



April 2022 Newsletter



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The History of Nuclear Fuel is a Tale of Innovation & Still Ongoing



PWR 16 × 16 BWR 10 × 10

“LWR fuel assemblies operate in an unforgiving environment of high pressure, high temperature, and neutron flux. In addition, it has to endure challenging chemistry conditions, steep temperature gradients, uncompromising hydraulic loads, and flow anomalies. All of this is accomplished safely and reliably 18 - 24 months at a time, providing zero-emission energy that powers our homes, businesses, and factories. The fuel pellets and fuel rod cladding also serve as a fission product barrier, preventing the release of radioactive products, such as gases, to the plant and the environment. And economically - its cost is much less than other alternative fuels.”

Commercial nuclear fuel for LWR (*light water reactor*) power plants is an amazing product. As the cornerstone of nuclear power, it has steadily evolved in terms of performance, safety, reliability, and economics.

LWR fuel assemblies operate in an unforgiving environment of high pressure, high temperature, high neutron flux, steep temperature gradients, challenging chemistry, with uncompromising hydraulic loads, and flow anomalies. But they do all of this reliably for 18 - 24 months at a time, providing zero-emission energy that powers our homes, businesses, and factories.

Even after its energy production days are over, we expect it to maintain its integrity for decades, or even centuries, during storage, transportation, and ultimately disposal.

From a safety perspective, the fuel pellets and fuel rod cladding serve as a fission product barrier, preventing the release of radioactive products, such as gases, to the plant and the environment. From an economic perspective - its cost is much less than other alternative fuels, which allows nuclear power plants to provide reliable energy at a relatively low cost. It is the up-front capital cost, operations and maintenance, regulation, and decommissioning that drive up the overall cost of our highly regulated

industry. But LCOE (*levelized cost of electricity*) from nuclear is moving lower and the positive attributes, such as reliability, resiliency, and zero-carbon emissions are moving sentiment to the realization of its benefits.

Over the past few decades, nuclear fuel has really improved. In its early days - 60's, 70's, and 80's - it was no big surprise when a reactor experienced a leaking fuel rod assembly during operation. However, the nuclear industry did not accept this as “status quo”, and changes were made in many areas that resulted in improvements in fuel assembly performance. Such as, fuel design enhancements (*e.g., debris-resistant bottom nozzles, corrosion-resistant cladding*), better analytical methods (*e.g., computational fluid dynamics, real-time pellet-cladding interaction modeling*), improved quality control in fuel manufacturing facilities, and stringent foreign material exclusion practices at reactors.

With these improvements we still had ~25% of our reactors with at least one leaking fuel rod in 2006. But that year the industry kicked off its Zero-by-Ten initiative to eliminate fuel failures during normal operation - INPO (*Institute of Nuclear Power Operations*), EPRI (*Electric Power Research Institute*), fuel vendors, and utilities, all participated and during

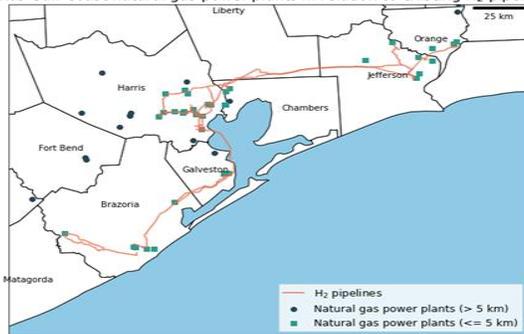
the 2010's it was reduced to ~5%.

Today - fuel vendors are developing and testing additional fuel improvements, such as coated cladding, doped pellets, and new cladding and pellet materials. We now have funding support from the DOE (*Department of Energy*) for the Accident Tolerant Fuel Program with technical support from national laboratories and universities. The industry is considering higher enrichment fuel (>5%) and higher burnup for LWR fuel. Advances in materials and manufacturing techniques could unlock additional performance and reliability improvements. But these improvements come at a cost, so the key question is, which of these improvements are cost-justified, considering the exceptional performance of nuclear fuel today?

Different fuel designs will be needed for advanced reactors (*e.g., metal fuel, TRISO fuel, HALEU fuel, even liquid fuel*). But fuel performance and its economics is a must if the designs are to be deployed on a large scale. Leaving current fuel design will be a departure from our technical comfort zone, but a necessary one if the potential advantages of advanced reactors are to be realized. But our experience from the past coupled with our programmatic knowledge will help us meet the challenge.

Could Hydrogen Lower Emissions & Keep Nuclear Plants Operating?

