中广核 CGN

Natural Energy Powering Nature

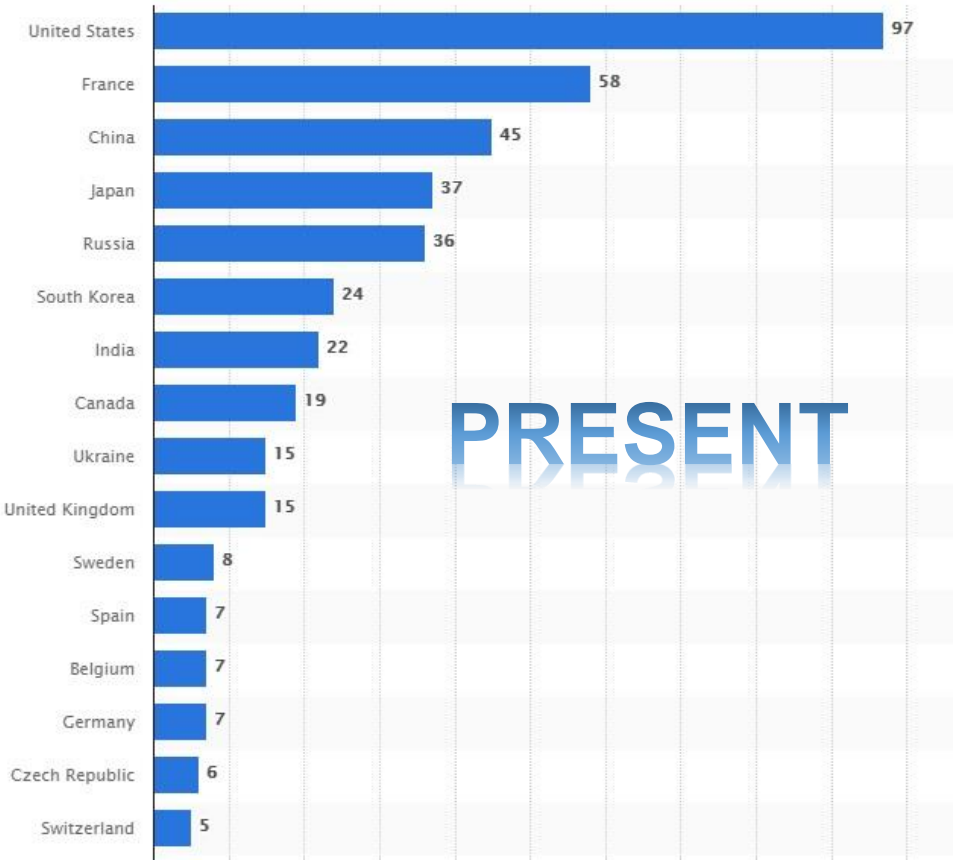
HPR1000, Reliable Nuclear Power Technology Powering A Clean and Safe Future

