

Nuclear District Heating

Warm the World, Guard the Globe

(Deep-pool Low-temperature Heating Reactor---DHR)

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China National Nuclear Corporation

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Introduction

Design Scheme and Technical Features

R&D of DHR Project

Remarks

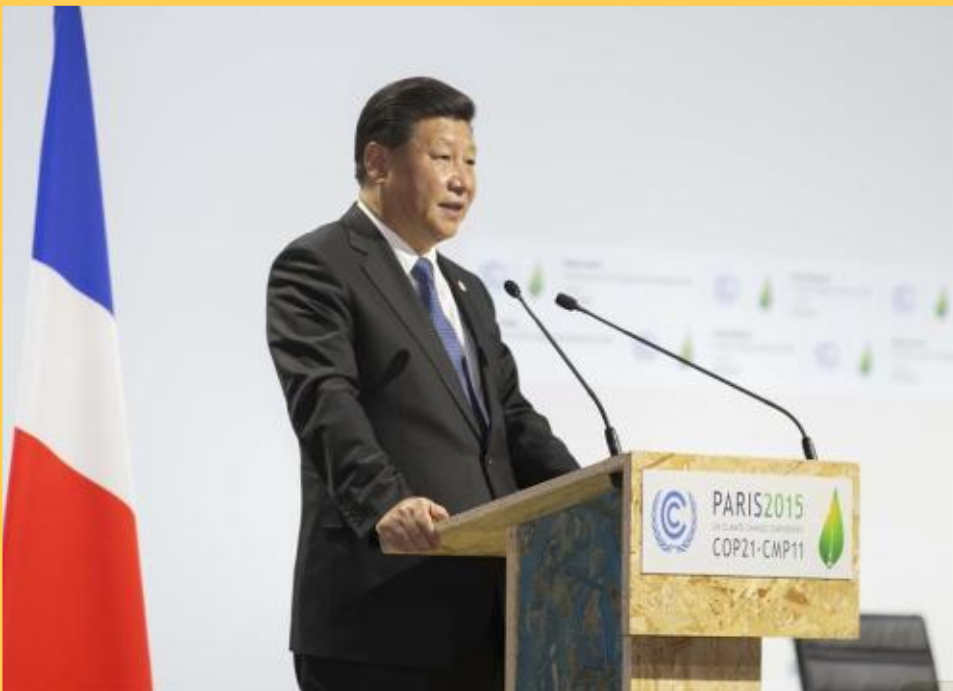


- Any human activity leave a Carbon Footprint
- Massive uses of fossil fuels leads to GHG emission, global warning and extreme weather
- Frequent haze in recent years in China

