



Orano in China

Press Kit – April 2018

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Contents

1. Introduction	3
2. Nuclear energy in China	4
2.1. Energy Policy	4
2.2. Nuclear energy development	5
2.3. Overview of the Chinese nuclear fleet	6
3. More than 30 years of cooperation with China	7
3.1. Orano in China	7
3.2. Key Dates	8
4. Our business in China	9
4.1. Mining	9
4.2. Conversion & Enrichment	9
4.3. Recycling	9
4.4. Logistics	10
4.5. Dismantling, Decommissioning and Waste Management	11
4.6. Sourcing & Supply Chain	11

1. Introduction

Over the past decades, People's Republic of China has experienced rapid economic and social development. China is now the world's 2nd largest economy by nominal GDP, and is increasingly playing an important and influential role in the global economy. Rapid economic ascendance has brought on a number of challenges (rapid urbanization, challenges to environmental sustainability, external imbalances among others). In order for the growth to be sustainable, Chinese government has taken several initiatives like "Made in China 2025" for domestic market and "Belt & Road Initiative (BRI)", "Go Abroad" to promote the development of Chinese economy on the international market. These initiatives are intended to support innovation-driven development and smart technologies, to strengthen the economy's foundations, to pursue green development and to increase efforts to transition from a low-end manufacturing country to a high-end manufacturing and service supplying country.

Despite efforts to cut down on the energy-intensiveness of the Chinese economy, demand for energy to support the growth increases every year. Highly dependent on coal plants, electricity production generates a sizeable part of China's CO₂ emissions that dramatically affects environmental conditions.

In September 2016 China ratified the Paris climate agreement. This is a major step in the fight against climate change that confirmed the decision taken by China in November 2014 to integrate 20% non-fossil fuels to its energy mix by 2030 and to limit its coal consumption.

Today, the Chinese energy sector faces different challenges if it wants to keep up with the expected economic growth, including:

- Security of energy supply
- Environmental protection
- Affordability

||| To support China's economic growth and to ensure access to electricity for all, the government is pursuing an ambitious nuclear development plan. China will therefore remain an **increasingly key market for Orano and a focus of its strategic action plan.**

**Orano,
A strategic
refocusing on
nuclear fuel cycle
business**



2. Nuclear energy in China

2.1. Energy Policy

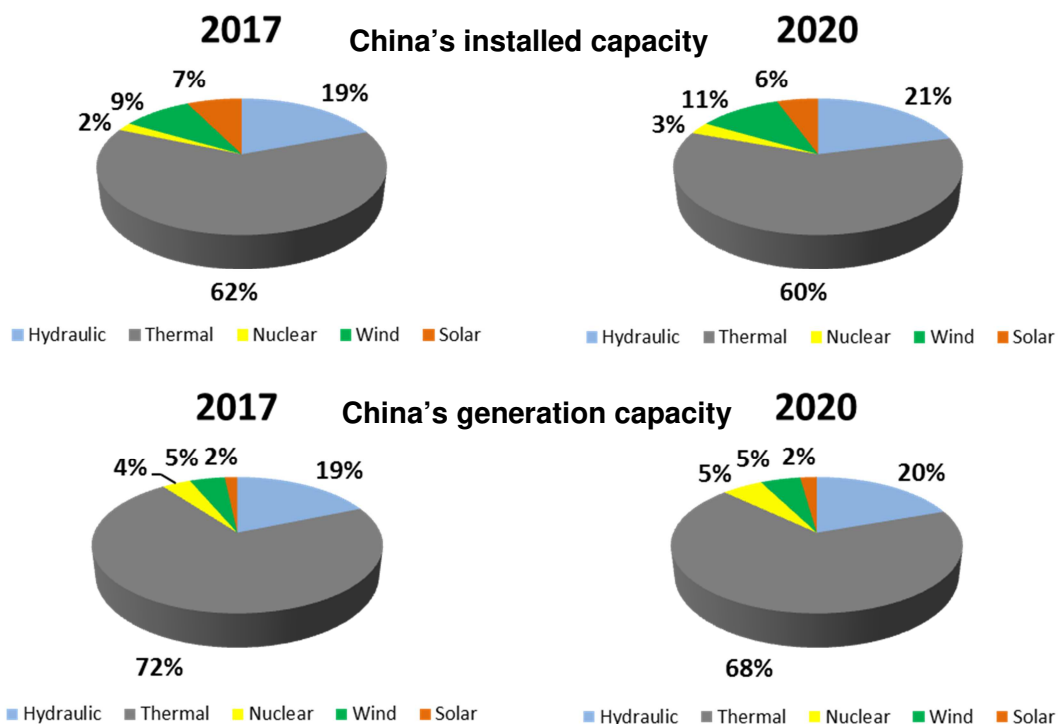
China has become the world 1st energy consumer since 2010 with huge energy needs. In 2017 the country accounted for almost 1/4 of the global energy consumption. A critical shift towards non-fossil energy is expected from China to reach its commitment towards a greener economy, as well as its ambition to reduce its dependency on foreign supply by achieving self-sufficiency.