China General Nuclear Power Corporation

November 6th, 2019

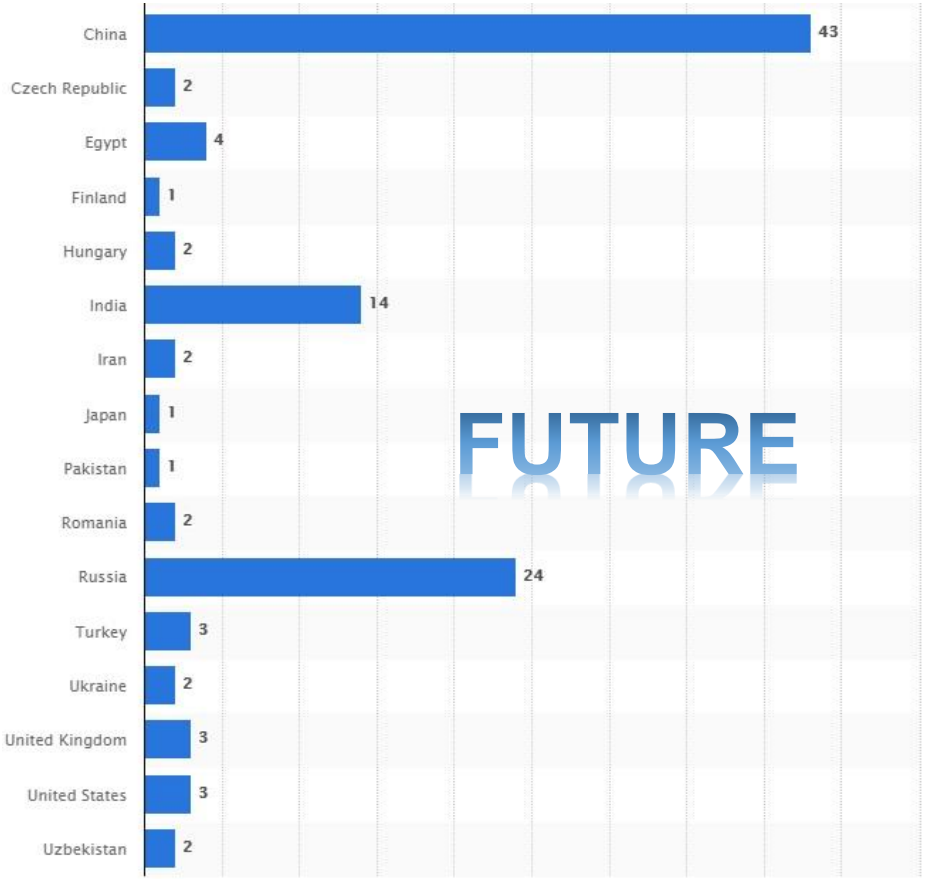
Global nuclear power development situation

Number of operable nuclear reactors as of June 2019, by country



Source: https://www.statista.com/statistics/267158/number-of-nuclear-reactors-in-operation-by-country/

Number of planned nuclear reactors globally as of May 2019, by country



Source: https://www.statista.com/statistics/268154/number-of-planned-nuclear-reactors-in-various-countries/

China nuclear power development situation

- China has 47 operable nuclear reactors, with a combined net capacity of 45.7 GWe. In 2018, nuclear generated 4% of the country's electricity.
- The country continues to dominate the market for new nuclear build. At the start of 2019, 13 of the 57 reactors under construction globally were in China. In 2018 China became the first country to commission two new designs – the AP1000 and the EPR.
- China is commencing export marketing of the HPR1000, a largely indigenous reactor design.
- The strong impetus for developing new nuclear power in China comes from the need to improve urban air quality and reduce greenhouse gas emissions. The government's stated long-term target, as outlined in its Energy Development Strategy Action Plan 2014-2020 is for 58 GWe capacity by 2020, with 30 GWe more under construction.

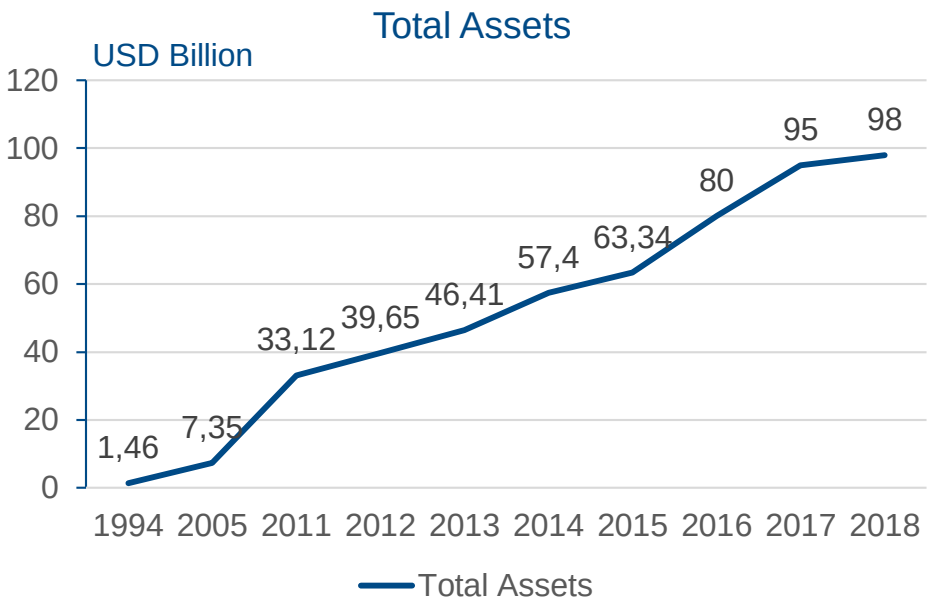
Source: http://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx

