NUCREAR PROSPECT

Japan-Taiwan Nuclear Symposium

SESSION 2

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CONTENTS

INTRODUCTION

- Activities of SNW concerning energy and global warming issues
  - Studied through lecture by and discussion with expert in such areas as;

    Energy policy issue, prospects of greenhouse gases (GHG) reduction, possibility of increasing renewable resources, etc
- Proposal submitted to Prime Minister Fukuda at the time
  - Goal and way to increase dependency on domestic energy including nuclear and to reduce GHG.

1 Back Ground of Energy Policy

1.1 Energy Resources

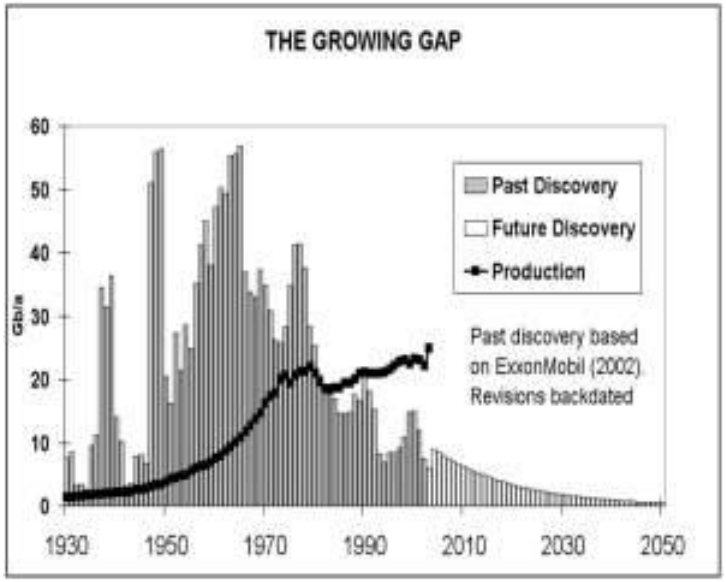
1.2 Global Warming

1.1 Energy Resources

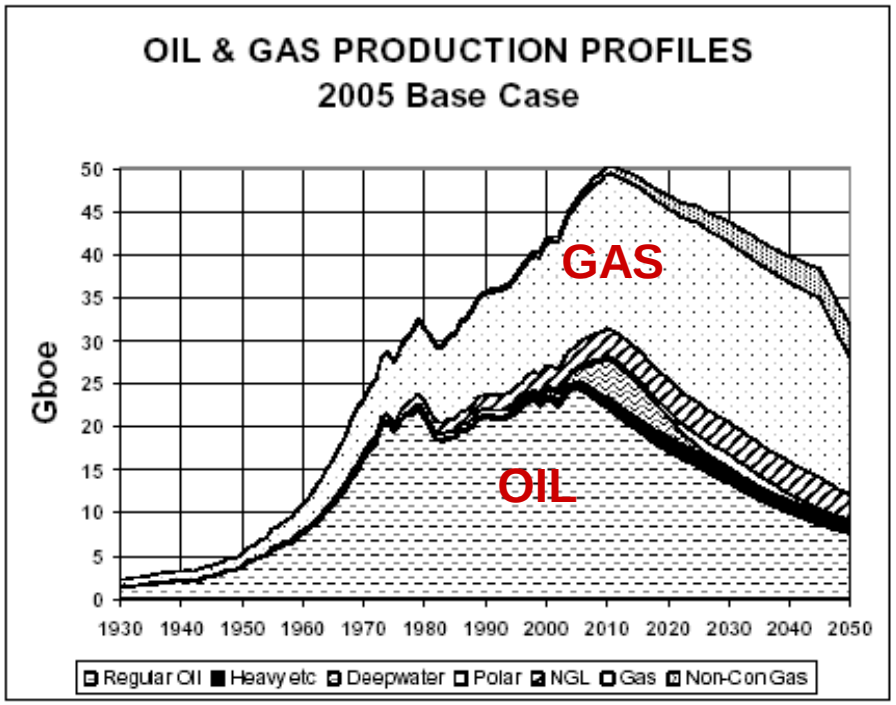
- **World Trend**
  - **War to get resources started !!**
    - **Resources exhausting (oil peak), uneven distribution, demand increasing rapidly**
- **Japanese Interest**
  - **Energy security**
    - **assurance of supply, increase dependency on domestic energies**

OIL PEAK

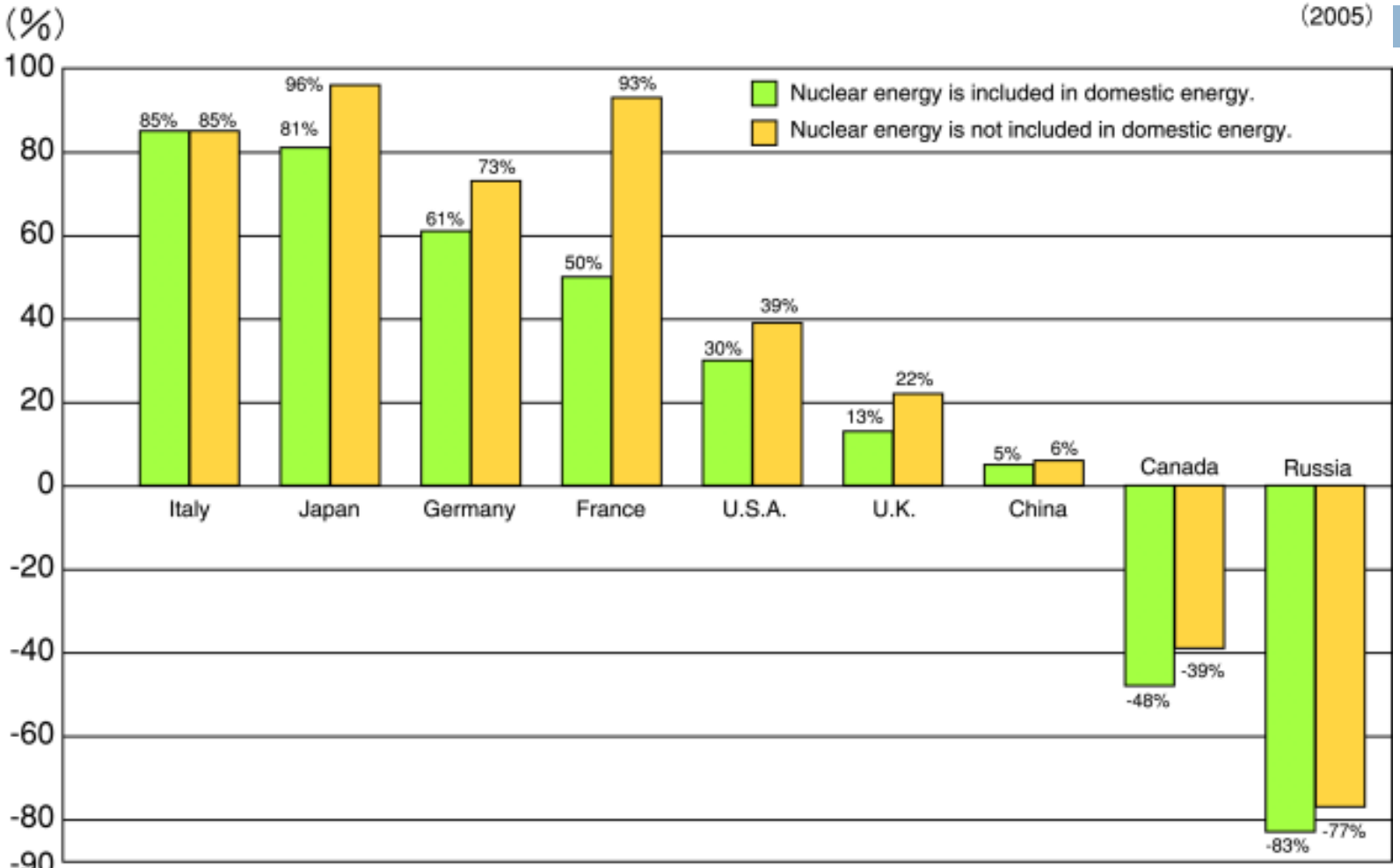
Peak of discovery of oil was 1960's.



Peak of production of oil and gas pass soon.



