

Plenary IIA: Alternative Fuel Cycles and Fuel Supply

- CANDU Fuel Cycle Flexibility Sermet Kuran (Candu Energy Inc.)
- Uranium Supply and Market Update Derek Gross (Cameco Corporation)
- DOE Activities Promoting Understanding of Advanced Nuclear Fuel Cycles Patricia Paviet (USDOE)
- Recycling and Advanced Fuel Cycles at Areva Jarret Adams
- Q&A

CANDU Fuel Cycle Flexibility

- Alternative Fuels in Operational CANDU Reactors (NUE)
- Alternative Fuels in New Build CANDU Reactors (AFCR)

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Alternative Fuels in CANDU Reactors (NUE)

- CANDU and Natural Uranium
- CANDU and Alternative Fuels
 - RU/DU, RU, LEU, Th and MOX
 - Significant availability of alternative resources
- CANDU differentiators in Fuel Cycles
 - Thermalized Core/Fuel Efficiency/Uranium Utilization
 - On-power fuelling
 - Simple Fuel bundle
 - Flexible reactor design enabling multiple fuel use



Alternative Fuel in Operational CANDU Reactors (NUE)

- Objective; Clear proof of CANDU fuel cycle capability
- A fuel behaving similarly to NU
 - NUE= a mixture of RU and DU
 - No need for enrichment
 - No supply restraints
 - ~50,000 tons in stock, ~4000tons/year production (RU)
 - 1.2-1.3million tons of DU in stock
 - Simple to mix and manufacture pellets
 - Use existing bundle design, minimal manufacturing impact
 - Stay within the existing licensing case and operational envelope
 - Fast paced
 - Partnership based;
 - reactor designer, reactor utility, research organization(s) and fuel manufacturer

Alternative Fuel in Operational CANDU Reactors (NUE)

- Short term project
 - Concept, Analysis, Design, Development & licensing case for testing 18 months
 - Manufacturing and two channel testing in Qinshan C6 units 14 months
 - Full core analysis and licensing case 24 months
 - Full core Regulatory review (in progress) 9 to 12 months
- **Expected start of Qinshan full core NUE conversion, first half of 2015**

- RU and DU back into the fuel cycle
- No long term RU/DU storage costs
- No need for fresh natural uranium
- ~Four LWRs feed one CANDU, synergy between reactor technologies
- Reduced fuel cost
- NUE can be used in all CANDU type reactors as NU replacement
- First of a kind in CANDU and clear proof of fuel flexibility, first step in a productive path

Alternative Fuels in New Build CANDU Reactors (Advanced Fuel CANDU Reactor—AFCR)

- What is the AFCR

- Based on the success and proof of NUE
- A successful joint Candu Energy and CNNC design collaboration
- Use high burn up RU and Th based fuels in a CANDU type new build reactor
 - Even higher uranium utilization
 - Effective use of indigenous resources
- Use fuel cycle advantages to further design margins
- Use C6/EC6 type reactor design to minimize delivery risk and ensure provenness
- Start with RU then convert to Th-LEU use without hardware change
- Ensure a Gen III design meeting all new safety and post-Fukushima requirements
- Complete detailed conceptual design within a period of 26 months
- Ready for review in China before the end of 2014
- First unit can be in-service 2023

Alternative Fuels in New Build CANDU Reactors (Advanced Fuel CANDU Reactor—AFCR)

