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**Introducing The MarketVector™  
Global Uranium and Nuclear Energy  
Infrastructure Index**

**Nuclear Fusion as an Energy Source**

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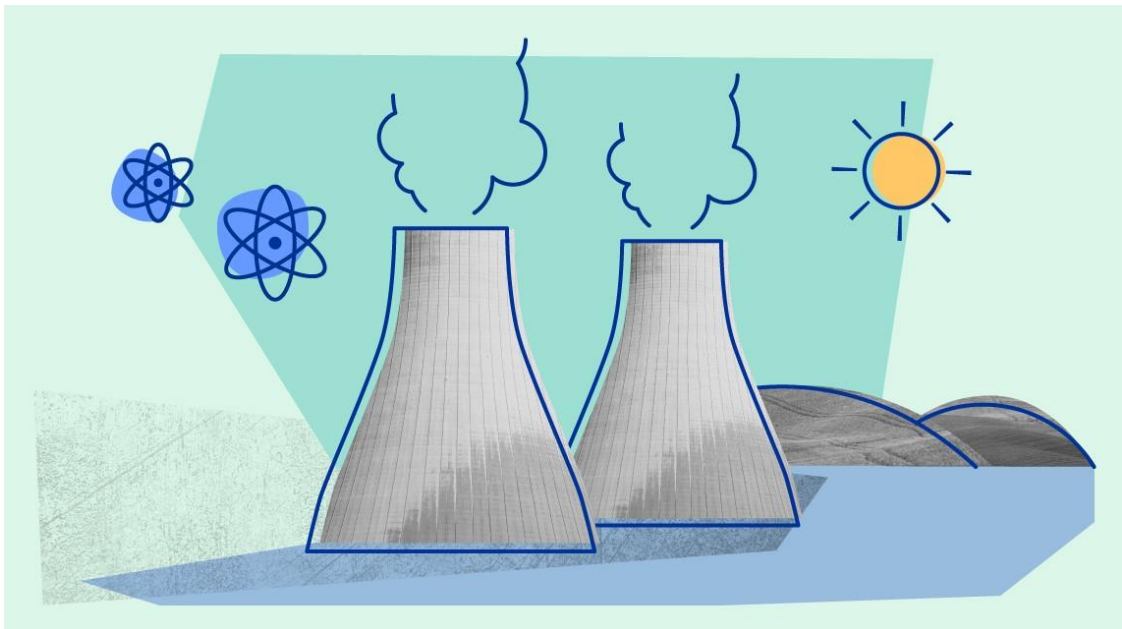
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## Introduction

The urgent need to address global change and the potential for geopolitical disruptions in current energy supply chains have led to increased adoption of alternative energy. Nuclear energy is a significant contributor to this transition, as it is a low-carbon emission energy source that can help nations achieve their emission reduction targets. Unlike many other alternative energy sources, nuclear energy is relatively reliable and is not dependent on weather conditions.

In contrast to renewable energy technologies, however, investments in nuclear energy are subject to exposures associated with commodities. Pressures on uranium prices, as a result of a limited supply of an in-demand commodity, are linked to profitability of nuclear power plants. For example, when uranium prices are low, operating costs will also be low, which can make it less economically viable to build and operate new nuclear power plants, as well as compete with other forms of power generation that are not tied to risks associated with the volatility of commodity prices. At the same time investments correlated to the dynamics of the uranium market can present a long-term opportunity for investors.

Despite uranium playing a large role in the profitability of nuclear power plants, there is a lot of recent innovation in the field of nuclear energy. Technologies such as Molten Salt Reactors (MSRs) and Small Module Reactors (SMRs) are enabling nuclear power plants to generate energy more efficiently than traditional reactors, shifting the scale on how we weigh nuclear energy against renewable energy. In this paper we demonstrate how the [MarketVector™ Global Uranium and Nuclear Energy Infrastructure Index](#) provides targeted exposure to companies that are taking part in these investment themes.



