



ROSATOM

World Nuclear Spotlight Brazil
3-5 April 2019, Rio de Janeiro

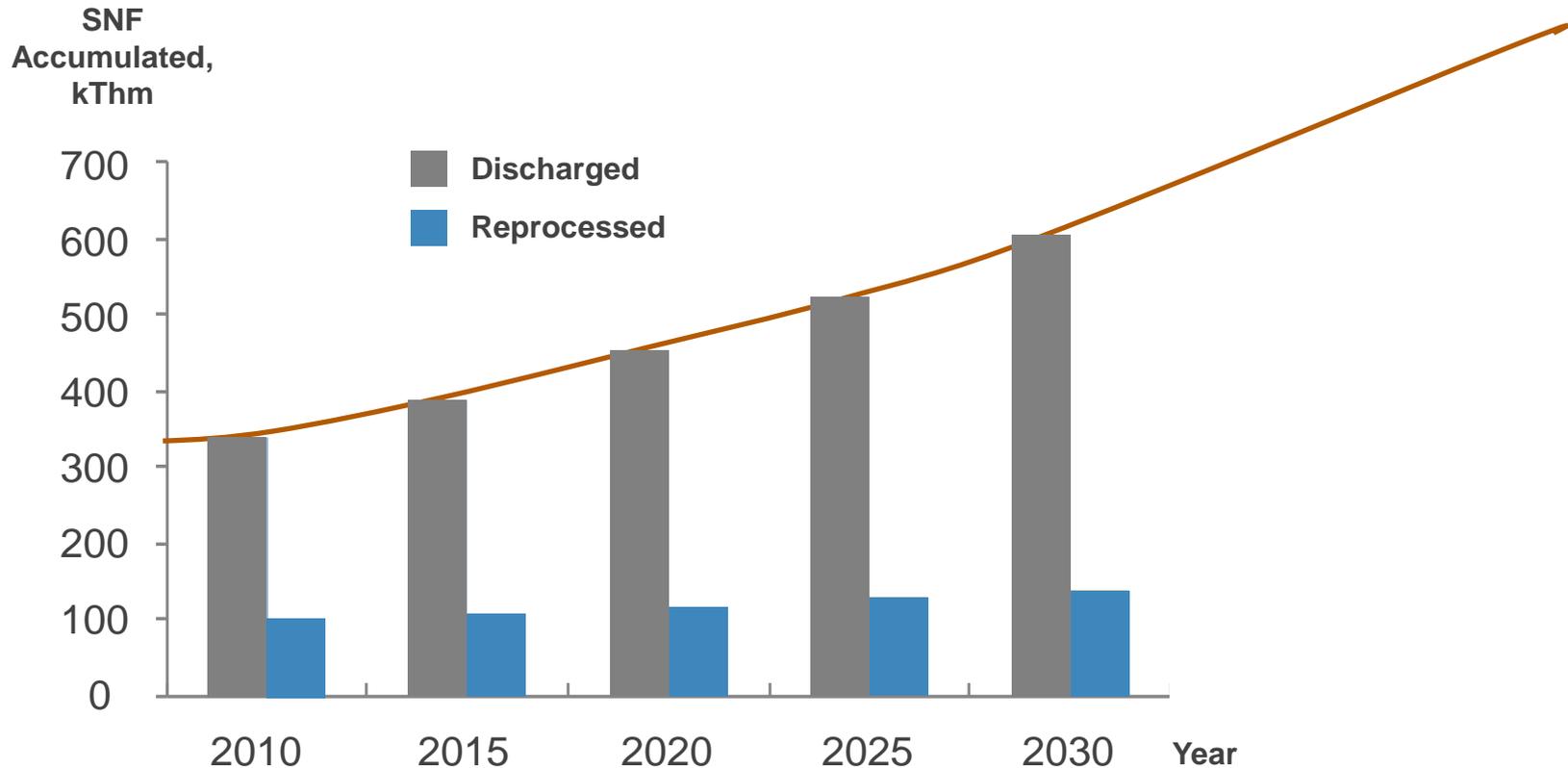
STATE ATOMIC ENERGY CORPORATION "ROSATOM"

