

# Investing in Clean Technology: A Perspective on the Risks and Rewards of the Renewable Energy Industry

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## ABSTRACT

As the world faces increasing environmental challenges and the need for sustainable solutions, the renewable energy industry has emerged as a promising sector for investors seeking both financial returns and positive environmental impact. This abstract explores the risks and rewards associated with investing in clean technology, focusing on the renewable energy industry.

The renewable energy sector encompasses a wide range of technologies, including solar, wind, hydro, geothermal, and biomass. Investments in clean technology have gained significant attention due to the potential for long-term growth and reduced carbon emissions. However, like any investment, there are inherent risks that need to be carefully considered. One of the key risks in the renewable energy industry is the inherent volatility of the market. Factors such as changing government policies, fluctuations in energy prices, and technological advancements can significantly impact the profitability and viability of renewable energy projects. Additionally, the availability and accessibility of financing, including government incentives and subsidies, play a crucial role in the success of clean technology investments.

On the other hand, the rewards of investing in renewable energy can be substantial. Governments worldwide are increasingly committed to transitioning to cleaner energy sources, leading to a growing demand for renewable technologies. This demand not only creates potential investment opportunities but also provides a stable and long-term revenue stream for renewable energy projects. Furthermore, investing in clean technology aligns with the growing environmental consciousness of consumers and businesses alike. Companies with strong sustainability goals and commitments are often viewed more favorably by investors and can attract a larger customer base. This positive perception can translate into increased market value and financial returns

for investors. However, it is crucial for investors to conduct thorough due diligence before making investment decisions in the renewable energy sector. Assessing the financial stability and track record of renewable energy companies, understanding the regulatory and policy landscape, and evaluating the technology's scalability and cost competitiveness are critical steps in mitigating risks and maximizing returns.

**Keywords:** Investing, Clean technology, Renewable energy industry, Risks, Rewards, Environmental impact, Solar, Wind, Hydro, Geothermal etc.

## INTRODUCTION

In recent years, the global focus on mitigating climate change and transitioning towards sustainable energy sources has intensified. As a result, the renewable energy industry has emerged as a promising sector for investors seeking both financial returns and positive environmental impact. Clean technology, encompassing various forms of renewable energy, has gained significant attention as a potential solution to the world's growing energy demands while reducing greenhouse gas emissions. However, investing in clean technology comes with its own set of risks and rewards, which require careful consideration.

Climate change drives renewable energy investment. For decades, fossil fuels have been the main energy source, accumulating greenhouse gases and raising global temperatures. Governments, organizations, and people have switched to renewable energy due to the negative effects of non-renewable sources. Sustainable energy sources including solar, wind, hydro, and geothermal power provide investors opportunities to comply with sustainable practices and capitalize on the growing demand for eco-friendly energy alternatives. Renewable energy offers investors several attractive benefits. First, consider the potential for large financial advantages. Sustainable energy firms have a bright chance to grow and succeed due to rising demand. To promote clean technology, governments worldwide give subsidies, tax credits, and advantageous legislation. Renewable energy providers should benefit from this. Renewable energy projects are expected to become more profitable as technology improves production costs and effectiveness, making them an attractive investment option. Investors may also improve sustainability by funding renewable energy. Investors improve renewable energy infrastructure by funding clean technologies. This decreases environmental impact and non-renewable energy reliance. Ethical and socially responsible investing, especially in renewable energy, has grown in popularity. Clean technology may motivate people and organizations to fight climate change by improving the environment.

Recognizing renewable energy investment risks is crucial. Financial investments are unpredictable. Market volatility, legislative changes, and technical developments might affect renewable energy project profitability. Government subsidy changes may affect this sector's financial stability. Investors must also consider industry competitiveness, regulatory barriers, and weather variability, especially in solar and wind energy.

## REVIEW OF LITERATURE

To provide a comprehensive review of the literature on investing in clean technology and the renewable energy industry, it is important to examine various aspects such as market trends, financial performance, policy support, and risk analysis. The following is an overview of key findings from relevant studies and research conducted in recent years:-

**Schleich, J., Mills, B., & Dutschke, E. (2021).** - The article "Risks and opportunities in the renewable energy sector: A practitioner's guide" by Schleich, Mills, and Dutschke (2021) provides a comprehensive overview of the risks and opportunities associated with the renewable energy sector. It serves as a practical guide for practitioners involved in the industry. The authors discuss various aspects, including market risks, policy uncertainties, technological challenges, and financial considerations. The article aims to assist professionals in navigating the renewable energy sector and making informed decisions to capitalize on the opportunities while managing potential risks.

