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Dennis Wamsted || Energy Finance Analyst, IEEFA

First-of-a-kind cooling plan at Fermi Nuclear Project likely to be costly, time-consuming

Westinghouse AP1000 reactor is not licensed to operate with hybrid cooling system

- Fermi America, a year-old startup with no completed power projects to its credit, wants to build a massive generation facility in the water-stressed region near Amarillo, Texas, theoretically to supply demand from new data centers.
- The company still does not know how it is going to cool its four planned nuclear reactors—meaning it also does not know what those systems are going to cost, how long they will take to construct, or even if those systems will be approved for use by the NRC.
- Fermi should not be able to proceed with construction of its planned reactors without securing NRC approval for its hybrid cooling system—a potentially time-consuming and expensive process since no large reactor in the U.S. has ever operated using anything other than water for its cooling systems.
- Fermi's plan to use a cooling system that is both unique and unlicensed is the opposite of standardization, and raises the real possibility that the cycle of cost overruns and construction delays that has plagued the U.S. nuclear industry will continue.

Introduction

The nuclear industry's argument for expansion has been "if only we can achieve a standardized design and repeat it over and over, then we can get costs down." The Westinghouse-designed AP1000 at Vogtle 4 has become the blueprint for this standardization for conventional large reactors, and the backbone of the administration's proposed 100-gigawatt (GW) expansion of nuclear power in the country.

Fermi America, a year-old startup with no completed power projects to its credit, has hopped onto this expansion bandwagon and wants to build a massive generation facility in the water-stressed region near Amarillo, Texas, theoretically to supply demand from new data centers. The company's plans include the proposed construction of four AP1000 reactors, with 4,456 megawatts (MW) of generating capacity, leveraging this "standard." There is only one problem: they want to completely change the cooling system to an unproven, unlicensed design.

The problems with Fermi America's plans have been evident from its initial licensing filings submitted to the Nuclear Regulatory Commission (NRC).

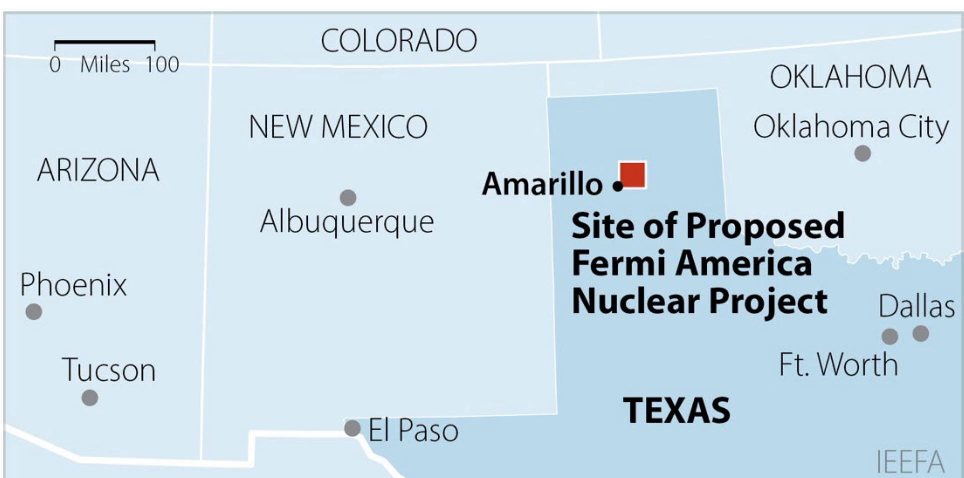
In one section, the company declared: "The operational phase of the AP1000 units at Fermi America will not rely on wet cooling towers. Instead, air-cooled condenser (ACC) systems significantly reduce consumptive water use, limiting demand to system makeup, domestic supply, and incidental process needs."[1]

In another, it acknowledged that the specifics of the cooling system have not yet been designed: "Fermi America's cooling system TO BE PROVIDED LATER [emphasis in original]."[2]

The two quotes raise significant questions about how Fermi is going to cool the reactors at its planned mega data center and power production campus in the Texas Panhandle. These questions have gone largely unanswered, overshadowed by the recent corporate blowup in which Toby Neugebauer, one of Fermi's founders, was removed as CEO, and the company's CFO, Miles Everson, resigned.

