International Conference on Fast Reactors
And Related Fuel Cycles: FR09

Development of FBR Fuel Cycle Technology in Japan

December 8, 2009

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- Near-term plan around 2015 in FaCT* Project
- International Collaboration
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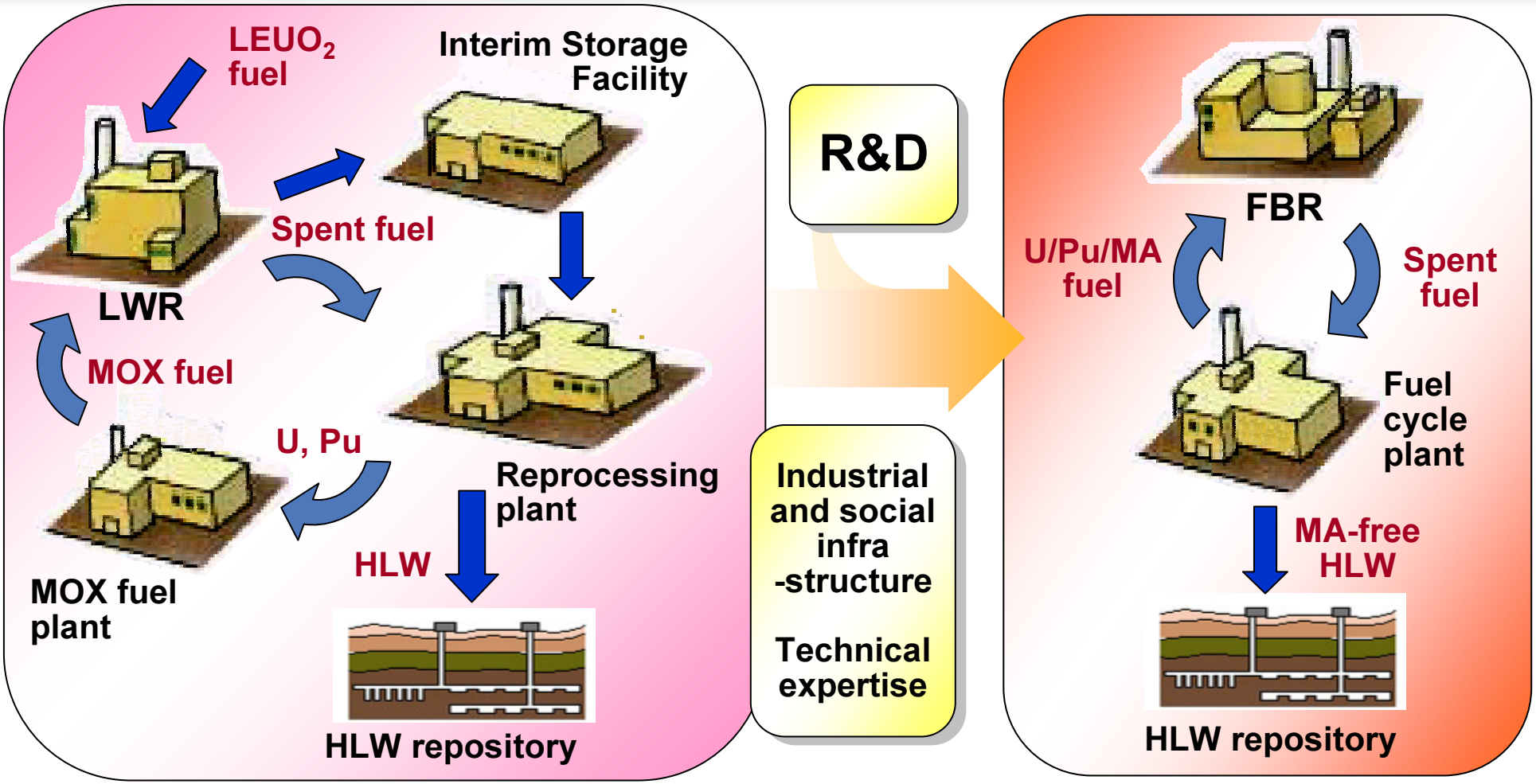
* Fast Reactor Fuel Cycle Technology Development

