

Chapter 9

Sustainable Finance and ESG Investing: A Theoretical-Practical Approach from Portfolio Management



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Abstract The climate emergency and its devastating consequences have become one of the most prominent risks in the twenty-first century. Dozens of cities are suffering from numerous floods, strong storms and weather phenomena with a severe impact on the population and their infrastructures. The need for change in our production and consumption patterns emerges as an action that must be taken now, without delaying it any longer. Focused on energy consumption and production, the energy transition explains the paradigm shift that we must carry out to reduce the negative impacts produced by the current fossil fuel-based system. A shift to renewable energies will help us to mitigate these consequences. However, this transition must be accompanied by a greater effort in the financial sector to finance and invest in this kind of activities. With this premise, the objective of this chapter is to theoretically introduce the problem and empirically test the financial viability of investing in renewable energy companies vs. fossil fuel companies. With a sample of 112 global companies, a set of portfolios is analyzed through portfolio optimization and Monte Carlo simulation for a period from 01/01/2022 to 08/16/2023. The results show that the most optimal portfolios in terms of the risk-return trade-off continue to consist mostly of fossil fuel companies. The financial markets continue to advocate a traditional view, with no real change in their investment decisions. This implies a lack of real action in finance to truly be part of the change, advocating more investment in environmentally responsible companies.

Keywords Sustainable finance · Monte Carlo simulation · O&G · Renewable energy

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9.1 Sustainable Finance & ESG Investment. Why Is So Urgent?

9.1.1 Sustainability as the Single Path

The excessive development that the planet has experienced over the last decades has been accompanied by serious environmental problems. A “more development, more fossil fuels” approach has been established, which does not make it possible to alleviate the climate change problems we are currently experiencing (Cong et al., 2022). The effects produced by greenhouse gases (GHG) are mainly due to carbon emissions (Raggad, 2020). Some organizations such as The Intergovernmental Panel on Climate Change (2021) note that the temperature will reach 1.5 °C-2 °C above pre-industrial levels. These kind of consequences suggest that climate change has become the real challenge to be faced in the twenty-first century. The United Nations warns that in order to try to alleviate this problem, immediate measures must be taken to reduce emissions and build a model in which development and human welfare do not contradict each other. Thus, sustainable development has become the most urgent priority these days (Jun et al., 2022). Some authors have warned that this sustainable development must respond to the energy trilemma: access to affordable energy, energy security and environmental sustainability (Cong et al., 2022). To provide a solution to these and other issues, during the last decades society has started to develop new initiatives and tools that try to mitigate the negative effects of economic development, from climate change to social inequalities or global economic inequity (Eccles et al., 2017).

Since the 1980s, academic research has already documented the need for good governance policies to contribute to sustainable development and in turn improve the economic-financial performance of companies (Gerard, 2019). Through the integration of environmental and social policies in business decisions, companies can come to develop their activity in a sustainable way. This strategy has been of particular interest within and outside companies (Kotsantonis et al., 2016). Since these types of initiatives have a long-term character, their consequences will also bring long-term consequences, which ultimately determines the way in which the company invests, spends and operates in the market (Anderson & Anderson, 2009). This new way of investing, known as sustainable investment, allows the company not only to generate less negative impact on the environment and society, but also to generate high financial returns (de Francesco & Levy, 2008).

Social Responsible Investments (SRI) is a way of contributing to the sustainable development of the planet. In some ways, it reflects from religious values to more actual factors such as social justice, climate change or good corporate governance policies. Modern SRI has two main aspects: the more traditional investment based on social values; and another that goes further through the implementation of ESG criteria that allow the introduction of environmental, social and good governance issues in business decision making, investment or reporting (Townsend, 2020). This new investment policy is expected to be increasingly influential in decision-making

by investors, especially investors at an early stage of their careers (Bank of America, 2018).

This new wave of investors is particularly interested in aspects concerning how the company is trying to care for the environment and society. Because of this, the use of non-financial information is increasing considerably, as the aim is to include this type of data in investment or spending decisions along with traditional economic-financial information (Aich et al., 2021). Due to this demand for non-financial information, in the last decades companies are starting to report this type of information. For example, more than 90% of S&P 500 companies are currently reporting non-financial information according to their environmental, social and governance policies (G&A Institute, 2021). Through this type of information, along with traditional economic-financial information, the market can detect whether companies are doing well, being good. Some authors even identify a positive relationship between energy efficiency, treatment of employees or good governance policies with traditional financial indicators such as the price/earnings ratio (Caplan et al., 2013).

9.1.2 ESG Investment: The Need of Change

ESG investment began to come to the fore in 2006 with the launch of the Principles for Responsible Investment (PRI) by the United Nations. The PRI are framed as a total of 35 possible actions that institutional investors can take in order to voluntarily integrate environmental, social and governance issues into investment decisions (Wen et al., 2022). Authors such as Eccles and Viviers (2011) define responsible investment as a practice that integrates ESG considerations in order to achieve optimal returns with the lowest possible risk of loss. Moreover, some authors argue that ESG factors can affect investment performance in terms of the return generated from the portfolio (Caplan et al., 2013). This issue has sparked academic interest in this relationship (Dai, 2021). Some authors warn that companies focused on operating with ESG factors tend to generate higher return and lower risk with respect to those that do not consider it (Dimson et al., 2015; Friede et al., 2015). This link, as well as the market's increased awareness of the ESG factors, has led companies to start reporting this type of non-financial information in order to receive a positive feedback from investors and shareholders (Drempetic et al., 2020). According to this increased interest in ESG factors, the authors tend to position themselves on the positive or negative aspects of carrying out a business operation based on these principles.

The prevailing notion is that socially responsible investment does not generate significantly high returns according to the risk incurred by this type of investment (Renneboog et al., 2008). Authors such as Caplan et al. (2013) or Branch et al. (2019) warn that ESG investment can lead to reduced portfolio returns since one of the strategies is to exclude certain investment options for not having specific ESG levels according to certain standards. According to Halbritter and Dorfleitner (2015)

the returns of investment portfolios with high ESG levels do not differ significantly from those portfolios with low ESG levels. For a study of mutual funds and stock indexes, Junkus and Berry (2015) warn that there is no significant difference in terms of the returns generated with respect to more traditional financial assets.

In contrast to this reject stance, it is noticed that money flows are starting to redirect towards sustainable investments. According to a recently report by Morningstar (2022), sustainable funds received \$70 billion in 2021, followed subsequently by \$87 billion dollars in the first quarter of 2022 and another \$33 billion in the second quarter. This suggests that there may also be a link to improve investment performance by taking ESG factors into account. Moreover, from an academic point of view, there is a significant increase in studies that note a positive relationship between ESG factors and corporate financial behavior (Eccles et al., 2017; Giese et al., 2019). For example, Whelan et al. (2021) find that 58% of studies show a positive relationship between ESG and corporate financial performance for a sample of 1000 studies between the years 2015–2020. Others such as De and Clayman (2015) warn that the integration of ESG criteria in portfolios tends to increase value and reduce volatility in post-crisis periods. These results indicate that sustainable policies give a positive signal to the market that increase the valuation of companies (Zhang et al., 2020).

Due to the need for sustainable development on the part of companies, an enormous amount of legislation has been developed in recent years that is improving the quality and standardization of non-financial information (Goldstein et al., 2022). However, due to such a large amount of regulation, standards and ratings, a certain ambiguity is being perceived when evaluating and analyzing the responsible practices of companies (Cornell, 2021). Authors such as Fish et al. (2019) document that in 2018 more than 600 ESG ratings were generated, which makes it especially difficult to differentiate companies with good practices from those that do not. Society needs concrete measures and a very well-structured model in order to be able to carry out an evaluation of the ESG activities and make the appropriate decisions according to ESG criteria (Park & Jang, 2021).

Within the framework of this new trend in financial markets, this chapter aims to reflect the most relevant theoretical aspects of this trend. On the other hand, through portfolio analysis and Monte Carlo simulation, we intend to test the level of acceptance of renewable energy companies vs. fossil fuels companies in terms of the portfolio's risk-return trade-off.

The chapter is structured as follows: Section 9.2 introduces a summary of the main standards and legal frameworks that regulate ESG investment and Climate Finance. Section 9.3 covers a comprehensive explanation of Climate Finance and its most relevant implications. The chapter ends with Sect. 9.4 where a comparison of renewable energy companies vs. fossil fuels companies is empirically analyzed.

9.2 Reporting Standards and Framework. Where Are we and What Remains to Be Done?

9.2.1 A Brief Look at the Regulation in Europe

In accordance with the need to regulate business activities in order to mitigate the environmental and social impact of certain practices, the regulation of countries has begun to work hard to try to establish an efficient model for the evaluation and measurement of activities. In order to focus the regulatory review, it has been considered pertinent to present the most recent regulations in the European Union. As shown in Table 9.1, regulatory activity in this area has been particularly active in the last 3 years. The general framework that seeks to reconcile the objectives of economic and sustainable development is known as Europe's Green Deal. A roadmap whose main objective is to make Europe an emission-neutral continent by 2050. Following this regulation, the EU Taxonomy was published. It is considered the first system for classifying European activities according to environmental and climate criteria. In this way, it is possible to classify and analyze the different business activities to improve the selection of socially and environmentally responsible investments. Other sets of measures, such as the Renewed Sustainable Finance Strategy or the Europe's Fit for 55, seek to respond to the urgent need for financial support for an optimal transition to an increasingly sustainable economy. The EU Sustainable Roadmap 2022–2024 was also born with this objective in mind. This roadmap aims, among other things, to alleviate greenwashing, promote transparency and improve the monitoring and analysis of ESG markets and their risks. Some regulations, such as the REPowerEU program, were implemented due to force majeure such as the war between Russia and Ukraine. This action plan aims to reduce energy dependence on Russia and promote the production and consumption of renewable energies in the European Union.

