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Global Technical Training Services, Inc. Newsletter

The State of the Industry

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The 93 operating commercial nuclear reactors in the U.S. generate ~2,000 metric tons of spent fuel each year resulting in 88,207 metric tons of spent fuel to date overall. While this may sound like a lot, if it were stacked up, it would fit on a single football field at a depth of less than 10 yards. The fuel is comprised of small ceramic pellets of low-enriched uranium oxide, stacked vertically and encased inside a metallic cladding to form a fuel rod. The fuel rods are bundled together to create one fuel assembly. We have 304,751 fuel assemblies stored at over 70 nuclear reactor sites in 37 states, with half the spent fuel stored in fuel pools and the other half stored via dry cask storage at the sites. This spent fuel *could* be recycled to make new fuel…but it's not. The major obstacle is nuclear weapons proliferation. In 1976, concerns over nuclear weapons proliferation led President Gerald Ford to issue a Presidential Directive indefinitely suspending commercial reprocessing & recycling of plutonium in the U.S. Then on April 7, 1977, President Carter banned reprocessing of commercial reactor spent fuel despite other countries, such as France, Japan, Germany, Belgium, and Russia, reprocessing their fuel to generate electricity and reduce their radiological waste footprint. In 1981, President Reagan lifted the ban, but did not provide enough subsidy to incentivize companies to start up reprocessing. In 1999, the Department of Energy reversed its policy on reprocessing and signed a contract to design and operate a MOX (***mixed oxide***) Fuel Fabrication Facility at the Savannah River Site. In 2016, President Obama called for termination of the facility and in 2018, Energy Secretary Rick Perry notified Congress that the facility project had ended.

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

Highlights

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GREEN MOUNTAIN POWER'S INTEGRATED RESOURCE PLAN TO END OUTAGES

Ten years ago, on Dec. 29, 2014, the Vermont Yankee Nuclear Power Plant, which had been providing 620 megawatts of reliable baseload power to the state, was shut down. Upon its closure, the loss of baseload could not be offset by the in-state power plants; therefore, power was needed from neighboring states and Ontario-Hydro to ensure adequate supply of electricity to Vermont.

Today, the struggle to meet demand and provide reliable, resilient power has continued for Vermont. Now Green Mountain Power (GMP), the largest service provider in the state, has offered a plan to their Public Utility Commission that will answer the issues challenging services to their customers. In fact, they are touting a first in the US, saying, "in about six years, the power will never go out again."

Green Mountain Power, which has about 270,000 customers, has filed a first-of-its-kind plan with state regulators that the company says will end outages for its customers by 2030. In the first two years, they need approval of up to $280 million to bury transmission lines, strengthen overhead lines to better withstand damage from falling trees, and supply homeowners in some rural areas with battery backup energy storage units. $30 million will be used for battery energy storage, the remainder for underground and storm hardening lines.

In the last 12 months, GMP has spent $45 million on storm repairs - the most in one year ever - dealing with three of the most damaging storms in the company's history. GMP already installed 50 miles of underground lines in rural residential areas, and those customers did not experience damage to those lines during these major storms. In addition, where spacer cables were installed, the trees outside the rights-of-way that fell on the lines, did not cause an outage.

Customers will have to pay for it. GMP says the average homeowner's bill will increase about 2%, but that it must be done because of climate change. Extreme weather in Vermont has cost the company $115 million since 2014, 60% of that in the last five years.

Regulators are expected to take six to nine months to review the plan. GMP said if the plan is approved, they will begin work in the spring of 2024 and start in the central and southern parts of Vermont. After the first two years, GMP will go back to the commission to bring their ***2030 Zero Outages Initiative*** statewide. The total price tag for this initiative could reach $1.5B.

The Zero Outages Initiative would provide residential batteries to customers in remote locations, delivering resiliency where it is needed most first, with a goal to have all customers with energy storage. GMP would control the batteries, allowing them to be programmed to store excess solar and wind energy from the utility's system for frequency stabilization and to dispatch this power during periods of peak demand.

GMP has several initiatives they say will allow partnering with customers while integrating innovative approaches. Examples include GMP's home battery programs, community microgrid and Resiliency Zones, and a resilient all-electric neighborhood which is under construction.