The company's problems have now broken out into a bitter proxy fight between Neugebauer and Fermi. How that will be resolved is uncertain, but it cannot be helping the company. Fermi's stock has been below $10 a share since early March, even before the executive shakeup, and it is down more than two-thirds from its initial opening price last October.

Figure 1: Fermi America's proposed nuclear site in the Texas Panhandle



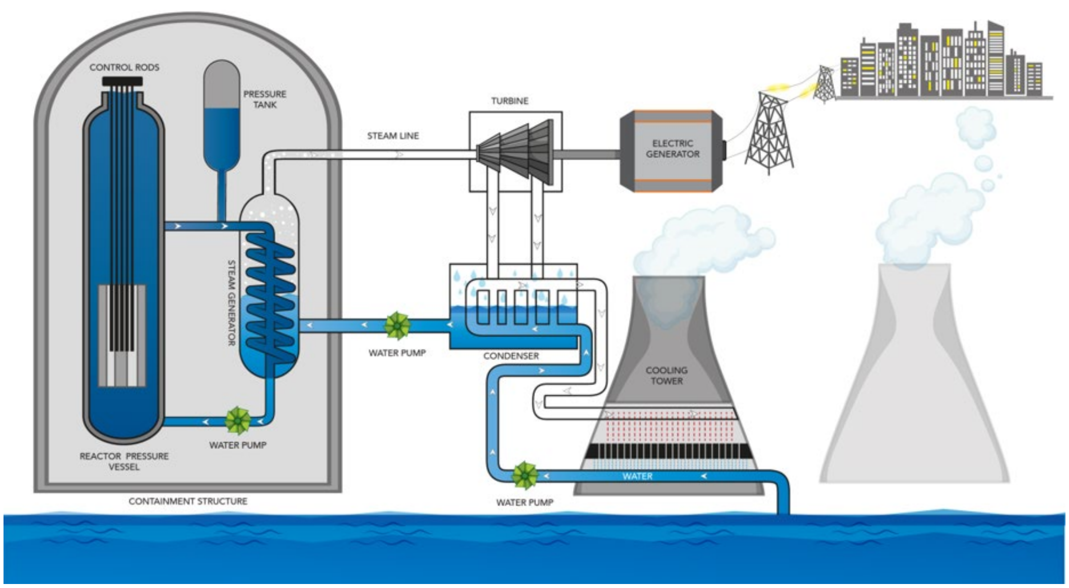
Source: IEEFA.

While the corporate shakeup and resulting stock battle have garnered most of the recent headlines, the questions regarding how the reactors will be cooled are as important, if not more so, than the startup's executive structure. Indeed, these questions tell a story about the uncertainty surrounding Fermi's nuclear construction plans, and point to significant risks both for investors considering funding the construction of the massive nuclear power plant complex, and data center developers and customers looking to lock in electricity supplies at competitive prices and on definitive timelines. IEEFA will unravel this story in the body of this analysis.

Nuclear power cooling needs

Strip away the radioactivity and conventional nuclear power is essentially just another way of heating water to produce steam and drive a turbine that generates electricity. In that sense, conventional nuclear is identical to coal and gas-fired power production; all three require systems to condense the rejected steam, cool the water, and return it to the heat source to begin the cycle again. Virtually all of these cooling systems are water-based: data from the Energy Information Administration (EIA) shows that there are only about 20,000 MW of dry or hybrid cooling systems in the U.S. spread across 83 plants.[3] Natural gas-fired combined cycle units account for more than 80 percent of that capacity since they have lower cooling needs than coal or nuclear plants. All of the operating nuclear reactors in the U.S., both boiling and pressurized water reactors (BWRs and PWRs), are cooled using water, either via once-through or recirculating systems. The graphic below illustrates the process for a PWR, which is the technology used in Westinghouse's AP1000 model.