NUCLEAR INNOVATION IN SPENT FUEL MANAGEMENT

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ROSATOM

Growing Nuclear: More Spent Nuclear Fuel Generation



Example of SNF volume worldwide accumulation
calculated for current NPP fleet size and SNF reprocessing rate

ROSATOM expert estimation, 2017

Main Nuclear Fuel Cycle Trends and Brazilian example



Most NPP operators' choice in favor of **referred solution** (interim SNF storage) by cause of absence of better scenarios



Lowering public acceptance and support issues in some countries, caused by – among others – lack of safe and reliable solutions in back end



Angra 1 and 2 in operation. SNF is stored in the existing spent fuel pools in each NPP. ELETRONUCLEAR choses solution based on SNF cask storage facility. This will save time till 2045. Final decision on SNF disposal is still to be made.

World Nuclear Industry and Brazilian one as well need new nuclear fuel cycle based on innovative solutions and integrated approaches

Key Requirements for New Nuclear Fuel Cycle

- ✓ **To decrease considerably amount and danger of waste to be disposed**
 - Obligatory SNF reprocessing
 - High level waste partitioning with the separate treatment of the different fractions
 - Minor actinides transmutation in fast reactors

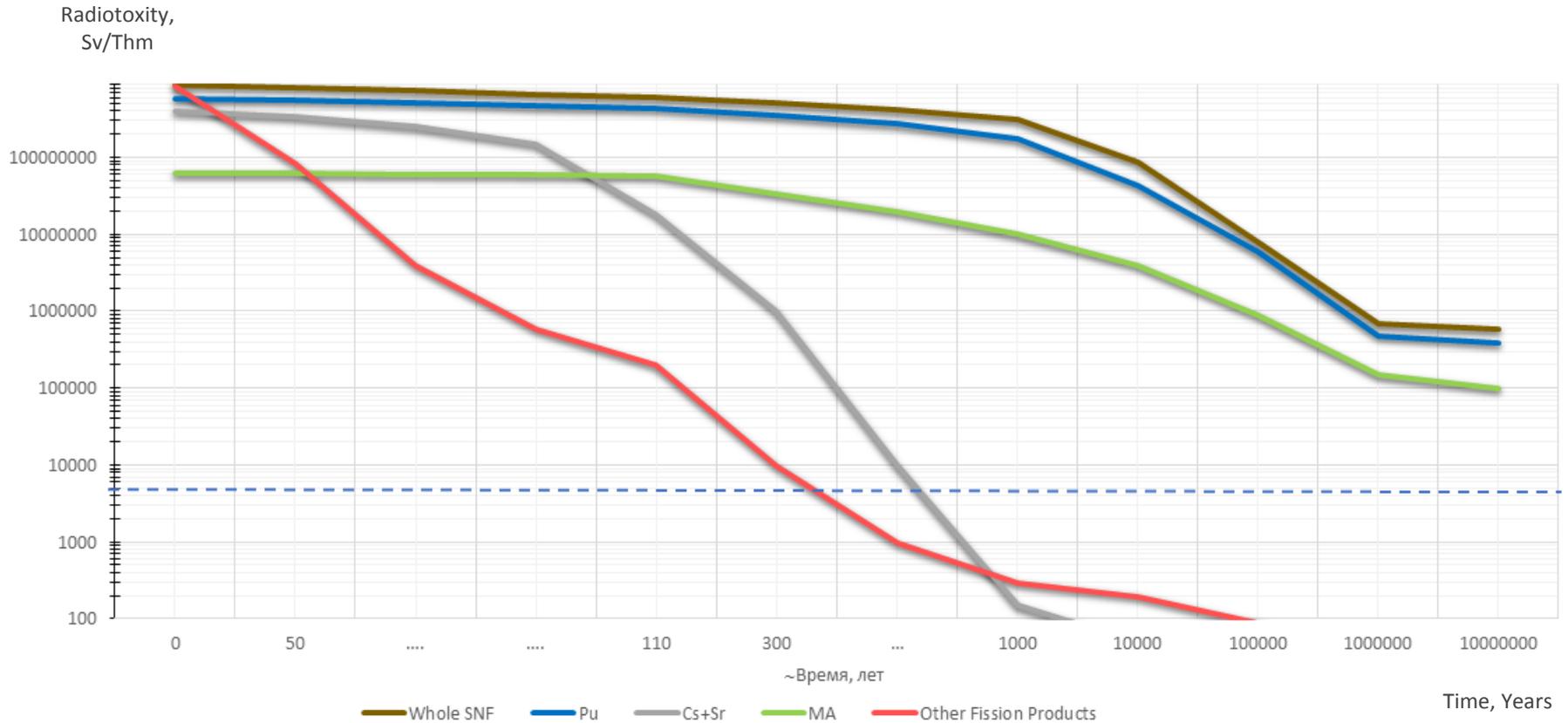
- ✓ **To enhance fissile materials consumption**
 - Recycling of the U and Pu
 - Multi-recycling of U and Pu
 - Pu 'cleaning' in the fast reactors

