

Risk and Return in the Energy Sector: A Financial Case for Nuclear Energy (2015–2024)
Independent Research Project by Sean Heard

Intro:

When you think of a nuclear power plant, what comes to mind? People generally associate nuclear power plants with either catastrophic failures or clean energy generation. Today's worldwide energy discussion revolves around this fundamental conflict. Nuclear power stands as an essential yet highly disputed solution which addresses climate goals alongside energy security and economic needs.

Personally, I believe a transition towards a heavier reliance on nuclear energy is not just preferable, but necessary if we hope to preserve the planet for future generations. While environmental and technical comparisons are often the focus of the energy debate, this project instead looks at how the financial markets perceive the future of nuclear power, analyzing how nuclear stocks compare to those associated with fossil fuels and renewable sources like solar and wind since 2015.

Thesis:

Long-term growth stability and risk-adjusted returns indicate nuclear energy has outperformed both fossil fuels and renewables during the past decade which makes it the most reliable economic energy source for the future.

Context:

Energy will forever be essential for communication, transportation, lighting, and everyday life. Further, as AI becomes more widespread, energy demands are only going to be inflated. But at what cost will we continue to harm the environment? Fossil fuel production is the world's leading source of carbon emissions. As a result, many governments, particularly left-leaning administrations, are working to reduce their carbon footprints and meet ambitious climate goals. That means investing in alternatives to fossil fuels — nuclear and renewable energy. Governments make the policies, but investors are the ones betting on what they believe will survive long-term. Using the stock market performance of different energy sectors becomes a useful representative for confidence in the future of an energy source. Energy prices are continuously fluctuating with political conflicts, supply chain issues, and a rising demand as the world becomes wealthier. Markets reflect which source is most resilient to these concerns. As the world continues to invest trillions of dollars into energy infrastructure, choosing unstable or inefficient sources of energy can be detrimental to one's economy and environment, forcing governments to think critically about their choices.

Methodology:

To analyze the performance of different energy sectors, I selected four representative stocks and one ETF from each of the three major energy categories: nuclear, fossil fuels, and renewables. These selections were chosen based on market capitalization, relevance to the energy category, and their role in sector-specific operations. I pulled the data from Yahoo Finance and created graphs and plots in R-Studio to analyze the data.

- Nuclear: CCJ, BWXT, LEU, ETR, and the ETF NLR. These selections cover a range of nuclear-related operations, including uranium mining, plant construction, and energy generation.
- Fossil Fuels: BP, CVX, SHEL, XOM, and the ETF XLE. These companies are among the largest players in the global oil and gas industry.
- Renewables: ENPH, FSLR, NEE, SEDG, and the ETF TAN. These firms are major investors in solar energy and focus primarily on renewable technologies.

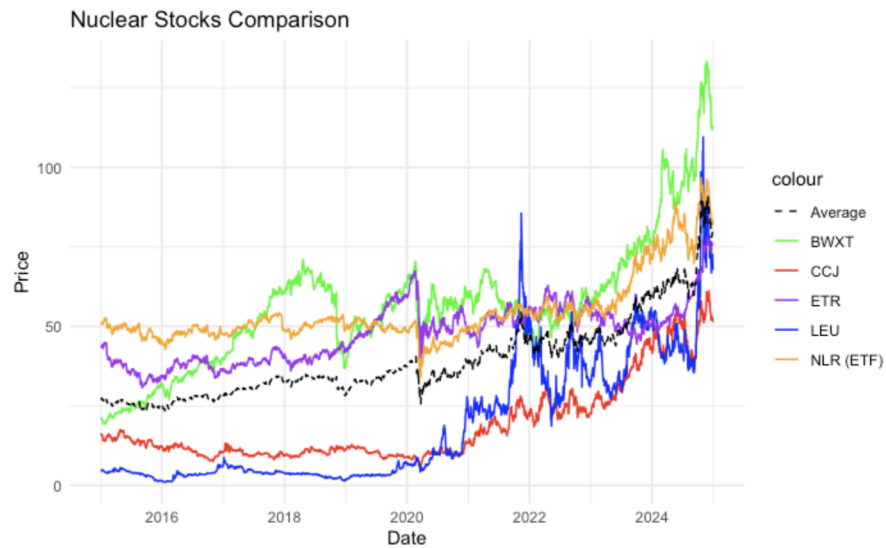
The analysis covers the period from January 1, 2015, to December 31, 2024. This 10-year window provides a meaningful time frame to observe long-term trends and performance while remaining relevant to current technological and economic conditions.