9.2.2 Several Standards and Frameworks: Is It Being Done Right?

Regarding standards and frameworks related to sustainable finance and ESG investment, Table 9.2 presents a selection of them. It can be seen that most of them have jurisdiction at the European or global level, some being mandatory and others voluntary. As a general rule, they focus on corporate sustainability and sustainable finance. These kinds of standards focus on company reporting, because by regulating these issues, the information extracted from the reports can generate a more objective analysis for investment or financing decisions. Some, such as the Corporate Sustainability Due Diligence Directive, go further by regulating not only the company's environmental and social reporting, but also its suppliers. Other frameworks such as the Task Force on Climate-Related Financial Disclosures have

Table 9.1 Sustainable and ESG investing regulation in Europe. Note: Own elaboration

Regulation	Date	What is it?	Main objective	Key pillars
Europe's green Deal	11 December, 2019	Roadmap	Improve the well-being and health of citizens and future generations; Europe becoming a climate-neutral continent by 2050	Climate action; clean energy; sustainable industry; eliminating pollution
EU taxonomy	22 June, 2020	Classification system	Defines criteria for economic activities that are aligned with a net zero trajectory by 2050 and the broader environmental goals other than climate	Common definition of economic activities that can be considered environmentally sustainable; protecting investors from greenwashing; helping companies become more climate-friendly; mitigating market fragmentation
Renewed sustainable finance strategy	July 6, 2021	Set of European measures	Support the financing of the transition to a sustainable economy	Transition finance; inclusiveness; resilience; contribution of the financial system and global ambition
Europe' fit for 55	July 14, 2021	Legislative package	Reducing net GHG emissions by at least 55% by 2030	Social climate fund; innovation and modernization fund; renewable energy directive and energy efficiency directive; CO ₂ emissions standards
EU Sustainable Roadmap 2022-2024	February 10, 2022	Practical tool	Ensure that European securities and markets authority (ESMA) is able to take action to fulfil its mandate in the wide array of sustainable finance tasks	Tackling greenwashing and promoting transparency; building NCAs and ESMA's capacities; monitoring, assessing and analyzing ESG markets and risks
REPowerEU	May 18, 2022	Action plan	Reduce dependence on Russian fossil fuels and fast forward the green transition	Accelerating the switch to electrification and renewable hydrogen; enhancing our low-carbon manufacturing capabilities; diversifying gas supplies; investing in the necessary infrastructure; more rooftop solar panels, heat pumps and energy savings

Table 9.2 Sustainable and ESG investing frameworks. Note: Own elaboration

Framework	Jurisdiction	Focus	Key components & Functions	Status	Mandatory / Voluntary
Corporate sustainability reporting directive	European Union	Corporate sustainability	Double materiality assessments determine the information to be reported through the ERSR reporting framework	In force as of January 2023	Mandatory regulation
Sustainable finance disclosure regulation	European Union	Sustainable finance	Entity and product level disclosures of sustainability related risk in investment decision	In force as of January 2022	Mandatory regulation
Corporate sustainability due diligence directive	European Union	Sustainable supply chains	Requiring companies to report on environmental and social impacts of their own operations and that of their suppliers	Approved by the European Parliament in June of 2023	Mandatory regulation
SEC climate disclosures	United States	Climate risk disclosure	Integration of TCFD and GHG protocol	Proposal stage with final rule anticipated in 2023	Mandatory regulation
International sustainability standards board	Guidance framework, no jurisdiction	Corporate sustainability	Comprehensive baseline of sustainability disclosure standards that can be mandated and combined with jurisdiction-specific requirements	Partially complete with an effective date of January 2024	Voluntary framework
Task force on climate-related financial disclosures	Guidance framework, no jurisdiction	Sustainable finance	Develop a set of recommendations for voluntary climate-related financial disclosures. These are aimed at all financial actors, from companies and investors to asset owners and managers, as the goal is to provide consistent and transparent information to global markets	Approved by the Financial Stability Board in December 2015	Voluntary framework
Corporate sustainability reporting directive	European Union	Corporate sustainability	Ensure that investors and other stakeholders have access to the information they need to assess the impact of companies on people and the environment and for investors to assess financial risks and opportunities arising from climate change and other sustainability issues	In force as of January 2023	Mandatory regulation

a global jurisdiction and their main objective is to generate consistent and clear information so that financial stakeholders have sufficient tools to evaluate a possible ESG investment.

These frameworks help companies' transparency and reporting objectives, but as Fish et al. (2019) point out, there is a current problem with the plethora of frameworks, standards and regulations that companies can or should adhere to for reporting their non-financial information. A standardized and global approach will be necessary so that investors and stakeholders can make their decisions according to reliable and standardized criteria.

9.3 The “E” in ESG Investing. The Climate Finance as a Global Priority

9.3.1 Mitigating Climate Change. An Urgent Issue

Due to the severe negative consequences that economic development has had on the environment, an immediate energy transition to alternative energy sources is required (Setyowati, 2020). Recent evidence warns of a catastrophic future if immediate and radical measures are not taken to eliminate the effects of conventional energies on the environmental well-being (IPCC, 2018). These measures require a huge innovation in the production and consumption matrix that must be accompanied by financial support (Calvet et al., 2022). The United Nations Framework Convention on Climate Change (UNFCCC) refers to this support as climate finance, which aims to redirect funding and investment towards activities that mitigate and adapt to climate change (UNFCCC, 2019). It even has among its objectives to redirect funds to traditional industry in order to improve the capture and elimination of emissions (Hong et al., 2020). Climate finance has been a topic of growing popularity in recent years, especially after the Paris Climate Accord (Bodansky, 2016). However, numerous studies warn that much work remains to be done in the framework of climate finance to mitigate much of the damage caused by certain industries (UNCTAD, 2014; IPCC, 2018; Buchner et al., 2019). This damage, and the associated natural disasters, can also have tremendous financial impacts on the stability of countries and companies (ESRB, 2016).

The importance of climate finance is mainly due to the need for investment in renewable energy and the technology associated with its development and viability, thus enabling a shift to a less energy-intensive economy (Kouwenberg & Zheng, 2023). For this reason, climate finance should be the cornerstone of monetary and financial policy. In this way, a greater amount of funds can be redirected towards low-carbon investments, thus reducing their risk level (Aglietta et al., 2015). It is estimated that around US\$200 billion will be needed in 2030 to return global GHG emissions to current levels (Gutiérrez & Gutiérrez, 2019). Issues such as the lack of incentives, low returns on investment or the risks associated with new low-carbon

technologies may hinder the achievement of ambitious targets by governments and institutions (Chawla & Ghosh, 2019).

9.3.2 Finance Tools. What Can Finance Do?

It is estimated that around US\$8 trillion of investment will be needed between 2015 and 2030 to address the need for infrastructure, energy efficiency and primary energy to reach the proposed emissions-neutral targets by 2030 (Meltzer, 2022). Finance is the indispensable tool to be able to come up with such an amount of financing and investment for the energy transition. For example, the World Bank Group has invested US\$31.7 billion in 2021 to help countries combat climate change (Schalatek & Bird, 2022). Tools such as the Green Climate Fund (GCF) are helping to redirect funds to developing and vulnerable countries to enable them to undertake a just and cost-effective energy transition (Samuwai & Hills, 2018). The GCF was established in 2010 by the United Nations Framework Convention on Climate Change (UNFCCC) at the Conference of the Parties (COP) in order to contribute to greater equity in climate change mitigation and adaptation capacity globally (Bowman & Minas, 2018). Not only public initiatives should be accounted for, but private climate finance also plays a crucial role in the goal of reducing emissions, reducing the vulnerability of developing countries, as well as in building a more resilient system to the damages produced by climate change. Private institutions and companies have the ability to decide on funds for low-carbon projects that contribute to an efficient, viable and just energy transition (Bowman, 2010).

Financial markets play a key role in mitigating and eliminating climate risks. They have the ability to facilitate relevant monetary flows to green projects, as well as reduce financing and investment to other types of traditional industries that may contribute to negative climate impacts (Giglio et al., 2021). Not only is their role critical for the planet, but also for the market itself. According to Dietz et al. (2016), around 17% of financial assets are exposed to certain climate risks. To mitigate this impact, platforms such as the “Global Investor Statement on Climate Change” (IIGCC, 2011) have been launched in order to attract more investment and financing towards clean energy sectors. This initiative was signed by 285 institutions, representing more than US\$20 trillion.

In the next section we will look at a quantitative approach from a portfolio management perspective to visualize the investment attractiveness of the energy sector, differentiating between renewable energy and conventional energy.

