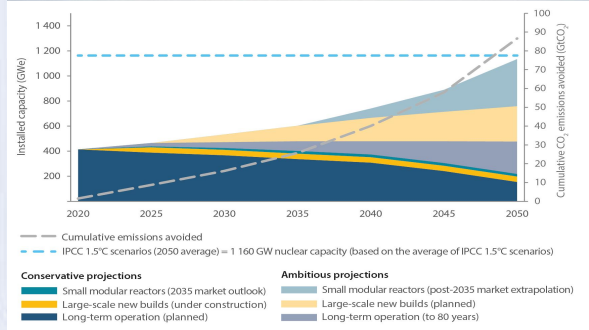


# Triple Nuclear Energy Capacity by 2050



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At COP28, 22 nations launched declaration to Triple Nuclear Energy Capacity by 2050, recognizing the key role of nuclear energy in reaching net zero emissions by 2050 and keeping the 1.5-degree goal set in Paris Agreement within reach.



Sources: OECD/NEA website (Dec. 2023)

## Triple Global Nuclear Capacity

390 GW to 1,170 GW by 2050

## Technology Innovation

Advanced reactors including SMRs

## Funding Mechanisms

Mobilize public/private investments

## Industrial Decarbonization

Coupling with industries to

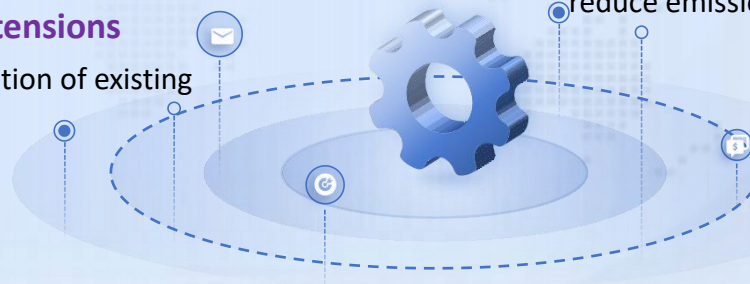
## Lifespan Extensions

Prolong operation of existing reactors

reduce emissions

## Equitable Transition

Adopting nuclear energy with safeguards for security and nonproliferation





# Nuclear Power for the Common Goals

## HIGH CASE

**950** GW by 2050

**2.5** times to 2023

**25%** by SMRs

## LOW CASE

**514** GW by 2050

**1.4** times to 2023

**6%** by SMRs

The IAEA has raised its projections for nuclear energy development for the 4th consecutive year.

**Low  
carbon  
emission**

**High  
energy  
density**

**Stable  
baseload  
power**

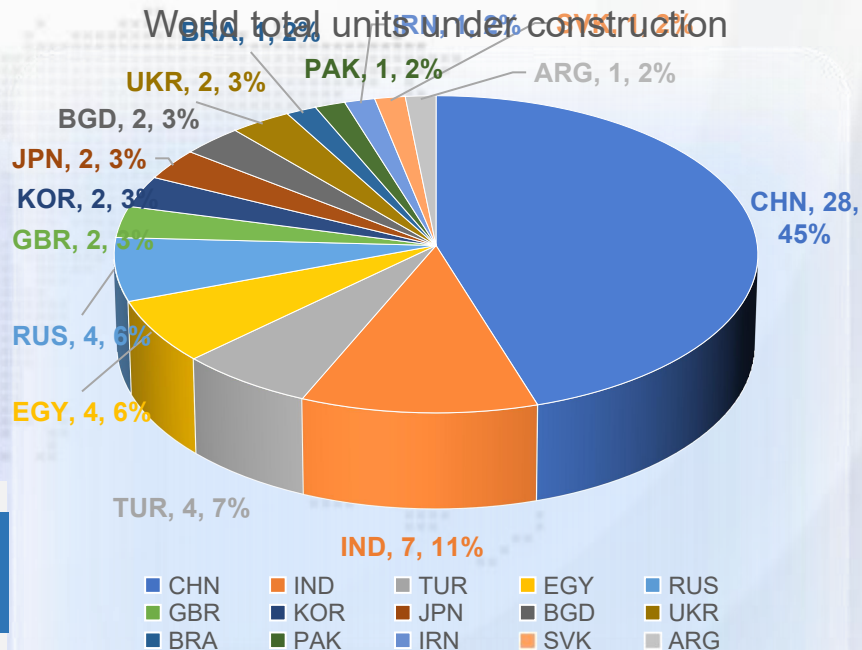
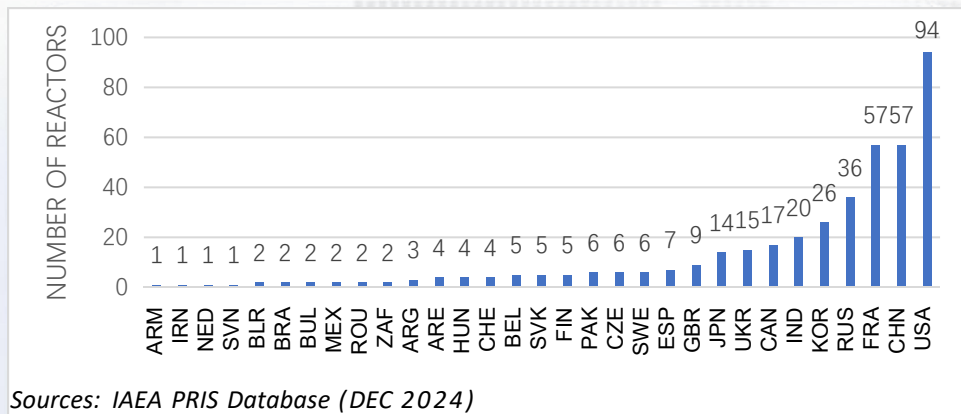


