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Global Technical Training Services, Inc. Newsletter

The State of the Industry

Sid Crouch, GTTSi Chief Technical Consultant

Net Zero needs nuclear energy! Yes, the nation's energy transition is happening, but no other technology except Nuclear can meet our transitional goals with affordability and reliability. **None.**

The nuclear industry, under the leadership of the American Nuclear Society (*ANS*), Nuclear Energy Institute (*NEI*), Institute of Nuclear Power Operations (*INPO*), and the Nuclear Regulatory Commission (*NRC*), is capitalizing on the opportunity and momentum that is building on our past performance, to promote the future of the nuclear industry. The nuclear industry is taking an essential role in our nation's climate strategy because it is the center of the net-zero future. It is critically important that we develop a new generation that truly understands the benefits that the nuclear energy industry delivers to climate strategy and society. We do have our challenges. We can't rely on supplies of enriched uranium from Russia…we need our own independent source of fuel. We also need to be unafraid to talk about our safety record. There has not been a single radiation-related death in our 70 years of civilian nuclear power operation, yet 13,000 deaths occur each year from the burning of coal according to the American Lung Association. In fact, since 2019, safety at our plants has increased by a factor of 10. We are not only getting safer, but even more reliable, with a capacity factor >90% for two decades – while wind averages 36% (*land-based wind ranges from 24% to 56%*), solar 20-25%, and hydro 44% (*range of 10% to 99% depending on water availability*).

I welcome your comments or questions - sid.crouch@gttsi.com

Highlights

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TERRAPOWER ON THE MOVE – TEAMING UP WITH GE HITACHI AND SOUTHERN CO.

TerraPower (*founded by Bill Gates*) recently secured $750 million to support development of their advanced nuclear energy technology and nuclear medicine. They have teamed up with GE Hitachi Nuclear Energy to commercialize their Natrium reactor design, an SMR (*Small Modular Reactor*) on the order of 345 MW that utilizes a molten salt energy storage system that can be used as an energy boost during peak electrical demand. The reactor operates at higher temperatures than conventional reactors, can use several different fuel sources, such as depleted or natural uranium or spent fuel assemblies from conventional operating reactors, and it provides a potential for process heat applications and thermal storage.

In addition, TerraPower, working in collaboration with the Advanced Reactor Demonstration Program (*ARDP*) and Southern Company, has completed a test facility called the Integrated Effect Test (*IET*) Facility at their laboratory in Everett, Washington. The IET is a multi-loop test facility, heated by a non-nuclear external power source, to validate the thermal hydraulics needed to demonstrate the molten salt energy storage system. TerraPower wants to commercialize their molten salt reactor technology to provide carbon-free energy to heavy industrial operations like water treatment plants, chemical processing plants, and other heavy industrial users.

Southern Company said, “This project culminates years of separate effects testing and is expected to demonstrate how the MCFR (*Molten Carbon-Free Reactor*) technology will perform in delivering a commercial-scale, cost-effective, carbon-free molten salt reactor energy source by 2035.” This seven-year, $76 million project began in 2015 to promote the design, construction, and operation of a Generation IV nuclear reactor. The project team included Core Power, EPRI, Idaho National Laboratory, Oak Ridge National Laboratory, and Vanderbilt University. The MCFR is separate from TerraPower’s Natrium reactor and integrated energy storage technology.

TerraPower is also working with GE-Hitachi to build their Natrium reactor design in Kemmerer, Wyoming, a southwestern city of 2,600 where the Naughton coal-fired power plant is located. Naughton Power Plant, owned and operated by PacifCorp, is scheduled to close in 2025. This reactor project will also establish a new metal fabrication facility scaled to meet the needs of this Natrium design demonstration project. And just recently, PacifCorp announced they are working with TerraPower to potentially deploy up to 5 more Natrium design reactors by 2035.