9.4 A Quantitative Approach Applied to the Energy Industry. Evidences from the Portfolio Management

9.4.1 *Relevance & Sector Impact*

Our economic system has been sustained for several hundred years by energy, which has played a fundamental role in the development and implementation of most of sectors (Adedoyin et al., 2020). This livelihood is accompanied by an enormous negative impact on the environment. According to data obtained from a report recently published by the International Energy Agency (IEA, 2023a), energy-related greenhouse gas (GHG) emissions have grown by 1% in 2022, reaching unprecedented levels of 41.3 Gt CO₂-eq. A fig. 89% of which is accounted for by fossil fuel-related emissions. In addition to this major impact of fossil fuels, the world's dependence on this energy source must also be considering. The Energy Institute (2023) report that the percentage of primary energy demand coming from fossil fuels was 82% in 2022, a percentage that, according to institutions such as the Energy Information Administration (2022), will remain stable over time, forecasting a 70% share of energy demand for fossil fuels by 2050. These data represent a handicap for achieving the goals to mitigate the environmental impact that this type of energy has on the planet. Moreover, organizations such as the Intergovernmental Panel on Climate Change (IPCC, 2023) warn that it is very likely that the goal of maintaining global temperatures at 1.5 °C will not be achieved even in the most favorable scenario of minimum GHG emissions. Not only does the current energy demand pose a problem, but the population will grow, so the demand for energy will also increase unprecedentedly. According to the United Nations (UN), the global population is expected to reach 9.7 billion by 2050. To avoid that energy coming from fossil fuels, huge efforts must be made to change the global energy mix (United Nations, 2015). Some companies even venture to launch some percentages. A report recently published by the oil giant Exxon Mobil (Exxon Mobil, 2023), warns that 15% more energy will be needed to maintain population growth at a certain standard of living. To avoid further damage to the planet, major changes are needed. According to the same report, it is estimated that by 2050, solar and wind energy will account for up to 11% of energy production, compared to 2% today.

This change in the energy mix from fossil fuels to renewable energy is known as Renewable Energy Transition (RET). A transition that is indispensable if the planet is to have a cleaner future in terms of energy consumption and production, being strictly necessary to make a shift towards less polluting energies such as wind or solar (Imteyaz et al., 2021; Bhattarai et al., 2022). Empirical studies such as Koondhar et al. (2021) or Bilgili et al. (2016) have shown that higher consumption of renewable energy reduces the level of emissions. However, the rate of action is dangerously low considering the proposed targets to rapidly mitigate environmental impact. According to a recent survey by the World Energy Council (WEC, 2023), 64% of global energy leaders warn that the global energy transition is too slow to achieve the UNFCCC Paris Agreement commitments and

UN Sustainable Development Goals. One of the reasons for this slow pace may be due to the high cost of capital and the need for investment, as this survey also warns. This need for investment is supported by reports such as the International Renewable Energy Agency (IRENA, 2022), recognizing that efforts in installed renewable capacity must triple by 2050 to achieve the goal of maintaining the 1.5 °C scenario. Other institutions such as the International Energy Agency (IEA, 2023b) also warn of this need, indicating that the flow of investment towards renewable energies must be considerably increased for a safe and reliable energy transition. Thus, the global financial system has become the biggest challenge at this time to achieve the energy sustainability goals (WEC, 2023).

Climate finance is the tool that the financial system uses to reallocate public and private investment flows to mitigate the risks associated with climate change. It is an area of study that has grown considerably in terms of the attention provided by the academic community, politicians and practitioners (Hong et al., 2020). Climate finance must become a cornerstone of the financial system, so it cannot be disconnected from the reforms or changes that concern it (Aglietta et al., 2015). On the other hand, politicians must also design policies to attract more capital to cleaner energy sources to mitigate negative environmental impacts (CFLI, 2021). One such policy is disinvestment in carbon-intensive industries, as empirically demonstrated by Fang et al. (2018) indicating that these types of industries present more risk relative to less carbon-intensive industries. In the energy investment area, the International Energy Agency (IEA, 2023b) forecasts that \$2.8 trillion will be invested in this sector in 2023, of which \$1.7 trillion will go to clean energy. To reach these investment levels, sustainable investment initiatives such as The Climate Finance Leadership Initiative and the Principles for Responsible Banking have the potential to influence this transition, reaching the investment levels needed to mitigate climate change (Hong et al., 2020).

Given the relevance of climate finance in the energy transition, this study aims to empirically analyze the risk-return pair for a global set of energy companies framed in fossil fuels (FF) and renewable energy (RE). Through portfolio management, an optimization and simulation analysis is carried out to verify the portfolio's performance according to the weights of each company in the portfolios. The results show that FF companies have a greater presence than RE companies in the portfolios optimized by standard deviation and by the Modified Sharpe Ratio (MSR), indicating that, a priori, the financial markets are not in favor of renewable energies in terms of risk-return. These results have worrying practical implications as it highlights the lack of predisposition of the financial markets towards the energy transition in terms of investment.

9.4.2 Data & Methodology

9.4.2.1 Data

Using the Refinitiv by Thomson Reuters database (Refinitiv, 2022), we extracted daily closing prices of the 122 companies studied for the period from 01/01/2022 to 08/16/2023. Considering the market capitalization, the 20 most capitalized companies were selected by sector (FF and RE) and by region (Europe, North America, Asia Pacific and Global), thus constitute the following investment portfolios for further analysis (for more information, please refer to Appendix A):

- Europe portfolio: 20 FF companies and 20 RE companies.
- North America portfolio: 20 FF companies and 19 RE companies (due to data availability 20 companies could not be selected).
- Asia Pacific portfolio: 20 FF companies and 20 RE companies.
- Global portfolio: 20 FF companies and 20 RE companies.

In order to analyze the sustainable environmental performance of the companies, the Environmental Score for fiscal year 2022 has been extracted. This variable measures a company's impact on living and non-living natural systems, including the air, land and water, as well as complete ecosystems. It reflects how well a company uses best management practices to avoid environmental risks and capitalize on environmental opportunities in order to generate long term shareholder value (Refinitiv, 2022). The values range from 0–100, with a score of 50 being the value used in this analysis to distinguish those with good environmental performance (>50) from those with a negative impact on the environment (<50).

9.4.2.2 Methodology

Portfolio Optimization Mao (1970) indicated that one of the challenges in portfolio management was the optimization of portfolios by minimizing risk and maximizing return, an goal that was considered key for investors and fund managers. Later, Sharpe and Stone (1971) laid the foundations of the Capital Asset Pricing Model (CAPM), allowing the measurement of an asset's return per unit of risk, which in turn generated a breakthrough in portfolio management and its optimization. In this study, the Sharpe Ratio is used as an goal to optimize the four portfolios analyzed, thus establishing the optimal portfolio. This optimal portfolio will be a combination of portfolios along the efficiency frontier of the portfolio combinations. For that purpose, a Modified Sharpe Ratio (MSR) is defined because the risk-free return is not taken into account (Jiang et al., 2015; Olmezsoy, 2015):

$$MSR = \frac{\overline{R_p}}{\sigma_p} \quad (9.1)$$

where, $\overline{R_p}$ is the portfolio expected return and σ_p is its Standard Deviation (SD). The MSR measures the excess return per total unit of risk. We use the MSR as the maximization function, resulting in Eq. (9.2):

$$\theta_{max} = \frac{\overline{R_p}}{\sigma_p} \quad (9.2)$$

Two constraints to the optimization function have also been used:

$$1. \sum_1^n x_i = 1, \text{ for } i = 1, \dots, n. \quad (9.3)$$

$$2. x_i \geq 0, \text{ for } i = 1, \dots, n. \quad (9.4)$$

The first constraint indicates that the sum of the weights must not exceed 1 (100%). The second constraint restricts the chance of short-selling in portfolio trading. The portfolio return has been measured as the sum of all the weights multiplied by the alphas of each stock in the portfolio:

$$\alpha_p = \sum_{i=1}^N X_i \alpha_i \quad (9.5)$$

Equation (9.4) calculates the SD of the portfolio. This function calculates the matrix resulting from multiplying two matrices (variance/covariance matrix and the weights of each asset in the portfolio):

$$\sigma_p = \left(w \sum w^T \right)^{\frac{1}{2}} \quad (9.6)$$

where, w is the variance-covariance matrix and the weights of each asset and w^T its transpose matrix.

The SD is also used in this study to minimize risk and extract the optimal portfolio based on this variable:

$$\theta_{min} = \left(w \sum w^T \right)^{\frac{1}{2}} \quad (9.7)$$

Therefore, substituting in the MSR of Eq. (9.1), the calculation to optimize the portfolios is presented:

$$\theta = \frac{\sum_{i=1}^N X_i \alpha_i}{\left(w \sum w^T \right)^{\frac{1}{2}}} \quad (9.8)$$

Monte Carlo Simulation The Modern Portfolio Theory (MPT) is based on the assumption that the investor is risk-averse. Two portfolios with the same expected

return, the one with the lower risk will be chosen. A maxim on which the statistical technique known as Monte Carlo Simulation is based. A technique that makes it possible to generate a large random sample to be able to forecast the portfolio performance (Choueifaty & Coignard, 2008). The technique allows random weights to be given to the assets by adding all the weights 1 (100%). Both the expected return and the SD are calculated randomly for X times. This number of times depends on the degree of confidence the investor has to accept. As the number of repetitions increases, the more reliable the forecast will be. In this study, 100,000 repetitions have been considered. Each of these repetitions generates a particular risk-return pair, forming what is known as the Efficient Portfolio Frontier. The Monte Carlo simulation makes it possible to plot all the portfolios generated as a function of expected return and risk, which translates into being able to verify the optimal portfolio where risk is minimum and return is maximum (Chekhlov et al., 2005).

