Overview of U.S. Spent Fuel Management – the Good, the Bad, and the Ugly

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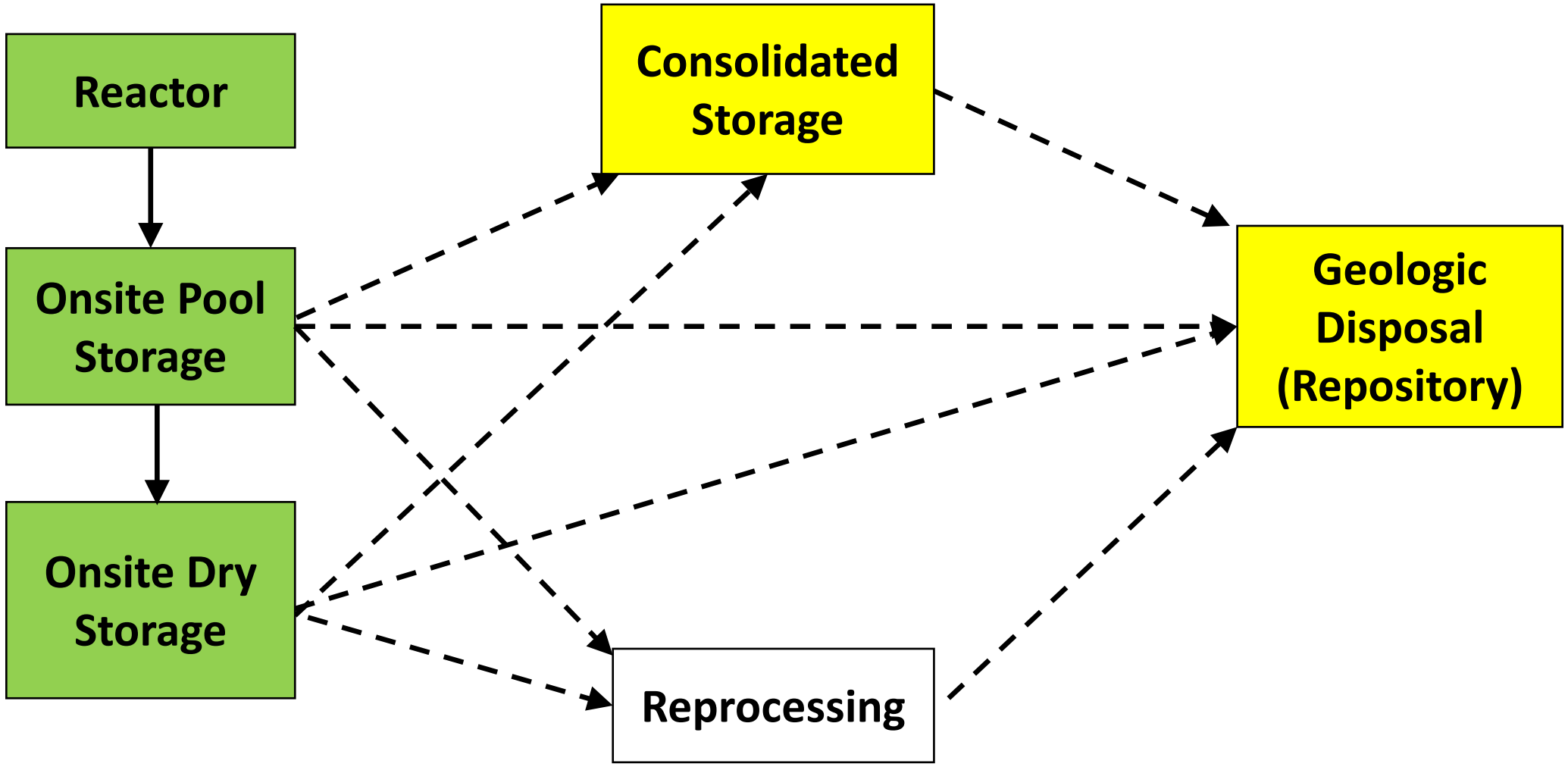
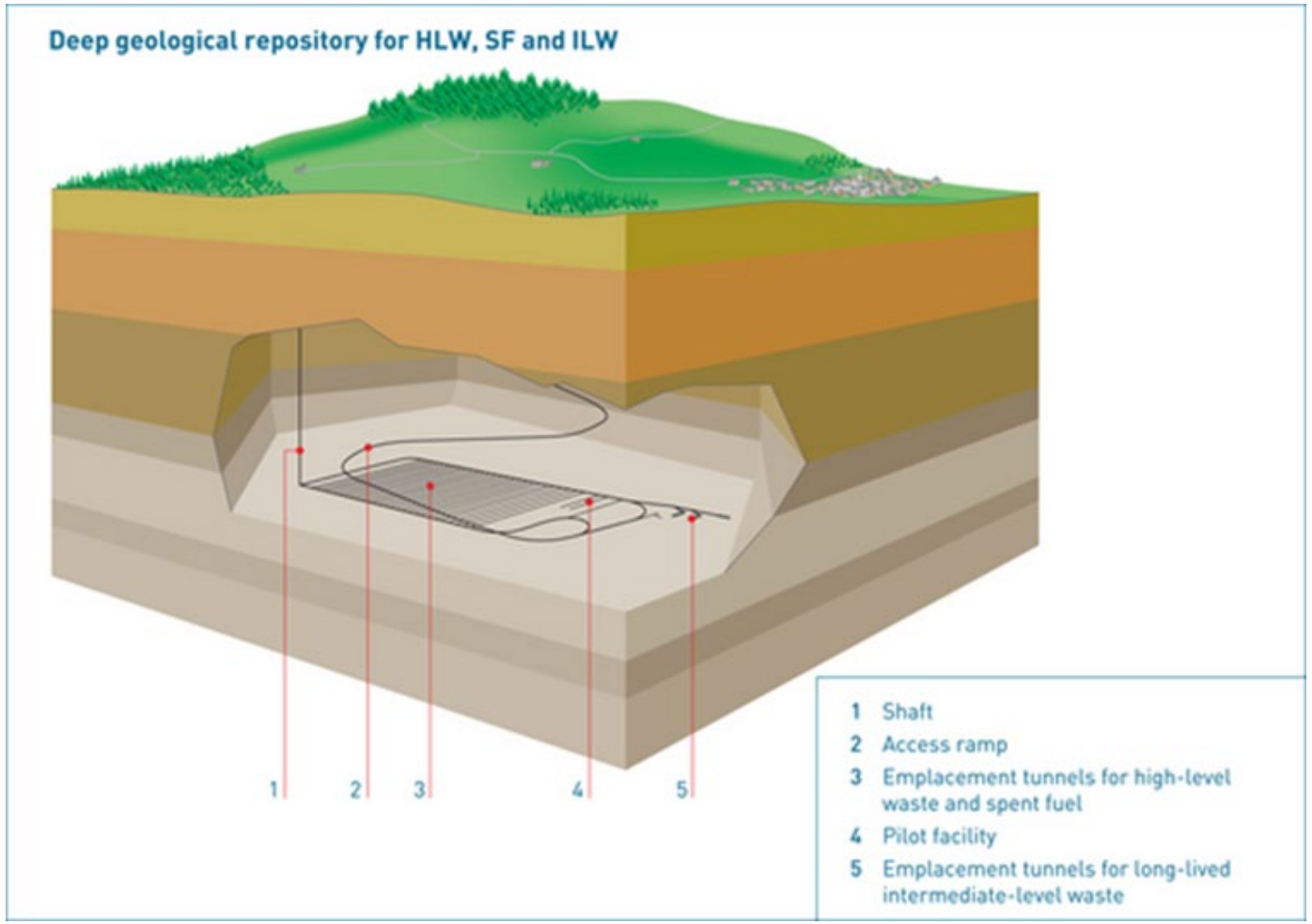
Spent Fuel Management - Overview

