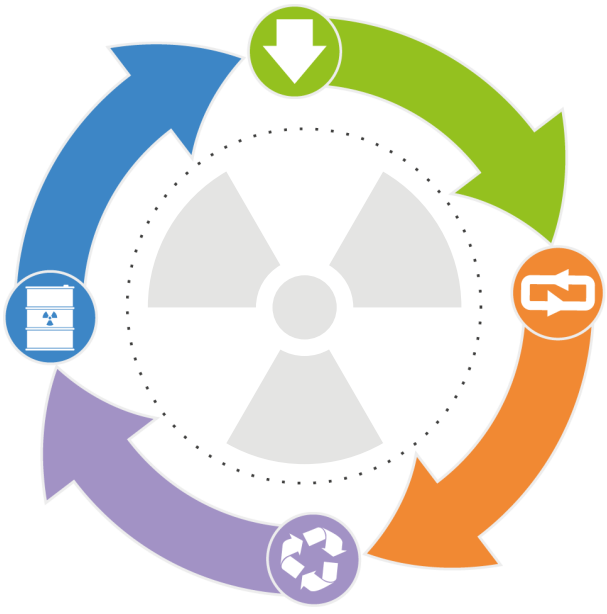
FORATOM
THE VOICE OF THE EUROPEAN NUCLEAR INDUSTRY

APPLYING A CIRCULAR ECONOMY APPROACH TO **RADIOACTIVE WASTE**

NUCLEAR

- IS A LOW-CARBON ENERGY SOURCE
- ENSURES SECURITY OF SUPPLY
- IS ENVIRONMENTALLY, ECONOMICALLY AND SOCIALLY SUSTAINABLE
- ACCOUNTS FOR 26% OF ELECTRICITY
- SUPPORTS AROUND 1Mn JOBS
- TURNOVER OF 100 Bn PER YEAR



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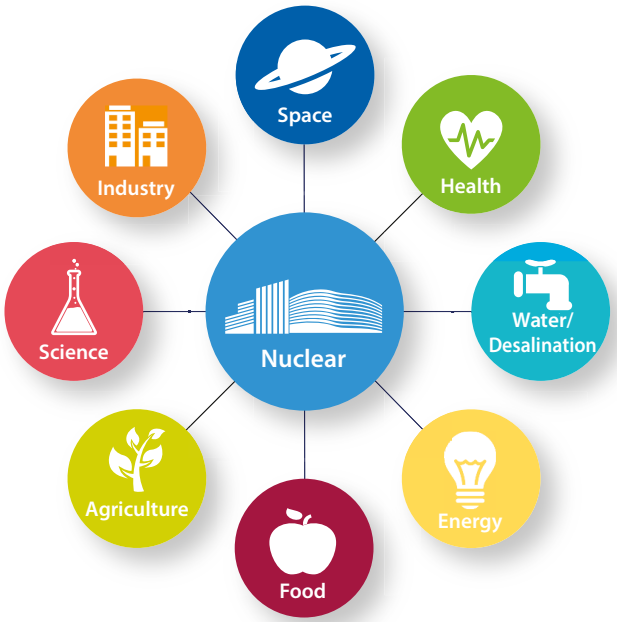
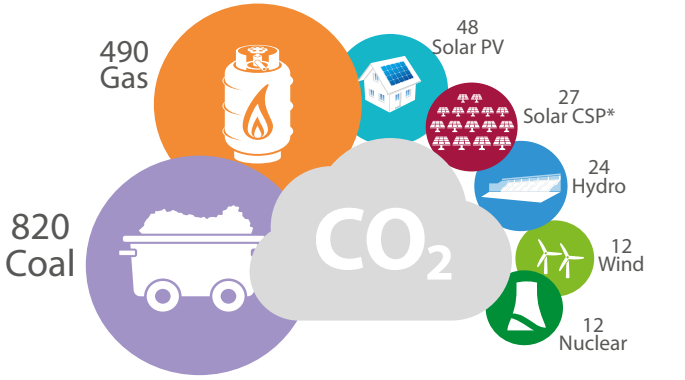
NUCLEAR WASTE IN A NUTSHELL

Nuclear technologies provide many benefits to citizens. These include the supply of low-carbon electricity as well as, for example, medical applications used in the diagnosis and treatment of cancer.