As already mentioned in the Data section, this study uses daily returns. However, in practice, companies and fund managers use annualized returns and SD (Mukherjee et al., 2022):

$$R_y = R_d * 252 \mid \sigma_y = \sigma_d * 252 \quad (9.9)$$

where, R_y is the annualized return, R_d is the daily return, σ_y is the annualized SD y σ_d is the daily SD. We take 252 as the number of active trading days a given year.

Both the portfolio optimization study and the Monte Carlo simulation were performed by Microsoft Excel Solver tool (Grover & Lavin, 2007).

9.4.3 Results

9.4.3.1 General Results. Portfolio Optimization

The results will be reported first considering the expected return, SD and the MSR for the set of the four analyzed portfolios and depending on whether the weights of the stocks are equal or optimized (minimize SD or to increase the MSR).

For the equally weighted portfolios (Table 9.3) it is observed that the North America portfolio reports a higher MSR than the other portfolios (0.0225), although it is true that the expected return (0.0554%) is accompanied by a significantly higher risk than the other portfolios (SD = 2.2025%). The Global portfolio and the Europe portfolio are the worst performers, even presenting a negative MSR (−0.3716; −0.0179, respectively).

Table 9.4 reports the results once the optimization of portfolio weights is carried out with the minimizing SD goal. In this case, the Global portfolio reports a MSR slightly higher than the rest of the portfolios (0.0487). It note that the North America portfolio has a higher MSR (0.0398) than the Europe and Asia Pacific portfolios, but the SD is the highest of the four portfolios (1.0474%), which indicates that the North America portfolio is the riskiest.

Table 9.3 Equally weighted portfolios. Note: Data is reported on a daily basis

	Europe	North America	Asia Pacific	Global
Expected return	−0.0214%	0.0554%	0.0076%	−0.0042%
Standard deviation	1.1958%	2.2025%	1.1133%	1.1429%
Sharpe ratio	−0.0179	0.0225	0.0068	−0.3716

Table 9.4 Optimization of portfolios by minimum SD. Note: Data is reported on a daily basis

	Europe	North America	Asia Pacific	Global
Expected return	0.0117%	0.0417%	0.0139%	0.0324%
Standard deviation	0.8804%	1.0474%	0.6124%	0.6653%
Sharpe ratio	0.0133	0.0398	0.0227	0.0487

Table 9.5 Optimization of portfolios by maximize MSR. Note: Data is reported on a daily basis

	Europe	North America	Asia Pacific	Global
Expected return	0.1064%	0.2189%	0.2388%	0.1374%
Standard deviation	1.1866%	1.8982%	1.1974%	1.0593%
Sharpe ratio	0.0897	0.1153	0.1994	0.1297

Table 9.6 Expected annual returns by portfolio and optimal weights

	Europe	North America	Asia Pacific	Global
Equally weighted	−5.25%	14.99%	1.94%	−1.06%
Min variance weights	3.00%	11.09%	3.57%	8.51%
Max Sharpe ratio weights	30.74%	73.51%	82.39%	41.34%

The results once the optimization of portfolio weights has been carried out with the maximizing the MSR goal are reported below (Table 9.5). This calculations reports different results from the rest. It is observed that the Asia Pacific portfolio reports a MSR slightly higher than the rest (0.1194), which makes it the most optimal portfolio for the purpose of maximizing return per unit of risk. In second place is the Global portfolio, with the lowest SD (1.0593%), but with a low daily expected return (0.1374%).

Finally, Table 9.6 presents the annualized expected returns by portfolio and target optimization. It can be seen that the most profitable portfolio for both balanced weights and minimum risk optimization is the North America portfolio (14.99%; 11.09%, respectively). The Asia Pacific portfolio is the most profitable when optimizing the portfolios by maximizing the MSR (82.39%).

9.4.3.2 Detailed Results. Portfolio Optimization by MSR Maximization

In this section we will focus on the results extracted once the portfolio optimization to maximize the return per unit of risk (MSR) has been performed. For each portfolio, we will present the company's weights in the portfolio, the geographic

Table 9.7 Distribution of portfolio weights by company

Company name	Ticker	Weights	Market Cap	Environmental Score	Sector
PNE AG	PNE3	25.40%	1,057,896,024	32.71 (C-)	Renewable energy
Tenaris SA	TS	19.46%	19,772,373,168	79.41 (A-)	Fossil fuels
Galp Energia SGPS SA	GALP	15.17%	9,909,790,280	74.51 (B+)	Fossil fuels
Repsol SA	REP	11.01%	19,117,274,016	87.69 (A)	Fossil fuels
Shell PLC	SHEL	10.01%	200,057,163,149	92.60 (A+)	Fossil fuels
Tatneft' PAO	TATN	8.12%	13,520,980,616	45.40 (C+)	Fossil fuels
Centrotherm international AG	CTNK	6.45%	133,470,133	26.10 (C-)	Renewable energy
Gazprom Neft' PAO	SIBN	2.65%	31,050,960,791	60.35 (B)	Fossil fuels
Eni SpA	ENI	1.73%	51,278,298,585	71.08 (B+)	Fossil fuels

distribution (according to the company's fiscal headquarters) and the distribution by activity within each sector.

Europe Portfolio The distribution of weights by company for the Europe portfolio is shown in Table 9.7. It can be seen that there is a considerable majority of companies belonging to the FF sector (68.15%), compared to those in the RE sector (31.85%). However, it is worth noting that the company with the highest percentage belongs to the RE sector (PNE AG). It should also be noted that oil giants such as British Petroleum (BP) or Total Energy are not present in the portfolio after the optimization analysis. Others such as Shell PLC (10.01%) or the Italian ENI SpA (1.73%) do not represent a considerable percentage of the portfolio. As for the Environmental Score, we observe that most of the companies are above 50 points, which denotes a relatively optimal environmental performance for the portfolio as a whole, with an average of 63.32 points.

Figure 9.1 shows the distribution of the portfolio by country. The most represented country is Germany, thanks to PNE AG's 25.40% share of the portfolio. Other countries such as Portugal (15.17%), Spain (11.01%), Russia (10.77%) and the United Kingdom (10.01%) also account for a large share of the portfolio.

As for the distribution of the portfolio by activity, Fig. 9.2 shows that Integrated O&G companies are the most represented (37.69%), followed by companies dedicated to RE equipment and services (31.85%). The rest of the portfolio is composed of Oil related Services and Equipment and O&G Refining and Marketing.

North America Portfolio Unlike the Europe portfolio, the North America portfolio is more concentrated in a smaller number of companies (Table 9.8). In fact, 53.99% of the portfolio is held by Marathon Petroleum Corp. a U.S. oil company engaged in O&G Refining and Marketing. RE companies account for 28.86% of the portfolio. It is important to note that oil giants such as Exxon Mobil, Chevron Corp and Conocophillips are not represented in the optimal portfolio. As for the



Fig. 9.1 Distribution of portfolio weights by country

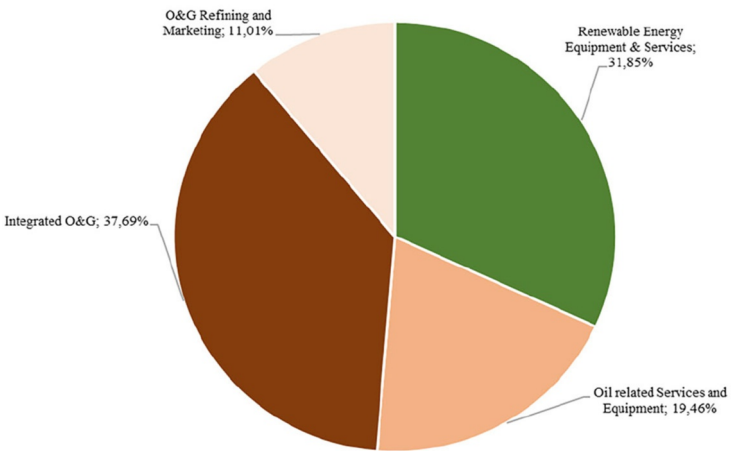


Fig. 9.2 Distribution of portfolio weights by activity

Environmental Score, the North America portfolio has an average score of 51.14 points, slightly lower than the Europe portfolio.

According to geographic distribution (Fig. 9.3), the United States clearly predominates (93.96%), as the only Canadian representation is in Alimentation Couche-Tard Inc. with 6.04% of the portfolio.

As for the distribution by activity (Fig. 9.4), 60.03% of the portfolio is held by companies dedicated to O&G Refining and Marketing (53.99% is due to Marathon Petroleum Corp). The rest is held by companies dedicated to RE Equipment and Services (28.86%) and O&G Exploration and Production (11.11%).