- ✓ **To comply with non-proliferation regime**

- ✓ **To be appropriate to reactor fleet**
Taking into account specifics of LWR, PHWR and F



Spent Nuclear Fuel is Quite Specific to be Disposed Better to split it and manage by fractions

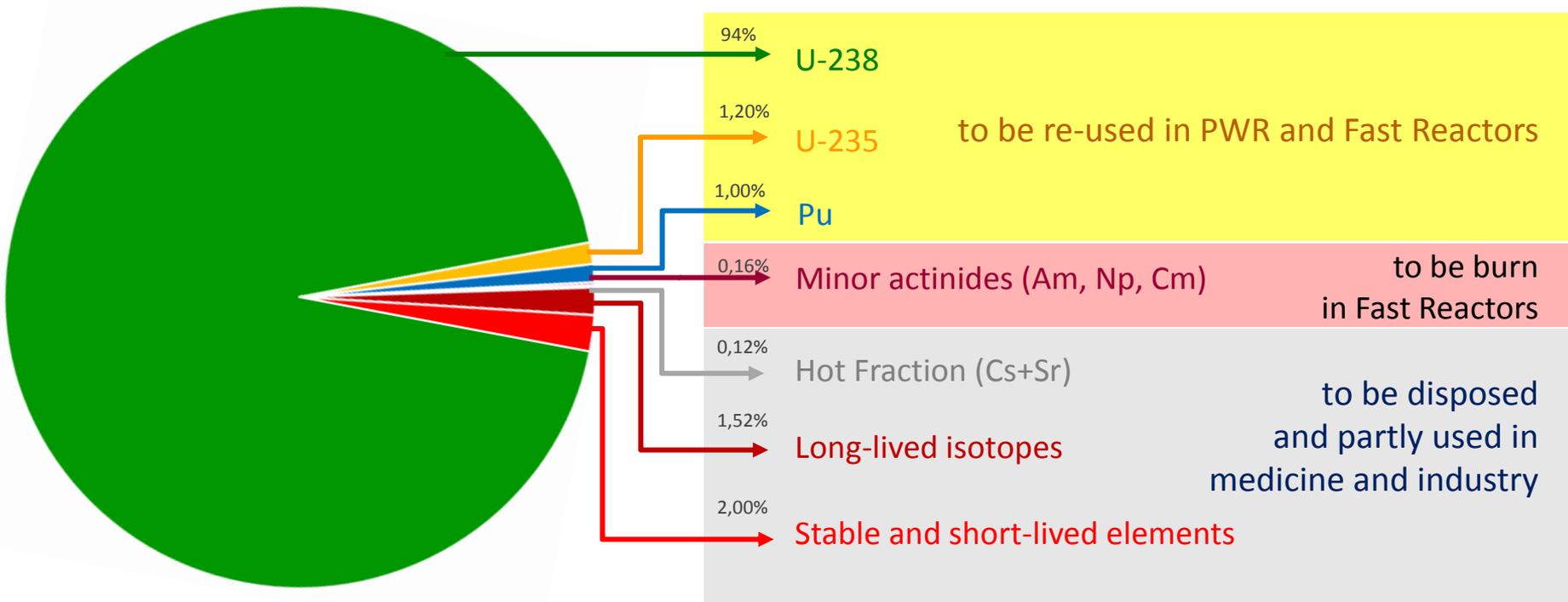


Nuclear Waste components radiotoxicity decrease

ROSATOM expert estimation, 2017

What to do with the different SNF fractions

After its partitioning

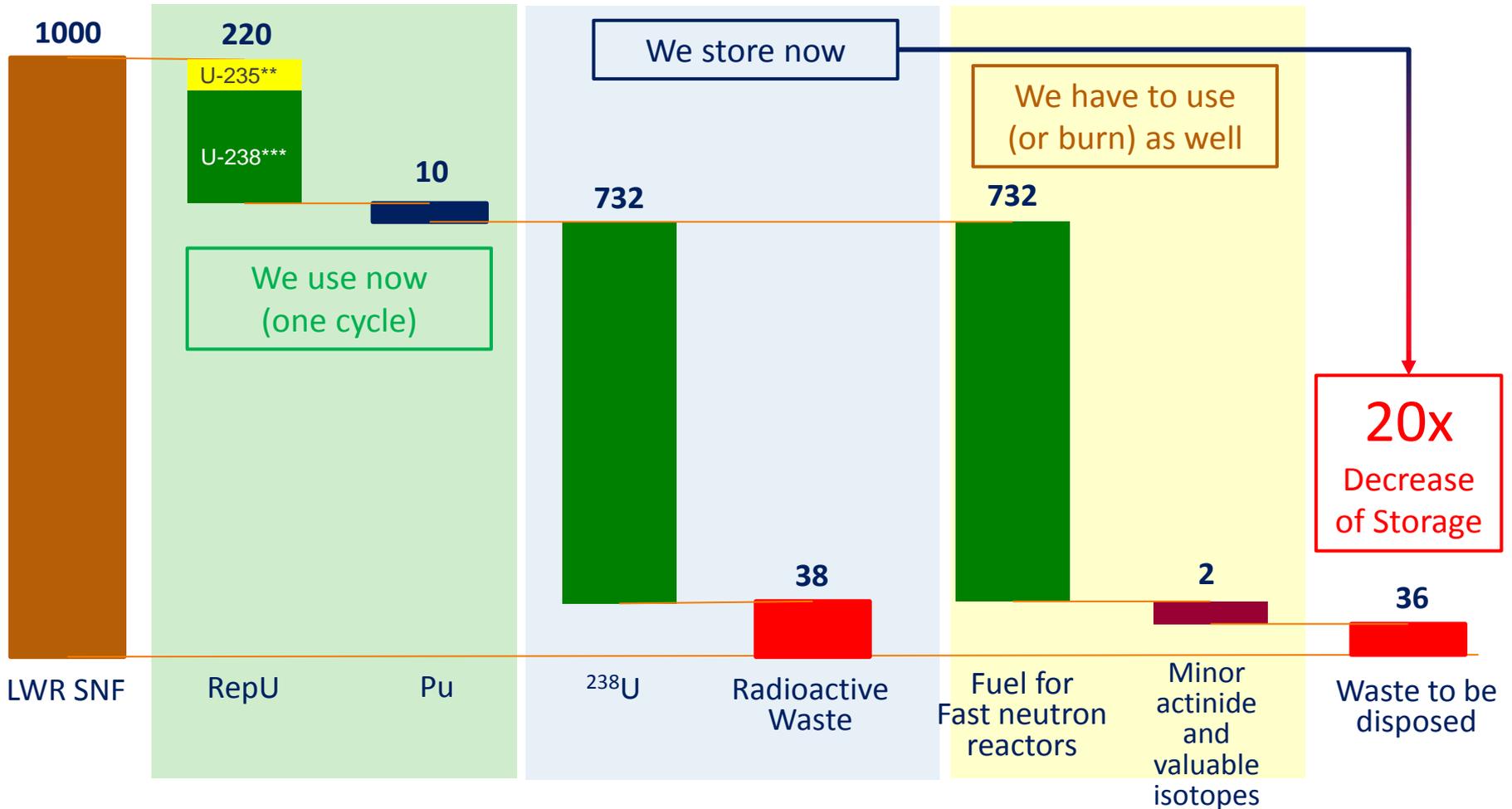


SNF components possible usage

ROSATOM Vision, 2019

SNF Partitioning

Allows to Minimize NatU Consumption and Amount of Waste



