

# Multilateral Management of Spent Fuel according to Korea's Power Supply Plan

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- Introduction : Study Background
- Outline of Energy Plan in KOREA
- Assumption of Long Term Energy Assessment
- Forecast of Operating NPP by Energy Consumption
- Result



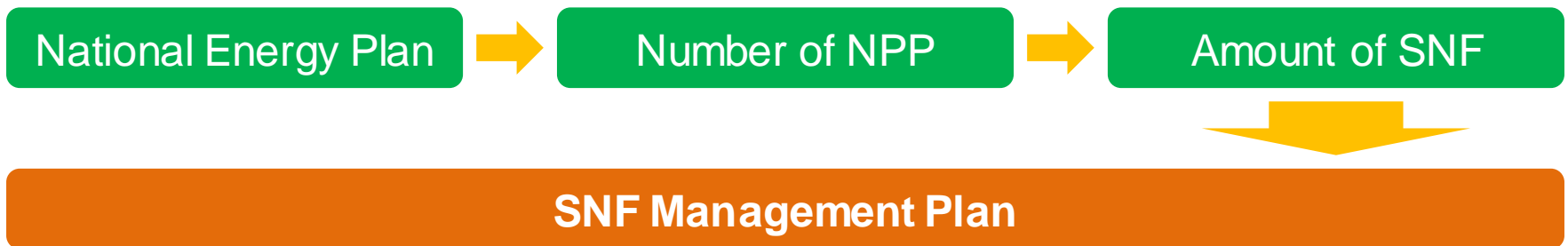
## ➤ History of Rad-Waste Disposal Facility

- 1980~90 : Tried but Failed to Site Decision
  - 1986~89 : Youngduck, Youngwoel, Uljin
  - 1990 : **Anmyun-island**
  - 1991~92 : Chungha
  - 1993~94 : Jangan, Uljin
  - 1994~95 : **Gulup-island**
- 1997 : Re-building the rad-waste management plan
- 2000~2004 : Many negotiation, Discussion, vote, etc.
- **3. Nov. 2005 : Decide Disposal facility site in Kyungju-si**
- **30. Jun. 2014 : Complete to construct**
- **11. Dec. 2014 : Start to operate the facility**





- Korea government is trying to decide the management plan of spent nuclear fuel
  - Maybe, Permanent SNF Disposal Facility?
    - Interim Storage and Final Disposal Facility Size, Location, etc.
  - Recycle?
    - Development Schedule, possibility
      - ; Pyro-processing, SFR(Sodium-cooled Fast Reactor)
- To build the SNF management plan, We must know how many SNF will be produced.





- Korea government has a 2 Kinds of Energy Plan
  - Electric Power Supply Basic Plan (6<sup>th</sup> in 2013)
  - Energy Basic Plan (2<sup>nd</sup> in 2014)
- Energy Plan is based on Mid-term Forecast(Max ; ~2035)
- Final SNF Management Plan Must be Set up to be based on Long-Term Forecast
- In This Study,
  - Summary of Korea Energy Plan
  - Calculation of SNF Quantity
  - Build the SNF Management Scenarios
  - Estimation of Possibility and Advantage of Each Scenarios

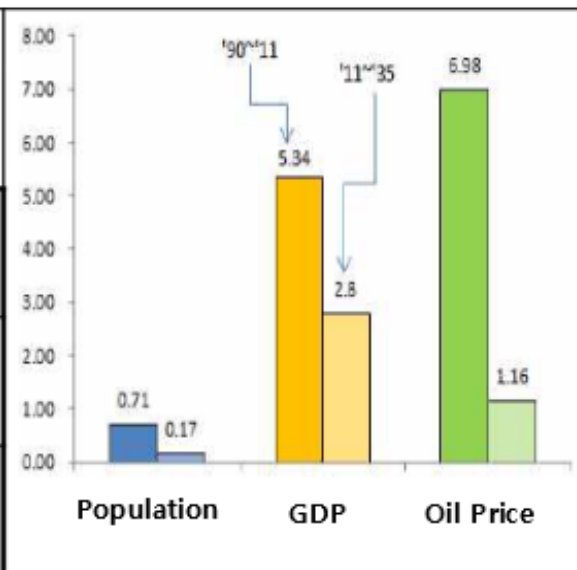


- Energy Basic Plan is Superordinate Plan than Electric Power Supply Basic Plan
- 2<sup>nd</sup> Energy Basic Plan predicts until 2035
  - Not Provide the Results of the Detailed Plan and Assessment
  - Prediction of Energy in Mid-term
- Prediction is Suggested by Analyzing Many Factors
  - Economic Growth Rate : Avg. 2.80% yearly from 2011 to 2035
  - Population and Household
    - Population : Avg. 0.17 % yearly (decrease after 30 years)
    - Household : Avg. 0.96% yearly
  - International Oil Price : Avg. 1.2% yearly ( \$140 by 2035)
  - Industry Constitution : High-energy Industry will Fall Down
- Total Energy Growth : Avg. 1.3 % yearly
- Final Energy Growth : Avg. 0.9 % yearly