## Industry Drivers

### ESG & Geopolitical Initiatives

The U.S. Energy Information Administration (“EIA”) projects an increase in world energy usage of nearly 50% by 2050<sup>1</sup>. Renewable and alternative power sources have been the center of attention as governments strive for their clean energy transition goals to be met. Nuclear energy is a net-zero greenhouse gas emitting process and is steadily contributing to the mix of clean energy generation.

### Nuclear vs. Renewables

Benefits to nuclear energy over renewables include increased capacity factors and scalability. Capacity factors measure the percent of time a power generating resource is producing energy against sitting idly. One of the main hurdles that renewable energy sources face in seeking to displace fossil fuels is their dependability in providing a constant source of energy, since their capacity factors are partly a function of uncontrollable weather patterns. The EIA reports that solar power has a capacity factor of 25% and wind a capacity of 34.6%, while nuclear energy has a reported capacity factor of 92.7%<sup>2</sup>.

### Uranium Supply and Demand

Factors that contribute to the supply of uranium include the exploration and mining of uranium deposits, the conversion of uranium ore into uranium concentrate, and the availability of enriched uranium for use in nuclear power plants. Elements that contribute to the demand for uranium include the number of nuclear power plants in operation, the rate of construction of new nuclear power plants, and the capacity factor of existing nuclear power plants. Economic variables, such as the price of electricity and the availability of alternative energy sources, also play a role in the demand for uranium.

In 2021, the top 10 uranium mining companies produced ~90% of the world’s uranium production<sup>3</sup>. Additionally, uranium consumption has increased globally, especially in China, rising over 100% from 5.34 (thousand metric tons) to 10.8 in the 2016 to 2020 period. The confined availability of uranium, combined with the limited ability to increase production in the near and medium term, will likely result in continued support for the price of uranium in the long term.

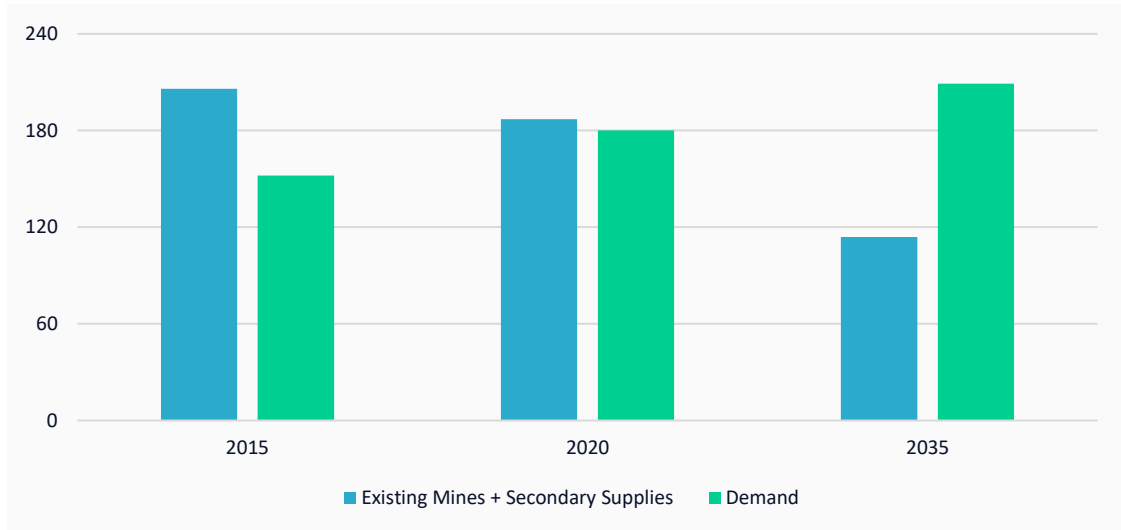
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<sup>1</sup> EIA “EIA projects nearly 50% increase in world energy usage by 2050, led by growth in Asia”

<sup>2</sup> [https://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.php?t=epmt\\_6\\_07\\_b](https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b)

<sup>3</sup> <https://world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production.aspx>

**Exhibit 1: Global Uranium Supply and Demand (in millions of pounds of uranium concentrate)**



Source: Orano, IEA.