Spent Nuclear Fuel Composition, reference kg*

ROSATOM Expert Estimation, 2019

*Expert estimation for SNF after 10 years of cooling **As reprocessed uranium in UO₂ fuel ***In MOX fuel

The objective is to minimize nuclear waste volume

ROSATOM is offering a number of feasible solutions for minimization of the SNF volume based on the up-to-date innovations.

All the options consider fissile materials recycling:

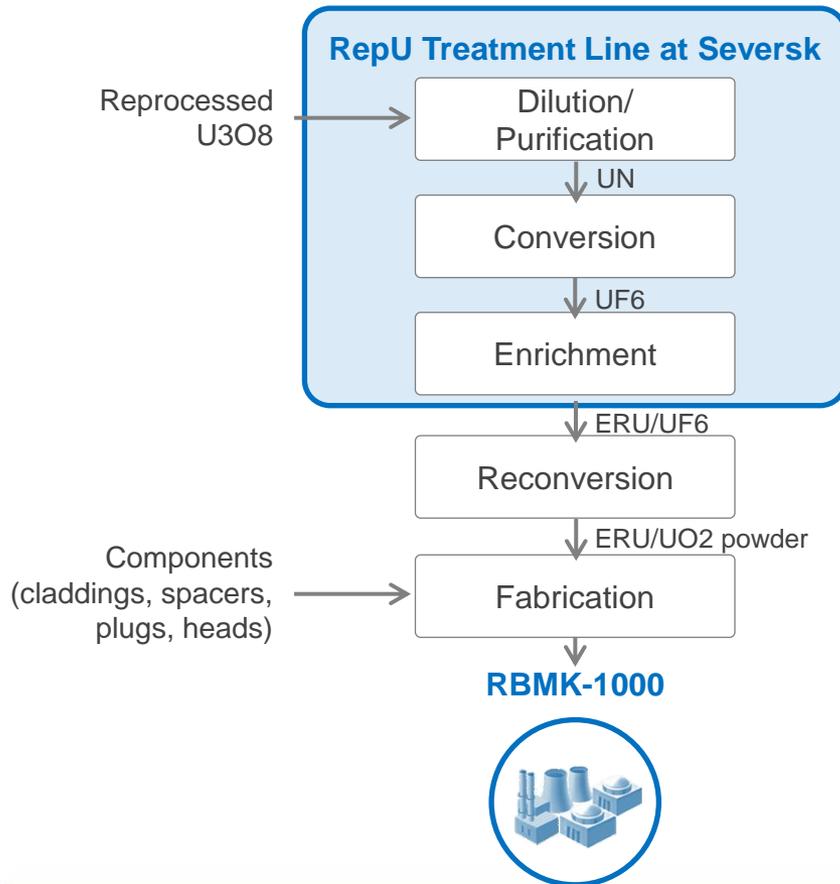
- Recycling of the reprocessed U and Pu in existing NPP fleet
- REMIX Nuclear Fuel Cycle
- Dual-Component Nuclear Power System