# 2<sup>nd</sup> ENERGY BASIC PLAN



	2011	2035	Avg. Increasing rate per year (%)
GDP (trillion korea won)	1,082	2,101	2.80
Population (million)	49.8	51.9	0.17
Oil Price (Dubai, USD/bbl)	106.0	139.8	1.16



Growth Forecast

Resources Forecast  
(Total Energy)  
(unit : million toe)

	2011	2025	2030	2035	Annual Avg. Energy Consumption Increasing Rate (%)
Coal	83.6	100.2	107.7	112.4	1.24
Oil	105.1	111.0	107.1	101.5	0.15
Natural Gas	46.3	64.8	69.8	73.3	1.93
Water Power	1.7	1.7	1.9	2.0	0.70
NUCLEAR POWER	32.3	59.6	65.3	70.0	3.28
New & Renewable, Others	6.6	16.8	18.0	18.8	4.44
<b>Total</b>	<b>275.7</b>	<b>354.1</b>	<b>369.9</b>	<b>377.9</b>	<b>1.32</b>

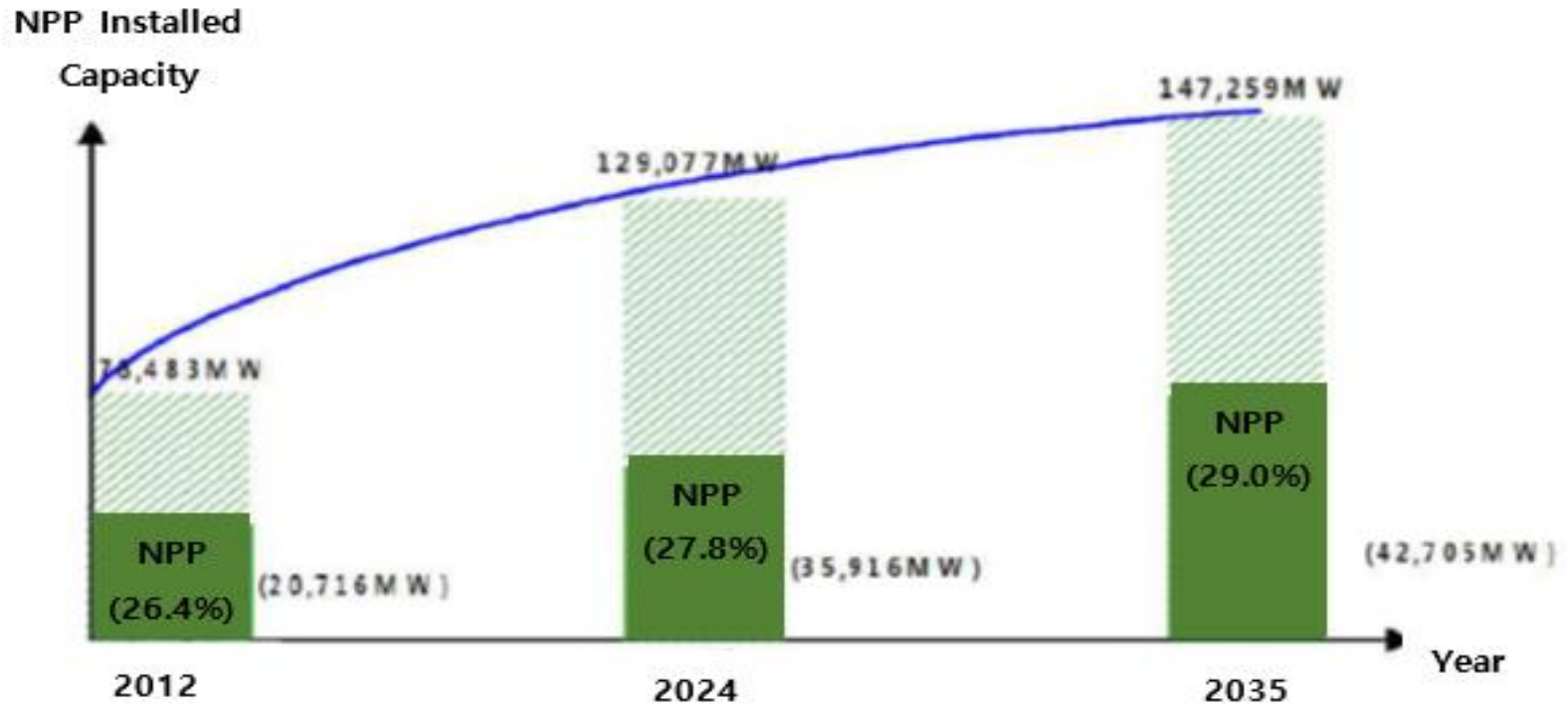






## ➤ Nuclear Power Plant Installation

- NPP : 23 to 34 by 2024 (21 GW to 36 GW)
- NPP Installed Capacity : Total 43 GW



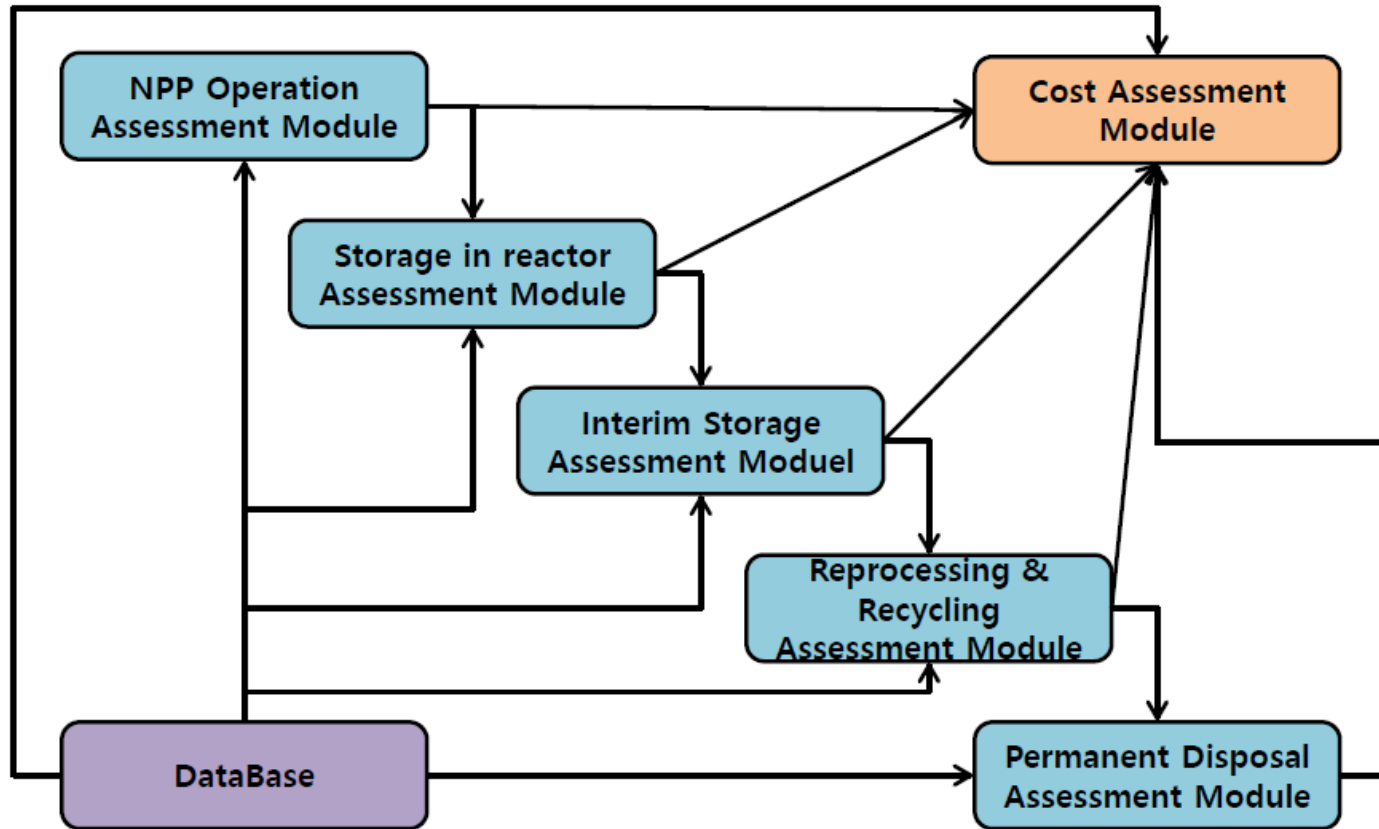


- Based on the First Energy Basic Plan in 2008
- Consumption and Supply Planning between 2013~2027
- Guide of Construction Plan of New Power Plants
  - Now Operating NPP ; 23 Units
  - Plan to Construct total 14 Nuclear Power Plants until 2024 in 5<sup>th</sup> Electric Power Supply Plan
  - By Effect of Fukushima Accident, 11 of 14 New NPP Construction are Decided
  - Total 34 NPP will be operated in 2024