Japan's Fundamental Strategy for Nuclear Fuel Cycle



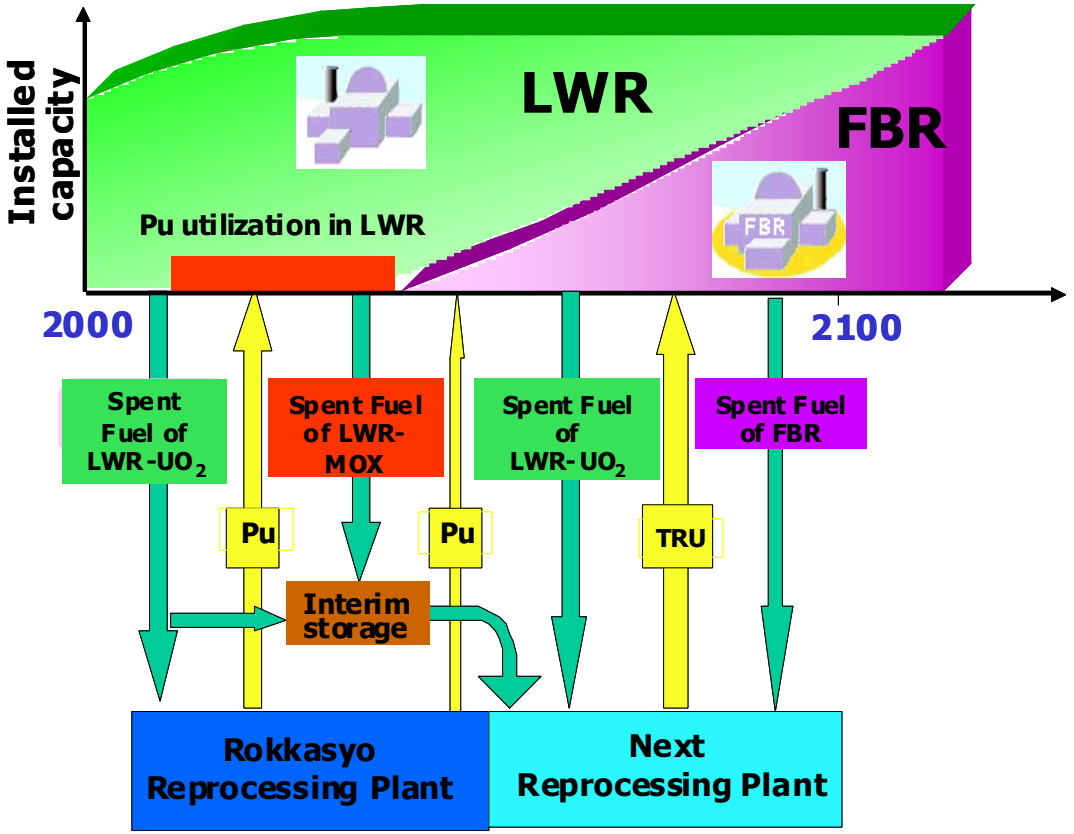
Current LWR fuel cycle

Future FBR fuel cycle

Preliminary Study on Transition from LWR cycle to FBR cycle

Example of preconditions for transition from LWR cycle to FBR cycle

- In order to replace all LWRs with FBRs, it will take about 60 years as transition period from around 2050.
- Next reprocessing plant (post-RRP) is envisioned around 2050.
- Spent LWR UO2 fuels have to be reprocessed to introduce FBRs in next reprocessing.
- Also reprocessing of spent FBR fuels and LWR MOX fuels have to start around 2055-2060.
- We need to figure out effective and rational image of next reprocessing plant.



Fast Reactor Cycle Technology Development (FaCT) Program in Japan

GOAL: To establish commercialized FBR cycle technologies competitive to future LWR cycle and other energy resources.

POLICY:
(1) Safety
(2) Economical competitiveness
(3) Efficient utilization of nuclear fuel resources
(4) Reduction of environmental burden
(5) Enhancement of nuclear nonproliferation

FS → FaCT* Project

*Fast Reactor Cycle Technology Development

FS Phase II (2001-2005)

Obtained results
- Selection of promising concept and principles for R&D prioritization
- R&D program until 2015 and the future issues

C&R

FaCT Phase I (2006-2010)

Expected results
- Determination of innovative technologies to be adopted.
- Establishment of commercial concepts

Items to be performed
- Elemental experiments and research aiming at the evaluation of the applicability of innovative technologies
- Conceptual design study on an innovative plant system

C&R

FaCT Phase II (2011-2015)

Expected results
- Conceptual design of a commercial facility
- Presentation of an R&D program leading to commercialization

Items to be performed
- Elemental experiments and research on the adopted innovative technologies
- Optimization study on the conceptual design of an innovative plant

C&R

Most Promising Concept
- ☐FR system: Sodium-cooled fast reactor
- ☐Fuel Cycle system:
  - ➢Advanced aqueous reprocessing
  - ➢Simplified pelletizing fuel fabrication

Low-DF MA-bearing MOX (homogeneous)

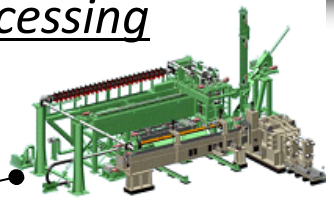
2025～2030: Start of Demonstration FBR and Fuel Cycle Facilities

