Sustainable Cycle Solutions
for smooth and optimized nuclear development

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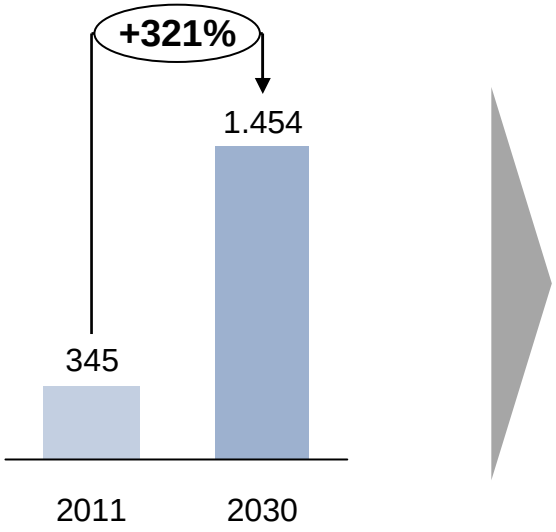
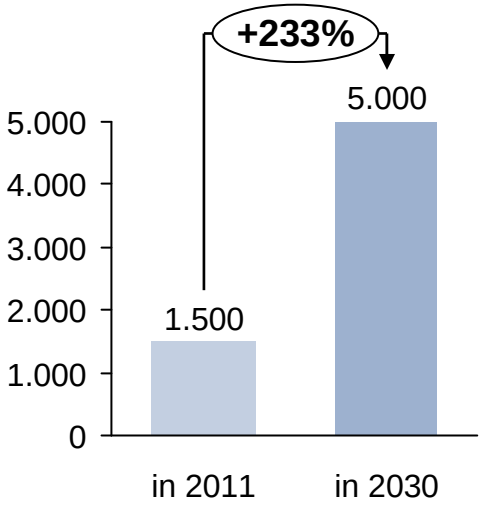
Asian nuclear capacity is expected to increase significantly over 2010-30

Nuclear energy consumption - Asia
(in TWh)



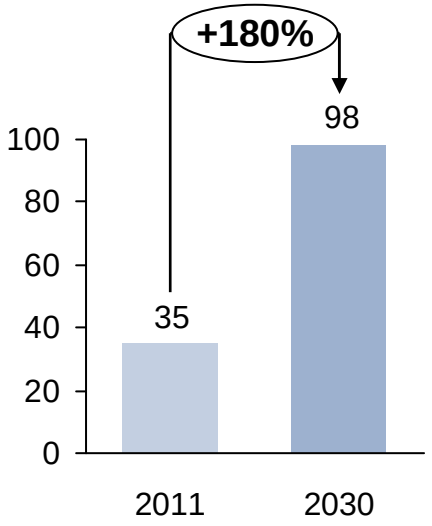
Source: BP Energy Outlook 2013

Annual unloading – Asia
(in tHM/yr)



Source: AREVA

Used fuel inventories – Asia
(in 1000 tHM)



Source: AREVA

Optimizing the fuel cycle will become even more crucial to ensure the sustainable growth of nuclear energy

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Main drivers of used fuel management

