

Nuclear fission energy

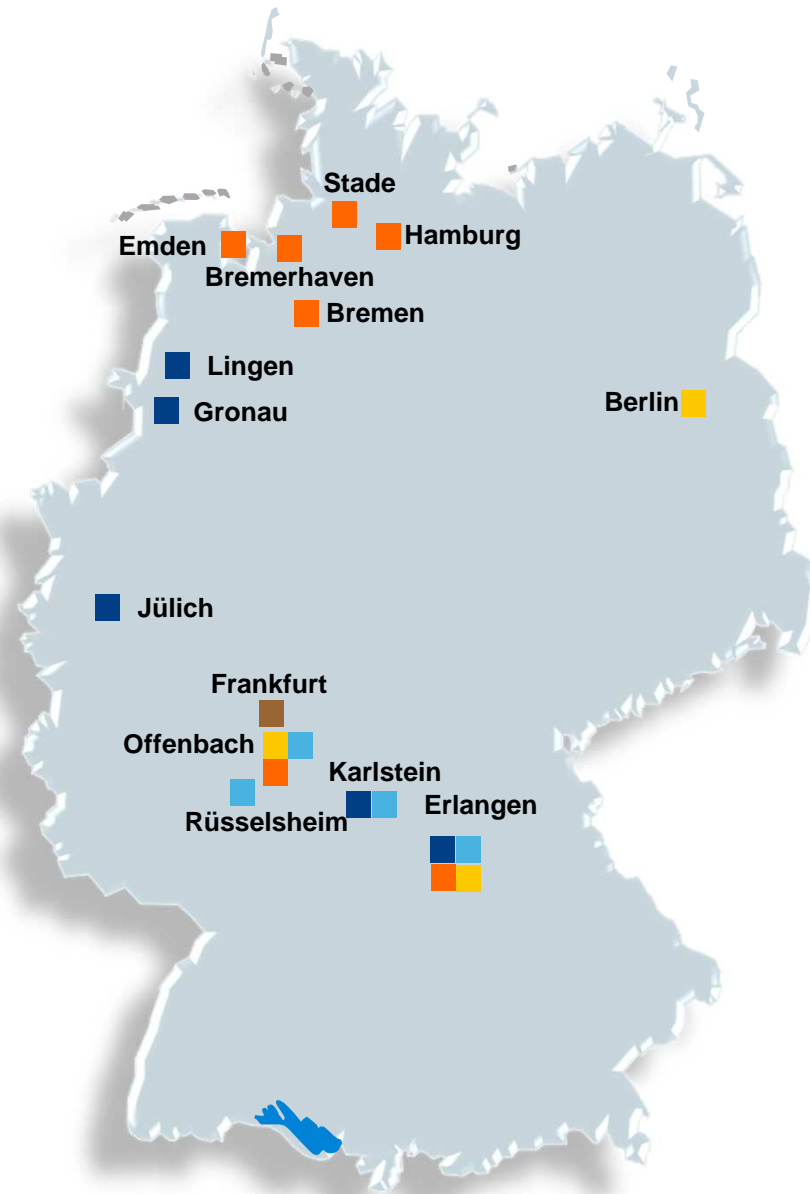
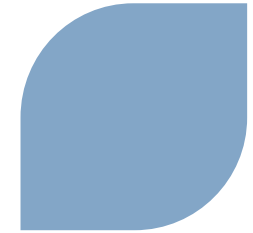
new build, operation, fuel cycle and decommissioning in the international perspective

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Berlin, March 16th 2015





AREVA in Germany

- Nuclear reactors and fuel
- Off-shore wind, biomass, energy storage
- Sales 1,2 bln €
- 5.000 employees