2050: Commercialization of FBR Cycle

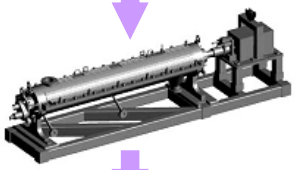
Innovative Fuel Cycle Technologies

Advanced Aqueous Reprocessing

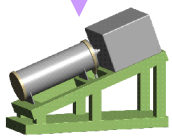
(1) Disassembling and Shearing
Mechanical Disassembling and Shorter Length Bundle Shearing



(2) Dissolution
Compact Continuous Dissolver

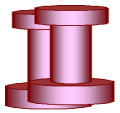


(3) Uranium Crystallization
Compact Continuous Crystallizer



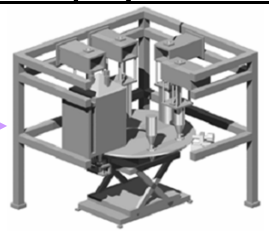
(4) U, Pu and Np Co-extraction
Centrifugal Contactor

(5) MA Recovery
Extraction Chromatography Method

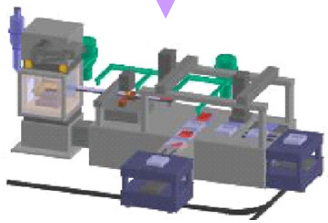


(6) Salt Free Waste Treatment

Simplified Pelletizing Fuel Fabrication



(7) Conversion and Granulation
Microwave Heating Denitration and Granulation

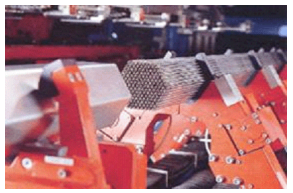


(8) Pelletizing
Die Wall Lubrication Pelletizing

(9) Sintering
Sintering and Adjustment of O/M Ratio

(10) Studies of Fuel Physical Properties
Physical Properties of MOX Fuel with MA etc.

(11) In-cell Remote Handling Technology
Automatic Operation and Remote Maintenance



(12) Fuel Handling Technology
Cooling System for MOX fuel with MA etc.

Typical Advanced Reprocessing Test in CPF

U Crystallization

Spent fuel

Disassembling/ decladding

Dissolution/ clarification

Crystallization

Co-extraction

Co-stripping (U/Pu/Np recovery)

Solvent regeneration

Np valence adjustment

MA recovery

Extraction chromatography

Am, Cm, heavy Ln

High level liquid waste

U/Pu/Np

U

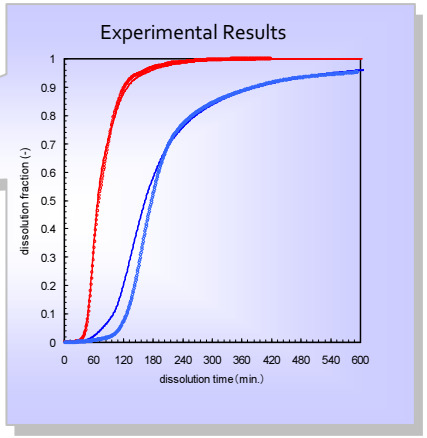
Concentration

Adjusting Pu content

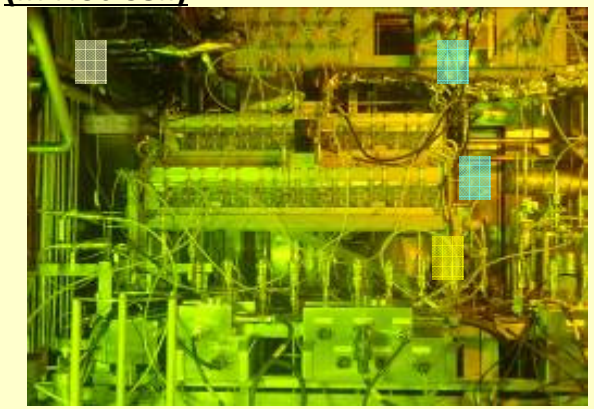
If necessary

U/Pu/MA (product)

U (product)



U/Pu/Np Co-Recovery (in Hot Cell)

