A look ahead at nuclear power

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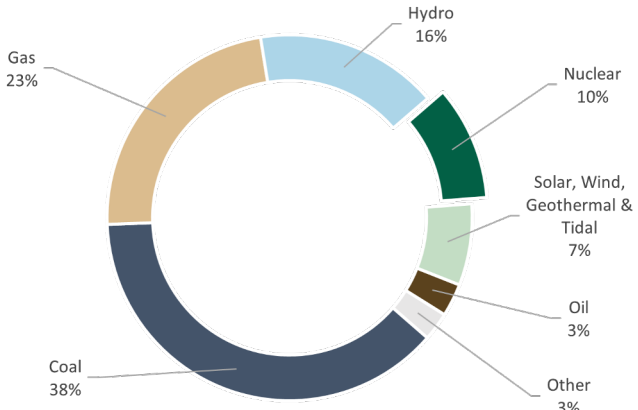
State of nuclear power

About 10% of the world's electricity is generated by 441 nuclear power reactors. 50 new reactors are under construction, equivalent to 15% of existing capacity. In 2020, these reactors supplied 2553 TWh (terawatt hours) of electricity. 2020 marked the first decline in nuclear power generation in 8 years. The top producers of nuclear energy were the US, China, and France with 790, 345, and 339 TWh respectively.



World electricity production by source 2018 (source: International Energy Agency)

Nuclear energy provides 29% of the world's low-carbon electricity, second only to hydroelectric. Thirteen countries produced more than a quarter of their electricity from nuclear power in 2020, with France leading (generated three quarters of their power from nuclear).

Looking ahead

According to the World Energy Outlook 2021, published by the International Energy Agency, "almost half of the emissions reductions needed in 2050 in the [Net-Zero Emissions Scenario] come from technologies that are today at the prototype or demonstration state, i.e. they are not yet readily available on the market."

The "Net-Zero by 2050" Scenario relies on heavy reductions in energy produced from natural gas, a production method that is not easily replaced by less consistent sources like wind and solar. Under the current energy system, natural gas acts as a "bridge fuel" that provides power load when solar and wind sources are not producing electricity. The solution to this is not to add more solar or wind to the grid, but rather to find another energy source that can act as a bridge. The energy outlook acknowledges that this will rely primarily on the innovation of nuclear technologies. This understanding is reflected a second time in the Department of Energy's record $1.85 billion budget allocation to the Office of Nuclear Energy.

Demand for nuclear technology, coupled with massive fiscal spending on electric grid rehabilitation, presents a unique opportunity for nuclear power plant operators as well as constituents along the uranium supply chain (assay, enrichment, mining, waste disposal).

This report seeks to describe the current state of nuclear power, the sector's major participants and thought leaders, as well as the technology being developed to bridge the gap between today and a net-zero future.

Recent innovations

The primary facilitator of technological innovation in the energy sector is often the US government. For nuclear energy, due to strict regulation of waste and fuel products, this is doubly true. The Office of Nuclear Energy has allocated its budget to five new reactor technologies: Small Modular Reactors, Light Water Reactors, Advanced Reactor Technology, Versatile Test Reactor, and Space Power Systems.

> "Almost half of the emission reductions needed in 2050 come from technologies that don't yet exist."

Small Modular Reactors (SMRs) are designed to be manufactured in factories and transported to sites where they would act as "plug and play" assets to microgrids and for locations that cannot support large reactors. SMRs offer utility companies the ability to scale production based on demand and respond more quickly to shortages with lower capital costs and construction times.

The **Light Water Reactor Sustainability (LWRS)** program conducts research and develops new technologies to improve the economics and efficiency of existing nuclear plants. This includes providing science- and technology-based solutions to overcome the current labor-intensive business model for operating nuclear plants and managing the aging systems, structures, and components (SSCs) associated with nuclear plants.

The development and implementation of **Advanced Reactor Technologies (ARTs)** are overseen by the Office of ART and focuses on programs that "promote safety, technical, economical, and environmental advances of innovative… nuclear energy technologies". ART has three RD&D activities: developing an accident-resistant high-temperature gas-cooled reactor (HGTR), designing reactor subsystems like liquid metal cooling and electrolysis, and technologies that enable advanced SMRs.