China has today the world's 1st electric power generation installed capacity (1777GWe in 2017) with thermal accounting for 72%. China builds between 100 and 120 GW of new generating capacity every year on average.

Today, the Chinese energy sector is undergoing a critical shift to answer to its needs:

- Secure energy supply and reduce foreign dependency,
- Tackle with environmental issues,
- Simultaneously cut down greenhouse gas emissions.

Though China still mainly relies on fossil energies (coal, oil and natural gas) to support its energy-intensive manufacturing industries, the country is determined to increase the contribution of clean energy to its energy mix, moving towards a less carbon-intensive energy mix, which offers Orano a great stage to contribute to nuclear industry in China.



Contribution of nuclear power generation to the mix is increasing gradually. At least **14GWe of nuclear power generation (corresponding to 11 additional reactors currently under construction) will be added by 2020**, and installed nuclear power capacity will then reach 50GWe or more.

Objective of China is a **nuclear installed capacity of 120 to 150GWe by 2030**.

2.2. Nuclear energy development

For 30 years nuclear power has been identified as a strategic sector of Chinese energy development.

Energy, and particularly electricity, is critical for sustainable development. Clean and reliable, nuclear energy is one of the pillars of the Chinese low-carbon future energy mix. Nuclear electric power generation is a source of sustainable energy and a strong priority for the Chinese government.

After Fukushima Daiichi accident in March 2011, China suspended temporarily the approval of new nuclear power plant projects. Yet the construction of on-going projects continued.

Former pace of nuclear program development resumed in 2015 with:

- Approval by the Chinese regulatory body of 8 new projects,
- Start of construction of 6 new reactors,
- Start of commercial operation of 5 new reactors.

However no new project was approved since 2015 till now, as Chinese Authorities are looking forward the commissioning of Gen 3 reactors (AP1000, EPR™) planned in 2018. On April 10, 2018 General Nuclear Power Corporation (CGNP) received the permit from the National Nuclear Safety Administration (NNSA) to load the fuel in Taishan 1 EPR™. The unit is set to become the first EPR™ reactor to enter operation later this year.

Meanwhile 9 new reactors entered into commercial operation in 2016-2017. They should be followed by the start of commercial operation of 5 additional reactors in 2018.

The Chinese government has set clear priorities for its nuclear program:

- Safety
- Sustainable development
- Internationalization

As part of its strategy to ensure the security of energy supply for the nuclear industry, China aims to produce domestically one-third of its uranium requirements, to get one-third through foreign equity in mines and joint ventures overseas, and to purchase one-third on the open market.

Orano is an historical and long-term supplier of uranium to Chinese nuclear electric power companies.

