

ANALYSIS OF SUITABILITY OF MULTI-RECYCLING OPTION AS NUCLEAR FUEL CYCLE OPTION FOR KENYA

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MOTIVATION & OBJECTIVE

Motivation

- ✓ Nuclear power has been incorporated in the country's energy plan as one of the potential sources of electricity generation to meet the rising demand in the long term.
- ✓ The country has evaluated a feasible option for her fuel cycle addressing the front end and back end.
- ✓ The country has developed a nuclear policy that provides a framework for the disposal and storage of radioactive waste and spent fuel.
- ✓ The policy addresses key aspects including waste minimization and reduction of disposal cost; research on the prospect of thorium; and security and nuclear fuel supply.

Objective

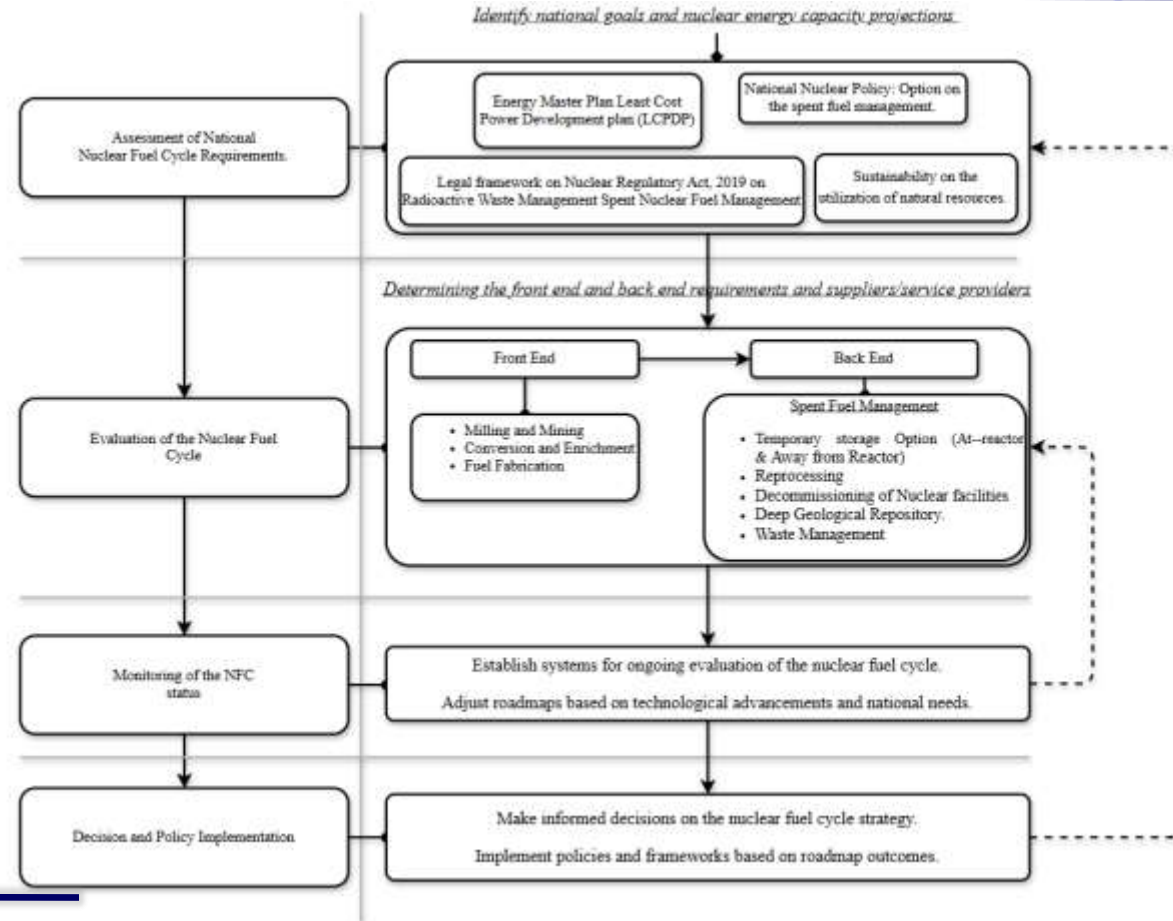
- ✓ Assessment of the viability, sustainability, and strategic implications of adopting a multi-recycling option for nuclear fuel cycle in Kenya, in the context of the country's long-term nuclear energy development strategy.
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DESCRIPTION OF THE STUDY

