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WORKSHOP ON APPROACHES TO FINANCING A MULTINATIONAL REPOSITORY – CHALLENGES AND ALTERNATE APPROACHES

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Sponsored by:

Reliable Nuclear Fuel Services Working Group (RNFSWG), Sean Tyson and Tomaž Žagar, Co-Chairs,

Organization for Economic Cooperation and Development (OECD),
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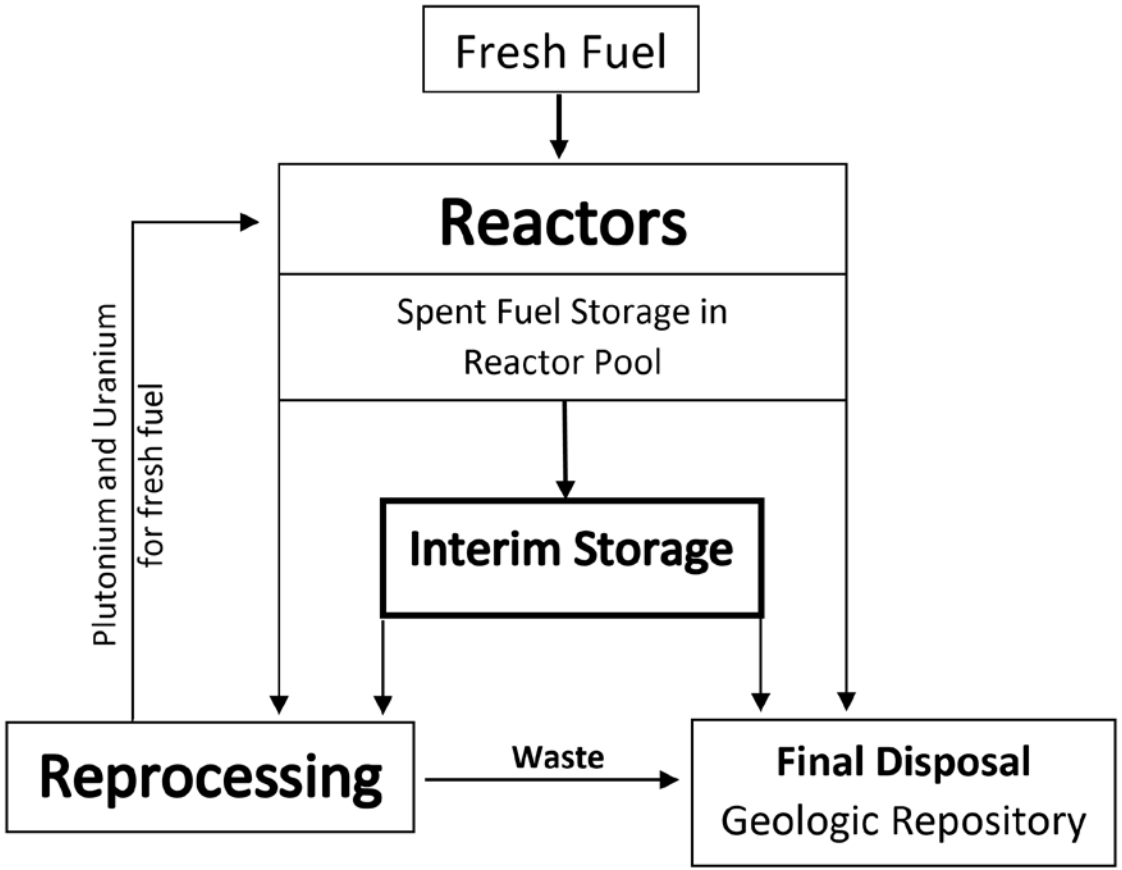
KEY ASPECTS OF THE NUCLEAR FUEL CYCLE