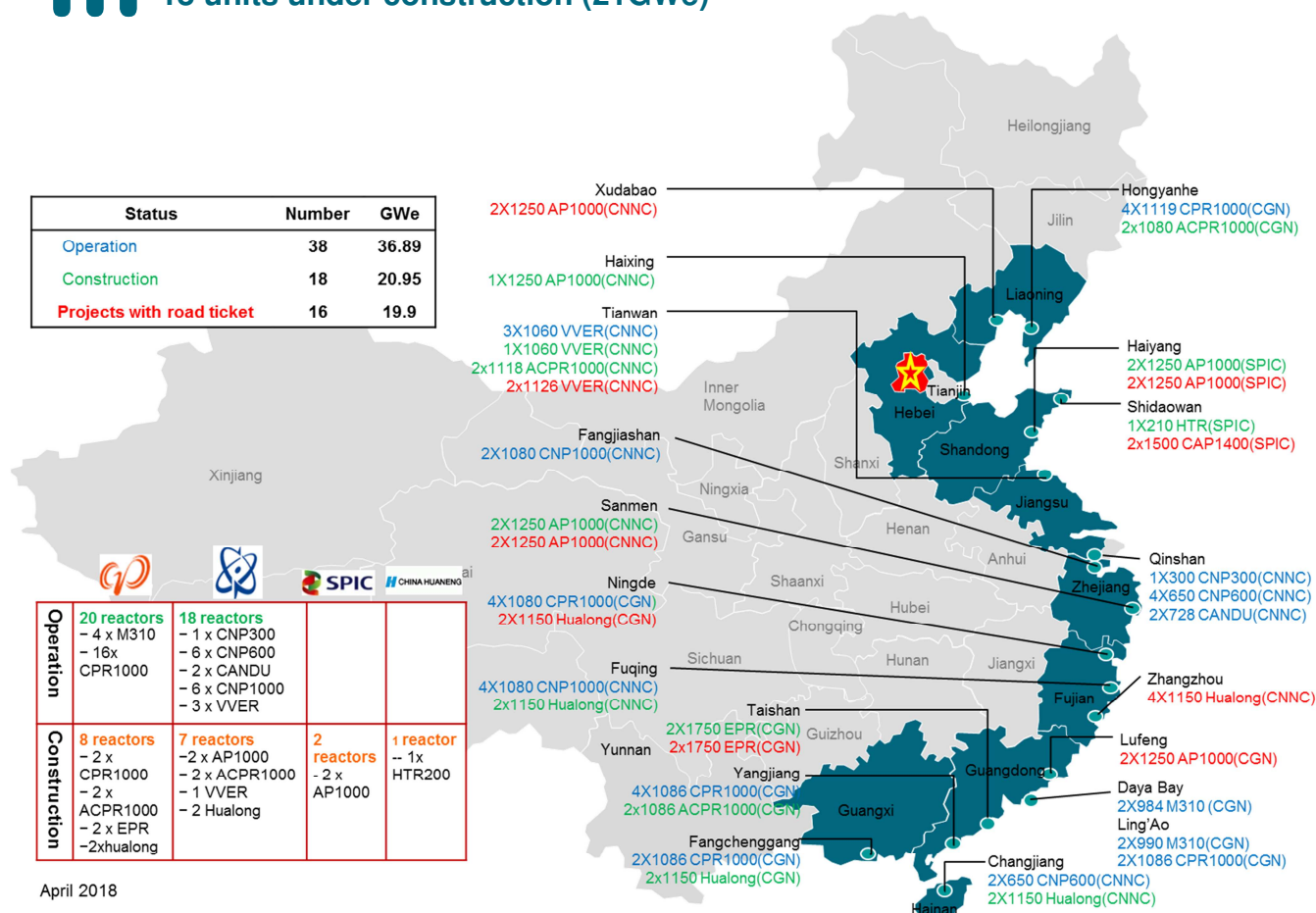
Used fuel management is a key success factor of the sustainable development of Chinese nuclear program. From the origin China has chosen, as France did, a closed nuclear fuel cycle strategy. At the end of 2017 China has accumulated more than 3,000t of used fuel across all reactors' site, and along with the growth of its nuclear installed base, total quantity of accumulated used fuel is expected to rise up to about 20,000t by 2030.