- ✓ Existing nuclear infrastructure development focused on the front-end of the NFC ; *limited strategic planning and analysis of the back-end*.
 - ✓ *Open fuel cycle* has been adopted as the option for the back end; other options (*multi-recycle*) are under consideration.
 - ✓ Back end analysis in order to :
 - a. Identifying and comparing scenarios for Kenya's nuclear energy system;
 - b. Mapping technology development milestones, gaps, and decision points related to the adoption of multi-recycling; and
 - c. Providing *evidence-based policy* recommendations for Kenya's nuclear energy planning.
 - ✓ Kenya plans to introduce its first, *300 MWe, SMR in 2034* and two (2) additional similar sized units in the subsequent years (2036 and 2038).
 - ✓ Kenya is considering the deployment of *Large Nuclear Power Plants (LNPP)* as part of its *future* reactor fleet.
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METHODOLOGY

- ✓ Tool Adopted for the CS - INPRO ROADMAPS-ET
- ✓ KIND-ET was used in the pervious study to determine the reactor technology design that was an input to this CS



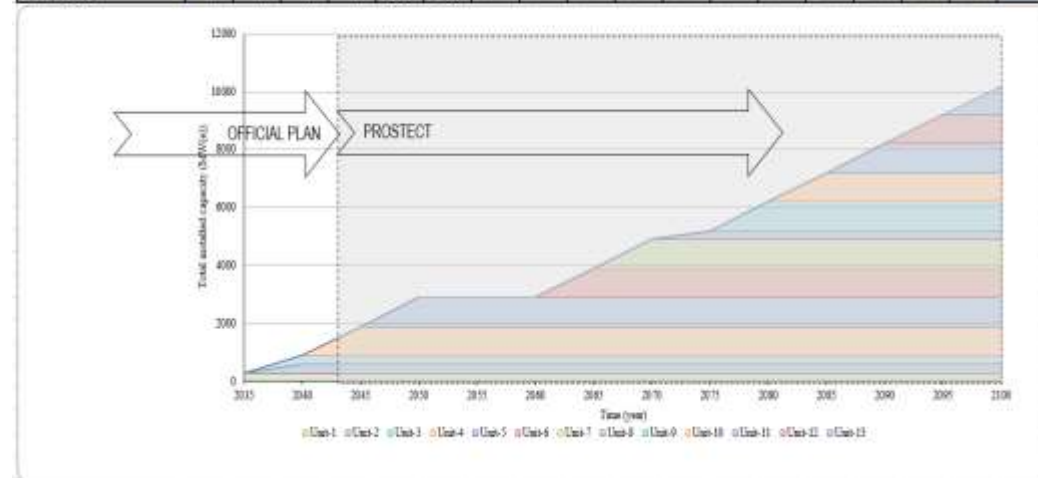
ASSESSMENT OF KENYA NPProg.

- ✓ The assessment of Kenya NPProg profile was based on the *planned (official)* and *prospect projects*.
 - ✓ The NPProg is focused on adopting a sustainable nuclear fuel cycle that aligns with its long-term energy goals.
 - ✓ Plans for deployment of *SMR units*, *LNPP* and *advanced reactors* as prospect project in its reactor fleet.
 - ✓ GAINS Classification, Kenya is categorized as an *NG2 country*.
 - ✓ A *once-through* NFC has been adopted with an option of pursuing recycling of SNF, as a future strategy, in collaboration with other countries.
 - ✓ Kenya seeks to enter into *collaborative agreements* on provision of nuclear fuel cycle front end and back end service.
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RESULTS & DISCUSSION