Figure 2: Schematic of a PWR's cooling and power generation systems

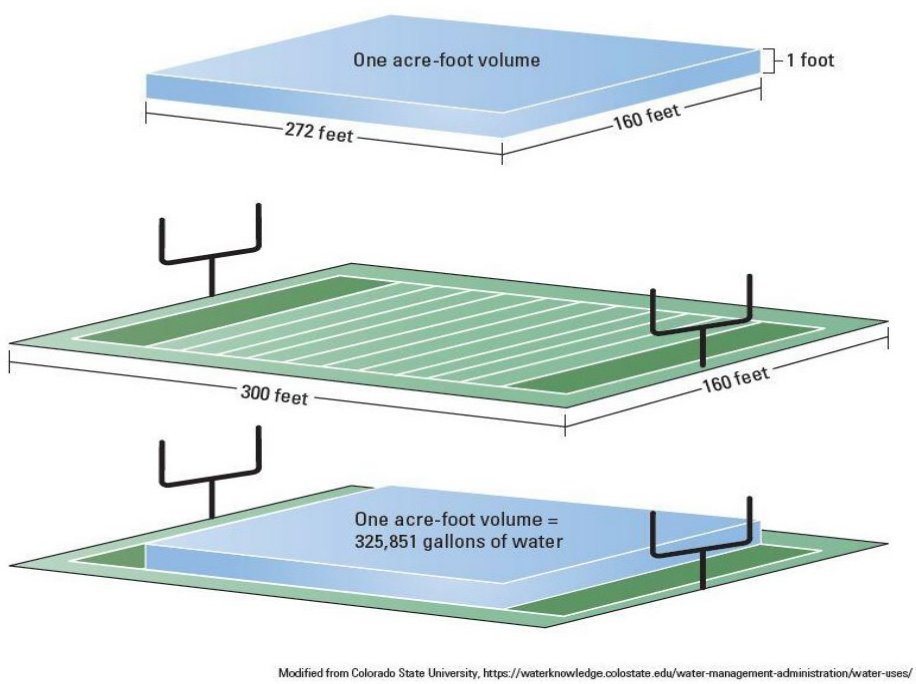


Source: DOE.

Currently, there are 96 nuclear reactors operating at 57 power plants across the U.S. Two-thirds of these facilities are PWRs with the remainder BWRs.[4, 5] All of them rely on water-based systems to condense the steam following power production, and it takes a lot of water to accomplish that task.

The two operating AP1000 reactors in the U.S., Units 3 and 4 at Southern Company's Vogtle nuclear power plant in Georgia, are permitted to use a maximum of 43,000 gallons of water per minute during operation.[6] That amounts to roughly 22.6 billion gallons of water a year, or 69,449 acre-feet.

Figure 3: The 69,449 acre-feet of water needed to cool Vogtle 3 and 4 each year is equivalent to an area nearly the size of a football field that extends 13 miles high



Source: USGS.

Given Fermi's project location in the water-stressed Texas Panhandle, the company's initial embrace of air-cooled technology is understandable. But as the next section shows, air cooling and nuclear power are not a good match.

Southern's verdict on air cooling at Vogtle: "not technically feasible"

In response to intervenor requests, Southern analyzed the possibility of using air-cooled condensers instead of water cooling during the licensing process for the two Vogtle AP1000 units. Its conclusions were categorical.

"The current reality is that an air-cooled system is not technically feasible for an AP1000 unit constructed at the Vogtle site," Southern Company wrote in its 2009 analysis.[7]

A key part of the problem, the company said, is that air-cooled systems simply are not as thermally efficient: more heat can be removed via evaporation than convection. Consequently, dry systems must be significantly larger than wet ones to achieve the amount of cooling required to keep power production at the same level; this significantly raises capital costs.