Reprocessing-recycling of used fuel is the best way to save natural resources and to minimize the volume / toxicity of final wastes. It allows for an optimized, long-term and responsible management of used fuel.

As the world leader in used fuel reprocessing-recycling activities Orano is supporting China building a safe and reliable commercial reprocessing-recycling plan in China.

2.3. Overview of the Chinese nuclear fleet

38 units in operation (37GWe) generating 4% of the country's electricity mix
18 units under construction (21GWe)



April 2018

Units in operation	Province	Power output (gross)	Type	Operator	Commercial Operation year
Daya Bay 1-2	Guangdong	984 MWe	PWR (French M310)	CGNPC	1994, 1994
Qinshan Phase I	Zhejiang	310 MWe	PWR (CNP-300)	CNNC	1994
Qinshan Phase II, 1-4	Zhejiang	650 MWe	PWR (CNP-600)	CNNC	2002, 2004, 2010, 2012
Qinshan Phase III, 1-2	Zhejiang	700 MWe	PHWR (Candu 6)	CNNC	2002, 2003
Ling Ao Phase I, 1-2	Guangdong	990 MWe	PWR (French M310)	CGNPC	2002, 2003
Tianwan 1-2-3	Jiangsu	1060 MWe	PWR (VVER-1000)	CNNC	2007, 2007, 2018
Ling Ao Phase II, 1-2	Guangdong	1080 MWe	PWR (CPR-1000)	CGNPC	2010, 2011
Ningde 1-4	Fujian	1080 MWe	PWR (CPR-1000)	CGNPC	2013, 2014, 2015, 2016
Hongyanhe1-2-3-4	Liaoning	1080 MWe	PWR (CPR-1000)	CGNPC-CPI	2013, 2014, 2015, 2016
Fangjiashan 1-2	Jiangsu	1080 MWe	PWR (M310+)	CNNC	2014, 2015
Yangjiang 1-4	Guangdong	1080 MWe	PWR (CPR-1000)	CGNPC	2014, 2015, 2016, 2017
Fuqing 1-4	Fujian	1080 MWe	PWR (M310+)	CNNC	2014, 2015, 2016, 2017
Fangchenggang 1-2	Guangxi	1086 MWe	PWR (CPR1000)	CGNPC	2016, 2017
Changjiang 1-2	Hainan	650 MWe	PWR (CNP 600)	CGNPC	2015 -2016