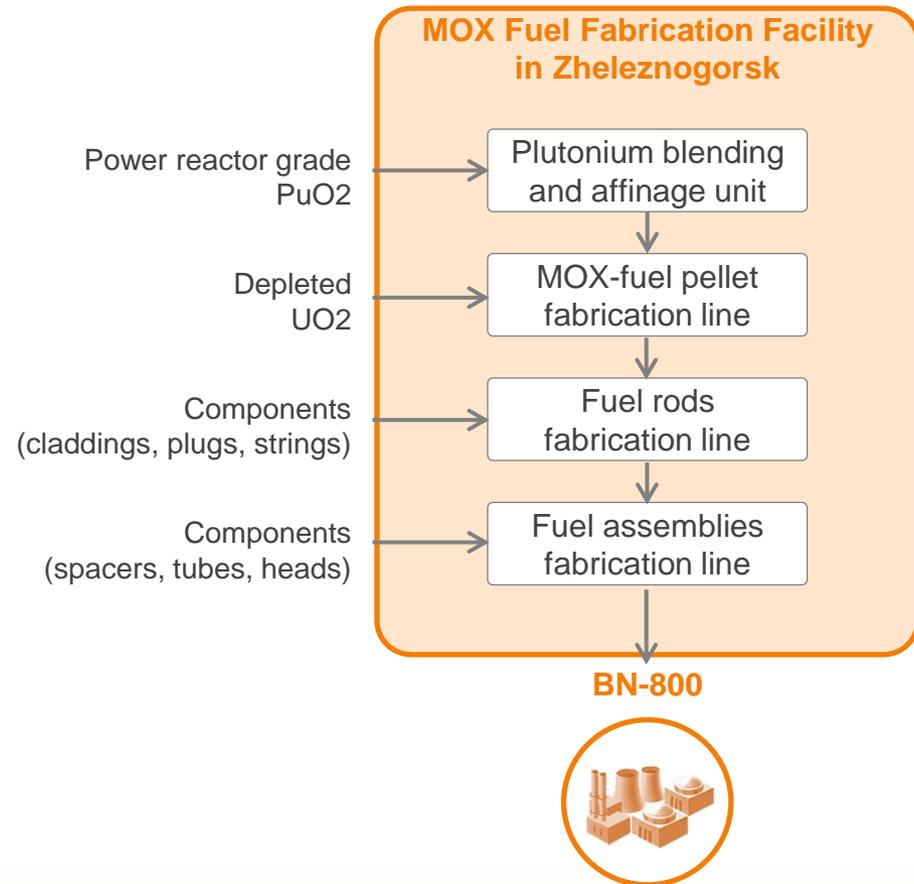
Possible Solutions. Rosatom Approach (1/3)

