


# White Paper on Nuclear Energy 2023

## published in June 2024

## Executive summary

Japan Atomic Energy Commission (JAEC)

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# Abbreviations

| | |
|---|---|
| **Ac** | Actinium |
| **AEC** | Atomic Energy Commission |
| **AESJ** | Atomic Energy Society of Japan |
| **ALPS** | Advanced Liquid Processing System |
| **AMG** | Accident Management Guideline |
| **ANRE** | Agency for Natural Resources and Energy |
| **At** | Astatine |
| **BWR** | Boiling Water Reactor |
| **CAO** | Cabinet Office, Japan |
| **Central NEXCO** | Central Nippon Expressway Company Limited |
| **CT** | Computed Tomography |
| **DCA** | Deuterium Critical Assembly |
| **FBR** | Fast Breeder Reactor |
| **FCA** | Fast Critical Assembly |
| **FNCA** | Forum for Nuclear Cooperation in Asia |
| **F-REI** | Fukushima Institute for Research, Education and Innovation |
| **FY** | Fiscal year (from April to March of the following year) |
| **G7** | Group of Seven |
| **GX** | Green Transformation |
| **HTGR** | High Temperature Gas-cooled Reactor |
| **HTR** | Hitachi Training Reactor |
| **HTTR** | HTTR, High Temperature Engineering Test Reactor |
| **IAEA** | International Atomic Energy Agency |
| **ICRP** | International Commission on Radiological Protection |
| **JAEC** | Japan Atomic Energy Commission |
| **JAERO** | Japan Atomic Energy Relations Organization |
| **JAIF** | Japan Atomic Industrial Forum, Inc. |
| **JMTR** | Japan Materials Testing Reactor |
| **Joyo** | Sodium-cooled experimental fast reactor "Joyo" |
| **JRR-2** | Japan Research Reactor No.2 |
| **JRR-3** | Japan Research Reactor No.3 |
| **JRR-4** | Japan Research Reactor No.4 |
| **KUCA** | Kyoto University Critical Assembly |
| **KUR** | Kyoto University Research Reactor |
| **METI** | Ministry of Economy, Trade and Industry |
| **MEXT** | Ministry of Education, Culture, Sports, Science and Technology |
| **MHI** | Mitsubishi Heavy Industries, Ltd. |
| **MHLW** | Ministry of Health, Labour and Welfare |
| **Mo** | Molybdenum |
| **MOE** | Ministry of the Environment |
| **MOFA** | Ministry of Foreign Affairs |
| **MOX** | Mixed Oxide |
| **Mutsu** | Nuclear powered ship "Mutsu" |
| **NCA** | Toshiba Nuclear Critical Assembly |
| **NPP** | Nuclear power plant |
| **NPS** | Nuclear power station |
| **NRA** | Nuclear Regulation Authority |
| **NSRR** | Nuclear Safety Research Reactor |
| **NuRO** | Nuclear Reprocessing Organization of Japan |
| **OECD** | Organisation for Economic Co-operation and Development |
| **OECD/NEA** | OECD Nuclear Energy Agency |
| **PCB** | Poly Chlorinated Biphenyl |
| **Pu** | Plutonium |
| **R&D** | Research and development |
| **SF** | Spent fuel |
| **STACY** | Static Experiment Critical Facility |
| **TEPCO** | Tokyo Electric Power Company Holdings, Incorporated |
| **TRACY** | Transient Experiment Critical Facility |
| **TRIGA** | Training, Research, Isotopes, General Atomics |
| **TTR-1** | Toshiba Training Reactor |
| **U.S.** | United States of America |
| **UN** | United Nations |
| **UTR-KINKI** | University Teaching and Research Reactor-KINKI |

# Special Report: Multifaceted issues for the peaceful and safe uses of nuclear and radiation technologies（1/10）

## Background of the special report

○ Discharge of ALPS treated water into the sea surrounding the plant was a hot topic both domestically and internationally.

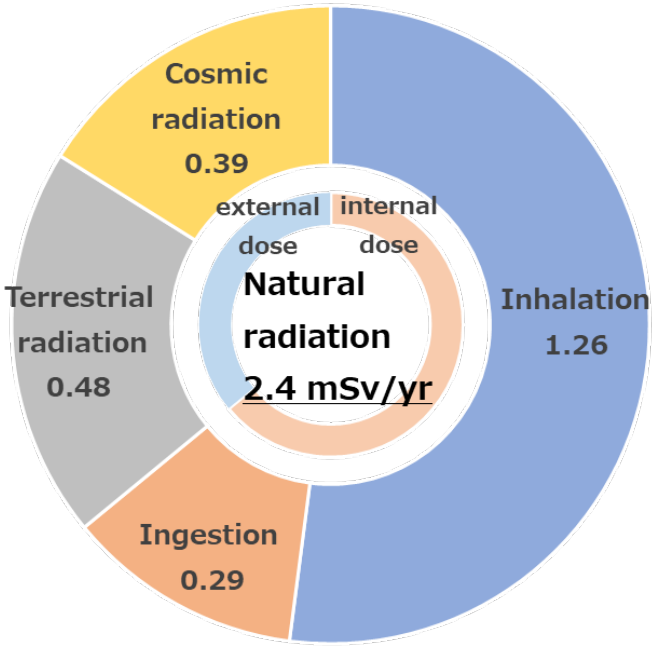
○ One reason may be that various phenomena related to radiation are difficult to understand, and accurate knowledge about radiation has not been sufficiently disseminated among the public, creating some feelings of concern.

○ On the other hand, we are exposed to a certain amount of natural radiation every day in our daily lives.

○ Radiation is also utilized in medicine, industry, agriculture, and other fields, and has become a technology that supports the social infrastructure.

○ In this context, it is necessary to promote the use of radiation, considering not only safety, but also public acceptability, economic efficiency, and other multifaceted aspects.

**Annual dose from natural radiation per capita(global average)**




*Source*: Data from UNSCEAR, UNSCEAR 2008 Report, 2008.

○ To promote future nuclear energy policy, specific topics are raised and discussed under the theme of "Multifaceted issues for the peaceful and safe use of nuclear and radiation technologies”.

○ The results of a survey on risk perceptions of various sources of risk, including nuclear and radiation, is also presented.

## Contents of the special report

**Basic knowledge of radiation**

Dose from natural and artificial radiation, the effects of constant exposure in our daily lives, and the effects of low-dose exposure are provided. In addition, a comparison of exposure doses as related to the following topics is summarized.

**Topic 1 Discharge of ALPS treated water into the sea surrounding the plant**

The purpose and need for the discharge, its scientific evaluations, and the national and international reactions to the discharge are discussed.

**Topic 2 Recycling by the clearance system**

The significance and issues of the clearance system, which allows radioactive waste below a certain level to be disposed of in the same way as conventional industrial waste, etc., are discussed.

**Topic 3 Use of radiation in the food, agricultural and medical fields**

Current status and issues regarding the use of radiation in the medical field, food irradiation, and radiation breeding are discussed.

**Topic 4 Final disposal of radioactive waste**

Methods for disposal of radioactive waste and efforts to ensure its safety are introduced, including examples from overseas, and issues related to the siting of disposal sites are discussed.

**Topic 5 Infrastructure inspection by radiation technology**

Examples of the use of radiation for nondestructive testing of infrastructure and methods of safety management are summarized and discussed.

**Survey on perceptions regarding various sources of risk, including nuclear and radiation**

Based on the results of a questionnaire survey conducted by the Cabinet Office, the public's perception of radiation risks related to the above topics are compared with risks from other factors and discussed.

**Message from the Commission**

A message on the importance of a multifaceted assessment, including risks and benefits, regarding the use of nuclear and radiation technologies, and on the importance of continued efforts by the government to gain public confidence.

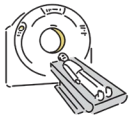
# Special Report: Multifaceted issues for the peaceful and safe uses of nuclear and radiation technologies (3/10)

## Basic knowledge of radiation

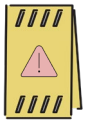
**"Radiation in our daily life"**

**<Artificial radiation>**

Reference level for the public in emergency exposure situations in ICRP recommendation: 20～100mSv/yr



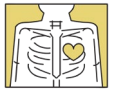
CT Scan : 2.4～12mSv [1]



**Dose limit at the boundaries of radiation controlled areas for X-ray inspection: 1.3mSv/3months** [J]

Topic 5

Dose limit in public exposure in ICRP recommendation: 1mSv/yr



Chest X-ray : 0.06mSv [2]

**Dose exposure limit for residents in the vicinity of low-level radioactive waste (excluding those subject to mid-depth underground disposal) after the management period: 0.01mSv/yr** <J>

Topic 4

**Dose limit of the "Clearance" system: 0.01mSv/yr** <J>

Topic 2

**Maximum exposure dose during safety assessment model cases* at final disposal sites : 0.002mSv/yr** (estimated by NUMO) [3]

Topic 4


* In the case of geological disposal of high-level radioactive waste, etc., all metal containers encasing 40,000 pieces of vitrified waste are assumed to simultaneously lose their confinement function after 1,000 years and the radioactive materials will leave the vitrified waste.

