How the Energy Secretary Can Achieve His Goal of Next-Generation Nuclear Energy Deployment

By **Dr. Matt Bowen**

The new secretary of energy, Chris Wright, views nuclear energy as a promising option for addressing growing world energy needs while minimizing adverse environmental and public health impacts. Wright has mentioned nuclear's high energy density, small land impact, large scaling ability, and ability to provide high temperature heat for industrial and other purposes.[1] He issued a secretarial order on February 5 that included an action item on enabling the rapid deployment of next-generation nuclear technology.[2]

Since the Department of Energy (DOE) has no regulatory role over commercial nuclear power, Secretary Wright will need to choose whether, where, and how his agency will make investments toward his goal of advancing nuclear energy. This commentary describes the underpinnings of interest in nuclear reactor designs the Nuclear Regulatory Commission (NRC) collectively calls "advanced reactors."[3] It then discusses two possible policy options if the secretary decides that a substantial investment in nuclear energy development is warranted: 1. negotiate an agreement with the Tennessee Valley Authority to move its Clinch River small modular reactor (SMR) project forward, and 2. partner with private high temperature reactor consortiums in the same way NASA partnered with SpaceX.

Growing Interest in Advanced Reactors

Nations are interested in nuclear energy for reasons that are similar to the United States (e.g., reliability, meeting load growth, low emissions) and different (e.g., energy security and reducing dependence on Russia).[4] In Europe, for example, targets to reduce emissions are juxtaposed with energy security and cost concerns. In July 2024, a working group of entities from 11 European countries formed to focus on deployment of the GE Hitachi BWRX-300 SMR design.[5] Table 1 lists the six countries with companies in this working group that have the highest combined dependency on fossil fuels for electricity generation, as well as each country's average price of electricity (which, in some cases, is substantially higher than it is in the United States).

Table 1: Electricity sources and prices in the six most fossil-fuel dependent nations with companies in the GE Hitachi SMR working group, 2023

Country	% electricity from coal	% electricity from natural gas	Electricity price (USD/MWh)
Poland	60	10	186
Estonia	45	0	181
Netherlands	9	38	335
Bulgaria	43	4	126
Romania	19	17	179
Czech Republic	39	5	277

Note: Poland, Estonia, Netherlands, and Czech Republic electricity prices are "ex tax." For comparison, the IEA's average 2023 electricity price for the United States is 160 US dollars/megawatt-hour.
Source: IEA, https://www.iea.org/

Small Modular Reactors

But why SMRs over traditional, larger nuclear reactor designs? One advantage over gigawatt-scale light water reactors is their likely shorter construction cycles (which reduce financing costs) and smaller amount of capital required for one unit, which means utilities would not have the same level of risk in committing to construction. The possibility of financial ruin when large reactor construction projects go badly has historical precedent. South Carolina utilities spent $9 billion on two Westinghouse AP1000 reactors (1,100 megawatts [MW] each) with ultimately nothing to show for it before they were cancelled in 2017, with substantial harm to state ratepayers.[6] Investigations into those projects would ultimately lead to four criminal convictions and sentences for the Westinghouse and South Carolina utility executives involved.[7] Westinghouse itself went bankrupt because of the first round of AP1000 projects going over schedule and budget.[8] AP1000s at the Vogtle site in Georgia were completed in 2023 and 2024 but at more than double the original cost and schedule; again, with harm to ratepayers in that state. Of course, it is possible first-of-a-kind SMR deployments could also go over schedule and budget, but the financial consequences would be smaller.

A 2024 Idaho National Laboratory assessment found that levelized cost of electricity (LCOE) estimates for both new SMRs and new large reactors are uncertain: the differences in LCOE between the two may ultimately be very small or, in some circumstances (e.g., in environments with a higher weighted average cost of capital), may be lower for an SMR than for a large plant.[9] Regardless, in some cases, a shorter construction cycle and smaller capital outlay for an SMR might outweigh even a higher projected LCOE given the greater financial strain and cost and schedule risks associated with a larger plant. In addition, an SMR might be a better fit to replace similarly-sized coal plants in the US and around the world compared with a large reactor—i.e., make use of the existing infrastructure at a given site—or may be better-sized for deployment to countries with smaller electrical grids.