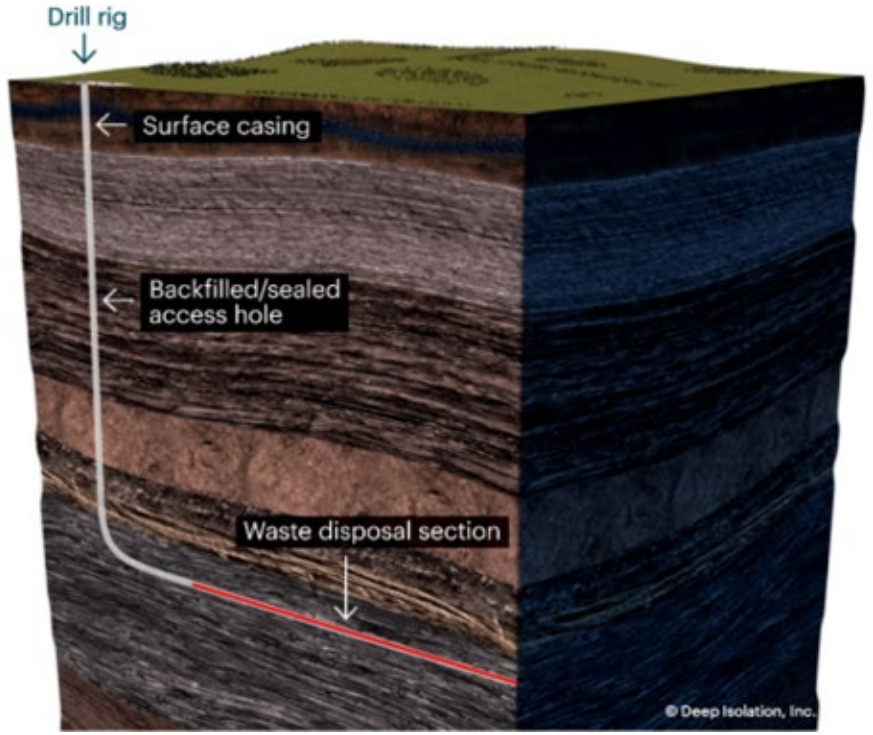


Geologic Disposal of Radioactive Waste



Mined geological repository

Horizontal borehole



Perspective on Geologic Disposal

- Consensus international approach to long-term management of used nuclear fuel and high-level radioactive waste (HLW)
  - Mined geological disposal (e.g., Onkalo, Yucca Mountain)
  - Boreholes (vertical or horizontal, e.g., Deep Isolation)
- You still need geologic disposal even if you reprocess/recycle
- You still need geologic disposal even if you have consolidated interim storage
- Geologic disposal is the linchpin of a viable nuclear fuel cycle back end

History of Geologic Disposal in the U.S.

- 1957 National Academy of Sciences (NAS) report ““The Disposal of Radioactive Waste on Land”
  - The NAS saw spent fuel and HLW disposal primarily as a manageable technical issue, not as a social and economic challenge
  - “… radioactive waste can be disposed of safely in a variety of ways and at a large number of sites in the United States.”
- Atomic Energy Commission conducted research on disposal through the 1970s
  - Focus was on HLW from reprocessing
  - Commercial spent fuel was accumulating in addition to weapons waste
  - Growing concerns about radioactive waste disposal among the NAS, Government Accountability Office, and the public

History of U.S. Geological Disposal (cont.)

- 1970 preliminary AEC designation of salt formations near Lyons, Kansas for disposal of solidified HLW from reprocessing
  - Geological investigations indicated a possibility of water ingress
  - Public and governmental relations were not handled well
  - Plans for a Lyons repository were shelved in 1972
- In the mid-1970s the federal government terminated plans for large-scale commercial reprocessing in the U.S.
  - Nonproliferation concerns about potential diversion of separated plutonium to weapons use after India exploded a “peaceful nuclear device” in 1974
  - Shifted back-end focus to storage and disposal

History of U.S. Geologic Disposal (cont.)

- Nuclear Waste Policy Act (NWPA) of 1982
  - Established geologic disposal as U.S. policy (two repositories to be developed)
  - Assigned responsibility for disposal to the Department of Energy (DOE)
  - Began collecting money from nuclear power plant operators to pay for it
- NWPA Amendments of 1987
  - Established Yucca Mountain, Nevada as the only site to be characterized for a geologic repository
  - Ended work on a second repository
- Yucca Mountain site selection in 2002 by the Secretary of Energy and President
  - Veto by State of Nevada overridden by vote of both houses of Congress

Yucca Mountain

History of U.S. Geologic Disposal (cont.)

- DOE submitted application for Yucca Mountain construction authorization to the Nuclear Regulatory Commission (NRC) in 2008
  - DOE discontinued all work on Yucca Mountain in 2010
  - NRC terminated its review of the construction authorization application in 2010
  - NRC restarted its safety review under court order and completed it in 2015
- Congress has not appropriated funds for Yucca Mountain since fiscal year 2010, nor has it amended the NWPA
- No administration has requested funding for Yucca Mountain since 2018
- The only DOE work on geologic disposal since 2010 has been non-site-specific studies
- Other countries (e.g., Finland, Sweden, France, Switzerland, Canada) are making good progress on geologic disposal

Consolidated Interim Storage

- Transport spent fuel from reactor sites to one or more large storage facilities (pool or dry, but typically dry storage in U.S. concepts)
- NWPA Amendments of 1987 provided for a Monitored Retrievable Storage Facility at a volunteer site – program discontinued in 1990s
- Three private centralized storage facilities received licenses from the Nuclear Regulatory Commission
  - Private Fuel Storage on Goshute Indian Reservation in Utah – 2006
  - Interim Storge Partners in Andrews County, Texas – 2021
  - Holtec in Leah County, New Mexico – 2023
- None began construction – all stalled by host state opposition