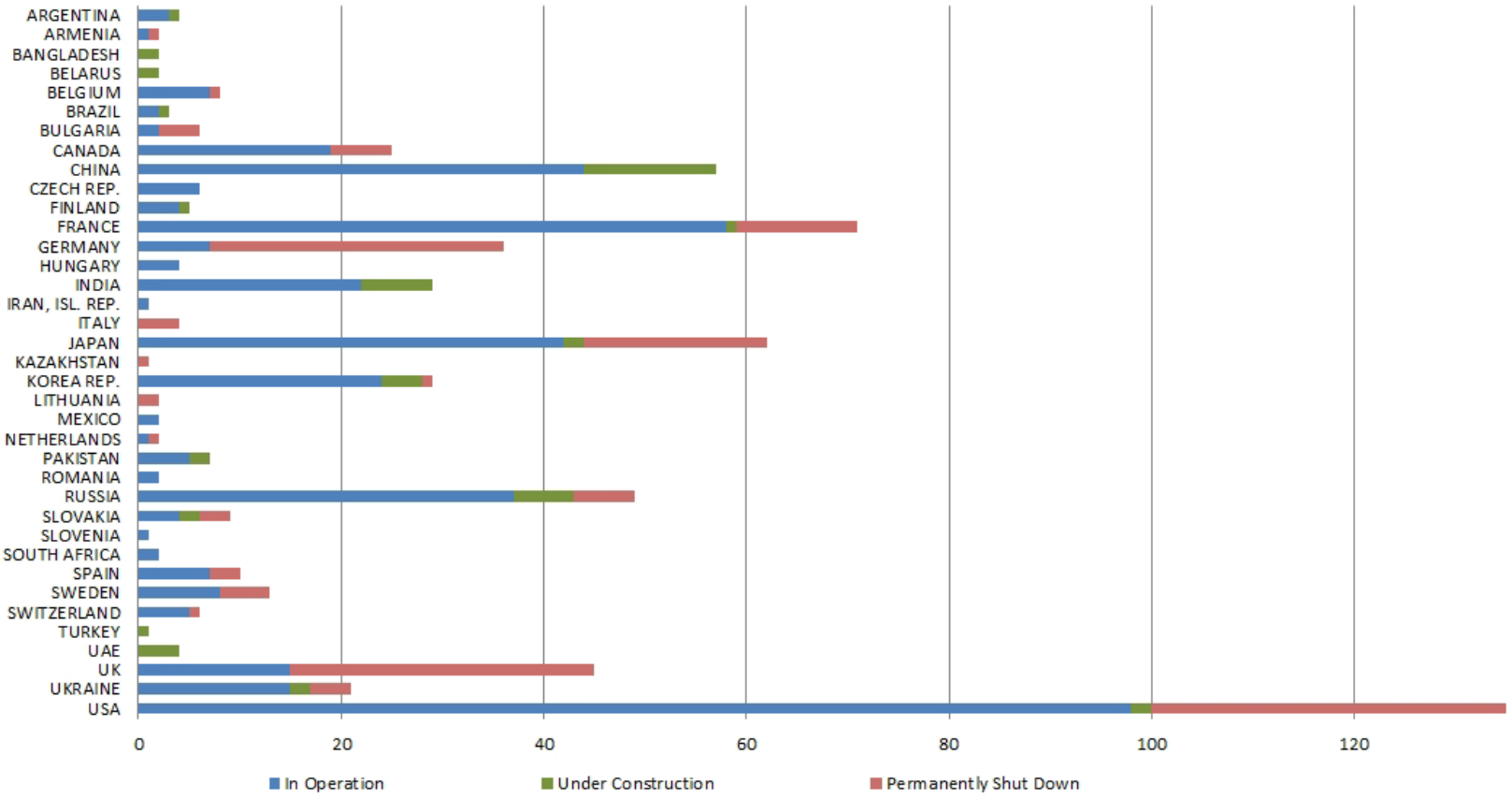
Interim Storage of Spent Nuclear Fuel, A Safe, Flexible, and Cost-Effective Near-Term Approach to Spent Fuel Management (A Joint Report from the Harvard University Project on Managing the Atom and the University of Tokyo Project on Sociotechnics of Nuclear Energy)

SELECTED SPENT NUCLEAR FUEL INVENTORIES

Country	Spent Fuel Inventory (metric tons)	Spent Fuel Policy
Australia[5]	0.4	None
Brazil[A, 6]	1398 fuel assemblies	On-site; geologic disposal proposed
Canada[7]	47,458	On-site: geologic disposal recommended
China[8]	3,974	On-site
Finland[9]	1,752	On-site; geologic repository under construction
France[10]	14,082	On-site and reprocessing; geologic disposal planned
Germany[11, 12]	14,886	On-site; off-site interim surface storage and geologic storage planned
India[13]		On-site and reprocessing; research into geologic storage
Indonesia[3]	None	On-site storage; possible repository if needed
Iran	None	Sent to Russia
Japan[14]	16,869	On-/off-site temporary storage, reprocessing; no long-term solution
Philippines[3]	None	On-site; repository planned
Russia[15]	21,362	On-site, off-site centralized storage, reprocessing; planned deep repository
South Korea[3, 16, 17]	13,428	Long-term on-site; disposal undecided
Sweden[18]	6,336	Centralized interim storage; geologic repository planned for 2045
Taiwan[19]	3,281	On-site; geologic repository planned for 2055
United Kingdom[20]	5,321	On-site and reprocessing; initial planning for geologic repository
United States[21]	72,959	60 years on-site; geologic storage site abandoned; new site planned

Best estimates as of the May, 2015 meeting of the contracting parties of the “Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.”