High Temperature Reactors

Accelerating the availability of high temperature reactors (which are all cooled using materials other than water) could be valuable to US interests as well. These designs might have reduced capital costs compared with light water reactors, and, because of their higher operating temperatures, should be able to serve more process heat needs outside of power production.

In the industrial sector, for example, the temperatures required for some processes greatly exceed what a light water-cooled reactor is capable of (e.g., 600°C or higher versus a light water reactor's approximately 300°C).[10] Since heat is what nuclear fission produces rather than electricity as with solar PV or wind turbines, directly using that heat might be a promising business opportunity for reactor developers, especially if more industrial entities want to reduce their fossil fuel usage in that regard.

Nuclear reactor and fuel company X-energy, for instance, has entered into a partnership with Dow Chemical to potentially deploy its first high temperature, gas-cooled SMR at a site in Texas (the gas that cools it being helium).[11] X-energy's Xe-100 reactor is designed to produce heat at around 600°C. The reactors would provide low-carbon process heat (replacing current fossil fuel use) as well as electricity. The specific facility in Texas produces material for food packaging and preservation, footwear, wire and cable insulation, solar cell membranes, and packaging for medical and pharmaceutical products.[12] X-energy's design uses a robust fuel form of graphite pebbles with coated fuel kernels inside that can contain fission products at temperatures exceeding 1,600°C for extended periods of time.

Another high temperature reactor company, Kairos Power, is building a test-scale version of its fluoride-lithium-beryllium (FLiBe) salt-cooled reactor in Tennessee with plans to commence operations of that test reactor in 2027.[13] The company has also obtained construction permits from the NRC to build two reactors at the same site that will produce electricity for part of their operational lifetimes (which the first reactor will not). The Kairos Power reactor design uses the same type of robust fuel as high temperature gas reactor designs like X-energy's, but is cooled with a FLiBe salt that does not boil until over 1,400°C and can be operated at near atmospheric pressure. It is possible that such a high-temperature, low-pressure system (utilizing a robust fuel form and high-boiling point coolant) could have lower capital costs than a light-water reactor.[14]

AI Demand

The secretary of energy has an additional reason to consider advanced nuclear energy development: the predicted surge in electricity demand coming from artificial intelligence (AI) and datacenter usage. Maintaining US leadership in AI almost certainly will require additional US power capacity, but many hyperscalers don't want to contribute to climate change by keeping existing coal plants running longer than they otherwise would or by building new natural gas plants.[15]

Several announcements in 2024 illustrated this nexus. In October, Google and Kairos announced a partnership to deploy 500 MW of the FLiBE-cooled reactors to power Google datacenters with the first deployment by 2030.[16] Also in October, Amazon announced a $500 million investment in X-energy and a plan to partner with Energy Northwest in the state of Washington and Dominion Energy in Virginia to deploy a total of 320 MW (with the option to increase to 960 MW).[17] Finally, in December, Meta announced it would seek proposals for 1,000 to 4,000 MW of nuclear power to help it meet its AI innovation and sustainability objectives.[18] However, this desire to avoid emissions on the part of the hyperscalers is clearly not without limits, as Meta is also planning to power a new datacenter in Louisiana with natural gas[19]—seemingly the alternative to nuclear for new AI demands.

Given these developments align with his own stated ambition to advance nuclear power, the secretary of energy could consider how DOE might leverage these growing interests to make greater progress on nuclear energy development and enhance US leadership.