Recycling of the reprocessed U and Pu in existing NPP fleet

RepU Treatment Chart

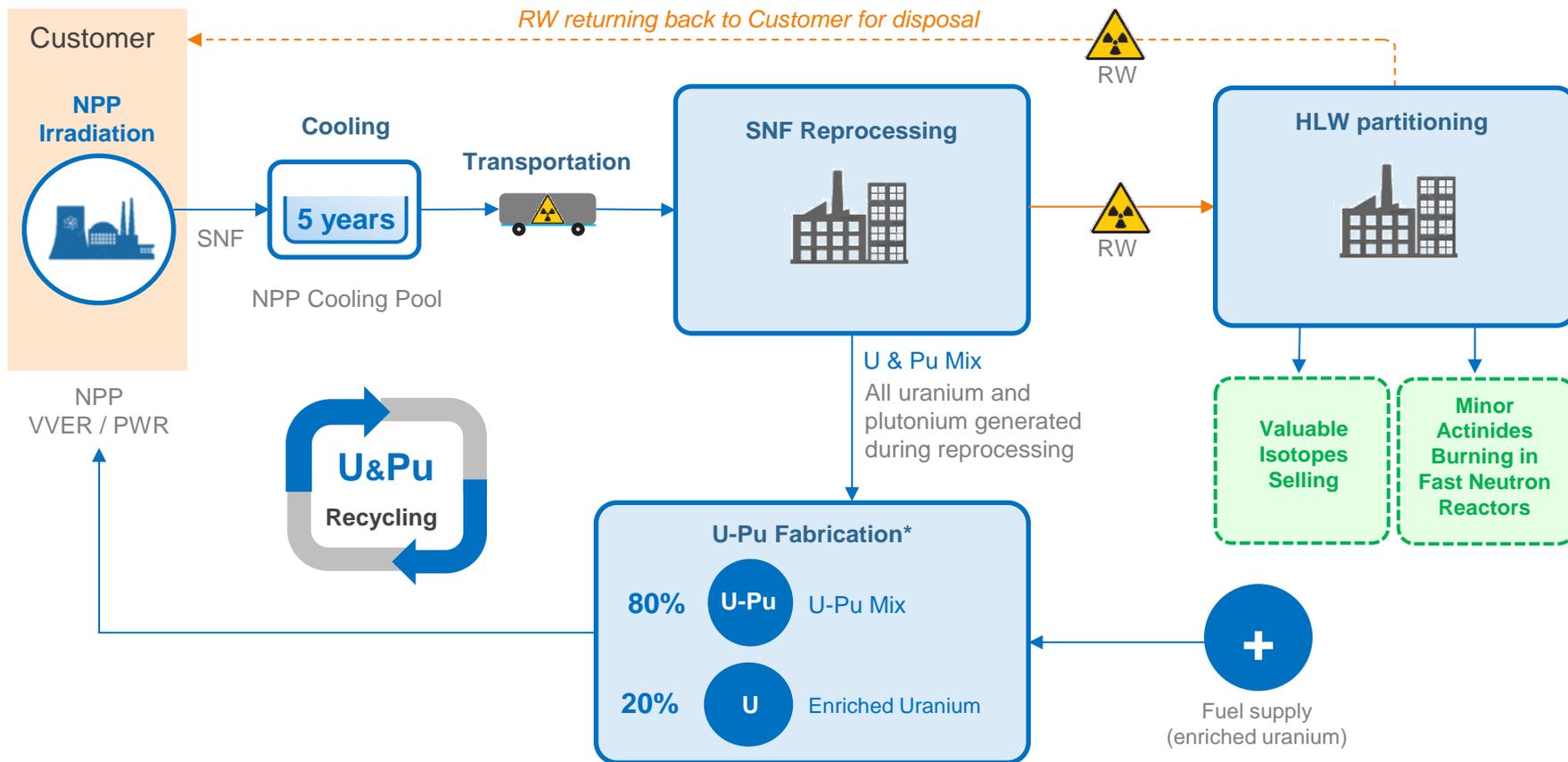