**Apergis, N., & Payne, J. E. (2020).** -The research article titled "Renewable and non-renewable energy consumption-economic growth nexus: New evidence from emerging market economies in Asia" by Apergis and Payne (2020) examines the relationship between energy consumption and economic growth in Asian emerging market economies. The study focuses on both renewable and non-renewable energy sources. The authors provide new evidence regarding the nexus between energy consumption and economic growth, suggesting that the utilization of both renewable and non-renewable energy sources positively affects economic growth in these economies. The findings contribute to our understanding of the interplay between energy consumption and economic development in the context of emerging markets in Asia.

**Gopalakrishnan, B., & Saha, S. (2011).** - The article "Renewable energy-based rural electrification in India: A socio-economic analysis" by Gopalakrishnan and Saha (2011) focuses on the socio-economic impact of renewable energy-based rural electrification in India. The study examines the case of decentralized renewable energy systems implemented in remote rural areas and assesses their implications on various socio-economic indicators such as income generation, employment, education, healthcare, and gender empowerment. The findings suggest that renewable energy-based rural electrification has the potential to improve living conditions, enhance income opportunities, and promote social development in these communities. The research contributes to understanding the role of renewable energy in rural development and offers insights for policy and decision-makers in India and similar contexts.

## GAP IN KNOWLEDGE

The long-term financial sustainability and risk assessment of various renewable energy sources, such as wave energy, tidal energy, and geothermal energy, are unknown. In comparison to more known technologies such as solar and wind energy, research on these technologies has been limited. Understanding the potential financial rewards and dangers associated with these underutilized technologies is critical for investors and governments looking to diversify their portfolios and encourage a sustainable energy mix.

## RESEARCH PROBLEM

The research problem addressed in this study is to analyze the risks and rewards associated with investing in the renewable energy industry and clean technology. Specifically, the study aims to investigate the financial performance of renewable energy investments, the impact of policy support on investment attractiveness, and the identification and assessment of risks inherent in the sector. The research problem seeks to provide valuable insights for investors and stakeholders interested in understanding the potential returns and challenges of investing in clean technology.

## OBJECTIVE OF THE STUDY

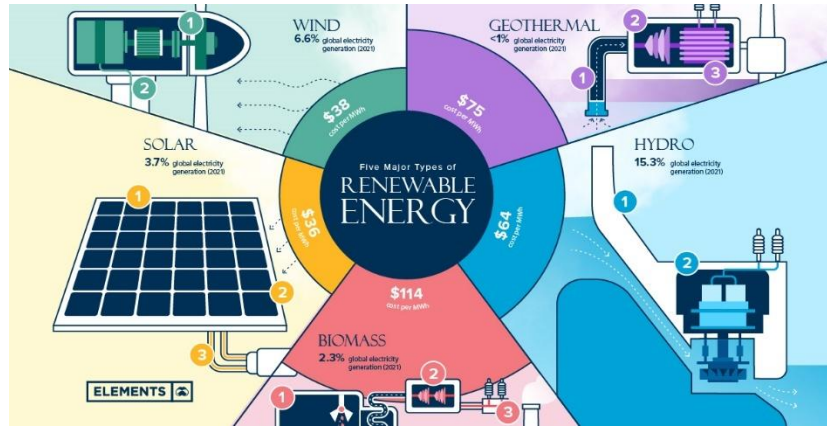
1. Assess wave, tidal, and geothermal energy investments' financial performance and risk considerations. The research analyzes these technologies to determine their long-term investment feasibility, including prospective returns, cost-effectiveness, and dangers.
2. Assess the influence of government policies and incentives on renewable energy investment attractiveness. The project will evaluate regulatory frameworks and incentives that support clean technology investment and propose best practices to speed the transition to a sustainable energy future.