# New Trend in Nuclear Energy Development



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World total units in operation



417 Units



62 Units



9 Units

31 Economies

377 GWe

15 Economies

64.5 GWe

CHN 6  
RUS/PAK  
/EGY 1



# KEY FACTORS IMPACTING THE EXPANSION OF CAPACITY



# 1. STABLE POLICY SUPPORT

■ The Chinese government advocates for clean energy transition and provides stable policy support to the nuclear power industry.

- Peak carbon dioxide emissions by 2030
- Achieve carbon neutrality by 2060

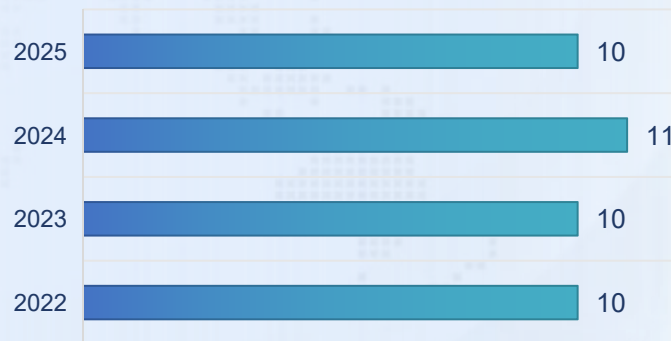
— By President Xi Jinping at the General Debate of the 75th UN General Assembly, 22 September 2020

- "Nuclear power should be developed in an active, safe and orderly manner."

— Government Work Report, March 5, 2021

China has approved over 10 nuclear power units annually for 4 consecutive years since 2022.

Units Approved





## RAPID AND STABLE GROWTH IN INSTALLATION



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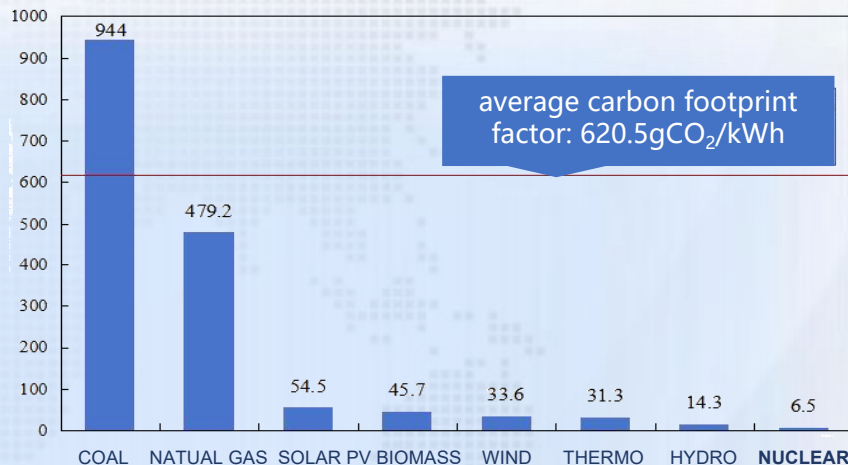
- China's nuclear power installed capacity has been steadily increasing, with nuclear energy playing an increasingly prominent role in supporting the reduction of carbon emissions.

### CHINA TO BE 102 UNITS IN 2030S

On operation: **58** units, **60,960** MWe

Under construction: **28** units, **33,650** MWe

Approved: **16** units, **18,400** MWe



Data source: China National Energy Administration, 2024

|           | Nuclear power generation | Reduction of standard coal | Reduction of CO <sub>2</sub> emissions | Reduction of SO <sub>2</sub> emissions | Reduction of NO <sub>x</sub> emissions |
|-----------|--------------------------|----------------------------|----------------------------------------|----------------------------------------|----------------------------------------|
| 1994-2024 | 4.38 trillion kWh        | 1.254 billion tonnes       | 3.285 billion tonnes                   | 10.66 million tonnes                   | 9.28 million tonnes                    |
| 2024      | 445 billion kWh          | 128 million tonnes         | 334 million tonnes                     | 1.1 million tonnes                     | 0.94 million tonnes                    |



## 2. STRENGTHENING SUPPLY CHAINS



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The key to building resilient industrial chains is the combination of **self-reliance** and **global diversification**.