Texas Gulf Coast natural gas power plants in relation to existing H₂ pipelines



“Hydrogen is currently being used in the oil refining industry and as a feedstock for fertilizer production in the U.S. But hydrogen is also one of the few fuels that burns without producing carbon dioxide, our most common greenhouse gas – environmental public enemy number 1. Utilities are gravitating to hydrogen fuel blends for their natural gas plants with an aim to burn 100% hydrogen by 2045. This emphasizes the approach by our nuclear power plants to explore production of hydrogen at their facilities via electrolysis.”

Hydrogen is currently being used in the oil refining industry and as a feedstock for fertilizer production in the U.S. But hydrogen is also one of the few fuels that burns without producing carbon dioxide, our most common greenhouse gas. Thus, hydrogen is also a potential solution to help decarbonize the economy, including electricity. Over the past few years, strides have been made in the development of power plants, particularly natural gas turbines and combined cycle system plants, that have the ability to burn hydrogen fuel blends. In Texas, Energry Texas is building a 1.2 GW Orange County Advanced Power Station near Bridge City, Texas that is designed to burn a blend of up to 30%

hydrogen (*pictured below*). Also in Texas ... El Paso Electric is working with Mitsubishi Power Americas to obtain an 80% carbon-free resource mix by 2035 and develop a roadmap to achieve a 100% carbon-free energy mix by 2045. Their strategy will focus on the utility using hydrogen to generate energy across its power generation fleet. Part of that plan includes conversion of their newest unit at Newman Power Station from all-natural gas generation to a blend of up to 30% hydrogen, and eventually to all hydrogen. In addition, their 840 MW Intermountain Power Plant located in Delta, Utah will combust a mix of 30% hydrogen (*by volume*) and 70% natural gas fuel when they go online in 2025. The contract requires that the plant’s hydrogen capability will transition to 100% hydrogen by 2045, enabling its operator and majority power purchaser, Los Angeles Department of Water and Power, to meet California’s stringent climate goals. While

these projects are promising, currently there are ~ 464 GW of natural gas turbine-driven power plants in the US, with most of them unable to burn high hydrogen fuel blends.

The Texas Gulf Coast is home to the largest hydrogen hub in the US. It consumes ~9 million kg of hydrogen per day, or about 1/3 of our total consumption in the U.S. The region is also home to the most extensive hydrogen pipeline network in the country, with ~ 440 miles of pipelines moving hydrogen throughout the region, to and from Louisiana. However, most of this hydrogen is being produced via steam methane reforming (*SMR*) - converting natural gas to hydrogen, which emits carbon dioxide as a waste product.

This results in an overall greater carbon emissions than just burning 100% natural gas. Therefore, to reduce carbon emissions, hydrogen generation by electrolysis or SMR with carbon capture is the best solution from an emissions perspective.



This emphasizes the approach by our nuclear power plants to explore production of hydrogen at their facilities via electrolysis. These power plants could produce hydrogen via electrolysis during low grid load operations, as an alternative “best practice” method for hydrogen production.

Gemini Solar Project Announces Kiewit Energy Group as EPC Lead



“Kiewit Energy Group (part of Omaha, Nebraska-based Kiewit, a company with a long history of power plant construction projects) as the project’s engineering, procurement, and construction lead for the Gemini Solar Project. This project, scheduled for completion in 2023, will be one of the largest solar projects in the United States. Total cost is ~\$1.2 billion and will sit on 6,500 acres with ~1.8 million solar modules and battery energy storage facilities capable of providing ~1400 Mw-hours of electricity.”

The Gemini Solar Project, when completed, will be one of the largest solar projects in the United States. This \$1.2 billion project will sit on 6,500 acres (pictured above) and is planned for completion in 2023.

It will consist of ~1.8 million solar modules providing 690-MW(ac) / 966-MW(dc), coupled with 1,416 MWh of battery energy storage and create about 1,000 jobs during construction.

Recently, Oakland, California-based Primergy Solar, part of Australia-based Quinbrook Infrastructure Partners and Gemini’s developer, owner, and operator, announced it has chosen Kiewit Energy Group (part of Omaha, Nebraska-based Kiewit, a company with a long history of power plant construction projects) as the project’s engineering, procurement, and construction lead. IHI Terrasun Solutions (Chicago, Illinois-based company) will serve as the battery energy storage

Integrator and Maxeon Solar Technologies (Singapore-based company) has been selected to provide the high-efficiency, bifacial solar modules.