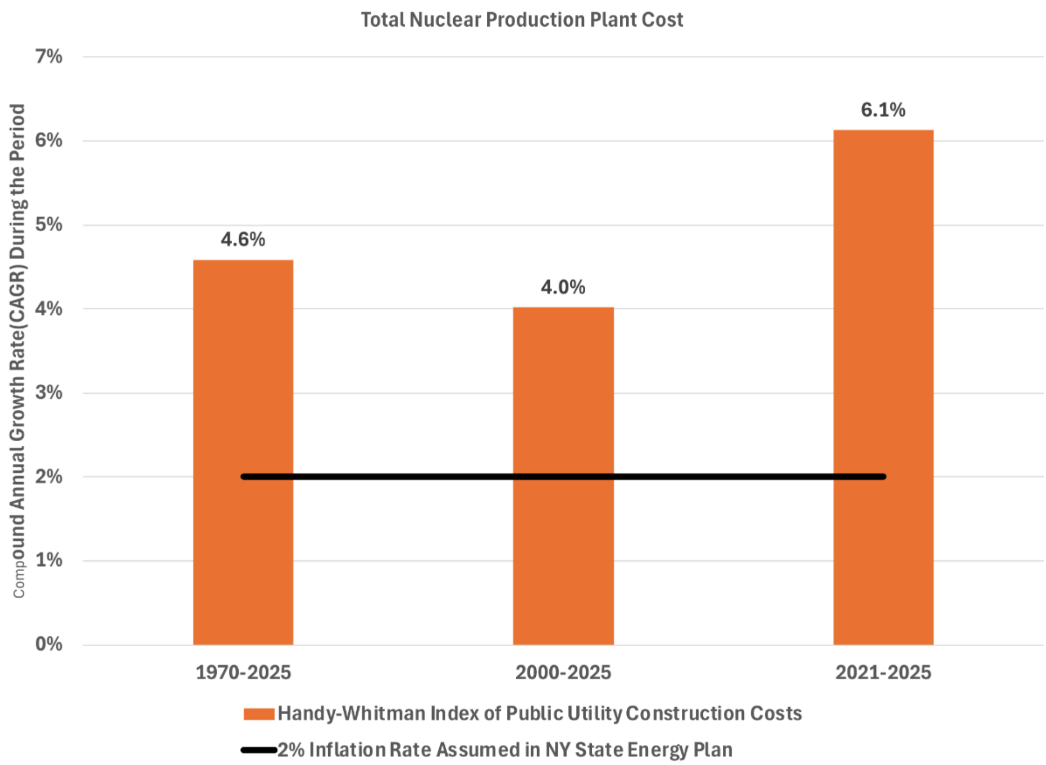
The only air-cooled nuclear reactor that operated for any length of time was at the Bilibino power plant in the Russian Arctic. That plant, consisting of four 12MW reactors, began operations in 1974; the final unit shut down Dec. 30, 2025. The plant's small size and the area's low temperatures made air cooling feasible.[8, 9]

While certain about air cooling's unsuitability for the AP1000, the Southern study did prepare two theoretical options. The first assumed that air cooled condenser (ACC) units could be used to replicate the performance of the wet cooling system, which Southern said would require significant advances in ACC technology. The second relied on current state-of-the-art performance numbers for ACC units. Doing this, Southern said, would require operational changes at the nuclear plant and stress steam turbine performance, particularly at temperatures above the design operating level of 95 degrees Fahrenheit. These temperature concerns would be even more pronounced at Fermi's Texas site, where summer highs frequently top 95 degrees.[10]

Either system would be extremely costly, Southern said. The capital costs of the two options were estimated at $445 million and $285 million, respectively. This would be as much as 6.5 times the cost of a conventional wet cooling system, Southern said. Both options would also require higher system power use, cutting the amount of electricity available for consumers, effectively raising the cost per megawatt-hour.

Escalating those estimates to current year dollars using the Bureau of Labor's Consumer Price Index (CPI) inflation calculator brings the potential capital costs to between $428 million and $668 million.[11] And those totals are almost certainly understated. Inflation has averaged 2.7 percent since 2010,[12] but a more indicative measure of utility construction cost increase has averaged 4% annually since 2000 and has jumped to 6.1% in the past five years.

Figure 4: Nuclear-related construction costs rising faster than general inflation



Source: Schlissel Technical Consulting.