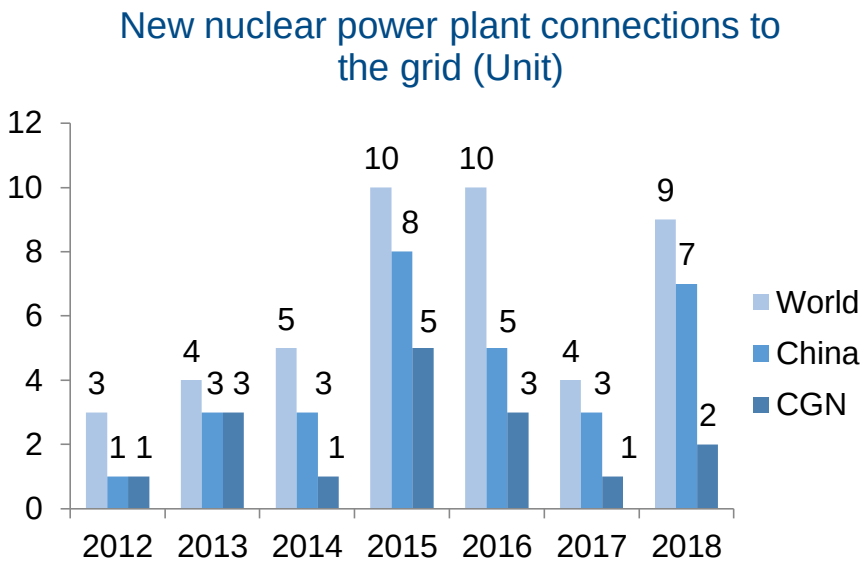
About CGN

- A world leading owner, constructor and operator of both nuclear power and renewable energy
- One of world's largest clean energy groups with 30 subsidiaries and 41,000 employees worldwide
- Provides its clients with integrated investment and engineering solutions for nuclear new build projects

About CGN

One of the fastest growing energy companies in the world





About CGN

(As of Aug 2019)