DOE Policy Options

While there have been positive developments in the US nuclear industry in recent years, there are no commercial reactors under construction and no firm orders from utilities for them yet either. The challenges associated with first-of-a-kind deployments of new nuclear energy technologies remain formidable, but if Secretary Wright is determined that "the long-awaited American nuclear renaissance must launch during President Trump's administration" (per his secretarial order), those challenges have to be overcome.

To support and accelerate the afore-identified developments in nuclear energy, this commentary suggests two potential policy options to the secretary that could help lower the barriers associated with first-of-a-kind reactor deployment and shorten timelines to commercial operations. The first option involves a federal utility that has been a longtime partner with DOE on SMR development and is the only utility that already holds an early site permit for SMR deployment. The second option would utilize a public-private partnership structure (payment-for-milestones)—that DOE has generally not used in the past but that has shown promise in other federal agencies—to partner with companies developing high temperature reactor designs.

1. Negotiate with TVA to move its Clinch River SMR project into construction

The Tennessee Valley Authority (TVA) was an early awardee in DOE's SMR licensing and technical support cost-share program and obtained an early site permit from the NRC in 2019 for SMR deployment at its Clinch River site in Tennessee.[20] TVA has selected GE Hitachi's BWRX-300 design for potential deployment at the site; the utility and entities from Canada and Poland have together invested a total of $400 million in the GE Hitachi reactor design.[21] In Canada, construction of a BWRX-300 at the Darlington site is expected to start this year.[22]

TVA is working toward a construction permit application to submit to the NRC for the Clinch River project, and other US utilities (e.g., Duke Energy[23]) have publicly stated their interest in building SMRs—but none has submitted an application to the NRC to build one yet, much less committed to construction.

If Secretary Wright wants to help create another nuclear energy option for utilities to use in addressing US energy and environmental challenges, as well as a new option to be exported to other countries, he could negotiate an agreement with TVA to help move the Clinch River SMR project into the next phase. This could take the form of an agreement by DOE to purchase power from TVA's Clinch River SMR at a higher price than it would pay for current grid electricity for DOE sites in the area (e.g., Oak Ridge National Laboratory or Y-12).[24] If construction of the SMR happens in the United States after the same design is deployed in Canada, it would help to further reduce schedules and costs as well as related uncertainties and risks, thereby helping this project and any later deployments by private US utilities. Depending on the DOE-TVA negotiations and other factors, construction on the Clinch River project could begin in the next few years. The key question for the negotiations will be cost, and especially the additional costs and schedule risks associated with the first deployments, which are part of the argument for a government role.

It bears mentioning that Congress has already directed DOE to support light water SMRs through the Consolidated Appropriations Act of 2024, which appropriated $900 million for this purpose.[25] DOE issued a request for proposals in October 2024 and applications to support SMR deployment were due by January 17, 2025. Presumably, DOE will complete this congressionally directed light water SMR cost-share award sometime in 2025. This is a separate action from what is suggested above.

2. Partner with private high temperature reactor consortiums à la NASA and SpaceX

Nearly 20 years ago, with the space shuttle retirement looming, NASA initiated the Commercial Orbital Transportation Services program to partner with the private sector to develop new launch vehicles to access space and specifically the International Space Station.[26] Rather than merely contract with the traditional aerospace giants for cost-plus contracts worth billions of public dollars, NASA took a chance on emerging private companies, creating a milestone-based funding program that rewarded objective achievements. Participating companies proposed a series of milestones and associated payments that NASA would pay them for achieving each milestone, and the agency selected the offers that it judged gave the public the best value for its dollars. The agency even brought in venture capital expertise to advise the program. If a company was selected but did not achieve its milestones (and one of the first companies selected by NASA did not), it did not get paid, thereby providing a measure of protection to the taxpayer. SpaceX was one of the first companies selected by NASA and ultimately emerged as the standout performer, meeting every milestone and ultimately transforming America's position in the global launch market from one of dependence to one of dominance.

