Russia's efforts to develop advanced nuclear cycles

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Advanced fuel cycles at Rosatom

- The role of Rosatom
  - Broad autonomy, political support
  - Government subsidies (direct and indirect)
- Long history of interest in closed fuel cycles
- Experience
  - Numerous research facilities
  - BN-350, BN-600 fast neutron reactors
  - Naval fast neutron reactors
  - Reprocessing of various fuels

Plutonium

- Civilian stock
  - 63 MT as of 31 December 2019
  - Includes some weapon-grade Pu (from BN reactors)

- Military stock
  - About 120 MT
  - 40 MT is not available for military purposes
    - 25 MT weapon-origin metal Pu at Mayak
    - 15 MT of post-1997 Pu, stored as oxide in Zheleznogorsk

BN reactors

- Fast neutron sodium-cooled reactors
- BN-350
  - Operated in Aktau, Kazakhstan in 1973-1999
  - Decommissioned
- BN-600
  - In operation since 1981 in Zarechnyy, Beloyarsk NPP
  - License to be extended to 2040
- HEU fuel
  - 17%, 21%, and 26% enriched uranium

BN-800

- Zarechnyy, Beloyarsk NPP
- Fast-neutron sodium-cooled reactor
- 800 MWe
- Connected to the grid in December 2015
- MOX Fuel
  - First loads – HEU + experimental MOX
  - Serial production MOX – since August 2019
  - Full transition to MOX – in 2022
- Nitride fuel
  - Under development

Proryv/Breakthrough project

- Seversk (Tomsk-7)
- Reactor + Reprocessing plant + Fuel fabrication
- Brest-OD-300 reactor
  - "OD" – experimental, demonstrator
  - Fast-neutron, lead-cooled reactor
  - 300 MWe, 700 MWt
  - "Mixed dense nitride uranium-plutonium fuel"
- Construction began in June 2021, to be completed in 2026-2027

Other projects

- BN-1200
  - Fast neutron sodium-cooled reactor
  - 1200 MWe
  - Nitride fuel
  - Decision to build postponed until 2030
- SVBR-100
  - Fast neutron lead-bismuth-cooled reactor
  - Based on naval reactor design
  - Mothballed in 2017
- Molten salt reactors
  - Research and development

REMIX fuel

- Unseparated U-Pu mixture + ~17% LEU -> 1% Pu+3% U-235
- Multiple recycling
- Full core loading without modifications
- No accumulation of separated reactor-grade Pu

- VVER-1000 reactors (or other PWR)
- Production – Zheleznogorsk (fuel pellets), Seversk (assemblies)
- Irradiation tests are underway (Balakovo NPP)
- Pilot fuel assemblies produced in 2021

Reprocessing – RT-1

- Operating since 1977 at NPO Mayak, Ozersk

- Mostly VVER-440 fuel, naval and research reactors
- Expanded to handle all kinds of fuels

- 400 MTHM/year capacity
- 100-130 MTHM/year actual throughput

Pilot Demonstration Center

- Zheleznogorsk (Krasnoyarsk-26)
- Wet and dry fuel storage (VVER-1000 and RBMK)

- Reprocessing – startup operations since 2018 VVER-1000 fuel, maybe BN-800 fuel

- Pilot operations at 5-10 MTHM/year
- Projected capacity 250 MTHM/year

- Fuel fabrication plant
  - MOX fuel for BN-800
  - Nitride fuel pellets