Units in operation

x24

27.1GW

56%
domestically

Units under construction

x4

4.6GW

9%
globally

41%
domestically

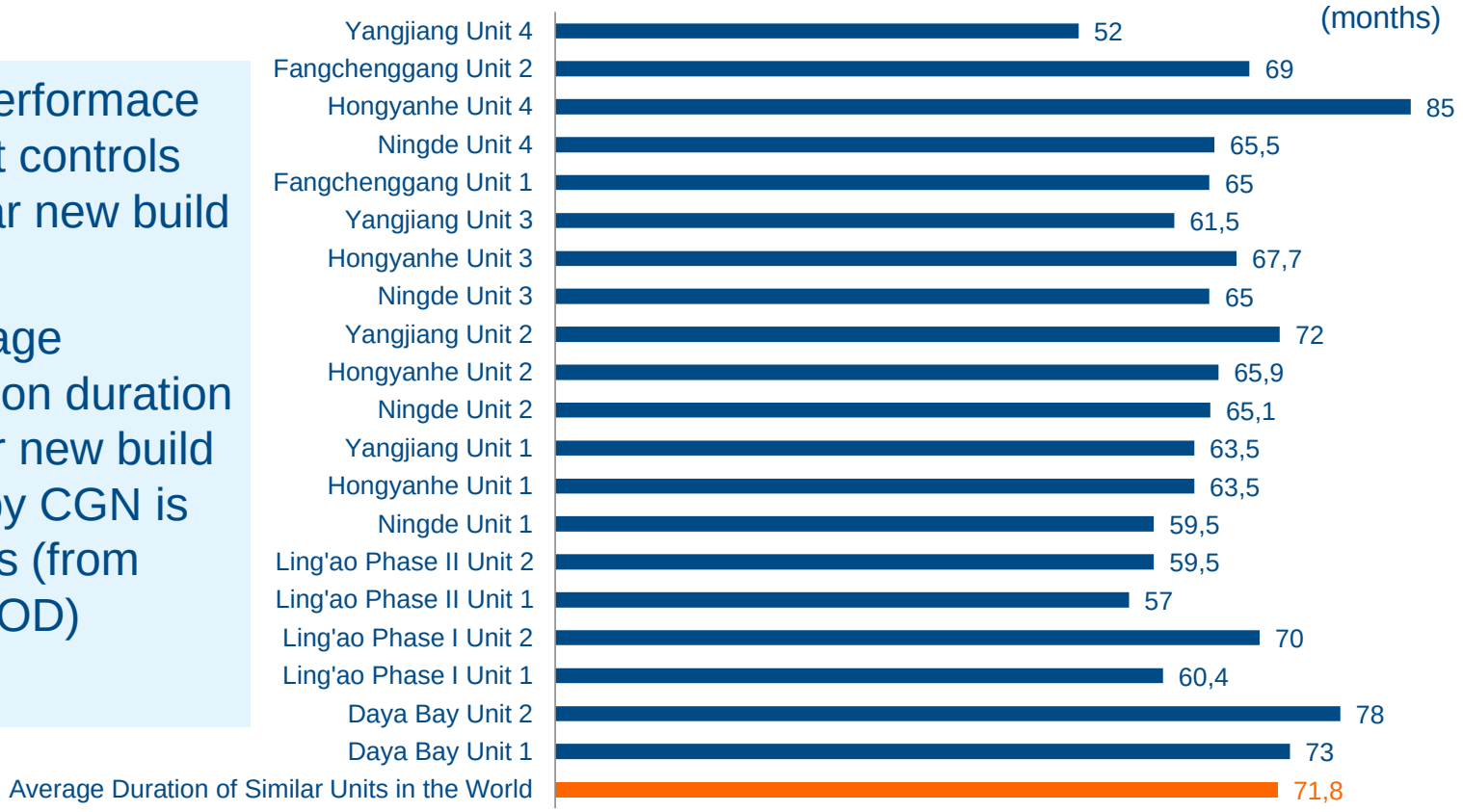
HPR1000 Units Approved by the Chinese Government for Implementationi in the future 10 to 15 years

x22

25GW

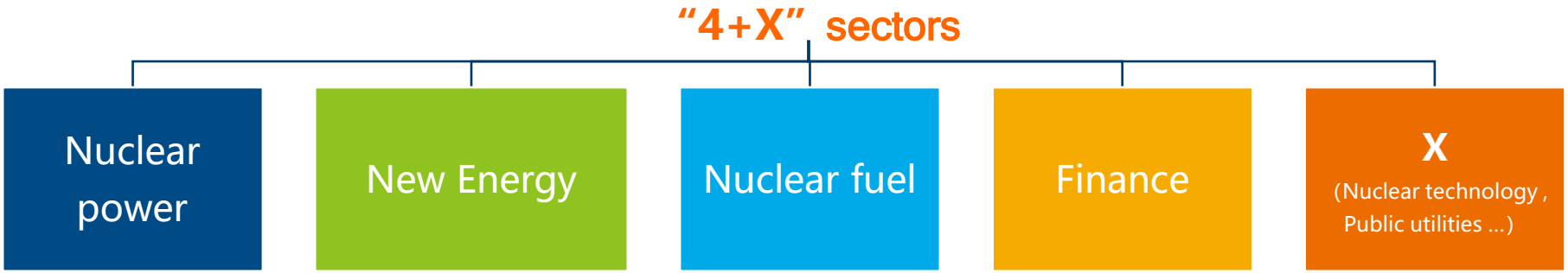
Continuous Nuclear Power Project Construction Experience over 30 Years