TerraPower is also building their Traveling Wave Reactor (*TWR*) which can burn mined uranium 30 times more efficiently than current reactor designs while greatly reducing the subsequent nuclear waste. This too is a sodium-cooled fast reactor. The TWR can use depleted and natural uranium as reload fuel, which would effectively extend the domestic (***continued***)

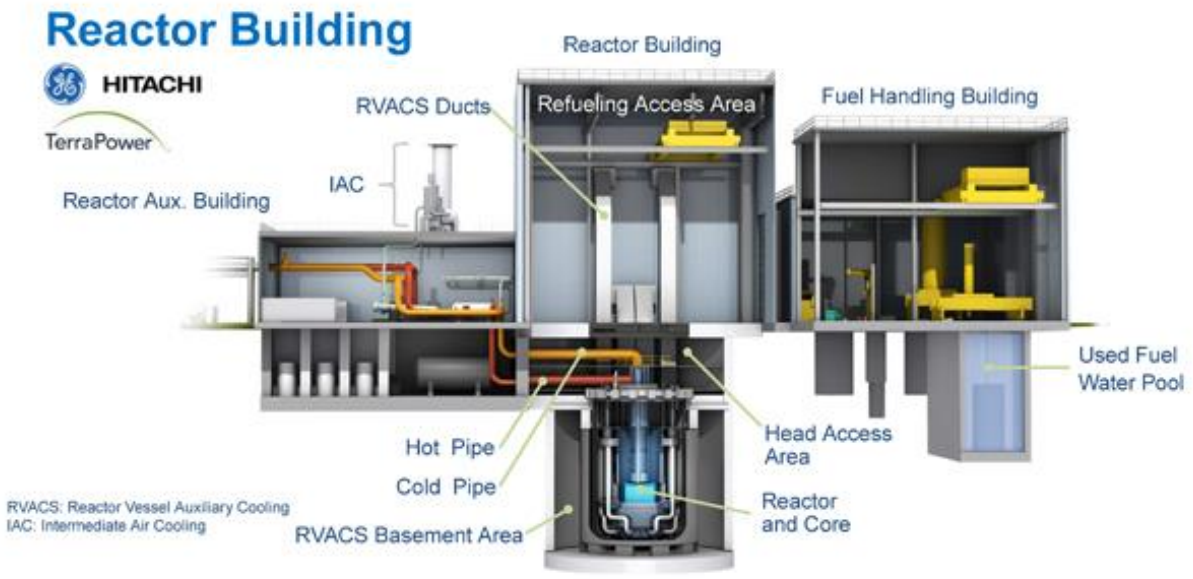
TERRAPOWER continued

reserves of the United States by hundreds of years. This can be achieved without the need to develop, fund, and build reprocessing facilities. After first using a low-enriched core to start the first reactor, an indefinite series of TWRs can be continued for hundreds of years without any ^{235}U enriched starter fuel. This simple once-through nuclear infrastructure could save trillions of dollars over the next 75 years.

The advantage of TWR's high-temperature low-pressure system, in the context of metal fuels and coolant, offers inherent safety features well beyond those of current reactors (*if theTWR is left unattended it will slowly shut down, making a catastrophic meltdown nearly impossible*) and the nuclear waste generated by the TWR is ~80% less heavy metal weight than that from the light water reactors (*LWR*) for each unit of electrical energy produced. This is very compatible with the bore-hole approach to nuclear waste disposal under development and testing in the United States and elsewhere.

Weapons-proliferation risks are reduced due to the reduced need of enrichment facilities, long-term isolation of the fuel in the nuclear island between infrequent decadal refueling outages, and the avoidance of reprocessing facilities. TerraPower estimates that current American stockpiles of spent nuclear fuel could be used in traveling-wave reactors to electrify the entire country for hundreds of years and far less expensively than current nuclear plants. This is carbon-free, baseload electricity that could easily provide the foundation for a next-generation, renewable-focused energy grid.

TerraPower is also working in the healthcare sector. Since small amounts of slightly radioactive material can be used in the treatment of cancers, TerraPower is developing advanced cancer treatments using Actinium-225. Currently Actinium-225 supply is limited; TerraPower believes they can use their "unique access" process to provide Actinium-225 to the pharmaceutical community.



Picture Source: NRC.gov

COMPRESSED AIR ENERGY STORAGE – AN ENERGY STORAGE ALTERNATIVE

60 MW / 300 MWh salt-cavern CAES facility, located in the province of Jiangsu

Photo Credit: ***pv-magazine.com***

CAES stands for Compressed Air Energy Storage. The first CAES facility, a 290 MW plant located in Germany, became operational in 1978 and is still in operation. In the U.S, Alabama Electric Cooperative began operation of its 110 MW McIntosh Facility in 1991 and it too is still in operation.