**Public Exposure to ALPS Treated Water : 0.002～0.03μSv/yr** (estimated by TEPCO) [4]

Topic 1

**<Natural background radiation>**

Risk of cancer has been shown to gradually increase with dose

100mSv

10mSv

1mSv

0.1mSv

0.01mSv

0.001mSv(1μSv)

0.0001mSv(0.1μSv)

0.00001mSv(0.01μSv)

**Natural radiation** (global average): **2.4mSv/yr** [1]

**Natural radiation** (in Japan): **2.1mSv/yr** [1]

From breathing: 1.26mSv/yr [1]

Terrestrial radiation: 0.48mSv/yr [1]

Cosmic radiation: 0.39mSv/yr [1]

From food, drinking water, etc.: 0.29mSv/yr [1]

**No measurable radioactivity is induced in foods treated with ionizing radiation at internationally approved energy levels.** [5]

Topic3

*Note:*
<J> Regulations specific to Japan

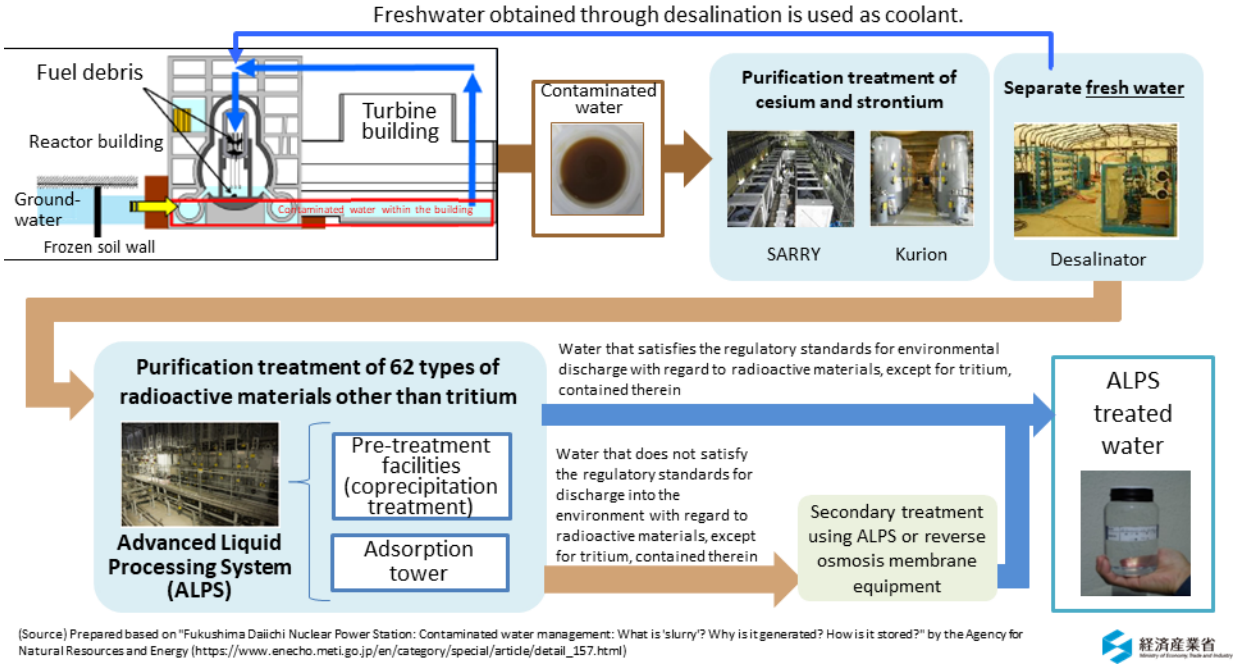
*Source:* Data from

[1] UNSCEAR, UNSCEAR 2008 Report, 2008.
[2] QST, website, 2018.
[3] NUMO, Interactive national information meeting reference materials, 2024.
[4] TEPCO, Results of reassessment of radiation environmental impact assessment (construction phase) by re-establishing the review of radionuclides to be measured and assessed, 2023.
[5] WHO, Safety and nutritional adequacy of irradiated food, 1994.

## Topic 1: Discharge of ALPS treated water into the sea surrounding the plant

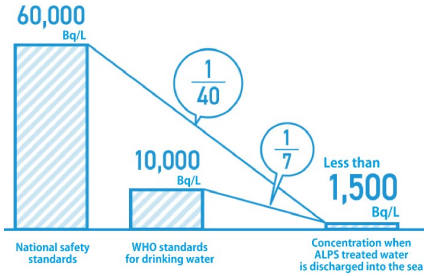
- ○ The government and TEPCO have worked together to disseminate objective and highly transparent information and have consistently communicated with stakeholders. As a result, safety of ALPS treated water has gained acceptance in public.
- ○ Efforts to ensure objectivity and transparency in the dissemination of information, including assessments by third-parties such as IAEA, are important.
- ○ The government and TEPCO need to continue in their persistent efforts to sincerely respond to the concerns of the public.

### Flow of the purification of contaminated water




*Source*: MOE, BOOKLET to Provide Basic Information Regarding Health Effects of Radiation, 2024.

### Comparison of tritium concentrations




*Source:* METI website, Five facts you should know.

### Opinion on ALPS treated water to be discharged into the sea

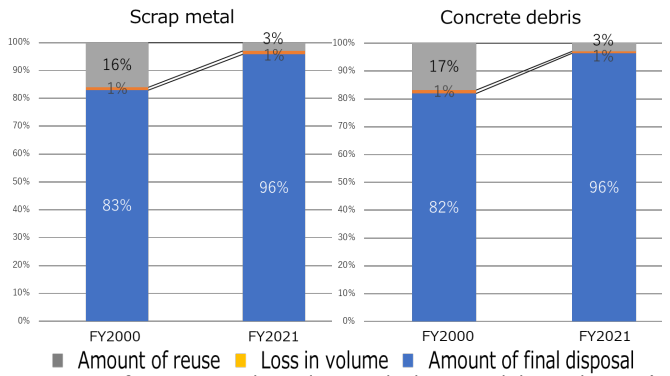
| Response options(partially extracted) | | Percentage of respondents |
|---|---|---|
| Discharge of treated water into the sea surrounding the plant | It's not problem | 35.3 |
| | It's problem | 18.4 |
| Purchase of marine products from Fukushima and other prefectures | Not particularly concerned | 46.3 |
| | Hesitant | 8.4 |
| Measures to prevent harmful rumors | They need to be strengthened | 44.8 |
| | They are good enough as it is | 3.2 |
| Disseminating information domestically and internationally | Need to be sent out | 49.8 |
| | Does not need to be sent out | 2.9 |

*Source*: Data from JAERO, Public opinion poll on nuclear energy(FY2023) Summary, 2024.

## Topic 2: Recycling by the clearance system

- Minimizing the amount of radioactive waste is an important issue for the safe and smooth decommissioning of nuclear facilities. It is necessary to utilize the clearance system to address this issue.
- Materials and wastes identified as less than 0.01 mSv are exempted by the clearance system from regulatory control. This is significantly lower than a dose from natural radiation.
- Most conventional industrial waste is reused. Conversely, the majority of recycled products from the clearance system are only reused in nuclear facilities.
- In consideration of the fact that recycled products from the clearance system will be widely supplied to the general market in the future, finding ways to improve the efficiency of the radioactivity concentration measurement method and expanding the use of recycled products on the basic premise of ensuring safety is important.

**Recycle ratio of the conventional industrial waste (scrap metal, concrete debris)**



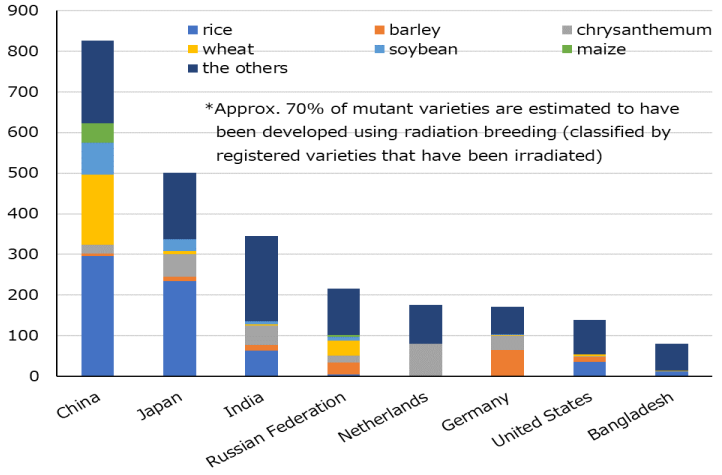

No progress has been made in recycling both scrap metal and concrete debris from nuclear facilities through the clearance system.

*Source*: Data from MOE, Industrial waste discharge and disposal status(FY2021 preliminary results), 2023.