"In summary," Southern wrote, "utilization of an ACC in conjunction with the deployment of an AP1000 unit at the Vogtle site is not feasible from the standpoint of technical viability, unit reliability, unit performance, and/or cost. Utilizing dry cooling would require an order of magnitude increase in capital expenditure only to produce less net power in a less reliable manner. Construction of a standard AP1000 unit on the Vogtle site utilizing dry cooling simply does not make sense."[13]

A subsequent study by the Electric Power Research Institute (EPRI) released in 2013 reached the same conclusion, particularly regarding the potential for using an ACC at a large-scale nuclear power plant in a hot environment. "It should be noted that the design for the Yuma, AZ, site is unrealistically large. Both the capital costs and the power costs for the 270 fans are exorbitantly high. The designs at the other sites [the report also looked at potential sites in Green Bay, WI, and Jacksonville, FL.] while less extreme still represent extremely high-cost solutions. It is likely that, given the constraints of current nuclear turbine designs, all dry cooling would not be selected for a large nuclear plant."[14]

Fermi moves toward hybrid cooling

By December 2025, Fermi had changed its tune on the project's cooling options, announcing an agreement with MVM EGI to begin "the design and development of hybrid dry–wet cooling towers, leveraging an existing, proven design platform to prioritize air-based cooling and dramatically reduce water use compared to conventional systems."[15]

Fermi described the agreement as a non-binding memorandum of understanding (MOU) under which the companies "will partner on preliminary engineering, and feasibility studies for a series of indirect hybrid cooling towers that will support both of Project Matador's 6 gigawatts of combined-cycle natural gas generation and four AP1000 nuclear units."[16]

Strip away the press release verbiage and what this means is that the company still does not know how it is going to cool its four planned nuclear reactors. And not knowing what exact system or configuration it plans to use means it also does not know what those systems are going to cost, how long they will take to construct, or even if those systems will be approved for use by the NRC.

The 2013 EPRI study referenced previously also looked at the feasibility of using hybrid wet-dry cooling systems for nuclear power plants. While possible, the study found that there would still be a significant cost increase compared to conventional wet cooling systems.

Specifically, it estimated that the capital costs of a hybrid system in the hot climate location (Yuma, AZ) would range from $206 million to $324 million, depending on the system's planned water savings. This would be 6-9 times more expensive than the costs of a conventional wet cooling system.[17]

MVM EGI was founded in 1948. One of its early products was an indirect dry cooling technology for power plants called the Heller System, named after its developers, Dr. László Heller and Dr. László Forgó). It is now a unit of MVM Group, Hungary's state-owned energy company.

Its principal manufacturing facility is located in China and as of 2023 it had installed more than 7,300 megawatts of dry cooling capacity there.

Its role in the U.S. has been limited to date, largely confined to smaller cooling infrastructure at gas turbine generation sites. It has not built any large power plant cooling units, nuclear or fossil fuel, in the U.S.

Adding annual operating costs and lost power production would worsen the comparison. The EPRI study pegged those costs at $9.2 million for a conventional wet system compared to $23.4 million to $26.1 million for the hybrid wet-dry system, with the range again depending on the system's planned water savings.

These costs are outlined in the table below, which also includes estimates for the Jacksonville and Green Bay locations. The numbers for those two sites underscore the significant cost penalty associated with locating a nuclear power plant in a hot, dry climate.

