Nuclear Energy
Nuclear Power: Risks and Benefits
Transcript

Narrator: Nuclear energy can generate massive amounts of electrical power. But as part of the process, reactors produce radioactive waste in the form of used or spent nuclear fuel. The waste remains radioactive and can be highly dangerous for hundreds of thousands of years. So, why is spent fuel so dangerous? What do we do with it? And how do we keep it safe?

At the core of every nuclear reactor is radioactive material slowly decaying, releasing heat. But this material doesn't stay hot forever. Take a common type of nuclear fuel, for example: uranium. Over a year or two, the fissile uranium breaks down and fission products build up, making it harder to keep a chain reaction going. The pellets that heat the coolant become too inefficient to work properly. At this point, the percentage of uranium-235 in the fuel will have depleted from just under 5% to around 1%. So it's still radioactive and quite hot.

Of all the materials a nuclear facility needs to dispose of, spent fuel is the most radioactive. It's referred to as high-level waste, which is one of three categories of radioactive waste, the other two being low level and intermediate level.

Low-level waste includes clothes and instruments that might have picked up some contamination. It's usually placed into drums or containers and disposed of in concrete-lined cells and covered over with earth.

Intermediate-level waste includes materials used to house and protect nuclear core components. While they don't require cooling, they do need to be isolated and contained for many hundreds of years. Some reactors store waste nearby. Others transport it to other facilities, often inside concrete bunkers or deep underground, surrounded by thick layers of rock.

High-level waste is often transferred into storage ponds for a period of time, from a few months to a number of years. The water provides a shield from radiation and absorbs the heat. Ultimately though, high-level waste needs permanent containment for up to hundreds of thousands of years. To prevent highly radioactive materials from fragmenting and entering the water table or atmosphere, they're often mixed with something that helps prevent disintegration, such as glass or ceramics.

Researchers are working on improving this process. Australia's Nuclear Science and Technology Organisation is developing a durable form of

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technology called synroc to safely lock up radioactive materials in a form that can be easily stored and contained. A combination of different chemicals is mixed with liquid or solid radioactive waste, producing a slurry. This is dried to create a free-flowing powder. The powder is heated and poured into canisters, which are then inserted into a second container. The whole unit is heated again, causing the powders to fuse with the inner canister and reduce in volume. Synroc's chemicals contain the radioactive particles, which prevents leaking into the environment.

Another option for spend fuel is to reprocess it by extracting the useful material within it and using it again. Only about 3% of spent fuel is actual waste that interferes with the chain reaction process. One percent is plutonium produced by the reaction. The rest is a mix of uranium, similar to the material that entered the reactor. Reprocessing the fuel reduces overall waste by about 80% while also decreasing it's radioactivity.

A number of countries, including the UK, France, Japan, Russia, and China support reprocessing in their nuclear power policies. But not everybody sees it as a viable option when mining fresh uranium is easier and cheaper. Reprocessing is similar to ore refining, with the isotopes extracted and turned into new fuel pellets. Improvements in technology are allowing us to squeeze more out of spent fuel, meaning much of the current waste stored in bunkers or deep underground could actually fuel future nuclear power generation, and it leaves less of a problem for our descendants.

After all, how do we ensure that dangerous radioactive waste remains isolated, contained, and safe for generations of people, hundreds and thousands of years into the future?

Nuclear energy was once seen as a means of ensuring cheap power for a long time into the future. As fossil fuel emissions drive global warming, it continues to be promoted as a cleaner alternative.

But with catastrophes like the 1986 meltdown at Chernobyl and the Fukushima Daiichi disaster in 2011, many fear the safety risks far outweigh the benefits. New reactor technology and improved waste-storage methods promise greater safety, but there's still the question of nuclear energy's economic viability. Building a nuclear fission power facility costs billions, and is far more expensive than establishing a coal-powered station.

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In the U.S., constructing a nuclear power station accounts for roughly 75% of the total cost of generation. The comparable figure for a coal-powered station is around 60%. Actual running costs for a nuclear plant are cheaper than fossil fuel generation, depending on availability of uranium. Fuel costs for a nuclear reactor come in at around 14% of the total running costs. For coal-fired power stations, the figure is nearly 80%.

But how might nuclear fission compare with renewable energy, which is increasingly becoming part of the energy production mix? After all, renewables have multiple advantages such as virtually zero waste when in operation, and technology is advancing rapidly. Right now though, it can still be a very expensive option. There is no perfect power source that ticks every box when it comes to cost, viability, safety, and meeting internationally ratified carbon emission targets.

While the technology is in its infancy, and it's a long way from being economically viable right now, nuclear fusion is another powerful energy source that some believe could play a major role in large-scale electricity generation in the future. In the meantime though, for better or worse, nuclear fission will continue to power nations across the globe for years to come.