Asia Pacific Portfolio For the Asia Pacific portfolio (Table 9.9) we again find a portfolio that is not very concentrated in terms of the number of companies, but

Table 9.8 Distribution of portfolio weights by company

Company name	Ticker	Weights	Market Cap	Environmental Score	Sector
Marathon petroleum Corp	MPC.N	53.99%	56,537,948,387	73.03 (B+)	Fossil fuels
First solar Inc	FSLR.OQ	24.10%	20,499,876,195	68.67 (B+)	Renewable energy
Occidental petroleum Corp	Oxy.N	11.11%	55,336,852,094	62.32 (B)	Fossil fuels
Alimentation Couche-Tard Inc	ATD.To	6.04%	49,652,482,998	65.38 (B)	Fossil fuels
Broadwind Inc	BWEN.OQ	4.75%	73,502,209	18.00 (D+)	Renewable energy
Fuelcell energy Inc	FCEL.OQ	0.01%	691,493,069	19.42 (D+)	Renewable energy



Fig. 9.3 Distribution of portfolio weights by country

with a considerable predominance of FF companies (88.69%) over RE companies (11.31%). In fact, it is the portfolio with the highest representation of fossil fuels in the analysis carried out. The Indonesian coal giant Bayan Resources Tbk PT (27.93%) and CNOOC Ltd. (19.46%) stand out as the most represented companies

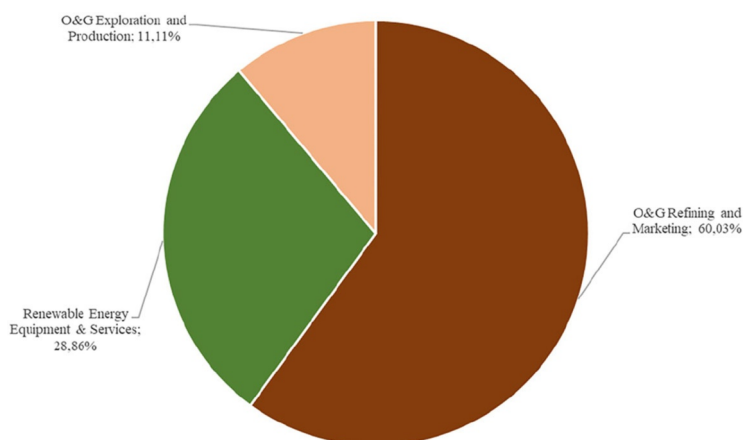


Fig. 9.4 Distribution of portfolio weights by activity

in the portfolio. In terms of Environmental Score, the portfolio has an average score of 60.53.

Figure 9.5 shows the geographic distribution of the portfolio. While it is true that most of the portfolio is concentrated in China (37.73%), other countries such as Indonesia (27.93%), India (14.74%) and Japan (9.28%) also account for a significant part of the portfolio.

Regarding the distribution by activity in the Asia Pacific portfolio (Fig. 9.6), we can observe the appearance of the coal activity, becoming a relevant part of the portfolio with 36.10%. It is important to highlight the low participation of the RE sector in this portfolio, with only 11.31% out of total.

Global Portfolio Table 9.10 reports the weights distributed by company for the Global portfolio. Once again there is a clear predominance of FF (82.94%) over RE (17.06%), with almost half of the portfolio's weight (45.86%) concentrated on two oil giants, CNOOC Ltd. and Exxon Mobil Corp. On the other hand, the portfolio has the highest Environmental Score of the four portfolios analyzed (72.66).

With regard to the global geographic distribution (Fig. 9.7), there is a clear predominance of the two world superpowers, such as China (51.85%) and the United States (35.52%). Other countries such as Saudi Arabia (8.91%) or India (3.68%) are also represented in the global portfolio.

As for the distribution by activity, it is certainly, together with the Asia Pacific portfolio, the most distributed (Fig. 9.8). The most representative activities are O&G Exploration and Production and O&G Refining and Marketing, both accounting for 61.48% of the total portfolio. The companies belonging to RE Equipment & Services represent only 17.06% of the total.

Table 9.9 Distribution of portfolio weights by company

Company name	Ticker	Weights	Market Cap	Environmental Score	Sector
Bayan resources Tbk PT	BYAN.JK	27.93%	38,582,764,672	55.28 (B-)	Fossil fuels
CNOOC ltd	600938.SS	19.46%	79,408,765,231	85.96 (A)	Fossil fuels
Inpex Corp	1605.T	9.28%	18,856,272,976	80.76 (A-)	Fossil fuels
PTT exploration and production PCL	PTTEP.BK	9.21%	18,019,871,513	61.89 (B)	Fossil fuels
Coal India ltd	COAL.NS	8.17%	17,259,816,332	33.74 (C)	Fossil fuels
PetroChina co ltd	601857.SS	7.42%	185,350,154,315	67.03 (B+)	Fossil fuels
Suzlon energy ltd	SUZL.NS	6.57%	3,303,600,921	46.85 (C+)	Renewable energy
China petroleum & chemical Corp	600028.SS	6.10%	92,940,726,283	83.90 (A)	Fossil fuels
Shanghai Aiko solar energy co ltd	600732.SS	3.23%	5,723,503,031	70.69 (B+)	Renewable energy
Daqo new energy Corp	DQ.N	1.51%	2,760,624,675	34.01 (C)	Renewable energy
Woodside energy group ltd	WDS.AX	0.63%	46,922,499,714	57.47 (B-)	Fossil fuels
Santos ltd	STO.AX	0.48%	16,433,488,453	48.80 (C+)	Fossil fuels

9.4.3.3 Monte Carlo Simulation

Once the optimal portfolios have been analyzed by risk minimization and maximization of the return per unit of risk, four portfolios with random weights are made to generate a total of 100,000 times. From this, the descriptive statistics presented in Table 9.11 were extracted. It can be observed that the North America portfolio is the one that reports a higher average expected return (14.86%). Being the risk similar to the rest of the portfolios, the North America portfolio is postulated as the most attractive one to invest in the future according to the Monte Carlo simulation carried out. Other portfolios such as the Europe or Global portfolios do not predict good results in terms of the risk-return pair, which assumes that a rational investor would not choose this type of portfolio.

Finally, the efficient frontier is reported for each of the portfolios once the expected return and SD have been predicted through Monte Carlo simulation with a total of 100,000 times. As can be seen in Fig. 9.9, the North America portfolio is the

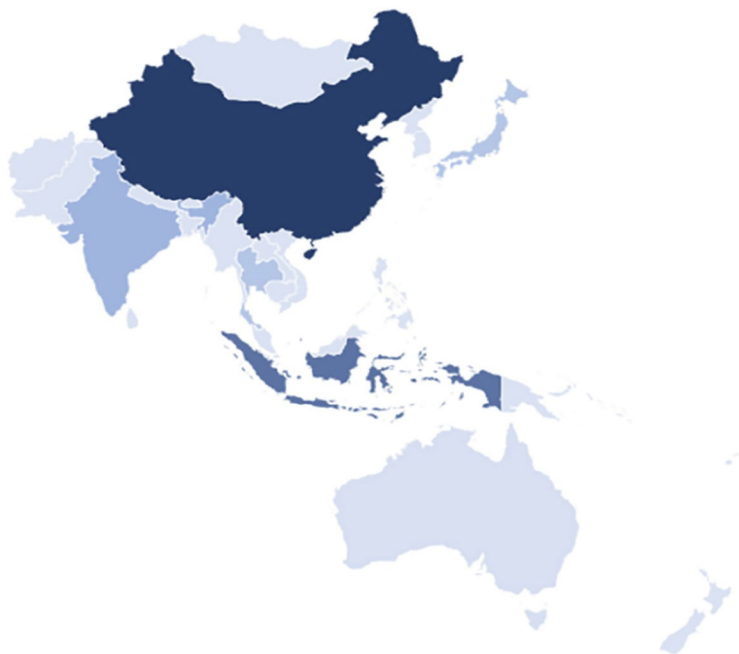


Fig. 9.5 Distribution of portfolio weights by country

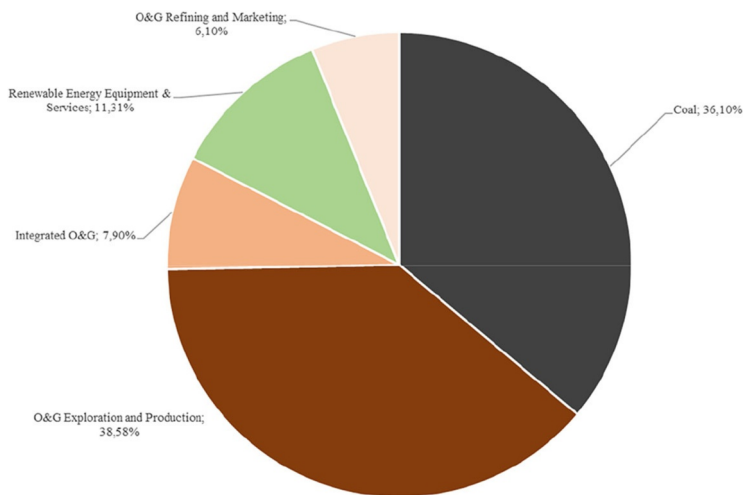


Fig. 9.6 Distribution of portfolio weights by activity

only one that remains positive in terms of expected return. The Asia Pacific portfolio also reports good results, with the majority of points in positive expected returns. In contrast, the Europe portfolio reports a higher number of points on negative returns.