### AUTONOMOUS & CONTROLLABLE

Controlling critical segments and securing critical resources is the foundation of stability.

### Hualong One

90%+

components were  
domestically  
produced

5,300+

upstream and  
downstream  
companies

114 major nuclear power equipment units in 2024



Natural uranium



Nuclear fuel



Reactor design & operation



Plant Construction



Equipment Manufacturing



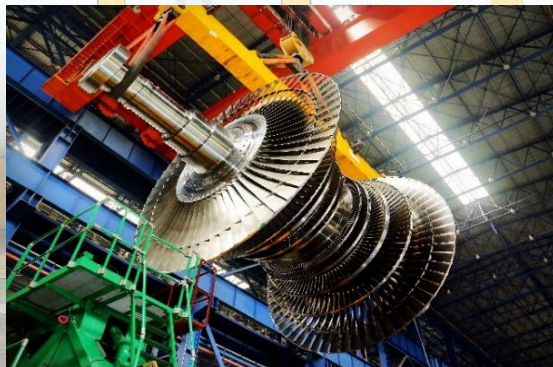
Radioactive waste disposal

# GLOBAL DIVERSIFICATION

Diversifying global suppliers reduces risks from over-reliance on single market or single supplier.

**For overseas projects:** “strong roots at home, smart partnerships abroad”

- **China Supply** : qualified suppliers can supply **100%** of key equipments, such as RPV, SG, Pressurizer, RCP, Primary piping, turbine-generator, etc.
- **Global Supply**: qualified suppliers can supply **RCP, DCS, EDG, I&C equipment etc.** as per owner's requirements.
- **Local Supply**: local suppliers will be evaluated and promotional activities will be carried out to **optimize local participation** in the NPPs construction.





### 3. ADDRESSING THE FUEL CYCLE



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■ Uranium is another issue that requires international collaboration.

## Uranium Exploration, Mining, Conversion and Enrichment

### Uranium resource exploration

We are equipped with the world-class **Space-Airborne-Ground-Underground integrated comprehensive exploration capability** and can quickly carry out geophysical data processing, interpretation, analysis and evaluation of mineralization geological conditions.



### Uranium mining

We are recognized as a global leader in **CO<sub>2</sub>+O<sub>2</sub> in situ leaching** uranium mining technology, with a track record of successful large-scale industrial applications.



### Uranium conversion and enrichment

We are capable of realizing uranium conversion (UF<sub>6</sub>) and enrichment (EUP) to obtain uranium dioxide (UO<sub>2</sub>) for fabrication of nuclear fuel pellets.



### 3. ADDRESSING THE FUEL CYCLE

China has advanced technology for manufacturing nuclear fuel assemblies for various reactor types including HPR1000, AP1000, VVER, CANDU-6, ACP100, HTR and others.

## Fuel Fabrication



□ CF3 for HPR1000



□ AFA3G/AP1000  
for major PWRs



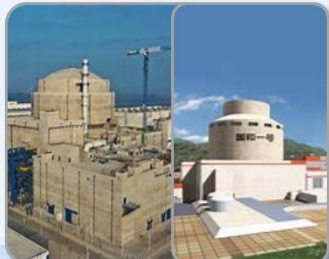
□ TVS for VVER



□ 37R/M for CANDU



□ Pebble fuel for  
HTGR



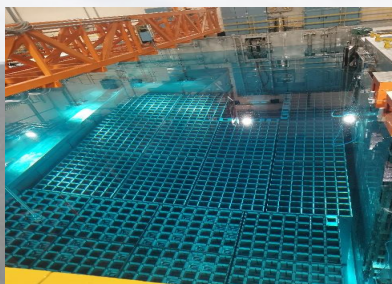


# SPENT FUEL MANAGEMENT



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- Spent fuel management is a complex and rigorous process involving multiple stages, each with specific purposes and technical requirements. By scientifically and reasonably managing spent fuel, radiation risks can be effectively reduced, valuable resources recovered, and environmental impact minimized.



Wet Storage  
in spent fuel pool  
(For HPR1000, 20 years)



Dry Storage (Interim Storage)  
in dry storage facility  
(40 years)



Reprocessing

After interim storage, spent fuel can undergo reprocessing. For overseas NPPs exported by CNNC, spent fuel can be returned back to China based on G-G agreement, Chinese laws and regulations.

## RADIOACTIVE WASTE MANAGEMENT

For 1 unit of HPR1000, the annual waste volume during operation stage is designed as  $<50\text{m}^3$ .

CNNC adopts advanced and proven treatment processes for all types of waste (Liquid/Solid waste treatment) to ensure radioactive waste minimization. We provides customized service covering the whole process from planning, site selection, construction, commissioning to operation.