Secretary Wright could pursue a similar program to accelerate advanced reactor deployment.[27] The secretary could solicit proposals from industry consortiums—including hyperscalers and industrial entities—in the form of payment-for-milestones and evaluate which proposals (if any) are worth the associated public expenditures.

A different tack the secretary could take would be to modify/renegotiate existing cost-share awards that were made by DOE to high temperature reactor companies in 2020 as part of the first Trump administration.[28] The three largest awards for high temperature reactors were to TerraPower, X-energy, and Kairos Power (largest to smallest, respectively). The current status of these awards (how much money has been used by the private entities) does not appear to be in the public realm, but it is known that the TerraPower and X-energy agreements were not structured as payment-for-milestones. Kairos Power held out for three years while negotiating its agreement to use that structure. As mentioned, in 2024, two of those companies (X-energy and Kairos) reached agreements with hyperscalers, and TerraPower is talking with datacenter companies as well. The secretary could renegotiate these agreements to structure them all as payment-for-milestones and to add scope/milestones relevant to hyperscaler needs, for example.

NASA (and the Department of Defense) also played an important role in SpaceX's development by being some of the early customers for the company's launch services. Similarly, DOE could assist advanced reactor developers by being an early customer (in addition to the hyperscalers and industrial entities). For example, Secretary Wright could consider offering commitments for DOE facilities to take power and heat from new advanced nuclear facilities, providing an additional incentive for new reactor construction projects.

Conclusion

If the new secretary of energy decides to make significant investments in nuclear energy development, he could pursue two initiatives this commentary discusses that focus on supporting and accelerating promising developments in nuclear energy. First, negotiations with TVA could advance its SMR project that has been in development but is not yet in construction, and in the process help create a new reactor option that could be deployed by US utilities and other nations. Second, Secretary Wright could partner with private high temperature reactor consortiums involving hyperscalers and industrial entities in a similar payment-for-milestones manner used by NASA with SpaceX. Both initiatives could help scale up new dispatchable nuclear energy options domestically and for export to meet growing energy demands for affordable, reliable energy while minimizing land use, air pollution, and greenhouse gas emissions.

Notes

1. For example, see Chris Wright's comments in a discussion forum at the Enverus Evolve Conference on May 17, 2023: Chris Wright, "Exploring the Future of Energy & Sustainability through Civil Dialog & Critical Thinking," posted May 24, 2023, YouTube, 1 hour, 10 min., 28 sec., https://www.youtube.com/watch?v=UnTZ2FPP3kc; and at his confirmation hearing: *Hearing to Consider the Nomination of Mr. Chris Wright to be Secretary of Energy*, 119th Cong.(2025), January 15, 2025, https://www.energy.senate.gov/hearings/2025/1/hearing-to-consider-the-nomination-of-mr-chris-wright-to-be-secretary-of-energy.

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11. X-energy, "Advanced Nuclear Reactor Project in Seadrift, Texas," accessed October 28, 2024, https://x-energy.com/seadrift.

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13. DOE, "Kairos Power Starts Construction of Hermes Reactor," July 30, 2024, https://www.energy.gov/ne/articles/kairos-power-starts-construction-hermes-reactor; Kairos website: https://kairospower.com/.

14. For example, the different set of barriers limiting the transport and release of radionuclides to the environment in place at an FLiBe-cooled reactor versus a light water reactor could reduce or eliminate the need for large containment structures used at the latter (and their associated costs). See: Generation IV International Forum, "Advanced Nuclear Technology Cost Reduction Strategies and Systematic Economic Review," September 2021, https://www.gen-4.org/resources/reports/advanced-nuclear-technology-cost-reduction-strategies-and-systematic-economic-0; Clean Air Task Force, "The Nuclear Decarbonization Option: Profiles of Selected Advanced Reactor Technologies," pgs. 21–27, March 2012, https://www.catf.us/wp-content/uploads/2019/10/Nuclear_Decarbonization_Option.pdf.

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