### Nuclear Plant Production

The quantity of global nuclear plant construction has been somewhat stagnant since the 1990s<sup>4</sup>. However, government efforts to work toward targeted goals of lower carbon emissions, as well as a shift to modern reactor technology, is expected to spark investment in nuclear infrastructure. Small module reactors (“SMR”) are the latest advancement in nuclear technology. While SMRs generate less energy than traditional factories, the energy is generated at a lower cost and operate more efficiently. SMRs are cheaper and faster to build than traditional plants—they also have smaller footprints.

### Innovation in Nuclear-Based Power Generation

Molten salt and nuclear fission have also contributed to recent innovation in nuclear-based power generation. Molten salt reactors (MSRs) use liquid fuel, typically a mixture of lithium and beryllium fluoride salts, which operates at a higher temperature than traditional solid-fueled reactors. This allows for a more efficient conversion of heat to electricity, ultimately leading to superior energy generation capacities. Moreover, nuclear fission in MSRs allow for the possibility of recycling used fuel<sup>5</sup>. Overall, the use of molten salt and nuclear fission in power generation has led to increased efficiencies and operating capacities.

<sup>4</sup> <https://www.statista.com/statistics/263939/nuclear-reactors-under-construction-worldwide/>

<sup>5</sup> <https://world-nuclear.org/information-library/current-and-future-generation/molten-salt-reactors.aspx>

## Index Architecture: Sustainable Investing through a Thematic Lens

MarketVector Indexes™ ("MarketVector") views sustainable investing -- such as investing in companies involved in low carbon energy sources like nuclear -- as a type of thematic investment approach, allowing investors to target groups of stocks tied to an investment thesis by reaching across traditionally defined sectors and industries.

The [MarketVector™ Global Uranium and Nuclear Energy Infrastructure Index](#) is designed to provide exposure to companies that are most connected with the growth in demand for uranium and for nuclear energy production-related technology, as described in Exhibit 2 (the index explicitly does not include utilities or power producers).

### Exhibit 2: Sub-Themes Included in MVNUCL

| Sub-Theme                     | Description and Minimum Revenue Exposure for Initial Inclusion in the MVNUCL   |
|-------------------------------|--|
| Uranium Mining                | Includes companies with at least 50% of their revenue from uranium mining, or for prospectors, companies with projects that have the potential to generate at least 50% of their revenue from uranium mining.  |
| Physical Uranium              | The index may include up to one exchange traded fund that tracks the spot price of uranium.  |
| Nuclear Energy Infrastructure | Include companies with at least 50% of their revenue from: <ul style="list-style-type: none"> <li>• Construction, engineering, and maintenance of nuclear power facilities and reactors.</li> <li>• Equipment or technology used by to generate nuclear power.</li> <li>• Development and commercialization of nuclear fusion technology.</li> </ul> |

MarketVector also incorporates ESG screening criteria, as shown in Exhibit 3, to attempt to exclude bad actors from the index knowing that the topic of nuclear energy can be controversial for some, and that many companies involved in uranium mining may also be connected to the nuclear weapons industry. Companies that pass our revenue and ESG screens are then tested for investability before being considered for selection to the index.