## 4. FACILITATING ADOPTION IN EMERGING ECONOMIES



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The IAEA Milestones Approach has provided a general guidance:



### Milestone 1

Ready to make a knowledgeable commitment to a nuclear power programme.



### Milestone 2

Ready to invite bids/negotiate a contract for the first NPP.

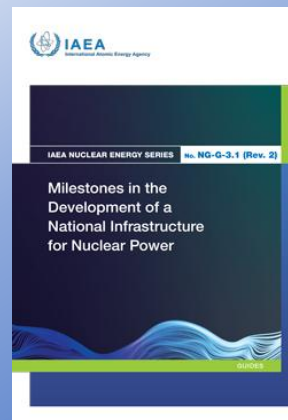


### Milestone 3

Ready to operate the first NPP

### The 19 infrastructure issues addressed:

|                                |                                         |
|--------------------------------|-----------------------------------------|
| 1. National position           | 11. Stakeholder engagement              |
| 2. Nuclear safety              | 12. Site and supporting facilities      |
| 3. Management                  | 13. Environmental protection            |
| 4. Funding and financing       | 14. Emergency preparedness and response |
| 5. Legal framework             | 15. Nuclear security                    |
| 6. Safeguards                  | 16. Nuclear fuel cycle                  |
| 7. Regulatory framework        | 17. Radioactive waste management        |
| 8. Radiation protection        | 18. Industrial involvement              |
| 9. Electrical grid             | 19. Procurement                         |
| 10. Human resource development |                                         |





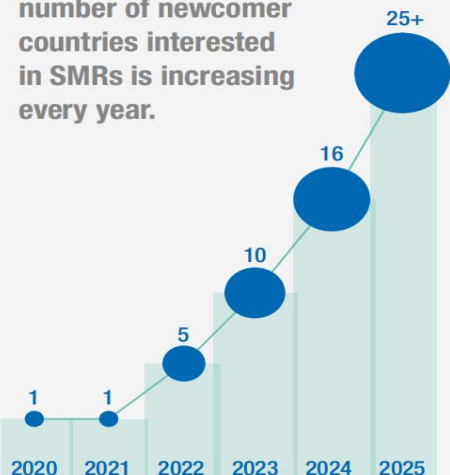
## EXPLORE THE FEATURES of SMRs



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### About 30 nuclear newcomer countries that are exploring the possibility of deploying SMRs

The cumulative number of newcomer countries interested in SMRs is increasing every year.



- A more affordable option for smaller grids;
- Replace fossil fuel generation in remote communities and industries;
- Coupling with renewables and energy storage;
- Low carbon power for urban&industrial heating, steam supply, seawater desalination, hydrogen production, and Super Computing Network.





# SMR in Operation

## HTR-PM

### 200MW HTGR demonstration project

The Pebble-bed Modular High Temperature Gas-cooled Reactor (HTR- PM) is an advanced reactor with the characteristics of **Gen-IV nuclear power technology** with independent Chinese intellectual property.

#### COMMERCIAL OPERATION

- In Shidao Bay, Shandong Province since December 2023

|                                   |                  |
|-----------------------------------|------------------|
| Installed Capacity                | 210MWe           |
| Coolant (Helium) Pressure         | 7MPa             |
| Reactor Outlet Temperature        | 750°C            |
| Main steam Temperature & Pressure | 541°C, 13.9MPa   |
| Design Life                       | 60 years         |
| Application                       | Power generation |
| Construction Period(FCD-COD)      | 132 months       |



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## Features

- Inherent Safety
- On-line Refueling
- High-Efficiency Power Generation
- On-Site Heating
- Industrial Steam Supply
- Urban Heating



# SMR under Construction

## ACP100

### “Linglong One”

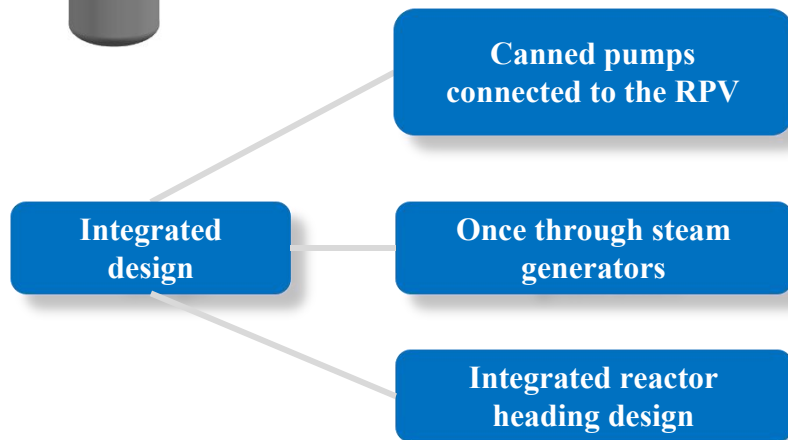
ACP100 is a new generation of small and elegant NPP, developed on the foundation of inherent mature technology, aimed at a broader users featuring with easily connected to **small and medium sized power grid, urban regional heat supply, industrial process steam supply and seawater desalination.**

