

Nuclear waste requires cradle-to-grave strategy

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After Fukushima, it is now imperative to redefine what makes a successful nuclear power program - from cradle to grave. If nuclear waste management is not thought out from the beginning, the public in many countries will reject nuclear power as an energy choice, according to research that appears today in the *Bulletin of the Atomic Scientists*.

According to Allison Macfarlane, associate professor of environmental science and policy at George Mason University, and a member of the Blue Ribbon Commission on America's Nuclear Future, coming up with storage solutions for nuclear waste continues to be a last-minute decision in a number of countries besides Japan. It is surprisingly common for reactor sites to be overburdened with spent fuel with no clear disposal plan. In South Korea, for example, storage at the nation's four [nuclear plants](#) is filling up, leading to a potential storage crisis within the next decade.

The [United Arab Emirates](#) broke ground for the first of four nuclear reactors on March 14, 2011 but has not prioritized storage. Hans Blix, former head of the [International Atomic Energy Agency](#) and current chairman of the UAE's International Advisory Board, noted: "The question of a final disposal plan is still open and more attention should be spent on deciding what to do."

Some very low level nuclear wastes can go into landfill-type settings. But low level wastes, composed of low concentrations of long-lived [radionuclides](#) and higher concentrations of short-lived ones, must remain

sequestered for a few hundred years in specially engineered subsurface facilities. Intermediate and high level wastes require disposal hundreds of meters below the ground for thousands or even hundreds of thousands of years to ensure public safety. Intermediate wastes contain high concentrations of long-lived radionuclides, as do high level wastes, including spent nuclear fuel and fuel reprocessing wastes. As well as being extremely radioactive, high level wastes also emit heat. There is no repository for high level nuclear waste disposal anywhere in the world.

In all types of energy production, money is made at the front end of the process rather than in waste management at the back end. Macfarlane argues, however, that a failure to plan for waste disposal can cause the more profitable front end of the operation to collapse.

Nuclear fuel is discharged from a light water reactor after about four to six years in the core. Because the fuel is extremely thermally and radioactively hot at discharge, it must be cooled in a pool. Actively cooled with circulated borated water, spent fuel pools are about 40 feet (12 meters) deep. The water not only removes heat but also helps absorb neutrons and stops chain reactions. In a number of countries, including the United States, metal racks in spent fuel pools hold four times the originally intended amount of fuel. Plans to reprocess fuel have failed for both economic and policy reasons. This means that today there is more fuel in the pools than in reactor cores, and this fuel poses a large radiation risk in the event of a coolant-loss accident, such as occurred at Fukushima.

Japan's Fukushima Daiichi plant has seven spent fuel pools, one at each reactor and a large shared pool, as well as dry cask storage for spent fuel on site. Initially, Japan had planned a short period of spent fuel storage at the reactor site prior to reprocessing, but Japan's reprocessing facility has suffered long delays (scheduled to open in 2007, the facility is still not ready). This has caused spent fuel to build up at the plant's reactor sites.

Countries should include additional spent fuel storage in their nuclear power plans from the start, rather than creating ad hoc solutions after spent fuel has already begun to build up. Siting storage is a technical issue, but, importantly, also a social and political one.

"Countries with nuclear power programs need a medium-term strategy for spent fuel storage prior to the long-term plan for spent fuel or high level waste disposal," Macfarlane explains. "Though difficult, the disposal of high level nuclear waste is possible and a clear strategy to develop a repository combines both technical and societal criteria in a phased approach."

After Fukushima, the nuclear industry and nuclear regulators must redefine a "successful" nuclear power program. Safe electricity production will not suffice – a [nuclear power](#) program must be safe, secure, and sustainable for its entire lifecycle, from mining uranium ores to disposing of spent nuclear fuel. Failure to plan ahead for [nuclear waste](#) management will lead the public in many countries to reject nuclear as an energy choice.

More information: It's 2050: Do you know where your nuclear waste is? by Allison Macfarlane appears in the *Bulletin of the Atomic Scientists*, July 2011 issue. The article will be free to access for a limited period at: thebulletin.sagepub.com

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