## Topic 3: Use of radiation in the food, agricultural and medical fields

- Food irradiation is used for sterilization and to prevent germination. Irradiated foods are distributed on a commercial scale worldwide, but in Japan, only potatoes are permitted to be irradiated.
- Radiation breeding is a long-used method. In Japan, approximately 18% of areas under rice cultivation contain varieties and lines improved through the use of radiation breeding technique.
- In the medical field, use of radiation has become widespread, including X-ray exams, CT scans, and cancer treatment.
- In contrast to the use of radiation in the medical field, where the benefits to individuals are easily understood, the use of radiation in the food and agricultural field has not advanced in Japan because it is difficult to recognize its personal benefits.

**Number of mutant varieties by country (as of January 2024)**

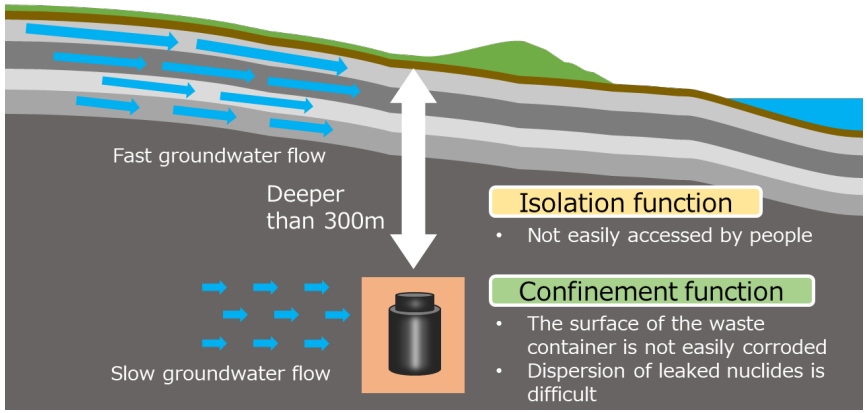



*Source:* Modified from IAEA website, Mutant Variety Database, 2024.

## Topic 4: Final disposal of radioactive waste

- Maximum safety of radioactive waste is ensured by the disposal method. A multiple barrier system is implemented for geological disposal, and detailed studies are being conducted on the function of each barrier. Relevant parties, including the government, actively disseminate information about these studies and hold dialogue-base meetings with local residents.
- The human and environmental impact in the event of a hypothetical radioactive material leak has been evaluated and explained to be within the safety limits.
- Siting of radioactive waste disposal sites is an essential issue. It is necessary for each and every citizen in Japan to address the issue as their own. Carrying out all possible measures and policies to ensure that science-based information on safety, including risk assessments, is widely disseminated is highly recommended.

**Functions of a multiple barrier for geological disposal**




*Source:* Modified from NUMO booklet, Geological disposal safety concept, 2018.

## Topic 5: Infrastructure Inspection by Radiation Technology

- In Japan, social infrastructure such as road bridges constructed during the period of rapid economic growth from the mid-1950s are aging. In response to this trend, inspection of the internal structural integrity of concrete by such as radiographic testing have been conducted.
- When performing inspections using X-rays, people and the environment must be sufficiently protected from the harmful effects of radiation. Protecting the surrounding public and workers from radiation is stipulated by law and regulations.
- Understanding and complying with regulations is crucial for effective radiation protection. Transparent and careful explanation of the regulations and compliance with them will help reassure the public.

**X-ray generator**


*Source:* Modified from Central NEXCO, the Utilization of Radiation for Infrastructure Inspection, the documents for the 7th regular meeting of JAEC, 2023.

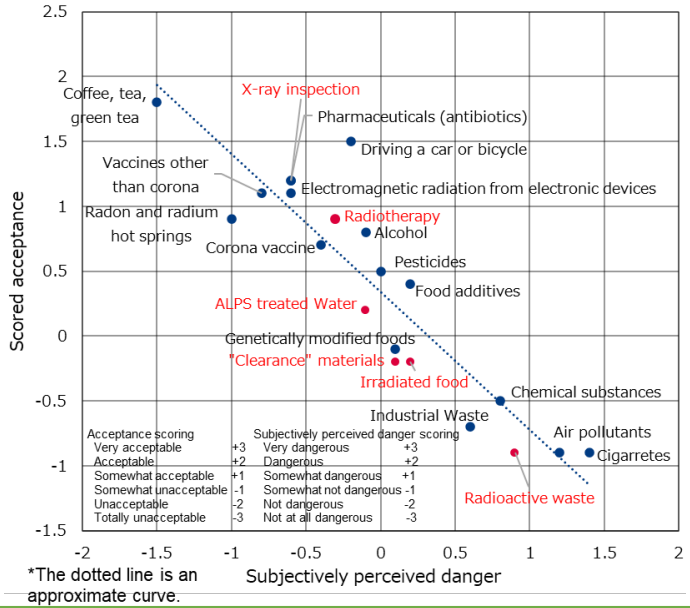
**Regulations for the use of radiation**

| | Protection of the Public | Protection of Workers |
|---|---|---|
| Examples of Standards | Establishment of radiation controlled area boundaries<br>1.3 mSv/3-months at the boundary of the radiation controlled area | Compliance with the radiation dose limits<br>50 mSv/year<br>100 mSv/5-years |

## Survey on perceptions regarding various sources of risk, including nuclear and radiation (1/3)

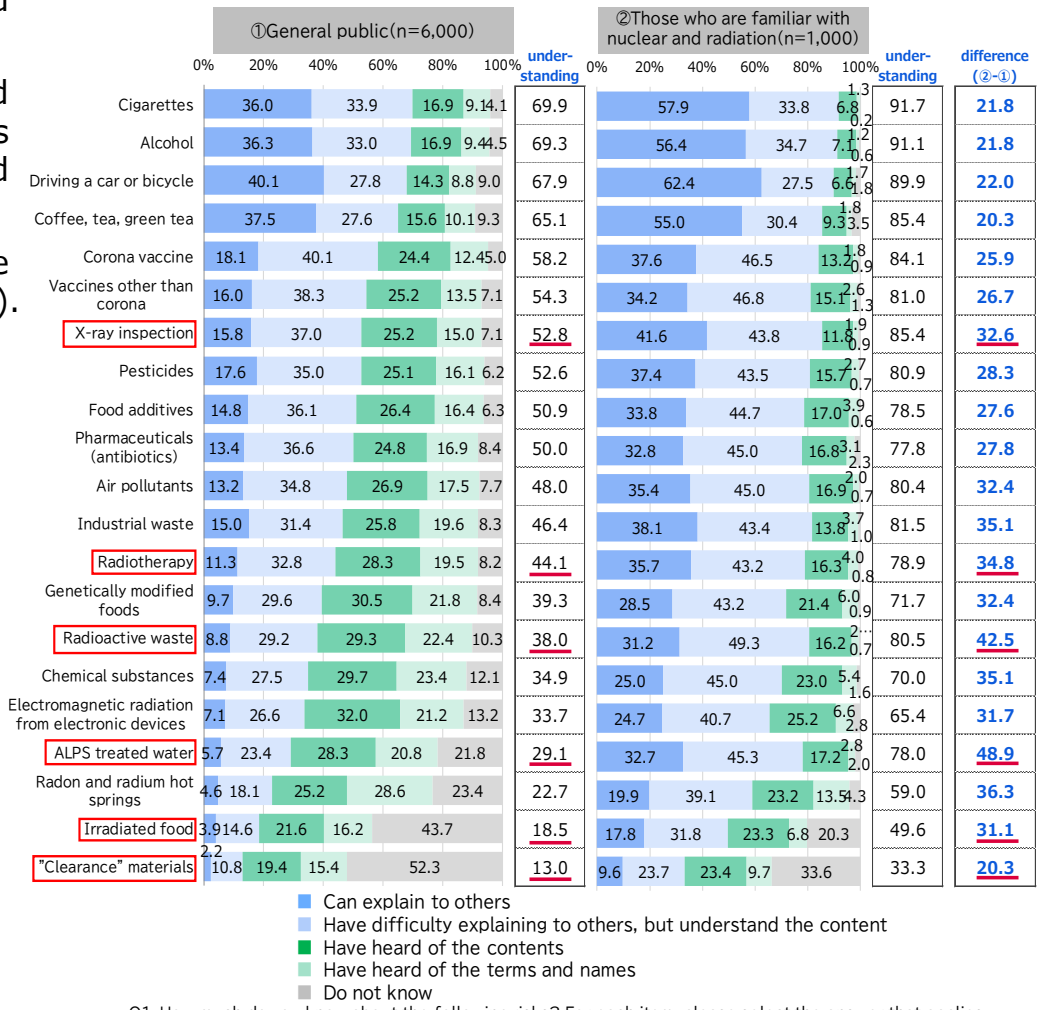
- We conducted a web-based survey of 6,000 persons from the general public and 1,000 people who correctly answered a certain number of nuclear and radiation-related questions (defined as those who are familiar with nuclear and radiation).
- Compared to those who are familiar with nuclear and radiation, the general public tends to have less understanding of items related to nuclear power and radiation (right figure).
- The level of acceptance tends to be low in relation to the degree of subjective perception of danger (lower left figure).