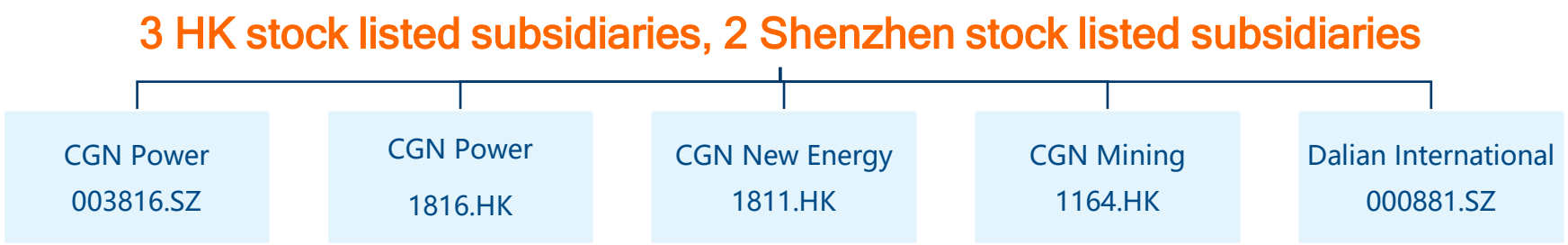
- Superb performace on project controls for nuclear new build projects.
- The average construction duration of nuclear new build projects by CGN is 70 months (from FCD to COD)



About CGN

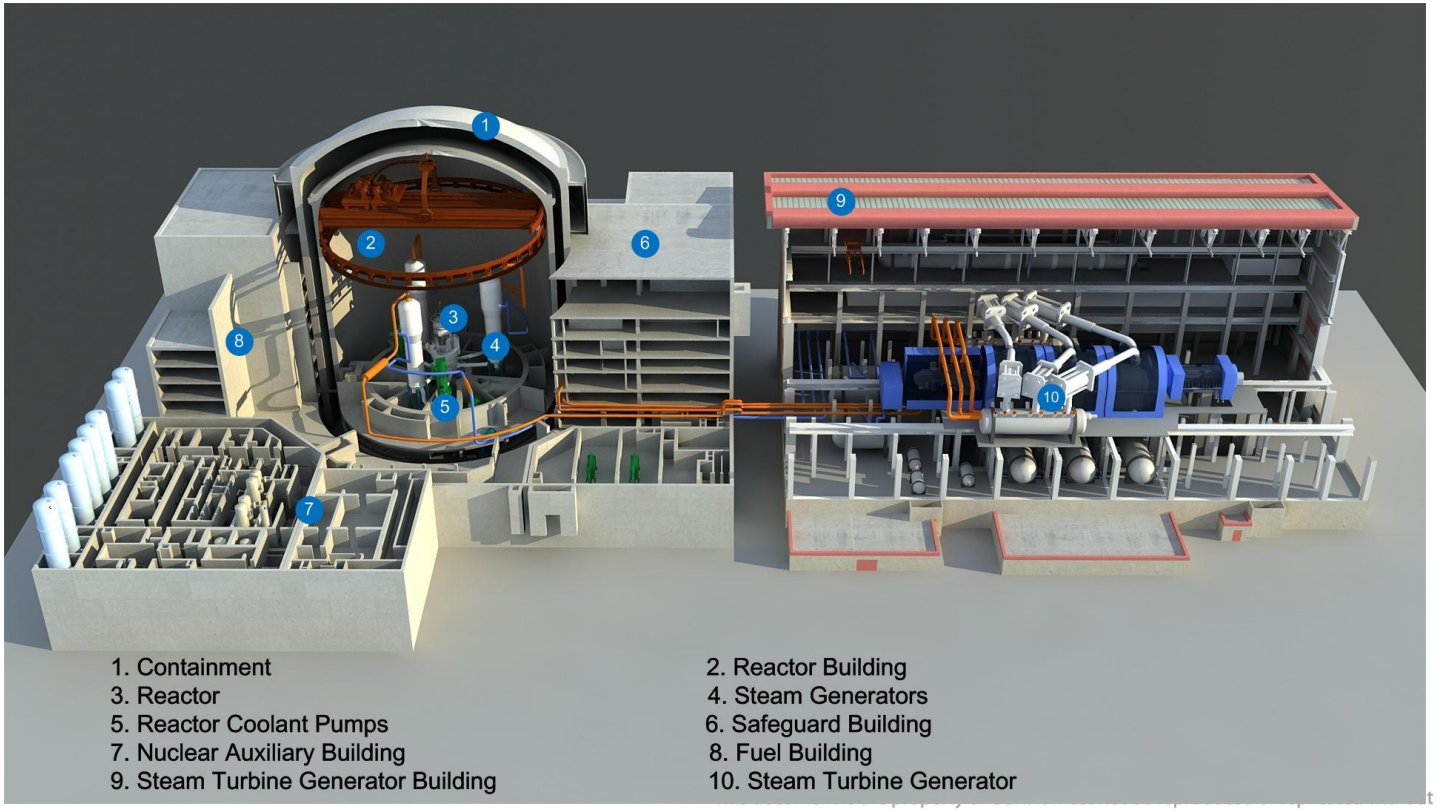
- As of August 2019, the total assets reached up to **$101 billions**
- **Business lines** includes four plus X sectors
- Full range of premier nuclear capabilities and extensive experience in all aspects of nuclear power plants





