Nukes – SMRs Take a Major Step

By John Benson

July 2025

1. Introduction

Small Modular Reactors (SMRs) have been around as a concept for more than five years. I wrote the post summarized and linked below in early 2019, where I explored this concept with the reactor manufacturer (RM) NuScale, that pioneered this type of reactor.

Nukes, Part 2: Little Nukes: *NuScale's Small Modular Reactor Design now appears to be viable, and thus this paper on their technology and economics.*

https://www.energycentral.com/c/cp/nukes-part-2-little-nukes

Soon after NuScale started offering their SMR, other major RMs came on board and offered their own SMRs including GE Hitachi Nuclear Energy (now GE Vernova Hitachi Nuclear Energy or GVH).

The idea behind SMRs is that the currently operating reactors are all custom designs where major components are largely fabricated on-site, making them extremely expensive to the point that these are no longer cost-effective. A SMR is small enough to where all of its major components can be manufactured in a centralized plant, each to a standard design, and transported to the reactor site using (more or less) standard rail, barge and highway methods. Also, SMRs can be used to implement a gigawatt-scale facilities via multiple SMR-units. This approach also has the advantage that the developer can add units over time as demand increases, rather than paying for a 1,000+ MW Monster up front, and then being responsible for its care and feeding for many decades up to a century.

Although NuScale has not commissioned one of their SMRs to date, they appear to have a few orders and are moving towards full-approval of their design.[1]

Meanwhile, a major Utility (TVA) has contracted with GVH for one of their BWRX-300 SMR designs.

2. TVA's Clinch River Reactor

The Tennessee Valley Authority announced Tuesday that it is the first utility in the U.S. to submit a construction permit application (CPA) for the GE Vernova Hitachi Nuclear Energy (GVH) small modular reactor (SMR) BWRX-300 technology to the U.S. Nuclear Regulatory Commission – the agency that issues licenses for constructing, operating and decommissioning nuclear power plants. This CPA is TVA's next step in pursuing an SMR at its Clinch River site, near Oak Ridge, Tennessee, and establishing America's energy dominance to power artificial intelligence, quantum computing and advanced manufacturing.[2]

[1] Wikipedia Article on NuScale Power, https://en.wikipedia.org/wiki/NuScale_Power

[2] Scott Fiedler, TVA Press Release, "TVA Submits … Permit Application for BWRX-300 SMR," May 20, 2025, https://www.tva.com/news-media/releases/tva-submits-nation-s-first-construction-permit-application-for-bwrx-300-smr

Author's comment: The Clinch River site has a long history in the U.S. Nuclear Industry, that includes your author. When I graduated from college in 1975, my first two jobs were with Rockwell Atomics International and GE Nuclear. In each of these I worked on the Clinch River Breeder Reactor Plant. This was to be the first US large Liquid Metal Fast Breeder Reactor, but it was never built. Apparently, TVA now holds the license for this site, and this will expedite construction of the BWRX-300.

"This is a significant milestone for TVA, our region and our nation because we are accelerating the development of new nuclear technology, its supply chain and delivery model to unleash American energy. TVA has put in the work to advance the design and develop the first application for the BWRX-300 technology, creating a path for other utilities who choose to build the same technology," Don Moul, TVA President and CEO, said. "TVA looks forward to working with the Administration to accelerate advanced nuclear technologies that are key to our nation's energy security. We believe deploying new nuclear is essential to providing American families and businesses affordable and abundant electricity for decades to come."

Author's comment: The above is a win-win-win. First for TVA, who gets to continue their leadership in owning and operating Nuclear Power Plants:

We operate three nuclear plants capable of generating an average of 8,275 megawatts of electricity each day:[3]

- *Browns Ferry, near Athens, Alabama*
- *Sequoyah, in Soddy-Daisy, Tennessee*
- *Watts Bar, near Spring City, Tennessee*

Then for GE Vernova Hitachi Nuclear Energy (GVH a.k.a. GEH) to continue their leadership in developing and building the latest generation of Nuclear Power Plants:

GE Hitachi (GEH) has more than 60 years of experience in BWR (boiling water reactor) licensing, fuel, design and manufacturing, and building supply chains. Today, we continue boldly innovating to provide reliable, carbon-free, new nuclear power to the world. the BWRX-300 SMR features an innovative and simplified configuration, resulting in less concrete and steel needed for construction. This modular nuclear reactor is a cost-competitive solution that can be deployed for electricity generation.[4]

Then for the current president's strong support for nuclear energy:

Today, President Donald J. Trump signed an Executive Order directing the reform of the Nuclear Regulatory Commission (NRC) in order to reduce our dependence on foreign technologies, decrease regulatory barriers, and support our domestic nuclear industry.[5]

Back to Reference 2.

