Recycling of Used Nuclear Fuel

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Executive Summary

To support nuclear growth in US, we need an integrated used fuel management (UNF) strategy, including recycling.

Implementation responsibility transferred to a new, commercially focused organization (FedCorp).

Nuclear industry cannot wait for transformational solutions from the government to manage UNF.

A “Two Step” recycling approach is proposed: Start recycling in existing reactors (with MOX) and evolve towards Fast Reactors when ready.

- Initial 800tHM/y “Pilot” facility producing LWR MOX, as a first step towards closing the fuel cycle in the US.

A progressive / regional deployment is recommended.

Design recycling facilities that can incorporate the benefits of future technology innovation.

Concerns such as non-proliferation and economics can be appropriately addressed.
US reactors currently discharge > 2,000 tUNF/y with a total inventory of >62,000 tUNF stored at reactor sites around the country.
Used Nuclear Fuel is Located in 4 regions

- 16,300 tHM
- 11,380 tHM
- 13,480 tHM
- 19,050 tHM

Total Current US UNF: 60,210 tHM/y
Nuclear Generating Infrastructure

- No market driver to move away from existing LWR infrastructure for the foreseeable future

- Gen IV reactors are 50 years away from deployment.
  - R&D infrastructure costs ~$4B
  - R&D ~$B
  - Cost of reactor > existing LWR's

- As interim step propose management of product’s from recycling in existing LWR's.

- Transition to new fuel cycle over a long period of time.

- Take the first step to create the technology pull to implement new technologies
Recycling of UNF

- Fresh Fuel ×8
- ERU Fuel ×1
- MOX Fuel ×1
- Used Fuel Recycle
- LWR
- Used Fuels ×8
- Recycling once
- Waste (FP, MA)
- Used Fuel ×2

• Actual value depends on fuel burn-up and enrichment
96% of a used fuel assembly is recyclable

Composition of used light water reactor fuel

- 1 LWR fuel assembly = 500 kg uranium before irradiation in the reactor

Recyclable materials

After irradiation*

- U 475 to 480 kg (94 to 96 %)
- Pu 5 kg (1 %)
- FP/MA 15 to 20 kg (3 to 5 %)

Recycling

Waste

* Percentages may vary based on fuel burnup
Initial Facility

- Balanced fuel cycle
  - Recycling capacity matched to product demand
- Propose an initial “Pilot” 800 tHM/y capacity plant that builds on best available technology to minimize risk
- COEX™ Separations process so “NO” separated Pu
- Manage product using existing nuclear infrastructure while DOE develops Gen IV Reactor (50 plus years for first commercial Unit.)
- LWR MOX is therefore an “interim” step for closing the cycle.
- Pilot Facility could supply fuel to,
  - Limited number of existing LWR’s or
  - ~4 Gen III+ reactors or
  - 500 MWe SFR
A Step Approach to Capacity Increase That Accommodates Technology Evolution

Advanced Separations and Transmutation Fuel Development Should be Developed by the National Labs and Universities.
Major Impact on Region from Primary and Secondary Jobs
Capital Costs, Employment and Operating Revenue

- **Large capital investment**
  - $20B over 15 years for a 800MT pilot recycling facility

- **Significant operating expenses spent locally**
  - $500M per year for 50 years
  - About 5,000 steady direct jobs for 50 years of Operation
    - And up to 30,000 additional Indirect jobs created in the wider economy

- **Large job creation opportunity**
  - Up to 18,000 direct jobs during construction
  - About 5,000 steady direct jobs for 50 years of Operation
    - And up to 30,000 additional Indirect jobs created in the wider economy
Pilot Regional Facility:
Inventory of UNF with 800tHM/y
Regional Recycling Facility Operating

Assumes no life after 60 for current reactor fleet and takes into account current identified new reactor build
Transformational Technology

- Recycling Facilities will be commercial facilities operated by industry.

- Support the transformational technology development programs of DOE and deploy as technology matures to meet industry requirements. “No compromise of Nuclear Safety, No Short Cuts.”

- Advanced separations for Am.

- Advanced target production technology.
Incorporation of Advanced Technology in Pilot Facility

Technology Evolution

Advanced Separations and Transmutation Fuel Production are an addition to the Pilot Facility and not a replacement.
ARR Closed Fuel Cycle

USED MOX/ERU Fuel

Used Fuel Recycle

Waste

Used Transmutation Fuel

ARR MA + Pu

Fresh Transmutation Fuel

Closed Cycle is a long term endeavor