Dependence on Imported Energy Sources by Major Countries

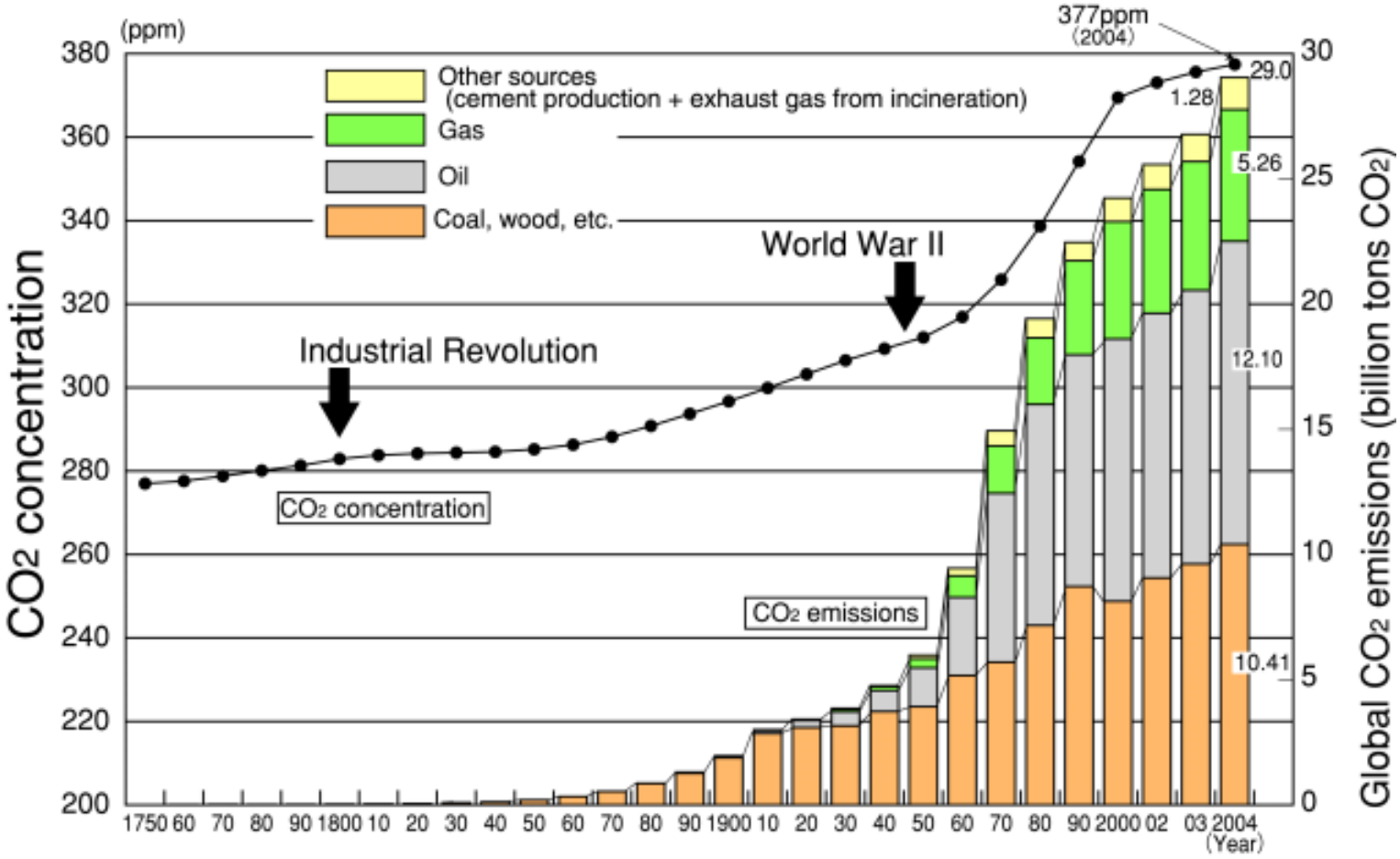


(Note) Canada and Russia are net-exporting countries.
(Source) ENERGY BALANCES OF OECD COUNTRIES 2004-2005
ENERGY BALANCES OF NON-OECD COUNTRIES 2004-2005

1.2 Global Warming Issue

- **Causes of Global Warming**
  - Most of observed increase in averaged temperature is very likely due to the observed increase in anthropogenic GHG concentration. (IPCC 4th Assessment Report)
  - However, another assumption indicates natural fluctuation would be dominant. (Prof. Akasofu, etc.)
- **Mitigation of global warming:**
  - Considering above causes, no regret option should be adopted to mitigate global warming by reducing GHG.

Changes in CO_2 Emissions from Fossil Fuels and Atmospheric CO_2 Concentration

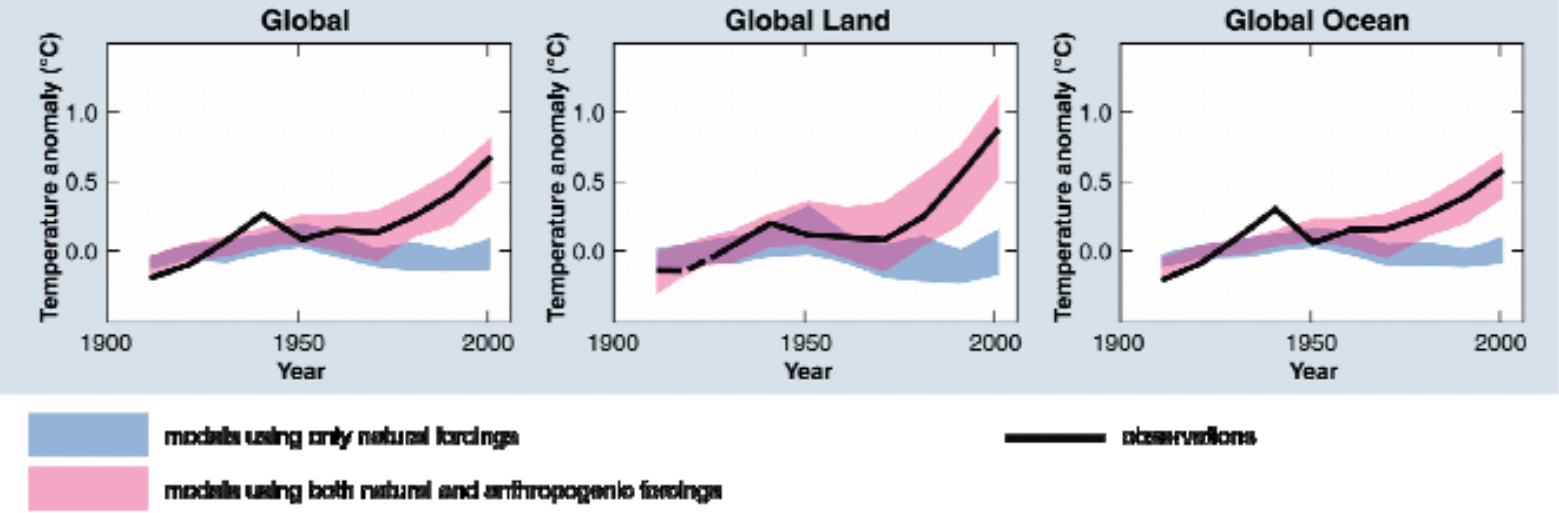


(Note) Figures do not necessarily total to 100% due to rounded numbers.
(Source) Carbon Dioxide Information Analysis Center (CDIAC, ORNL) website

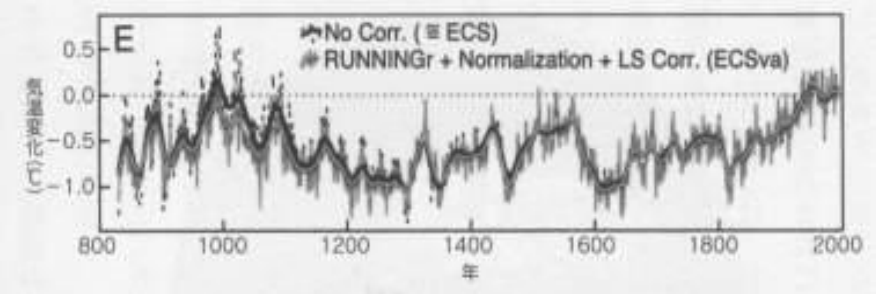
IPCC 4th Assessment Report

Most of observed increase in averaged temperature is very likely due to the observed increase in anthropogenic GHG concentration.