Opponents of the Gemini project have said they don’t think the installation’s benefits outweigh its environmental impact, arguing that it will disrupt a desert ecosystem of flora and fauna about 30 miles northeast of Las Vegas. However, Primergy claims they have “invested significant resources” to minimize risks, including a partnership with biologists to create a Desert Tortoise Relocation Plan that “tracks, cares for, and will safely reintroduce the protected species back into their natural habitat once construction is complete.” In addition, Primergy said, “the project’s construction will minimize impact to the area, with narrow road corridors to the construction site, and

building appropriately spaced, raised rows of solar modules to ensure nearly 80% of the land on site remains open to the sky.”

Primergy, founded in 2020, said their Nevada portfolio already exceeds 1,300 MW(ac) of solar and 3,330 MWh of battery energy storage systems under contract with Las Vegas-based NV Energy, as well as multiple additional projects in the development phase. Primergy has more than 6 GW of operational and development assets across the U.S.

Developing renewable energy resources, especially solar, is widely perceived by the public as “green technology”. But the construction, operation, maintenance, and eventual decommissioning of them all have known and potential negative impacts to natural resources, including plant communities and wildlife. This is especially true in the fragile ecosystems of the Desert Southwest where large-scale solar energy development is occurring. U.S. Geological Survey (USGS) scientists, as well as the utilities desiring to utilize these lands, are conducting research to address these concerns and assist resource managers like the Bureau of Land Management in what is needed to promote development and protect our land resources.

Energy Secretary Exhibits a Different Tone – Calls for More Oil & Gas



“U.S. Energy Secretary, Jennifer Granholm (pictured above), exhibited a different tone than from the past - asking energy executives, at CERAWEEK, to start “producing more right now.” Some experts, at the Conference, believe this could be signaling a shift in the Administration to the production of more oil and gas here in the United States. If our oil and gas industry were let loose, it would do a lot to reduce gas prices, create more jobs, reduce our current inflation levels, and help Europe, which is highly reliant on Russian oil and gas.”

In a speech at the CERAWEEK, by S&P Global Energy Conference in Houston, Texas, the U.S. Energy Secretary, Jennifer Granholm, exhibited a different tone than from the past - asking energy executives to start "producing more right now."

Some energy experts, at the Conference, believe this could be signaling a shift in the Administration to the production of more oil and gas here in the United States.

New York University professor Steven Koonin, whom you may recall served as a Department of Energy undersecretary for science under former President Barack Obama, said, "I think some things that she said are welcome. She acknowledged the need that we should be producing more oil and gas right now. She reached out to the industry, which has not been the case before."

He and several other members of the energy industry at CERAWEEK said they're seeing positive signs concerning the production of more oil and gas in the U.S. from the Biden administration.

Toby Rice, the CEO of EQT, which is the largest U.S. producer of natural gas, spent his CERAWEEK pushing a plan to massively increase exports of U.S. natural gas to replace international coal. He said

the Biden administration needs to adjust its priorities on energy policy and sees signs of Granholm and others moving in that direction.

"It's been clear the administration has really had a focus on, 'How can we make energy cleaner?' But there is an aspect of cost, and there is an aspect of reliability, and I think that we need to have a more balanced approach in the solutions that we're providing," said Toby Rice to FOX Business.

The mere presence of Energy Secretary Granholm, EPA Administrator Michael Regan, and other Biden officials at CERAWEEK is a positive sign. "All these people are here at this conference which is amazing. And at this conference, we're talking about how we make energy cheaper, more reliable, and cleaner. And we need to have them participating here," Rice said.

AES Corporation senior vice president Chris Shelton touted his company's efforts to decarbonize the tech industry, largely using wind, solar and battery storage. He called Granholm's address "balanced" on the short-term need for fossil fuels and the long-term need to switch to alternative energies.

Alaskan Senator Mike Sullivan lambasted the

administration for pushing against U.S. energy production on several fronts. "Americans recognize that the BS coming out of D.C. these days is the doublespeak coming from the President and members of his administration, when it comes to skyrocketing energy prices," Sullivan said.

"This administration has unilaterally done everything within its power to shut down the production of American energy," Sullivan continued, "killing energy infrastructure, like pipelines, and strong-arming American financial institutions to not invest in American energy projects, particularly in Alaska. All while begging dictators around the world to produce more."

Europe is highly reliant on Russian oil and natural gas, but the U.S. oil and natural gas industry could resolve this issue for Europe. If our oil and gas industry were allowed to fully engage in more production, it would do a lot to reduce gas prices here in the U.S., create more jobs, and reduce our current inflation levels.