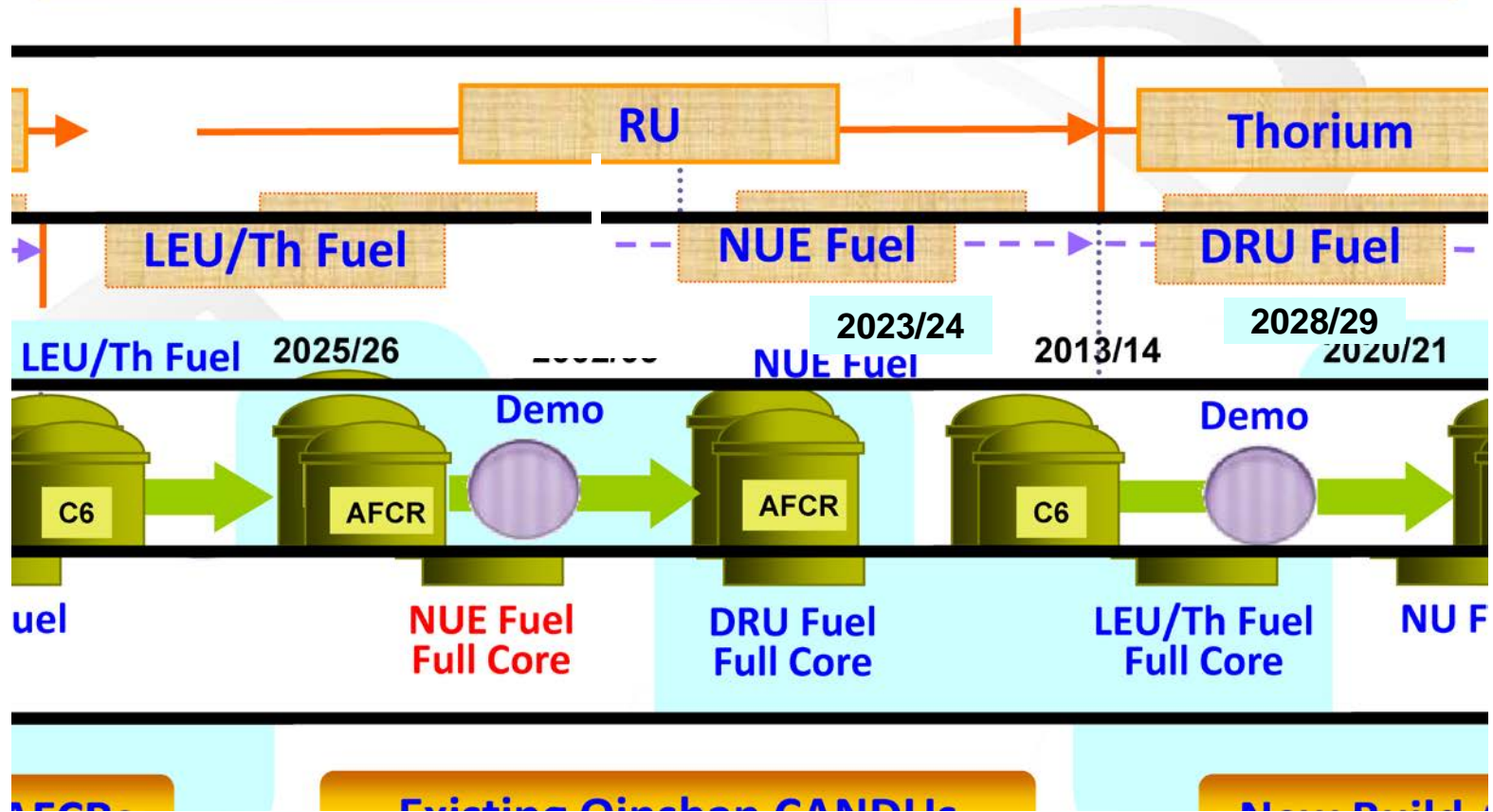
The two fuels focused on;

- Reuse of LWR fuel stream (RU)
- Introducing new, alternative resources (Th)