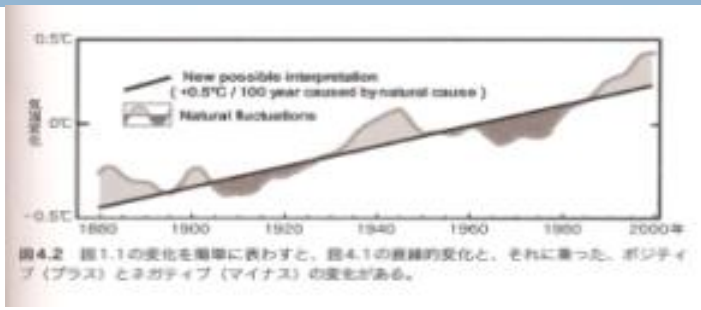
Global and Continental Temperature Change

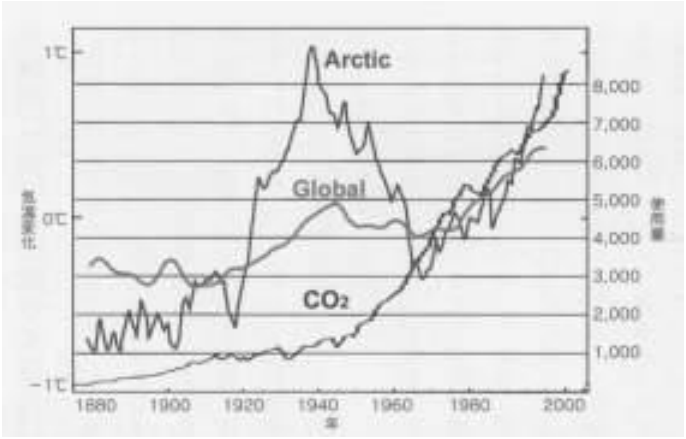


Magnitude of Natural Variation on Fluctuation



Temperature estimated from annual ring. Ice age recover from around 1800.



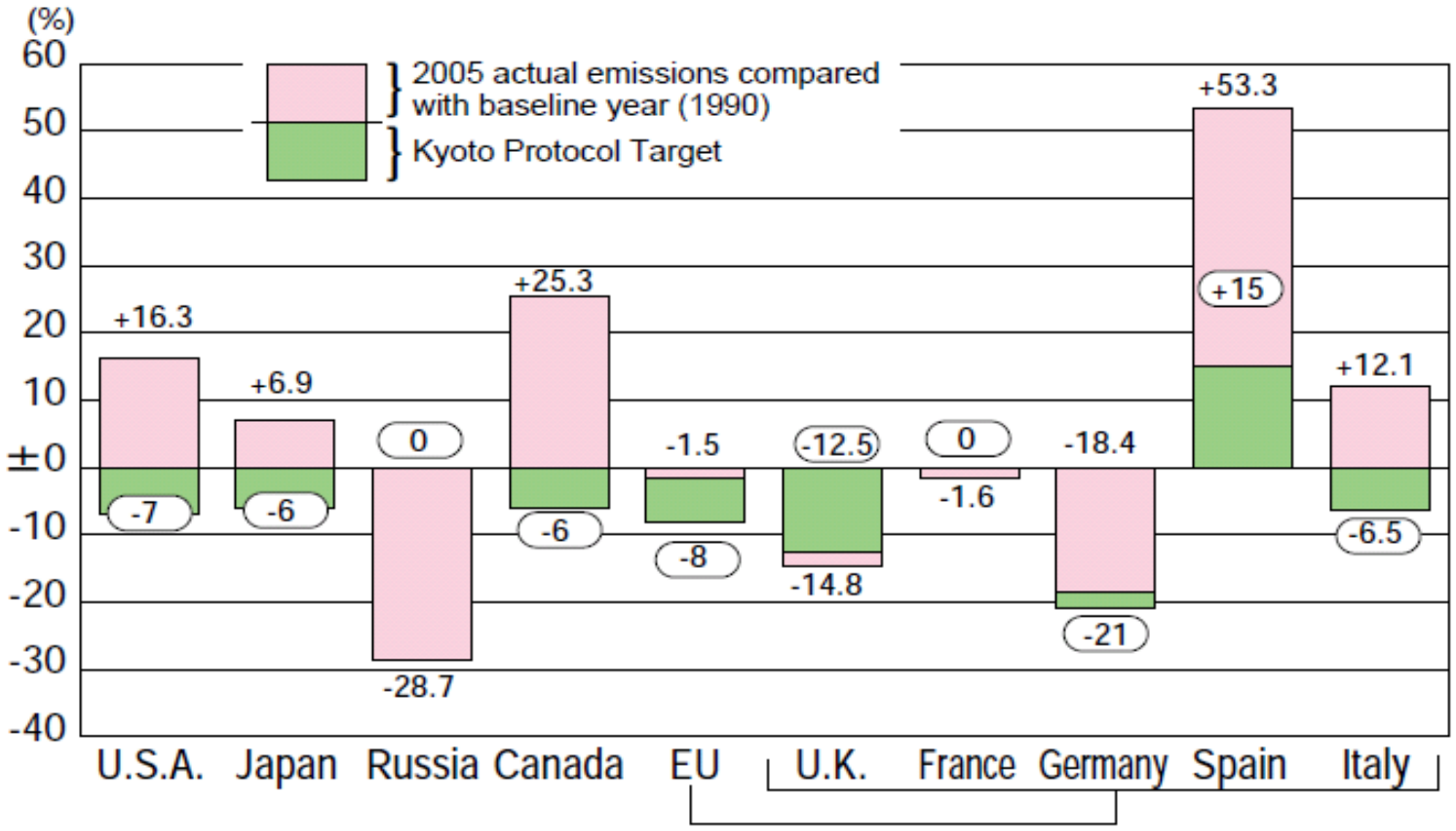


Global and Arctic temperature change. Increase of CO2 from around 1945.

- Little ice age recovering now.
- Temperature rising linearly from 1880.
- Temperature fluctuation during 1920-1970 seems to be independent from CO2.
- Warming during 1950-2000 in Arctic is distinguished..
- Contribution of CO2 for warming from 1900 would be around 1/6.

(Reference : Prof Akasofu)

Kyoto Protocol Targets and Current State of Greenhouse Gas Emissions



(Note) Numerical reduction target is not set for developing countries such as China, India and Brazil.
(Source) Institute for Global Environmental Strategies

Policy to Mitigate Global Warming

- **Cause of warming** **not known completely**
  Natural fluctuation: solar, volcano, atmosphere, marine, etc.
  Anthropogenic : GHG, land use, etc.
- **Mitigation principle**
  - **GHG emission mitigation is necessary even if;**
    - **Natural fluctuation >>anthropogenic effect**
  - **No regret principle should be adopted for unknown area**