CERAWEEK
by S&P Global

Did You Know?



“That Greta Thunberg, Swedish climate change activist, will launch a series of events via her global youth movement “Fridays for Future,” to protest Russia’s invasion of Ukraine. “All across the world, people are taking to the streets,” Dominika Lasota, a 20-year-old student at the University of Warsaw in Poland and a climate justice activist with “Fridays for Future”, told Yahoo News. “It’s quite surreal to see it all unfolding because it has felt like such a dark time — but still, “Fridays for Future” rises up to that.”



Energy Harbor to sell or deactivate coal-fired plants

That **Energy Harbor plans to sell or deactivate its remaining coal-fired units by the end of 2023.** The Akron, Ohio-based company said it would divest ~ 3,000 MW of coal-fired capacity this year, by **shutting down Units 5-7 of W.H. Sammis Power Station** in Stratton, Ohio, representing 1,694 MW; and **Units 1&2 of Pleasants Power Station** in Willow Island, West Virginia, which provides 1,368 MW. Energy Harbor will also **sell or deactivate four diesel-fired units at W.H. Sammis Power Station**, ~12.5 MW.



Dominion Energy to add 1,000 MW of solar and energy storage

That **Dominion Energy plans to add nearly 1,000 MW in solar and energy storage in Virginia with 15 utility projects and power purchase agreements (PPAs) with 24 other projects.** The 15 utility projects include 11 utility-scale solar generating facilities (~561 MW), one solar facility paired with battery energy storage (150 MW - 100 MW solar / 50 MWh storage), one stand-alone battery energy storage resource (~20 MWh), and two other distributed solar projects (~4 MW). These additions will be finished in 2022 and 2023.



Russia’s energy clout doesn’t jut come from oil and gas – it’s a key nuclear supplier

That unlike some mined commodities such as cobalt, **uranium resources are spread out across the globe. Kazakhstan ≥ 40% of the global supply, Canada ≥ 12%, Australia ≥ 12.1%, Namibia 10%, Russia ~5%, while the U.S. and Europe produce less than 1%.** However, much of the milled uranium from Kazakhstan travels through Russia before it is exported to global markets. Other parts of the supply chain also route through Russia. Only a handful of facilities in the world convert milled uranium into uranium hexafluoride; Russia produced 1/3 of the 2020 supply, much of it made with uranium from Kazakhstan. **Russia also has 43% of the global enrichment capacity, followed by Europe 33%, China 16% and the U.S. 7%.**



Invenergy & GE complete ~1 GW OK wind project

That **Invenergy & GE Renewable Energy have completed the Traverse Energy Center, the largest of three wind projects in Oklahoma collectively known as the North Central Energy Facilities.** This 998 MW project is the largest wind farm constructed in a single phase in North America. It joins the already operational 199 MW Sundance Wind Energy Center and the 287 MW Maverick Wind Energy Center as the last of three projects developed by Invenergy for American Electric Power (AEP).



Mitsubishi Power’s blueprint for decarbonization

That **billions of federal dollars are allocated for funding of hydrogen development and therefore, a major topic of discussion at the CERWeek conference. Mitsubishi Power touted four of their hydrogen projects – a blueprint for decarbonization.** One of these projects is the 840 MW Intermountain Power Project in Delta, Utah. Mitsubishi Power will supply two hydrogen-capable M501JAC gas turbines, helping the soon-to-be-retiring coal-fired plant transition to a natural gas and hydrogen blend. Starting in 2025 the project will burn 30% hydrogen and go 100% hydrogen-fired by 2045.

Russian Invasion Could Spell Trouble for U.S. Nuclear Power Plants

RESTORING AMERICA'S COMPETITIVE
NUCLEAR ENERGY ADVANTAGE
A strategy to assure U.S. national security



“Sanctions on Rosatom could pose long-term challenges for our fleet of more than 90 reactors which depend on low-enriched uranium. Our plants have enough fuel for the next six to eight months or more, but sanctions on Russian imports could raise the global cost of low-enriched uranium and rile U.S. plants sensitive to cost swings. Russia supplies 20% of the low-enriched uranium needed to run American nuclear plants, according to the Nuclear Energy Institute. Perhaps you recall when Secretary of State, Hillary Clinton, allowed the partial sale of Uranium One to Rosatom, giving Moscow control of more than 20% of America’s uranium supply.”