### Relationship between scored acceptance and subjectively perceived danger




*The dotted line is an approximate curve.

### Recognition of each risk item

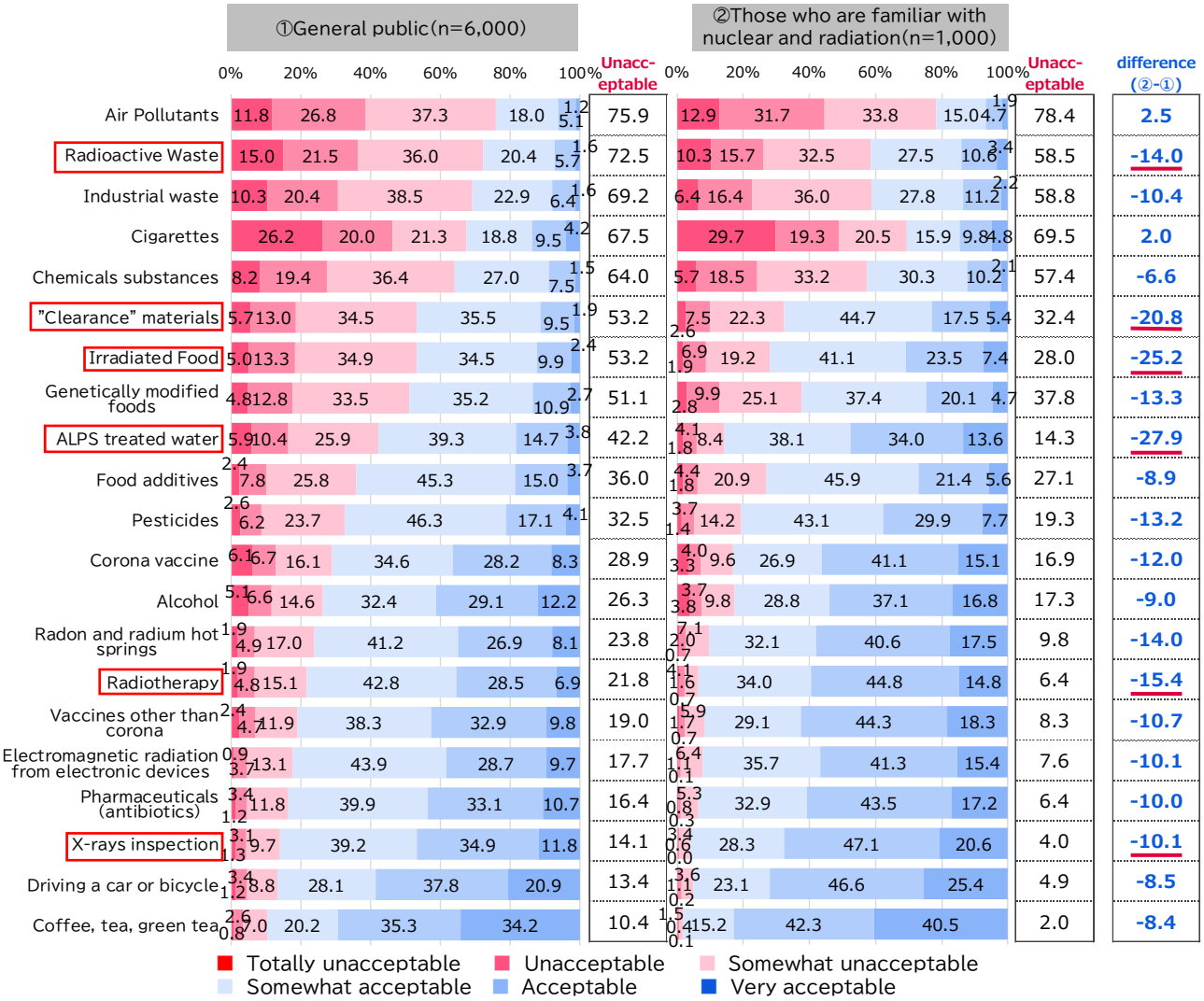



Q1. How much do you know about the following risks? For each item, please select the answer that applies.

## Survey on perceptions regarding various sources of risk, including nuclear and radiation (2/3)

- ○ Generally, the percentage of respondents who consider each risk item "unacceptable" tends to be lower among those familiar with nuclear and radiation.
- ○ Among items related to nuclear and radiation, there tends to be a large difference between the two groups regarding the percentage of respondents who answered "unacceptable."
- ○ Although parties involved in nuclear and radiation, including the government, actively disseminate information and engage in dialogue with local residents, continuing to conduct necessary reviews from the standpoint of the public is considered important.

**Percentage of respondents who consider each risk item "unacceptable"**

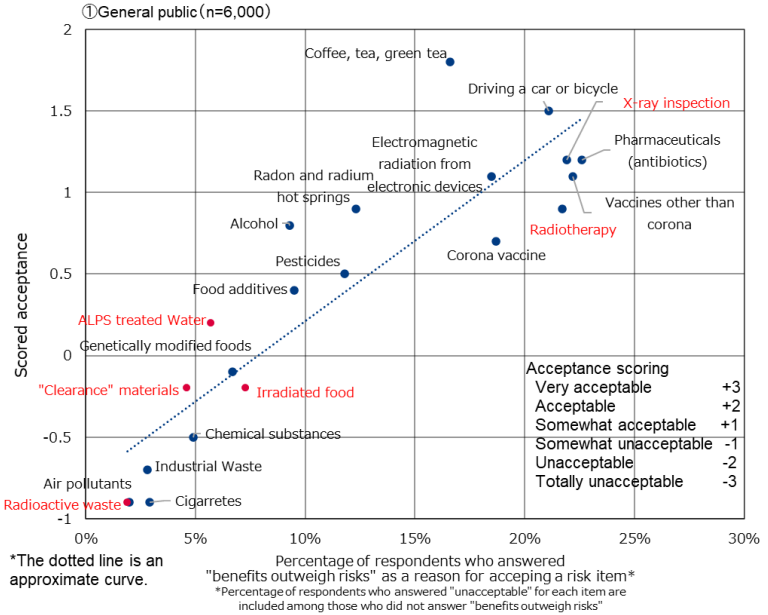



Q5. To what extent do you accept the following in your own life? For each item, please select the answer that best applies. If you don't know the word, please answer with its image.

## Survey on perceptions regarding various sources of risk, including nuclear and radiation (3/3)

- ○ Among reasons for rating each risk item as "acceptable," the main reasons, not only for nuclear/radiation-related items but also for the overall situation, were “if it is small, there is no risk" and “standard values are properly controlled" (lower right figure).
- ○ The percentage of respondents who answered that "benefits outweigh risks" was high for routinely used items such as vaccines and medicines, and acceptance tends to be high for such items (lower left figure).
- ○ On the other hand, while NPPs contribute to the stable supply of electricity, etc., continuous efforts to gain public understanding and trust regarding the social significance of safe disposal of waste and reuse of “clearance” materials and other resources are important.

### Relationship between the percentage of respondents who answered "benefits outweigh risks" as a reason for accepting a risk item and the level of acceptance




### Reasons why each risk item is "acceptable"

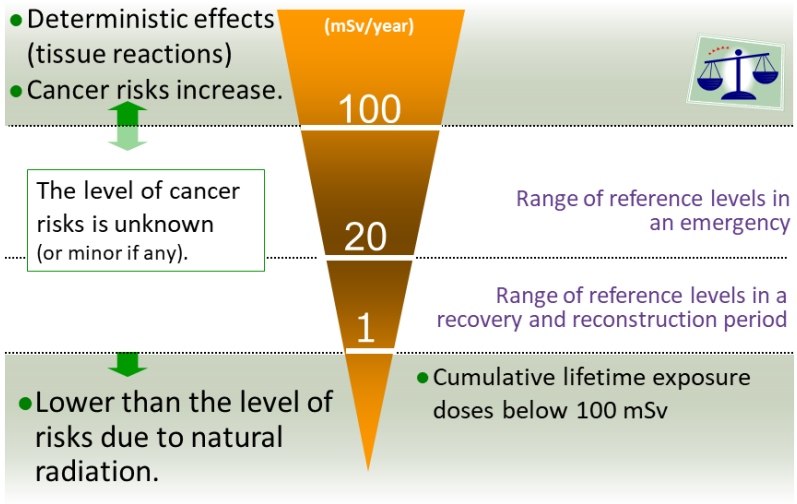
※Based on respondents who answered "Acceptable" (TOP 3) for each item.
1st
2nd
3rd

