

The U.S. Nuclear Fuel Cycle: Looking Forward to 2020

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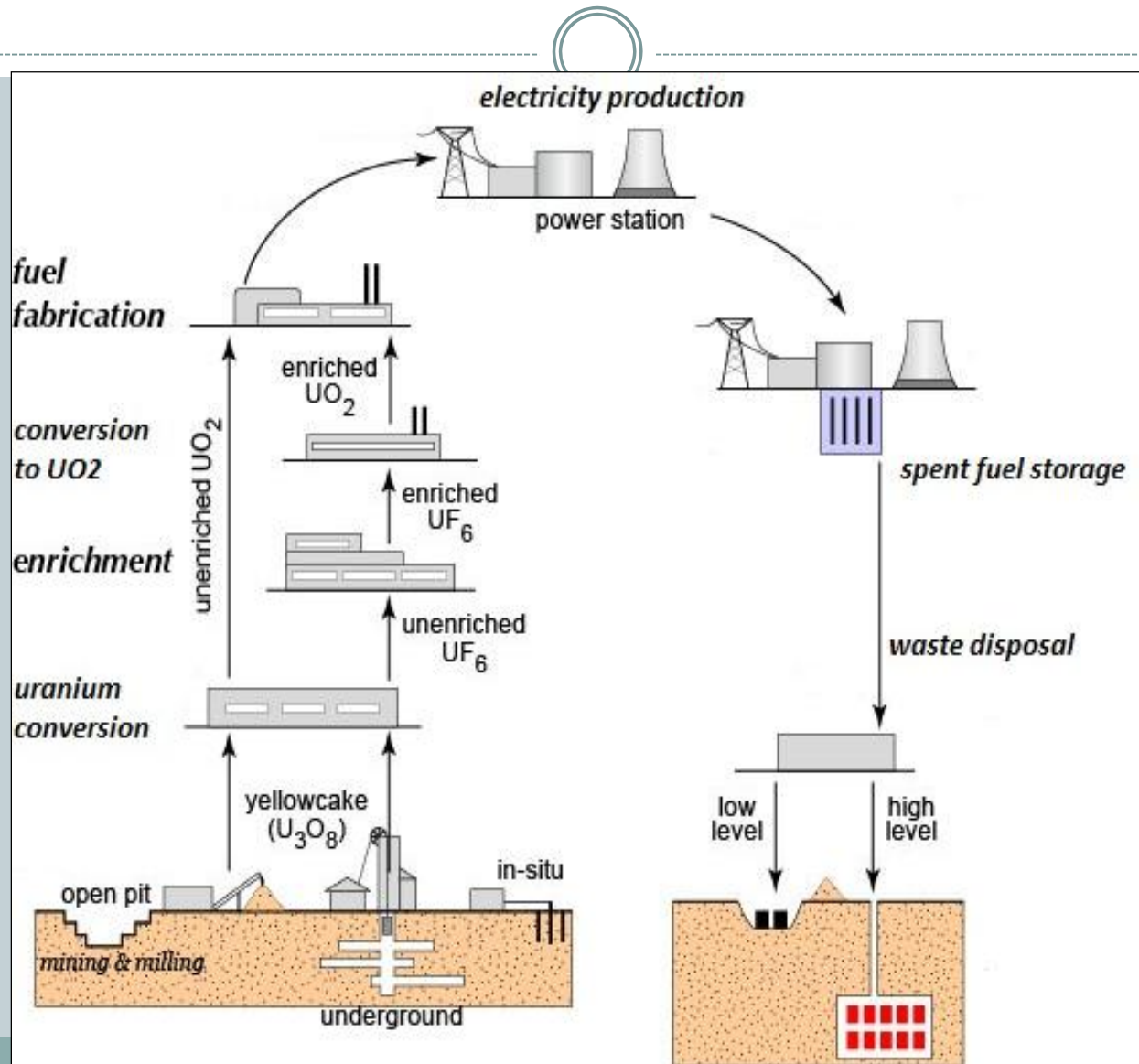
2015 FUEL CYCLE INFORMATION EXCHANGE