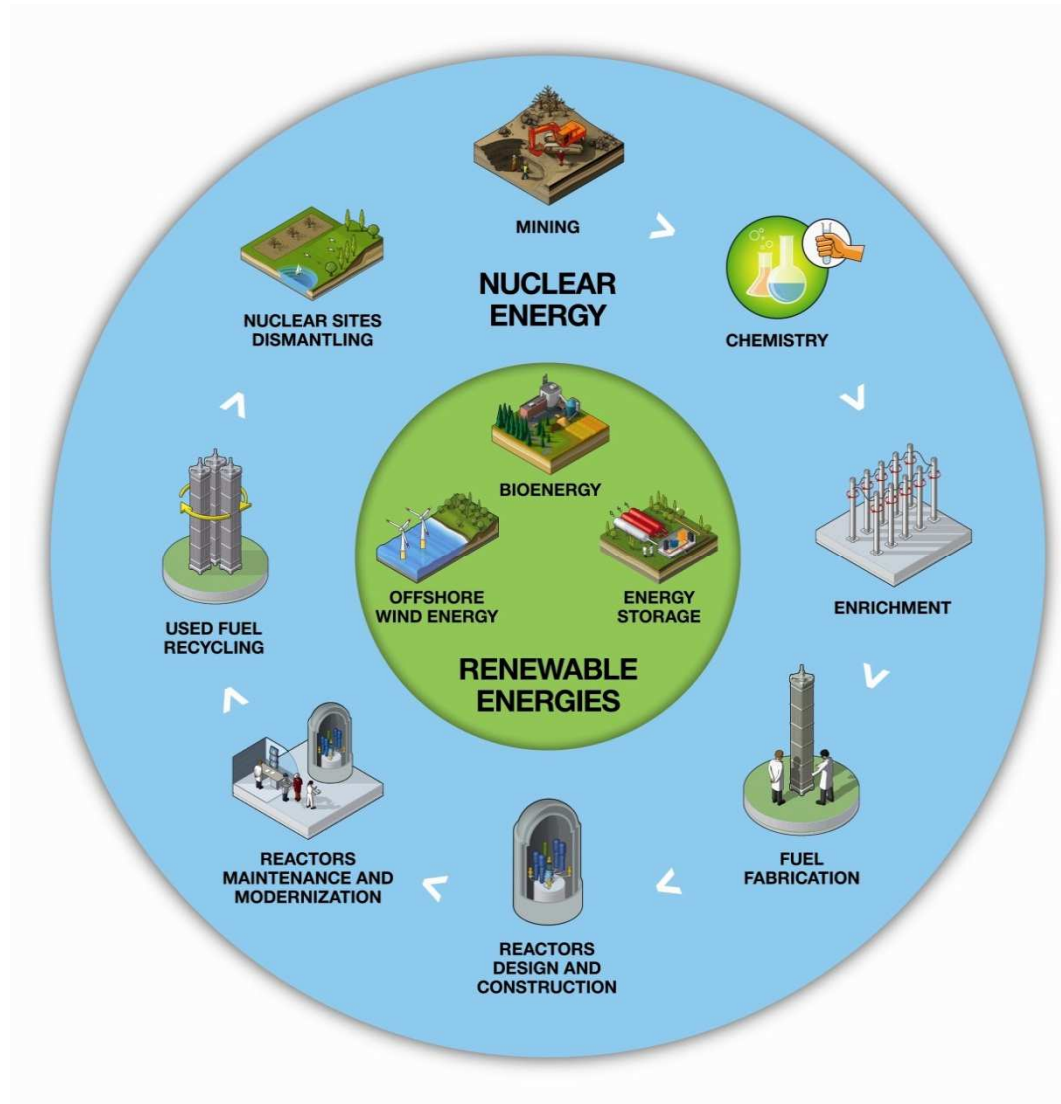
AREVA worldwide

- Total nuclear cycle
- Off-shore wind, biomass, solar-thermal, energy storage
- Sales 8,2 bln €
- 45.000 employees