Nuclear: More than just power



Comparison of greenhouse gas emissions (grammes CO2 eq/kWh)



*Concentrated Solar Power

At the same time, like all industries, nuclear generates waste. For example, construction waste such as the steel and concrete used in a nuclear power plant or the radioactive waste which results from reprocessing spent fuel.

Unlike others, the nuclear sector is one of the few industries which takes full responsibility for the handling and traceability of its waste. It also follows the 'polluter pays' principle. As a result, it manages its waste in such a way so as to protect people and the environment.

Waste production, per year (global):

2 billion tonnes - Municipal solid waste

240 million tonnes
Plastic waste

50 million tonnes
E-waste

On average, each year one person generates:

1.36 tonnes of total waste

270 kg
Municipal solid waste

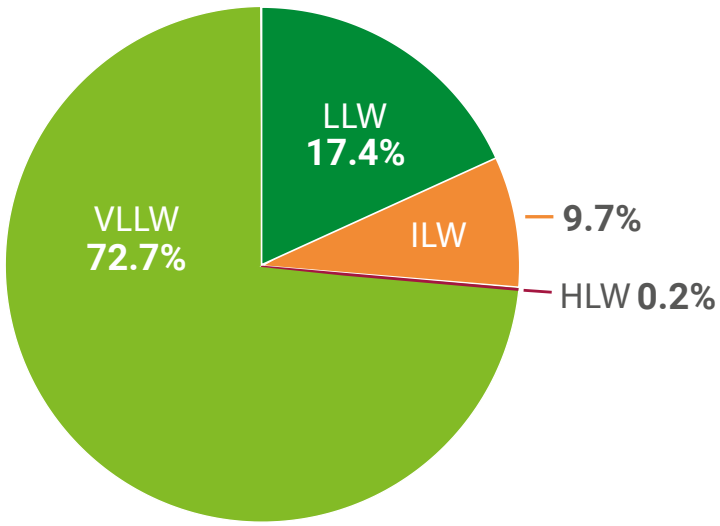
54 kg
Hazardous waste

54 g
Radioactive waste

THERE ARE FOUR CATEGORIES OF RADIOACTIVE WASTE

Category	Description	Examples
Very low-level waste	Waste that does not need a high level of containment and isolation and, therefore, is suitable for disposal in near-surface, landfill-type facilities with limited regulatory control.	These include clothing, paper towels, concrete used in nuclear power plants, research facilities, hospitals etc.
Low level waste	Waste that is above clearance levels, but with limited amounts of long-lived radionucleides (which have a long radioactive life). Such waste requires robust isolation and containment for periods of up to a few hundred years. It is suitable for disposal in engineered near-surface facilities.	
Intermediate level waste	Waste that, because of its content, particularly of long-lived radionucleides, requires a greater degree of containment and isolation than that provided by near surface disposal. However, ILW needs no provision, or only limited provision, for heat dissipation during its storage and disposal.	Waste resulting from historical research activities, instrumentation used close to the core of the reactor
High level waste	Waste with levels of activity concentration high enough to generate significant quantities of heat by the radioactive decay process or waste with large amounts of long-lived radionucleides that need to be considered in the design of a disposal facility for such waste.	Residues remaining from the treatment/recycling of spent fuel

DISTRIBUTION OF RADIOACTIVE WASTE PER CATEGORY, BY VOLUME (2016)