PuO2 based MOX Fuel Fabrication Chart



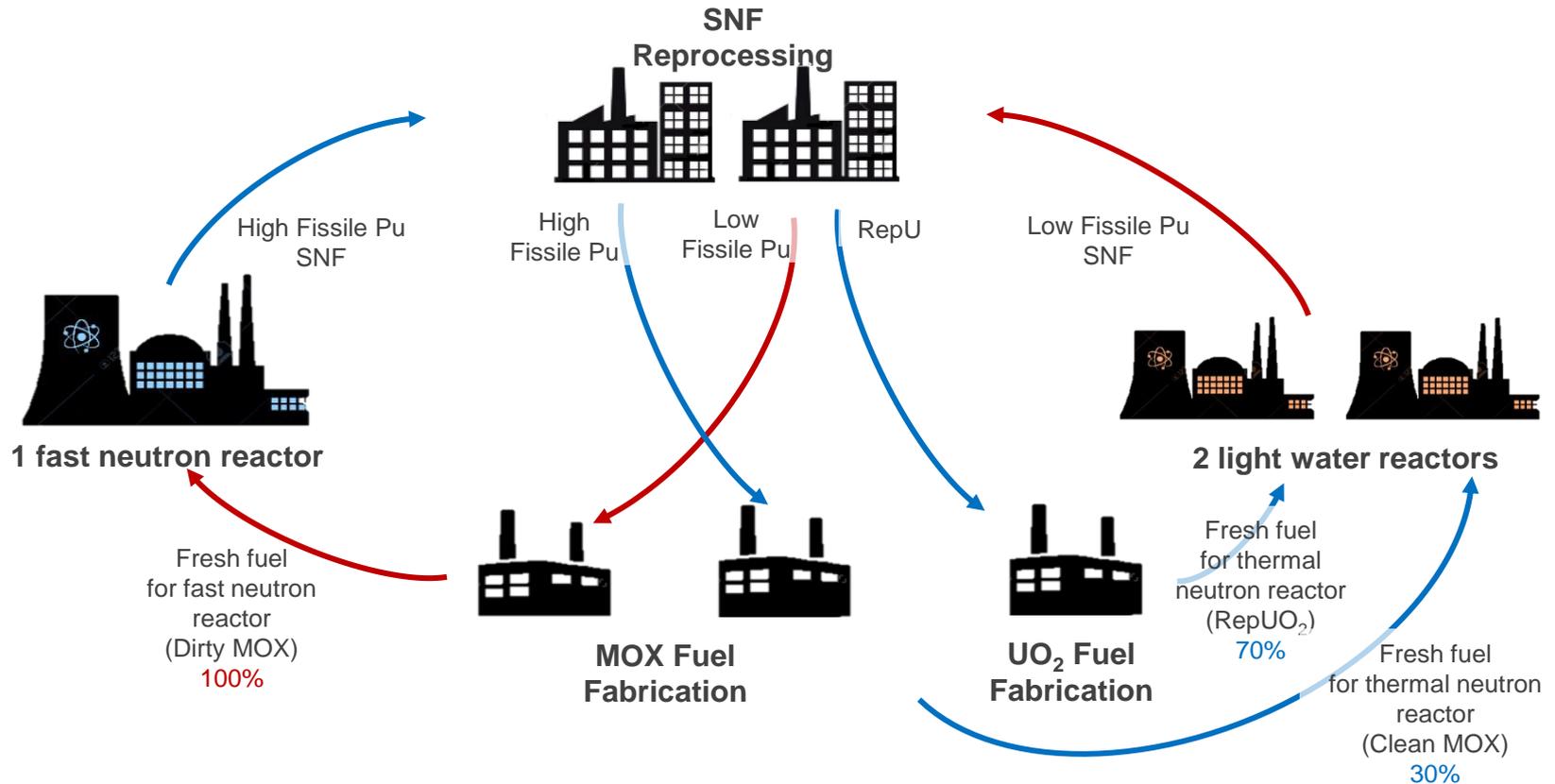
Possible Solutions. Rosatom Approach (2/3)