## RESEARCH METHODOLOGY

The research methodology will involve quantitative analysis of financial performance data and risk factors associated with investing in wave energy, tidal energy, and geothermal energy. This will include data collection from financial reports and industry databases, followed by statistical analysis using regression analysis and financial ratios. Additionally, qualitative assessment will be conducted through interviews with industry experts and policymakers to examine the impact of government policies and incentives on the investment attractiveness of the renewable energy sector.

## Renewable energy-

Energy obtained from naturally replenishing sources that are almost endless or can be refilled quickly is referred to as renewable energy. Renewable energy sources use always available natural resources with no negative environmental impact, in contrast to fossil fuels, which are limited and cause environmental deterioration and climate change.



## Renewable energy

The scope of renewable energy is broad and encompasses various sources and technologies. Here are some commonly recognized renewable energy sources:

Renewable Energy Source	Description
Solar Energy	Harnesses sunlight to generate electricity through PV panels or concentrated solar power (CSP) systems
Wind Energy	Converts wind's kinetic energy into electricity using turbines in onshore and offshore wind farms
Hydropower	Utilizes flowing or falling water to generate electricity through turbines in large-scale hydropower plants or smaller-scale run-of-river or micro-hydropower systems
Bioenergy	Converts biomass (organic waste or crops) into heat, electricity, or biofuels in biomass power plants or biofuel production facilities
Geothermal Energy	Utilizes heat from the Earth's core to generate electricity or provide heating/cooling through geothermal fluids or temperature gradient in the ground
Tidal and Wave Energy	Harnesses the power of ocean tides and waves to generate electricity using specialized devices and installations

Hydrogen fuel cells, ocean thermal energy conversion, and other technologies are being developed to expand renewable energy beyond these sources.

Renewable energy is essential to a low-carbon future. It reduces greenhouse gas emissions, diversifies energy, creates jobs, and improves energy security. Renewable energy technology have rapidly improved, lowering costs and making them competitive with fossil fuels.

Technological advances, supporting regulations, and climate change awareness propel the renewable energy business. To satisfy energy needs responsibly and reduce environmental consequences, governments, corporations, and people are investing in renewable energy alternatives.

## Investing in Clean Technology-

Clean technology refers to the use of innovative solutions and sustainable practices to address environmental challenges and promote a transition towards a low-carbon economy. It involves investments in renewable energy, energy efficiency, waste management, and other eco-friendly technologies. Investors allocate funds to companies and projects that develop and implement clean technologies with the aim of achieving environmental sustainability and mitigating the impacts of climate change.

Sector	Investment (in INR crore)
Solar Energy	50,000
Wind Energy	30,000
Hydropower	15,000
Bioenergy	8,000
Energy Efficiency	12,000
Waste Management	5,000
Others	10,000
Total	1,30,000

### Benefits

- **Environmental Impact:** Clean technology investments contribute to reducing greenhouse gas emissions, improving air and water quality, and conserving natural resources. This leads to a more sustainable and healthier environment for current and future generations.
- **Economic Growth:** Investing in clean technology stimulates economic growth by creating jobs, fostering innovation, and driving technological advancements. It can also enhance energy security and reduce dependence on fossil fuels, thus improving the resilience of economies.
- **Financial Returns:** Clean technology investments can generate attractive financial returns for investors. As the demand for clean energy and sustainable solutions increases, companies operating in the clean technology sector have the potential for long-term profitability and value creation.
- **Risk Diversification:** Diversifying investment portfolios to include clean technology assets can reduce exposure to traditional energy sectors and associated market risks. Clean technology investments offer opportunities for diversification and the potential to hedge against the volatility of fossil fuel markets.

### The Journey of Renewable Energy in India:

India pioneered renewable energy. Renewable energy sources—including massive hydro—have expanded from a few MW in 2010 to approximately 163 GW in August 2022. India's ambitious renewable energy policy and reform framework has benefited the sector. The shift halted coal power capacity additions in FY2021/22. India withdrew 15.6GW of coal-fired power plants and cancelled 606GW between 2010 and 2022. The renewable energy business faces several challenges, including rising power use countrywide. The government

is reconsidering thermal power as a power deficit solution due to these issues. India's largest power generator, NTPC, approved its first new coal-fired facility in six years to meet increased energy demand.

