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Back-End to the Future

Spent Nuclear Fuel (SNF) Management and Back-End Safeguards

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Spent Nuclear Fuel Storage and Disposal

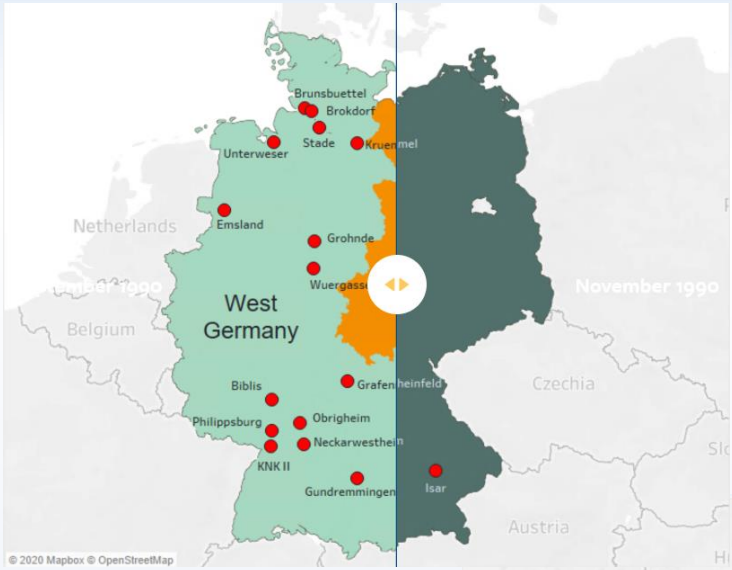
Interactive Tool

- Objective 1: Assist the larger Back-End to the Future project assessing the resiliency of nuclear safeguards systems
- Objective 2: Educate the general public on the back-end of the nuclear fuel cycle and spent fuel management
- Objective 3: Provide a consolidated resource for experts

- Focus: 21 countries around the world with significant nuclear energy activities
- Notes on data:
  - Tool does not include military material
  - Data originates from open-source reporting