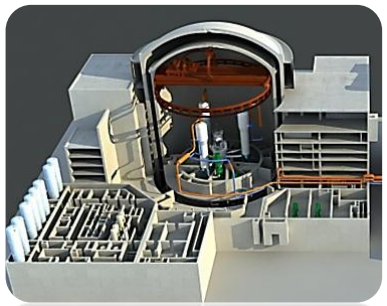
About HPR1000

- China's 3rd Generation Nuclear Power Technology with Independent IP rights
- Domestic reference projects: units 3 and 4 of Fangchenggang nuclear power plant in Guangxi Province
- To be adopted in the UK: the Bradwell B Project



About HPR1000

- Based on over 30 years of experience of continuous design, construction and operation of nuclear power plants in China
- Innovation by adopting proven technologies
- Fukushima nuclear accident feedback adopted in the design



HPR1000

About HPR1000

- Main design parameters of HPR1000 are in line with or higher than the requirements of URD and EUR.

Items	HPR1000	URD	EUR
Core Damage Frequency, /(reactor·year)	$<1\times10^{-6}$ (Fangchenggang NPP:~6.48E-07)	$<1\times10^{-5}$	$<1\times10^{-5}$
Large Radioactive Release Frequency, /(reactor·year)	$<1\times10^{-7}$ (Fangchenggang NPP:~6.79E-08)	$<1\times10^{-6}$	$<1\times10^{-6}$
Core Thermal Margin	>15%	>15%	>15%
Design Availability Factor	≥90%	≥87%	≥90%
Safe Shutdown Earthquake	0.3g	0.3g	0.25g
Operator Grace Time	≥30 min	≥30 min	≥30 min
Solid waste, m^3/(year·unit)	< 50	< 50	< 50
Design Lifetime, year	60	60	60

About HPR1000

Single Unit-Layout

- Optimized Single Unit-Layout
- Better for physical separation
- Easy for construction, Operation and Maintenance

Active + Passive Systems

- Secondary Passive Residual Heat Removal System
- Passive Reactor Cavity Injection System to prevent the melting accidents

Advanced I & C

- Digital I & C
- Diverse Auction System
- Advance MCR with Emergency inhibition system

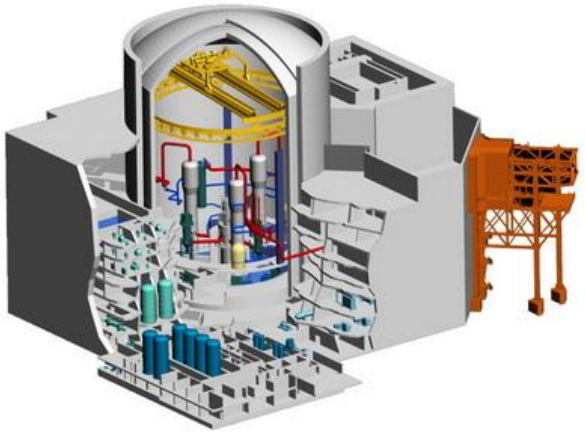
Double Containments

- Double Containments with large volume
- Ventilation System in double containments
- Resistance to impact of large airplane crash