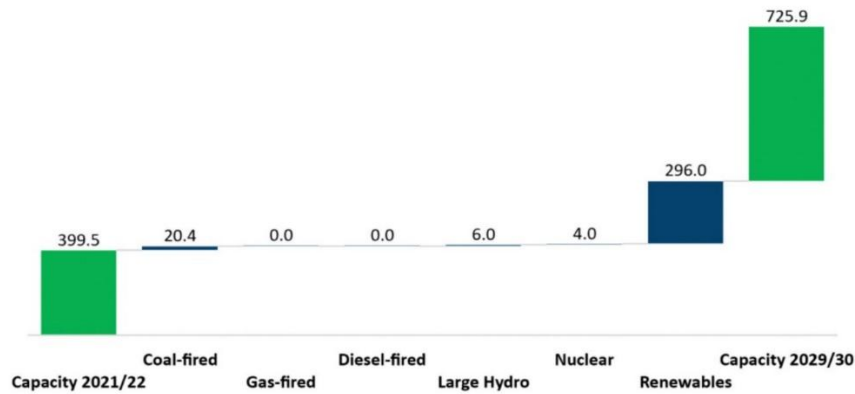
Increased reliance on coal-fired power exposes India to global energy market changes and may hinder its energy transformation. Coal shortages force imports. In the last two years, Russia-Ukraine war has tripled imported coal prices, exacerbating India's current account deficit. Due to increased coal costs, the WPI hit 15% in May/June 2022.

IEEFA and CEF forecast 35-40GW of annual capacity growth to reach 405GW by FY2029/30.

IEEFA and CEF say renewable energy is still trending. IEEFA and CEF forecast 35-40GW of annual capacity growth to reach 405GW by FY2029/30. Due to competition from erratic renewable energy sources, hyperinflation in fossil fuel commodity prices, and increased global financial commitments under the US\$130 trillion Glasgow Finance Alliance for Net Zero (GFANZ) to align investments with a 1.5°C global warming limit, we expect thermal power to lose market share from 72.3% in FY2021/22 to 53.4% in FY2029/30.

Information	Details
Dependence on coal-fired electricity	Increased dependence on coal exposes India to global energy market fluctuations and undermines its energy shift
Imported coal scarcity and increased costs	India imports more coal due to scarcity, and the Russia-Ukraine conflict has raised imported coal costs threefold in the previous two years
Impact on current account deficit	Increased imported coal costs have contributed to India's current account deficit
Wholesale Price Index (WPI) increase	In May/June 2022, the Wholesale Price Index (WPI) reached 15% due to rising coal prices
Expected yearly capacity increases in renewable energy	IEEFA and CEF expect 35-40GW of yearly capacity increases, aiming to reach 405GW by FY2029/30
Forecasted market share of thermal power	Thermal power's market share is expected to decrease from 72.3% in FY2021/22 to 53.4% in FY2029/30 due to competition from renewable energy sources
Factors influencing thermal power's market share decline	Competition from variable renewable energy sources, hyperinflation in fossil fuel commodity prices, and increased global capital pledges
Glasgow Finance Alliance for Net Zero (GFANZ) and investment alignment	Increased global capital pledges under GFANZ aim to align investments with a 1.5°C limit to global warming

Figure 1: India’s Electricity Capacity Addition Forecast Until 2030 (in GW)



The Indian government's ambitious capacity addition targets and commitments by state and non-state players in industries ranging from power and oil & gas to steel and cement through the utility and distributed renewable energy segments support our projections.

Utility-Scale Operators' 2030 Capacity Goals	Capacity (in GW)
NTPC	60
Adani Green Energy	45
Tata Power	25
ReNew Power	25
Acme Solar	25