2 Energy Policy

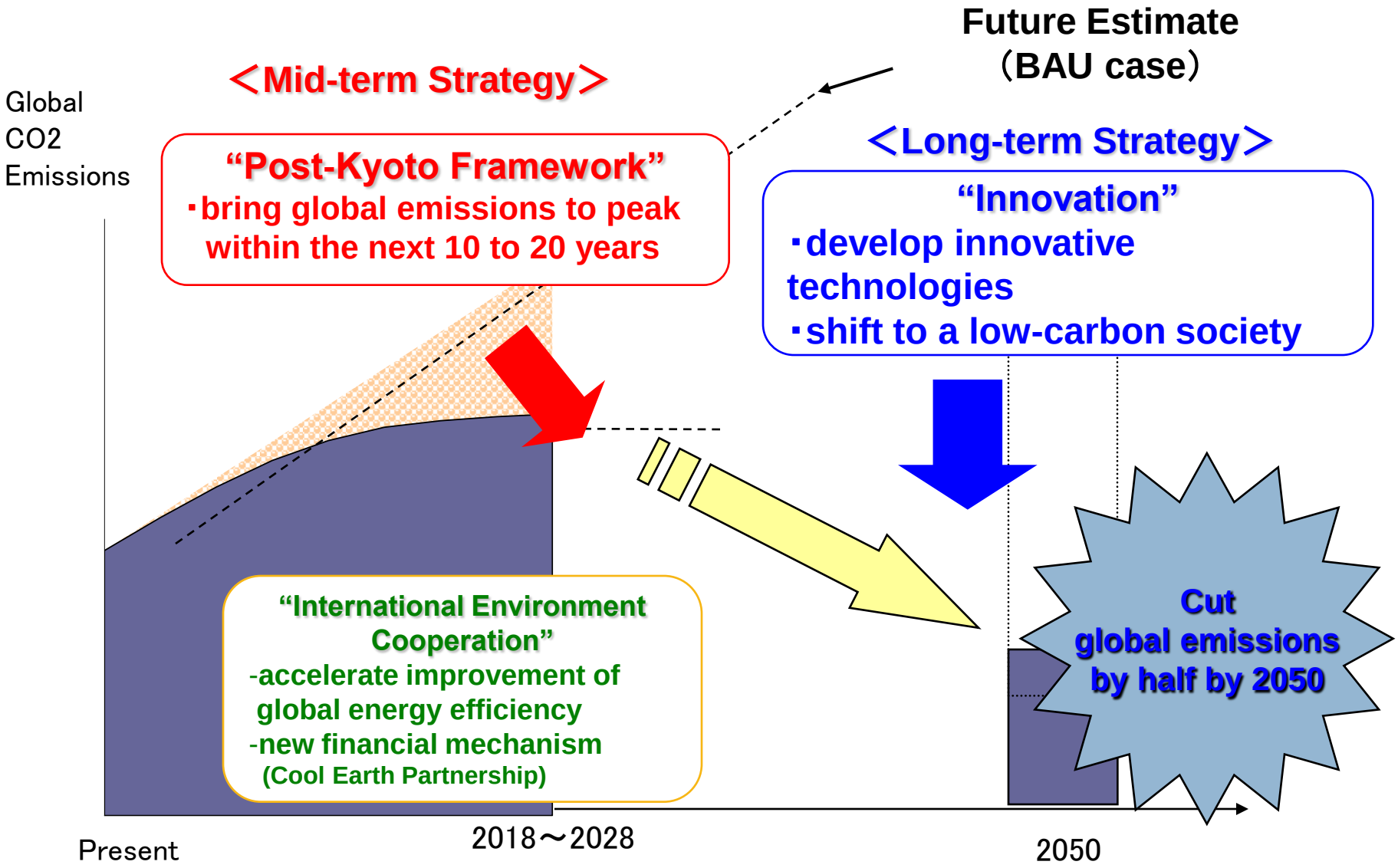
2.1 World Trend

2.2 Japanese Policy and Prospect

2.1 World Trend

- Resource and global warming issues should be resolved simultaneously with maintaining economic growth.
- Adjustment of national interest, equality between developed and developing countries is difficult.
  - Hokkaido Toyako Summit: Reducing 50% GHG emission by 2050.(recognition shared)
  - COP14 : no progress.
- No regret option should be adopted
  - Nuclear option is best choise.
    - Saving energy, increasing efficiency and renewable option are also no regret. However, they can not satisfy demand since amount of supply is limited.

Mid-term Strategy and Long-term Strategy



福田総理講演資料より

2.2 Japanese Policy and Prospect

- **Basic Energy Policy: 3E policy** Economy, Environment, Energy Security satisfied simultaneously.
- **Nuclear Energy Policy**
- **Cool Earth 50**
- **Fukuda Vision** (Prime minister at the time)
  - 60-80% GHG emission reduction by 2050
  - GHG emission peak out in few years
  - Increase of zero emission generation such as nuclear and renewable 40-50% above 2006, etc.
- **Senior proposed "Triple 50" policy.**

Japan's Energy Policy

Outline of the "Basic Law on Energy Policy Making"

(enacted June 2002)

Provision of basic policies on energy supply and demand

1. Securing of stable supply (diversifying energy supply sources, increasing energy self-sufficiency ratio and achieving energy security)
2. Environmental suitability (preventing global warming, preserving local environment and achieving recycling-oriented society)
3. Utilization of market mechanisms (promoting deregulation measures while considering the above two political objectives)

Outline of Basic Energy Plan

(approved by the Cabinet and submitted to the Diet in October 2003)

Political measures to be comprehensively and systematically implemented with a long-term view

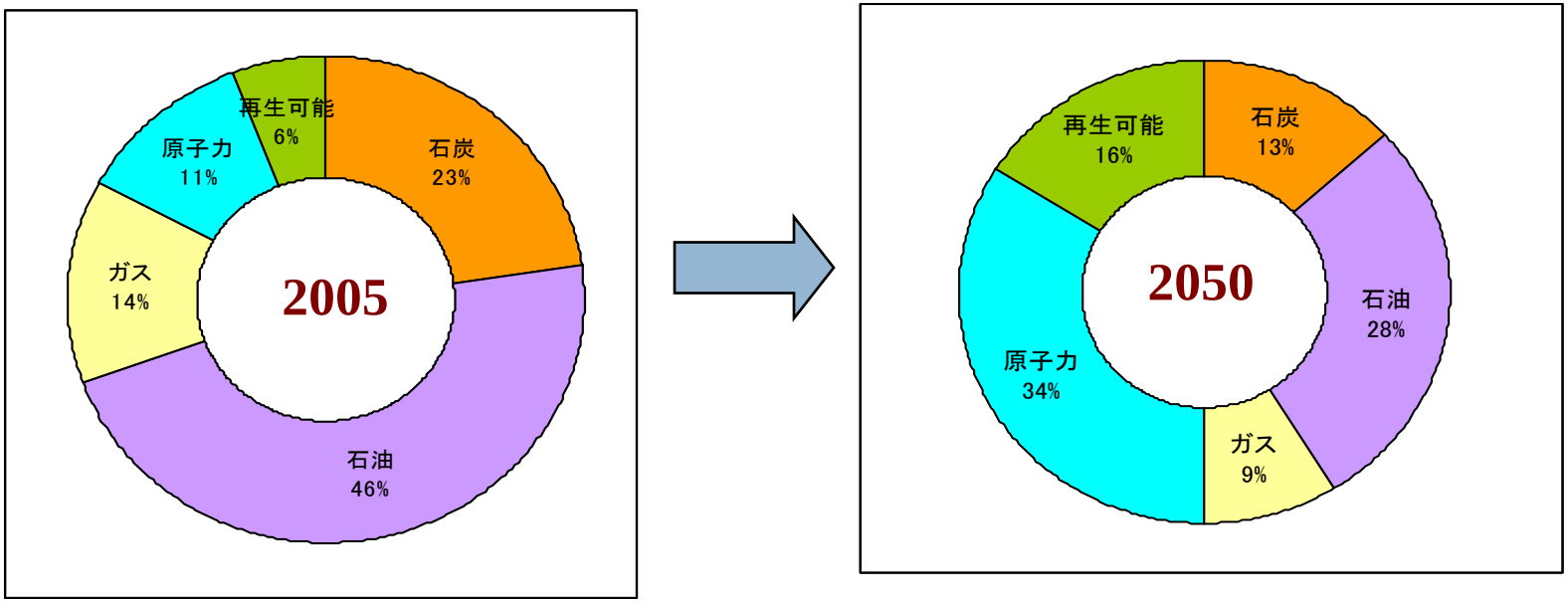
1. Promotion of energy supply/demand measures
2. Development, introduction and utilization of diversified energy sources
   1) Development, introduction and utilization of nuclear energy
      Nuclear power generation – Promotion of nuclear energy as the key source of electricity
      Promotion of nuclear fuel cycle – Focusing on the plu-thermal policy for the foreseeable future on condition of safety and nuclear nonproliferation
   2) Assurance of safety of and reliance on nuclear energy
   3) Development, introduction and utilization of new energy sources
   4) Development, introduction and utilization of gas energy
   5) Development, introduction and utilization of coal, etc.
3. Assurance of safe and stable oil supply

"Triple 50" Proposed to Prime Minister

- **Outline of Proposal for Cool Earth 50**
  - **Goal ：Triple 50**
    - **Dependency on domestic energy up to 50%, CO2 emission reduction 50% by 2050**
- By ：
  - save energy and increase efficiency to reduce demand: 25%, increase of renewable twice and nuclear 2.5 times, reduction of fossil fuel: 50%.
- **Proposal was submitted to Prime Minister Fukuda (at the Time) by senior 3 parties.**

Outline of "Triple 50" Proposal

25% demand reduction by save energy and efficiency increase, dependency on fossil energy 50%, increase of nuclear and renewable 50%.