Three Safety System Trains

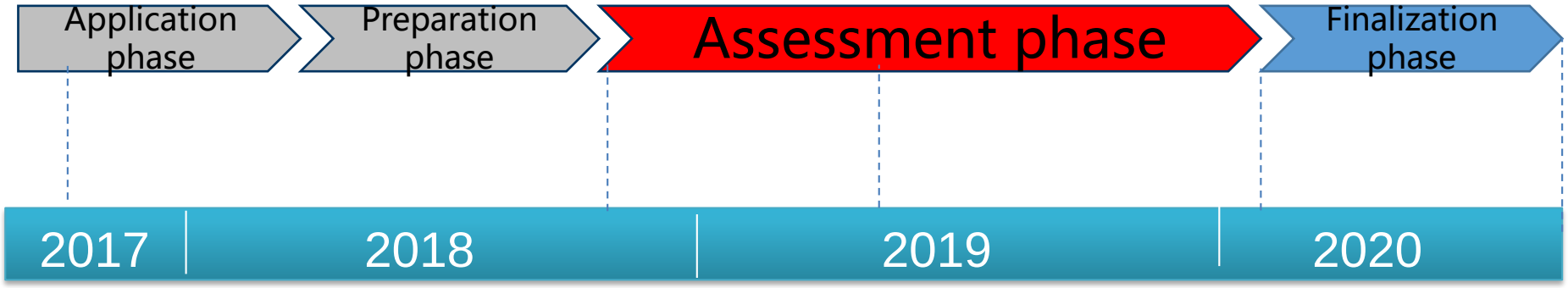
- 3x100% redundant systems for safety safeguards, fully independent and physically separated
- Effective resistance to accidents and internal and external hazards

Advanced Generation III Nuclear Power Technology



About HPR1000 - EUR Assessment

- In 2017, CGN submitted the application to EUR organization starting the assessment process of HPR1000.
- HPR1000 is the first nuclear power technology being assessed based on EUR version E.
- The assessment is in good progress and is expected to be completed in 2020.

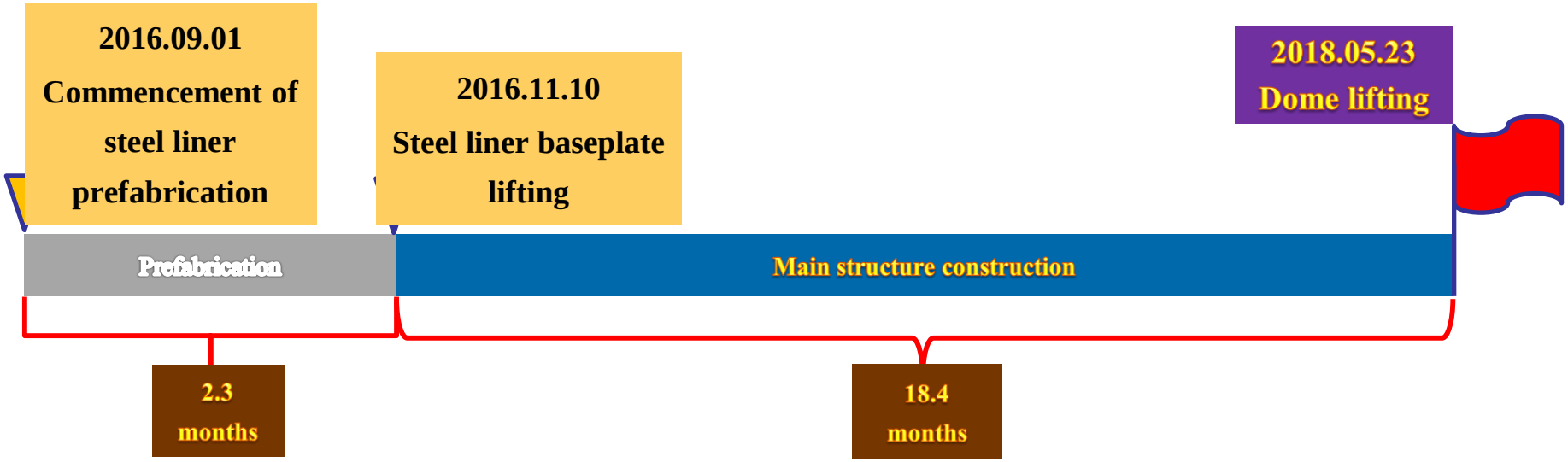


Overall Project Progress

- Unit 3: started construction on Dec.24, 2015. Dome lifting was completed in advance on May 23, 2018. At present, the first two floors of main buildings have been handed over for installation.
- Unit 4: started construction on Dec. 23, 2016.