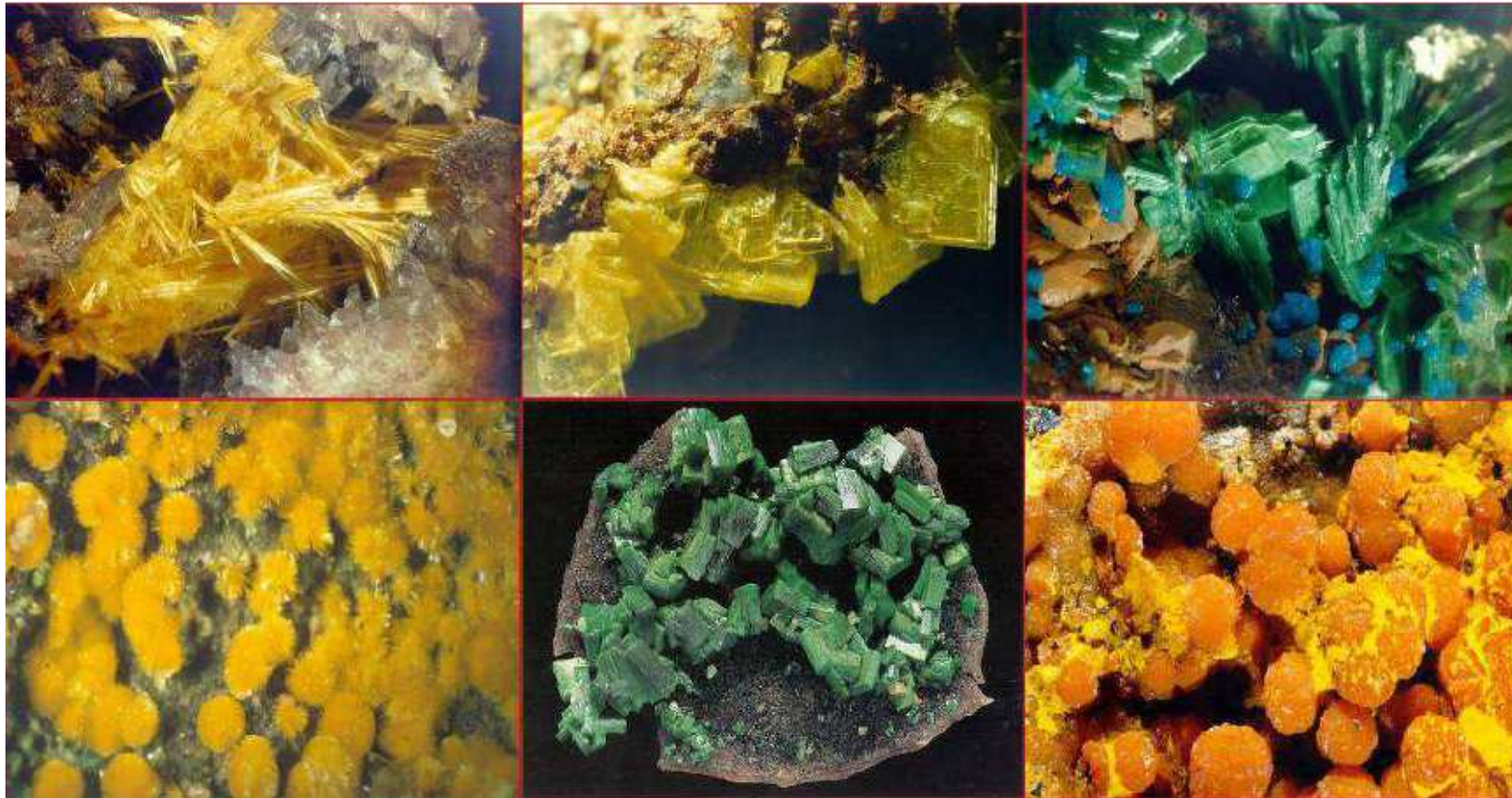
Erlangen



Nuclear and renewables: a well-rounded offering



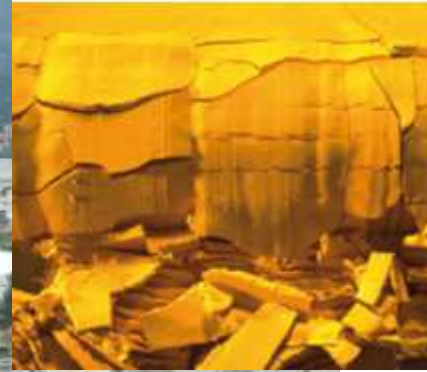
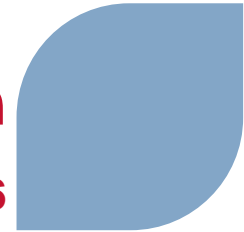
Natural Uranium