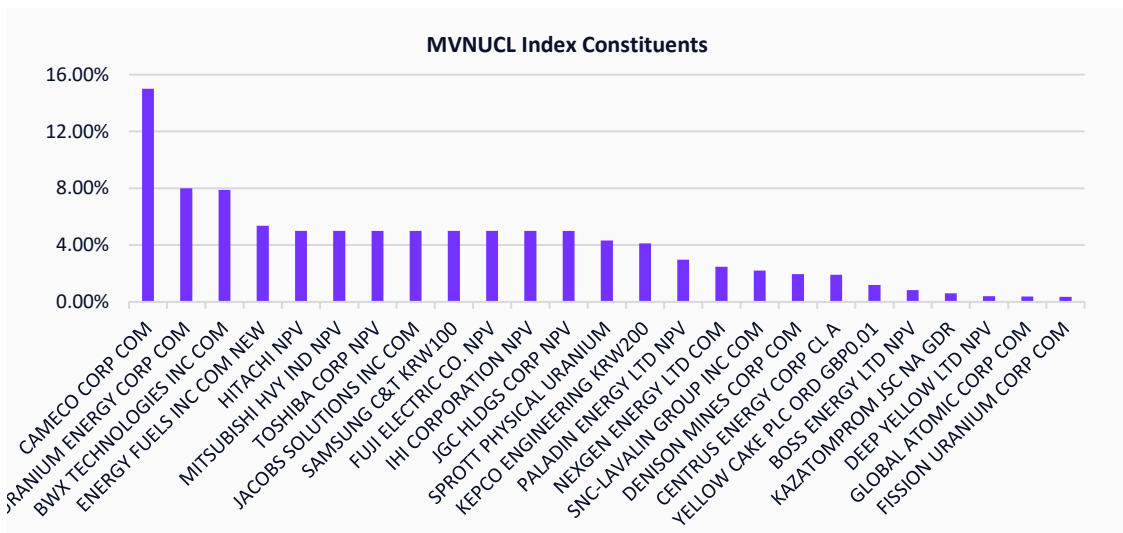
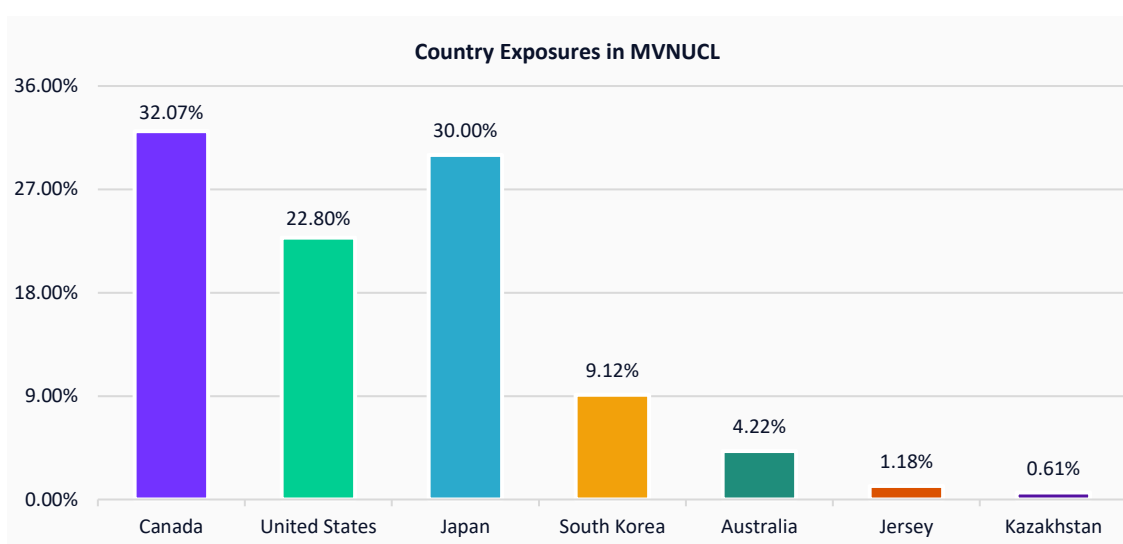
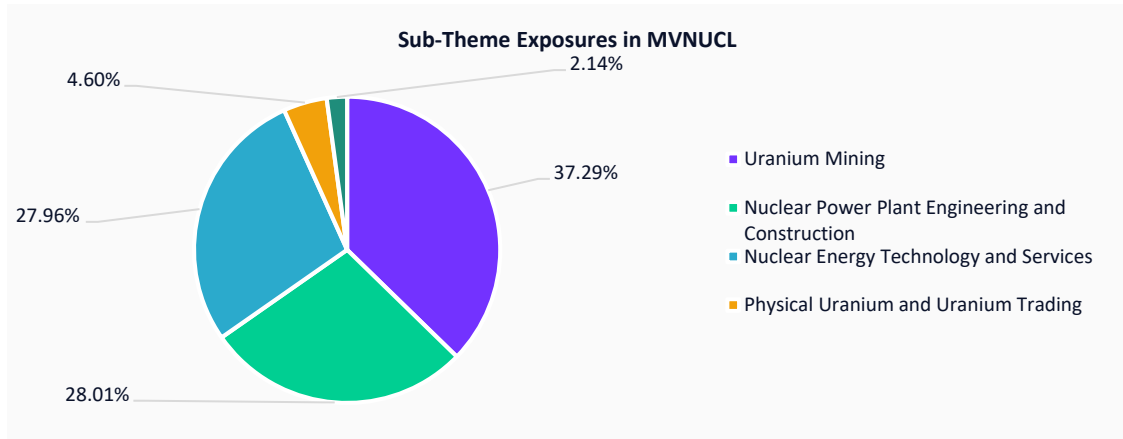
### Exhibit 3: ESG Factors Considered in MVNUCL