EEE会議福田総理への提言書より

3 Scenario of Recycle Option

- Recycled Pu will be used in Pu-thermal (MOX fuel) until commercial FBR introduced.
- Existing reactors will be replaced by advanced light water reactor from around 2030.
- Commercial FBR will be introduced by 2050 and the light water reactors will be replaced since then.
- Second reprocessing facility will start around the termination of Rokkasho reprocessing facility. Recycled Pu will be reused in FBR.

Outline of JNFL's Nuclear Fuel Cycle Facilities

(As of December 31, 2007)

	Reprocessing Plant	MOX Fuel Fabrication Plant	Vitirfied Waste Storage Center	Uranium Enrichment Plant	Low-level Radioactive Wasate Disposal Center
Site	Iyasakatai, Rokkasho-mura, Kamikita-gun, Aomori Prefecture			Oishitai, Rokkasyo-mura, Kamikita-gun, Aomori Prefecture	
Capacity	Maximum capacity: 800 ton-U/year Storage capacity for spent fuel:3,000ton-U	Maximum capacity: 130 ton-HM/year(*)	Storage capacity for wastes returned from oversea plants: 1,440 canistiers of vitrified waste Planned to be expanded to 2,880 canisiters	1,050 ton-SWU/year(*) Planned to be expanded to a maximum capacity of 1,500 ton-SWU/year	Authorized capacity: 200,000m^3 (equivalent to 1 million 200 liter drums) Planned to be expanded to 600,000m^3 (equivalent to 3 million 200 liter drums)
Current Status	Under construction	Applying for a business license	Cumulative number of stored canisters:1,310	Present capacity: 300 ton-SWU/year	Cumulative number of stored drums:199,539
Construction Cost	about 2.19 trillion yen	about 130 billion yen	about 80 billion yen (**)	about 250 billion yen	about 160 billion yen (***)
Schedule	Start of construction:1993 Start of operation: 2008(planned)	Start of operation: 2012(planned)	Start of construction:1992 Start of storage:1995	Start of construction:1988 Start of operation:1992	Start of construction:1990 Start of operation:1992

(*) "ton-HM" stands for "tons of heavy metal" which indicates the weight of plutonium and uranium metallic content in MOX.
"SWU" stands for "Separative Work Unit" which is a measure of the work expended during an enrichment process of uranium.
(**) Construction expense regarding 1,440 canisters of vitrified waste.
(***)Construction expense regarding 200,000m^3 low-level radioactive waste (equivalent to 1 million 200 liter drums)
(Source) JNFL's website and others

原子燃料サイクル施設の概要

（2007年12月末現在）

日本原燃・青森県六ヶ所村

	再処理工場	MOX燃料工場	高レベル放射性廃棄物貯蔵管理センター	ウラン濃縮工場	低レベル放射性廃棄物埋設センター
建設地点	六ヶ所村弥栄平地区			六ヶ所村大石平地区	
施設の規模	最大処理能力 800トン・U／年 使用済燃料貯蔵容量 3,000トン・U	※1 最大処理能力 130トン・HM／年	返還廃棄物貯蔵容量 ガラス固化体 1,440本 将来的には 約2,880本	※1 1,050トンSWU／年 最終的には 1,500トンSWU／年規模	約20万立方メートル（200ℓドラム缶約100万本相当） 最終的には 約60万立方メートル（200ℓドラム缶約300万本相当）
現状	建設中	事業許可申請中	累積受入1,310本	300トンSWU/年規模で操業中	累積受入199,539本
建設費	約2兆1,900億円	約1,300億円	※2 約800億円	約2,500億円	※3 約1,600億円
工期	工事開始 1993年 操業開始 2008年（予定）	操業開始時期 2012年（予定）	工事開始 1992年 貯蔵開始 1995年	工事開始 1988年 操業開始 1992年	工事開始 1990年 埋設開始 1992年

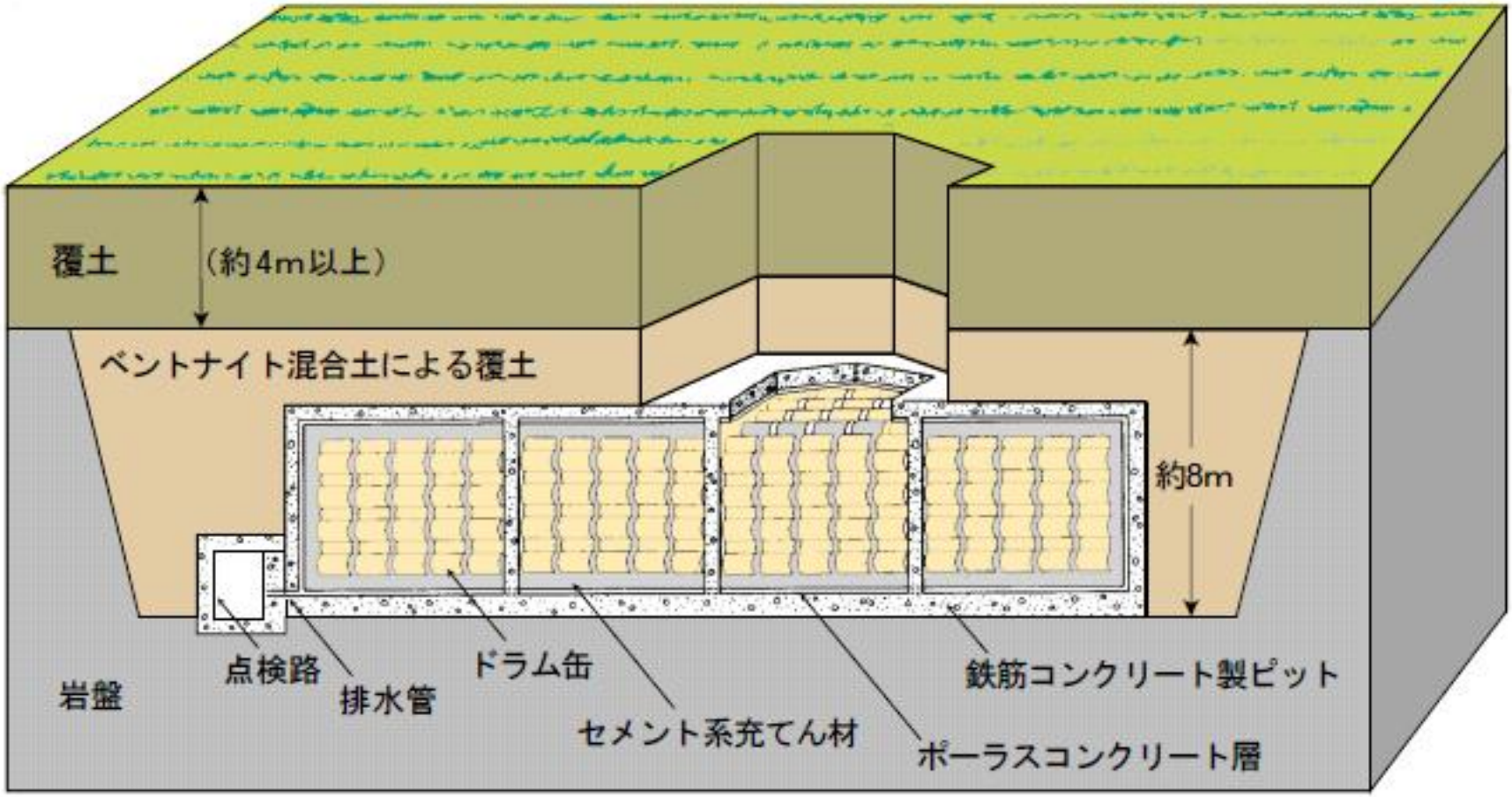
※1 HM:MOX中のプルトニウムとウランの金属成分の重量、SWU:ウランを濃縮する際に必要となる仕事量の単位
※2 高レベル放射性廃棄物（ガラス固化体）1,440本分の建設費
※3 低レベル放射性廃棄物20万立方メートル（200ℓドラム缶約100万本相当）分の建設費