# Assessment Tool of SNF Management Plan

- Apply the System Dynamics Model
  - Based on Godsim Program

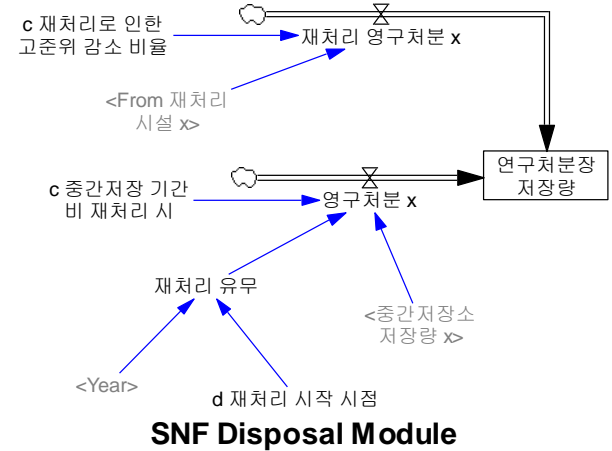
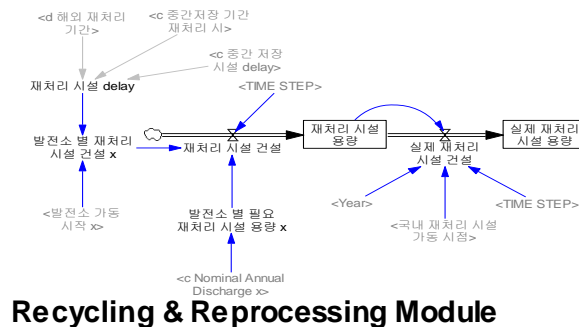
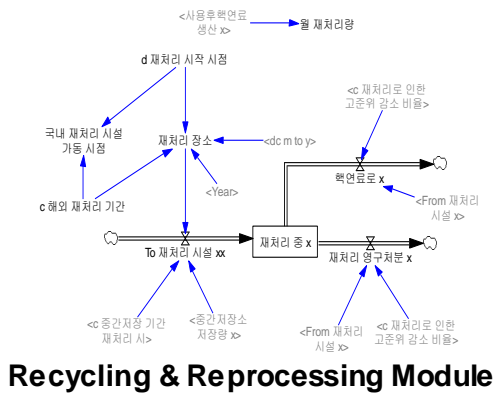
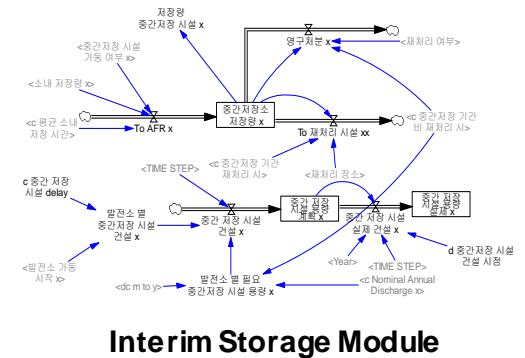
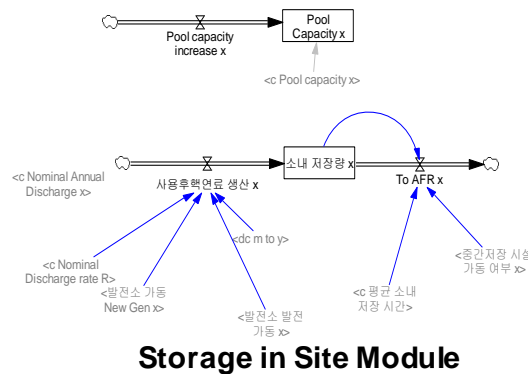
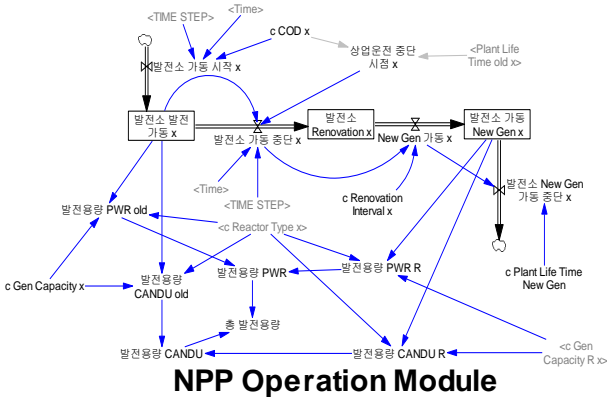