## Technical Features

- Advanced integrated reactor
- Passive design of safety system
- Multi Applications
- Modular Design



### □ Integrated design



More compact

More advanced

Safer



# SMR under Construction

## ACP100

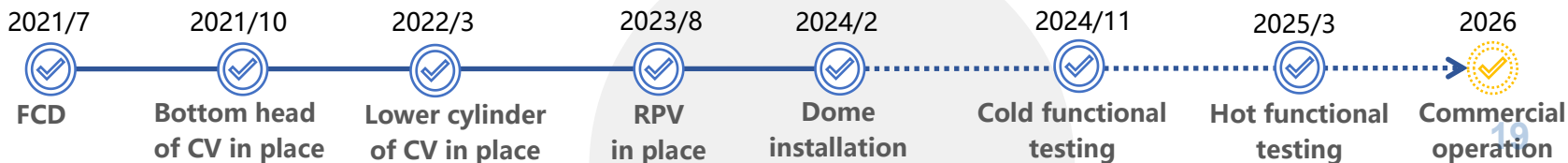
### “Linglong One”

| Items                        | Changjiang Unit    |
|------------------------------|--------------------|
| Installed Capacity           | <b>125 MWe</b>     |
| Design Life                  | 60 years           |
| Refueling Cycle              | 24 months          |
| Availability Factor          | ≥90%               |
| Safety Shutdown Earthquake   | 0.3g               |
| FCD                          | July 13, 2021      |
| Planned COD                  | Dec., 2025         |
| Construction Period(FCD-COD) | <b>53.5 months</b> |



ACP100 unit in Hainan Province

#### Milestones of construction





## Other SMR DESIGNS



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The other SMR designs like ACP300, DHR-400, ACP100s, Small Modular Fast Reactors, etc., each tailored for diverse energy needs, from cities to offshore, ensuring adaptable power generation and fitting other industrial needs.

### ACP300:

- 290 MWe electrical output, 80 years design lifetime;
- Compact N1 layout, automation and intelligent;
- Micro-grid, mining areas, island and remote areas.

### ACP100s:

- Floating reactor;
- 125 MWe electrical output;
- Power, heat, desalination;
- Offshore oil platforms, islands, coastal industrial parks.

### DHR-400:

- Used for heating
- Proven technology, simplified operation and maintenance.
- Zero reactor melt-down, zero emission, easy decommissioning.
- No need for off-site emergency response.
- Strong site adaptability and application expansion.

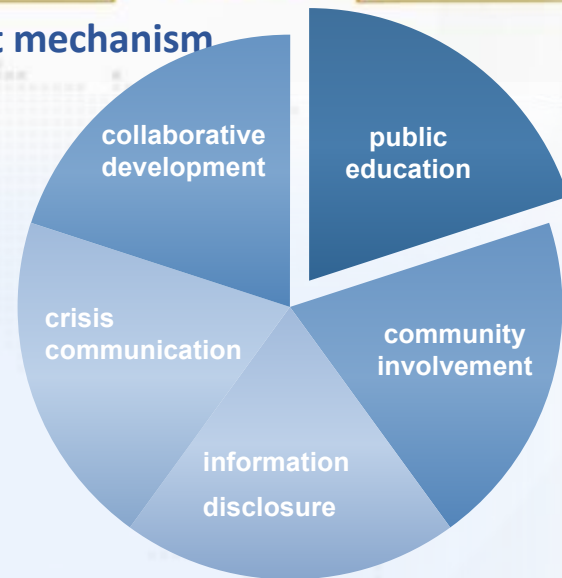


## 5. PUBLIC PERSPECTIVES ON NUCLEAR ENERGY



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### China has established a 4-dimensional public engagement mechanism



- **Host Open Days** for residents near nuclear plants to build trust.
- **Generate jobs and boost local income** through plant operations and infrastructure projects.
- **Improve environmental quality** by reducing carbon emissions and air pollutants.
- **Offer weekly nuclear science classes** in local schools (e.g., Hainan's curriculum reaching 5,000+ students).
- **Spread nuclear safety culture via trending platforms** like TikTok/WeChat (e.g., "Nuclear Apple" video hit 160K views in 24h).