To determine which sector is the strongest, I analyzed six key performance metrics:

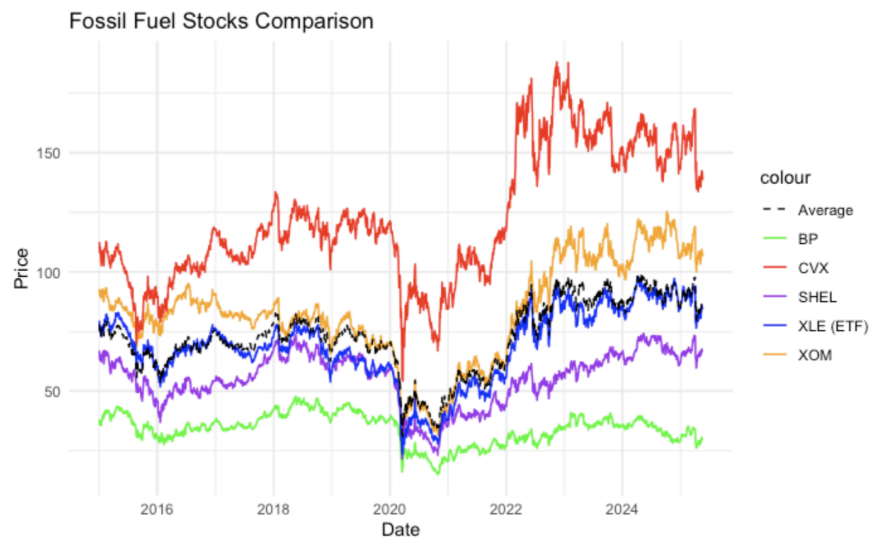
1. Compound Annual Growth Rate (CAGR) – Measures the average annual return assuming steady, compounded growth from start to finish.
2. Final Cumulative Price – Reflects the final value of a hypothetical \$100 investment made in 2015, offering a tangible view of overall gains.
3. Max Drawdown – Captures the largest peak-to-trough decline, giving insight into the risk and downside exposure of each sector.
4. Total Return – Shows the overall percentage change in value from the beginning to the end of the period.
5. Standard Deviation of Returns – Measures volatility; a lower value implies more stability. Ideally, strong sectors combine low volatility with high returns.
6. Sharpe Ratio – Assesses the return per unit of risk, with higher values indicating a more efficient investment in terms of risk-adjusted returns.

My analysis evaluated sector performance alongside risk profiles to determine nuclear energy delivered the best combination of sustained growth and risk-adjusted returns and operational resilience.

Analysis:

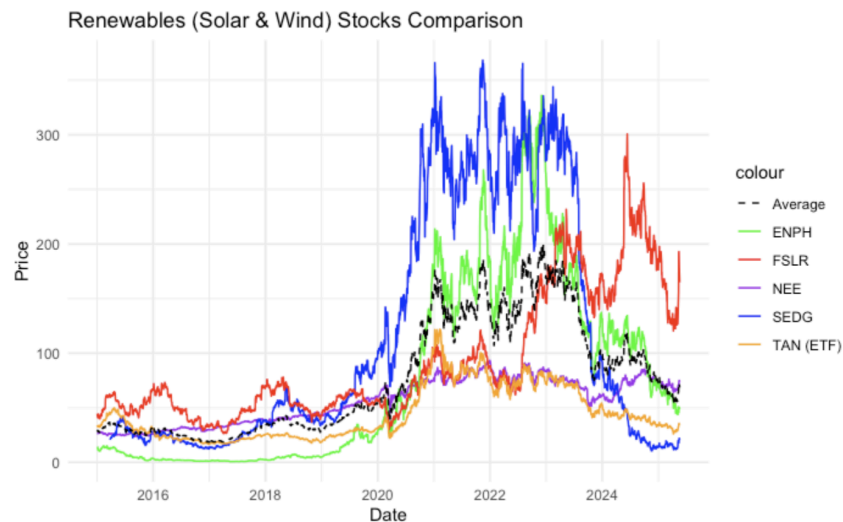


Nuclear energy stocks demonstrated continuous growth starting from 2015 and experienced increased momentum after the COVID-19 pandemic. Global climate awareness has led to increased popularity of nuclear power as a clean low-carbon energy solution that provides high efficiency. A significant market rise happened in September 2024 because of rising international funding for nuclear projects combined with government backing to build new nuclear facilities under net-zero carbon strategies.



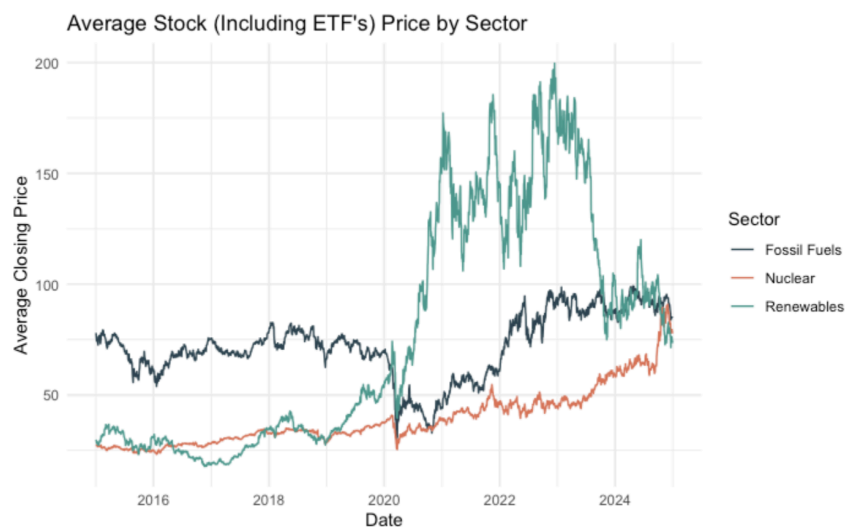
The high efficiency of fossil fuels as an energy source faces diminishing long-term growth prospects due to environmental issues. The leading source of worldwide carbon emissions faces

regulatory and public opposition because of its position as the primary source of emissions. The forward-looking momentum that nuclear and renewable sectors enjoy does not exist in fossil fuels which reduces their desirability for a decarbonizing world.