NUMBER OF POWER REACTORS BY COUNTRY & STATUS



MISSION AND GOALS: UNDERLYING PRINCIPLES

- Regardless of your view on the future viability of the nuclear sector, managing the nuclear waste, including spent fuel, is necessary for the existing fleet and future opportunities.
- Advancing global nuclear safety and security, including by normalizing first-in-class standards, technologies and operations, with the bedrock goal of minimizing proliferation and related risk, is necessary to advance confidence in the sector.
- Improving multinational Repository economics and success, e.g., via development consolidation, development and operational economies of scale, and optimized knowledge management.
- Advancing commercial investment in viable nuclear assets in a step-wise, commercially savvy manner, e.g., both “walking before we run” and de-risked investment.
- Solidifying nuclear sector reputation as being capable of effectively managing the entire fuel cycle, recognition and support in a manner that fosters sector viability.
  - Leading through collaborative solutions.
  - Addressing an industry reputation of stymied cradle-to-grave waste management.
  - Recovering overall sector innovation reputation, e.g., tackling big problems well.

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MISSION AND GOALS: THE ELEVATOR SPEECH

- A secure, commercially financed, multinational, co-located, *interim (<25 years) and final (permanent)* repository (Repository) that accepts and manages conforming spent nuclear fuel from participating entities and nations, i.e., those that fund in.
- A staged Repository consisting of:
  - An initial, interim, state-of-the-art, independent spent fuel storage installation (ISFSI) phase (dry storage).
    - with a portion of revenue allocated to development of the permanent Repository,
    - facilitating reasonable commercial investor involvement in a step-wise fashion.
  - The final Repository, perhaps co-located.
- An approach that augments global nuclear security and safety via a functional, step-wise approach that builds credibility and experience, under consensus regulatory standards with optimized cost and knowledge management advantages.

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KEY CONCEPTUAL ELEMENTS OF AN INTERIM STORAGE/FINAL REPOSITORY INVESTMENT

- A functional, accessible and familiar investment structure:
  - A public/private partnership or blended finance formula that depends on participation from spent fuel owners (whether public or private) and de-risks commercial investment.
  - A functional pricing model, grounded in landfill formulae, that provide near-term success and “start up” capital for the final Repository.
  - A step-wise approach that allows investment at an accessible initial scale and validates the approach, before asking for the final Repository investment.
- A committed public/private consortium that supports commercial capital:
  - A first-in-class project developer and operator, ideally a global major, that can satisfy inevitable concerns about safety, security, long-term responsibility and schedule.
  - A host nation that delivers on the heightened standards of security, avoids a politicized battle over inter-generational waste equity, e.g., the developed world using the developing world as a landfill.
  - Governments, employing consensus legal rules, de-risking mechanisms and incentives, e.g., a co-located research institution.

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SUMMARY OPTIONS, WITH A FOCUS ON BLENDED FINANCE

- **Option 1**, public/private partnership:
  - Governments fund initial Repository development and early operational costs, via sovereign capital at reduced returns (e.g., grants and concessionary loans) and risk-control mechanisms (e.g., loan guarantees and insurance), likely in exchange for preferred access to and reduced pricing at the Repository.
  - Savvy commercial partners, with initially guaranteed returns that meet expectations.
- **Option 2**, fully privatized approach: A developer, likely a global major, that undertakes the investment on spec and assumes 100% of upside/downside.
- **Option 3**, a blended approach of the Options 1 and 2: Government funds the development and initial years, with a contractual buy-out by the commercial global major at liquidity (e.g., a “put”) at a reasonably determined price or valuation.