GREEN MOUNTAIN POWER

WORLD'S MOST ROBUST NUCLEAR FUEL

The support for nuclear energy is surging in the U.S. with many states supporting SMR (***Small Modular Reactor***) development. Federal support such as the Inflation Reduction Act, $700 million for High-Assay Low-Enriched Uranium (***HALEU***), and an extra $2.5 billion from the Bipartisan Infrastructure Law has brought about renewed investment and interest for the nuclear energy industry.

There are more than seventy projects underway in the U.S. for new reactor designs, many of which are being touted as less expensive to build and operate than traditional nuclear plants. Many of them will require HALEU (***high-assay low enriched uranium***) fuel and the fuel needs to be able to handle operation at higher temperatures than current PWR and BWR reactors - also called light water reactors (***LWR****s*).

One such fuel is called TRISO (***tri-structural isotropic***) fuel. The Department of Energy (***DOE***) said that TRISO fuel is the most robust nuclear fuel on earth. Each TRISO particle is a uranium, carbon, and oxygen fuel kernel. The kernel is encapsulated by three layers of carbon-and ceramic-based materials, preventing the release of radioactive fission products by capturing them within the kernel.

In 2009, TRISO fuel was improved by the DOE by using uranium oxycarbide fuel kernels. During a 3-year test at the Idaho National Laboratory ***(INL)***, the improved TRISO fuel set an international record, achieving a 19% burnup with excellent fuel performance, nearly doubling the previous mark set in Germany in the 1980s. This amount of burnup is three times greater than current LWR fuel burnup, demonstrating long-life capability.

The fuel can be fabricated into cylindrical pellets or billiard ball-sized spheres, called "pebbles," for use in high temperature gas or molten salt-cooled reactors. It can also be fabricated to accommodate LWR and CANDU reactors.

TRISO fuel is structurally resistant to neutron irradiation, corrosion, oxidation, and high temperatures. These fuel particles are so resilient that irradiated TRISO fuel can withstand temperatures well above current fuels. In fact, it was exposed to 300+ hours of testing at temperatures up to 1800 °Celsius/ 3272 °Fahrenheit, temperatures greater than the those predicted for worst-case accident conditions of high-temperature gas reactors. In addition, the TRISO fuel showed minimal to no damage with low fission product release.

In October 2023, X-energy announced their Xe-100 SMR will use TRISO fuel. The Department of Defense has shown interest in the Xe-100 SMR and recently expanded their contract with the Project Pele initiative which will be located at INL, aimed to develop a cost-effective nuclear microreactor prototype for use in remote military locations.

Other partnerships include the Dow Chemical Co., which has agreed to employ up to four of X-Energy's reactors at a Texas site, with construction slated for completion by the end of this decade. Furthermore, Texas Governor Greg Abbott has shown enthusiasm for nuclear energy in his state, including X-energy's reactors. In a recent collaboration with Energy Northwest, X-energy has inked a joint development agreement for up to 12 Xe-100 SMRs to provide 960 MW of clean energy for central Washington.

SPECIAL EDITORIAL BY SID CROUCH: OUR TROUBLING GRID AND THE DYNAMICS OF OUR ELECTRICAL SYSTEM.

Years ago, the US electrical system was dominated by the utilities who owned the poles, wires, and power plants that brought the power to America. But today, major portions of our electrical system have been restructured into power markets that function like auction houses in which power plant owners have to bid to supply power to the grid. This came about through "*deregulation*," which promised to give the little guy the opportunity to compete with the big boys and decrease the cost of electricity. In the beginning, cost was reduced, but at the expense of grid ***reliability***.

To keep the electrical system running, RTOs (***Regional Transmission Organizations***) formed new market structures which resulted in more regulation. These market structures are controlled by a network of insiders (***traders***), selected by the RTOs. These traders are not responsible for "***keeping the lights on.***" Instead, they prefer volatility to stability. Why? The traders want volatility – making them money. What's good for traders isn't necessarily good for the country.

For example, in New England, auctions for power are split in two categories: *energy* and *capacity*.

An energy auction happens just five minutes ahead of the provision of supply to meet grid's demands, and the low-priced unit(s) get picked first, requiring all other power plants to be paid the same price as the highest of the low-price plants chosen, called the "clearing price".