出典：日本原燃ホームページ　他

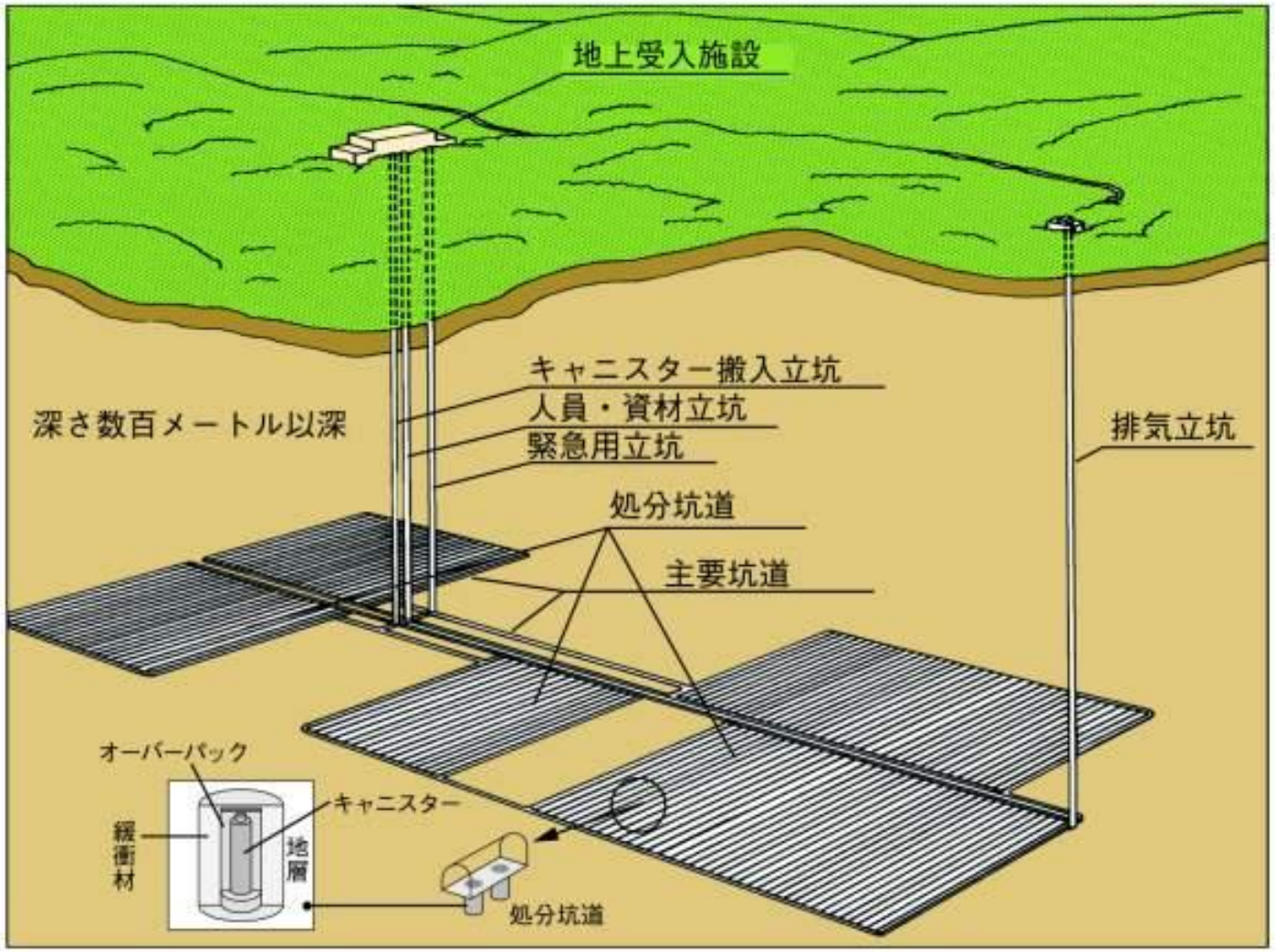
4 Processing and Disposal of Radioactive Waste

- **LLW**
  - LLW Disposal Center started at Rokkasho.
    - 200,000m³(current)→finally 600,000m³
- **HLW**
  - Acceptance of resident of HLW disposal site is dominant issue.

Conceptual Diagram of LLW Disposal



Conceptual Diagram of HLW Disposal



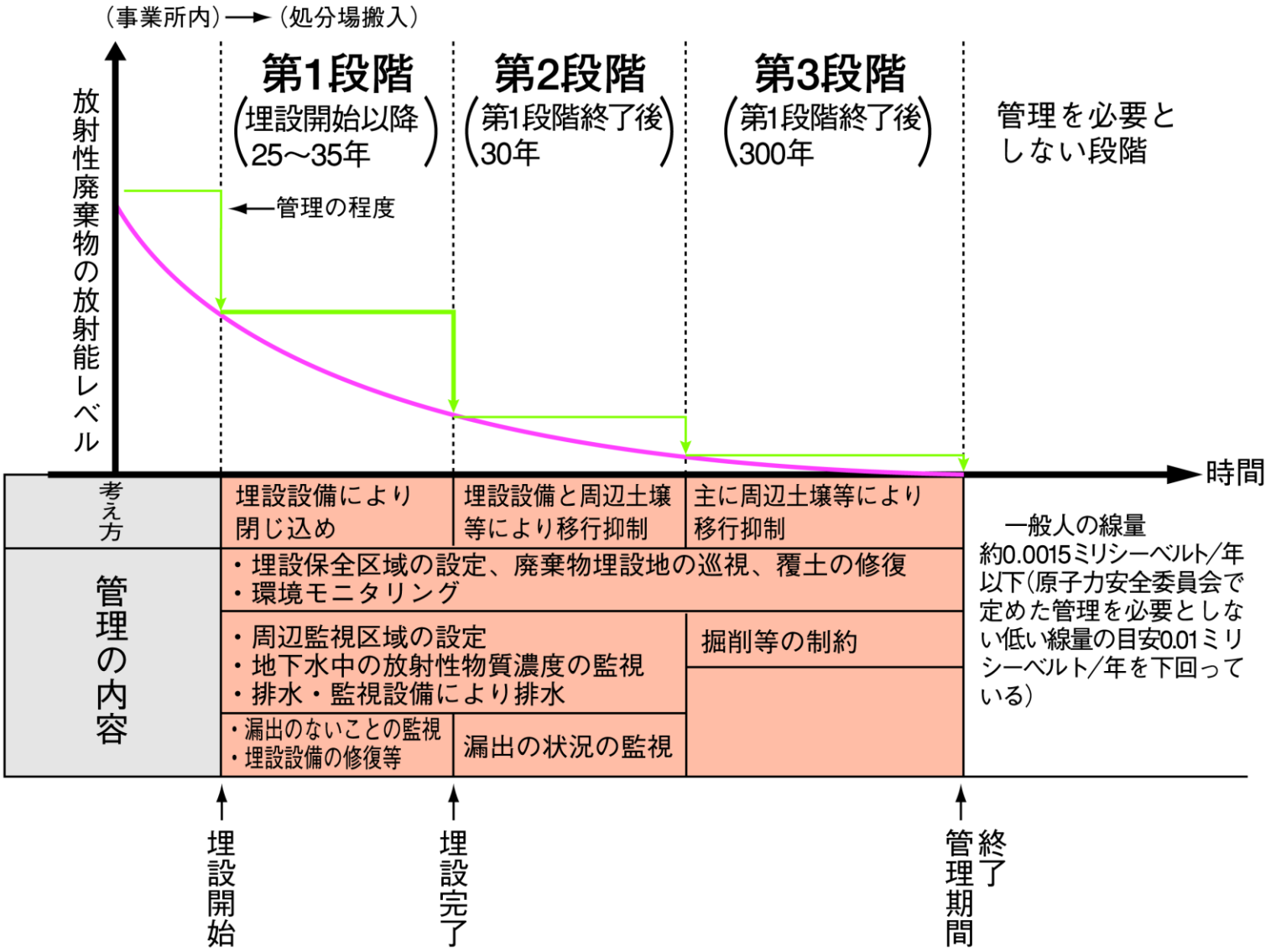
出典：資源エネルギー庁「原子力2004」

5 Conclusion

- Nuclear option is best solution for energy resource issue and mitigation of global warming.
- Renaissance will continue from this point of view.
- For Japan, increase of dependency on domestic energy is important and nuclear will play dominant roll on this issue.