Table 9.10 Distribution of portfolio weights by company

Company name	Ticker	Weights	Market Cap	Environmental Score	Sector
CNOOC ltd	600938.SS	28.64%	79,408,765,231	85.96 (A)	Fossil fuels
Exxon Mobil Corp	XOM.N	17.22%	425,699,520,970	85.29 (A)	Fossil fuels
First solar Inc	FSLR.OQ	13.51%	20,499,876,195	68.67 (B+)	Renewable energy
China petroleum & chemical Corp	600028.SS	11.95%	92,940,726,283	83.90 (A)	Fossil fuels
Saudi Arabian oil co	2222.SE	8.91%	2,222,758,418,429	49.51 (C+)	Fossil fuels
PetroChina co ltd	601857.SS	6.72%	185,350,154,315	67.03 (B+)	Fossil fuels
Schlumberger NV	SLB.N	5.79%	82,101,916,144	87.54 (A)	Fossil fuels
Reliance industries ltd	RELINS	3.68%	209,374,540,332	83.35 (A)	Fossil fuels
Shanghai Aiko solar energy co ltd	600732.SS	3.55%	5,723,503,031	70.69 (B+)	Renewable energy
Petroleo Brasileiro SA Petrobras	PETR4.SA	0.04%	86,975,524,798	66.41 (B)	Fossil fuels
Equinor ASA	EQNR.OL	0.01%	91,231,247,968	74.74 (B+)	Fossil fuels

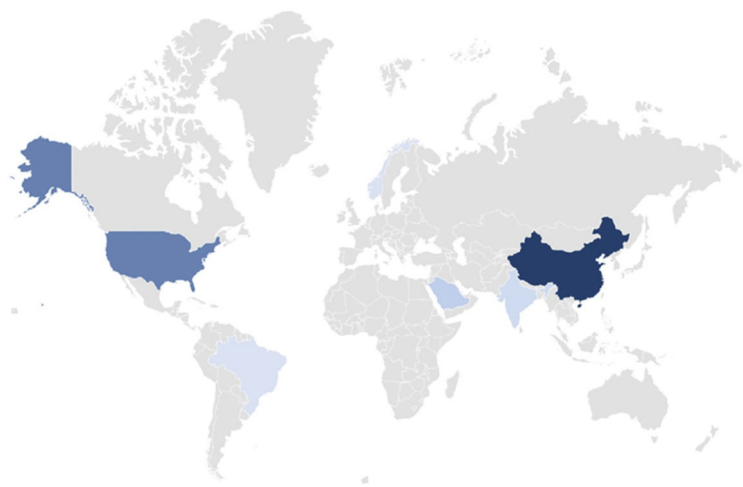


Fig. 9.7 Distribution of portfolio weights by country

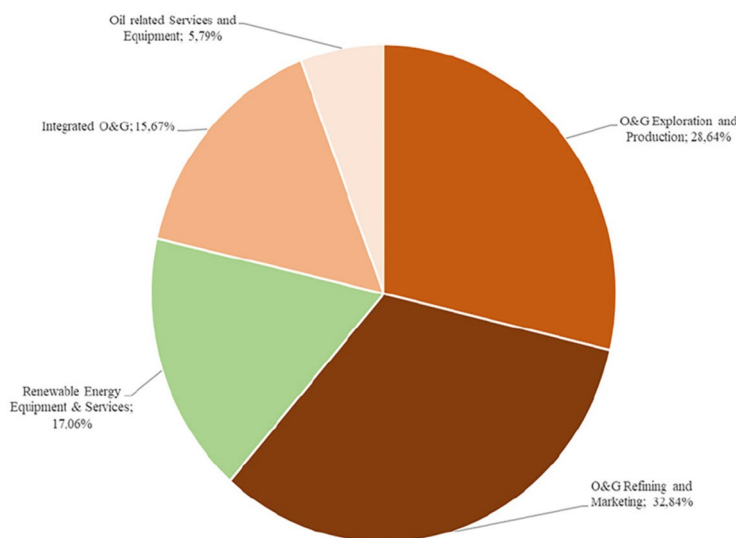


Fig. 9.8 Distribution of portfolio weights by activity

Table 9.11 Descriptive statistics of the annualized expected return. Monte Carlo simulation

	Europe	North America	Asia Pacific	Global
Mean	−5.15%	14.86%	2.04%	−1.00%
Std dev	2.55%	3.07%	3.07%	3.07%
Min	−16.60%	−1.00%	−9.13%	−14.04%
Max	5.97%	30.93%	15.73%	13.42%
Per 1%	−10.72%	7.31%	−4.68%	−0.08%
Per 5%	−9.13%	9.49%	−2.98%	−0.05%
Per 10%	−8.21%	10.60%	−2.00%	−0.05%

The Global portfolio has a neutral performance, with its points slightly above and below 0% in terms of expected return.

9.4.4 Conclusions. What Is Next?

For hundreds of decades, economic development has been accompanied by unsustainable environmental degradation of our planet. A model where sustainable economic growth is not taken into account can lead to catastrophic consequences due to climate change (Cong et al., 2022). These risks caused by climate change can have a dangerous impact on the global financial system. Thus, the financial tools available to professionals, politicians and academics should be used to help

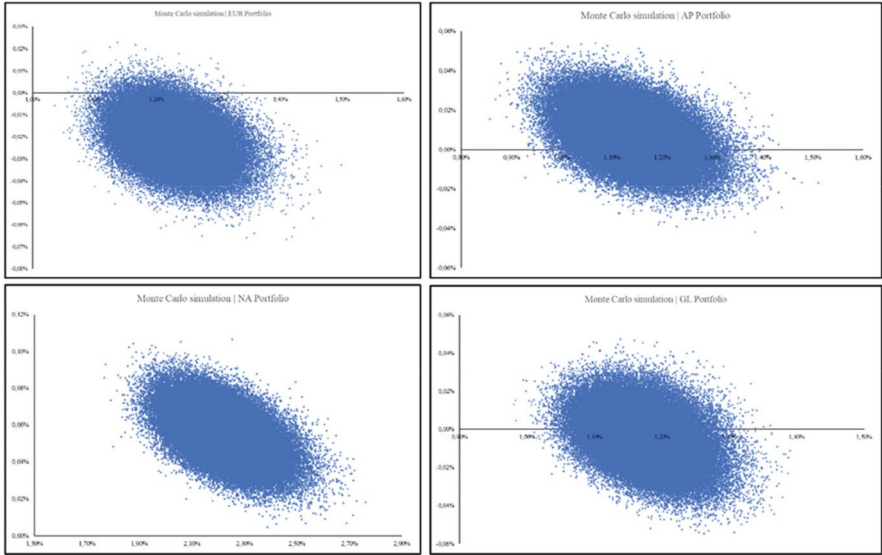


Fig. 9.9 Efficient Frontier. Note: 100.000 times through Monte Carlo Simulation

society avoid being affected by this type of risk and move towards a cleaner future (Litterman et al., 2020; Giglio et al., 2021).

The aim of the study was to find out how a set of portfolios made up of energy companies performance through global perspective. Given the results, it is observed that FF companies continue to predominate over RE companies in terms of return-risk pair. This means that investors and professionals do not advocate putting money into companies that contribute to a cleaner future, precisely because they do not report optimal risk-return performance. For example, the North America portfolio is the best performer in terms of expected return and associated risk, and at the same time it is the portfolio with the worst Environmental Score. This indicates that the financial markets are not really taking this type of information into consideration. Given this situation, politicians and their initiatives should make every effort to contribute with public financial support to make companies with a firm goal towards a cleaner future and more profitable and thus attract more and more private investors.

This study is not without limitations. The statistical technique employed may give rise to some subjectivity. An empirical study based on non-parametric techniques such as GARCH or VAR analyses, as well as the use of more advanced techniques such as wavelet analysis or Random Matrix Theory, could alleviate this limitation in future studies. The small sample of companies is another limitation. The use of aggregated stock market indices, Exchange-Traded Funds (ETF) or hedge funds specialized in ESG investment could be one of the points to be addressed in order to reduce this limitation. Regulation is also an issue that is overlooked in this study. Each country or region has implemented different regulations on Climate Finance, even some (emerging countries) do not have any regulation at all. Taking this into account, the results may bring new and more comprehensive conclusions on the adequacy of the applied regulations. Finally, an event study may bring interesting results about how some relevant shocks such as the Ukraine war or Covid-19 pandemic have impacted on the higher or lower acceptance of Climate Finance by financial markets.