Capacity auctions look into the future, anticipating the electrical needs. This requires power plants to be available whenever the grid might need them. However, that doesn't mean they will always be available, as evidenced by severe weather events where natural gas pipelines often freeze, or at best can't receive the flow of gas needed to produce full power. In the case of renewables, the sun may not be shining, or the wind may not be blowing. So, their ability to provide "just in time" supply is not reliable.

L V Sutton Plant (Gas replaced Coal)
Photo Credit: Wilmington Star/News

In either case, these auctions do not focus on reliability, but focus on fairness in competition - often resulting in power redistribution or brownouts, when the customers need reliability.

These auctions hurt baseload plants (***nuclear & coal***) but promote more natural gas plants because they can ramp up or down as the grid demand changes. Nuclear and coal plants are built to run at a steady load, most of the time, providing a baseload supply to the grid. Since the 1990s, natural gas has risen to supplying nearly 40% of our electrical needs. In addition, switching from coal to natural gas has helped to decrease our overall carbon emissions, but there is an important difference between natural gas and our baseload plants, they don't store fuel onsite - completely reliant on the pipelines.

In 2021, 80% of all renewables were associated with an RTO. This increases the electric system's volatility as renewables produce *(continued)*

power intermittently, making the rest of the system work around them. Natural gas, with its fast-acting turbines, has proven to be the ideal partner - most renewable projects are planned with backup by natural gas plants.

The heavily subsidized renewables make it almost impossible for baseload power plants to stay in business because wind and solar renewables can bid at a cost of zero or below, and still make money due to their subsidies – in turn, our reliable baseload plants are then forced to supply power at the "clearing price". This has brought about a fictitious signal to the markets since renewables are making money, and the baseload plants are not. So, the traders want to retire the baseload plants and bring on more renewables, which will only create more volatility (***checkout September 13, 2023, blog article on the Duck Curve***) and increase our electricity costs.

Because reliability is no longer the focus and the pursuit of a renewables-only climate policy continues (***as evidenced by the subsidies and incentives initiated by the Inflation Reduction Act***), we will see more regions of the country without enough power to meet their demands and subsequently rely on their neighbors to help bail them out. Like California - where many of their utilities import power from power plants in Arizona and Utah. They also import electricity from hydro power plants in the Pacific Northwest, largely across high-voltage transmission lines running from Oregon to the Los Angeles area. Eventually, more and more regions of the country will be needing to import power from their neighboring states, but they will find their neighbors are also facing similar issues and will be unable to help them.

Photo: James E. Rogers Energy Complex
Photo Credit: Power Engineering

This overdependence of 1) renewables, 2) natural gas, and 3) the import of power from other states is a big threat to our grid network – making our grid extremely vulnerable. Just how long can grid operators continue to redistribute power - borrowing power from others to meet the ever-changing demands? The more volatile our grid becomes, the less capable the redistribution of power will become, and eventually supply and demand will get out of tune, and blackouts will roll.

Renewable proponents tout energy storage as the answer. They justify higher percentages of wind and solar generation based on energy storage. But our best and largest energy storage systems are pumped storage hydro. Like Duke Energy's Bad Creek or TVA's Raccoon Mountain. Bad Creek is rated at ~2,800 MW and TVA's Raccoon Mountain at ~1,650 MW of storage. Our entire pumped storage hydropower fleet has about 22 GWs (***gigawatts***) of electricity-generating capacity and 550 GWh of energy storage. The "h" after GW means hour, which means the electricity stored is good at the rated capacity for one hour. There are other alternatives for energy storage – batteries and hydrogen. Our largest battery electric storage system (***BESS***) is at the Moss Landing Plant in California – rated at 3,000 MWh.

Battery energy storage gives the RTO enough time to startup gas turbines or buy power from a neighboring utility on the grid. *(continued)*

Hydrogen can also be a source of storage; however, it must be remembered that it takes about four times the input of electricity to produce one unit of Bulk Power from hydrogen. **The most reliable, proven, safe, and affordable form of Energy Storage is a large pile of coal, located onsite at a clean, efficient coal power plant. It is common for coal power plants to have a 30 to 60-day supply of coal stored at their site.**

Hopefully, you see, it is impossible to replace fossil fuels with wind and solar any time soon. Attempting to do so will create hardships, economic decline, and weaken our country and our National Security.