“ Meet your power demand  
with our **Delivery Capacity** ”

**INTEGRATED SOLUTIONS**  
**TO BRING NEW CAPACITY ONLINE**

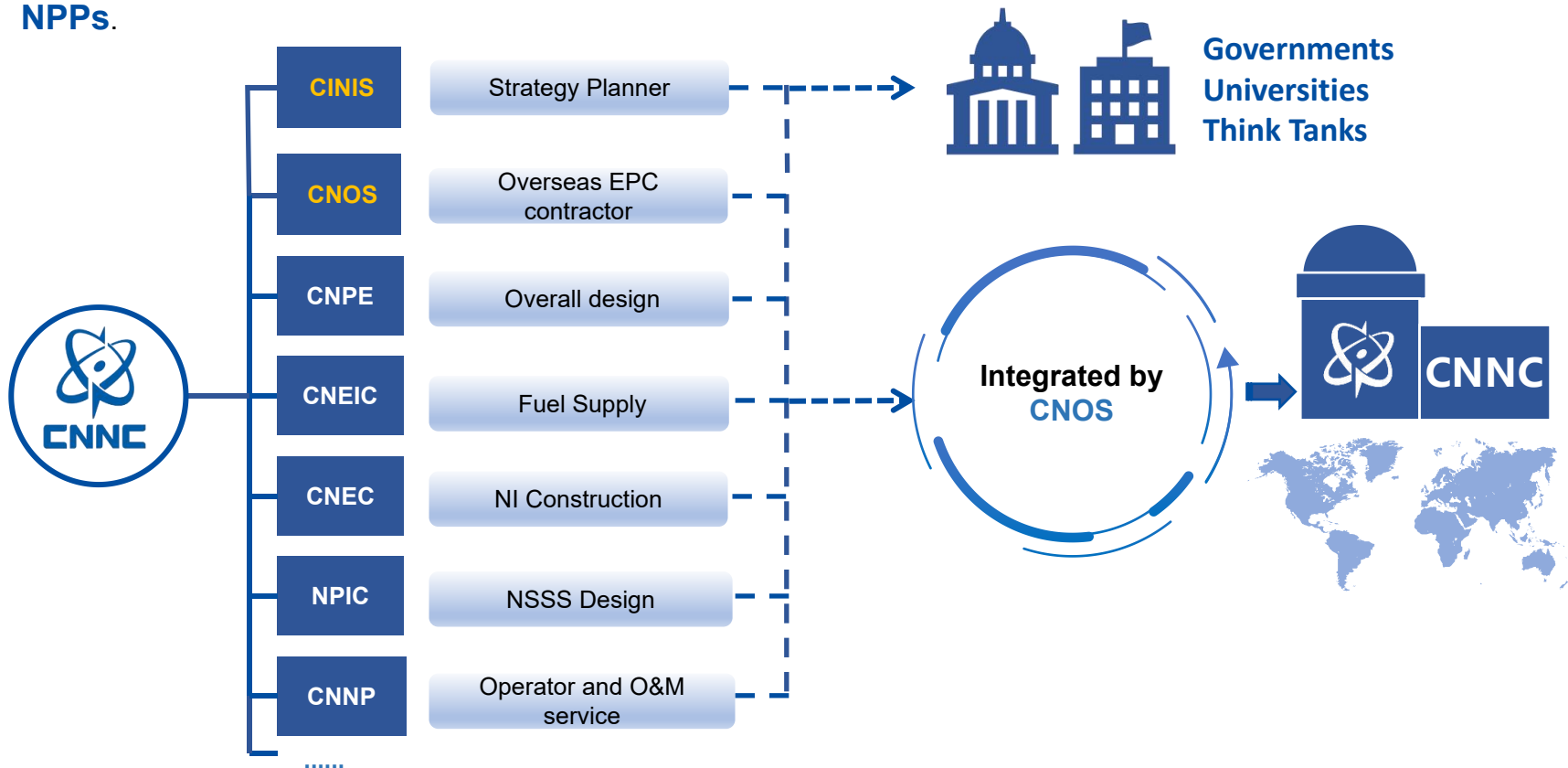


# INTEGRATED SOLUTIONS



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Based on the complete nuclear industry chain, **we provide life cycle integrated solutions for overseas NPPs.**



# Overseas Projects

Over the past 40 years, CNOS has successfully exported 1 nuclear research reactor to Algeria and 6 nuclear power units to Pakistan.

| Unit | Type    | Installed Capacity (MWe) | FCD          | COD          |
|------|---------|--------------------------|--------------|--------------|
| C-1  | CNP300  | 300                      | Aug 1, 1993  | Sep 25, 2000 |
| C-2  | CNP300  | 325                      | Dec 28, 2005 | May 12, 2011 |
| C-3  | CNP300  | 340                      | Mar 4, 2011  | Dec 6, 2016  |
| C-4  | CNP300  | 340                      | Dec 18, 2011 | Sep 26, 2017 |
| K-2  | HPR1000 | 1100                     | Aug 20, 2015 | May 20, 2021 |
| K-3  | HPR1000 | 1100                     | May 31, 2016 | Apr 18, 2022 |



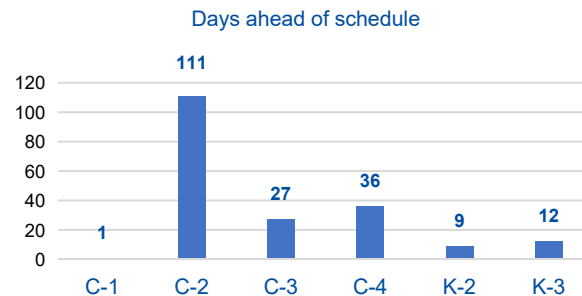
Chashma Unit 1~4 in Pakistan



Karachi Unit 2~3 in Pakistan



Research reactor in Algeria, praised by IAEA as a "model of south-south cooperation"



All the 6 units in Pakistan were completed within budget, ahead of schedule and operated by owner safely and stably.