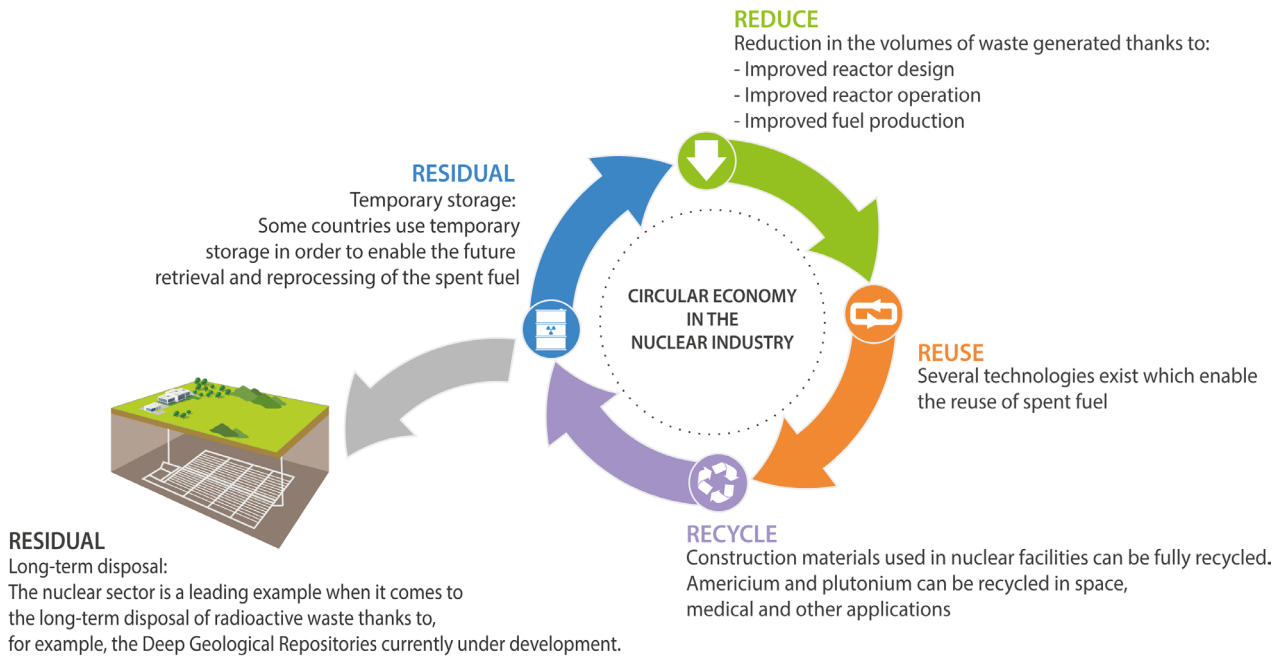


2019, Second Report from the Commission to the Council and the European Parliament on progress of implementation of Council Directive 2011/70/EURATOM and an inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects

SPENT FUEL

Spent fuel is nuclear fuel removed from a reactor following irradiation that is no longer usable in its present form. In the EU each Member State remains free to define its fuel cycle policy. This means that the spent fuel can be regarded either as a valuable resource that may be reprocessed or as radioactive waste that is destined for direct disposal.

APPLYING A CIRCULAR ECONOMY APPROACH TO RADIOACTIVE WASTE



REDUCING THE VOLUMES OF WASTE GENERATED

Several improvements have been implemented in the nuclear lifecycle, leading to a reduction in the volumes of waste generated:

- Newer reactors are designed with decommissioning in mind – this means that it is easier to sort and categorize the waste and thus increases the volumes recycled
- Thanks to improvements in the operation of existing reactors in France, for example, the volume of waste generated has been divided by three compared to 1985
- Making use of fuel reprocessing technologies can help to reduce the amount of waste generated
- Depleted uranium which results from the enrichment process ('uranium tails') can be re-enriched/ reprocessed
- Measuring the materials used in a nuclear facility (such as concrete and steel) to check whether or not they are radioactive or contaminated means that more can be cleared and thus go for recycling
- Technologies also exist to compress the waste and reduce its volume (eg compacting & melting)
- Innovation is currently ongoing into burning spent fuel in order to decrease its radioactive lifespan and toxicity

REUSING THE WASTE WITHIN OUR OWN INDUSTRY

Much of the spent nuclear fuel remains a valuable resource for the nuclear industry. Below are just a few examples

- Separating the uranium and plutonium from the spent fuel enables the production of new fuel
- Some plants reuse the uranium twice
- Metal waste is reused for the packaging of medium-level radioactive waste
- Depleted uranium is used for radiation shielding purposes
- Innovation into 'closing the cycle' is expected to enable the multiple reuse of spent fuel

RECYCLING RADIOACTIVE WASTE IN OTHER APPLICATIONS

The industry implements well developed waste separation technologies. As a result, what might otherwise be considered as a waste can in fact be recycled in many different ways. For example, concrete waste from decommissioned nuclear facilities can be used as a road base. Metal waste from nuclear applications can be recycled for use in the car industry.