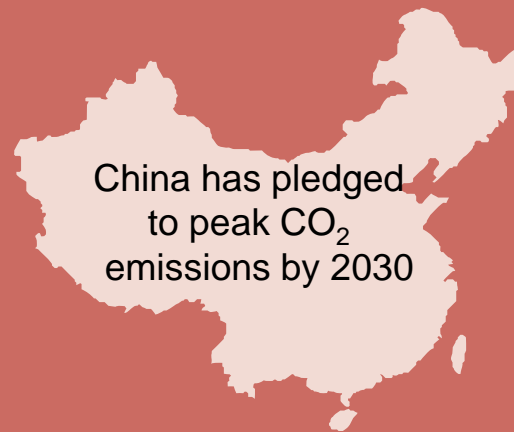




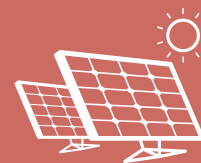
CHINA CONTINUES ITS COMMITMENT TO CLIMATE LEADERSHIP

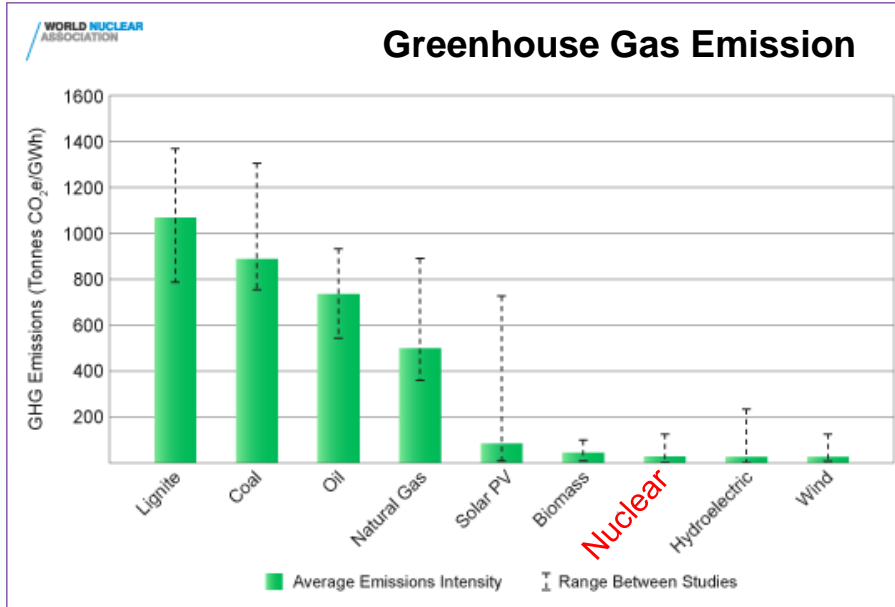


Chinese President Xi Jinping delivers a speech at the opening ceremony of the United Nations (UN) climate change conference in Paris, France, Nov. 30, 2015.



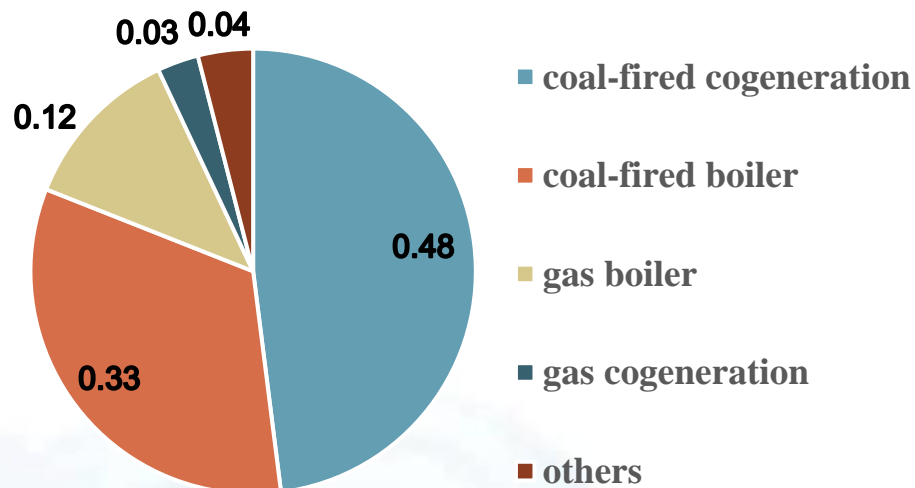
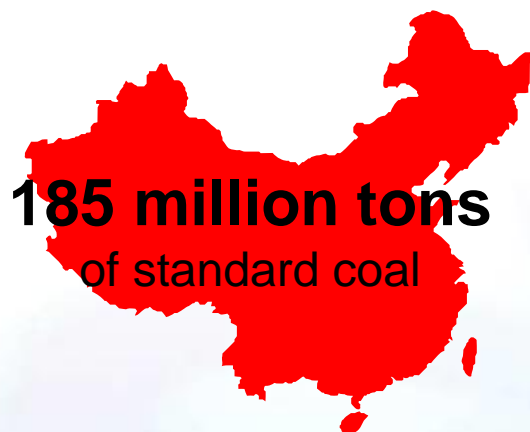
China will increase non-fossil energy sources in the total primary energy supply to around 20% by 2030