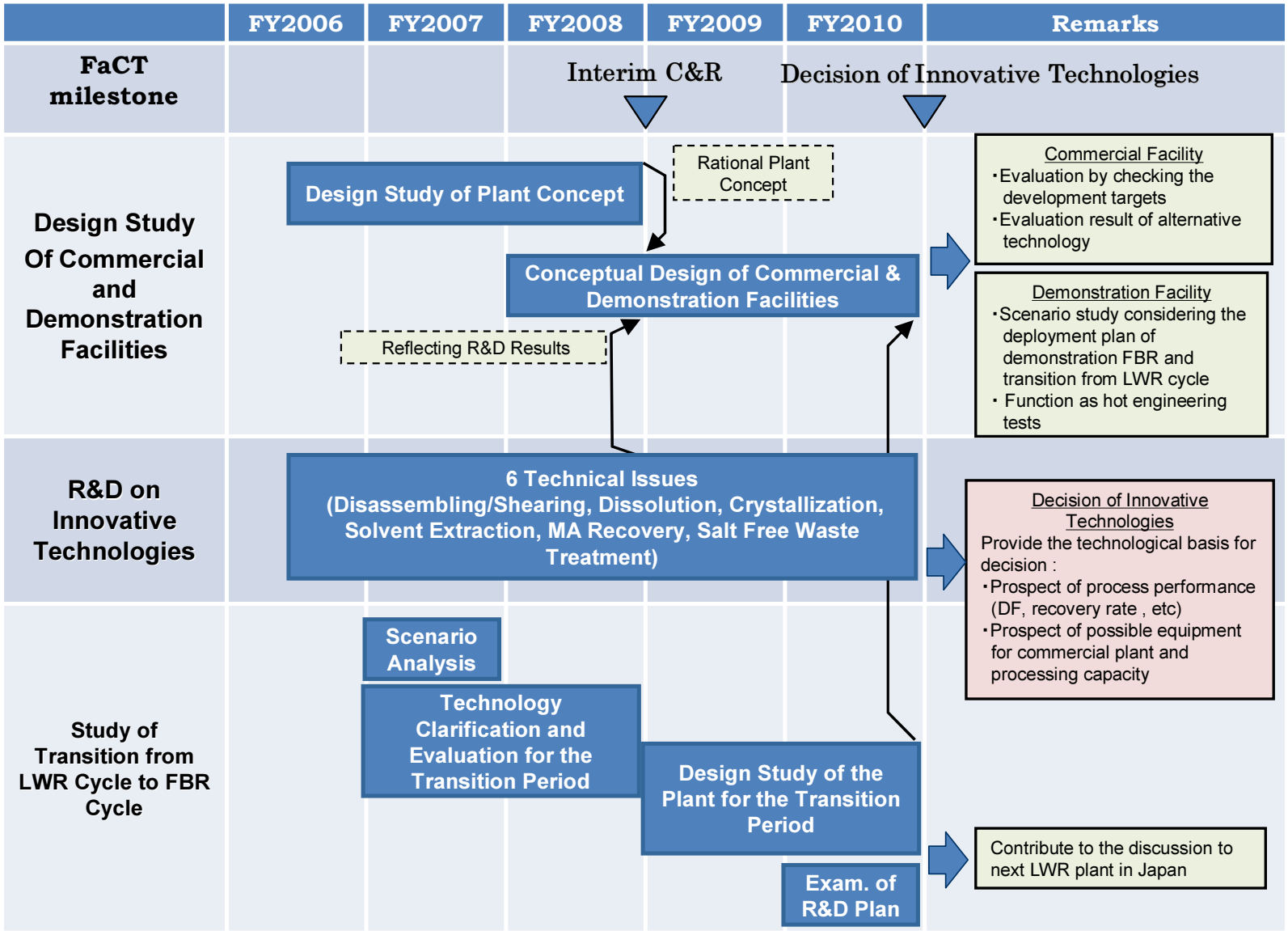


Decontamination Factor ≧1,000

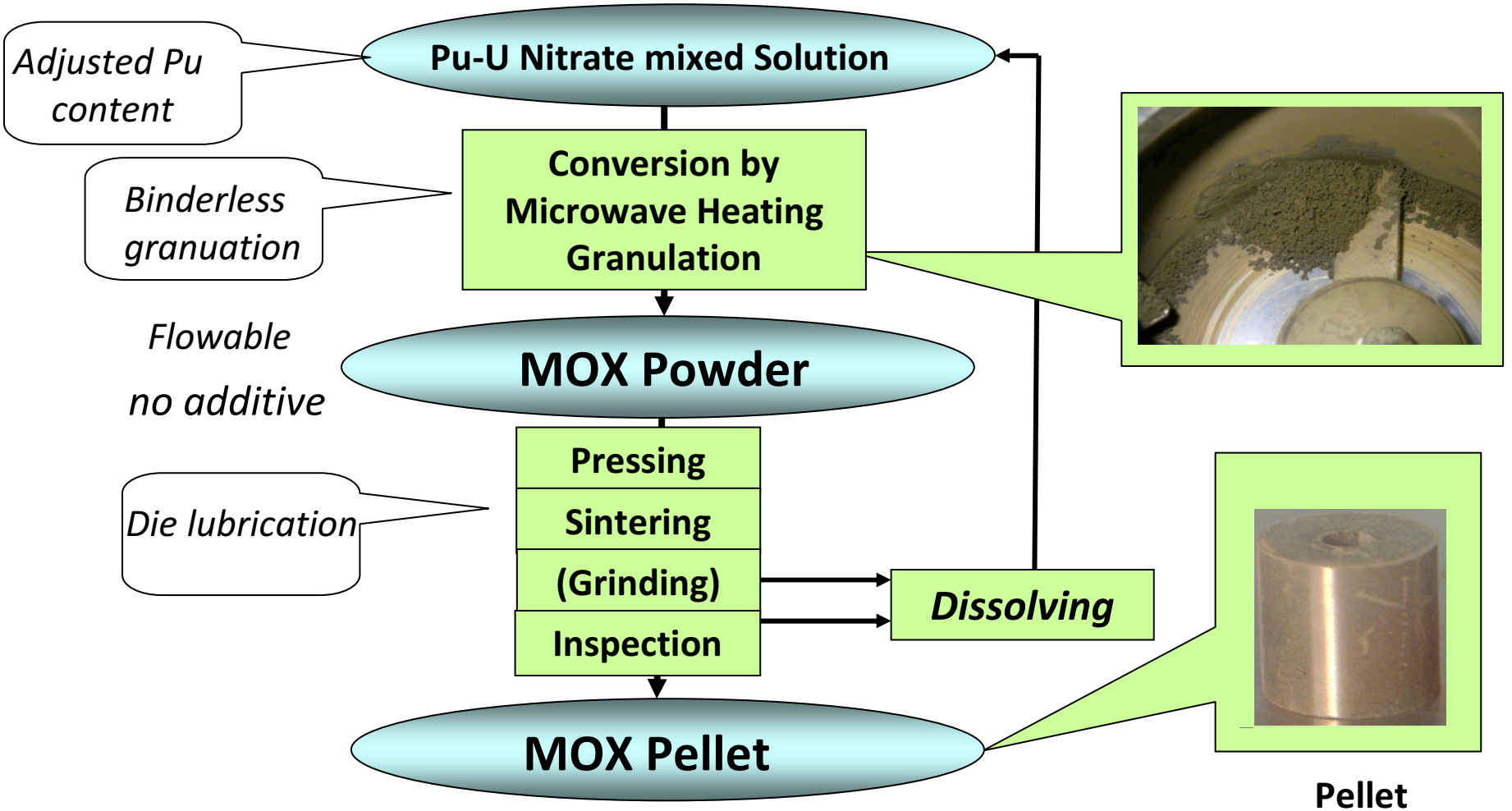
New technologies

Conventional technologies

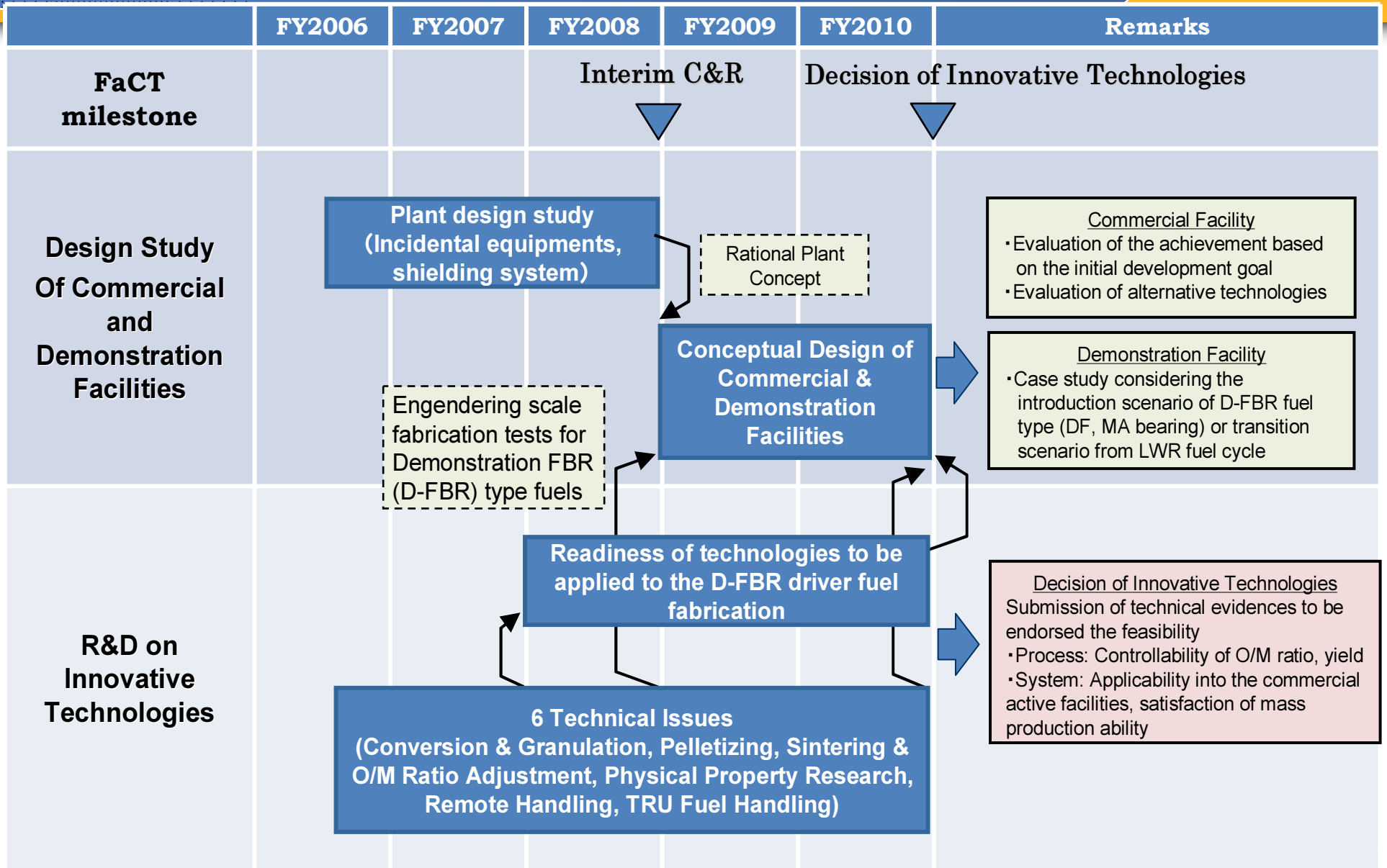
