Used Nuclear Fuel/Spent Nuclear Fuel – Reprocessing world nuclear association

**Processing of Used Nuclear Fuel**

*(Updated December 2020)*

* **Used nuclear fuel has long been reprocessed to extract fissile materials for recycling and to reduce the volume of high-level wastes.**
* **Recycling today is largely based on the conversion of fertile U-238 to fissile plutonium.**
* **New reprocessing technologies are being developed to be deployed in conjunction with fast neutron reactors which will burn all long-lived actinides, including all uranium and plutonium, without separating them from one another.**
* **A significant amount of plutonium recovered from used fuel is currently recycled into MOX fuel; a small amount of recovered uranium is recycled so far.**

A key, nearly unique, characteristic of nuclear energy is that used fuel may be reprocessed to recover fissile and fertile materials in order to provide fresh fuel for existing and future nuclear power plants. Several European countries, Russia, China and Japan have policies to reprocess used nuclear fuel, although government policies in many other countries have not yet come round to seeing used fuel as a resource rather than a waste.

Over the last 50 years or so the principal reason for reprocessing used fuel has been to recover unused plutonium, along with less immediately useful unused uranium, in the used fuel elements and thereby close the fuel cycle, gaining some 25% to 30% more energy from the original uranium in the process. This contributes to national energy security. A secondary reason is to reduce the volume of material to be disposed of as high-level waste to about one-fifth. In addition, the level of radioactivity in the waste from reprocessing is much smaller and after about 100 years falls much more rapidly than in used fuel itself.

These are all considerations based on current power reactors, but moving to fourth-generation fast neutron reactors will change the outlook dramatically, and means that not only used fuel from today’s reactors but also the large stockpiles of depleted uranium (from enrichment plants, about 1.2 million tonnes end 2018) become a fuel source. Uranium mining will become much less significant.

Another major change relates to wastes. In the last decade interest has grown in recovering all long-lived actinides\* together (*i.e.* with plutonium) so as to recycle them in fast reactors so that they end up as short-lived fission products. This policy is driven by two factors: reducing the long-term radioactivity in high-level wastes, and reducing the possibility of plutonium being diverted from civil use – thereby increasing proliferation resistance of the fuel cycle.

\* Actinides are elements 89 to 103, actinium to lawrencium, including thorium, protactinium and uranium as well as transuranics, notably neptunium, plutonium, americium, curium and californium. The minor actinides in used fuel are all except uranium and plutonium.

Reprocessing used fuel[a](https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/fuel-recycling/processing-of-used-nuclear-fuel.aspx#Notes) to recover uranium (as reprocessed uranium, or RepU) and plutonium (Pu) avoids the wastage of a valuable resource. Most of it – about 96% – is uranium, of which less than 1% is the fissile U-235 (often 0.4-0.8%); and up to 1% is plutonium. Both can be recycled as fresh fuel, saving up to 30% of the natural uranium otherwise required. The RepU is chiefly valuable for its fertile potential, being transformed into plutonium-239 which may be burned in the reactor where it is formed.

So far, about 400,000 tonnes of used fuel has been discharged from commercial power reactors, of which about 30% has been reprocessed[1](https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/fuel-recycling/processing-of-used-nuclear-fuel.aspx#References). Current commercial reprocessing capacity is about 2000 tonnes per year (see below). With the restart of Japanese plant Rokkasho-Mura, capacity would increase by 800 tHM per year.

**World commercial reprocessing capacity**[2](https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/fuel-recycling/processing-of-used-nuclear-fuel.aspx#References)

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| (tonnes per year) |
| **LWR fuel** | France, La Hague | 1700 |
| Russia, Ozersk (Mayak) | 400 |
| Japan (Rokkasho) | 800\* |
| **Total LWR (approx)** | **2100** |
| **Other nuclear fuels** | UK, Sellafield (Magnox) | 1500 |
| India (PHWR, 4 plants) | 260 |
| **Total other (approx)** | **1760** |
| **Total civil capacity** |   | **3860** |

*\* now expected to start operation in 2021*

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