REMIX Nuclear Fuel Cycle



Possible Solutions. Rosatom Approach (3/3)

Dual-Component Nuclear Power System



Dual-Component Power System = reactors on thermal neutrons (VVER, PWR, BWR) + fast neutron reactor (BN) + SNF reprocessing facility + fabrication facility(ies).

Possible Nuclear Fuel Cycle Solutions for near-term future



«We are certain that **the future of world atomic energy is intrinsically linked to closing of the nuclear fuel cycle**, and fast reactor technologies constitute an integral part of it...Considering the scientific and technological backlog we are convinced that the **closed fuel cycle** is no longer a distant prospect. And we are basically witnessing the first stage of this project's implementation today. Closing of the fuel cycle will allow peaceful atom to become an environmentally safe source of energy with practically inexhaustible resources for millennia to come. There are all grounds to believe that such a comprehensive product will be offered to the market **within the next 10-12 years**. In terms of nuclear energy, it is almost tomorrow»

Alexey Likhachev, ROSATOM CEO

IAEA Ministerial Conference

“Nuclear Power in the XXI century”

17-21.09.2018

Nuclear Fuel Cycle needs to be Smart

Most NPP operators' choice in favor of **referred solution** (interim SNF storage) by cause of absence of better scenarios



Customizing: ability to offer the Customer optimal NFC options

Lowering public acceptance and support issues in some countries, caused by – among others – lack of safe and reliable solutions in back end



Comprehensiveness: readiness to offer NFC solutions, that includes utilization of recovered products, waste volume reduction and its safe disposal

Let-up of SNF reprocessing by some big players, caused by – among others – inefficiency of the solutions in SNF reprocessing itself, in recycling of the RepU and Pu and in waste treatment



Emphasis on advanced scientific and engineering achievements: involving the partitioning technologies, fast reactors, the best practices in the field of geological disposal of radioactive waste treatment

Delay in performance of promising international projects due to the infrastructure construction barriers



International cooperation enhancement in different forms

Further development of Nuclear is possible only with the new Nuclear Fuel Cycle



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THANK YOU FOR YOUR ATTENTION!