Overall project progress

- **The dome lifting of unit 3 was completed 8 days in advance compared with the schedule plan date.** The actual duration of civil engineering critical path of Unit 3 is at the optimal level of Generation III units; **the duration for lifting the steel liner baseplate to the dome is 18.4 months, creating the best historical result.**

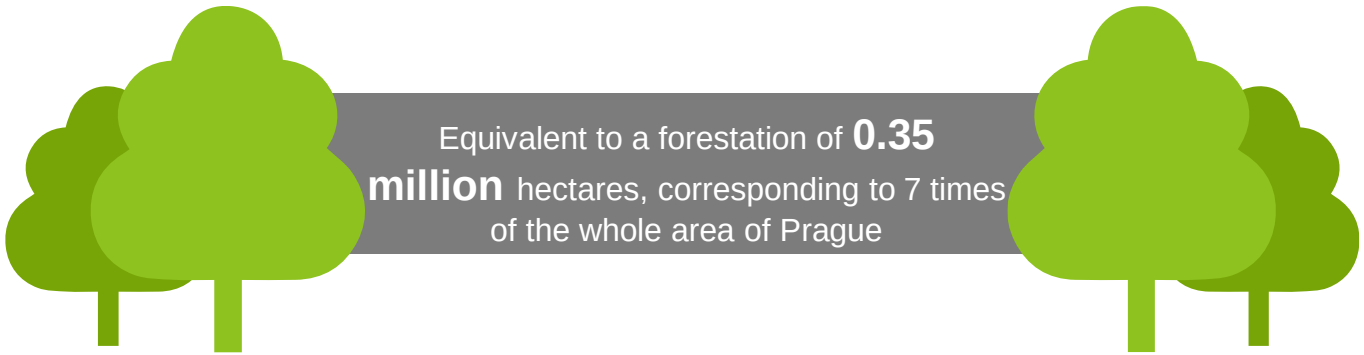


Environmental Benefits

Bluer Sky Cleaner Water

In 2018, on-grid power generated from nuclear power was 157.05 TWh.

Reduced consumption of standard coal	Reduction of CO_2 emission	Reduction of SO_2 emission	Reduction of nitrogen oxides emission
48.37 Million tons	126.73 Million tons	0.47 Million tons	0.31 Million tons



Environmental Benefits – 2 HPR1000 units

The two HPR1000 units of Fangchenggang NPP are expected to generate 16.5 TWh electricity annually. Compared with a same scale thermal power plant, it will reduce consumption of standard coal by 5.3 million tons, reduce CO_2 emission by 13 million tons and reduce SO_2 and nitrogen oxides emission by 0.21 million tons, which is equivalent to a forestation of 40 thousand hectares.

CGN's Proposal for Sino-Czech Cooperation on Nuclear New Build Projects

1

Based on the capabilities and experience of both sides, CGN and Czech companies will take charge of EPC of Nuclear and Convectional islands, respectively.

2

When awarded NI of the two Czech nuclear new build projects to CGN, CGN will equivalently award CI to Czech companies on two CGN nuclear new build projects in China simultaneously.

3

Furthermore, CGN-led Chinese enterprises and Czech enterprises can participate in each other's nuclear new build projects as well as jointly in the third country nuclear power new build projects.

Being Czech Strategic Partner

- Combining the premier capability and extensive experience of both sides in nuclear new build projects ensuring CGN complying with Czech legal and license requirements for siting and construction
- Promoting the sustainable development of the nuclear industry in both countries through the nuclear new build projects
- Making full use of the human resources of both sides
- Establishing long-term technical, research and education cooperation with Czech research institutes and universities based on CGN's sound research and education systems
- CGN's abundant localization experience can be effectively applied to the manufacturing and construction of nuclear new build projects in Czech Republic
- CGN with the high investment capability and rich financing experience is willing to provide the most competitive packages to our Czech partners
- Setting a benchmark of cooperation in the world nuclear power industry

THANK YOU

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