Uranium exploration portfolio



Conversion from Yellow Cake to UF₆



U₃O₈



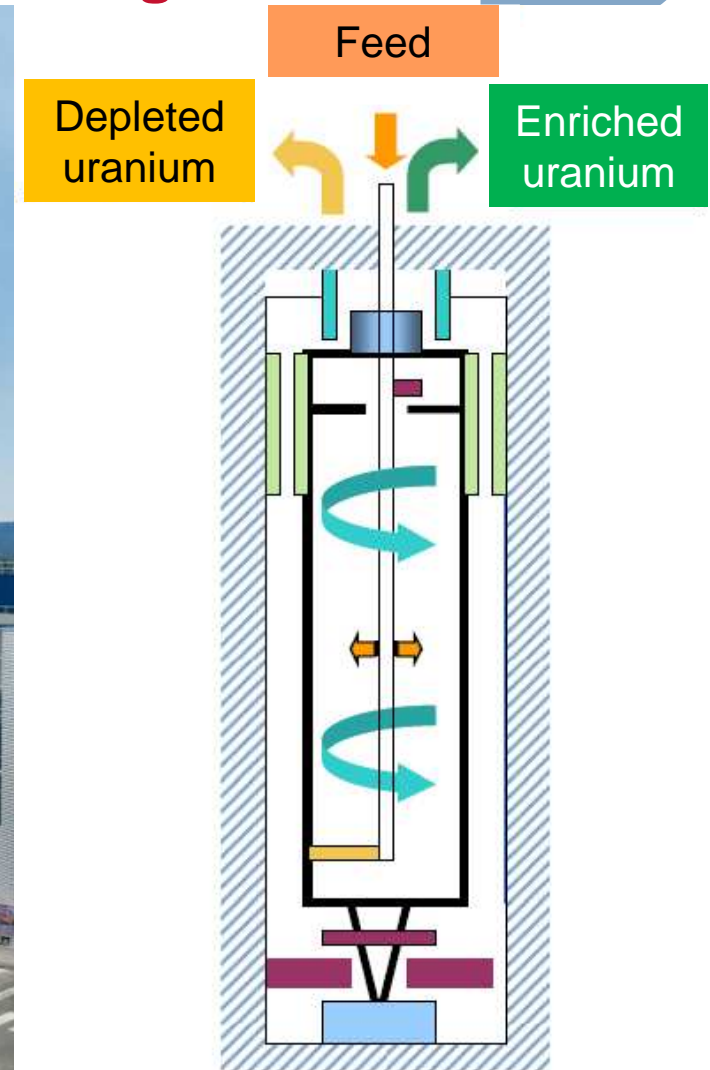
UF₄



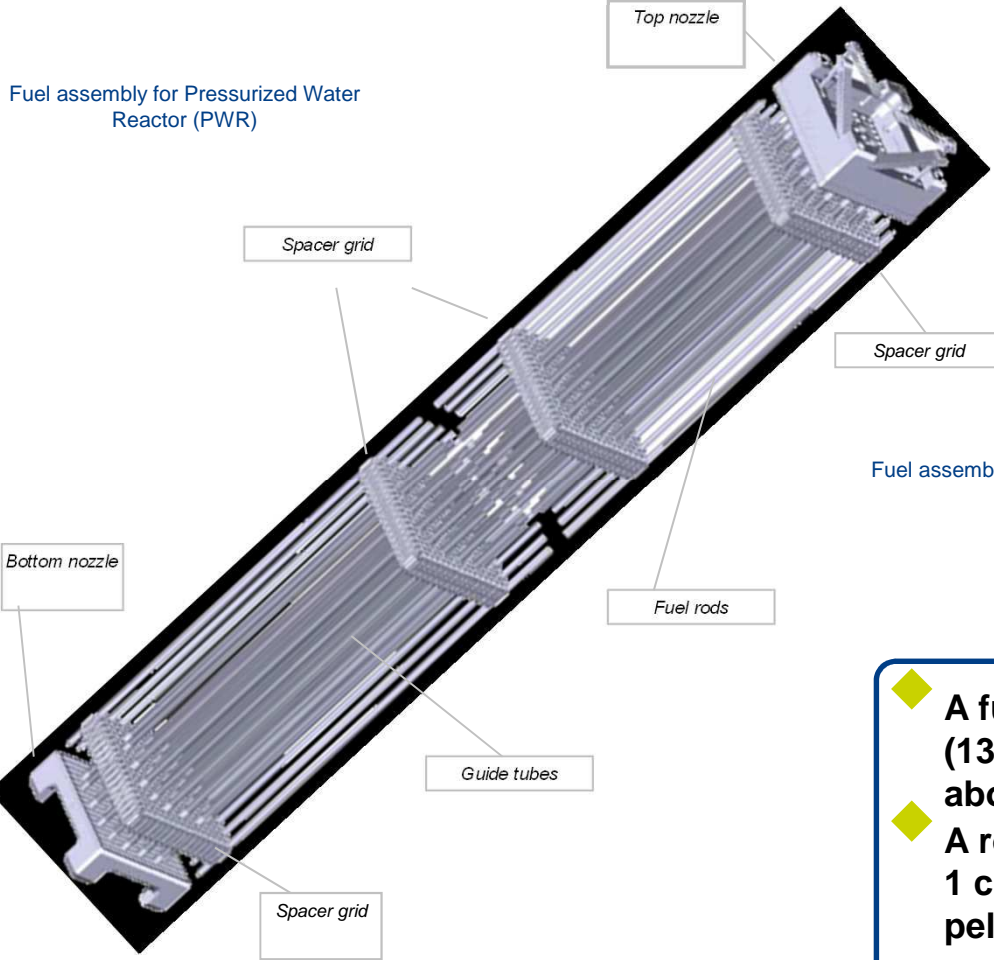
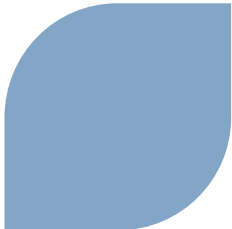
UF₆