|   |  |
|---|--|
| <p><b>Norm-Based Research</b></p>                         | <p>Examples include: Child labor violation, gender discrimination, racial discrimination, human rights violations, environmental protection violations.</p>  |
| <p><b>Controversial Weapons Involvement</b></p>           | <p>Examples include: Biological weapons, chemical weapons, cluster munitions, depleted uranium. The index allows companies that are involved in nuclear weapons but limited to those that deal in nuclear weapons within the non-proliferation treaty of 1968.</p> |
| <p><b>Sector Involvement or Revenue Exposure</b></p>      | <p>Examples Include: Civilian firearms, gambling, tobacco.</p>   |
| <p><b>Energy Extractives Through Revenue Exposure</b></p> | <p>Examples Include: Fossil fuels, coal mining, oil sands.</p>   |

## Index Exposures

Weightings by sub-theme, country, and company are shown in **Exhibits 4-6**. The index is globally diversified across 7 countries spanning North America, Europe, and Asia.

Exhibit 4-6:



Source: MarketVector. As of Q4 2022 index review.



## Company Examples

### Fuji Electric

Fuji Electric is a Japanese company that is involved in various aspects of nuclear energy. They are involved in the design, manufacture, and maintenance of various types of nuclear power equipment and systems. Their most notable developments include Pressurized Water Reactors (PWRs) and boiling Water Reactors (BWRs), both of which are types of nuclear reactors commonly used in nuclear power plants.

### Kazatomprom

Kazatomprom is the national uranium company of Kazakhstan, and it is one of the largest uranium producers in the world. The company is involved in various aspects of the nuclear fuel cycle, including exploration, mining, conversion, enrichment, and fuel fabrication. Kazatomprom's major activities also include supplying nuclear fuel to domestic and international power utilities.