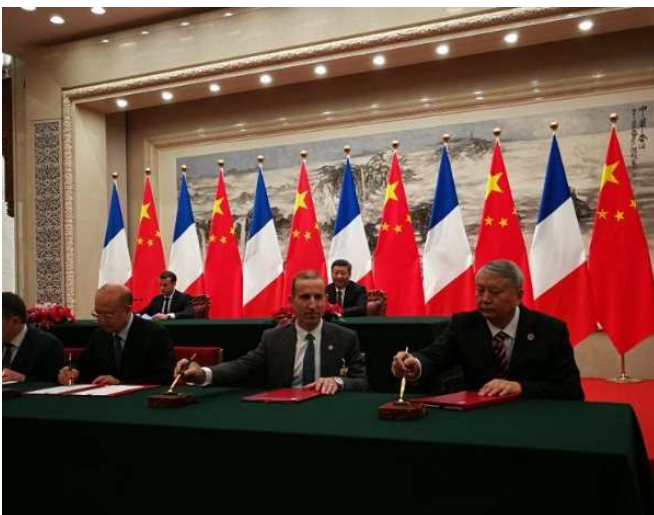
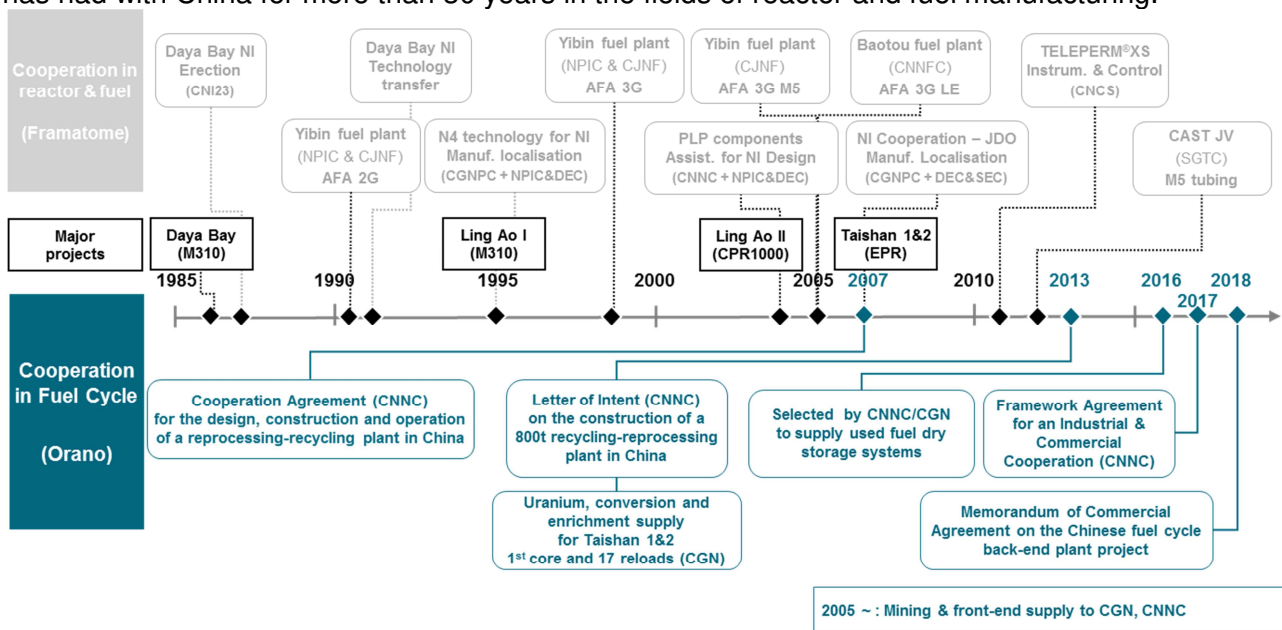
3. More than 30 years of cooperation with China

The strategic dialogue in the field of civil nuclear energy initiated more than 30 years ago between France and China was the starting point of the cooperation between nuclear industries of both countries. Since then Orano is supporting durably the development of the Chinese nuclear industry.

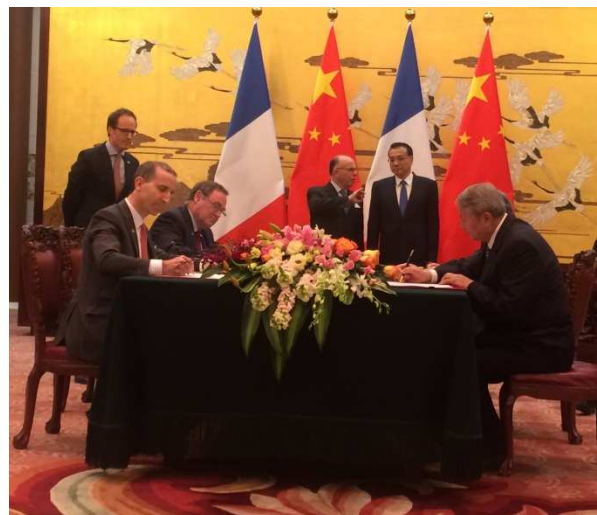
This long-standing and uninterrupted cooperation between France and China has been key for the strengthening of the relationships between Orano and Chinese nuclear industry (electric power companies, manufacturers, institutions, etc.)