Enrichment by centrifugation, George Besse II



Focus on the finished product: Nuclear fuel assembly

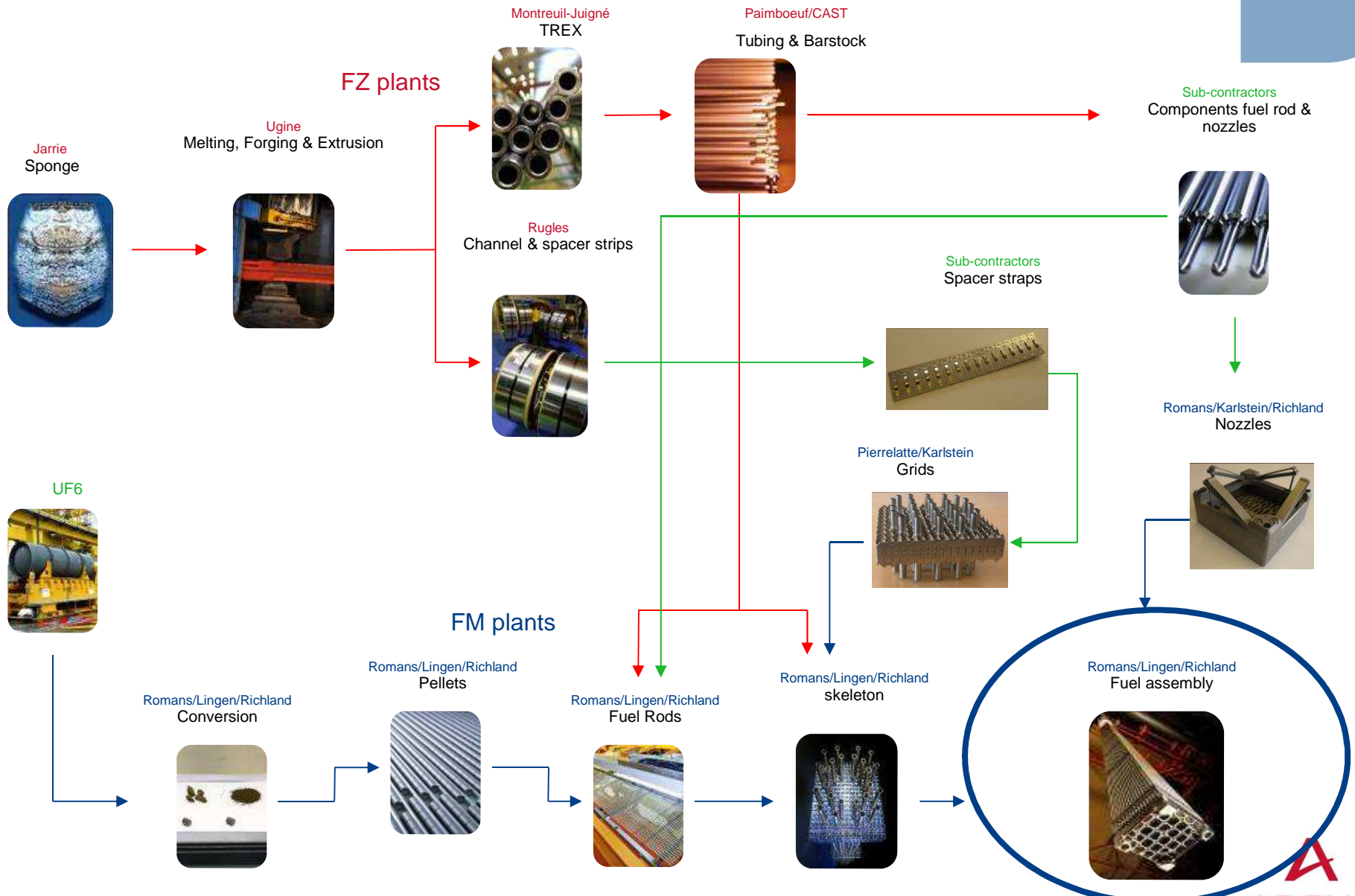


Fuel assembly for Boiling Water Reactor (BWR)