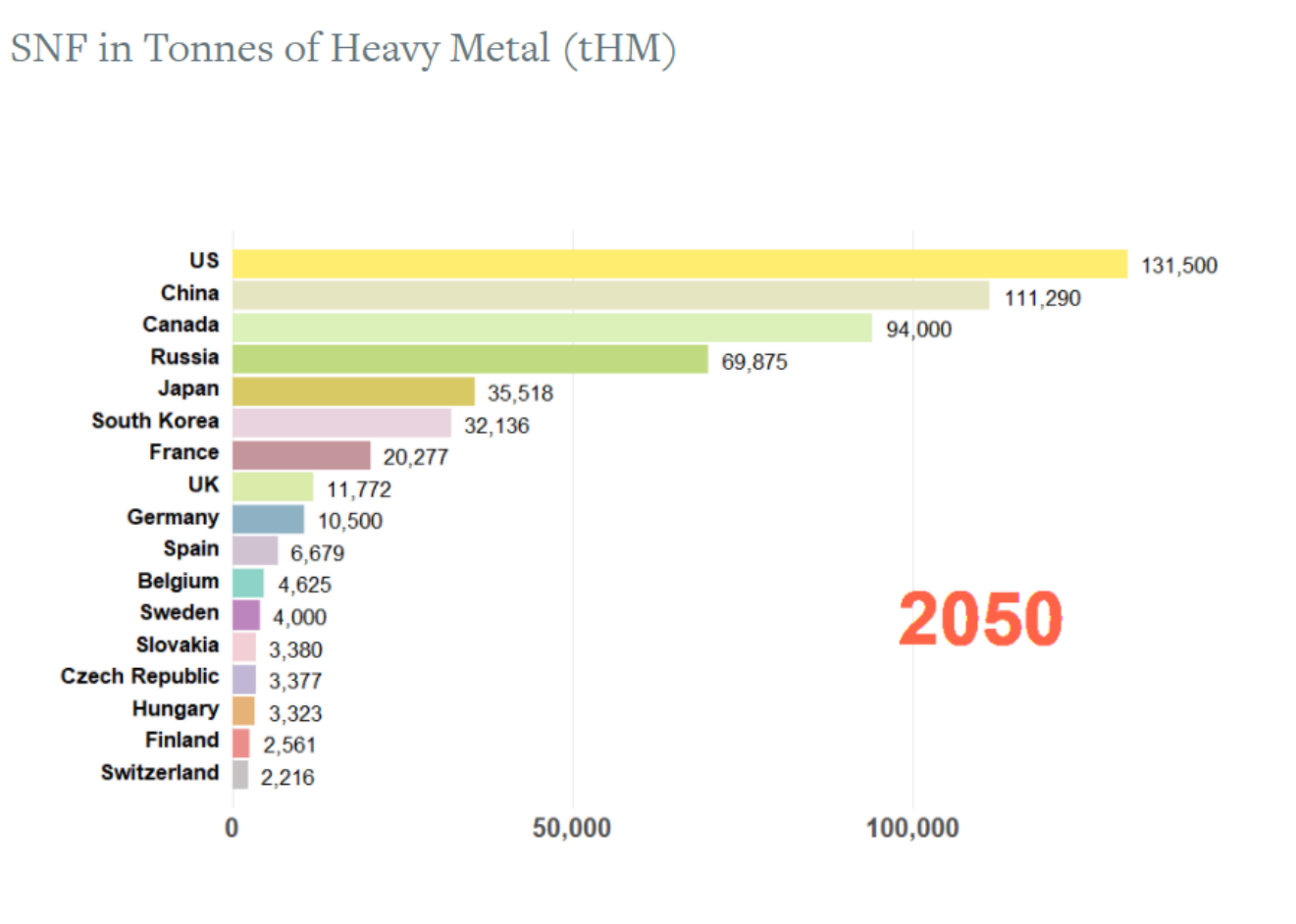
Interactive Tool

Changing Borders



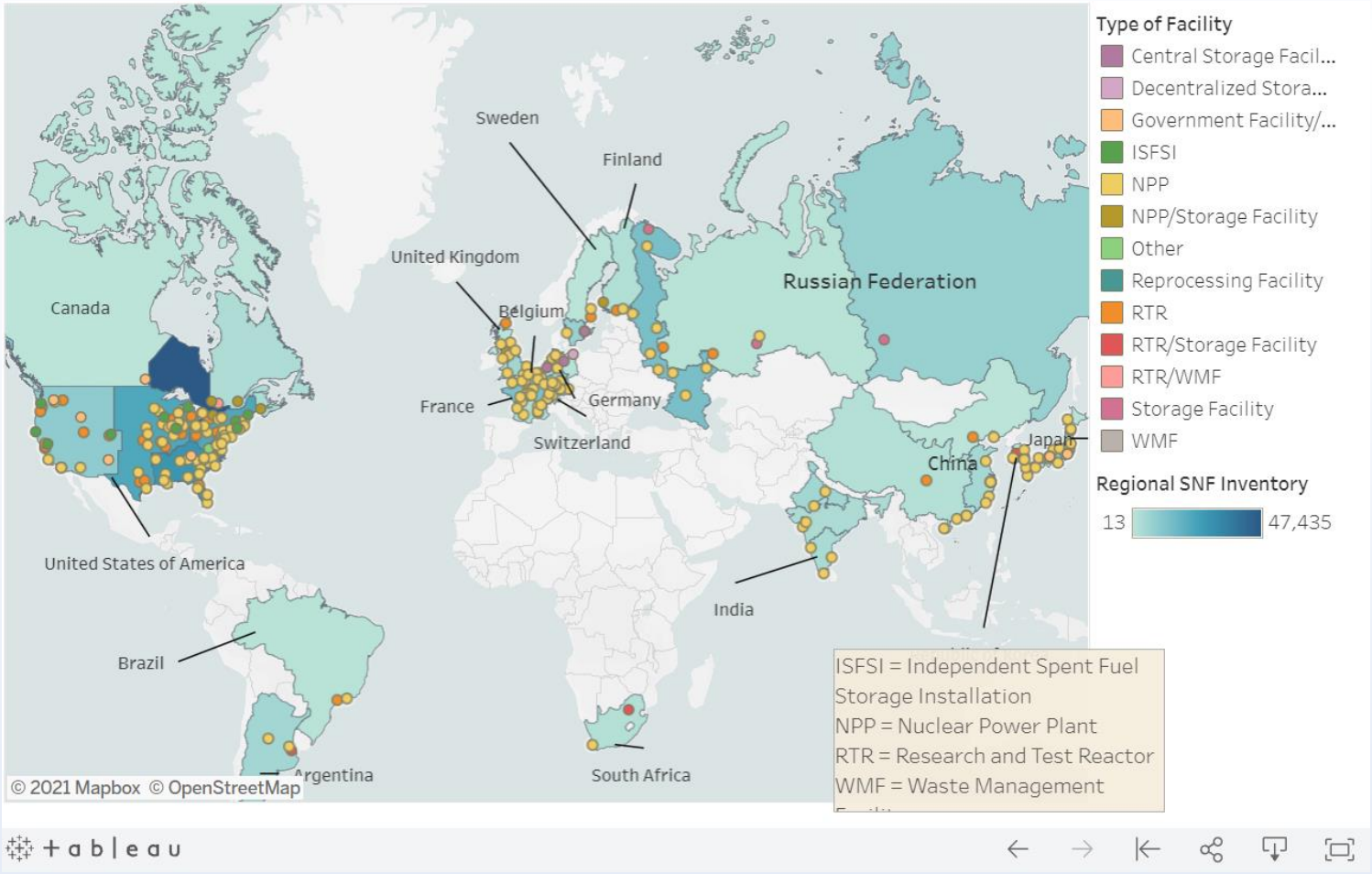
Interactive Tool

Global SNF Tracker (1960-2050)



Interactive Tool

Where is SNF stored today?



Deep Geological Disposal

- Considered the most effective and safest option to manage SNF as it radioactively decays over tens of thousands of years
- Some deep geological repository (DGR) concepts:
  - Multi-barrier system
  - Deep borehole disposal
  - Multinational geological repositories

The Role of Public Acceptance

- Public engagement and acceptance is important for building trust in and credibility of entities involved in DGR development

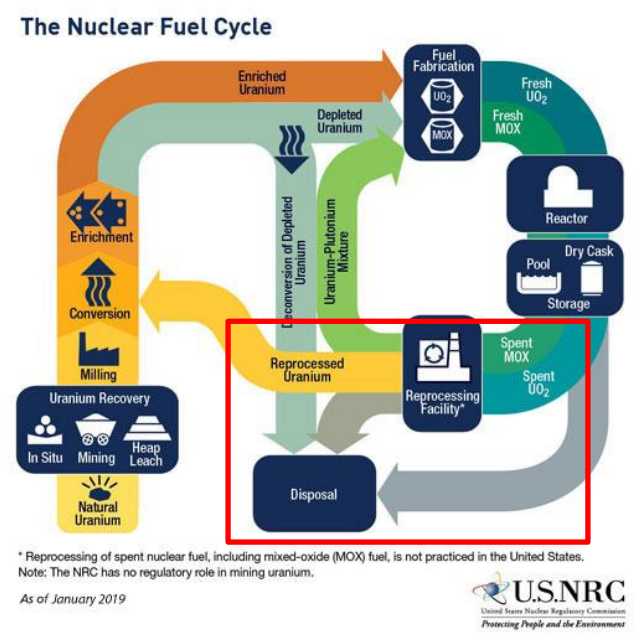
- Finland, Sweden, France, Canada, and Switzerland have used a community-driven approach

IAEA Safeguards for Disposal Facilities

- The plutonium within SNF is considered direct use material for nuclear weapons
- IAEA considers SNF in a repository to be retrievable even after enclosure, meaning safeguards apply in perpetuity (so long as the agreement with the IAEA exists)
- Long operating lifetimes, constant changes to designs and material quantities over those lifetimes, inaccessibility, and the need for remote monitoring post-closure make DGRs a new Safeguards challenge
  - Require innovation in remote monitoring

Spent Fuel Management and Safeguards Considerations for Emerging Reactors

- New fuel forms and other features of emerging non-light water reactor designs could impact spent fuel management decisions:
  - Transport
  - SNF quantities
  - DGR designs
  - Closed fuel cycles



Safeguarding Emerging Reactors and SNF

- "Safeguards by design" & "safeguardability"
- Bulk material accounting
  - Countable traditional fuel rods vs.

  New fuels in large "bulk" volumes
- Non-visual monitoring
  - Material and temperature challenges
  - Sealed cores
- Inspection capacity
  - "zero growth" budget
  - Complexity added to training

U.S. DOE

DOE NNSA

Back-End to the Future

- Countries require long-term management solutions to the growing global SNF inventory
- New facilities including DGRs and emerging reactors will pose safeguards challenges that can begin to be addressed with early, consistent engagement with the IAEA
- Demonstrating technical and operational competence and public acceptance are key factors for the development of a DGR

THANK YOU

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"Spent Nuclear Fuel Storage and Disposal," https://www.stimson.org/2020/spent-nuclear-fuel-storage-and-disposal/
"Bringing the Back-End to the Forefront: Spent Nuclear Fuel Management and Safeguards Considerations for Emerging Reactors," https://www.stimson.org/2021/bringing-the-back-end-to-the-forefront/