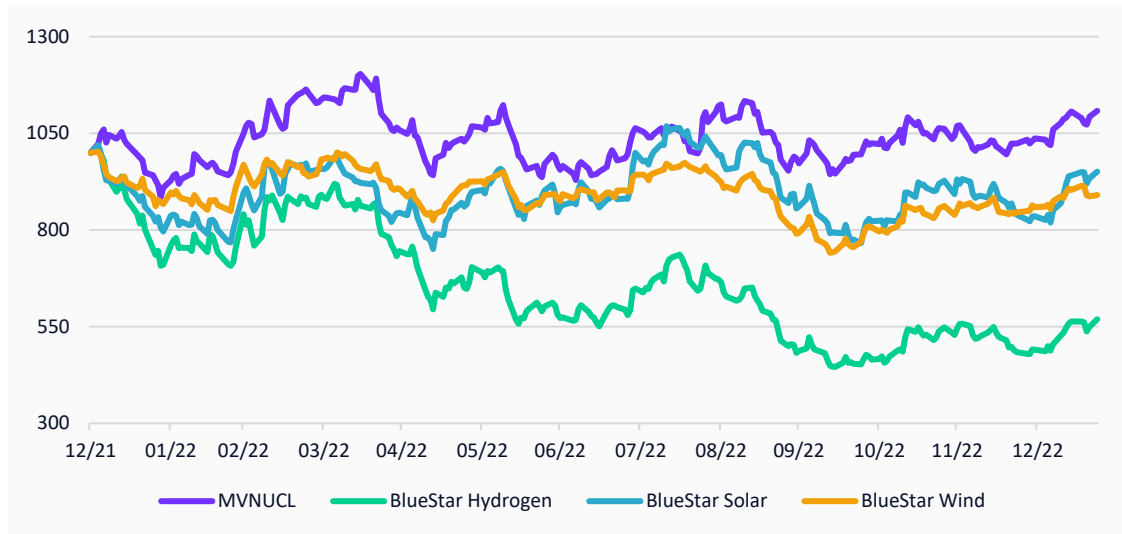
### KEPCO Engineering & Construction Company (KEPCO E&C)

KEPCO Engineering & Construction Company (KEPCO E&C) is a South Korean company that works with various aspects of nuclear energy. They are mainly focused on the engineering, construction, and maintenance of nuclear power plants. KEPCO E&C has been involved in the construction of several nuclear power plants in South Korea, as well as in other countries such as UAE, and Egypt. They also provide maintenance and retrofitting services for nuclear power plants to ensure their safe and efficient operation. Overall, KEPCO E&C is a major player in the nuclear energy industry, with a wide range of products and services that cover the entire lifecycle of a nuclear power plant.

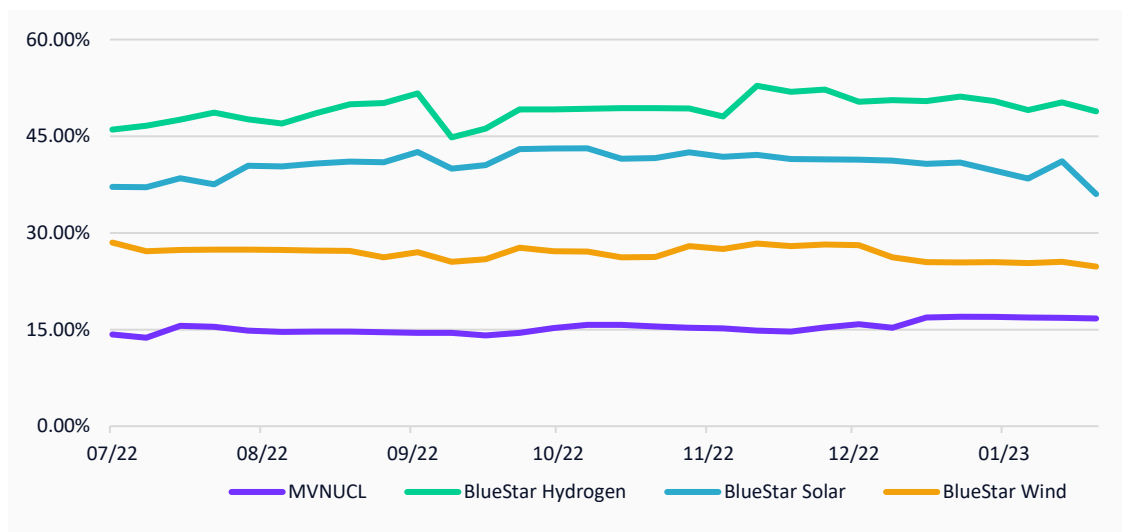
## Risk and Return Profile

The MarketVector™ Global Uranium and Nuclear Energy Infrastructure Index has back-tested history beginning at the end of 2021, shown in Exhibit 7. Compared to other pure-play clean energy indexes maintained by MarketVector, covering solar, wind, and hydrogen, uranium and nuclear energy stocks have held up relatively well, with lower volatility as shown in Exhibit 8, since the start of the 2022 bear market in global equities.