SMRs are advanced reactors with a smaller and more modular design than the nuclear technology that powers many U.S. states today. TVA is pursuing the BWRX-300 technology, with the potential benefits of enhancing safety, making them easier to replicate and more efficient. Their smaller footprint means they can be built more quickly, are easier to operate and better fit into the landscape due to their compact size.

[3] https://www.tva.com/Energy/Our-Power-System/Nuclear
[4] https://www.gevernova.com/nuclear/carbon-free-power/bwrx-300-small-modular-reactor
[5] https://www.whitehouse.gov/fact-sheets/2025/05/fact-sheet-president-donald-j-trump-directs-reform-of-the-nuclear-regulatory-commission/

Moul noted that America must lead the commercialization of affordable and abundant nuclear energy. TVA has the best path to deploying a commercial BWRX-300 SMR in the U.S. because the agency holds the nation's first and only early site permit for SMRs from the NRC at its Clinch River site. In 2023, TVA joined a global collaboration to speed up the design and development of the BWRX-300 technology. Now, TVA is leading a strong coalition of industry partners in submitting an application for an $800 million U.S. Department of Energy grant to accelerate BWRX-300 development and seeking an $8 million DOE grant to support the NRC license review cost. TVA has already completed the Environmental Report for the Clinch River site and submitted it to the NRC. Preliminary site-preparation could begin as soon as 2026.

3. BWRX-300

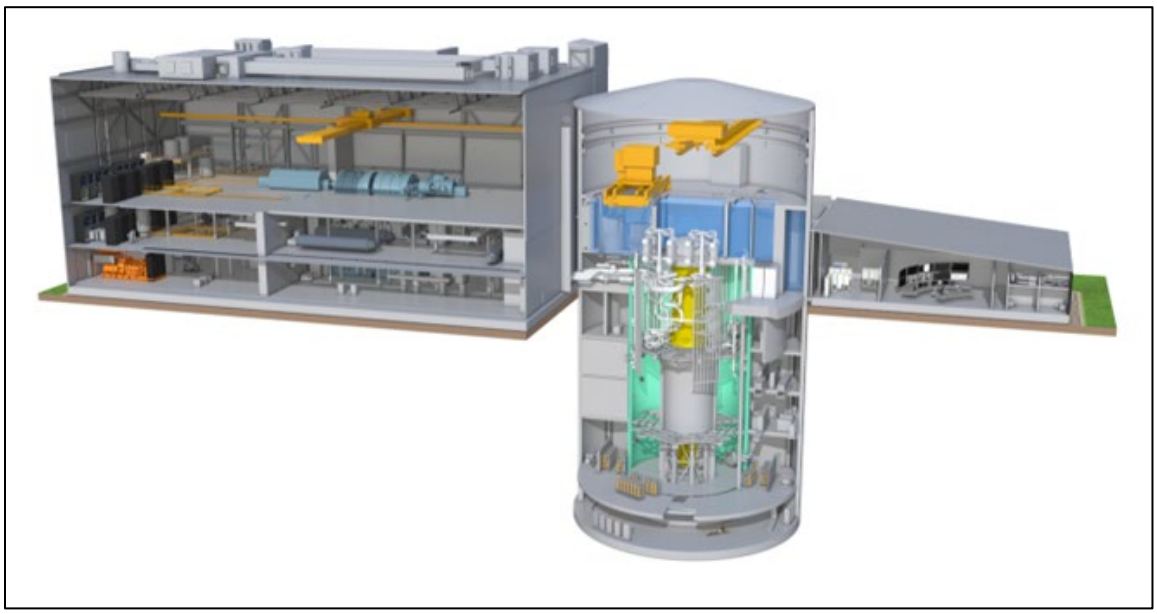
GE Vernova Hitachi Nuclear Energy (GVH) configures and constructs boiling water nuclear reactors (BWRs), a core component of modern commercial nuclear power plants. Our configurations are rigorously engineered to provide abundant, clean electricity, and have a decades-long record of safe, reliable operation.[6]