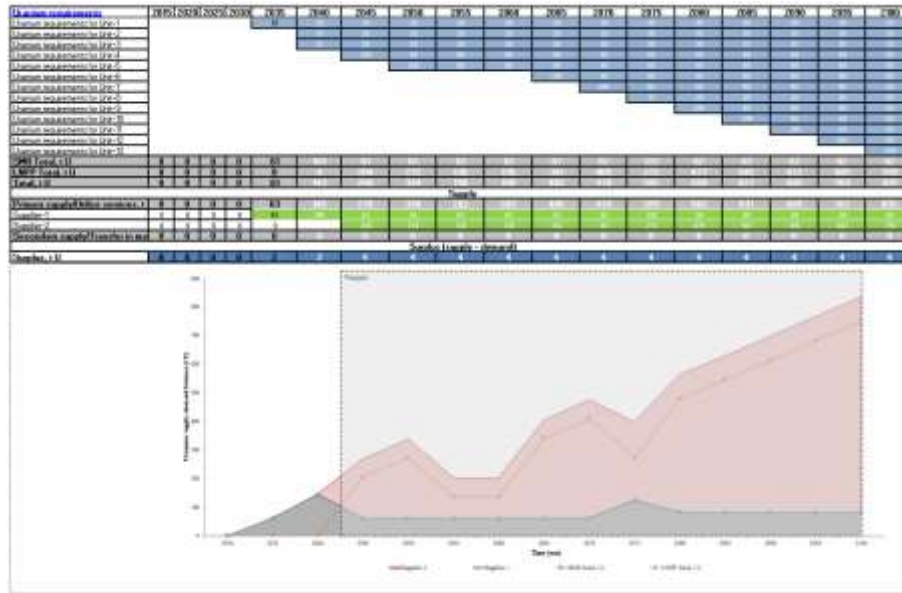
- ✓ 13 NPPs between 2035 and 2100, 3 SMRs (2034-2038); and 10 units (advance reactor and LNPPs)
- ✓ Installed capacity of about 10 GWe from nuclear power (2100).

Total install capacity, MW	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075	2080	2085	2090	2095	2100
Unit-1					300	300	300	300	300	300	300	300	300	300	300	300	300	300
Unit-2						300	300	300	300	300	300	300	300	300	300	300	300	300
Unit-3							300	300	300	300	300	300	300	300	300	300	300	300
Unit-4								1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Unit-5									1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Unit-6										1000	1000	1000	1000	1000	1000	1000	1000	1000
Unit-7											1000	1000	1000	1000	1000	1000	1000	1000
Unit-8												1000	1000	1000	1000	1000	1000	1000
Unit-9													1000	1000	1000	1000	1000	1000
Unit-10														1000	1000	1000	1000	1000
Unit-11															1000	1000	1000	1000
Unit-12																1000	1000	1000
Unit-13																	1000	1000
Total, MW(e)	0	0	0	0	300	900	1500	2100	2700	3300	3900	4500	5100	5700	6300	6900	7500	8100

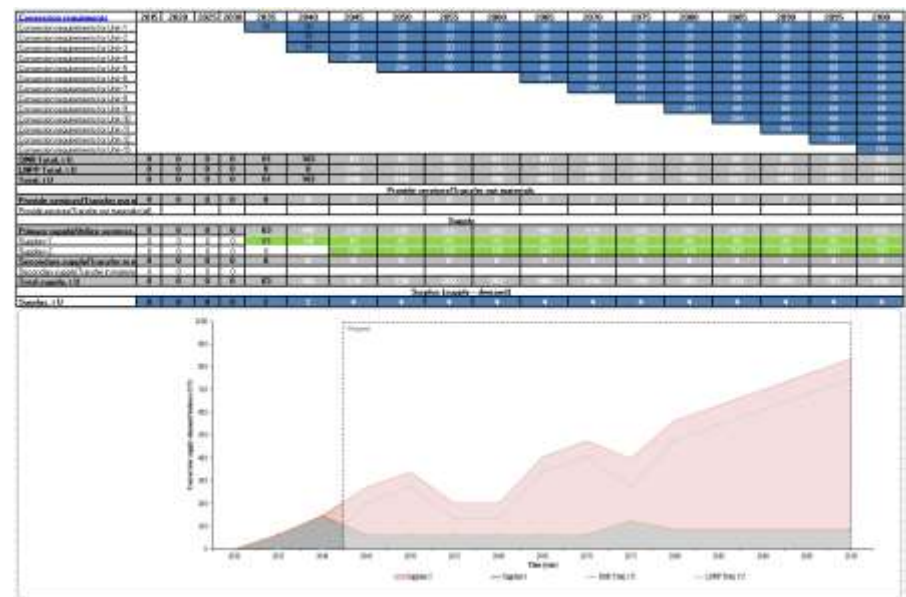


RESULTS & DISCUSSION... FRONT-END

- ✓ The nuclear fuel cycle front end requirements were determined by the reactor type specification and NPP characteristic (*per unit reactor, per GWe and per t HM of annual fuel reload*).
- ✓ Based on the aforementioned planned and prospects reactor fleet, the nuclear front end services are expected to grow exponential.
- ✓ *Two (2)* suppliers (1 SMR and 1 LNPP)