Overview



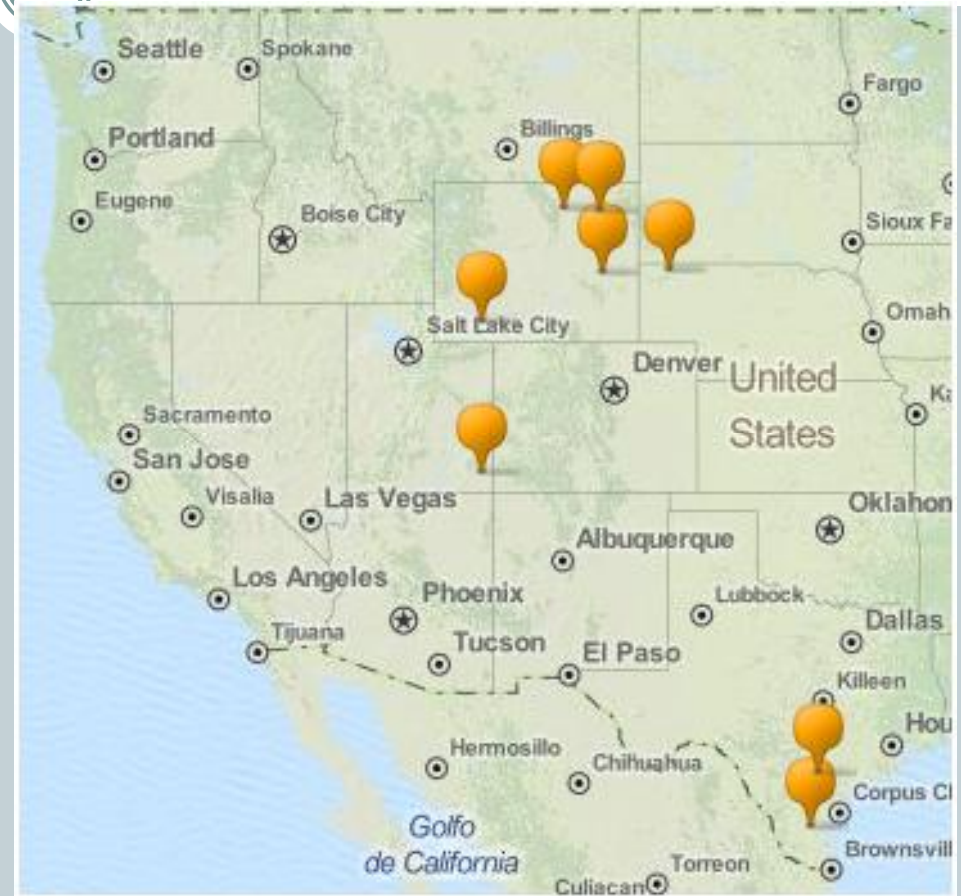
- **U.S. Nuclear Fuel Cycle in 2015**
- **Uranium production 2020**
- **Fuel cycle facilities 2020: natural uranium conversion, uranium enrichment and fuel fabrication**
- **Spent fuel management 2020**

Nuclear Fuel Cycle in U.S.