Appendix

Appendix A

Europe Portfolio

Company name	Ticker	Sector	Activity	Market Cap	Environmental Score	Country
Shell PLC	SHEL	Fossil fuels	Integrated O&G	200,057.163.149	92.60 (A+)	United Kingdom
TotalEnergies SE	TTE	Fossil fuels	Integrated O&G	153.422.497.859	90.59 (A)	France
BP PLC	BP	Fossil fuels	O&G Refining and marketing	103.682.980.143	91.02 (A)	United Kingdom
Equinor ASA	EQNR	Fossil fuels	Integrated O&G	91.231.247.968	74.74 (B+)	Norway
NK Rosneft' PAO	ROSN	Fossil fuels	Integrated O&G	58.573.219.383	74.55 (B+)	Russia
Eni SpA	ENI	Fossil fuels	Integrated O&G	51.278.298.585	71.08 (B+)	Italy
Novatek PAO	NVTK	Fossil fuels	Integrated O&G	50.087.231.514	41.57 (C)	Russia
NK Lukoil PAO	LKOH	Fossil fuels	Integrated O&G	43.822.770.666	73.39 (B+)	Russia
Gazprom PAO	GAZP	Fossil fuels	Integrated O&G	42.708.147.507	58.42 (B)	Russia
Gazprom Neft' PAO	SIBN	Fossil fuels	Integrated O&G	31.050.960.791	60.35 (B)	Russia
Neste Oyj	NESTE	Fossil fuels	O&G Refining and marketing	27.418.802.392	71.71 (B+)	Finland
Vestas wind systems A/S	VWS.CO	Renewable energy	Renewable Energy Equipment & Services	24.320.404.546	77.66 (A-)	Denmark
Tenaris SA	TS	Fossil fuels	Oil related services and equipment	19.772.373.168	79.41 (A-)	Luxembourg
Repsol SA	REP	Fossil fuels	O&G Refining and marketing	19.117.274.016	87.69 (A)	Spain
Orlen SA	PKN	Fossil fuels	O&G Refining and marketing	18.069.599.369	56.61 (B-)	Poland
Aker BP ASA	AKRBP	Fossil fuels	O&G Exploration and production	17.130.168.314	59.12 (B)	Norway
Snam SpA	SRG	Fossil fuels	O&G transportation services	16.692.698.994	96.17 (A+)	Italy
Surgutneftegaz PAO	SNGS	Fossil fuels	Integrated O&G	15.046.264.404	37.37 (C)	Russia
OMV AG	OMV	Fossil fuels	O&G Refining and marketing	14.927.453.326	76.92 (A-)	Austria
Tatneft' PAO	TATN	Fossil fuels	Integrated O&G	13.520.980.616	45.40 (C+)	Russia
Siemens energy AG	ENR.DE	Renewable energy	Renewable Energy Equipment & Services	11.796.723.279	66.99 (B+)	Germany
Galp Energia SGPS SA	GALP	Fossil fuels	Integrated O&G	9.909.790.280	74.51 (B+)	Portugal
Verbio Vereinigte Bioenergie AG	VBK.BE	Renewable energy	Renewable fuels	3.023.870.301	56.24 (B-)	Germany

Nel ASA	NEL	Renewable energy	Renewable fuels	1.885.746.681	34.89 (C)	Norway
PNE AG	PNE3	Renewable energy	Renewable Energy Equipment & Services	1.057.896.024	32.71 (C-)	Germany
Bonheur ASA	BONHR	Renewable energy	Renewable Energy Equipment & Services	993.282.988	38.50 (C)	Norway
Grenenergy Renovables SA	GREG.MC	Renewable energy	Renewable Energy Equipment & Services	858.518.085	74.38 (B+)	Spain
CropEnergies AG	CE2	Renewable energy	Renewable fuels	834.359.223	10.74 (D)	Germany
Ceres power holdings PLC	CWR.L	Renewable energy	Renewable Energy Equipment & Services	776.171.464	62.25 (B)	United Kingdom
ABO wind AG	AB9	Renewable energy	Renewable Energy Equipment & Services	521.396.268	20.00 (D+)	Germany
SFC energy AG	F3C	Renewable energy	Renewable Energy Equipment & Services	438.047.923	17.73 (D+)	Germany
Sif holding NV	SIFG	Renewable energy	Renewable Energy Equipment & Services	385.873.978	34.51 (C)	Netherlands
LPKF laser & electronics SE	LPKFF	Renewable energy	Renewable Energy Equipment & Services	210.216.900	36.58 (C)	Germany
AFC energy PLC	AFC	Renewable energy	Renewable Energy Equipment & Services	156.225.504	2.59 (D-)	United Kingdom
Centrotherm international AG	CTNK	Renewable energy	Renewable Energy Equipment & Services	133.470.133	26.10 (C-)	Germany
Everfuel A/S	0HR	Renewable energy	Renewable fuels	110.741.348	22.70 (D+)	Denmark
Nhoa SA	NHOA	Renewable energy	Renewable Energy Equipment & Services	99.953.172	16.70 (D+)	France
Biokraft international AB	BIOGAS	Renewable energy	Renewable fuels	77.903.277	42.12 (C+)	Sweden
Clean power hydrogen PLC	CPH2	Renewable energy	Renewable fuels	76.651.290	1.82 (D-)	United Kingdom
Esken ltd	ESKN	Renewable energy	Renewable fuels	44.284.252	55.55 (B-)	United Kingdom

North America Portfolio

Company name	Ticker	Sector	Activity	Market Cap	Environmental Score	Country
Exxon Mobil Corp	XOM.N	Fossil fuels	O&G Refining and marketing	425,699,520.970	85.29 (A)	United states
Chevron Corp	CVX.N	Fossil fuels	O&G Exploration and production	302,602,276.609	78.85 (A-)	United States
Conocophillips	COP.N	Fossil fuels	O&G Exploration and production	137,280,330.753	67.47 (B+)	United States
Schlumberger NV	SLB.N	Fossil fuels	Oil related services and equipment	82,101,916.144	87.54 (A)	United States
EOG resources Inc	EOG.N	Fossil fuels	O&G Exploration and production	74,878,751.483	51.02 (B-)	United States
Enbridge Inc	ENB.TO	Fossil fuels	O&G transportation services	70,194,428.616	82.34 (A-)	Canada
Canadian natural resources ltd	CNQ.TO	Fossil fuels	O&G Exploration and production	65,336,102.156	63.33 (B)	Canada
Enterprise products partners LP	EPD.N	Fossil fuels	O&G transportation services	57,160,521.378	61.91 (B)	United states
Marathon petroleum Corp	MPC.N	Fossil fuels	O&G Refining and marketing	56,537,948.387	73.03 (B+)	United States
Occidental petroleum Corp	OXY.N	Fossil fuels	O&G Exploration and production	55,336,852.094	62.32 (B)	United states
Pioneer natural resources co	PXD.N	Fossil fuels	O&G Exploration and production	54,590,000.975	32.70 (C-)	United States
Phillips 66	PSX.N	Fossil fuels	O&G Refining and marketing	50,437,763.605	86.13 (A)	United States
Alimentation Couche-Tard Inc	ATD.TO	Fossil fuels	O&G Refining and marketing	49,652,482.998	65.38 (B)	Canada
Hess Corp	HES.N	Fossil fuels	O&G Exploration and production	46,903,572.485	76.24 (A-)	United States
Valero energy Corp	VLO.N	Fossil fuels	O&G Refining and marketing	46,239,219.307	59.99 (B)	United states
Williams companies Inc	WMB.N	Fossil fuels	O&G transportation services	41,930,047.830	75.48 (A-)	United States
Suncor energy Inc	SU.TO	Fossil fuels	Integrated O&G	41,409,691.049	77.08 (A-)	Canada
Energy transfer LP	ET.N	Fossil fuels	O&G transportation services	40,138,754.054	34.45 (C)	United States
Cheniere energy Inc	LNG.A	Fossil fuels	O&G transportation services	38,545,432.330	71.36 (B+)	United States
Kinder Morgan Inc	KMI.N	Fossil fuels	O&G transportation services	38,346,725.966	88.05 (A)	United States
First solar Inc	FSLR.OQ	Renewable energy	Renewable Energy Equipment & Services	20,499,876.195	68.67 (B+)	United States
Enphase energy Inc	ENPH.OQ	Renewable energy	Renewable Energy Equipment & Services	18,118,220.187	62.03 (B)	United States

Plug power Inc	PLUG.OQ	Renewable energy	Renewable Energy Equipment & Services	5,164,922.137	38.00 (C)	United States
Sunrun Inc	RUN.OQ	Renewable energy	Renewable Energy Equipment & Services	3,231,688.352	44.01 (C+)	United states
Array technologies Inc	ARRY.OQ	Renewable energy	Renewable Energy Equipment & Services	3,124,119.328	3.14 (D-)	United States
Ameresco Inc	AMRC.N	Renewable energy	Renewable Energy Equipment & Services	2,472,227.994	43.17 (C+)	United States
Canadian solar Inc	CSIQ.OQ	Renewable energy	Renewable Energy Equipment & Services	2,050,808.417	77.71 (A-)	Canada
Green Plains Inc	GPRE.OQ	Renewable energy	Renewable fuels	1,864,425.354	58.04 (B-)	United States
Sunnova energy international Inc	NOVA.N	Renewable energy	Renewable Energy Equipment & Services	1,732,503.613	35.37 (C)	United States
SunPower Corp	SPWR.OQ	Renewable energy	Renewable Energy Equipment & Services	1,306,930.134	73.73 (B+)	United States
Ballard power systems Inc	BLDP.TO	Renewable energy	Renewable Energy Equipment & Services	1,294,664.649	48.67 (C+)	Canada
Stem Inc	STEM.N	Renewable energy	Renewable Energy Equipment & Services	860,029.309	14.42 (D)	United States
Fuelcell energy Inc	FCEL.OQ	Renewable energy	Renewable Energy Equipment & Services	691,493.069	19.42 (D+)	United States
REX American resources Corp	REX.N	Renewable energy	Renewable fuels	641,343.901	29.50 (C-)	United States
Gevo Inc	GEVO.OQ	Renewable energy	Renewable fuels	341,860.499	46.40 (C+)	United States
FutureFuel Corp	FF.N	Renewable energy	Renewable fuels	318,596.409	27.45 (C-)	United States
Aemetis Inc	AMTX.OQ	Renewable energy	Renewable fuels	225,316.886	3.29 (D-)	United States
TPPI composites Inc	TPIC.OQ	Renewable energy	Renewable Energy Equipment & Services	194,965.502	43.29 (C+)	United States
Broadwind Inc	BWEN.OQ	Renewable energy	Renewable Energy Equipment & Services	73,502.209	18.00 (D+)	United States