3.1. Orano in China

Orano's cooperation with China is deeply rooted in the historical cooperation Orano (ex-AREVA) has had with China for more than 30 years in the fields of reactor and fuel manufacturing.



M. Knoche (Orano CEO) and M. Wang (CNNC Chairman) signing the Memorandum of Commercial Agreement (MOCA) on the Chinese fuel cycle back-end plant project (January 9, 2018 in Beijing)



M. Knoche (Orano CEO) and M. Wang (CNNC Chairman) signing the Framework Agreement for an Industrial & Commercial Cooperation (FICCA) (February 21, 2017 in Beijing)

3.2. Key Dates

- 2007** • The governments of France and China signed a cooperation agreement on the back-end of the nuclear fuel cycle in November and simultaneously, Orano and CNNC (China National Nuclear Corporation) signed a cooperation agreement in the field of the Chinese back-end of the fuel cycle for the **design, construction and operation of a reprocessing-recycling plant in China**.
 - Orano and CGNP (China General Nuclear Power Corporation) entered in a long-term partnership through a series of agreements for: the construction of two EPR™ reactors (Taishan 1 & 2); the **supply of fuel (uranium conversion & enrichment services, fuel manufacturing) for the two reactors over a period of 15 years**; the technology transfer on nuclear island and nuclear fuel.
-
- 2013** • Orano and CNNC signed a letter of intent in which main terms applicable to the reprocessing-recycling plant in China are agreed upon.
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- 2016** • Orano is awarded contracts by Chinese nuclear electric power companies CNNC and CGN to supply used nuclear fuel dry storage systems in China.
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- 2017** • Orano and CNNC signed a **Framework Agreement for an Industrial & Commercial Cooperation** that covers all nuclear fuel cycle activities. This framework agreement supports the on-going industrial negotiations between Orano and CNNC (reprocessing-recycling plant project in China in particular) and opens up new industrial and commercial opportunities for both sides (February 21st)
-
- 2018** • Orano and CNNC signed a **Memorandum of Commercial Agreement on the Chinese fuel cycle back-end plant project** to acknowledge the substantial progress made in the negotiations (January 9th)

4. Our business in China

4.1. Mining

Domestic and overseas uranium production of China remains limited, and cannot satisfy the needs of the Chinese growing nuclear fleet. China is therefore an important buyer of uranium.

Orano provides a significant part of the Chinese natural uranium requirements. It represents today the major part of Orano's order intake and sales in China.

In particular Orano stands as a reference natural uranium supplier to CGNP, one of the two major Chinese nuclear electric power companies (19 reactors in operation totalling 20.4GWe and 11 reactors under construction totalling 12GWe).

Orano also supplies to CGNP uranium, conversion and enrichment services for the first core of the 2 EPR™ reactors Taishan 1 & 2, as well as for the first 17 reloads.

4.2. Conversion & Enrichment

China being fully self-sufficient in terms of conversion and enrichment services, Orano offers services to address specific requirements of Chinese electric power companies, as well mining-conversion-enrichment supply partnerships for projects of these companies.

4.3. Recycling

The cooperation between China and France on used fuel recycling started in November 2007 with the signatures of (i) an inter-governmental agreement on the back-end of the fuel cycle and (ii) a cooperation agreement between Orano and CNNC¹ for the design, construction and operation of a reprocessing-recycling plant in China.



Orano La Hague reprocessing plant in France

Since then several agreements have marked the progress of the discussions with CNNC, including a memorandum of understanding in 2010 which defined the mutual cooperation model (respective scope of Orano and CNNC) and a letter of intent in 2013 on the construction of a 800tHM/year recycling-reprocessing plant in China.