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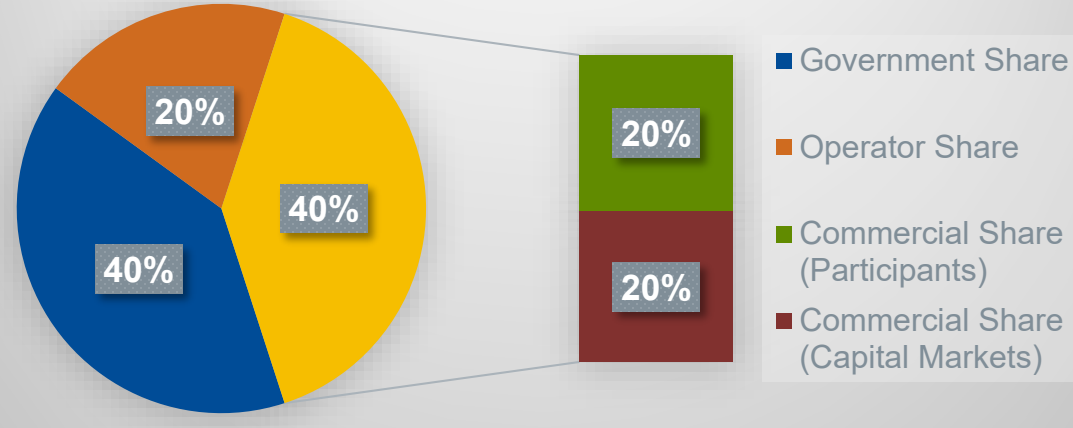
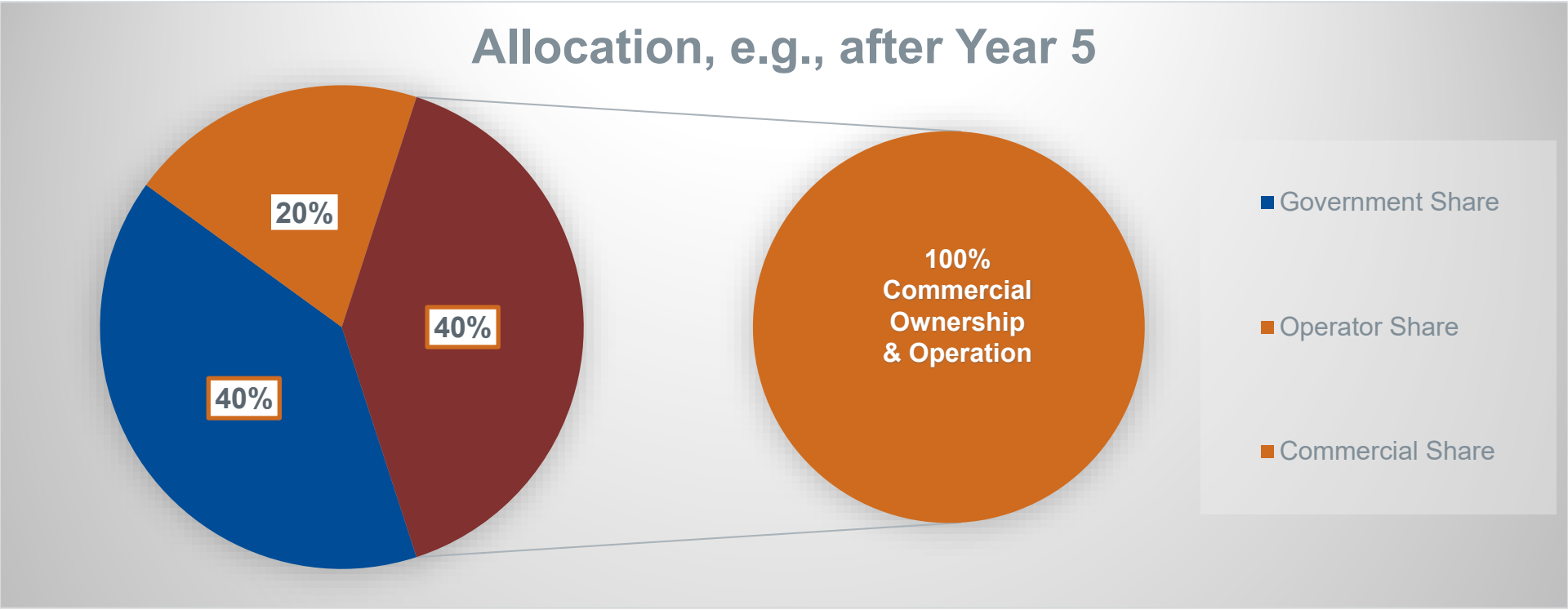
PUBLIC/PRIVATE PARTNERSHIP, OPTION 1 EXAMPLE

- Interim Storage Facility: $8B in development and operational costs (through year 3), with a call right to an additional $2B Reserve through liquidity (e.g., through year 5).
  - Government share (40%): $4.8B, with a Reserve of $1.6B.
  - Operator share (20%): $1.6B, with a Reserve of $0.4B.
  - Commercial investor share (40%): $4.8B, with a Reserve of $0.0B:
    - 51% of market capital share will be self-funded by fuel participants (nuclear power plant owners): $2.5B.
    - 49% of the market capital share syndicated: $2.3B.