| | ①General public(n=6,000) n= | Standard values are appropriate | Standard values are properly controlled | Can trust the information from the government | If it is small, there is no risk | I can control it by myself | I am well aware of the risks | Benefits outweigh risks | Other | ②Those who are familiar with nuclear and radiation(n=1,000) n= | Standard values are appropriate | Standard values are properly controlled | Can trust the information from the government | If it is small, there is no risk | I can control it by myself | I am well aware of the risks | Benefits outweigh risks | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | (%) | | | | | | | | | (%) |
| Air Pollutants | 1,450 | 14.8 | 22.8 | 16.6 | 25.4 | 13.4 | 8.3 | 8.1 | 7.2 | 216 | 19.0 | 29.2 | 7.9 | 30.1 | 9.3 | 7.9 | 13.4 | 5.1 |
| Radioactive Waste | 1,657 | 20.5 | 31.6 | 18.3 | 22.9 | 10.7 | 7.4 | 7.0 | 5.4 | 415 | 29.9 | 43.6 | 14.9 | 16.4 | 8.0 | 8.0 | 14.5 | 4.3 |
| Industrial waste | 1,851 | 20.6 | 31.7 | 17.5 | 20.3 | 10.4 | 7.4 | 9.0 | 5.3 | 412 | 25.7 | 41.0 | 12.9 | 16.5 | 7.8 | 9.7 | 13.3 | 5.6 |
| Cigarettes | 1,954 | 9.5 | 12.9 | 10.6 | 22.0 | 35.9 | 17.7 | 9.0 | 4.9 | 305 | 9.2 | 11.1 | 7.2 | 23.6 | 41.3 | 17.7 | 15.1 | 4.6 |
| Chemicals substances | 2,164 | 17.0 | 25.8 | 14.4 | 28.8 | 11.4 | 7.3 | 13.5 | 4.9 | 426 | 20.0 | 32.2 | 9.2 | 31.5 | 11.3 | 8.9 | 21.6 | 4.2 |
| "Clearance" materials | 2,812 | 22.2 | 33.7 | 16.1 | 24.6 | 9.7 | 6.3 | 9.8 | 5.1 | 676 | 28.3 | 38.8 | 16.6 | 24.7 | 7.7 | 5.9 | 18.0 | 4.3 |
| Irradiated Food | 2,808 | 19.7 | 28.4 | 14.1 | 28.8 | 14.8 | 5.8 | 15.6 | 4.5 | 720 | 23.3 | 31.9 | 11.0 | 25.1 | 13.5 | 7.2 | 28.6 | 3.1 |
| Genetically modified foods | 2,929 | 17.1 | 24.5 | 11.9 | 27.3 | 19.3 | 6.8 | 13.8 | 4.7 | 622 | 20.4 | 28.8 | 9.8 | 23.6 | 19.6 | 7.4 | 26.2 | 4.3 |
| ALPS treated water | 3,466 | 24.7 | 38.7 | 19.4 | 21.4 | 6.3 | 6.6 | 9.9 | 4.9 | 857 | 35.4 | 42.1 | 19.6 | 21.7 | 4.3 | 8.3 | 18.6 | 4.4 |
| Food additives | 3,839 | 16.6 | 23.5 | 10.2 | 32.0 | 22.2 | 6.4 | 14.9 | 3.6 | 729 | 21.4 | 29.2 | 10.0 | 31.7 | 20.4 | 8.9 | 27.3 | 2.7 |
| Pesticides | 4,052 | 17.1 | 25.4 | 9.9 | 32.3 | 17.5 | 6.2 | 17.4 | 3.5 | 807 | 22.2 | 29.7 | 8.7 | 31.5 | 20.7 | 8.4 | 27.9 | 2.9 |
| Corona vaccine | 4,270 | 18.5 | 24.0 | 15.2 | 15.0 | 19.2 | 9.1 | 26.3 | 3.0 | 831 | 21.5 | 25.9 | 13.8 | 11.6 | 19.7 | 12.3 | 41.5 | 1.6 |
| Alcohol | 4,418 | 11.3 | 11.1 | 6.3 | 31.2 | 39.5 | 14.1 | 12.6 | 3.3 | 827 | 12.5 | 10.3 | 4.1 | 31.7 | 41.6 | 17.3 | 22.1 | 3.0 |
| Radon and radium hot springs | 4,574 | 15.9 | 18.1 | 8.3 | 27.9 | 22.2 | 6.5 | 16.2 | 6.5 | 902 | 19.0 | 18.5 | 7.2 | 30.8 | 24.4 | 8.5 | 25.7 | 4.2 |
| Radiotherapy | 4,689 | 20.4 | 26.3 | 9.3 | 26.0 | 12.8 | 7.0 | 27.7 | 3.0 | 936 | 23.8 | 30.8 | 8.5 | 24.4 | 13.7 | 10.5 | 40.6 | 2.0 |
| Vaccines other than corona | 4,862 | 19.2 | 23.4 | 14.4 | 16.2 | 18.8 | 8.8 | 27.4 | 3.2 | 917 | 21.3 | 26.0 | 13.3 | 12.3 | 20.2 | 13.0 | 41.9 | 1.6 |
| Electromagnetic radiation from electronic devices | 4,937 | 14.5 | 17.1 | 7.9 | 29.5 | 19.8 | 7.2 | 22.5 | 4.6 | 924 | 18.2 | 19.7 | 6.7 | 30.6 | 19.8 | 10.2 | 34.5 | 2.6 |
| Pharmaceuticals (antibiotics) | 5,018 | 20.0 | 23.8 | 10.6 | 23.9 | 15.6 | 7.4 | 27.0 | 3.0 | 936 | 22.4 | 28.7 | 9.9 | 22.1 | 15.4 | 9.8 | 40.2 | 1.3 |
| X-rays inspection | 5,156 | 20.6 | 24.6 | 9.9 | 32.5 | 11.5 | 7.2 | 25.4 | 2.8 | 960 | 24.8 | 29.5 | 8.1 | 29.5 | 12.0 | 9.6 | 40.8 | 1.7 |
| Driving a car or bicycle | 5,200 | 20.4 | 16.2 | 6.3 | 12.5 | 29.7 | 14.3 | 24.3 | 4.7 | 951 | 20.4 | 17.7 | 5.2 | 7.7 | 31.9 | 18.9 | 37.7 | 3.7 |
| Coffee, tea, green tea | 5,379 | 14.2 | 10.7 | 5.6 | 28.8 | 35.7 | 10.4 | 18.5 | 5.1 | 980 | 16.6 | 11.0 | 4.3 | 25.9 | 36.6 | 15.0 | 28.8 | 5.2 |

Q6. Please select all applicable reasons why you answered (very/somewhat) ”acceptable” for the following items in the previous question. [Multiple answers].

## Importance of multifaceted evaluation on the use of radiation

**Relation between exposure doses and health risks**




Source: Prepared based on the 2007 Recommendations of the ICRP

*Source*: MOE, BOOKLET to Provide Basic Information Regarding Health Effects of Radiation, 2024.

**Fundamental Principles of Radiological Protection**
(ICRP recommendation)
① Justification*
② Optimization of Protection
③ Application of dose limits.
*Any decision that alters the radiation exposure situation should do more good than harm.

## Message from the Commission

① When parties involved in the use of nuclear energy and radiation, including the government, consider the use of radiation, evaluating the risks and benefits to society as a whole, both scientifically and in a multifaceted manner that includes comparisons with alternative means, and then sharing the results of these evaluations with the public, is essential.

② When sharing information, the parties must avoid conveying only what they themselves wish to convey. The parties must consistently strive to gain public confidence by providing accurate information based on fairness and objectivity, and by engaging in sincere two-way dialogue with the public.

③ It is important for us to present radiation with a scientific basis, e.g. referring to natural radiation doses, and to utilize radiation safely.

## 1. Efforts toward the reconstruction and revitalization of Fukushima

- Evacuation orders for all the “Specified Reconstruction and Revitalization Bases Areas” were lifted in November 2023.
- The "Reconstruction and Revitalization Plan for the Specified Living Areas for Returnees" for towns of Okuma, Futaba, Namie and Tomioka was approved by the government in April 2024. Initiatives to lift the evacuation order, such as decontamination and infrastructure development, will be implemented.
- Fukushima International Research and Education Institute (F-REI) was established in April 2023, and research began. In January 2024, the Reconstruction Agency determined the basic facility plan.

## 2. Continuous efforts to improve safety and emergency response for nuclear disasters

- The Atomic Energy Association developed the "Guidelines to revise the AMG, etc. on Hydrogen Protection Measures For BWR Buildings" in FY2023.
- A comprehensive nuclear emergency response exercise was conducted at the Kashiwazaki-Kariwa Nuclear Power Station in October 2023.