- Nuclear energy plays an important role in world electricity supply and contributes a lot in carbon dioxide emission reduction
- The world's NPPs have reduced **6 billion tons of carbon emission**, equivalent to **15million hectares afforestation**





Energy used in central heat supply in China during 2015

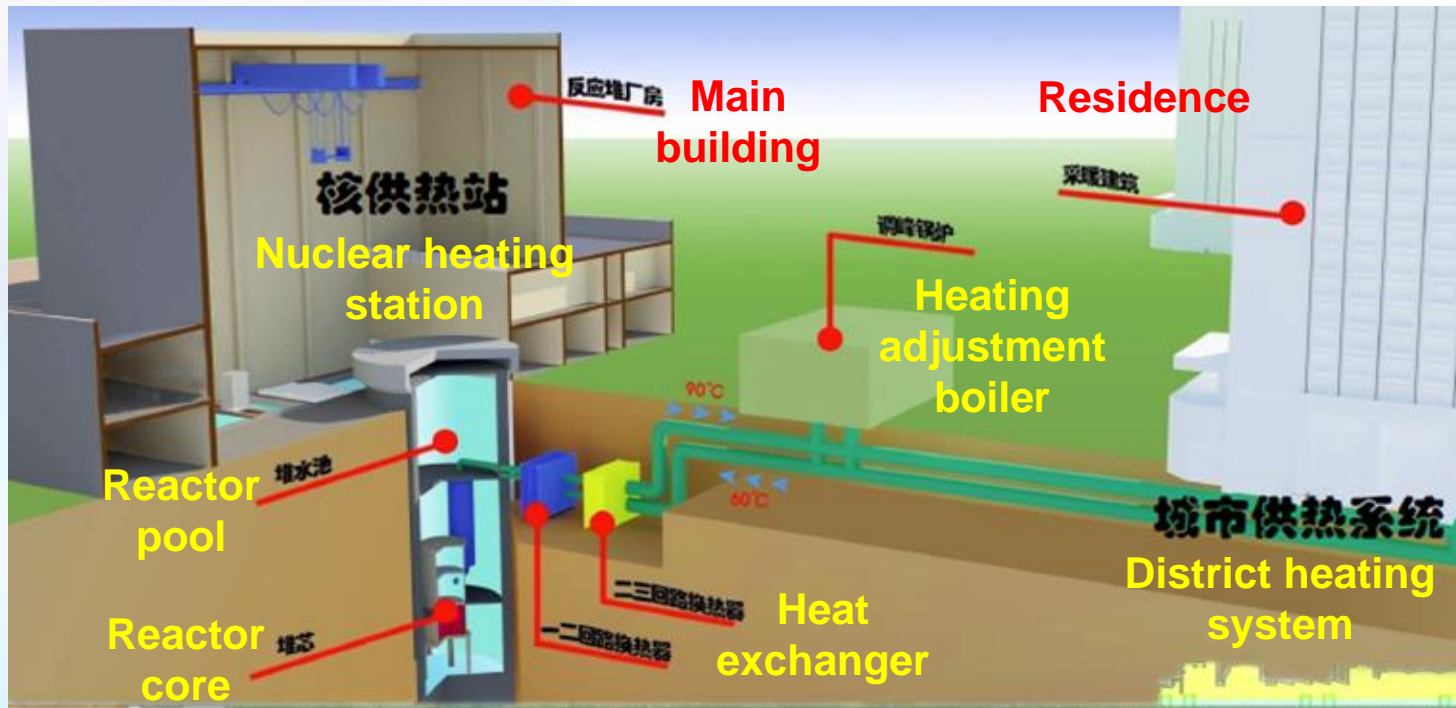
The proportions of different heat sources in central heating supply in china in 2016

- There exists a huge demand for green energy in the market of central heat supply in China
- Nuclear provides an ideal alternative to fossil fuel heating



Nuclear Heating

Using the heat generated by a nuclear reactor for heat supply



Overall schematic of District Heating System



- CNNC has developed a **Depool Low-temperature Heating Reactor (DHR, Yan Long, 燕龙)** on the basis of a pool type research reactor.
- The prototype of **DHR(Yan Long)** is the swimming pool reactor (**SPR IAE**) located at CIAE of CNNC.