The Chinese reprocessing-recycling plant is developed based on the processes and technologies of Orano's La Hague UP3/UP2-800 and Melox plants.

Over the past decades ORANO successfully and safely reprocessed more than 33,000 tons of used fuel at La Hague plant, and produced more than 2,500 tons of MOX (Mix Oxide) fuel at Melox plant. These two plants will stand as reference plants for the Chinese reprocessing-recycling plant.

¹ China National Nuclear Corporation (CNNC), a Chinese State-Owned Enterprise (SOE), is both a nuclear power plant operator and in charge of all fuel cycle activities in China.



In 2015 technical discussions ended and commercial negotiations started. The negotiations are now in their final stage. Objective of CNNC is to start the plant commercial operation in the early 2030s, which means the launch of the project in 2018/2019.

3D picture of the future Chinese 800t/year reprocessing-recycling plant

4.4. Logistics

Based on its extensive logistics technologies, know-how and experience over the entire fuel cycle internationally, Orano proposes to its Chinese customers full range of logistics solutions and services (design, licensing and supply of transport packages ; transport of uranium ore, UF₆, fresh fuel, used fuel, nuclear wastes and other nuclear materials ; consulting services; etc.). Orano also offers used fuel dry storage solutions pending the start of commercial operation of the Chinese commercial reprocessing-recycling plant.

Late 2016 CGNPC and CNNC selected Orano for the supply of 37 used fuel dry storage systems (NUHOMS[®]) for respectively Daya Bay (300 PWR 17x17 fuel assemblies) and Tianwan (800 VVER 1000 fuel assemblies) nuclear power plant sites.

NUHOMS[™] is a proven and reliable technology made of:

- Concrete storage modules
- Stainless steel canisters holding the used fuels
- Transfer cask
- Specific transporter



NUHOMS[®] used fuel dry storage system at the site of a US utility



Stainless steel canister of NUHOMS[®] being manufactured for the contract with CNNC/CGNP

Orano established a partnership with the Chinese company Shanghai Apollo Machinery Co. Ltd to manufacture locally part of these used fuel dry storage systems.

The contract execution is on-going and first dry storage systems will be delivered to the nuclear power plant sites in 2019/2020.

4.5. Dismantling, Decommissioning & Waste Management

Orano is the unique player combining huge feedback in dismantling and decommissioning (D&D) as both nuclear operator of our own facilities and as supplier and partner for our customers. This gives us an acute view on D&D performance levels, for scenario design, processes and equipment development, D&D work operations, environmental protection and project management.

Orano offers to its Chinese clients customized solutions for the dismantling and decommissioning of nuclear facilities, as well as for the waste management.

In the field of waste management Orano offers to the Chinese market its unique high level waste vitrification technology, which is successfully implemented and operating at La Hague reprocessing plant in France for more than 40 years.



High level waste vitrification technology at Orano's La Hague reprocessing plant in France

4.6. Sourcing & Supply Chain

With the objective to reduce the company operational cost, Orano set up a sourcing team in China more than 10 years ago to identify potential suppliers, promote cost-effective solutions and facilitate procurement in China.

The sourcing & supply chain team also actively participate in Orano's projects in China.



Orano transforms nuclear materials so that they can be used to support the development of society, first and foremost in the field of energy.

The group offers products, technologies and services with high added value throughout the entire nuclear fuel cycle, from raw materials to waste treatment. Its activities, from mining to dismantling, as well as in conversion, enrichment, recycling, logistics and engineering, contribute to the production of low carbon electricity.

Orano and its 16,000 employees bring to bear their expertise and their mastery of cutting-edge technology, as well as their permanent search for innovation and unwavering dedication to safety, to serve their customers in France and abroad.

Orano, giving nuclear energy its full value.



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Energy is our future. Don't waste it!