The worldwide movement to minimize climate change by curtailing carbon emissions impacts every industry, including power generation. GVH stands as a pioneer in one of the most effective methods to address this important issue: nuclear energy generation. Providing dispatchable power places, nuclear power is vital to meeting the world's energy needs while mitigating excess greenhouse gases.

Powered by proven and commercially available fuel, the BWRX-300 SMR features an innovative and simplified configuration, resulting in less concrete and steel needed for construction. This modular nuclear reactor is a cost-competitive solution that can be deployed for electricity generation and industrial applications, including hydrogen production, desalination, and district heating.

- ***300 MW carbon-free power:*** *A compact nuclear reactor ideally sized for plant conversion from coal to nuclear*
- ***Competitive cost:*** *Less capital cost per MW when compared with typical water-cooled SMR.*
- ***Proven & reliable fuel:*** *Licensed and proven fuel configuration with qualified facilities in the U.S. and Europe.*
- ***World-class safety:*** *Steam condensation and gravity allow the BWRX-300 to cool itself for a minimum of seven days without power or operator action.*
- ***Robust supply chain:*** *Decades of experience building supply chains, supporting local jobs and economies.*
- ***Project certainty:*** *Deployable globally as early as 2029 thanks to proven know-how and innovative construction techniques.*

[6] GE Vernova Hitachi Nuclear Energy (GVH a.k.a. GEH),"Carbon-free power with proven nuclear technology," ©2025 GE Vernova Hitachi Nuclear Energy https://www.gevernova.com/nuclear/carbon-free-power . Note that the author found the acronym "GEH" used in various legacy documents, although GVH and the above name is current for this company.



Decarbonizing the power generation industry is crucial to reaching net zero emissions. While the future of energy will be a mix of power generation technologies, low-carbon power sources like solar, wind and hydro aren't always available. Nuclear power plants operate at much higher capacity factors than renewable energy sources, making them a highly available power source for customers concerned about energy security.

The BWRX-300 SMR supports decarbonization efforts by delivering clean, always-available power to the grid and behind-the-meter applications. This nuclear reactor can also provide hot water and steam that can be used for district heating, clean hydrogen and fuel production, reverse osmosis, and direct air capture.

3.1. BWRX-300 SMR Features

The construction technologies incorporated into the BWRX-300 design adopt advanced concrete solutions and innovative techniques that have been proven in the petroleum, tunneling and power industries.

Using a combination of modular and open-top construction techniques, the Nth-of-a-kind BWRX-300 can be constructed in 24-36 months while achieving an approximate 90 percent volume reduction in plant layout. In addition, reducing the building volume by about 50 percent per MW should also account for 50 percent less concrete per MW—a significant improvement in both affordability and advantageous size.

An advanced reactor, the BWRX-300 uses natural circulation and passive cooling isolation condenser systems to promote simple and safe operating rhythms. In the global race for advanced nuclear power, the BWRX-300 sets itself apart with its proven, less complicated attributes

- *Reactor type: Boiling water reactor*
- *Electrical capacity: 300 MW(e) net to the grid*
- *Primary circulation: Natural circulation*

- *Fuel enrichment: 3.81% (avg)/4.95% (max)*
- *Refueling cycle: 12-24 months*
- *Approach to safety systems: Fully passive*
- *Design life: 60 years*

4. History

In an earlier post on this subject, I would have sent readers to the first “Nukes…” paper to understand where BWRs came from, and my qualifications for writing about these. Unfortunately, that 2018 paper is no-longer available on-line. But since your author never tosses any of his older documents, I have Nukes, and have put excerpts below to define this information.

