KY STEM Brief from the Kentucky Academy of Science

November 2025 Issue: Nuclear Energy in Kentucky

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Science and technology are ever-changing, and new developments require sound legislation. The Kentucky Academy of Science (KAS) is a local resource for scientific knowledge right here in the state of Kentucky. Each month we'll send updates to you about scientific developments affecting our state. We are committed to providing non-partisan insights that translate science into actionable policy, with the goal of supporting informed legislative action. When senators and representatives need expert scientific advice, our policy group is here for you.

Nuclear Energy

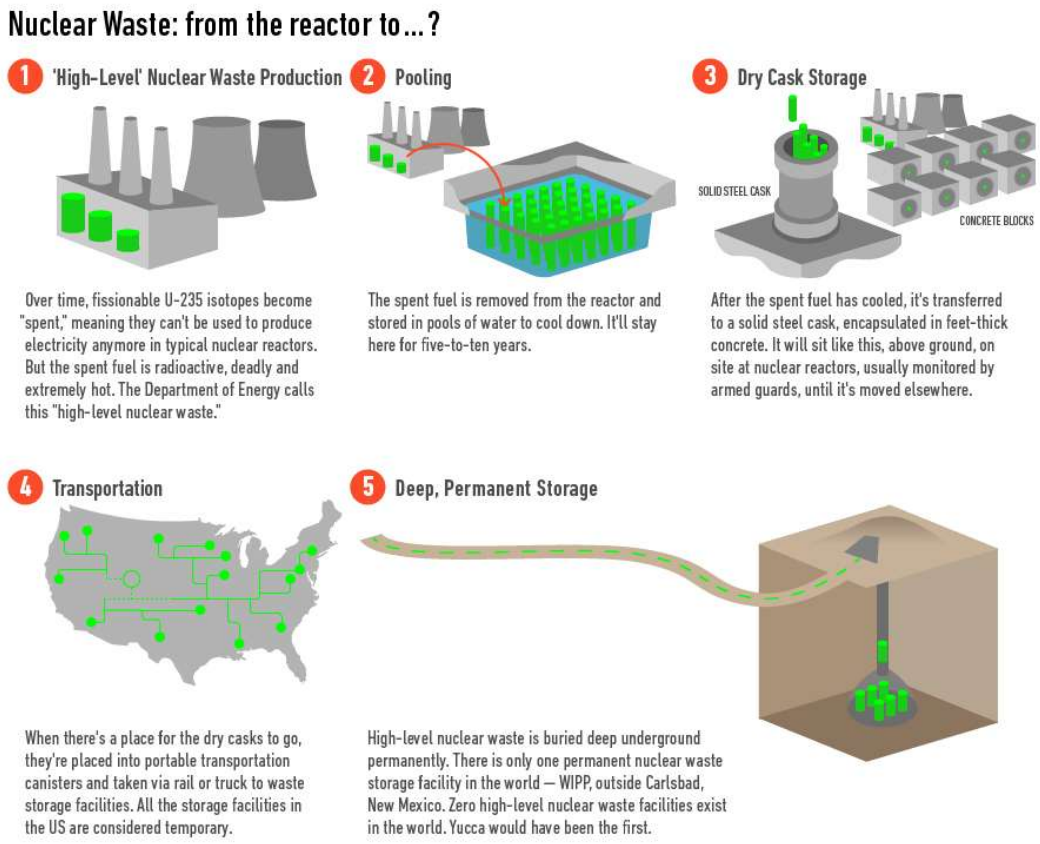
Nuclear Energy is energy released from the nucleus of an atom via the process of nuclear fission or fusion. Nuclear fission is the source of all commercial nuclear energy today. https://www.iaea.org/newscenter/news/what-is-nuclear-energy-the-science-of-nuclear-power

Nuclear fission is the process of splitting the nucleus of an atom into 2 or more smaller nuclei while releasing energy. This initial split causes a chain reaction when it releases free neutrons, which split other atoms in the fuel source. https://www.eia.gov/energyexplained/nuclear/

High Level radioactive waste (HLRW) is the highly radioactive material produced as a byproduct of the reactions that occur inside nuclear reactors. High-level waste takes one of two forms: spent fuel or waste materials from fuel reprocessing. Improper storage of this HLRW can lead to contamination of groundwater, ecosystem disruption, and increased cancer risks, genetic damage, and acute radiation sickness for the surrounding population.

Waste Disposal:

There is no operational long-term storage facility for commercially produced HLRW in the United States or any other country. All operating nuclear power plants store waste in temporary storage facilities, on site or otherwise. It is imperative that solutions be implemented for the minimization and long-term storage of HLRW for the safety of Kentuckians and all Americans at a time when many states are seeking to enhance their usage of nuclear energy to meet rising energy demands. https://iwaste.epa.gov/guidance/radiological-nuclear/high-level-waste



https://longnow.org/ideas/a-half-century-history-of-nuclear-was

Context & Trends:

- The type of nuclear reactors operating in the US are primarily *Pressurized Water Reactors* (PWRs) and *Boiling Water Reactors* (BWRs), both of which use water to cool the reactor core. https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/nuclear-power-reactors
- The next generation (Gen IV) are in development and include several new concepts, including Molten Salt Reactors (MSRs), Fast Neutron Reactors (FNRs), High-Temperature Gas-Cooled Reactors (HTGRs), Sodium-Cooled Fast Reactors (SFRs). https://www.iaea.org/sites/default/files/gc/gc69-inf9.pdf
    - *Small Modular Reactors* (SMRs), part of the generation IV reactor development concepts, are a promising innovation especially for industry and smaller communities. These reactors produce a fraction (1/4-1/2) of the energy of a conventional nuclear reactor, which can produce about 1 GW (or 1000 MW). Only 2 are currently functional in the world, in China and Russia.
        - SMRs can also be configured to burn or transmute nuclear waste as part of the fuel cycle, reducing the total volume and radioactivity of HLRW.
- *General Matter* and *Global Laser Enrichment (GLE)* are currently constructing 2 separate uranium enrichment facilities in Paducah, Kentucky.