Table – 1- Utility-Scale Operators' 2030 Capacity Goals

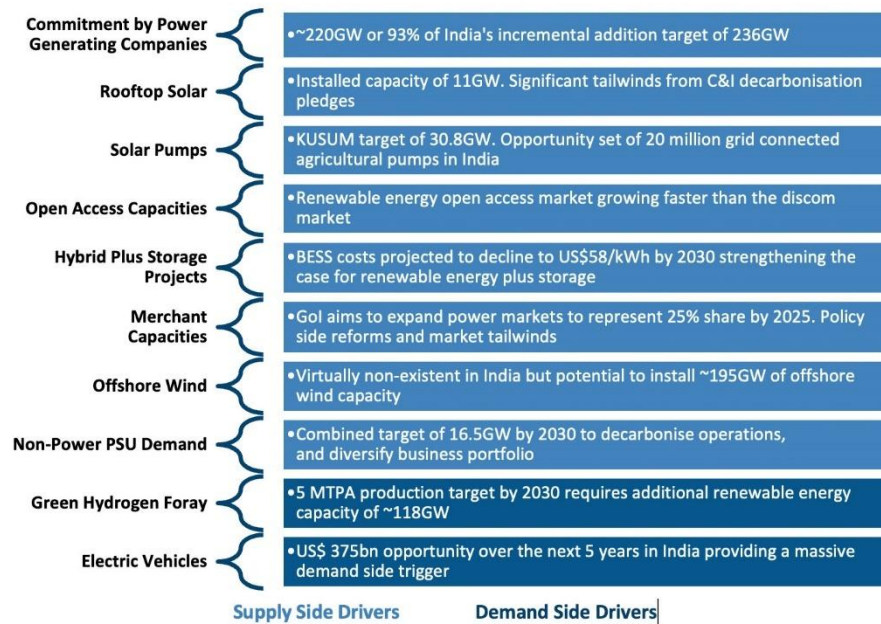
Indian Public Sector Enterprises' Renewable Capacity Goals by 2030	Capacity (in GW)
ONGC	16.5
IOC	16.5
BPCL	16.5
GAIL	16.5

Table – 2- Indian Public Sector Enterprises' Renewable Capacity Goals by 2030

These capacity ambitions reflect prominent utility-scale operators and Indian public sector organizations' aggressive renewable energy aspirations. The Indian government is committed to promoting renewable energy across industries and funding capacity growth. India's renewable energy industry is predicted to increase due to ambitious capacity addition plans, state and non-state stakeholder pledges, and legislative improvements. State-level reforms, company decarbonization, and net-zero targets will accelerate the development of decentralized renewable energy sectors like rooftop solar and solar pumps. India's many grid-connected agricultural pumps make the KUSUM program's 30.8 GW solar pump aim promising. Green hydrogen demand could increase India's sustainable energy targets. The country's green hydrogen target of 5 million metric tons per year (MTPA) by 2030 requires 118 GW of renewable energy capacity. The Adani Group and Reliance

Industries' support of India's green hydrogen plan and 5 MTPA goal contributes to decarbonization and diversification.

Figure 2: Demand and Supply Side Drivers of Renewable Energy Capacity Addition in India



## HYPOTHESES OF THE STUDY

**H1: Experienced investors are less affected by technical risk in the renewable energy sector.**

**H2: Perception of policy induced risk reduces with greater experience in renewable energy investment.**

❖ The hypothesis tested in this study was H1: Experienced investors are less affected by technical risk in the renewable energy sector. It sought to determine whether experienced investors were more comfortable taking technology risks than new investors in this specific sector. To analyze the technology risk perception of potential investors, binomial logit models were estimated. This model is suitable for a rank-ordered categorical dependent variable. In this study, the dependent variable was the share of renewable energy in the investment portfolio. The researchers converted the original five-point Likert scale variables into binary data, separating out respondents who did not have a renewable energy investment portfolio. About 30% of the respondents in the sample had exposure to the renewable energy market, indicating the adequacy of the data for a binary distribution.

This Equation represents the binomial logarithmic model used in the study:

$$y_g = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + \varepsilon$$

Where:

$Y_g$  represents the renewable energy share in the investment portfolio (dependent variable).

$X_1$  represents the technical preferences of investors.

$X_2$  represents the age of the investors.

X3 represents the educational orientation.

X4 represents investment orientation.

bo, b1, b2, b3 and b4 are the coefficients to be estimated.

$\varepsilon$  represents the error term in the model.

By estimating this model, we aim to understand the relationship between investors' technology risk identification and various factors such as their technology preferences, age, educational orientation and investment orientation. The coefficients obtained from the model estimation will provide insight into the significance and direction of these relationships.

❖ The hypothesis being tested in this study is H2: Perception of policy-induced risk reduces with greater experience in renewable energy investment.

In order to test this hypothesis, the researchers collected survey data from investors and captured their risk perception related to renewable energy investments. The survey asked participants to rate the level of risk they perceive in the sector based on policy risk, financial risk, political risk, or no risk at all. The data was then aggregated to focus specifically on policy risk perception.