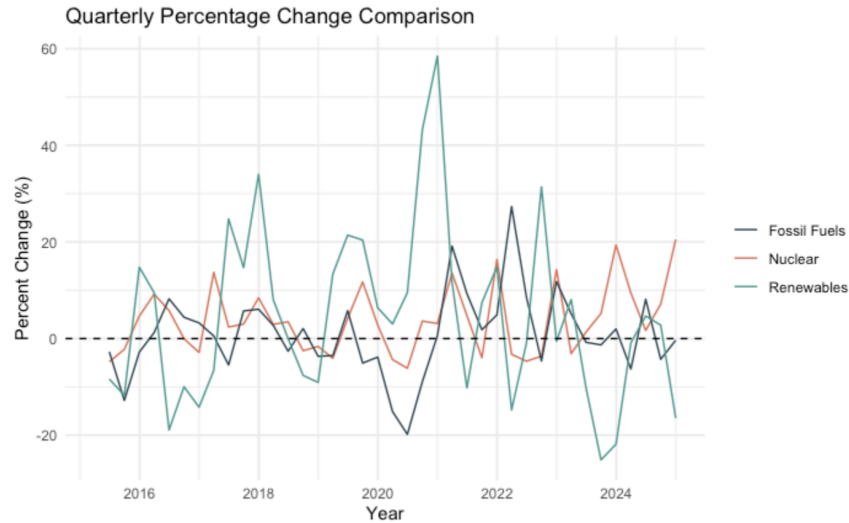
Renewable energy stocks achieved their largest sectoral growth in 2020 because clean energy adoption received positive policy support. The sector experienced major setbacks during 2023 which exposed various developing problems. The transition to solar and wind power faces a major hurdle because their capacity to produce at nuclear or fossil fuel levels remains unattainable. The feasibility of using renewables as an independent solution for big energy requirements remains restricted by infrastructure requirements and power supply stability problems.

*note SEDG started at the start 2015 causing missing data



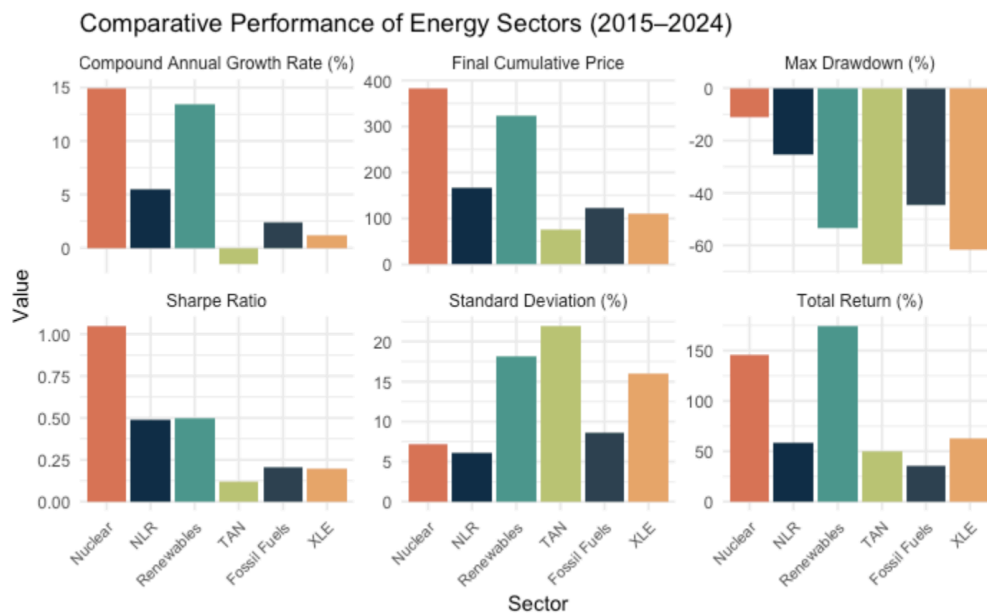
The market experienced fossil fuel dominance throughout 2015 to 2020 because of their widespread presence and established global infrastructure network. The renewable energy sector

led the market forward from 2020 until 2023 because of policy backing and rising public interest and pandemic recovery funding. All three sectors possess identical average valuation levels during the beginning of 2025, with a future potential for nuclear to dominate the energy sector.



This graph reveals striking differences in volatility between the energy sectors. Renewables are clearly the most volatile, having both the sharpest spikes in growth and the steepest declines. Fossil fuels fluctuate frequently, swinging between positive and negative growth in a pattern that reflects their sensitivity to geopolitical and macroeconomic shocks. In contrast, nuclear shows steady, measured growth, with fewer dramatic swings. Even during downturns, nuclear stocks suffer smaller, more contained losses, indicating stronger investor confidence and resilience.