Nuclear power generation is a zero-carbon source of electricity but to increase our nuclear power generation supply chain will take decades and instead we have been steadily eliminating these plants. Since 2013, ten nuclear power plants have been shut down – a loss of 8,181 MW.

Unless the current path to Net-Zero is stopped, America faces shortages of electricity, including rolling blackouts - especially during extreme weather events. As you know, Texas spent the summer, especially the better part of August, on the brink of blackouts. According to energy analyst Brian Bartholomew, the Texas power market, ERCOT, saw successive days at over $1 billion in market costs.

The PJM (***Pennsylvania, New Jersey, Maryland***), the largest RTO power market in the country, warned that the reliable power plants in its footprint are all marching towards closure by the end of this decade – in fact, 40 GWs (***21 % of their installed capacity***) is at risk of retiring by 2030 - enough to power 30 million households. This is bad news for PJM's neighbors, especially MISO (***Midwest Independent System Operator***), which relies on PJM's spare capacity whenever its renewables underperform, and Hydro-Québec, upon whose power both New York and New England's grid operators have come to rely on, especially during the winter months. Now Hydro Quebec worries it has oversold itself to its neighbors and Ontario Hydro, which sold Québec the power it needed to stabilize the Northeast, this winter, has ended its winter power contracts with Québec. If this contract is not renewed, natural gas is the best hope for electric reliability in the Northeast.

All of this is mushrooming into a full-blown reliability crisis. Even the commissioners at FERC (***Federal Energy Regulatory Commission***) are beginning to speak up. Earlier this year, all four commissioners testified before the Senate that America is hurtling towards calamity in its power sector. "This problem is coming. It's coming quickly," commissioner Mark Christie told the Senate. ***"The red lights are flashing."***

If only more of the current administration could see it. We are doling out hundreds of billions of dollars to renewable energy projects - while incentivizing the mass adoption of electric vehicles. In other words, we are destabilizing our electric supply while increasing its demand.

Recently, the Environmental Protection Agency (***EPA***) announced their plans to put new power plant emissions rules into place. Several of our grid operators have spoken out against these rules, saying it will shutter much needed reliable power plants (***coal and natural gas***). Department of Energy's Jigar Shah recently described the reliability threat posed by over-building wind and solar as a "rumor." However, one week later, the North American Reliability Corporation (***NERC***), a nonpartisan non-profit organization dedicated to monitoring the grid's integrity, ranked our current energy policy as the number one threat to the grid.

Wake up America before it's too late! Our energy and electrical supply are being decimated, one coal, gas, and nuclear power plant at a time.

DID YOU KNOW?

Photo Credit: Progressive Engineer

The New York Power Authority (NYPA) is leading the way in New York for green hydrogen. In conjunction with GE Vernova, EPRI, Sargent & Lundy, Fresh Meadow Power, and Airgas, an Air Liquide company, a retrofit of their natural gas facility at the Brentwood Power Station (pictured left) on Long Island in Suffolk County, New York has been completed successfully. This was the first retrofit of an existing U.S. natural gas facility to operate on a blended mixture of natural gas and green hydrogen.

The 2024 Deloitte Report sees many opportunities for growth in the clean energy sector while also noting continued challenges for renewable deployment. Although the Inflation Reduction Act (***IRA***) and the Infrastructure Investment and Jobs Act (***IIJA***) have stimulated growth for renewable energy, paving the way for decarbonization, they have also brought on new issues including exacerbating grid, supply chain, and workforce challenges. Its real impact will be realized in 2024. In 2023 growth in the solar market continued while the wind electric generation industry faced sweeping challenges. In addition, limitations were experienced due to labor and capital cost pressures, interconnection and permitting delays, and transmission capacities.

Photo Credit: Westinghouse

Westinghouse has secured their first customer for the eVinci Nuclear Microreactor (pictured left). The 5MWe/13-MWth microreactor also referred to as a “nuclear battery” is planned as a pilot project for the Saskatchewan Research Council ***(SRC)***, Canada’s second-largest research and technology organization. SRC, who will serve as the microreactor’s licensed operator, stated, “We will be working with Westinghouse to learn how this technology can be applied in Saskatchewan, and part of that will be to understand project costs for future deployments.”

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