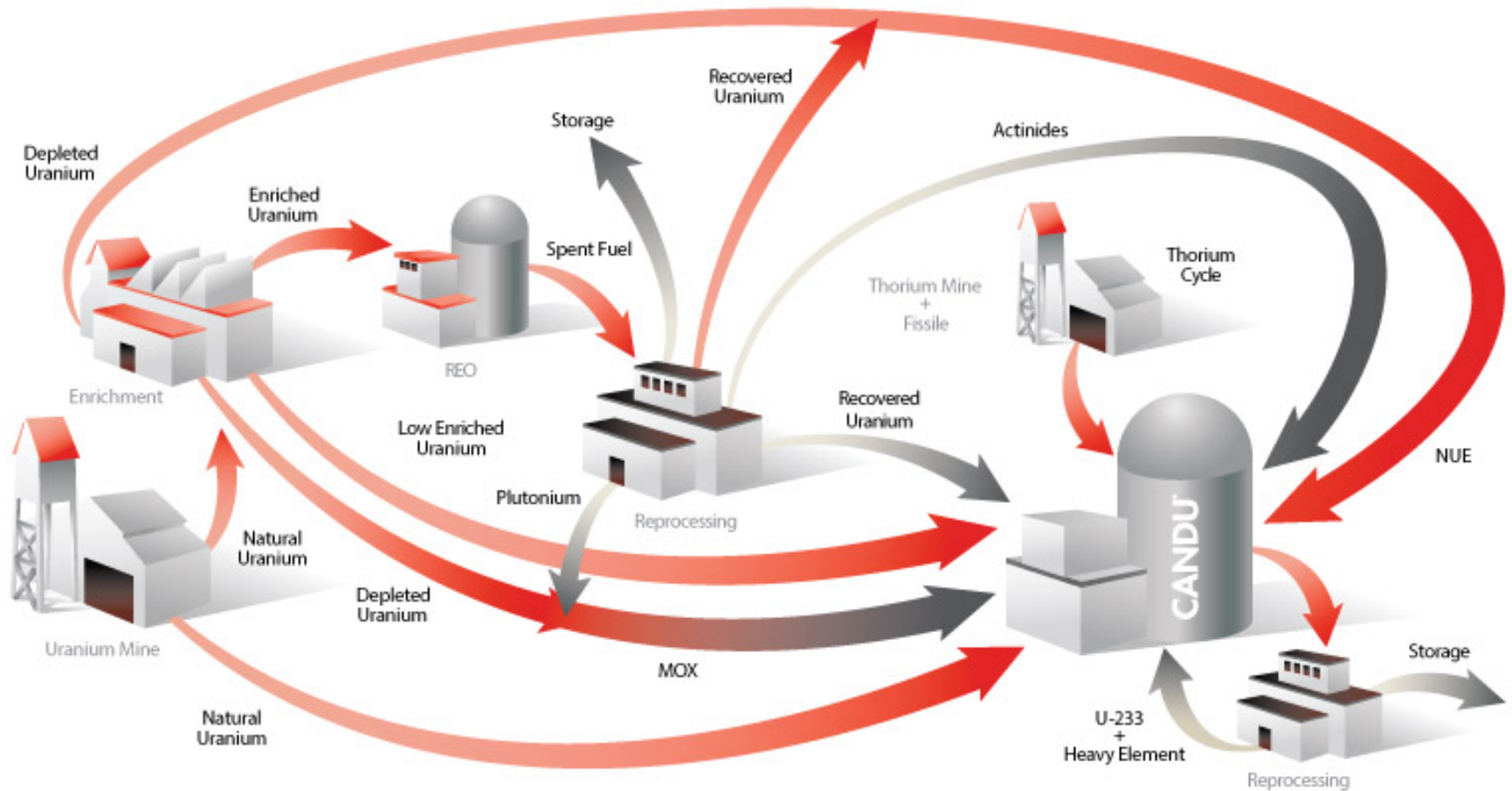
- Recycled Uranium Fuel (reactor to be started with this fuel)
 - 10 MWd/kgHE
 - No enrichment required, direct use of RU
 - 0.95 wt% fissile content
 - Proven 43-element CANFLEX fuel bundle
 - Logical next step to NUE fuel
- LEU-Th fuel
 - 20 MWd/kgHE
 - CANFLEX fuel bundle
 - 8 centre elements contain Th
 - Commercial verification tests in AFCR
 - AFCR converted to LEU-Th as per owner's timing
 - Lowest risk approach and rapid/practical commercial reactor based solution

NUE and AFCR – Progress and Timelines

Advanced Fuel Technology & AFCR Project Roadmap



CANDU Fuel Cycle Flexibility—The Whole Picture



Alternative Fuels in Operational and New CANDU Reactors—Conclusions

- Candu Energy has alternative fuels available for all operational and future CANDU units
 - Highest uranium and other fuel utilization
- An evolutionary low risk, step by step implementation path is adopted in association with partners
- Each step will bring CANDU closer to “closed fuel cycles”
 - Effective, simple low cost use of RU
 - Start the Th cycle in a low risk manner
 - Recycle Th; reduce spent fuel volume and the need for new fuel material
 - Gradually approach “closed cycles”
- Synergy with other reactor technologies is considered to be a common benefit to the industry
- Advanced Fuel Cycle Reactor AFCR is now ready for review & implementation
- Candu Energy approach is a step by step progress in fuel cycles.