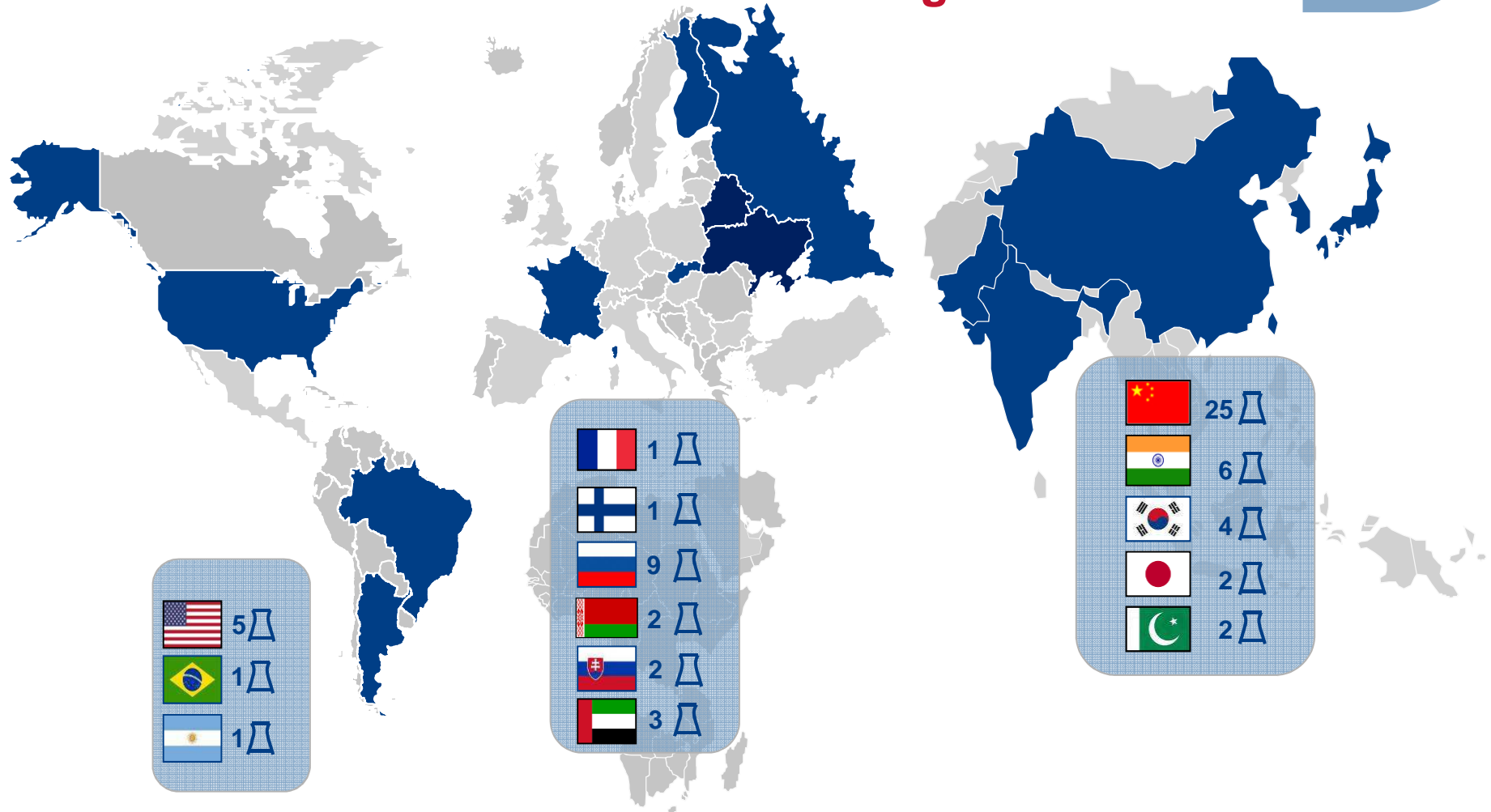


- ◆ A fuel assembly is about 4 m (13 feet) long and contains about 250 fuel rods
- ◆ A rod has a diameter of about 1 cm and contains roughly 300 pellets each weighing 7 grams

Main steps in fuel assembly manufacturing



Nuclear Power Plant under construction throughout the World



Reactors under construction 68 ☐ 60.1 GW

Source: [PRIS](#) database retreated. Last updated on 2015/03/09



Olkiluoto 3

■ Milestones 2014

- February: Reactor containment tightness tests completed
- April: Validation by STUK of the overall I&C system plan (architecture)
- April: Launch of I&C TXP tests
- July: Launch of the I&C TXS tests

■ Next steps

Delivery of the I&C cabinets to OL3 site starting from September 2015. This delivery is the condition to start the main phases of commissioning in the first half 2016

■ Pouring of the concrete base



Delivery of a liner segment



Installation of a liner segment





Flammanville 3

■ Milestones 2014:

- January: RPV moved into the reactor building
- March: Delivery of steam generators
- April: Operational Instrumentation & Control 100th cabinet installed on site
- May: First commissioning tests from the control room
- June: Beginning of welding on the reactor coolant system
- September: Introduction of the first steam generator into the reactor building
- October: Documentation for the Operating License Application delivered to EDF
- November: Installation of the pressurizer in the reactor building

■ Schedule:

- Commissioning 2017

Taishan 1&2

Milestones 2014:

- January: Safety and operational I&C cabinet testing continues apace in Beijing
- February: Design Review finalized
- March: Completion of welding of pressurizer surge line on unit 1
- May: Installation of RPV Internals in unit 1 reactor vessel
- June: Delivery of the pressurizer for unit 2
- June: Introduction of the first hydraulic pump of the reactor coolant pump system for unit 1
- June: Delivery of the first I&C cabinets
- June: Installation of the full scale simulator on site
- October: Introduction of first steam generator in unit 2

Next steps:

- Starting test phases before commissioning
- HVAC and Piping erection completed
 - Electrical cable pulling in progress
 - Commissioning activities started

Large components: PWR steam generator

Design



Commissioning



➤➤ **Heat transfer surface:
4,700 to 7,000 square meters**

FUNCTIONS

- ▶ to transfer heat and ensure leak-tightness between the primary (P) and secondary (S) circuits

DUTY

- ▶ mechanical effects of the circulating P and S flows
- ▶ chemical effects of the P and S fluids
- ▶ nominal and transient temperatures and pressures on P and S sides