# Assessment Tool of SNF Management Plan

## ➤ Apply the System Dynamics Model

— Based on Godsim Program

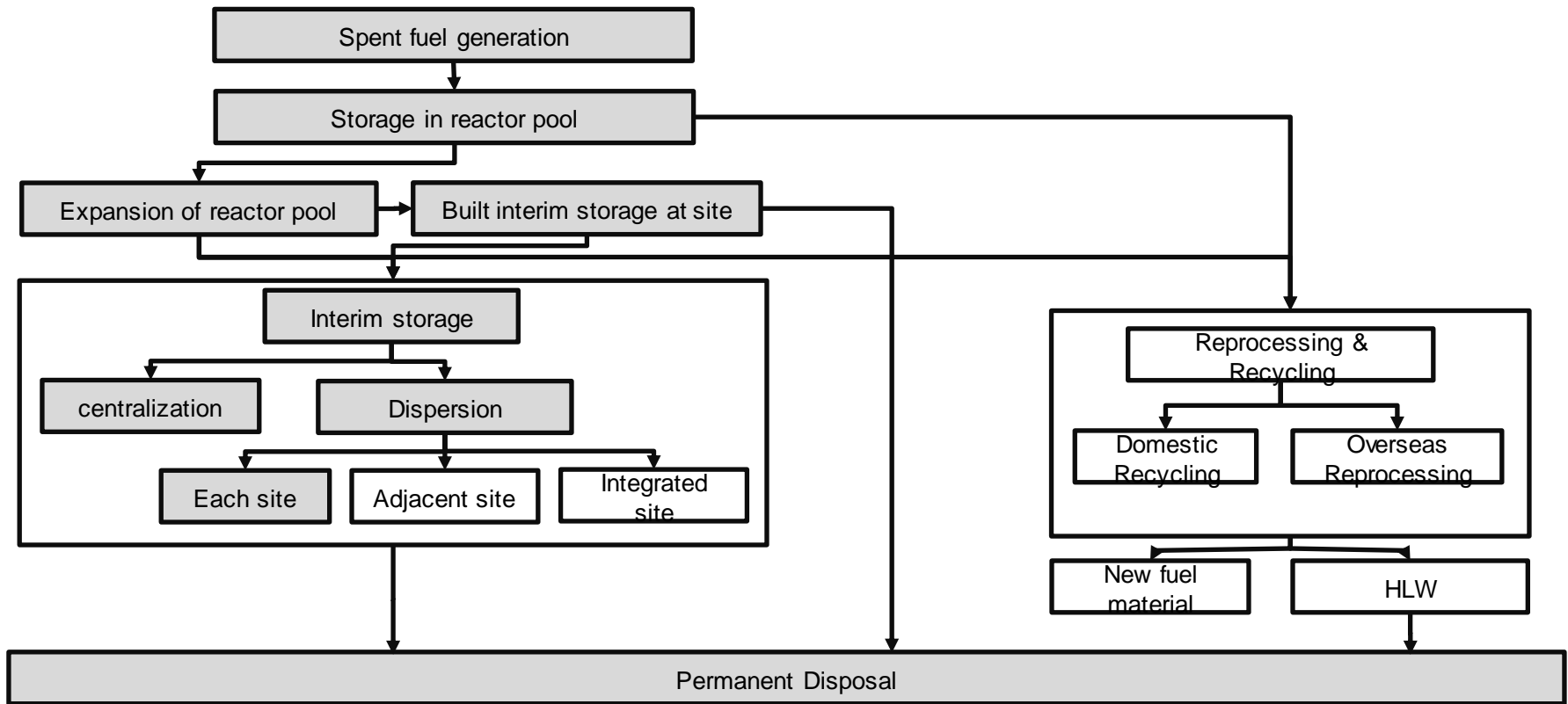




# Analysis of SNF Management plan

## ➤ System Dynamics Analysis of SNF Management plan

- Basis on 34 Unit NPP Operation (6th ELECTRIC POWER SUPPLY BASIC PLAN)
- Management System Flowchart