*note that data starts halfway through 2015 to calculate percent change causing an error



Growth (CAGR, Final Cumulative Price, Total Return):

Nuclear and renewable stocks exhibit the highest overall growth. Nuclear leads with a compound annual growth rate (CAGR) of 14.94%, a total return of 145.7%, and a final cumulative price of \$383.13 from an initial \$100 investment. Renewables also show strong performance, though slightly behind nuclear in consistency and risk-adjusted returns.

Max Drawdown:

Nuclear is the only sector without a major collapse in the past decade. Its maximum drawdown of -11.14% is significantly lower than renewables (-53.15%) and fossil fuels (-44.66%), indicating strong resilience during market downturns.

Volatility (Standard Deviation of Return):

Nuclear has the lowest volatility, with a standard deviation of 7.10%, compared to 18.06% for renewables and 8.56% for fossil fuels. This suggests nuclear stocks experience less dramatic price swings and are more stable over time.

Risk-Adjusted Return (Sharpe Ratio):

Nuclear also delivers the best reward for its level of risk, with a Sharpe ratio of 1.052, far surpassing renewables (0.496) and fossil fuels (0.210). This further supports the argument that nuclear energy offers a superior balance between risk and return. Both renewables and fossil fuels have sub-optimal Sharpe ratios, emphasizing their inefficiency.

Implications:

These market signals clearly indicate that nuclear has been the strongest and most resilient energy sector over the past decade, with strong momentum suggesting it may continue to grow, and potentially dominate, in the years to come.

The three sectors present different types of risks to investors. The renewable energy sector faces obstacles in expanding its manufacturing capacity to meet worldwide power requirements despite its promising features. The energy output of fossil fuels remains effective yet their sustainability and public health risks stem from their destructive impact on the environment. The main security threats to nuclear power plants stem from outside attacks and accidents but modern safety technology reduces the likelihood of another Chernobyl disaster to near zero. The recycling capability of a large portion of nuclear waste together with enhanced long-term storage solutions from engineering progress have minimized the risks.

If I were to invest in energy or advise someone who is, I would confidently choose nuclear. It combines market strength and resilience with low carbon emissions and scalable production capacity, making it the most promising path forward in the global energy transition.

Limitations:

Data Scope and Timeframe: The research period extends from 2015 to 2024. The analysis provides strong insights about recent market trends but may not exhibit the full picture of extended market patterns together with new technological developments after 2024.

Stock Selection Bias: The choice of representative stocks and ETFs, though based on market leaders, may not encompass the entire diversity within each energy sector. Smaller or emerging companies with different performance profiles are excluded.

External Factors: Market performance can be influenced by geopolitical events, policy changes, and technological breakthroughs that are difficult to predict or quantify. This analysis assumes historical trends continue to be relevant.

Non-Financial Considerations: Environmental, social, and technical risks of nuclear energy (e.g., waste management, public perception) are acknowledged but not deeply quantified here, as the focus is financial market performance.

Next Steps:

Expand the Data: Updating the dataset every year and adding additional stocks can help enhance and capture a more whole picture.

Incorporate Environmental, Social, and Governance (ESG) Metrics: Integrate ESG scores to evaluate how sustainability and social factors might influence financial performance and investor confidence.

Deeper Risk Assessment: Investigate nuclear-specific risks, including technological advances in waste management and plant safety, to better understand their financial implications.

Conclusion:

Nuclear energy shows strong potential to emerge as the dominant energy sector, effectively addressing both production needs and environmental concerns. Markets increasingly reflect this confidence, and while I anticipated nuclear would outperform, the strength of its lead was surprising. Energy is essential to modern life, and based on current trajectories, the question is not if we will transition to greater nuclear reliance, but when. Moving forward, energy policy must prioritize sustained investment in nuclear energy to reduce carbon emissions and meet growing global demand.