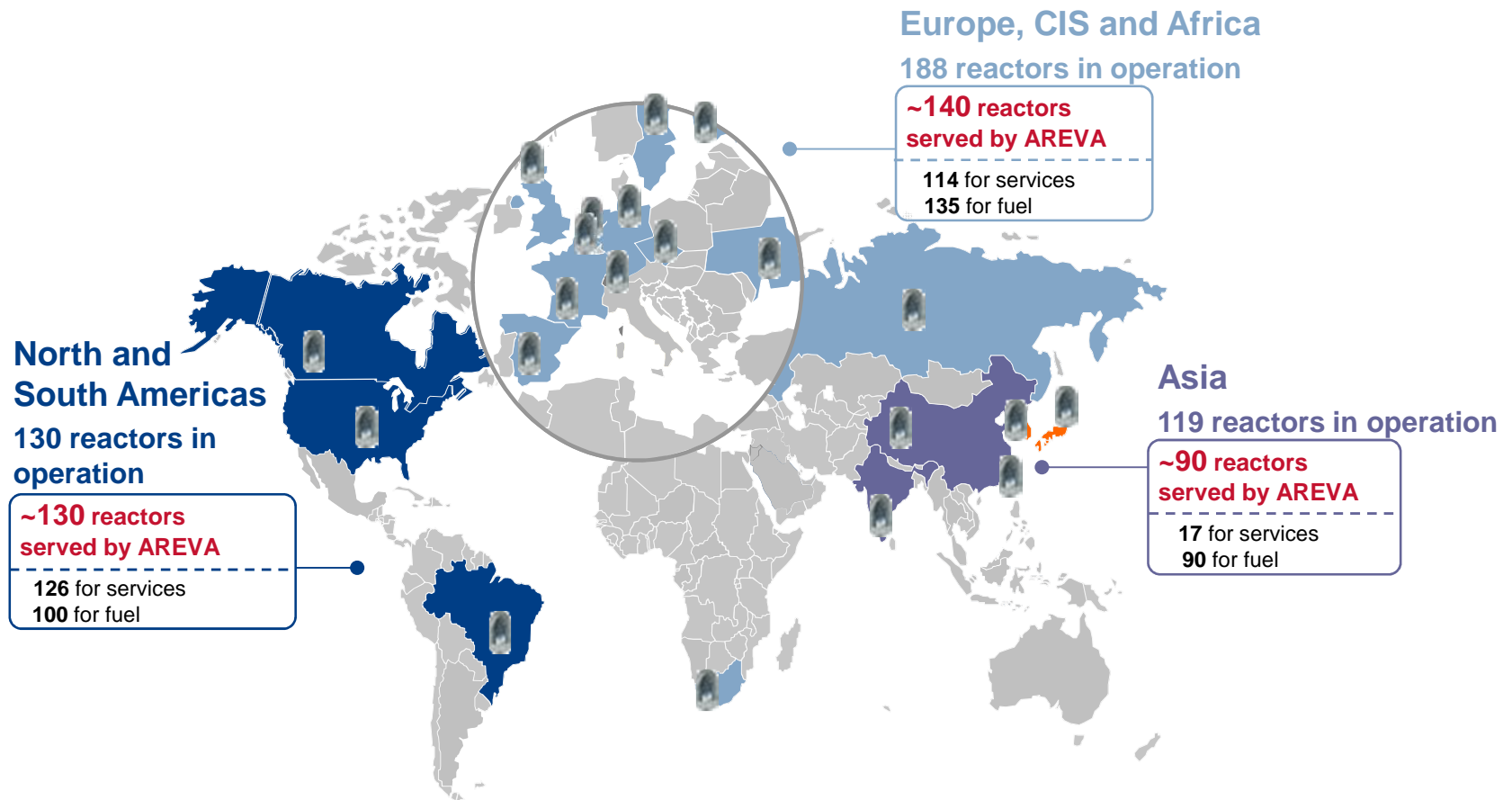
MATERIALS

- ▶ nickel-based alloy (tubes), low internal alloy carbon steel (structures) with a stainless steel layer the water chamber (P side)

DIMENSIONS & WEIGHT

- ▶ height: 20 to 22 meters
- ▶ diameter: 3.5 to 5 meters
- ▶ weight (empty): 300 to 420 metric tons

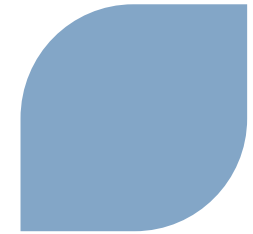
95% of all nuclear utilities are AREVA customers