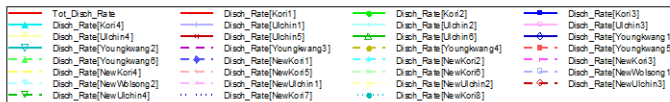
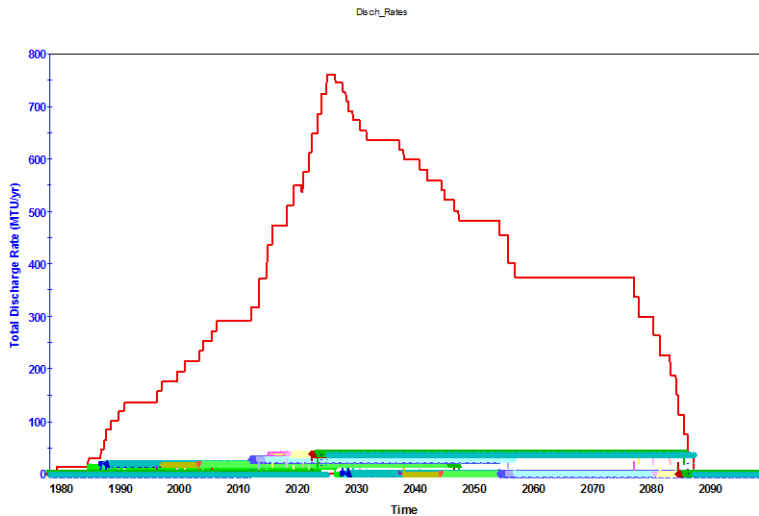


# Analysis of SNF Management plan

## ➤ System Dynamics Analysis of SNF Management plan

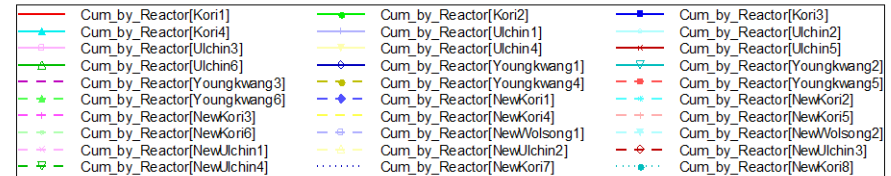
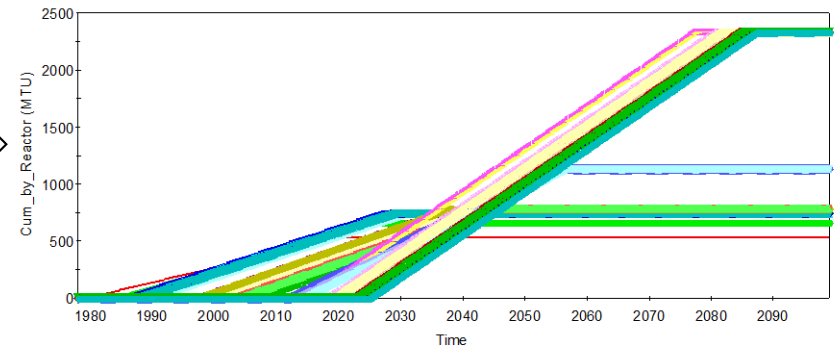
### – Estimation of SNF Quantities