Table 1: Hybrid cooling costs much more than conventional wet systems

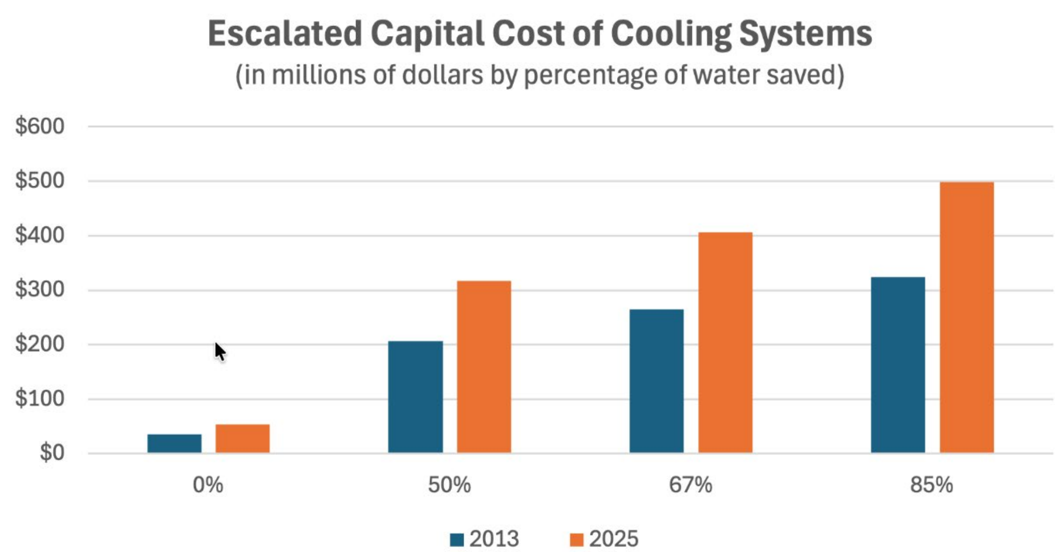
Cost comparison among sites					
			Hybrid—5 in Hga		
Site/Cost	Wet—3.5 in Hga	50%	67%	85%	Dry—7 in Hga
Yuma					
Installed cost	$34,800,000	$206,250,000	$264,270,000	$324,240,000	$226,980,000
Power + Penalty	$9,270,000	$23,475,000	$24,678,000	$26,199,000	$30,204,000
Annualized	$12,060,000	$40,095,000	$45,978,000	$52,329,00	$48,504,000
Jacksonville					
Installed cost	$37,800,000	$124,230,000	$161,190,000	$196,650,000	
Power + Penalty	$8,163,000	$19,278,000	$19,068,000	$20,406,000	
Annualized	$11,223,000	$29,298,000	$32,058,000	$36,246,000	
Green Bay					
Installed cost	$35,490,000	$106,140,000	$133,950,000	$164,670,000	$140,700,000
Power + Penalty	$8,742,000	$14,973,000	$91,811,000	$13,833,000	$21,531,000
Annualized	$11,592,000	$23,523,000	$25,611,000	$27,093,000	$32,871,000

Source: EPRI.[18]

The study added that the key factor driving capital costs, particularly at the hot weather location, is the expense associated with the air-cooled condenser. This is true, EPRI said, even at the moderate water conservation targets. The takeaway is that, as with the all-dry cooling option, the cost and risk associated with building the Fermi reactors cannot be pinned down since such a system has never been built for a large-scale nuclear reactor and is not currently even licensed in the U.S.

While the cost of the Fermi reactors' cooling system is uncertain, there is no doubt it is going to be extremely high, and much more costly than a conventional water-cooled system. Escalating the costs from EPRI's 2013 report to current day dollars pushes the estimated capital cost of all three hybrid cooling options well over $300 million, with the cost of the most water-efficient system—the one that would be most beneficial in the water-stressed Texas Panhandle—climbing to almost $500 million.

Figure 5: Cost estimates of hybrid systems jump with higher water savings goals



Source: IEEFA calculations, EPRI data.

Details from Fermi about its hybrid cooling system are incomplete, at best. Mesut Uzman, the company's chief nuclear officer, presented some details at an NRC meeting in March. He said that each of the four reactors will have two 600-foot-tall cooling towers and that they will be built with air-cooled condensers at the base and then have water-to-water heat exchangers above that.[19] But he did not offer any details on the towers' expected cost or licensing needs.

While the cooling system represents a clean break from the wet cooling used at Vogtle, Uzman stressed the need to use proven designs in his presentation. "[Fermi will] copy Unit 4 at Vogtle as much as possible."[20]

He also noted that delays in placing orders, particularly for long lead time items such as the reactor pressure equipment and the steam generators, effectively push out the reactors' completion dates day-for-day. The company's plans already have slipped by a year: when Fermi announced its massive project last year, it said the first reactor would be online in 2032; Uzman said 2033 was now the target date for Unit 1, but warned that even meeting that date means the company must move quickly this year.

The NRC question

Left unanswered by Uzman is the key question regarding how NRC will treat Fermi's plans to use alternative cooling systems for its four reactors, and what that means for the project's cost and ambitious construction schedule.

Westinghouse is currently working with the NRC to incorporate changes made during the construction of Unit 4 at Vogtle and have that unit certified as the reference plant for the reactor design in the U.S. This process involves updating what is called the design control document (DCD) for the AP1000. Each NRC-approved reactor has a DCD that includes all the technical details of its standard design; the current AP1000 revision is number 20. Assuming it is ultimately okayed by NRC, developers can then cite that approved design, speeding their application process.