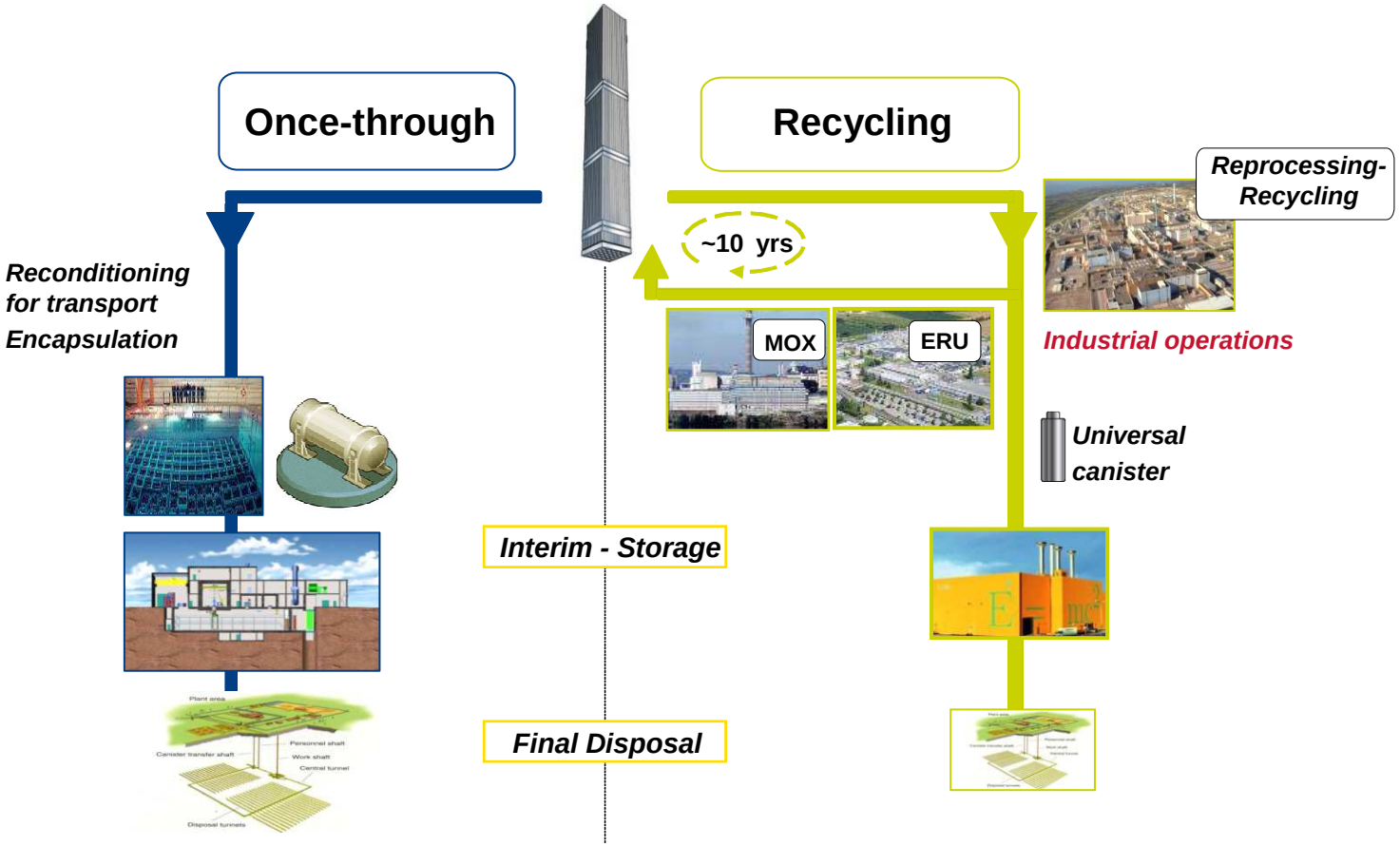
Risk management

- **Non-proliferation & security**
  - Research reactor fuels
  - Not self protected fuels
  - Fuels located in « risky areas »
- **Nuclear safety**
  - Damaged fuels
  - Saturated sites (core unloading)
  - Saturated pools close to reactors
- **Environmental impact & footprint**
  - Seismic
  - Maritime
  - Flooding
- **Public acceptance**

Nuclear System Performance

- **Minimize waste generated**
- **Preserve natural resources**
- **Increase energy independence**
- **Optimize cost of nuclear electricity**

Choosing between two options for Used Fuel Management



Used fuel economics

- **Used fuel management is 6% of nuclear cost.**
- **According to international studies, cost of both cycle are comparable.**