PWR SNF Cumulative of each Reactor

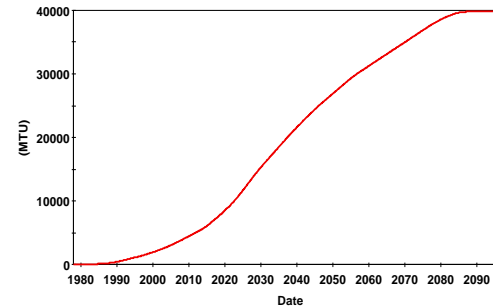


PWR Yearly SNF Quantities

Result\_Cum\_by\_Reactor



Cumulative Spent Fuel Generated



Cumulative PWR SNF





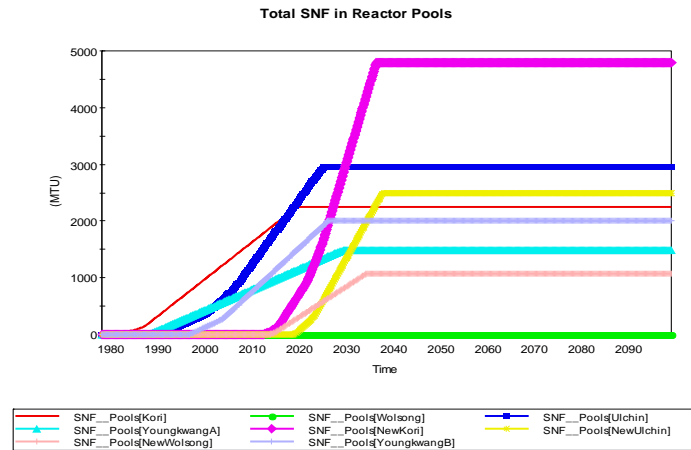
# Analysis of SNF Management plan

## ➤ System Dynamics Analysis of SNF Management plan

### – Short term Management

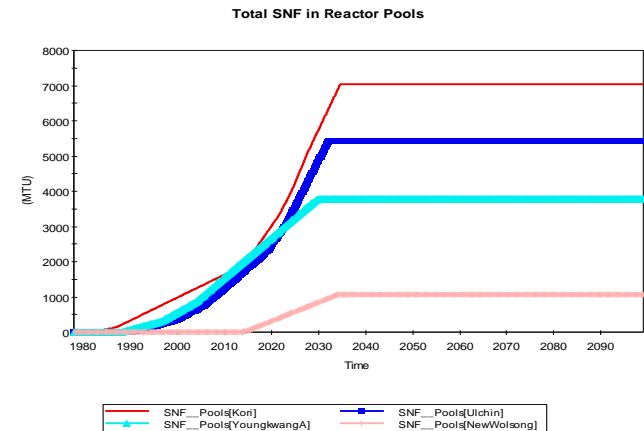
- Saturation year in each site of PWR

Section		Capacity After expansion (MTU)	Saturation Year
Kori	Kori	2,253	2019
	New-Kori	4,789	2036
Hanbit (Younggwang)		3,786	2029
Hanul (Uljin)	Hanul	2,961	2025
	New-Hanul	2,485	2037
Wolsong	New-Wolsong	1,068	2033



- Saturation year in adjacent site of PWR

Section		Capacity After expansion (MTU)	Saturation Year
Kori	Kori + New-Kori	7,042	2034
Hanbit (Younggwang)		3,786	2029
Hanul (Uljin)	Hanul + New-Hanul	5,446	2032
Wolsong	New-Wolsong	1,068	2034



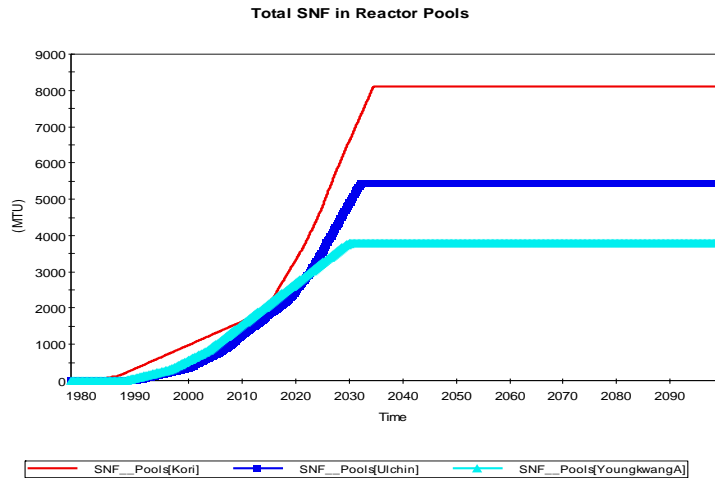


# Analysis of SNF Management plan

## ➤ System Dynamics Analysis of SNF Management plan

- Short term Management
  - Saturation year in integrated site of PWR

Section		Capacity After expansion (MTU)	Saturation Year
Kori	Kori + New-Kori + New-Wolseong	8,110	2034
Hanbit (Younggwang)		3,786	2029
Hanul (Uljin)	Hanul + New-Hanul	5,446	2032







## ➤ Scenario setup of Management Plan

Section	Management Method	Outline of Each Method	
A-1	Temporary Facilities	Building of temporary facility at each site	
B-1	Interim Storage	Centralization	
B-2		Dispersion	
B-3			Adjacent Site
B-4			Integrated Site
C-1	Reprocessing & Recycling	Overseas Reprocessing	
C-2		Domestic Recycling	
C-3		Link between reprocessing and Recycling	



# Analysis of SNF Management plan

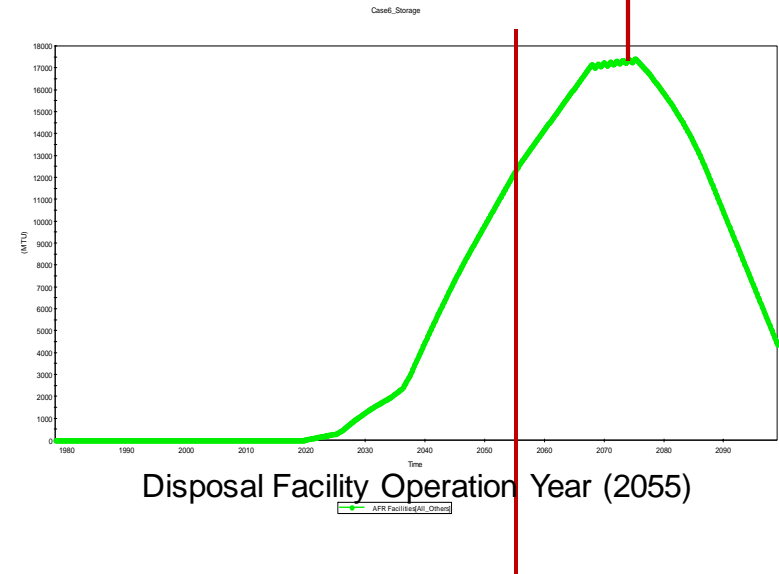
## ➤ Scale Analysis of each Scenario

	Scenario
A-1	Temporary Storage
Outline	
Building of temporary facility at each site	