**Exhibit 7: Comparative Historical Returns of MVNUCL**



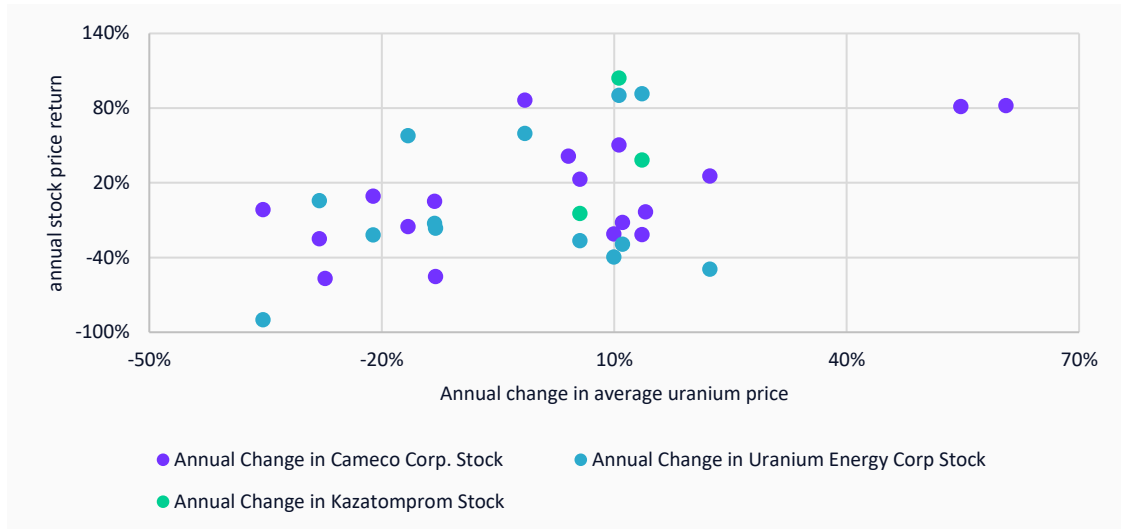
**Exhibit 8: Comparative Rolling 6-Month Annualized Weekly Volatility**



Source: MarketVector. As of January 23, 2023.

Exhibit 9 illustrates the generally positive relationship between the annual change in the average spot price of uranium and returns in the stock of some of the largest Uranium miners, whether by market capitalization or market share, including Cameco Corp, Uranium Energy Corp, and Kazatomprom. For visual effect, the plot in Exhibit 8 excludes outlier years (2007) in the change in uranium price, and outlier points (Uranium Energy Corp in 2009) in share price changes.

**Exhibit 9: Annual Change in Uranium Prices vs Change in Select Uranium Miner Stock Prices**



Sources: Statista, IMF. Cameco data from 2001-2021; Uranium Energy Corp data from 2008-2021; Kazatomprom data from 2019-2021.

## Conclusion

In a world where there is growing support for measures to address climate change, both renewable and nuclear energy sources have received increased attention. Nuclear energy, in particular, is considered a valuable option as it is a low-carbon emissions source that can help decrease the carbon footprint and achieve emission reduction goals.

In recent years, there has been significant advancement in nuclear technology through extensive research and development. This has resulted in the creation of innovative reactors that are not only smaller in size, but also safer and more efficient compared to conventional reactors. This has made nuclear energy more appealing to countries that are looking to add nuclear power to their energy mix. Although commodity prices pose a significant risk, nuclear energy is viewed as a viable option for countries that are seeking low-carbon, reliable, and cost-effective energy sources, as well as for those that are looking to reduce their dependence on fossil fuels and increase their energy security.

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## IMPORTANT DEFINITIONS AND DISCLOSURES

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