Decommissioning nuclear facilities: a technical feasibility not yet fully demonstrated

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The decision to decommission nuclear facilities after they have been shut down should make it possible to reuse the space freed up. However, the technical feasibility of the decommissioning and decontamination process has not yet been proven for every type of French nuclear facility.

To find out more

- *Rapport sur le démantèlement des installations nucléaires de base*, Conseil supérieur de la sureté et de l'information nucléaires (CSSIN), 16 mai 2007.
- *Faisabilité technique et financière du démantèlement des infrastructures nucléaires*, rapport de la Mission d'information parlementaire (M. Julien Aubert, président, Mme Barbara Romagnan, rapporteure), 1er février 2017, www.assemblee-nationale.fr/14/rap-info/i4428.asp

France is currently in an interim period as regards nuclear decommissioning, which, given the scale of the work that remains to be done, requires the utmost vigilance. Decommissioning involves the deconstruction of a nuclear reactor, the decontamination of operational buildings and the clean-up of soil that may have been contaminated. In theory and in the best-case scenario, decommissioning allows the unrestricted reuse of the cleared and fully decontaminated areas. This is known as a return to "greenfield" status, the image evoking a return to its natural state. But the reality is more complex: since total decontamination is particularly expensive, under certain circumstances and at the request of the operator the French Nuclear Safety Authority (Autorité de sûreté nucléaire, ASN) may allow the decommissioning to forgo this requirement. In the United States it is even accepted that some radioactive remains may be left in situ covered by a concrete sarcophagus; in other cases, spent fuel may be stored on sites of decommissioned reactors in sealed canisters, in which case the land has "brownfield" status and is suitable for industrial use.

France has opted in principle for the immediate dismantling of facilities after their shutdown. However, not all questions have been resolved regarding the progress of dismantling techniques and whether there has been sufficient testing of the proposed methods. In this respect, two main points should be noted: on the one hand, the knowledge gained from experience doesn't apply to all the different facilities; on the other hand, there are still questions about the management of waste resulting from the dismantling.

Disparity in the knowledge gained through experience across the different facilities

The French nuclear fleet is distinctive in being made up of two types of reactor: a first generation of "natural uranium graphite gas" (NUGG) reactors that are no longer in operation, and a second more recent fleet, still in operation, of pressurized water reactors (PWR). Électricité de France (EDF) reports that it has encountered some difficulties with the first NUGG fleet, which was initially intended to be dismantled "under water", and these technical complications have led it to reconsider its strategy. As the water was supposed to limit the release of radioactivity during the removal of the graphite layers, the main reactors have now seen their decommissioning deadlines extended considerably. For example, the Bugey reactor, whose decommissioning began in 1994, is not expected to be fully decommissioned until 2037, and the Chinon reactor until 2041. However, when ASN learned in 2016 of EDF's decision to proceed with dismantling in air, they didn't find the operator's justifications were satisfactory. Consequently, EDF intends to test its new technique on a test reactor by 2060, and to dismantle the remaining reactors by 2100.

With regard to the PWR fleet, it appears that the technical feasibility of decommissioning is more assured. However, in reality, no PWR has been decommissioned worldwide to date. Caution is called for, since unpleasant surprises in this area have been the rule up to now. EDF has 58 pressurized water reactors currently in operation and nine reactors that have been shut down: Brennilis, a heavy water reactor, Superphénix running on sodium, six first-generation reactors running on graphite gas, and the Chooz A underground reactor, the oldest French PWR. For this fleet, the difficulty lies more in EDF's plan to rebuild reactors on the sites currently in use. As a result, the operator does not refer to these reactors as being "decommissioned" but simply "deconstructed". In other words, EDF does not foresee a global and precise schedule for their decommissioning. In addition to this, there are also occasional difficulties with individual reactors, such as Superphénix and Brennilis. Superphénix entered service in 1985 and was shut down in 1996. According to EDF, Superphénix should be dismantled by 2028, which is more than 30 years after its final shutdown. This time-frame is unsatisfactory because it does not respect the principle of immediate dismantling. Brennilis, meanwhile, was shut down in 1985 and in view of the difficulties encountered by EDF, is not likely to be dismantled before 2032 i.e. 47 years after it was shut down. Moreover, such difficulties have a real financial impact: the Court of Auditors estimates that the costs of decommissioning could be multiplied by a factor of twenty, reaching almost 482 billion Euro[a]. The technical feasibility of decommissioning is therefore also a financial issue.

There are a number of discrepancies in the technical knowledge of the different reactor types which makes it impossible to assess the technical feasibility of decommissioning. In addition to the specific site-related issues, there is also the challenge of spent fuel disposal, which is essential for the successful completion of decommissioning.

Siloé experimental reactor (Grenoble), in operation from 1963 to 1997. The decontamination and dismantling phases lasted from 1998 to 2011.

Waste management still raises questions

Here again, the current picture does not indicate that the technical issues have all been resolved[b]. Whilst the waste from decommissioning will account for nearly 60% of the volume of waste to be treated by 2030, 40% will come from reactor operations, and will cause certain facilities to be over-filled, depending on the category of waste to be treated.

The method used for reprocessing and storage of waste depends on its level of radioactivity. 60% of it has very low activity (VLL), but the National Agency for Radioactive Waste Management (Agence nationale pour la gestion des déchets radioactifs, ANDRA) storage center located in the Aube region will reach full capacity in 2025.

More broadly, the issue of storage questions the wisdom of setting a disposal limit for nuclear waste. At present, everything that leaves a power plant must be stored in specialized centers; however, some waste has not been contaminated and perhaps therefore saturates the centers unnecessarily. ANDRA estimates that 30 to 50 per cent of the waste has little or no radioactivity. This would therefore be an avenue to explore in order to respond to the very imminent problem of saturation of our storage facilities.

The methods used for storing waste are also a cause for concern, particularly deep geological storage. The Industrial Center for Geological Storage (Centre Industriel de stockage Géologique, Cigéo) project located at Bure in the Meuse region plans to bury the most radioactive waste from the nuclear industry for hundreds of thousands of years. In view of the long-term consequences and the effectively irreversible nature of this choice[c], the wisdom of underground disposal is highly questionable, although it is possible to store the waste underground whilst at the same time pursuing research in parallel in the hope of one day being able to recycle it satisfactorily. The limitations of underground storage have been illustrated by a former salt mine in Lower Saxony: access corridors do not remain straight at the scale of a human lifetime so how can we hope to guarantee safety over thousands of years? All these questions may be the focus of different strategic choices, but no irreversible decision should be taken because waste storage, like reactor decommissioning, is a decisive step for the successful dismantling of nuclear infrastructure. It must be said that in this area, too, the current outlook is unsatisfactory. ▮

a. Court of Auditors, *Le coût de production de l'électricité nucléaire*, updated May 2014, www.ccomptes.fr. See also the article by A.-S. Dessillons (p. 29).

b. Several articles address this question, in particular that of J.-Y. Le Déaut (p. 13), and the interview with C. Stéphan and P. Barbey (p. 19).

c. Act No 2016-1015 of 25 July 2016 theoretically requires reversibility, defined as "the capacity, for successive generations, either to continue the construction and then the operation of successive sections of a storage facility, or to reassess the choices previously defined and to develop management solutions [...]. It includes the possibility of recovering waste packages already stored." [Ed.].