R&D Schedule of Reprocessing System



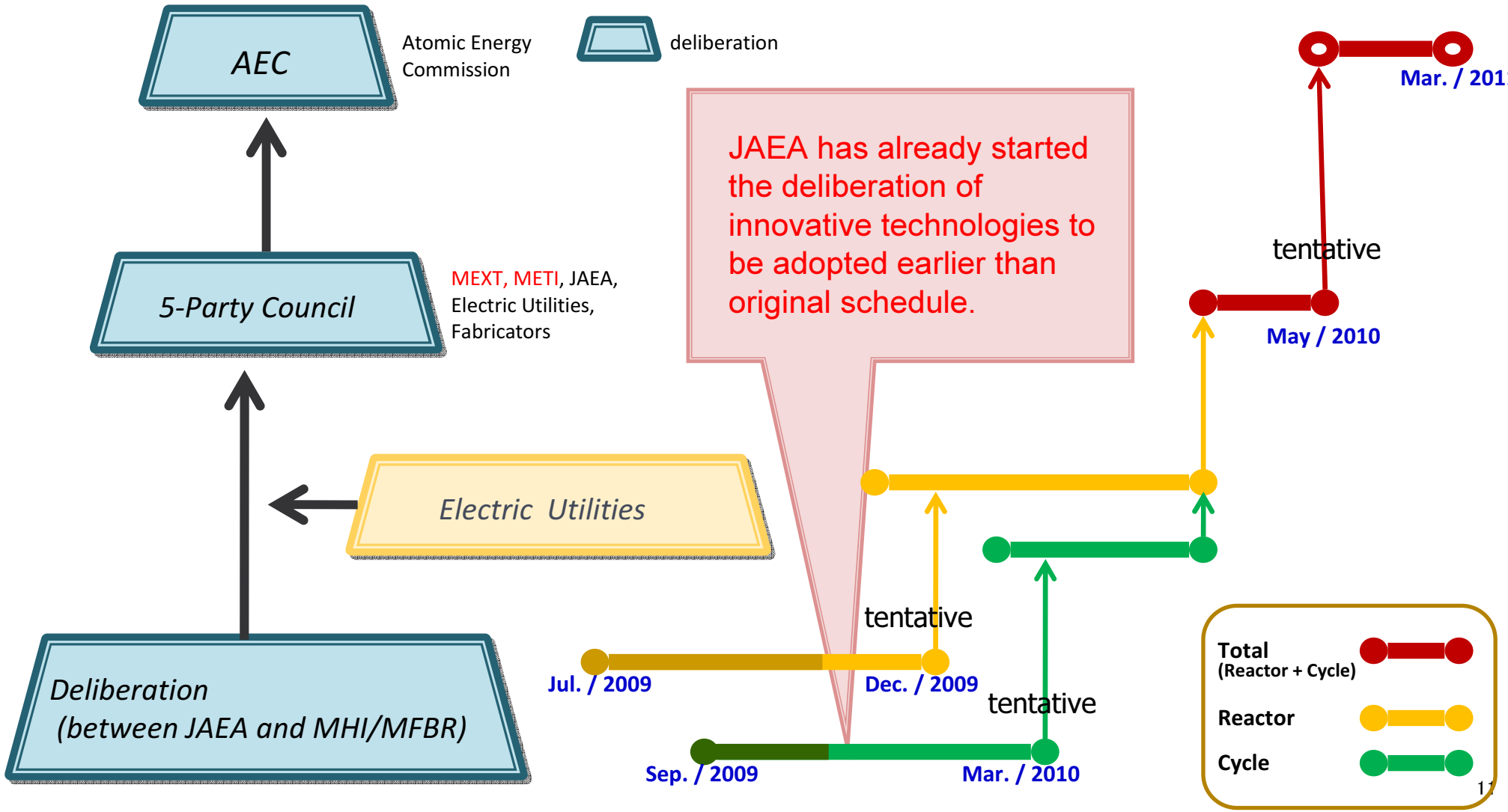
MOX Pellet Fabrication Tests by Simplified Pelletizing Method



R&D Schedule of Fuel Fabrication System



Schedule for Determination of Innovative Technologies to be Adopted



Determination of Innovative Technologies to be Adopted

12 innovative technologies for Fuel Cycle System are just deliberating whether adopted or not.