- For currently fielded reactor technology and currently stored HLRW, *Nuclear waste reprocessing* can be utilized to extract usable plutonium, uranium, and other actinides (elements 89 to 103) from spent nuclear fuel. This enables enhanced energy production from the same amount of fuel but still produces about 20% of the high-level radioactive waste (HLRW) left after traditional fuel use, which degrades more quickly than unprocessed HLRW. However, HLRW produced by reprocessing of spent fuel still needs to be stored for 100+ years before radioactivity falls off significantly.
- *While Generation IV reactors are expected to maximize recycling of fuel and degradation of minor actinides, this still leaves some amount of high-level radioactive waste to be stored.*
    - *With the planned mass proliferation of nuclear energy seen across the US and the world, long-term storage remains a key issue even with reprocessing efforts.*

Conclusion: The implementation of nuclear power plants into Kentucky's grid requires robust scientific evidence to adequately plan for every stage of implementation and the centuries-long commitment required for waste storage.

Solutions:

- Support for research and development of Gen IV reactor designs and optimization of actinide transmutation.
- Research on how to improve reprocessing efficiency for existing reactors
- Siting for safe, long-term storage for radioactive waste generated in Kentucky.
- Partnering with other businesses to complement General Matter and GLE and work towards a closed fuel system in nuclear energy.

Legislation to Watch:

Senate Bill 179 (2025): Created the Kentucky Nuclear Energy Development Authority and the Nuclear Energy Development Grant Program to advance nuclear energy projects and support the entire nuclear energy ecosystem, including SMRs. This followed the 2024 Senate joint resolution that directed the Public Service Commission to prepare to regulate nuclear energy.

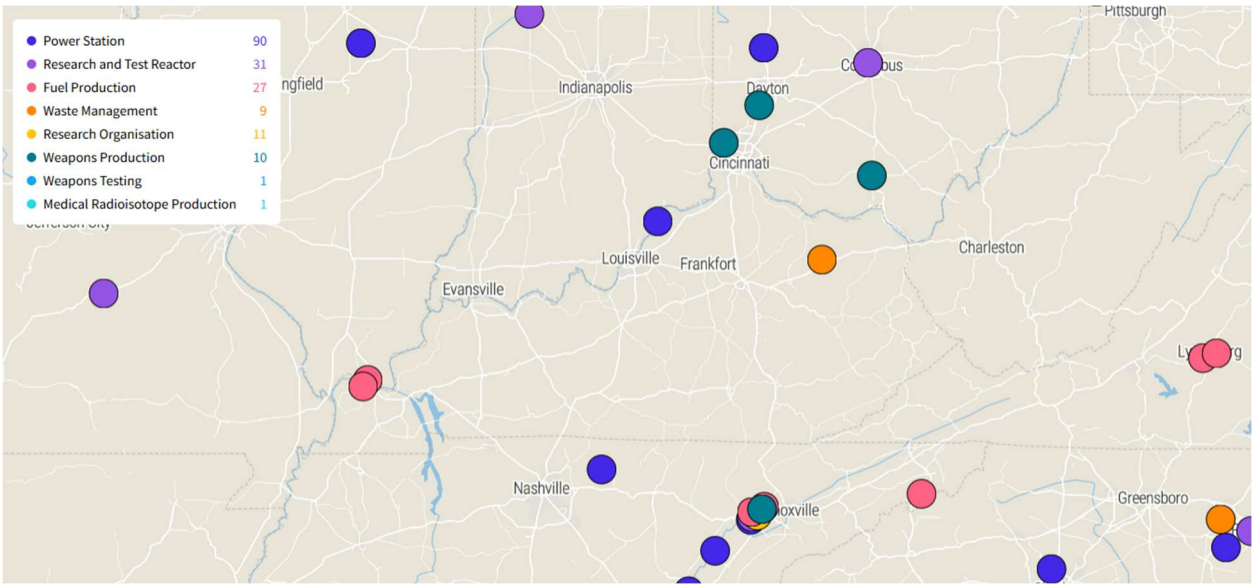
- Legislation in 2026 is likely to expand upon this initiative.
- HLRW storage, reprocessing, and reuse within the Kentucky energy market over the next century are integral parts of this conversation.

STEM POLICY UPDATES

Other states, (Colorado, Texas, Tennessee, Virginia) appear to be focusing on easing regulations or providing funding to get nuclear power plants built fast. DOE has identified a small number of locations nationally that they are prioritizing for nuclear development, including Paducah, Kentucky. There are currently no Small Modular Reactors operating in the United States.

RESOURCE OF THE MONTH

🔧 Interactive Map of Nuclear Power-related facilities, including waste storage sites (Explorenuclear.com)



Want expert input on a STEM policy bill?

Email Austin McMasters, KAS' Science Policy Specialist, at policy@kyscience.org — we will present you with an evidence-based analysis of the bill and its implications for Kentuckians. We may even feature it in a future issue!