The effort, the company said, "is part of Westinghouse's strategic plan to enable a fleet-scale deployment of the advanced AP1000 modular reactor and support President Trump's vision to build a U.S. fleet of large nuclear reactors."[21]

Standardization and repetition have been key goals of the nuclear power industry for years, with proponents preparing study after study showing that those measures should lower costs and speed deployment, thereby improving the sector's economic competitiveness.

Dan Sumner, Westinghouse's CEO, stressed this point when the company began the revision process at NRC in April.

"The AP1000 stands alone as the only fully designed, licensed and operating advanced modular reactor that is ready for construction right now. Establishing Vogtle Unit 4 as the standard as-built reference plant for all new AP1000 projects will enable Westinghouse and its partners to rapidly deliver multiple industry-leading AP1000 units simultaneously with more predictability. For our customers, the ability to deploy a standard plant based on an as-built and operating unit without the technology risk associated with a first of a kind, never built design is a game changer for unlocking fleet-scale deployment."[22]

There is one problem with that statement. The current AP1000 reactor design is licensed for construction in the U.S. using wet cooling, as was done at Vogtle Units 3 and 4. It is not licensed to operate using alternative cooling systems, and the current Revision 20 process before the commission does not include any changes other than those made at Vogtle 4.

As NRC told IEEFA: "The AP1000 DCD Revision 20 updates the design to reflect Vogtle Electric Generating Plant, Units 3 and 4, which are water cooled. It does not propose additional design changes. The potential for air or hybrid cooling is not considered in the current design. Any applicant wishing to utilize alternate cooling would have to come to NRC for approval."[23]

In other words, Fermi should not be able to proceed with construction of its planned reactors without securing NRC approval for its first-of-a-kind hybrid cooling system. This could be a time-consuming and expensive process since no large reactor in the U.S. has ever operated using anything other than water for its cooling systems.

This likelihood, in turn, should serve as a bright flashing warning sign both for financial entities considering investing in the Fermi reactor project and data center developers and users being wooed to locate at the site. Building the four reactors, already estimated to cost $41 billion, is likely going to take much longer and cost far more than those current forecasts.

The Fermi project also represents a big step backward for the industry's push for standardization as a cost-cutting measure. Indeed, Fermi's plan to use a cooling system that is both unique and unlicensed is the opposite of standardization, and raises the real possibility that the cycle of cost overruns and construction delays that has plagued the U.S. nuclear industry will continue.

Endnotes

[1] Fermi America COL Application, Part 1, General and Financial Information, Revision 0. P. 3-74.
[2] Fermi America COL Application, Part 2, Final Safety Analysis Report, Revision 1. P. 2.4-10.
[3] EIA. Some U.S. Electricity Generating Plants Use Dry Cooling. August 29, 2018.
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[10] National Weather Service records show that summer high temperatures were 95 degrees or higher an average of 18 days in August alone in 2023-2025.
[11] Cost escalation calculated from January 2010-January 2026 using the BLS.gov CPI inflation calculator.
[12] CPI inflation calculator. $100 in 2010 is equivalent to $152.72 today.
[13] Southern Company. Op. Cit. p. 25.
[14] EPRI. Advanced Cooling Options for Nuclear Power Plants. November 2013.
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[16] *Ibid*.
[17] EPRI. Op. Cit. 5-23.
[18] The cases developed by EPRI are based on the amount of pressure at the turbine's exhaust outlet, measured in inches of mercury (3.5, 5, and 7). Nuclear power plant turbines are generally designed to operate at a pressure of 3.5 or below. The higher pressures modeled, 5 and 7, would necessitate technology developments and operating changes.
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[20] *Ibid*.
[21] Westinghouse. Westinghouse Establishes Standard AP1000® Plant for Fleet-Scale Deployment in U.S. April 6, 2026.
[22] *Ibid*.
[23] NRC email correspondence with IEEFA. June 9, 2026.

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About the author

Dennis Wamsted

Dennis Wamsted is an IEEFA energy finance analyst who has covered energy and environmental policy and technology issues for 30 years. He is the former editor of The Energy Daily, a Washington, D.C.-based newsletter.

dwamsted@ieefa.org