**R&D area of F-REI**

**Robotics**

Drones work in natural disaster occasion

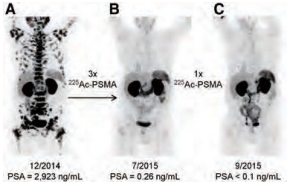
**Agriculture, Forestry and Fisheries**

Agricultural machinery control systems that move and operate autonomously across multiple agricultural fields

**Energy**

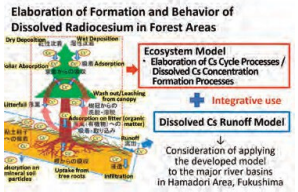

Production of plants with added functions, such as early growth and large-scale carbon absorption (BECCS)

**Radioactive Science, Medicine Development & Applications for Radiation**




Elimination of prostate cancer with alpha emitting radionuclides

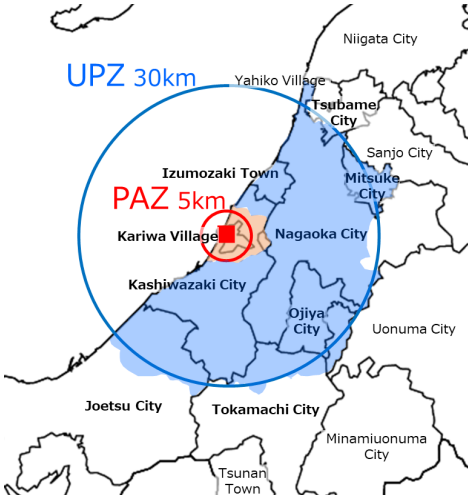
**Collection and dissemination of Data and Knowledge on Nuclear Disasters**




Development, Elaboration and Advancement of Environmental Dynamic Models Courtesy: NDS

*Source*: Modified from Cabinet Office, the F-REI Brochure, 2023.

**Emergency preparedness priority zone in the Kashiwazaki-Kariwa area**




*Source*: Modified from Cabinet Office, the overviews of the comprehensive nuclear emergency response exercise in 2023

# Chapter 2: Use of nuclear energy for stable energy supply and carbon neutrality

## 1. Direction of future energy supply

- Based on the "Basic Policy toward Realization of GX" approved by the Cabinet in February 2023, the GX Decarbonized Electricity Act was enacted in May of the same year.
- In April 2023, "Future Nuclear Energy Policy Direction and Action Guidelines" was decided at Ministerial Meeting on Nuclear Energy in accordance with the "Basic Policy for Nuclear Energy" which was revised by the Atomic Energy Commission in February 2023, and the "Basic Policy for the Realization of GX."

## 2. Status of nuclear power generation

- Takahama Power Station Unit 1 and 2 resumed commercial operation in 2023.
- 5 units (Shimane-2, Kashiwazaki-Kariwa-6 and 7, Onagawa-2, and Tokai-2) have received permission for the modification of the installation based on the new regulatory standards, but have not yet been restarted.

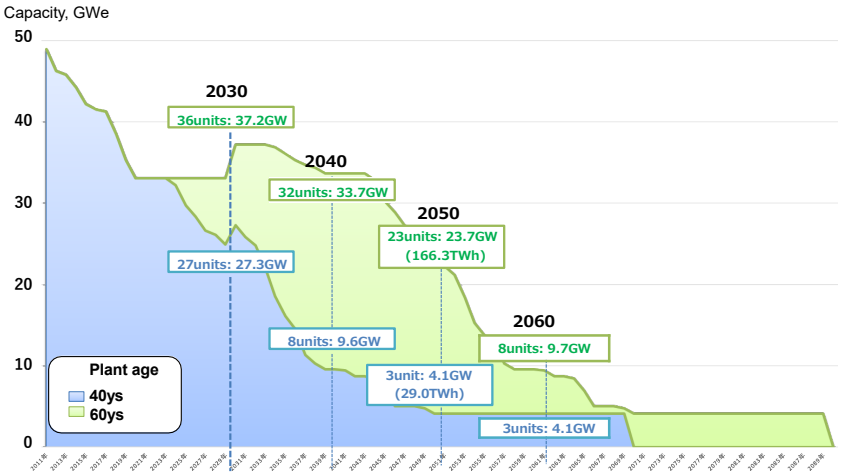
## 3. Spent fuel management

- Many NPPs are approaching the limit of their remaining capacity for SF storage.
- In August 2023, Kaminoseki Town announced its acceptance of a feasibility study for the siting of an off-site SF interim storage facility.

## 4. Coexistence with local communities

- In November 2023, the "Co-Creation Council on the Future Vision for Nuclear Facilities-Hosting Communities and Nuclear Related Organizations in Aomori" was launched.
- The government is providing tailored support to address the specific conditions of each region. This includes the establishment of a framework for developing a vision for the future of the regions where nuclear facilities are located.

**Prospects of the total capacity of NPPs in Japan**




*Source:* Modified from METI/ANRE, 31st Nuclear Energy Subcommittee, Future Considerations on Nuclear Energy Policy, 2022.

## 1. Trends in international organizations and countries leading nuclear power

- In July 2023, the IAEA Comprehensive Report on the Safety Review of ALPS-Treated Water at the Fukushima Daiichi Nuclear Power Station was published and submitted to Prime Minister Kishida by IAEA Director-General Grossi.

  The report concluded that the approach to discharge ALPS treated water into the sea and the associated activities by TEPCO, NRA, and the government of Japan, are consistent with relevant international safety standards, and that discharge of ALPS treated water, as currently planned by TEPCO, will have a negligible radiological impact on people and the environment.

- In December 2023, over 20 countries including Japan launched the "Declaration to Triple Nuclear Energy by 2050" at COP28, based on the key role of nuclear power in achieving carbon neutrality.

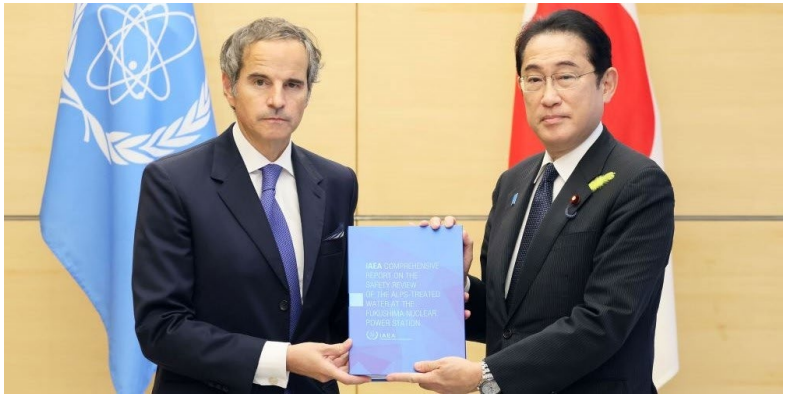
**Declaration to the "Triple Nuclear Energy"**


*Source:* METI/ANRE Website "Nuclear Energy Utilization Attracts Global Attention under the Spotlight at COP28", 2023.

## 2. Engagement in and collaboration with international organizations, and promotion of bilateral and multilateral collaboration

- At the FNCA (Forum for Nuclear Cooperation in Asia) ministerial-level meeting held in October 2022, a joint communiqué was adopted that refers to future collaboration between FNCA and the IAEA in the field of medical applications, promotion of radiation cancer treatment, etc.

**Courtesy Call on Prime Minister Kishida by IAEA Director-General Grossi**



*Source*: MOFA Website, the safety of the discharge of ALPS treated water, 2023.

## 1. The peaceful use of nuclear energy

- The total amount of separated plutonium in Japan's possession is approximately 45.1 tons as of the end of 2022.
- JAEC evaluates the plutonium utilization plans and the mid-term plans for spent fuel reprocessing, formulated by the operators, etc. from the viewpoint of ensuring peaceful use and the plutonium balance.

**Provisional Operation Plans for Rokkasho Reprocessing Plant and MOX Fuel Fabrication Plant**

| fiscal year | FY2024 | FY2025 | FY2026 | FY2027 | FY2028 |
|---|---|---|---|---|---|
| Possible reprocessing quantity, $tU_{pr}$ | 0 | 70 | 170 | 70 | 280 |
| Expected plutonium recovery, $tPu_{total}$ | 0 | 0.6 | 1.4 | 0.6 | 2.3 |
| Possible MOX fuel fabrication quantity, $tPu_{total}$ | 0 | 0 | 0.1 | 1.4 | 1.1 |

Note. $tU_{pr}$: converted mass of metallic uranium before irradiation; $tPu_{total}$: total mass of Pu isotopes

*Source:* Data from the JNFL Website Press release, Provisional Operation Plans for Rokkasho Reprocessing Plant and MOX Fuel Fabrication Plant (Possible Annual Quantities of Reprocessing and Plutonium for MOX Fuel Fabrication), 2024.

## 2. Nuclear Security

- Physical protection, fostering a nuclear security culture, and strengthening nuclear security measures, in accordance with Act on the Regulation of Nuclear Reactors, etc.
- IAEA Nuclear Security Training and Demonstration Centre was inaugurated in October 2023
- The de facto operating ban on the Kashiwazaki-Kariwa NPS was lifted in December 2023 based on the results of a nuclear regulatory inspection by the NRA.

## 3. Maintaining and strengthening the nuclear disarmament and nonproliferation framework

- As the only country which has suffered atomic bombings in a war, Japan has actively engaged in efforts toward nuclear disarmament and non-proliferation based on the Nuclear Non-Proliferation Treaty, such as submission of resolution on the elimination of nuclear weapons to the UN General Assembly, while taking into consideration the peaceful use of nuclear energy, an inalienable right granted to non-nuclear weapon countries.
- The first G7 Leaders' standalone statement document "G7 Leaders' Hiroshima Vision on Nuclear Disarmament" was issued in May 2023.