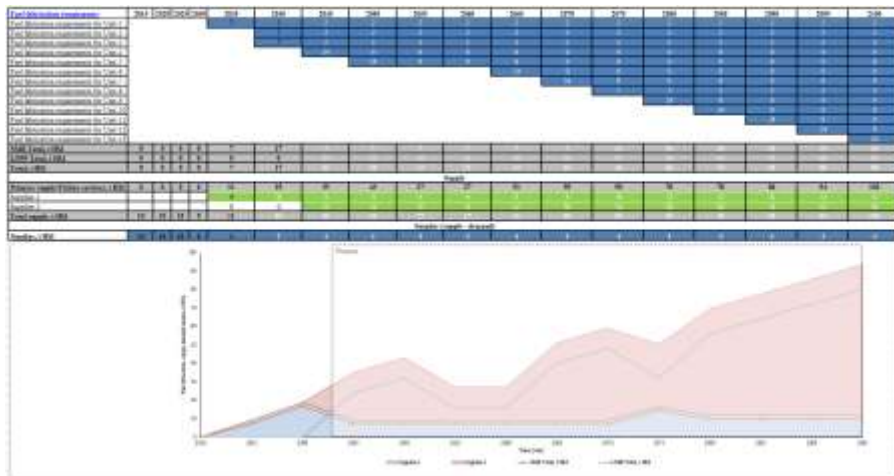
Uranium Requirement (SMR and LNPP)



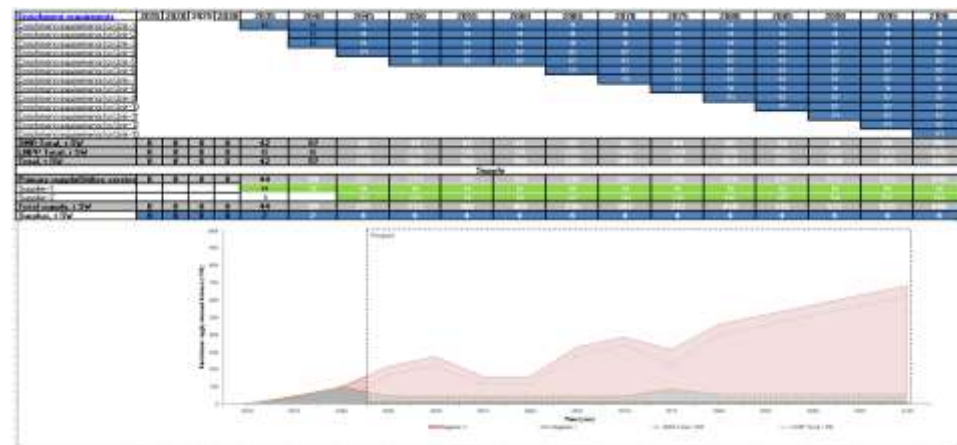
Conversion Requirement (SMR and LNPP)

RESULTS & DISCUSSION... FRONT-END..CONT..

- ✓ Based on the aforementioned planned and prospects reactor fleet, the nuclear front end services are expected to *grow significantly*
- ✓ Kenya shall rely on the *global suppliers* for the provision of the nuclear fuel cycle front end services to meet its demand and supply.

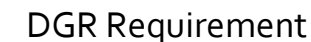


Fuel Fabrication Requirement (SMR and LNPP)



Enrichment Requirement (SMR and LNPP)

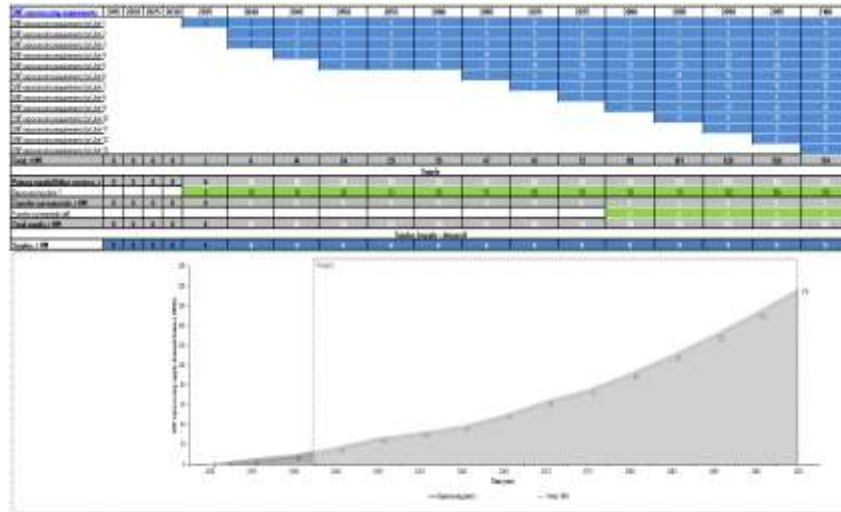
- ✓ This approach aligns with Kenya's current national policy directive on the management of SNF.
- ✓ SNF will be stored at: *AR-pool, AFR-Dry, SNF facility* and *DGR*.
- ✓ Based on the assessment it was determined that the requirement for DGR will be *3488 tHM* by 2100