from senior's understanding

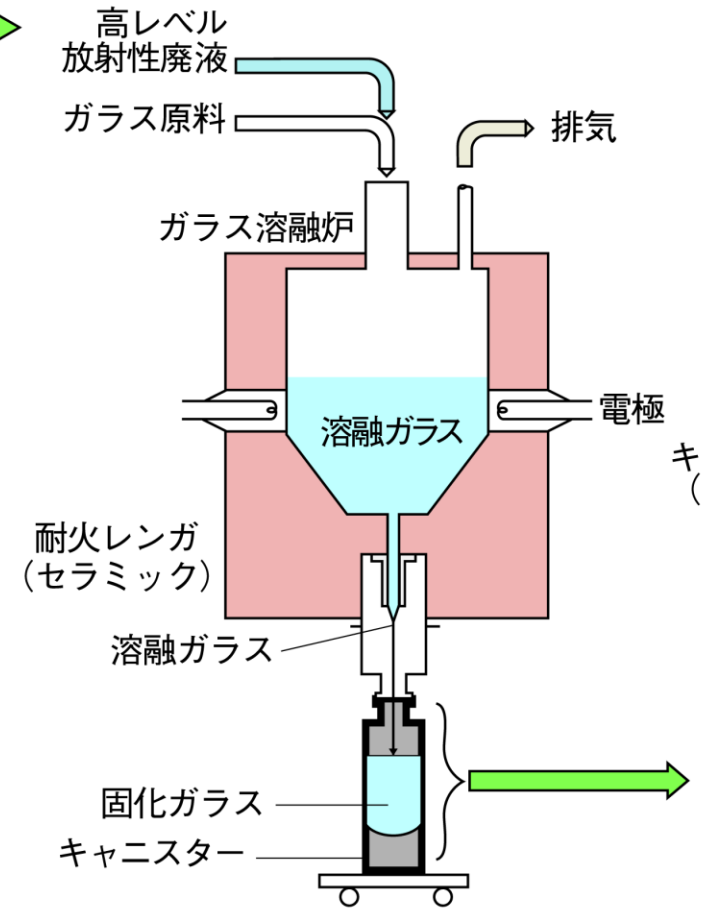
低レベル放射性廃棄物の段階管理の考え方



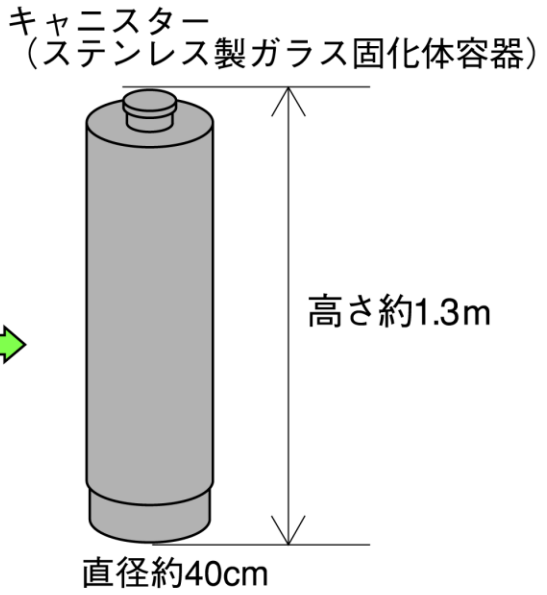
出典：日本原燃パンフレット　他

高レベル放射性廃棄物（ガラス固化体）ができるまで

再処理工場



ガラス固化体仕様
体積：約150リットル
重さ：約500kg



出典：高レベル放射性廃棄物処分懇談会報告書

高レベル放射性廃棄物の地層処分の概念

高レベル放射性廃棄物が、将来のいかなる時点においても人間とその環境に影響を与えないようにする

廃棄物自体が、直接人間に影響を与えないように、人間との距離を将来とも保つ

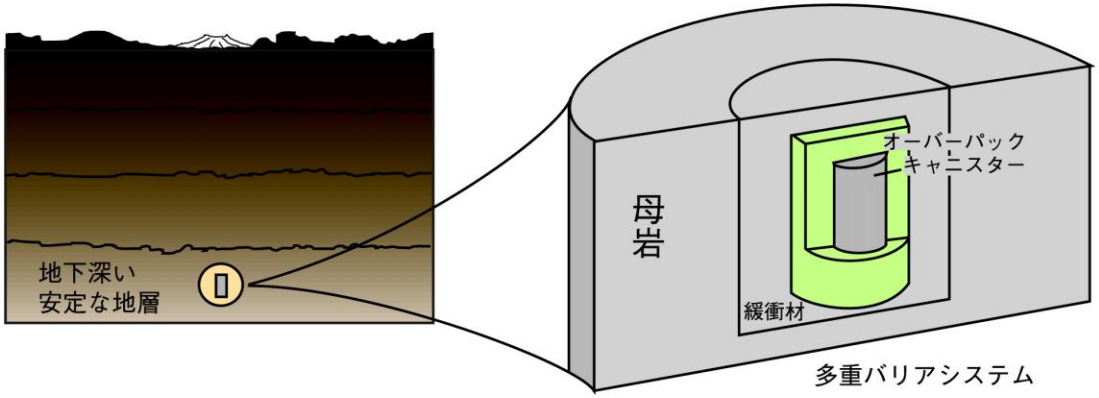
適切な条件を持つ地層(「安定な地層」)を埋設場所とする

- 地殻変動等の影響が小さい
- 地下資源の存在可能性が低い
- 適切な埋設深度が確保できる

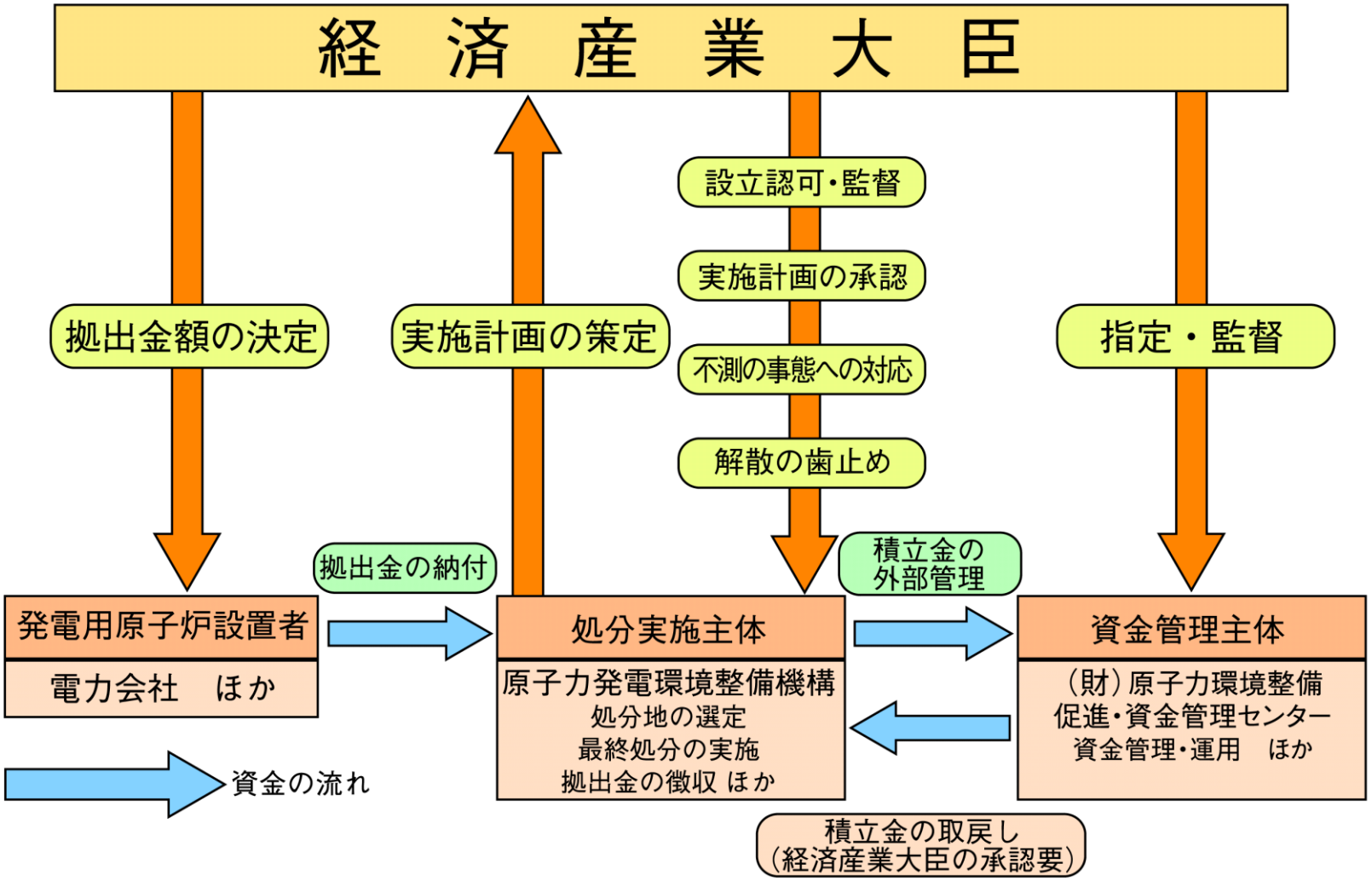
廃棄物中の核種が地下水に溶け出ることを想定しても、人間とその環境に影響を与えないようにする