## 1. Information and Communication Efforts

- The government and nuclear-related organizations have held symposiums on energy policy, etc., and made efforts to disseminate timely information through the Internet.
- Nationwide dialogue-based explanatory meetings are being held regarding final disposal of high-level radioactive waste.
- Several dialogue-meetings were held in Suttsu-cho and Kamoenai-mura, Hokkaido, Japan in FY2023 related to the literature survey on geological disposal of high-level radioactive waste.

**Dialogue with local communities**
Tohoku Electric Power Co.

*Source:* Tohoku Electric Power Co. Website, 2023.

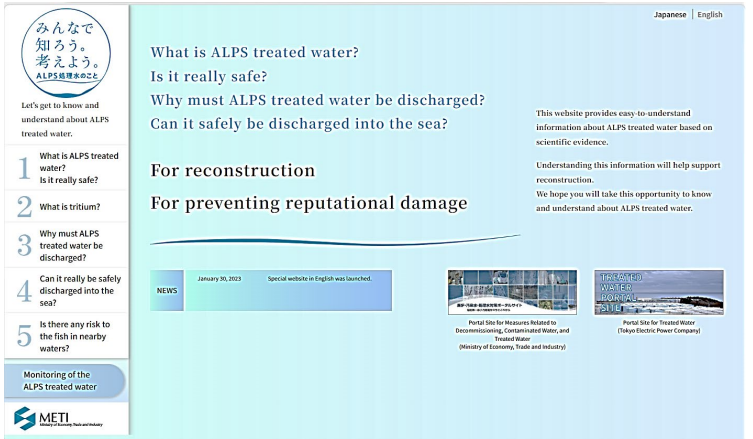
**Education for the next generation**
Chubu Electric Power Co.

*Source:* Tohoku Electric Power Co. Website, 2023.

## 2. Information and communication activities related to the decommissioning of TEPCO Fukushima Daiichi NPPs

- The decommissioning of TEPCO's Fukushima Daiichi NPPs must proceed with the understanding of Fukushima Prefecture and the public. To this end, the operators and METI/ARNE are working to provide accurate information and improve communication.
- The "Package of Information Dissemination and Other Measures to Foster Understanding of ALPS Treated Water: Toward Peace of Mind for Consumers and Understanding by the International Community" (revised in April 2023) was jointly compiled by the relevant ministries and agencies to achieve this goal.
- In December 2022, METI posted a special website on the discharging ALPS treated water into the sea, "Let's get to know and understand about ALPS treated water," which provides information on the ALPS treated water based on scientific evidence in an easy-to-understand format. The website also provides easy access to the monitoring results of ALPS treated water by various organizations.

**Let's get to know and understand about ALPS treated water**

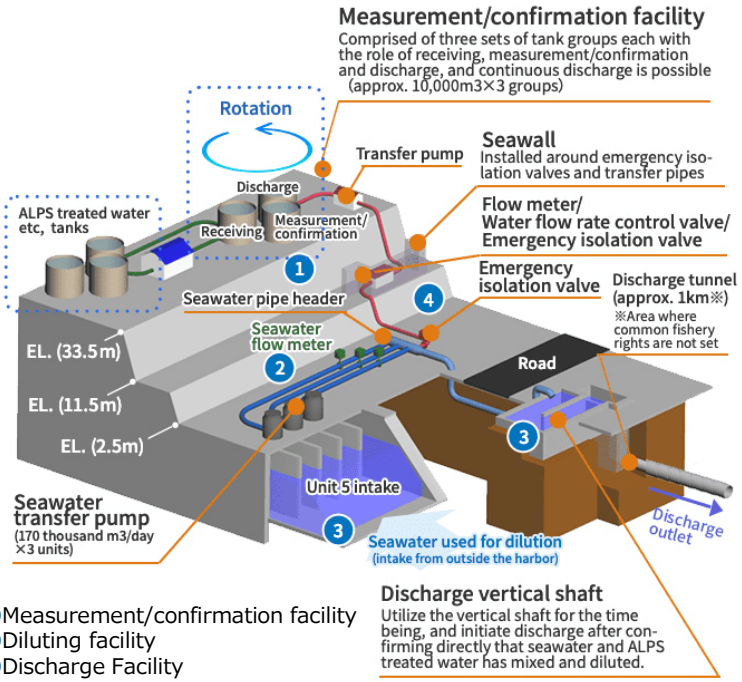



*Source:* METI Website "Let's get to know and understand about ALPS treated water", 2023. <https://www.meti.go.jp/earthquake/nuclear/hairo_osensui/english/shirou_alps/no1/>

## 1. Decommissioning of TEPCO Fukushima Daiichi NPS

- TEPCO has been discharging ALPS treated water into the sea surrounding the plant since August 2023, for a total of approximately 31,145 $m^3$ in four operations as of the end of March 2024. Results of the monitoring surveys up to now are well within the fluctuation range of past tritium concentrations in seawater across Japan.
- In January 2024, the IAEA published a report on the first review mission to Japan after the start of ALPS treated water discharge in October 2023. It stated that the Task Force did not identify any inconsistencies with the requirements by relevant international safety standards.
- Test removal of fuel debris from Unit 2 is expected to start around October 2024 at the latest. Removal of sediment inside containment vessel X-6 Penetration, which is the entrance to the robotic arm, is underway.
- A questionnaire survey was conducted among decommissioning workers. An increasing number of workers were found to consider their work worthwhile. On the other hand, some workers expressed concern about the safety of the work, and TEPCO is further improving the working environment.

**The discharge facility for ALPS treated water**




❶Measurement/confirmation facility
❷Diluting facility
❸Discharge Facility
❹Measures in the event of abnormality

*Source*: TEPCO Treated water portal site, 2024. <https://www.tepco.co.jp/en/decommission/progress/watertreatment/oceanrelease/index-e.html>

## 2. Decommission of nuclear facilities and R&D facilities, and radioactive waste management

- As of March 2023, 18 commercial NPPs and 13 R&D facilities, etc. are in decommissioning stage.
- With revision of the law, the Nuclear Reprocessing and Decommissioning Facilitation Organization of Japan (NuRO) was re-established with additional duties to facilitate the decommissioning of NPPs. A system requiring nuclear power plant operators to pay a "decommissioning contribution" was also established.

# Chapter 7: Promote the utilization of radiation and radioisotopes

## 1. Radiotherapy and radiodiagnosis

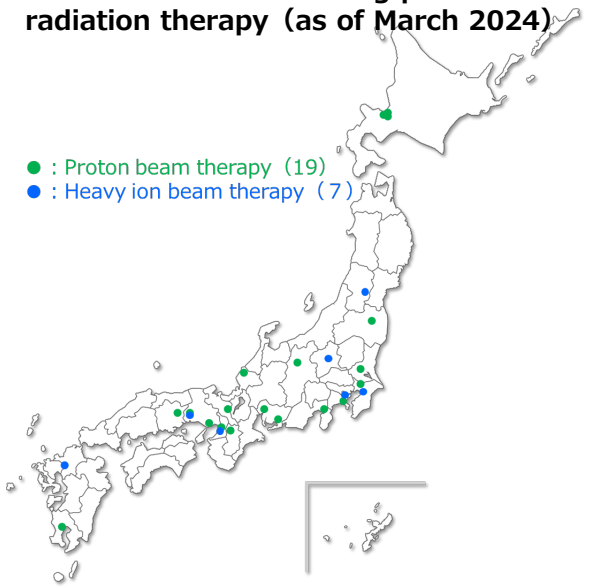
- Follow up the Japan AEC's Action Plan for Promotion of Production and Utilization of Medical Radioisotopes.
- In January 2024, the Order for Enforcement of the Radioisotopes Control Law was enforced to resolve the dual regulation* on some unapproved radiopharmaceuticals.

*the Medical Care Act and the Act on the Regulation of Radioisotopes, etc.

## 2. Use of radiation in other fields

- Radiation is used in various sectors, such as industry and agriculture, as essential technology underpinning society.
- Construction of the NanoTerasu Synchrotron Light Source began in April 2019 and the first beam was achieved in December 2023. The facility is expected to contribute greatly to the creation of new materials and devices and the acceleration of R&D in the fields of catalytic chemistry, life sciences, magnetism and spintronics, and polymer science.

**Medical institutions offering particle beam radiation therapy (as of March 2024)**




*Source:* Modified from MHLW, List of Medical Institutions Providing Advanced Medical Care, 2024.