When I worked for GE Nuclear, one of the (other) hats I wore was the facilities electrical engineer for GE's Vallecitos Nuclear Center near where I live (Livermore, CA). There were a couple of old decommissioned nuclear power plants on the site when I started working there (late 1970s), One of them, VBWR, had a nice bronze plaque that proclaimed it had been issued U.S. commercial power reactor license number-one.

The Vallecitos Boiling Water Reactor was the first privately owned and operated nuclear power plant to deliver significant quantities of electricity to a public utility grid. During October 1957 to December 1963, it delivered approximately 40,000 MWh.[7]

4.1. Generation I and II Reactors

VBWR was arguably the first member of "Generation I" reactors. These were the early-prototype and power reactors that also included Shippingport, Magnox, Fermi 1, and Dresden. The terms for four 'generations', were proposed by the US Department of Energy when it introduced the concept of generation IV reactors.8

A generation II nuclear reactor refers to the class of commercial reactors built up to the end of the 1990s. Typical generation II reactors include the PWR, CANDU, BWR, AGR, and VVER.

Generation II reactor designs generally had an original design life of 30 or 40 years. However, many generation II reactors are being life-extended to 50 or 60 years, and a second life-extension to 80 years may be viable.

4.2. Generation III and III+ Reactors

Generation III (Gen III) are the nuclear reactors currently being built. These are developments of the generation II designs incorporating evolutionary improvements developed during the lifetime of the generation II reactors. These include improved fuel technology, superior thermal efficiency, passive safety systems and standardized design for reduced maintenance and capital costs.

[7] Wikipedia Article on Vallecitos Nuclear Center, https://en.wikipedia.org/wiki/Vallecitos_Nuclear_Center
[8] Stephen M. Goldberg and Robert Rosner, American Academy of Arts & Sciences, "Nuclear Reactors: Generation to Generation", 2011, https://www.amacad.org/pdfs/nuclearReactors.pdf

Improvements in reactor technology result in a longer operational life (60 years of operation, extendable to 120+ years of operation prior to complete overhaul and reactor pressure vessel replacement). Furthermore, core damage frequencies for these reactors are lower than for Generation II reactors: 3 events per 1000 million reactor–years for the ESBWR, significantly lower than the 10,000 events per 1000 million reactor–years for BWR/4 generation II reactors. The first Gen III reactors were built in Japan, while others have been approved for construction in Europe.

Note the following reactors have been offered in the U.S. Market. Additional Gen III and III+ designs have been offered and/or built for the international market.

GE Hitachi Nuclear Energy Advanced Boiling Water Reactor (ABWR) and Economic Simplified Boiling Water Reactor (ESBWR): A GE Gen III design that first went online (ABWR) in Japan in 1996. Three additional ABWRs are operating in Japan, with two more under construction in Japan, and two in Taiwan. DTE's Fermi 3 plant may be the first ESBWR (Gen III+), but DTE has no immediate plans to start construction.

Author's comment: I did a bit of research on whether there has been any movement on Fermi 3, and there has not.

AP1000 Pressurized Water Reactor: is a Gen III+ nuclear power plant designed and sold by Westinghouse Electric Company. The plant has improved use of passive nuclear safety. A Westinghouse AP1000 became operational in Sanmen, China on June 30, 2018. Vogtle Units 3 and 4 are under construction and proceeding, although they continue to fall further behind schedule, the budget continues to escalate and they may face cancellation.[9]

Author's comment: I researched the status of Vogtle Units 3 and 4, and found the article referenced below. The short story is the excerpt below.[10]

Southern Nuclear and its stakeholders celebrated the completion of Vogtle Units 3 and 4: the first new commercial nuclear power construction project completed in the U.S. in more than 30 years.

[9] Megan Geuss, Ars Technica, The last nuclear reactors under construction in the US are facing opposition, 9-20-2018, https://arstechnica.com/tech-policy/2018/09/georgias-vogtle-nuclear-reactors-face-an-uncertain-vote-in-coming-days/

[10] Dot Schneider, Nuclear News, "A Series of Firsts Delivers New Plant Vogtle units," January 17, 2025, https://www.ans.org/news/2025-01-10/article-6658/a-series-of-firsts-delivers-new-plant-vogtle-units/