「多重バリアシステム」を構築する

- 廃棄物と地下水が触れにくい
- 触れたとしても核種が溶けにくい
- 溶けたとしても埋設場所から移動しにくい
- 移動したとしても、人間とその環境に影響を与えない

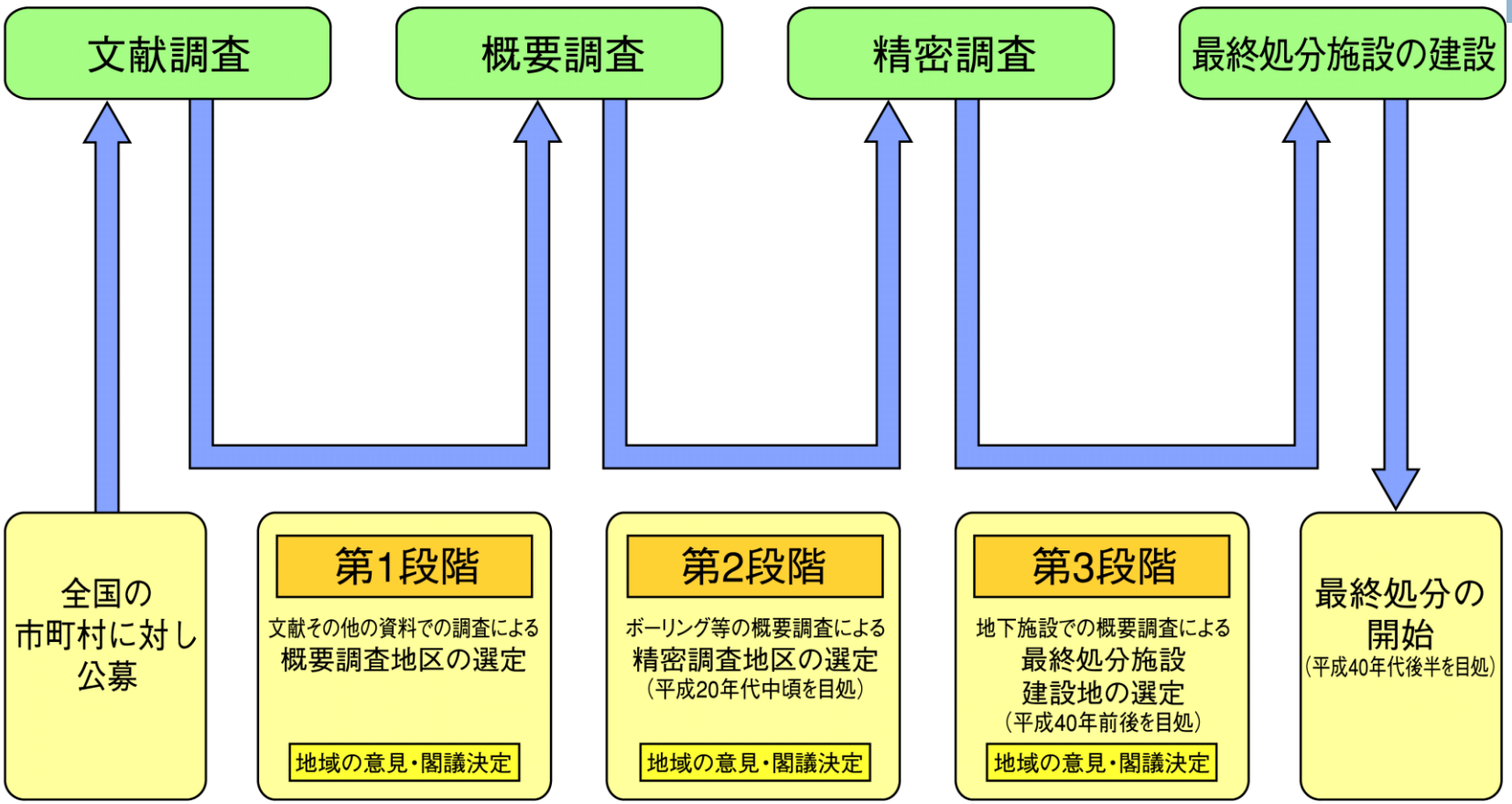


高レベル放射性廃棄物処分の取り組み体制



出典：放射性廃棄物小委員会資料　他

高レベル放射性廃棄物の処分地選定プロセス



出典：放射性廃棄物小委員会資料　他

世界の高レベル放射性廃棄物処分計画

国　名	使用済燃料取扱	軽水炉プルトニウム利用	廃棄物処分実施主体	廃棄物処分形態	処分量	処分地候補及び岩種	処分深度	処分開始予定時期	備　考
フランス	再処理	推進中	放射性廃棄物管理機構（ANDRA）	未定	未定	未定	400～1,000m	未定	処分形態について、地層処分、分離変換技術、長期貯蔵について、研究実施中
日　本	再処理	少量の使用実績あり	原子力発電環境整備機構（NUMO）	ガラス固化体	未定	未定	300m以深	2030年代～2040年代半ば	
ベルギー	（海外委託）再処理（1991年まで）間接処分	推進中	放射線廃棄物・核物質管理庁（ONDRAF/NIRAS）	ガラス固化体（返還廃棄物）使用済燃料	未定	候補地：選定未着手	220m	2010年	現在、再処理中止
スイス	（海外委託）再処理（2006年まで）間接処分	推進中	放射線廃棄物管理協同組合（NAGRA）（政府・民間共同出資）	ガラス固化体（返還廃棄物）使用済燃料	4,400トン（ウラン換算、内再処理は1,200トン）	候補地：未定 岩種：花崗岩 オパリナス粘土	400～1,000m	2050年	
アメリカ	（国が引き取り）直接処分	実績あり現在は中止	エネルギー省（DOE）	使用済燃料ガラス固化体	70,000トン（ウラン換算）	候補地：ユッカマウンテン 岩種：凝灰岩	200～500m	2017年	
ドイツ	（海外委託）再処理（2005年まで）直接処分	推進中	連邦放射線防衛庁（BfS）	使用済燃料ガラス固化体	24,000m³（廃棄物量、使用済燃料、ガラス固化体等）	候補地：ゴアレーベン 岩種：岩塩ドーム	840～1,200m	2030年	ゴアレーベンを含めサイト選定手続再検討中
フィンランド	直接処分	実績なし	（民間会社）ポシヴァ社	使用済燃料	6,500トン（ウラン換算）	候補地：オルキルナイト 岩種：結晶質岩	500m（基本ケース）	2020年	
スウェーデン	直接処分	実績あり現在は中止	（民間会社）核燃料・廃棄物管理会社（SKB）	使用済燃料	9,300トン（ウラン換算）	候補地：オスカーシャム エストハンマル 岩種：結晶質岩	400～700m	2020年代前半	

出典：原子力ポケットブック2007年版
第13回特定放射性廃棄物処分安全調査会資料等