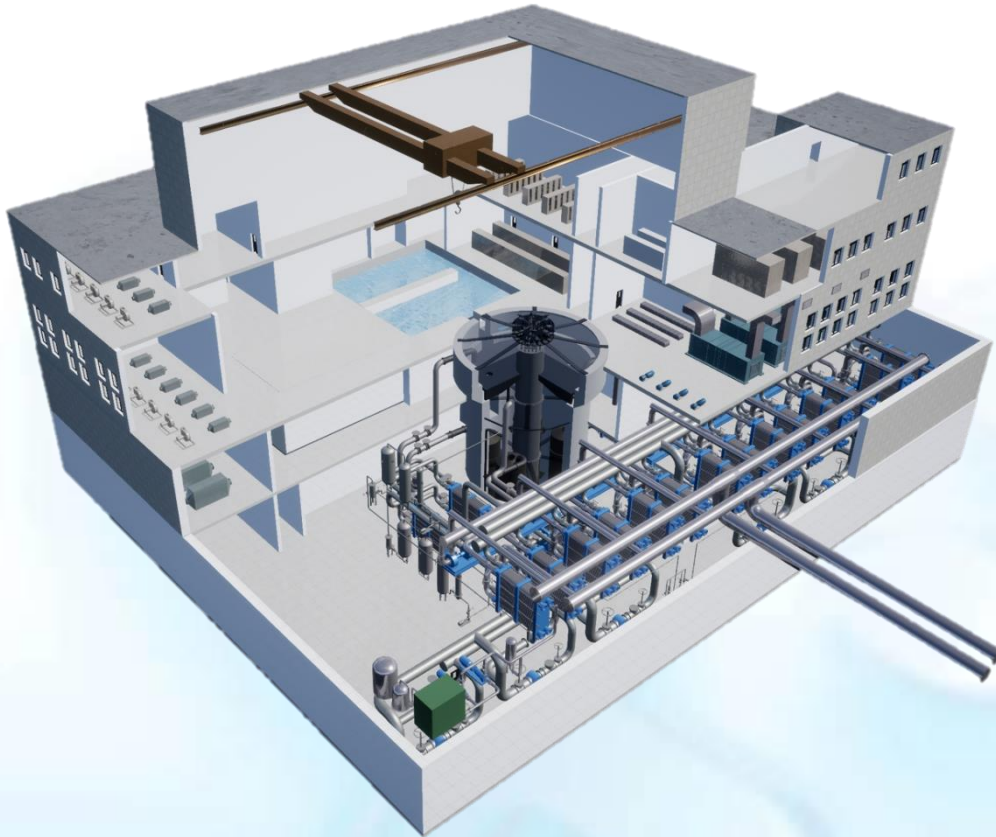
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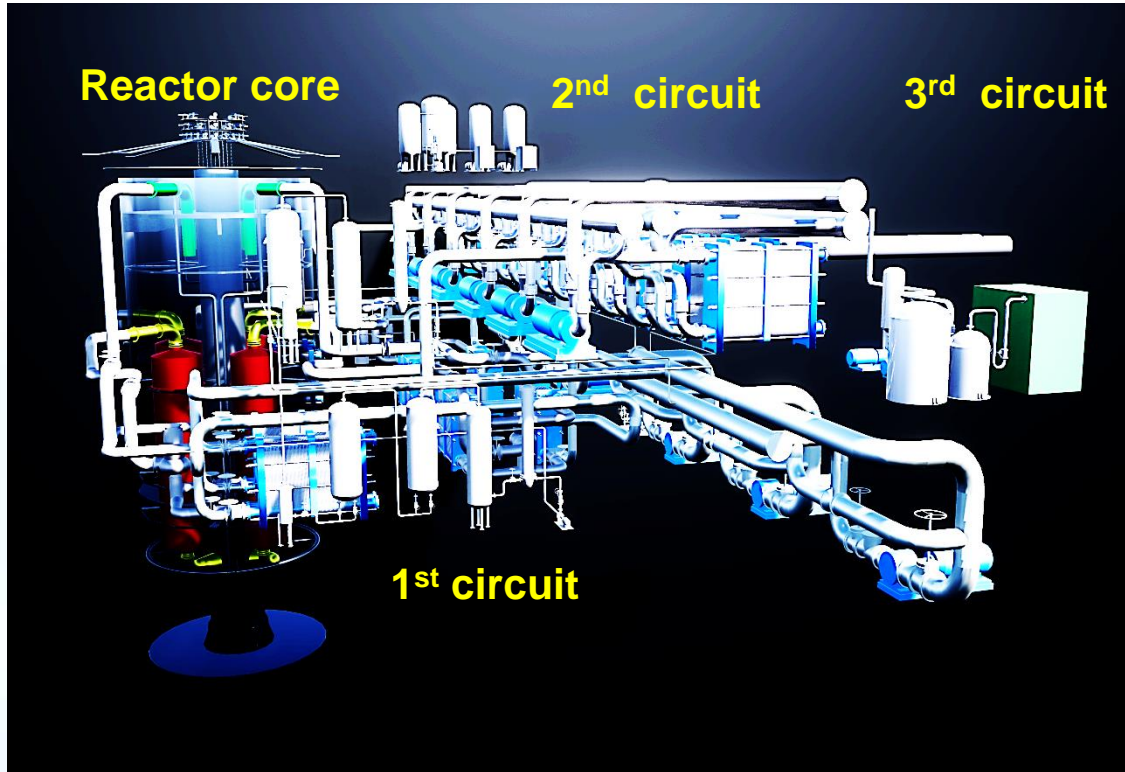
- The reactor core is placed in the bottom of an atmospheric-pressure pool
- A proper core outlet TEMP is achieved by increasing the static pressure of the water layer