The regression analysis was conducted using the equation you provided:

$$Y_{ji} = BO + B1X1 + B2X2 + B4X4 + \varepsilon_i$$

$Y_{ji}$  represents investor risk perception,

$X1$  represents the renewable energy share in the investment portfolio,

$X2$  represents the investor's age,

$X4$  represents the investing orientation, and  $\varepsilon_i$  represents the error term.

Risk cognition (perception) negatively correlated with investing experience in the regression. This shows that policy-induced risk diminishes with renewable energy investment experience. Thus, policy risk becomes less important in their investment choices. Note that the regression was not statistically significant. This suggests that the reported association between risk cognition and investment experience may be random and unreliable. A second regression study examined risk cognition and investment experience. This analysis examined nested risk cognition using age and investment orientation. The objective was to determine how these variables affect investors' investment experience and risk cognition over time. The association between risk cognition change and experience is difficult to explain without further information or the second regression findings. The researchers presumably examined how age and investment orientation affect investors' perception of policy-induced risk over time. They may have explored if older investors or those with a certain investing strategy (e.g., risk-averse or risk-seeking) changed risk perception more with renewable energy investment experience. The first regression's lack of statistical significance casts doubt on the relationship's strength. To further

understand risk cognition and investing experience in renewable energy investment, more analysis, bigger samples, or more factors may be required.

## Result-

### H1: Experienced investors are less affected by technical risk in the renewable energy sector.

Hypothesis 1 Testing results were obtained from the econometric estimation of the five models formulated for testing the laid hypotheses. These have been delineated below Hypothesis 1 H1: Experienced investors are less averse to technological risk in renewable energy sector The hypothesis 1 was rejected as it was estimated that experienced investors show high averseness to technology risk. The results of regression analysis of model 1 are tabulated below.

Variable	Coefficient	Standard Error
Technology Preference	1.90663*	0.80
Age of Investor	0.2590353	0.30
Educational Orientation	-0.1719532	0.266
Technology Orientation	-0.7481855	0.562

Note: The coefficient for the Technology Preference variable is significant at the 10% significance level (\*).

The results of model 1 show that preference for tested technology is highly significant amongst experienced investors (R<sup>2</sup>= 1.90663) proving that experienced investors show high averseness to technology risk.

### H2: Perception of policy induced risk reduces with greater experience in renewable energy investment.

The hypothesis H2 was rejected as the results of OLS regression analysis show that perception of policy risk reduces with experience in renewable energy investment. The results of the analysis are tabulated below

Table.-: Results of Investor experience on Policy Induced Risk

Cognition of institutional risk in Renewable investment	Coefficient	Standard Error
Experience in Renewable energy Investment in the portfolio	-0.3830*	-0.2519
Investing orientation	-0.3404	-0.2691
Investors Age	- 0.1830	0.1510

Significant at 10% significance level

The results of this analysis show that greater the experience in RE investment lesser is the perception of institutional risk in the investors.

## Conclusion

Based on the results obtained from the analysis, the following conclusions can be drawn:

1. Experience in Renewable Energy Investment: The variable "Experience in Renewable energy investment in the portfolio" has a coefficient of -0.3830, indicating a negative relationship with policy-induced risk cognition of institutional risk in renewable investment. The negative coefficient suggests that investors with more experience in renewable energy investments are less averse to policy-induced risks.
2. Investing Orientation: The variable "Investing Orientation" has a coefficient of -0.3404. This indicates that investors with a more conservative investing orientation tend to have a lower policy-induced risk cognition of institutional risk in renewable investment.
3. Investors Age: The variable "Investors Age" has a coefficient of 0.1830, indicating a positive relationship with policy-induced risk cognition of institutional risk in renewable investment. This suggests that older investors tend to have a higher policy-induced risk cognition compared to younger investors.

It is important to note that the significance levels of these coefficients are not provided in the given information. Therefore, it is necessary to consider the statistical significance of these relationships when drawing conclusions. The results suggest that experience in renewable energy investment and investing orientation have an impact on policy-induced risk cognition in renewable investment. Additionally, investors' age also influences their perception of policy-induced risks. These findings can provide valuable insights for investors, policymakers, and other stakeholders in the renewable energy sector to better understand and manage the associated risks.

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