	Scenario
B-1	Centralization
Outline	
Centralized management	

Section		Storage Capacity (MTU)
Kori	Kori	435.2
	New-Kori	8,489
Hanbit		1,154
Hanul	Hanul	1,689
	New-Hanul	4,897
Wolseong	New-Wolseong	1,191

- Max Capacity of Centralization : 17,389 MTU





## ➤ Scale Analysis of each Scenario

	Scenario
B-2	Dispersion
Outline	
Independent each site from NPPs, but nearby	

	Scenario
B-3	Dispersion
Outline	
Adjacent Site	

Section		Storage Capacity (MTU)
Kori	Kori	435.2
	New-Kori	8,489
Hanbit		1,154
Hanul	Hanul	1,689
	New-Hanul	4,897
Wolseong	New-Wolseong	1,191

Section	Storage Capacity (MTU)
Kori + New-Kori	8,905
Hanbit	1,154
Hanul + New-Hanul	6,619
New-Wolseong	1,191



# Analysis of SNF Management plan

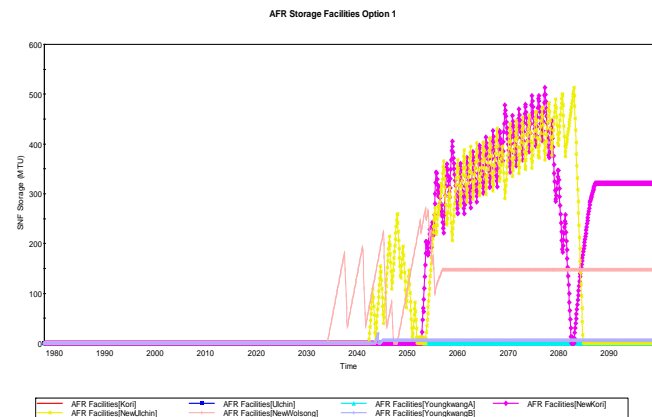
## ➤ Scale Analysis of each Scenario

	<b>Scenario</b>
<b>B-4</b>	<b>Dispersion</b>
<b>Outline</b>	
Integrated Site	

	<b>Scenario</b>
<b>C-1</b>	<b>Reprocessing</b>
<b>Outline</b>	
Overseas Reprocessing	

Section		Storage Capacity (MTU)
<b>Kori</b>	Kori + New-Kori + New-Wolseong	9,928
<b>Hanbit</b>		1,154
<b>Hanul</b>	Hanul + New-Hanul	6,421

- **Yearly Reprocessing amount : 360 MTU/yr**
- **From 2015 to Final Disposal**
- **Exceed 500 MTU SNF than Max Capacity**
- **Impossible of management plan**





# Analysis of SNF Management plan

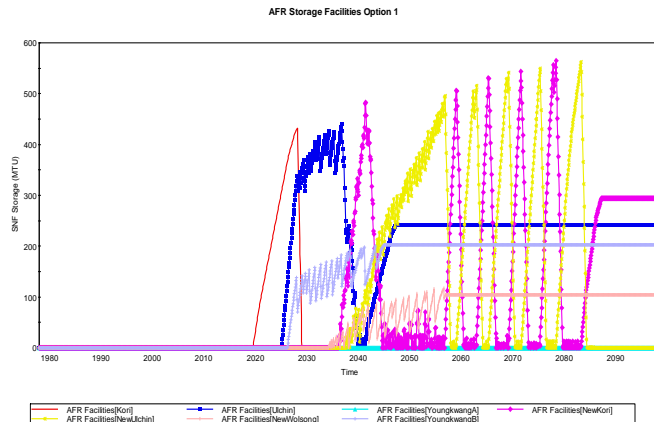
## ➤ Scale Analysis of each Scenario

	Scenario
C-2	Recycling
Outline	
Domestic Recycling	

	Scenario
C-3	Reprocessing + Recycling
Outline	
Link between reprocessing and Recycling	

- Yearly Recycling : 600 MTU/yr
- Start from 2028
- Exceed 400 MTU SNF than Max Capacity
- Impossible of management plan

- Complexes Method with C-1 & C-2
- Exceed 35 MTU than Mac Capacity
- Need of additional technical assessment









# THANK YOU

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