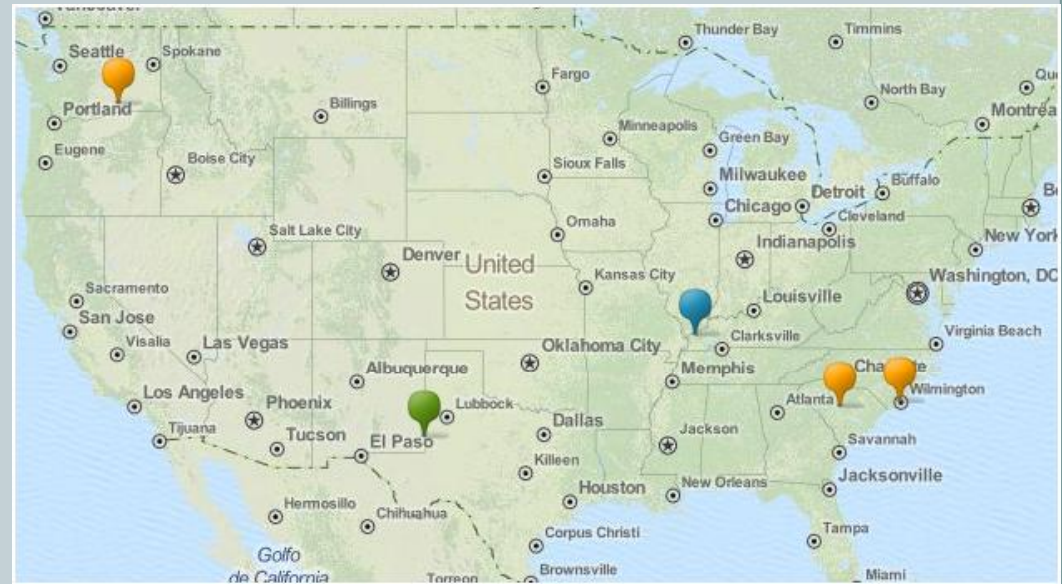
U.S. Nuclear Fuel Cycle in 2015

- **U.S. Uranium Production**
 - In 2014, U.S. uranium production was 4.9 million pounds U_3O_8 from 8 facilities in Nebraska, Texas, Utah and Wyoming.
 - Most production from in-situ recovery (ISR) facilities.
 - Several additional facilities are partially or fully permitted and licensed.
 - Wellfield development on hold at several ISR facilities and as is production at the operating conventional mill.
 - Uranium production in 2015 expected to decline from 2014 levels.



U.S. Nuclear Fuel Cycle in 2015

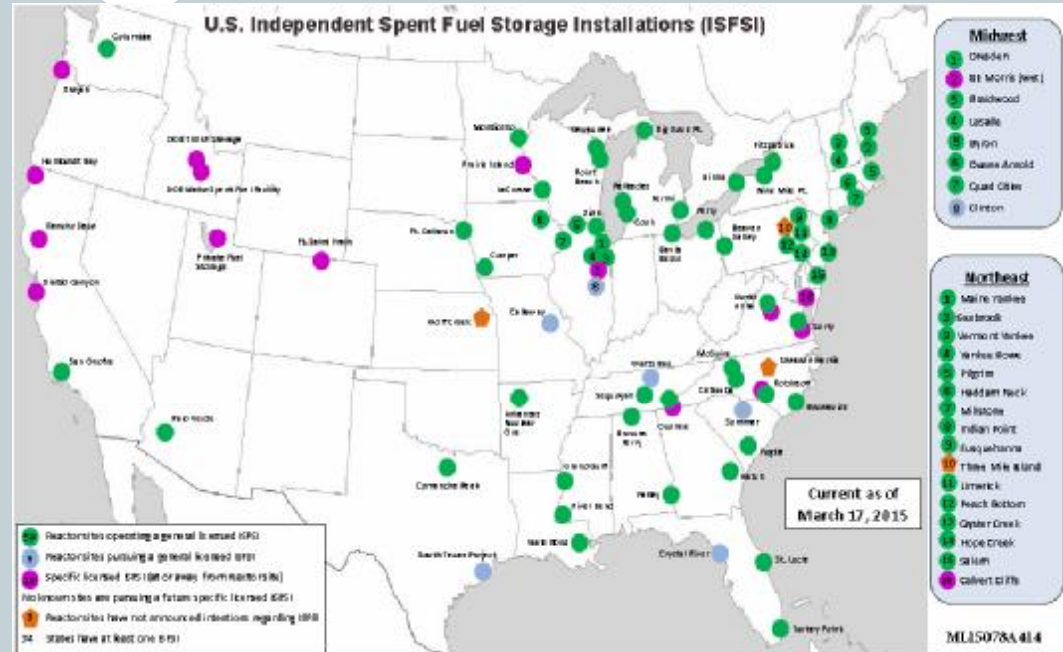
- Fuel cycle facilities include:
 - i One uranium conversion plant
 - i One gas centrifuge enrichment plant
 - i Three fuel fabrication facilities



- Nuclear fuel inventories held by nuclear operating companies are at record levels – at more than twice annual requirements
- Inventories at supplier facilities are at record levels (includes supplier inventories, U.S. and international customer inventories, trader inventories, etc.). Storage space is at a premium.