When President Biden issued an executive order to block imports of Russian crude and natural gas, did he realize how it could affect our nuclear power plants? Now the White House is consulting with the nuclear sector about the potential impact of imposing sanctions on Rosatom, Russia’s state-owned atomic energy company.

Sanctions on Rosatom could pose long-term challenges for the United States’ fleet of more than 90 reactors running on low-enriched uranium. While our existing plants have enough fuel for the next six to eight months or more, sanctions on Russian imports could raise the global cost of low-enriched uranium and rile U.S. plants sensitive to cost swings. Russia supplies 20% of the low-enriched uranium needed to run American nuclear plants, according to the Nuclear Energy Institute. Perhaps you recall when Secretary of State, Hillary Clinton, allowed the partial sale of Uranium One to Rosatom, giving Moscow control of more than 20% of America’s uranium supply.

However, the larger concern could affect our advanced reactor designs that are expected to come online around 2028. They require high-assay, low-enriched uranium, or HALEU and Russia is the only viable commercial supplier globally. Other firms that could supply

are years away from having the ability to do so.

Alan Ahn, a senior resident fellow for the climate and energy program at the liberal think tank Third Way, said Russia is the sole provider of HALEU because of its existing enrichment infrastructure, capabilities, and licenses. Ahn said it has become clear the U.S. needs to invest in an alternative, preferably domestic source of fuel for the new reactors.

When asked about lobbying efforts around Rosatom, John Kotek, the Nuclear Energy Institute’s senior vice president of policy development and public affairs said, “The Russian invasion of Ukraine underscores the need for us to invest in our domestic fuel cycle. The ability to enrich uranium or do the conversion given the mining in the U.S. is not sufficient to meet U.S. needs.”

At the same time, the nuclear sector is facing long-standing safety questions as Russian troops occupy reactors in Ukraine, triggering concerns about the safety of personnel and the integrity of the Ukrainian reactors.

Kotek in an interview at CERAWEEK said “nuclear power is still recognized as critical to decarbonization and even since the [Russian] invasion, we’ve seen Belgium, for example, announcing that they’re

actively reconsidering their decision to shut down nuclear power plants”.

Frank von Hippel, a physicist, and professor emeritus at Princeton University said, If Rosatom were ruled out for U.S. and European buyers, the surplus situation for Western companies might end, and the price of [enrichment services] could increase, which could dramatically affect utility operators that are located in tightly contested cost competitive areas.

It’s unclear how sanctions would affect U.S. operators that import fuel. In 2020, Russia accounted for only 16% of the total uranium that American reactor operators bought, according to U.S. Energy Information Administration. During that time, a quarter of the uranium delivered was purchased under spot contract — or one-time deliveries — while more than 75% was bought under long-term contracts.

Constellation Energy Corp., the operator of the largest nuclear fleet in the U.S., said none of the company’s existing nuclear fuel contracts has been affected by current sanctions. What’s more, Constellation said they have enough nuclear fuel to support all their refueling needs for multiple years, regardless of any potential sanctions.



GTTSi

Minority & Woman Business Enterprise



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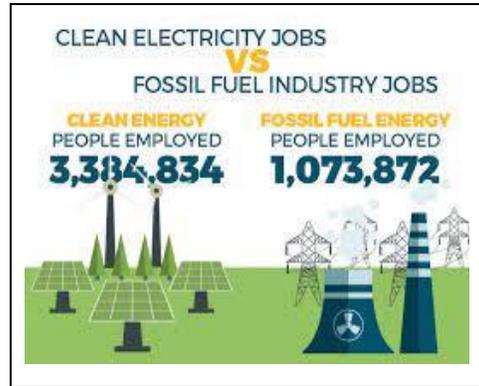
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GTTSi Job Board Update



GTTSi provides professional services to the energy and nuclear industry since 1980. We are a MWOBE (*minority woman owned business enterprise*) and have served over 80% of the US commercial nuclear facilities, 8 Federal agencies and prime contractors, and one foreign government. If you are qualified and interested in any of the job opportunities listed below, please contact us at ginfo@gttsi.com or call our Home Office at 864.882.3111.

- **ITAAC Engineer (all disciplines needed)**
- **Quality Assurance Lead Auditor / Surveillance Lead**
- **Business Intelligence Analyst**
- **Electrical Production Team Member**
- **Nuclear Technical Specialist**
- **Nuclear SRO Instructor (simulator & classroom qualified)**
- **Operational Sourcing Specialist**
- **In-Service Testing Engineer**
- **Planner / Scheduler**

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