Schematic view of DHR



Item	Parameter	Item	Parameter
thermal power /MW	400	enrichment of equilibrium refueling	3.1%
cooling type	forced	refueling period /EFPD	450
diameter of pool /m	10.0	average discharge burnup /GWD/tU	~30
depth of pool /m	26	refueling number per year /assembly	24
height of active zone /m	2.15	temperature of pool water /°C	68
equivalent diameter of core /m	2.02	inlet/outlet of core /°C	68/98
type of assembly	truncated PWR assembly(CF3-S)	inlet/outlet of secondary circuit /°C	63.5/93.5
number of assemblies	69	inlet/outlet of heating loop /°C	60/90
form of assembly	17×17 ₋₂₅	pressure of primary /MPa	0.6
diameter of fuel rod /mm	9.5	pressure of secondary /MPa	1.2
fuel loading of core /t	23.45	pressure of heating loop /MPa	1.8
average linear power density /kW/m	8.87	type of heat exchanger for primary circuit and secondary circuit	Plate-type

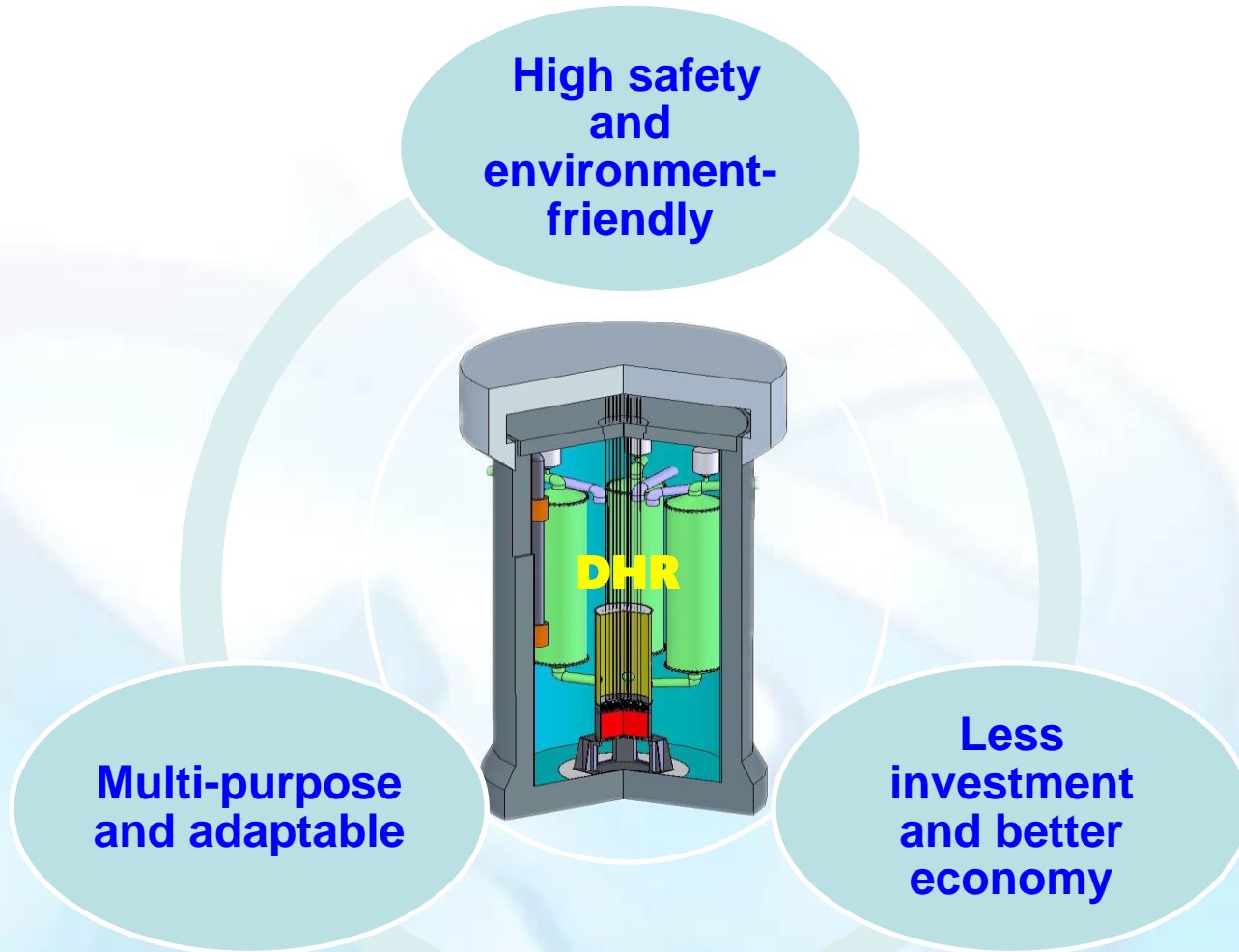




- Setting up the 2nd isolation circuit
- $P_3 > P_2 > P_1$, to ensure radioactivity will not enter heating pipe