U.S. Nuclear Fuel Cycle in 2015

- Spent fuel (SNF) management:
 - i 59 ISFSIs storing SNF under general license
 - i 15 ISFSIs with site-specific licenses
 - i No active program for geologic disposal



Uranium production 2020

- **U.S. uranium production by 2020.**
 - i **U.S. production could increase in future over 2014 levels, depending on market conditions:**
 - ÷ Existing ISRs and conventional mill
 - ÷ Expansion of existing ISR
 - ÷ Restart of idle ISRs and conventional mills
 - ÷ Development of prospective ISRs and conventional mines
 - i **U.S. production expected to be < 15% of U.S. annual requirements.**



Fuel Cycle Facilities 2020

- **Conversion of U_3O_8 to uranium hexafluoride (UF_6)**
 - **Metropolis Works, Metropolis, Illinois – operated by Honeywell**
 - **Production capacity of 15 million kgU as UF_6**
 - **Has operated ~ 10 million kgU as UF_6 in recent years**
 - **U.S. requirements for conversion services ~ 18 million kgU annually**
- **U.S. nuclear operators will continue to import significant quantities of natural UF_6 or UF_6 feed contained in enriched uranium product from Canada, Europe, Russia and China.**
- **U.S. will export natural UF_6 feed to enrichers in Europe and possibly Russia and China.**
- **Stability in transport package certification is a necessity for reliable fuel supply in the U.S. and with our international partners.**



Fuel Cycle Facilities 2020

– Uranium enrichment

- U.S. requirements for enrichment services are ~ 15 million SWU annually.
- Urenco USA, Hobbs, New Mexico – gas centrifuge enrichment facility operated by Louisiana Energy Services, LLC.
 - ÷ Capacity is currently 4.2 million separative work units (SWU) annually.
 - ÷ Licensed capacity is 10 million SWU.
 - ÷ Capacity of 4.7 million SWU by year-end 2015 and capacity of 5.7 million SWU by 2022.



- U.S. will continue to import significant quantities of enriched uranium with corresponding need for processing of import licenses of enriched UF_6 from Europe, Russia and China.
- Export of U.S. enriched uranium to other countries.
- Maintenance of existing approvals for transport packages and approval of new packages for the shipment of enriched uranium.

Fuel Cycle Facilities 2020

– Uranium enrichment

i Regulatory impacts – Changes to 10 CFR Part 61 and impact on DUF_6 disposal

- ÷ Changes to site characterization requirements for disposal
- ÷ Concerns regarding possible changes to waste classification

i New Facilities by 2020?

- ÷ Two gas centrifuge enrichment facilities have been licensed by NRC
 - ⌘ Areva's Eagle Rock Enrichment Facility, Idaho
 - ⌘ Centrus Energy's American Centrifuge Plant, Ohio
- ÷ One laser enrichment facility has been licensed
 - ⌘ Global Laser Enrichment facility, North Carolina

i Under projected market conditions, it is unlikely that any of these facilities will be constructed and operational by 2020.



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Part II

Nuclear Regulatory Commission

10 CFR Parts 20 and 61
Low-Level Radioactive Waste Disposal; Proposed Rule

Fuel Cycle Facilities 2020

– Fuel fabrication

• Three fabrication facilities

- ÷ Areva, Richland, Washington - PWR and BWR fuel
- ÷ Global Nuclear Fuels – America, Wilmington, North Carolina - BWR fuel
- ÷ Westinghouse Electric, Columbia, South Carolina - PWR and BWR fuel



- Fabricators are expected to continue to seek approval for new fuel design features to address fuel reliability and fuel cycle economics.
- New fuel designs may require NRC resources for review and approval of designs, materials, lead test assembly (LTA) programs, etc.

Fuel Cycle Facilities 2020

– Fuel fabrication

i Possible new entrants to U.S. fabrication market

- ÷ Lightbridge Corporation LTAs – advanced metallic fuel rods
- ÷ Russian fuel manufacturer TVEL - 17x17 PWR LTAs of TVS-Kvadrat in a Swedish PWR

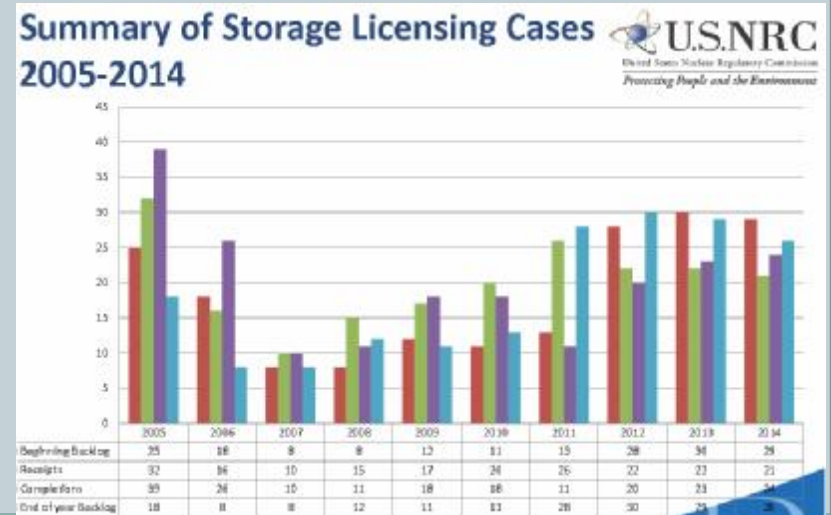


i Regulatory issues:

- ÷ NRC Generic Letter 2015-01: Treatment of Natural Phenomena Hazards in Fuel Cycle Facilities
- ÷ Shipment of UO_2 powder, UO_2 pellets, and fabricated fuel to facilities in Europe and Asia will require:
 - ⊕ Continued attention to import/export licenses
 - ⊕ Approval and maintenance of Certificates of Compliance for transportation packages

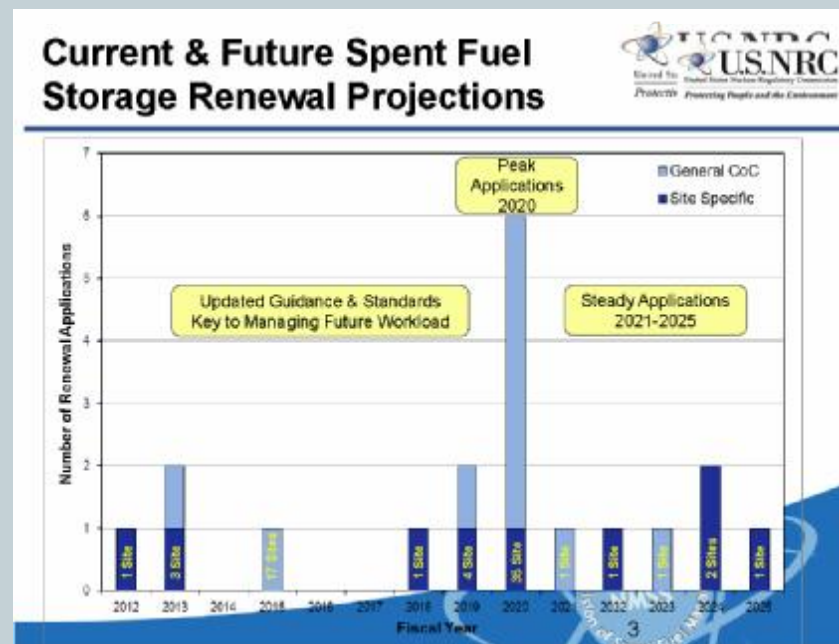
Spent Fuel Management 2020

- At-Reactor SNF Storage – wet and dry
 - i By 2020:
 - ÷ 87,000 MTU of SNF arisings
 - ÷ 36,000 MTU in dry storage in ~3,000 casks
 - ÷ Dry storage at almost every plant site expected ~72 to ~75 ISFSIs (including INEL)
 - ÷ Four sites with recently shutdown reactors plan to transfer SNF from pool storage to dry storage by ~ 2020
 - i Amendments to existing Part 72 and Part 71 CoCs and review of applications for new storage technologies are expected to continue at same rate seen in recent years.



Spent Fuel Management 2020

- At-Reactor SNF Storage – wet and dry
 - License renewal for site-specific licenses at 6 ISFSIs will be in process (North Anna, Rancho Seco, Trojan, DOE TMI-2, DOE-INEL, GE Morris)
 - License renewal for 7 cask designs certified in accordance with 10 CFR 72, Subpart L
 - ÷ VSC-24 (ongoing)
 - ÷ NUHOMS (ongoing)
 - ÷ TN-32
 - ÷ TN-68
 - ÷ HI-STAR 100
 - ÷ HI-STORM 100
 - ÷ NAC MPC
 - ÷ NAC UMS



Spent Fuel Management 2020

- **Centralized Storage?**
 - **Two companies have proposed sites in Texas and New Mexico**
 - **DOE supports a pilot facility for storage of SNF from shutdown plants**
 - **Can the Nuclear Waste Policy Act be amended to allow the Nuclear Waste Fund to be used to pay for interim storage?**

- **Geologic Disposal?**
 - **DOE plans to separate disposal of defense waste and commercial SNF**
 - **Restart of Yucca Mountain licensing or start of a new siting process for one or more repositories?**