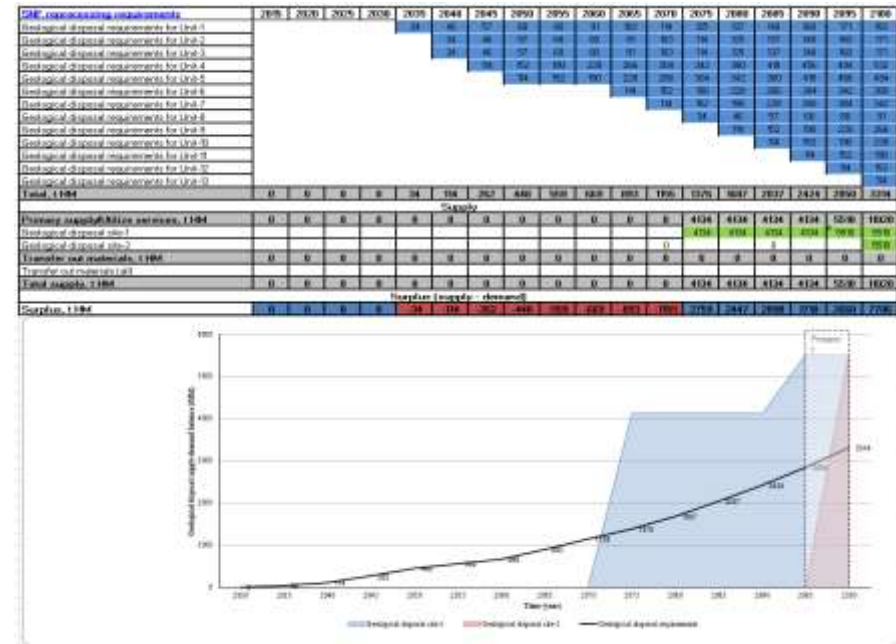
RESULTS & DISCUSSION BACK-END

SCENARIO #2: Close Cycle

- ✓ Informed by the goal of ensuring long-term sustainability, resource efficiency, and energy independence for Kenya's nuclear energy system.
- ✓ Given that 5% of the SNF can be reprocessed to reusable material, the total amount of the SNF requirement for processing was determined to be 174 t HM by 2100



SNF Reprocessing Requirement

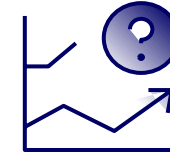


DGR Requirement- Reprocessing

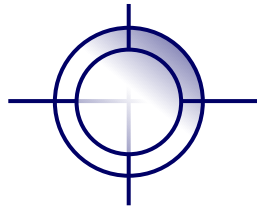
PROPOSED AREAS FOR IMPROVEMENT



- ✓ Reduction of the inputs to the tool through *linking the different sheets* on the roadmap tool to enhance accuracy of the tool.



- ✓ Incorporation of *sensitivity analysis* to address uncertainty such as change in policy direction



- ✓ Expansion of the scope and capability of the tool to Include *scenarios (open, mono and multi recycling options)* for comparison purposes



- ✓ Inclusion of the *economic evaluation* of the nuclear fuel cycle front and back end in the roadmap tool.

CONCLUSION

- ✓ Sustainability in the nuclear fuel cycle can be enhanced through the adoption of a closed cycle, thereby reducing the demand for front-end resources and deep geological repositories (DGRs).
 - ✓ Consideration of regional or international partnerships, including potential arrangements with supplier nations, to support its nuclear fuel cycle.
 - ✓ Possibility of sharing DGRs with neighboring countries as a strategic approach to addressing the significant infrastructure requirements associated with their development.
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STEP FORWARD



STEP FORWARD TM in Indonesia – 6 to 10 October 2025

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THANK YOU