In terms of radioactive wastes such as americium and plutonium, these can be used in multiple applications, including:

- as a power source in space applications
- in medical applications such as pacemakers
- in the production of radioisotopes
- in some smoke detectors
- in doping electronic chips

In addition, research is currently ongoing into converting carbon-14 it into a diamond for use in batteries.

RESIDUAL WASTE SOLUTIONS

Of course, like other industries, a very small percentage of the waste generated does become residual waste, particularly high-level waste. But even here, the nuclear sector is a leading example when it comes to handling such waste.

Currently, temporary storage is used for spent fuel. This enables the heat and decay to diminish overtime and, in some countries, such storage will enable the future retrieval and reprocessing of spent fuel.

COVRA processing and storage facility in Borsele, Netherlands

Regarding more long-term solutions, deep geological repository projects are currently under development in several countries.

Research has shown that these repositories do not cause significant harm to humans and the environment. For example, one repository under development in Finland is located on the island of Olkiluoto close to a Natura 2000 site, and the natura assessment conducted concludes that there is no foreseen adverse effects on the flora and fauna in the area.

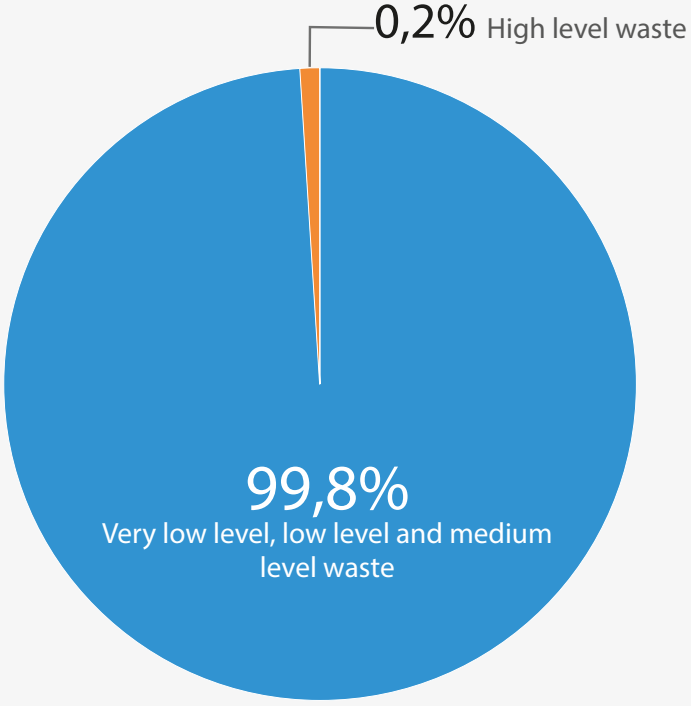
In addition, they integrate passive safety measures – which means that they do not require additional human intervention. For example, the geological stability of the sites selected ensure that these repositories will remain harmless to human health and the environment for centuries.

Some countries will also enable future retrievability of the waste from these repositories, meaning that this waste will become a resource for future generations!

DID YOU KNOW?

LESS THAN 1% OF THE WASTE GENERATED IN THE NUCLEAR INDUSTRY IS CLASSED AS **HIGH-LEVEL WASTE!**

% OF WASTE PRODUCED BY VOLUME (2016)



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About us

The European Atomic Forum (FORATOM) is the Brussels-based trade association for the nuclear energy industry in Europe. The membership of FORATOM is made up of 15 national nuclear associations and through these associations, FORATOM represents nearly 3,000 European companies working in the industry and supporting around 1.1 million jobs.

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