**Typical follow-up results for the Japan AEC's action plan for promotion of production and utilization of medical radioisotopes (as of June 2023)**

| |
|---|
| **Promote initiatives for domestic production and stable supply of important radioisotopes** |
| • Development of irradiation technology for JRR-3 for Mo-99 production and evaluation of the production cost were started at JAEA.<br>• Preparations for the operation of JOYO are underway at JAEA for the production demonstration of Ac-225.<br>• A pharmaceutical company reported successful production of a commercially viable amount using the accelerator.<br>• AMED has established a new R&D area for the development of treatment utilizing At-211, etc. |
| **Establishment of systems and structures to promote the use of radioisotopes in the medical field** |
| • Development is underway for trailer house type radiation-controlled area beds that contribute to securing treatment beds with alpha radiation. |
| **Promote research and development that contributes to the domestic production of radioisotopes** |
| • JAEA has taken necessary budgetary measures for facility and technology development for Joyo operation and medical RI production.<br>• AMED has compiled a draft guideline for non-clinical studies. |
| **Strengthen research infrastructure, human resources, and networks for radioisotope production and utilization** |
| • Academic goals related to radiation and radioisotopes are reflected in the Model Core Curriculum for Pharmacy Education.<br>• Information was collected through international workshops, etc. |

*Source*: Modified from JAEC, JAEC 23rd Regular Meeting material, 2023.

**NanoTerasu Synchrotron Light Source**

*Source*: Courtesy of QST.

# Chapter 8: Facilitate innovations relevant to nuclear energy utilization

## 1. Promoting research, development and innovation

- JAEA successfully completed the world's first safety demonstration test for HTGR in the event of loss of forced cooling, using the HTTR.
- MHI was selected as the core company for the future manufacture and construction of the HTGR.
- In November 2023, the Japanese and Polish governments signed the Memorandum of Understanding on joint research of HTGR Technology.
- In July 2023, Mitsubishi FBR Systems' "Tank-type Sodium-cooled Fast Reactor" was selected as a proposed fast reactor concept, and MHI was selected as the core company responsible for its conceptual design.
- In October 2023, JAEA, MHI, Mitsubishi FBR Systems, and TerraPower expanded the memorandum of understanding for the development of sodium-cooled fast reactor technologies.
- In April 2023, the Fusion Energy Innovation Strategy was decided by the Integrated Innovation Strategy Promotion Council.

## 2. Strengthening infrastructures for R&D

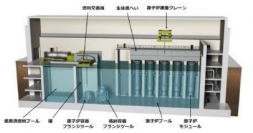
- The number of research reactors and critical assemblies decreased from about 20 at its peak to 8 as of the end of March 2023. Many are in the process of complying with the new regulatory standards.
- JAEA Static Experiment Critical Facility (STACY) is scheduled to resume operation in August 2024, and the experimental fast reactor Joyo is scheduled to resume operation in 2026.

### The next-generation advanced reactors

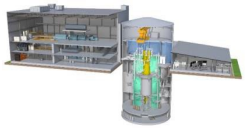
**Advanced LWR**

SRZ-1200, MHI

**SMR** (Small Moduler Reactor)



VOYGR, NuScale



BWRX-300, Hitachi-GE

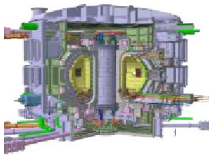
**Fast Reactor**

Joyo,JAEA

**HTGR**


HTTR, JAEA

**Fusion Reactor**



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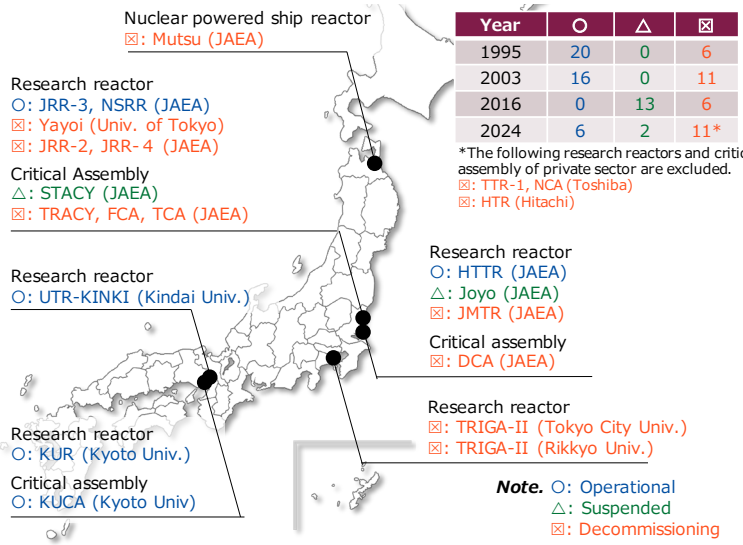
*Source:* : Modified from METI/ANRE, 55th Strategic Policy Committee, 2024.

### Status of research reactors and critical assemblies




| Year | ○ | △ | ☒ |
|---|---|---|---|
| 1995 | 20 | 0 | 6 |
| 2003 | 16 | 0 | 11 |
| 2016 | 0 | 13 | 6 |
| 2024 | 6 | 2 | 11* |

*The following research reactors and critical assembly of private sector are excluded.
☒: TTR-1, NCA (Toshiba)
☒: HTR (Hitachi)

*Source:* Modified from the material provided by MEXT, 2024.

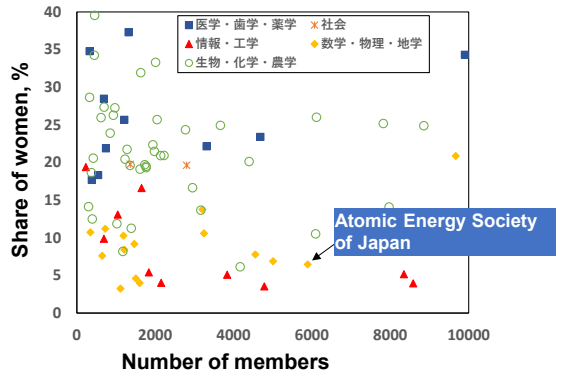
## 1. Human Resource and Supply Chain

- The Nuclear Human Resource Development Network, a collaboration of more than 80 organizations from industry, academia, and government, planned and implemented the establishment of relationships with domestic and foreign organizations and the development of human resources.
- The "Nuclear Energy Open Campus" for high school students was jointly held by MEXT and the Atomic Energy Research Institute of Kindai University, providing the students with an opportunity to learn and explore career options.
- As part of next-generation education, MEXT has prepared supplementary reading books on radiation for elementary school students and junior and senior high school students. In addition, the AESJ has conducted surveys and made recommendations on the explanation of the use of radiation, energy resources, and nuclear energy in textbooks.
- METI established the Nuclear Supply Chain Platform in March 2023. The platform, which also has a website, provides information on actual conditions, management support, and various support information for the nuclear industry. In addition, Japanese-affiliated supplier delegations were dispatched to the U.S. and Canada to conduct market research.

## 2. Diversity

- In June 2023, the OECD/NEA published the “Recommendation of the Council on Improving the Gender Balance in the Nuclear Sector,” recommending actions to attract more women to the nuclear sector and develop more female leaders. The status of the Task Group on Improving the Gender Balance in the Nuclear Sector has also been upgraded.
- IAEA also has the page "Gender at the IAEA" on its website and is implementing programs to support women.

**Share of women in academic societies**

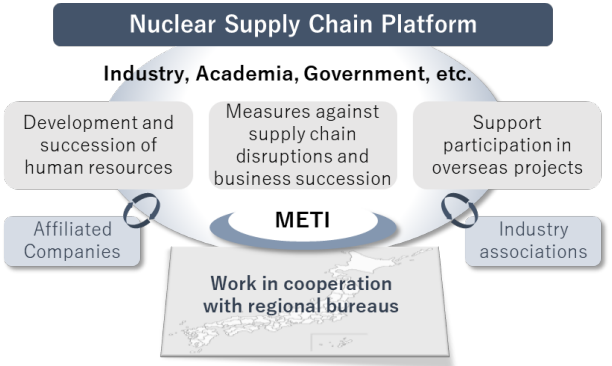



*Source:* Modified from the Japan Inter-Society Liaison Association Committee for Promoting Equal Participation of Men and Women in Science and Engineering, Survey on the ratio of women in academic associations affiliated with the committee, 2023

**Supplementary readers on radiation**


*Source:* MEXT, Supplementary Reader on Radiation, amendment 2022

**Nuclear Supply Chain Platform(NSCP)**




*Source:* Modified from METI/ANRE, 38th Nuclear Energy Subcommittee Advanced Reactor WG, Recent Developments and Future Initiatives Regarding Nuclear Energy Policy, 2024

## Commissioners (as of July 2024)

Chairperson
Dr. UESAKA, Mitsuru

Commissioner
Mr. NAOI, Yosuke

Commissioner
Dr. OKADA, Yukiko

## Website

http://www.aec.go.jp/jicst/NC/eng/index.htm

## Decisions, Statements

**White Paper on Nuclear Energy 2023**, June 2024
http://www.aec.go.jp/jicst/NC/about/hakusho/index_e.htm

**Basic Policy for Nuclear Energy**, February 2023
http://www.aec.go.jp/jicst/NC/about/kettei/kettei230220_5.pdf

**Plutonium Utilization in Japan**, October 2017
http://www.aec.go.jp/jicst/NC/about/kettei/kettei171003_e.pdf

**Basic Policy for Nuclear Research and Development (R&D),** June 2018
http://www.aec.go.jp/jicst/NC/about/kettei/180612_e.pdf