Global scientists have searched for decades to find low-cost methods to store excess electricity for use during peak energy demand. The two most common methods for energy storage - battery and hydro, have limitations. Batteries offer the highest energy efficiency – more than 90% – but are expensive. Hydroelectric storage – storing kinetic energy by pumping water to a higher place – has an efficiency of 70-80% but the facility must be built next to a dam, which is also expensive and requires extensive land. CAES uses up to 10x less land and 20x less water compared to pumped hydro systems.

Today there is a renewed interest in CAES technology with utility-scale projects announced in Canada, China, Israel, and the U.S.

In China, at least nine CAES plants have commenced construction or operations with a total capacity of 682.5 MW. Most of these store compressed air in containers but two are planning storage in salt caverns. The most recent is under construction for the 1st phase of the salt-cavern CAES project in the province of Shangdong. This 1st phase will have a capacity of 350 MW / 1.4 GWh (*gigawatt-hour*) and is scheduled to begin operation in 2024. When both phases are completed, a 600 MW / 2.4 GWh capacity is expected. Just a few months ago, construction started on a 100 MW CAES facility in the province of Hebei and this past May operation began of a 60 MW / 300 MWh salt-cavern CAES facility in Jiangsu.

In California, Hydrostor (*a Canadian-based company*) is planning for an Advanced – CAES facility. When completed it will be called the Gem Energy Storage Facility, located in Kern County near the town of Rosamond, with a capacity of 500 MW / 4 GWh. Although the project has had some setbacks, *(continued)*

CAES continued

the California Energy Commission (***CEC***) is in the process of producing a report, which will be followed by public meetings and the solicitation of public comments with a goal of having their staff report completed for review in 2023. Proponents claim the Gem Energy Storage Facility will help California meet its goal of 100% carbon free electricity by 2045.

In addition, Hydrostor has another facility planned for California in San Luis Obispo County – Pecho Energy Storage Center. This too will be an A-CAES facility with a capacity of 400 MW / 3.2 GWh. It was originally proposed for grid stability, as a spinning reserve that could provide peaking power for local contingencies and synchronous voltage support services while facilitating the integration of intermittent renewable energy sources after the retirement of the Diablo Canyon Nuclear Plant.

In Canada, the Hydrostor A-CAES Goderich Facility, located in Ontario, was brought online in late 2019. This facility has a 1.75MW peak power output rating, 2.2MW charge rating and a storage capacity in excess of 10MWh. The Goderich Facility plays into the merchant electricity market opportunities while also being capable of providing services to the grid of the Ontario Independent Electricity System Operator (***IESO***). Underground salt caverns are pumped full of compressed air, with the salt sealing cracks in the walls.

The Hydrostor A-CAES technology removes the heat generated by the compression process and stores it for later use, which increases the A-CAES process' efficiency over other compressed air technologies.

Hydrostor deployed its first small-scale demonstration plant in Toronto in 2015, before Goderich. They have plans for a 300-500 MW system being supported with funding from the government's natural resources department and Sustainable Development Technology Canada, a government-created clean energy funding foundation.

Seamus O'Regan,. Canada's Minister of Natural Resources said, "Investing in clean technology will lower emissions and increase our competitiveness. This is how we get to net zero by 2050." Although the site of this plant has not been disclosed, Hydrostor said it will be designed and built along the principles of the already-operating A-CAES system in Goderich.

Portion of the Goderich A-CAES facility visible above ground

Photo credit: ***energy-storage.news via Hydrostor***

THE MIGHTY MISSISSIPPI – DROUGHT STRICKEN

Just weeks ago, thousands of visitors walked across the riverbed in Tennessee to Tower Rock, a protruding formation about 100 miles southeast of St. Louis. It's the first time that tourists could make this trek and stay dry.

Photo Credit: Jeff Roberson/AP Photo

The Mississippi River is in serious trouble - nearly the entire stretch of the Mississippi River — from Minnesota to the river's mouth in Louisiana — has experienced below average rainfall over the past two months. As a result, water levels on the river have dropped to near-record lows (***pictured below***), disrupting shipping and barge traffic critical for moving recently harvested agricultural goods, such as soybeans and corn, downriver for export.