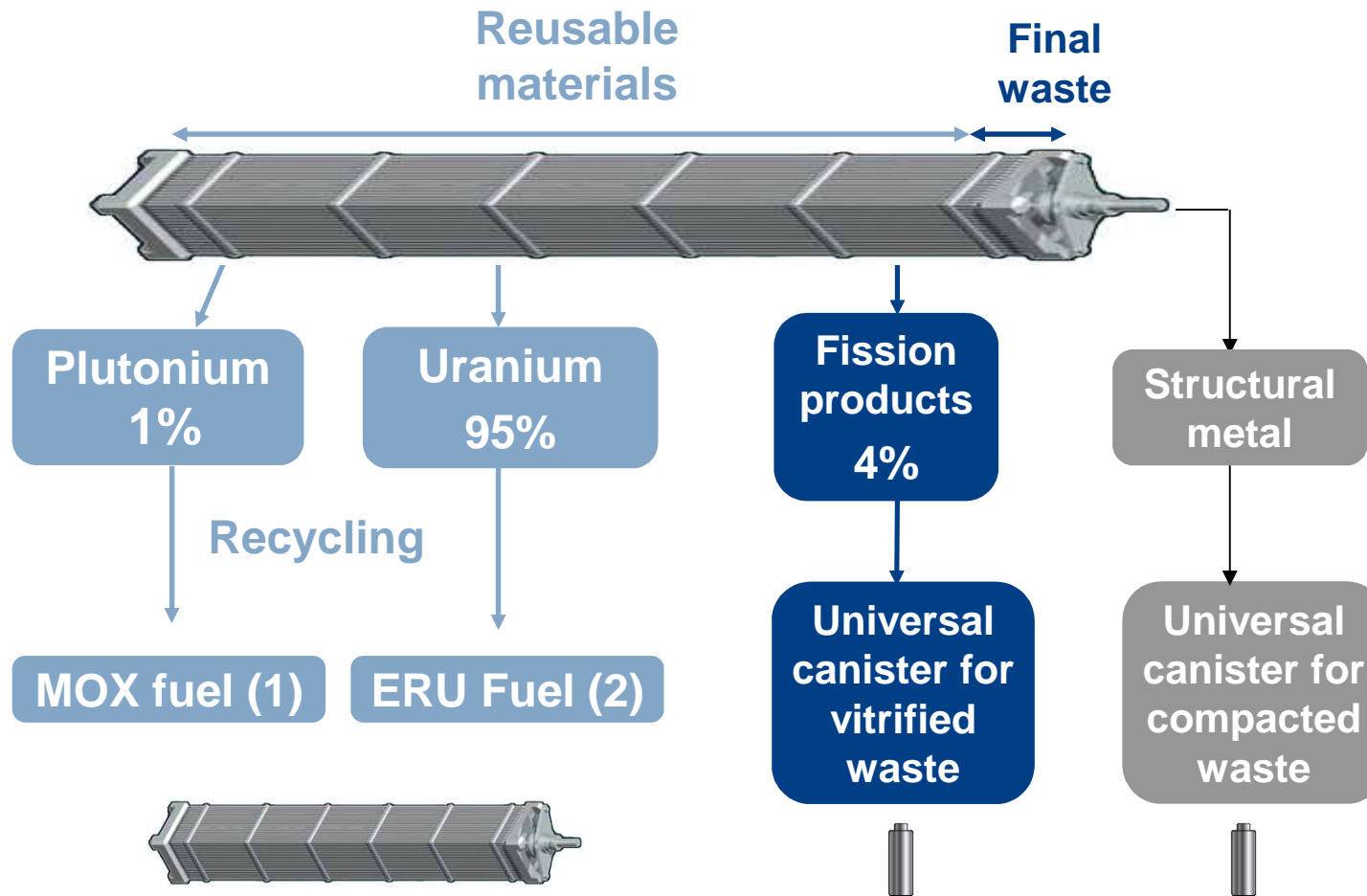
AREVA provides products and services to 360 reactors worldwide*

* As at December 31, 2012

96% of the content of used fuel is recyclable



► Composition of light water reactor fuel when unloaded



(1) MOX: Mixed Oxide (2) Enriched Recycled Uranium

Recycling at La Hague



MOX Fuel Fabrication at Romans









Dismantling: broad expertise in managing customer projects



Reactor vessel / internals: decontamination and dismantling (D&D)

-  **Stade, Würgassen, Obrigheim** ▶ Dismantling of the reactor vessel and internals
▶ Decontamination of primary and auxiliary circuits
-  **Millstone, Rancho Seco, Yankee Rowe** ▶ Dismantling of the reactor vessel and internals





Used fuel, effluent / radioactive waste management

-  **Fukushima** ▶ Design and implementation of a full water treatment system
-  **Dounreay** ▶ Special equipment to retrieve damaged fuel in research reactor

Assistance to the project owner / Design and engineering

-  **Creys-Superphénix** ▶ Support to the sodium retrieval and D&D preparation

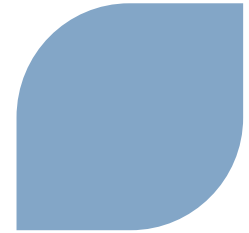
M&O (maintenance and operations) for D&D projects

-  **Hanford** ▶ High level waste treatment (customer: DOE)
-  **Savannah** ▶ Vitrification of high level waste (customer: DOE)
-  **Marcoule** ▶ D&D of a large fuel treatment facility (customer: CEA)
-  **Sellafield** ▶ Member of the site's M&O consortium



Creation of an expertise center for decommissioning and dismantling in Germany

Conclusion



- The nuclear cycle is highly know-how-intensive
- It takes decades to build up and relatively little to maintain