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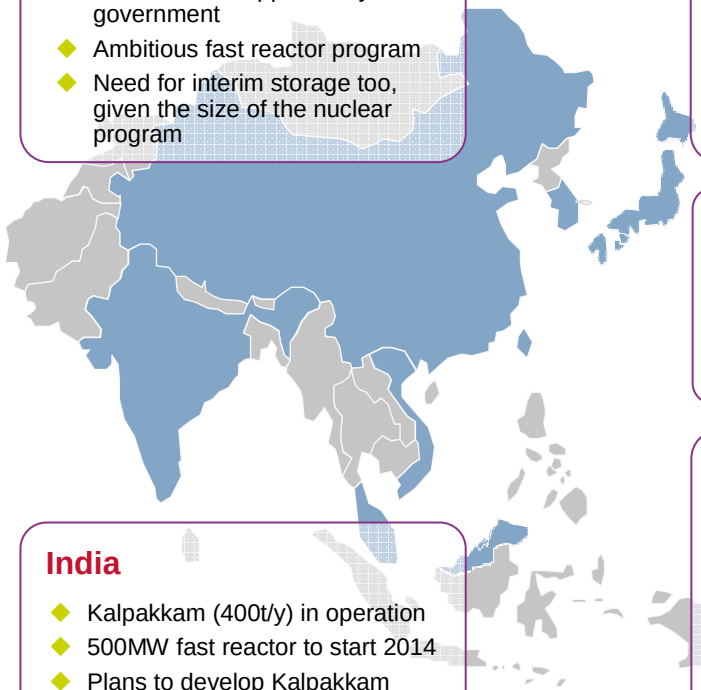
Today's picture of Used Fuel Management programs in Asia



China

- Ambitious plan for recycling installations, supported by the government
- Ambitious fast reactor program
- Need for interim storage too, given the size of the nuclear program

South Korea

- 123 agreement under revision with the USA
- R&D on Pyroprocessing
- R&D program on Gen IV reactor
- Difficulties to choose a clear path

Japan

- Rokkasho-Mura (2014)
- J-Mox plant design project (MOX fabrication)
- Tokai plant & Monju reactor

Taiwan

- Used fuel storage issues : pool's maximum capacity is reached
- Political & Public issue, call for urgent remediation
- 123 agreement which pave the way towards reprocessing overseas

India

- Kalpakkam (400t/y) in operation
- 500MW fast reactor to start 2014
- Plans to develop Kalpakkam treatment facility
- Ambitious fast reactor/AHWR program

Malaysia

- Nuclear program under discussions

Vietnam

- Nuclear program is being launched
- 1st consideration on Used Fuel Management

Countries are at different steps of their nuclear program:

- **Choice of the recycling path**
- **Choice of the once-through path**
- **No long-term political decision taken yet**

Countries launching or discussing a nuclear program tend to look from the beginning the used fuel management

- **Differentiating factor in New Build offers**

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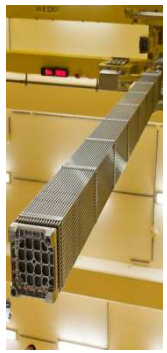
Setting up a deep geological disposal repository is a long term project

		License to build	Start of operations	Corresponding electricity output (TWh)	Status
Closed cycle		2032	2047-2090	1860	Under discussion
		2019	2025	18 000	Siting in progress
		2025	2035	16 400	Under discussion
		2030	2050-2060	-	Siting under investigation
Open & Closed cycle		2019/2020	2045 (at the earliest)	1 300	Siting under discussion
Open cycle		Yucca Mountain Project stopped by the Obama administration in 2010			
		2010	2025	2 900	Application submitted – Main criticality safety issues to be solved
		2012	2020	-	Construction license submitted

Sources: "The Economics of the Back End of the Nuclear Fuel Cycle", NEA, 2013
CNNC presentation, 2013

Industrial solutions for a sustainable and responsible management of used fuel exist

LONG TERM SOLUTIONS



RECYCLING

INTERIM OPTIONS

DRY STORAGE

WET STORAGE

Sustainable Cycle Solutions

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Recommendations for Used Fuel Management

- **Overall used fuel management policy and consistent implementation plan are key to the responsible development of nuclear energy**
  - Two sustainable solutions are available for nuclear countries
  - The faster it is implemented with the long-term support of government, the safer.
  - Countries lacking of clear plan for used fuel management implementation are facing difficulties (notably in Public Acceptance, Technics, Investment look-out…).
  - Wait and see is not a plan
- **In all cases, a final disposal center (big for one-through option, smaller for recycling one) is mandatory**
  - Development and implementation are a long time process
  - Program should advance faster in all Asia

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