3(1st, 2nd and 3rd) circuits layout, 2 times heat exchange

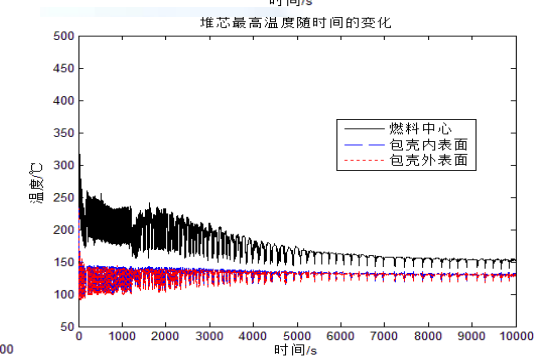
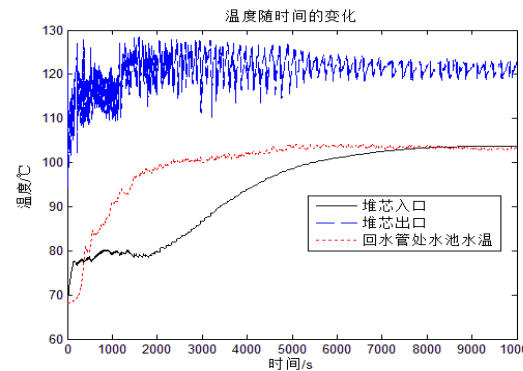
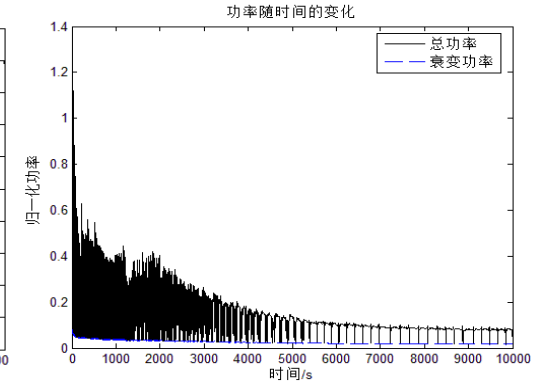
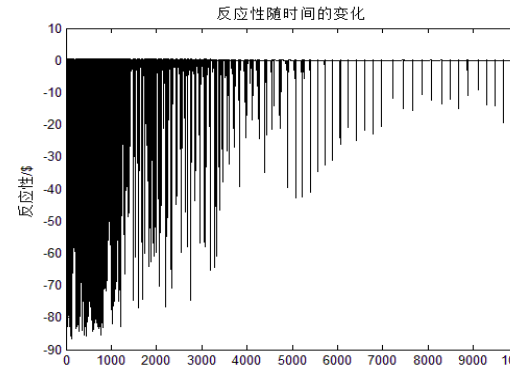






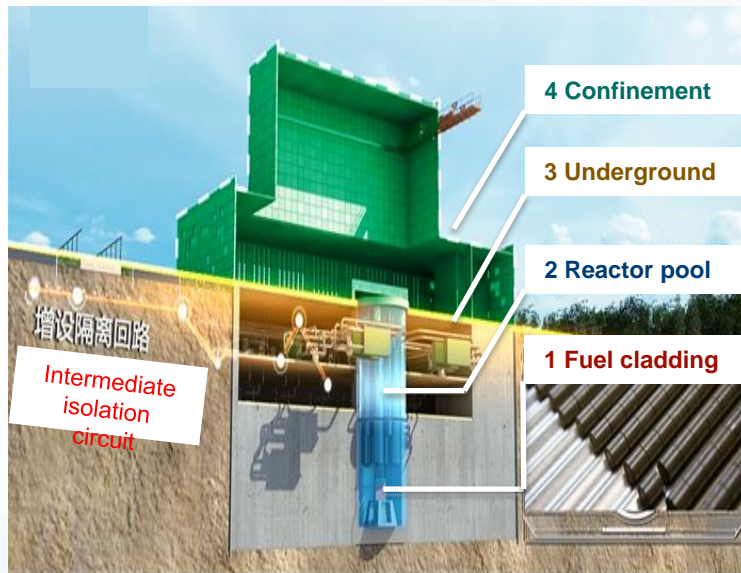
Nearly "zero" meltdown

Time (s)	Accident sequences
0	SBO ATWS, FP
0~6000	ρ , P , T_c , T_f , oscillating, not beyond the limit
6000	Smooth change, stabilizing at 10% P
3.1E7(10d)	Core uncover



- Automatic shutdown only relying on the negative reactivity feedback, without any intervention.