In 2019 the DOE announced its plans to build a **Versatile Test Reactor (VTR)** to test advanced nuclear fuels, materials, instruments, and sensors. Unlike the other projects, the VTR is designed to streamline RD&D and thereby improve the progress for the other mentioned projects.

Global militaries have long used nuclear reactors to power submarines and battleships and NASA has used radioisotope power systems (RPSs) to enable deep space exploration. These **Space and Defense Power Systems** are responsible for the majority of innovation and applicable experience in the nuclear power industry. Applications of RPSs include electricity and heat generation and utilizes Plutonium-238. Several space missions, including the New Horizons spacecraft that transited to Pluto in 2015 and is currently exploring objects in the Kuiper belt, have used this technology as their primary fuel systems.

Nuclear power was also used in the Mars Curiosity Rover, the Saturn Cassini Mission, and the Voyager Missions throughout our solar system. The proven efficacy of nuclear technology for deep space travel makes it a highly demanded commodity as space investment expands. This includes both reactor technology and enriched uranium.

Company highlights

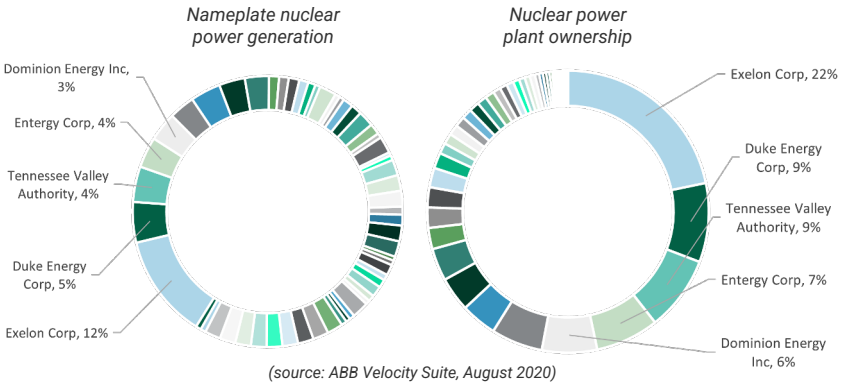
1. In 2020, Fluor-owned (FLR) company **NuScale Power** received the first ever approval for a small modular reactor design from the U.S. Nuclear Regulatory Commission. NuScale is expected to go public via SPAC merger with Spring Valley Acquisition Corp (SV) in early 2022.

2. **Exelon Corp, Duke Energy**, and **Dominion Energy** are primary sponsors of the LWRS program. These firms provide data and infrastructure, host conferences, and act as consultants to allow the program to leverage their industry expertise.

3. On October 8, 2020, **FuelCell Energy** was awarded $12.5 million to develop a solid oxide electrolysis demonstration. The project is expected to enable utility scale SMRs and demonstrate how nuclear-hydrogen production can help plants diversify and increase their profitability by switching between electricity generation and electrolysis (to generate hydrogen). Similarly, **Xcel Energy** was awarded $13.8 million to design and build a fully-functioning hydrogen plant that can be hooked up to an LWR to test electrolysis and reactor technologies at scale.

Industry majors

Nuclear power generation in the United States is dominated by 5 majors: Exelon Corp, Duke Energy, Tennessee Valley Authority, Entergy Corp, and Dominion Energy. Together they control 28% of the nameplate power generation and own 53%. They are also the primary contributors of expertise and infrastructure to the Department of Energy.



(source: ABB Velocity Suite, August 2020)

These companies are the current industry leaders and may be able to maintain their competitive advantage via M&A and outspending, but there are also a number of young firms challenging the large utility and energy companies. A few notable players are FuelCell Energy, NuScale Power, and Bill Gates-backed Terrapower.

Wrap-up

Nuclear energy is experiencing a renaissance as sentiment turns increasingly positive. We agree with Bill Gates that "nuclear energy will absolutely be politically palatable again". New technologies are making reactors safer, more efficient, and increasingly flexible. This is a sector we are watching very closely and may include leading names in our client portfolios over the next few years. With any industry upset comes volatility and restructuring, so the current leaders may not be the ones to solve today's problems. Balancing established dominance with innovation capacity is key when selecting holdings within the nuclear energy industry.

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