PUBLIC/PRIVATE PARTNERSHIP, OPTION 3 EXAMPLE



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A DEEPER DIVE: THE OPERATOR INVESTMENT SHARE

- Operator share options: 10%-40%.
- Select things to consider:
  - Ownership mentality, e.g., ensuring “skin in the game.”
  - Commercial investor preference for a robust Operator with a public footprint, nuclear credentials and longevity, e.g., a nuclear savvy super major with engineering credentials, without obvious conflicts, or failed project history.
  - Whether the Operator also is the Repository project developer and to what degree the Operator shares in development responsibility and risk, i.e., “first in” dollars.
  - To what degree the Operator involvement and share depends on liability allocation:
    - Is lability allocated to the Operator for solely post-construction operations or for short- and long-term human health concerns and/or environmental harm?
    - Does Operator take title to fuel, except in the host nation?

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A DEEPER DIVE: THE GOVERNMENT INVESTMENT SHARE

- Government share options: 40%-100%.
- Select things to consider:
  - Is Government participation at concessionary or decreased rates necessary for a viable commercial investment?
  - Is a Government capital allocation enough?
    - What additional level of de-risking will it take and how is it best achieved to facilitate commercial investment, e.g., loan guarantees, insurance, title over fuel at certain stages, legal framework assurances and management of risks related to changing political regimes?
    - Is one Government, e.g., the host nation, enough? If not, why not?
    - Is syndication across Governments necessary?
  - At what priority, rate of return and for what term?
    - Must Government absorbs the Reserve?
    - For how long?

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A DEEPER DIVE: THE COMMERCIAL INVESTOR SHARE.

- Commercial share options: 40%-100%.
- Select things to consider:
  - Do the interim storage facility and the final Repository constitute a viable commercial investment, and if so at what debt/equity mix?
    - What level of de-risking will it take and how is de-risking achieved, beyond Government and Operator contributions, e.g., loan guarantees, title over fuel?
    - Is market or institutional capital dependent on priority and guaranteed returns, via a concessionary Government and/or utility or fuel-owner allocation, e.g., does the utility capital allocation merely entitle them to access and discounted rates?
    - Is syndication necessary?
  - What priority and rate of return would be required, and for what term?
    - Responsibility for the Reserve and orphan shares.
    - Commercial (institutional) investor allocation.

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A DEEPER DIVE: PRICING AND THE VALUE OF A FAMILIAR MODEL

- Select things to consider:
  - Bucketing development versus operating costs, e.g., cost overruns and Reserves, development and construction optimization incentives, phasing and timing of full buildout.
  - Rates:
    - Whether the rate structure is adjusted to cover Operational costs over the interim storage facility's operational life (particularly if extended), payable on a blended, discounted and annual basis, less surcharges for non-conforming fuel or waste.
    - Surcharges for nonconforming waste, e.g., in quantity, quality and schedule, are paid solely by the participant as a rate schedule adjustment.
    - Repackaging, particularly for the final Repository.
    - Offsets for fuel re-use (e.g., reprocessing).
    - Does the rate contemplate a charge for development of the final Repository and/or the interim storage facility's decommissioning?
  - Community shares, e.g., taxation or payments in lieu of taxes, institutes and other incentives.

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A DEEPER DIVE: PRICING AND THE FAMILIAR MODEL, CONT'D

- Cost estimates, interim and final storage:
  - DOE and National Labs have validated interim storage facility consolidation for the U.S. fleet on an economic (avoided cost) and stakeholder basis.
  - Multi-factorial assumptions are non-trivial, but a few norms emerge:
    - Licensing and construction timeframe of five to ten years is the current consensus, but host nation-dependent.
    - Return on investment is decadal.
    - Final Repository assumptions, including dates in service, can materially skew cost savings.
    - Transportation costs considerations are relatively insignificant, i.e., 3-11% of the total, based on U.S. data.
- Daunting realities:
  - Perception of U.S. nuclear cost escalation is non-trivial, despite being dated (pre-1978) and largely irrelevant, i.e., reasonable cost standardization across ISFSI's is the current norm.
  - At reactor cost comparison is skewed by U.S. spent fuel obligations.

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