Evaluated Technologies	Key Points to Adaptation	Current Status (Major Point)
(1) Disassembling and Shearing	- Disassembling Time - Operability of Disassembling System	- Demonstrated Disassembling and Shearing Capability by use of "Monju" Type Fuel Assembly Mockup - Under Deliberation about its Applicability for Commercial Scale FR Assembly
	- Powdering Rate by Short-Length Shearing - Shearing Length Precision	
(2) Dissolution	- Operation Condition and Dissolver Structure for Highly Concentrated Dissolution	- Deliberation will start in December 2009
(3) Uranium Crystallization	- Uranium Recovery Rate - Crystal Purity Improvement	- Deliberation will start in December 2009
(4) U, Pu and Np Co-extraction	- U-Pu-Np Recovery Rate - Operability and Durability of Centrifugal Contactor	- Confirmed the Prospect of the Recovery Rate Requirement. - Under Deliberation about Capacity Requirement of the Contactor Development
(5) MA Recovery	- Selection of Optimum Reagent - Solution for Safety Issues	- Deliberation will start in December 2009
(6) Salt Free Waste Treatment	- Safety Decomposing of Spent Reagents - Refractory Materials for Electro-Oxidation Cell	- Deliberation will start in December 2009

Determination of Innovative Technologies to be Adopted

12 innovative technologies for Fuel Cycle System are just deliberating whether adopted or not.

Evaluated Technologies	Key Points to Adaptation	Current Status
(7) Conversion and Granulation	-Feasibility of the MH system in the engineering scale -Yield in the tumbling granulation process	- Deliberation has started. Data will be available by Mar. 2010.
(8) Pelletizing	- MOX pellets quality and yield for a die-lubrication type compaction machine	-Confirmed by dummy powder tests. MOX test results will be available in 2010JFY.
(9) Sintering	-Controllability and shortening of the processing time for low O/M ratio MOX pellets in the engineering scale	-MOX test equipments are under construction. MOX test data will be available in 2010JFY.
(10) Studies of Fuel Physical Properties	-Expansion of physical property data-base for MOX and MA-MOX	-Deliberation has started.
(11) In-cell Remote Handling Technology	-Confirmation of the appropriateness of the remote maintenance system based on the modulizing concept	-Mock-up test results for modulized compaction machine will be available by Mar. 2010.
(12) Fuel Handling Technology	-Controllability of the high decay heat in the fabrication system, especially for the bundle assembling process	-Deliberation has started. Feasibility of the heat removal from anticipated MA-MOX bundle has almost confirmed by mock-up tests and analysis tools.

International Collaboration

Trilateral Collaboration

JAEA - DOE - CEA

"COOPERATION ON SFR DEMO/PROTOTYPES"

Jan.2008 MOU → Aug.2008 revised

Gen-IV International Forum (GIF)

12 countries, **1** organization

SFR

Parties : Japan, France, US, Korea, EU, China, (Russia)

SFR Project (Broad long-term R&D items)

- -System Integration and Assessment
- -Safety and Operation
- -Advanced Fuel
- -CD・BOP
- -GACID (Japan-France-US)

Cooperation

Cooperation

Information Exchange

JAEA-EDF Technical Cooperation on the FR Systems (Oct. 2008)

JAEA-CEA Framework Arrangement (Dec.2005)

Japan-France Collaboration

Fast Reactor WG
Fuel cycle WG etc.

JNEP (US-Japan Joint Nuclear Energy Action plan)

*Missions and Objectives were reviewed in Apr., 2009

Japan-US Collaboration

INPRO (International Project on Innovative Nuclear Reactors and Fuel Cycles)

TWG-FR (Fast Reactor Technology Working group)

IAEA

Conclusion

- **Medium to Long-term plan around 2050 and beyond**

  JAEA has been conducting the preliminary study and examination for the transition in cooperation with the concerned parties for the intensive discussion on the subsequent reprocessing plant to RRP which will be started in Japan Atomic Energy Commission around 2010.

- **Near-term plan around 2015 in FaCT Project**

  Design study and R&D of innovative technologies are now in progress aiming at adopting of innovative technologies by judging of their applicability in JFY2010.
  Furthermore, study of future reprocessing technology would be discussed not only as FaCT project but also in the field of transition from LWR cycle to FBR cycle.

