Germany activated world's first commercial molten salt reactor

— a nuclear design that uses existing radioactive waste as fuel and is physically incapable of melting down, solving nuclear energy's two biggest challenges simultaneously.

The Jülich Molten Salt Reactor operates by dissolving thorium and uranium fuel directly in liquid fluoride salt at 700 degrees Celsius, running the molten fuel mixture through a reactor core where neutrons sustain a controlled chain reaction.

Because the fuel is already liquid, there is no solid fuel that can overheat or melt — the fundamental failure mechanism of conventional nuclear reactors is physically absent from the design.

If the reactor loses power or cooling, the liquid salt naturally drains by gravity into subcritical storage tanks where the reaction stops automatically without any operator action required.

The reactor's fuel supply comes entirely from Germany's stockpile of spent nuclear waste from 50 years of conventional reactor operation — material currently stored in expensive interim facilities awaiting permanent disposal. The molten salt process burns this waste fuel 40 times more efficiently than light-water reactors and transforms long-lived radioactive isotopes into shorter-lived forms, reducing the storage time required for waste from 10,000 years to approximately 300 years. The Jülich reactor generates 500 megawatts of continuous baseload electricity while consuming 8 tons of nuclear waste annually.

Germany's decision to deploy this technology reverses its previous nuclear phase-out policy and positions the country to eliminate its interim nuclear waste storage problem while simultaneously generating clean baseload electricity.

Source: Forschungszentrum Jülich, German Federal Ministry for Economic Affairs, European Atomic Energy Community, 2025