## One HPR1000 Unit

- Supply electricity for **4,000,000** families per year
- Equivalent to **70,000,000+** trees planted
- Reduce **3,120,000** tons of standard coal per year
- **10,000+** direct jobs
- Reduce **8,160,000** tons carbon dioxide emissions
- **40,000+** indirect jobs



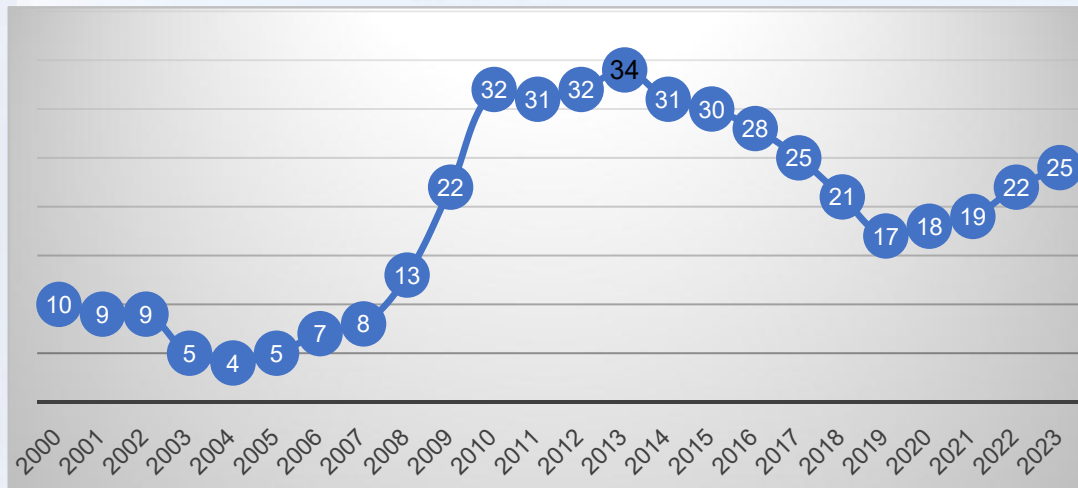
# CONSTRUCTION CAPABILITY



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■ CNEC has developed a series of advanced construction technologies, and successfully completed the construction of world's first HPR1000, EPR and AP1000 units.

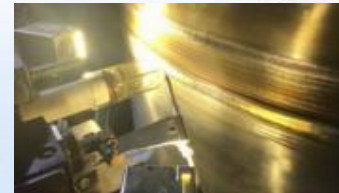
By the end of August 2024, one of CNNC's subsidiaries, CNEC has successfully constructed 63 NPPs (domestic and overseas) which across multiple reactors (125MW~1750MW) and has the capability to build up to 40 NPPs simultaneously.



NPPs constructed by CNEC since 2000 to 2023



Open top installation



Automatic welding



Modular construction



Digital construction



Smart construction



Modelling and simulation



# ADVANCED DIGITAL PLATFORM FOR NPP



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Cyber security

Standards

Digital Operation

Digital Equipment

Digital Maintenance

Digital Safety quality

Digital Management

Digital Summation

Digital Engineering

Digital New Energy

Industrial Data  
Engineering

Industrial Artificial  
Intelligence

Intelligent  
Equipment (robot)

Advanced Sensors and  
Intelligent Control

Industrial Software

Digital twin

Industrial Internet Platform (DHP)



# HIGH STANDARDS IN SAFETY AND PERFORMANCE



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- China's commercial nuclear power units maintain the highest global standards in operational safety, with world-leading performance in critical operational metrics.



## 01 Long-Term Safety Record

As of April 2025, nuclear power units in Chinese mainland have safely operated for over 600 reactor-years without any INES Level 2 or higher incidents or accidents.

## 02 Globally Recognized Safety Performance

38 Chinese units achieved a perfect WANO Composite Index score of 100, average WANO Composite Index for 54 Chinese units reached 97.52, both ranking first globally.





# FINANCING SOLUTIONS



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- **ECA (Export Credit Agency) facilities have been utilized in the NPP units exported to Pakistan successfully, which can provide stable and sustainable financing support. Financing close can be realized within 1 year on the basis of sovereign credit.**

Chinese financial institutes can provide mixed financing support for overseas NPPs construction, includes:

- concessional loan
- preferential buyer's credit
- commercial loan

Financing amount can be up to **85% of EPC contract price**, depends on the Chinese export share.

Financing term of ECA facility currently is **20 years**, including **8 years' grace period**.

Moreover, CNNC can participate **minority equity investment** in the project company according to owner's requirements.