Multiple means to reduce radioactive release



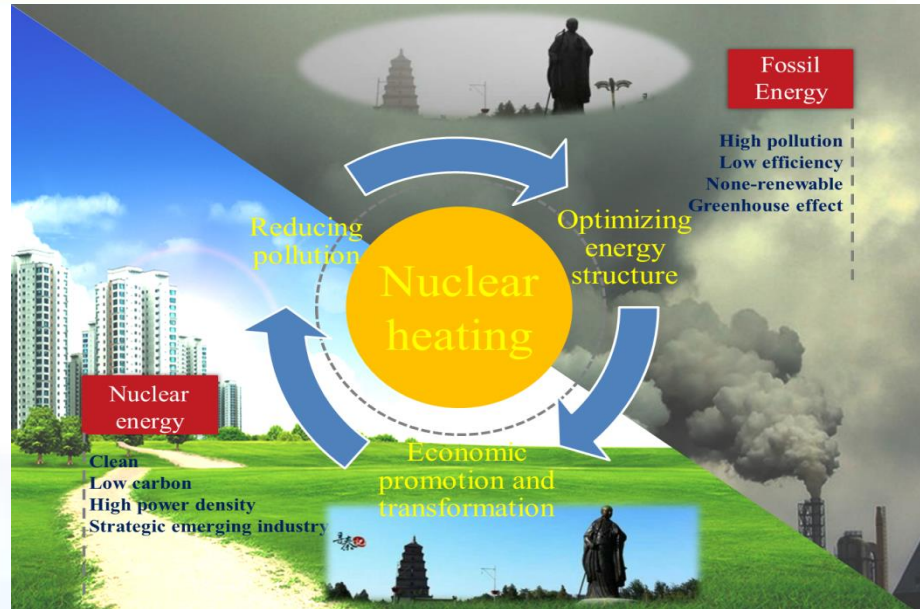
- DHR is equipped with four barriers, effectively isolating radioactivity

- An intermediate isolation circuit with higher pressure ensure that the coolant does not enter the heating loop.

- Equipped with a gaseous and liquid effluence collection and treatment system



No carbon emission, no emission of NO_x, SO₂, dust, ash, etc. DHR400 can replace **320,000 tons of coal** per year, equivalent to 1300 hectares afforestation.



Heat source	CO ₂ (tons/y)	SO ₂ (tons/y)	NO _x (tons/y)	Dust (tons/y)	Ash (tons/y)	Radioactivity (mSv/person)
Coal	520000	6000	2000	3200	100000	0.013
Gas	260000		1000			
Nuclear	0	0	0	0	0	0.005



● Energy application

- District heating supply
- **Refrigeration**(lithium-bromide absorption-type refrigerating machine)
- **Desalination of Sea Water**(low temp. multiple effect distillation(MED))
- **Supply hot water** for green-house, farming, cultivation, etc.

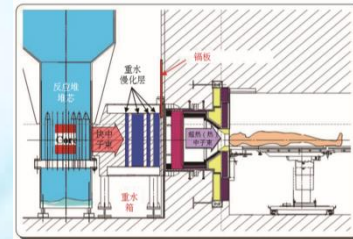


Non-heating season



● Neutron application

- Irradiation testing for fuel assemblies and material
- Production of RIs, NTD silicon, gem, topaz, pearl, nuclear membrane, etc.
- Neutron analysis, NAA, NRG, Neutron scattering, etc.
- Medicine, BNCT, FNT, etc.



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1st step

Principle
verification

2017-12

2nd step

Demo
Project

2020-12

3rd step

Commercial
promotion

After 2020





2019-4-30
Approval

2020-4-30
Confinement
completed

2021-3-30
Heating supply

2019-7-31

FCD

2021-2-31

First
criticality



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- **DHR is safe, environment friendly and economical**
 - **DHR provides an ideal alternative to coal-fired heating.**
 - **DHR would make important contributions to CO₂ emission reduction and environment protection.**

Thanks for your attention