- **International collaboration**

  International collaboration is indispensable to efficient development of FR fuel cycle. JAEA expects further collaboration with concerned countries on FR fuel cycle by sharing the R&D items on the same target.

Fast Reactor Cycle Technology Development Program (FaCT)

2005 — 2010 — 2015 (JFY)

Feasibility Study
(JFY 1999 - 2005)
Identify Most Promising Candidate Concept

C&R

Review & Basic Policy by MEXT & AEC

Fast Reactor Cycle Technology Development (FaCT) Project

Decision of which tech. should be adopted to JSFR (2010)

R&D of Innovative Technologies

Conceptual Design of Commercial & Demonstration FR Cycle Facilities

Commercialized FR Cycle

Plutonium Fuel Production Facility

Experimental FR "Joyo"

Chemical Processing Facility

Prototype FBR "Monju "

R&D at "Monju"

- Demonstrate Reliability as operating Power Plant
- Establish Sodium Handling Tech.

2015

Production of Conceptual Design of Commercial & Demonstration FRs and Related Fuel Cycle Facilities, with R&D Programs toward their Commercialization

~2025

Start of Operation of Demonstration FR & its Fuel Cycle Facilities

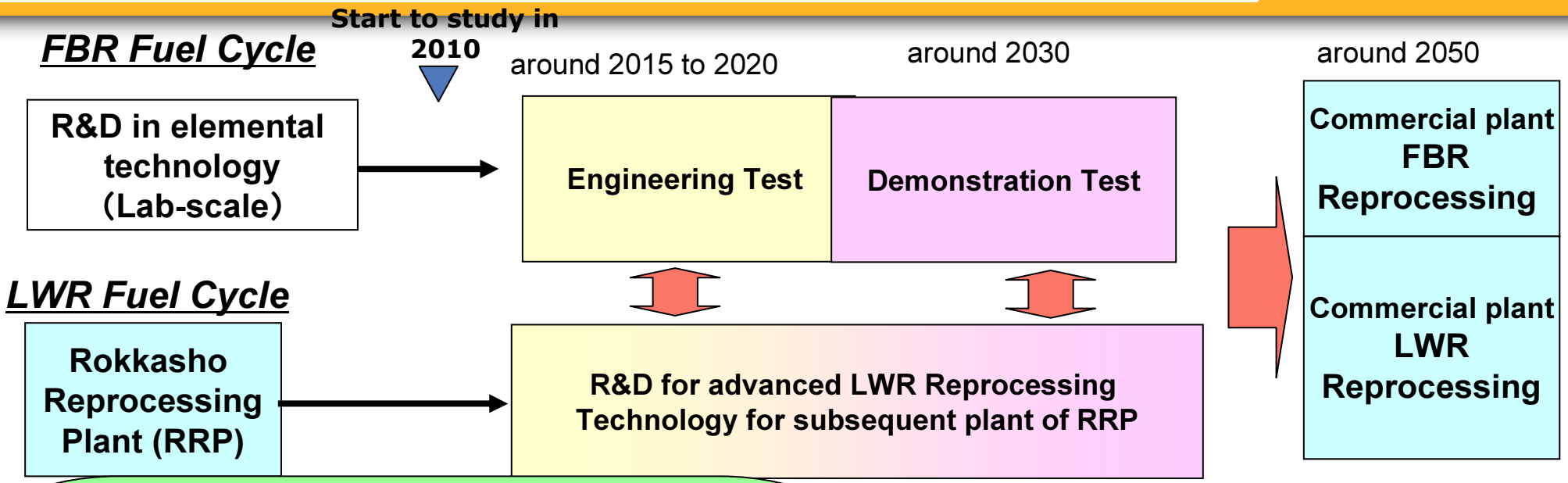
before2050

Deployment of Commercial FR

◆Cooperation with Various Organizations

◆International Cooperation (Bilateral, Trilateral and Multilateral Cooperation （GNEP, GEN-IV, INPRO etc.）)

Issues on Fuel Cycle around 2050 in Japan



Issue 2. Main items to be studied by 2010

①Mass flow analysis for nuclear fuel cycle
②The evaluation from various view points of options for fuel cycle (ex. recovered U, MA recovery, LWR MOX)
③The study of applicable reprocessing technology for the subsequent reprocessing plant of RRP
④The relation of LWR reprocessing with FBR reprocessing for fuel cycle scenario
⑤The roadmap for the long-term R&D scheme
⑥The study of nuclear non-proliferation and so on

Issue 3. Framework to begin discussions in around 2010 for transition of LWR to FBR

around 2040 to 2050

Issue 1. Perspective for fuel cycle around 2050

①LWR reprocessing capacity and FBR reprocessing capacity in accord with the introduction of FBR
②The concept of the subsequent plant to RRP
③ - - - - -