The lower water levels have revealed parts of the Mississippi that are usually inaccessible. On the border of Tennessee and Missouri, where the river is a half-mile wide, four-wheeler tracks can be seen snaking across vast stretches of the exposed riverbed.

The mighty Mississippi moves more than half of our U.S. grain exports but this drought has reduced the flow of goods by about 45%. In October, the U.S. Coast Guard said there had been at least eight "groundings" – barges hitting bottom and getting stuck in the mud.

From the electrical power perspective, these drought conditions could present some additional concerns since a total of 7,670 MW could be affected. The Mississippi River is 2,340 miles long and has 703 dams but only 20 conventional hydro-power plants with a total capacity of 395 MW. Eight of these dams are managed by the U.S. Army Corp of Engineers, while the remaining are owned and operated by private companies or municipalities. Six nuclear power plants use the Mississippi River for their cooling water – Prairie Island, Monticello, Quad Cities, Grand Gulf, River Bend, and Waterford 3 – with a total capacity of 7,275 MW.

Carrollton Gauge in New Orleans

Photo Credit: Chris Granger, The New Orleans Times-Picayune, courtesy of the University of Missouri Ag & Water Desk

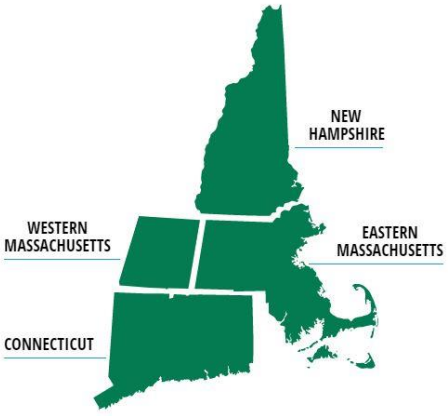
DID YOU KNOW?

Photo Credit: michiganradio.org

Hope springs eternal for the Michigan nuclear power plant, Palisades. The operating license for Palisades was transferred from Entergy Corporation to Holtec International for plant decommissioning services in June 2022. At that time, Entergy had determined they could no longer operate the plant due to economics and their inability to compete against cheaper and cleaner natural gas and renewables. Recent passage of the Inflation Reduction Act, may have provided a path for the plant to reopen. Holtec has announced they will make their decision - decommission or restart - by January. According to Patrick O'Brien, Holtec's Director of Government Affairs and Communications, a key factor is potential federal funding under a US Energy Department program aimed at providing aid to struggling nuclear plants. According to O'Brien, no U.S. nuclear site has ever been restarted after shutting down, but chances of Palisades being brought back online improved significantly after Michigan Governor Gretchen Whitmer voiced her support for the idea in September.

Rice University engineers and scientists have devised a new way for petrochemical industries to turn hydrogen sulfide (*that rotten egg smelling noxious and corrosive gas*) into "high demand" hydrogen. Current catalytic technology refineries work through a method known as the Claus process, which requires multiple steps and produces sulfur, but no hydrogen which is converted into water. Hydrogen sulfide emissions can result in hefty fines for industry, and remediation is very expensive. This light-activated nano-catalyst process is a game changer because it is economical and efficient – 20 times better than thermo-catalysis. It uses visible light with no external heat source to produce "hot carriers" – high energy electrons – that drive catalysis and converts hydrogen sulfide directly into hydrogen gas and sulfur.

Photo Credit: audioundwerbung/iStock



Picture from eversource.com

The Federal Energy Regulatory Commission (***FERC***) held a forum in Burlington, Vermont and outlined a potential catastrophe that could impact New England over the winter. Why? Because the region has become overly reliant (*more than 50%)* on natural gas for power and should an extremely cold winter befall the United States, grid operator ISO-New England said the supply of natural gas to the region could become so strained that generators could not produce power. In response to the potentially dire situation, Joe Nolan, President and CEO of Eversource, the largest New England electric utility **with 4 million customers in Massachusetts, New Hampshire, and Connecticut,** sent a letter to President Biden asking him to take immediate action to remedy the situation. He could issue a ***Jones Act waiver*** – allowing shipment of natural gas via foreign-flagged vessels – because the U.S. doesn't own any natural gas tanker ships and can't deliver domestic natural gas by ship under the current rules, or exercise emergency authority under the Federal Power Act, Natural Gas Policy Act, or the Defense Production Act to allow delivery of natural gas to New England..

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