Other financing solutions can be discussed as per owner's requirements, such as BOT/BOOT/BOO.

Export Credit Agency(ECA) facility for units exported to Pakistan (**82% of the EPC contract**):

- Concessional loan
- Preferential buyer's credit
- Commercial loan

**Note: Concessional loan and Preferential buyer's credit need to be approved by the government of China.**



# SYSTEMATIC TRAINING



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■ CNNC utilizes the **Systematic Approach to Training (SAT)** to ensure effective training for personnel and has established a complete training system fully applicable to both domestic and overseas.

## Training sources:

- Nearly 1,000 professional instructors
- Comprehensive training programs
- Operation training centers
- Skill training centers
- Nuclear vocational skills evaluation centers
- Full scope simulators for HPR1000, AP1000, M310, CANDU6 and VVER

## Training content:

- 19 infrastructure issues
- Nuclear regulatory system
- Pre-project works
- Design, manufacture, commissioning, O&M and simulator training

## University education programs supported by CNNC:

- Atomic Energy Scholarship Program of China (**AES**)
- Tsinghua University International Master's Program in Nuclear Engineering and Management (**TUNEM**)

**5,000+** international operators trained



Training center



Mock-ups of main equipment



Simulator



Pumps training facility



# IAEA TRAINING CENTER FOR SMRs



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■ We are establishing “Small Modular Reactor Interregional Training Center ” as the cradle of the development for small modular reactors in Hainan where the ACP100 is located.

## TRAINING SCOPE

- ❑ Supply chain and localization
- ❑ Licensing
- ❑ Siting and preliminary preparation
- ❑ Plant design
- ❑ Construction management
- ❑ Procurement
- ❑ Commissioning
- ❑ Operation& maintenance
- ❑ Outage management



## Human Resource Development



# VISION FOR BROADER INTERNATIONAL COOPERATION



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After four decades efforts in building nuclear capacity from scratch, China has some experience to share with countries that are interested in nuclear energy .

## Bilateral agreements on nuclear energy cooperation

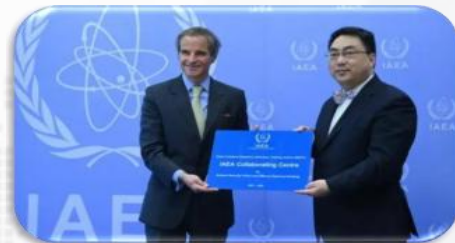
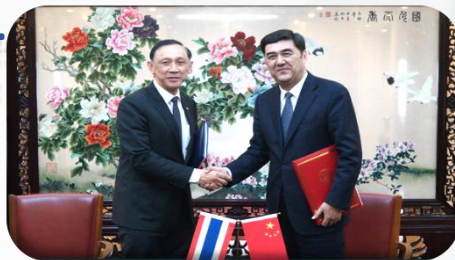


- Signed Agreement on the Peaceful Uses of Nuclear Energy with many APEC countries (THA, IDN, RUS, AUS, CAN, USA...)
- Joint Statements on Advancing the Comprehensive Strategic Cooperation that include nuclear or energy sectors.



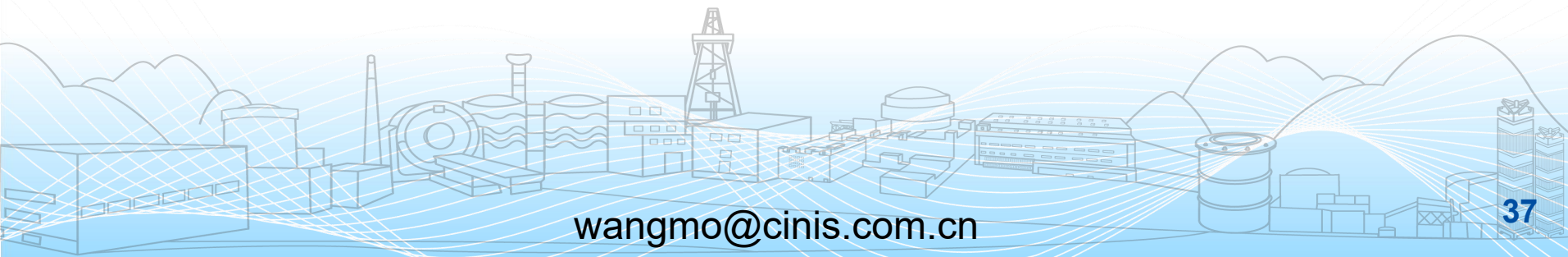
## Multilateral Platforms and Mechanisms

- BRICS Nuclear Energy Platform
- Regional Comprehensive Economic Partnership Agreement (RCEP)
- China-ASEAN Forum on Peaceful Uses of Nuclear Technology
- International Atomic Energy Agency (IAEA)
- Silk Road Fund
- Asian Infrastructure Investment Bank (AIIB)





**Thank you**  
**for your attention!**



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