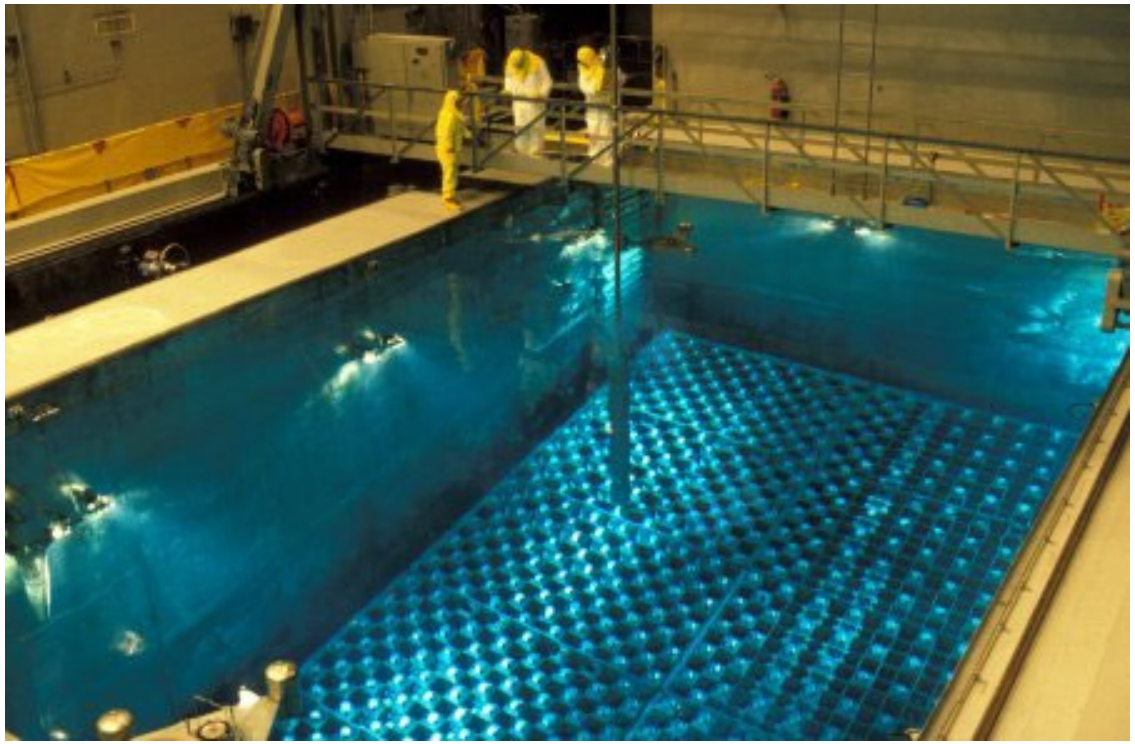
Summary

- The U.S. government is responsible for spent nuclear fuel management
- The government has done nothing productive since 2010 when it cancelled the Yucca Mountain repository project for political reasons
- Utilities store nuclear fuel safely on reactor sites in spent fuel pools and dry storage systems
- Dry storage is a proven technology that can work indefinitely, if needed, but it is not a permanent solution

Additional Material

Spent Fuel Storage

- Reactors must periodically refuel -- discharge spent fuel assemblies from the core and insert fresh ones
- Initial concept was to store spent fuel in “spent fuel pools” located on reactor sites
- Spent fuel would cool for years and then be transported offsite for reprocessing, freeing up space for more discharges



Alternatives to Spent Fuel Pool Storage

- In the 1970s the U.S. government changed its policy and forbade domestic reprocessing
- Spent fuel pools began to fill up, threatening plant shutdowns
- Alternatives
  - Re-rack spent fuel pools to fit more assemblies in the same pool
  - Consolidate fuel rods to fit more fuel in the same pool
  - Ship fuel offsite to other reactors with more space in their pools
  - Ship fuel offsite to a geologic repository for disposal
  - Ship fuel offsite to a centralized storage facility
  - Store fuel in onsite dry storage

Dry Storage of Spent Fuel

- Fuel assemblies are loaded into casks in the spent fuel pools
- The casks are drained, backfilled with pressurized inert gas, sealed, and emplaced on concrete pads on the reactor site
- Heavy shielding protects people from the radiation from spent fuel and protects the fuel from external events (e.g., wind-driven missiles)
- Natural convection cooling to the air prevents the spent fuel from overheating
  - Passive system with no pumped flow or electrical power required
- First deployed in 1986 in the U.S. – now used at almost all U.S. nuclear power plants

Nuclear Regulatory Commission Fact Sheet

Dry Storage

Consolidated Interim Storage Facilities (CISFs)

- Ship spent fuel from multiple reactors to central sites
  - Store either in very large pools or dry storage systems
- Used in Europe and Japan but not in the U.S. *
- Failed or stalled attempts in the U.S.
  - Department of Energy (DOE) Monitored Retrievable Storage Project (~1990)
  - Private Fuel Storage in Utah (licensed in 2006, never built)
  - Interim Storage Partners in Texas (licensed in 2021, never built)
  - Holtec in New Mexico (licensed in 2023, never built)
- DOE is beginning a project to site and construct a CISF

* There is actually a limited amount of fuel stored in a pool at the General Electric Morris Facility in Illinois