Asia Pacific Portfolio

Company name	Ticker	Sector	Activity	Market Cap	Environmental Score	Country
Reliance industries ltd	RELI.NS	Fossil fuels	O&G Refining and marketing	209,374,540,332	83.35 (A)	India
PetroChina co ltd	601857.SS	Fossil fuels	Integrated O&G	185,350,154,315	67.03 (B+)	China
China petroleum & chemical Corp	600028.SS	Fossil fuels	O&G Refining and marketing	92,940,726,283	83.90 (A)	China
CNOOC ltd	600938.SS	Fossil fuels	O&G Exploration and production	79,408,765,231	85.96 (A)	China
China Shenhua energy co ltd	601088.SS	Fossil fuels	Coal	71,530,063,907	90.39 (A)	China
Woodside energy group ltd	WDS.AX	Fossil fuels	O&G Exploration and production	46,922,499,714	57.47 (B-)	Australia
Bayan resources Tbk PT	BYAN.JK	Fossil fuels	Coal	38,582,764,672	55.28 (B-)	Indonesia
LONGi green energy technology co ltd	601012.SS	Renewable energy	Renewable Energy Equipment & Services	29,089,962,080	67.37 (B+)	China
PTT PCL	PTTBK	Fossil fuels	Integrated O&G	28,878,029,297	93.00 (A+)	Thailand
Oil and natural gas corporation ltd	ONGC.NS	Fossil fuels	O&G Exploration and production	27,069,400,950	54.22 (B-)	India
Formosa petrochemical Corp	6505.TW	Fossil fuels	O&G Refining and marketing	23,734,292,100	60.25 (B)	Taiwan
Sungrow power supply co ltd	300274.SZ	Renewable energy	Renewable Energy Equipment & Services	21,772,283,715	81.53 (A-)	China
Shaanxi coal industry co ltd	601225.SS	Fossil fuels	Coal	21,489,116,552	66.24 (B)	China
Tongwei co ltd	600438.SS	Renewable energy	Renewable Energy Equipment & Services	20,291,220,945	77.75 (A-)	China
Inpex Corp	1605.T	Fossil fuels	O&G Exploration and production	18,856,272,976	80.76 (A-)	Japan
PTT exploration and production PCL	PTTEP.BK	Fossil fuels	O&G Exploration and production	18,019,871,513	61.89 (B)	Thailand
Coal India ltd	COAL.NS	Fossil fuels	Coal	17,259,816,332	33.74 (C)	India
Santos ltd	STO.AX	Fossil fuels	Integrated O&G	16,433,488,453	48.80 (C+)	Australia
Indian oil corporation ltd	IOC.NS	Fossil fuels	O&G Refining and marketing	15,833,191,621	86.63 (A)	India
Yankuang energy group co ltd	600188.SS	Fossil fuels	Coal	14,826,169,770	85.35 (A)	China
TCL Zhonghuan renewable energy technology co ltd	002129.SZ	Renewable energy	Renewable Energy Equipment & Services	14,406,171,534	62.20 (B)	China
SK innovation co ltd	096770.KS	Fossil fuels	O&G Refining and marketing	13,617,766,007	76.42 (A-)	South Korea

China coal energy co ltd	601898.SS	Fossil fuels	Coal	13,170,308,120	57.67 (B-)	China
JA solar technology co ltd	002459.SZ	Renewable energy	Renewable Energy Equipment & Services	12,920,082,429	76.32 (A-)	China
Xinjiang Daqo new energy co ltd	688303.SS	Renewable energy	Renewable Energy Equipment & Services	11,435,922,454	45.19 (C+)	China
ENEOS holdings Inc	5020.T	Fossil fuels	O&G Refining and marketing	10,748,421,033	73.95 (B+)	Japan
Trina solar co ltd	688599.SS	Renewable energy	Renewable Energy Equipment & Services	10,319,015,450	79.64 (A-)	China
Fiat glass group co ltd	601865.SS	Renewable energy	Renewable Energy Equipment & Services	9,491,363,276	53.00 (B-)	China
Xinyi solar holdings ltd	0968.HK	Renewable energy	Renewable Energy Equipment & Services	7,898,256,569	71.03 (B+)	China
Shanghai Aiko solar energy co ltd	600732.SS	Renewable energy	Renewable Energy Equipment & Services	5,723,503,031	70.69 (B+)	China
Ming Yang smart energy group ltd	601615.SS	Renewable energy	Renewable Energy Equipment & Services	5,669,472,687	63.67 (B)	China
Goldwind science & technology co ltd	002202.SZ	Renewable energy	Renewable Energy Equipment & Services	5,577,602,084	73.17 (B+)	China
GCL technology holdings ltd	3800.HK	Renewable energy	Renewable Energy Equipment & Services	4,899,650,004	68.46 (B+)	Hong Kong
Hanwha solutions Corp	009830.KS	Renewable energy	Renewable Energy Equipment & Services	4,591,603,541	70.94 (B+)	South Korea
GoodWe technologies co ltd	688390.SS	Renewable energy	Renewable Energy Equipment & Services	3,685,823,451	71.99 (B+)	China
HOYUAN green energy co ltd	603185.SS	Renewable energy	Renewable Energy Equipment & Services	3,531,939,712	23.48 (D+)	China
Suzlon energy ltd	SUZL.NS	Renewable energy	Renewable Energy Equipment & Services	3,303,600,921	46.85 (C+)	India
Titan wind energy Suzhou co ltd	002531.SZ	Renewable energy	Renewable Energy Equipment & Services	3,287,325,809	32.09 (C-)	China
Risen energy co ltd	300118.SZ	Renewable energy	Renewable Energy Equipment & Services	3,096,021,535	44.52 (C+)	China
Daqo new energy Corp	DQ.N	Renewable energy	Renewable Energy Equipment & Services	2,760,624,675	34.01 (C)	China

Global Portfolio

Company name	Ticker	Sector	Activity	Market Cap	Environmental Score	Country
Saudi Arabian oil co	2222.SE	Fossil fuels	Integrated O&G	2.222.758.418.428,56	49.51 (C+)	Saudi Arabia
Exxon Mobil Corp	XOM.N	Fossil fuels	O&G Refining and marketing	425.699.520.969,58	85.29 (A)	United States
Chevron Corp	CVX.N	Fossil fuels	O&G Exploration and production	302.602.276.609,31	78.85 (A-)	United States
Reliance industries ltd	RELI.NS	Fossil fuels	O&G Refining and marketing	209.374.540.331,87	83.35 (A)	India
Shell PLC	SHEL.L	Fossil fuels	Integrated O&G	200.057.163.149,22	92.60 (A+)	United kingdom
PetroChina co ltd	601.857.SS	Fossil fuels	Integrated O&G	185.350.154.315,49	67.03 (B+)	China
TotalEnergies SE	TTEF.PA	Fossil fuels	Integrated O&G	153.422.497.858,75	90.59 (A)	France
Conocophillips	COP.N	Fossil fuels	O&G Exploration and production	137.280.330.752,72	67.47 (B+)	United states
BP PLC	BPL	Fossil fuels	O&G Refining and marketing	103.682.980.142,77	91.02 (A)	United Kingdom
China petroleum & chemical Corp	600.028.SS	Fossil fuels	O&G Refining and marketing	92.940.726.283,25	83.90 (A)	China
Equinor ASA	EQNR.OL	Fossil fuels	Integrated O&G	91.231.247.968,41	74.74 (B+)	Norway
Petroleo Brasileiro SA	PETR4.SA	Fossil fuels	Integrated O&G	86.975.524.797,94	66.41 (B)	Brazil
Petrobras						
Schlumberger NV	SLB.N	Fossil fuels	Oil related services and equipment	82.101.916.144,32	87.54 (A)	United states
CNOOC ltd	600.938.SS	Fossil fuels	O&G Exploration and production	79.408.765.231,31	85.96 (A)	China
EOG resources Inc	EOG.N	Fossil fuels	O&G Exploration and production	74.878.751.482,80	51.02 (B-)	United States
China Shenhua energy co ltd	601.088.SS	Fossil fuels	Coal	71.530.063.907,11	90.39 (A)	China
Enbridge Inc	ENB.To	Fossil fuels	O&G transportation services	70.194.428.615,63	82.34 (A-)	Canada
Canadian natural resources ltd	CNQ.TO	Fossil fuels	O&G Exploration and production	65.336.102.156,03	63.33 (B)	Canada
NK Rosneft' PAO	ROSN.MM	Fossil fuels	Integrated O&G	58.573.219.383,00	74.55 (B+)	Russia
Enterprise products partners LP	EPD.N	Fossil fuels	O&G transportation services	57.160.521.378,24	61.91 (B)	United States
LONGi green energy technology co ltd	601012.SS	Renewable energy	Renewable Energy Equipment & Services	29.089.962.080,46	67.37 (B+)	China
Vestas wind systems A/S	VWS.CO	Renewable energy	Renewable Energy Equipment & Services	24.320.404.546,34	77.66 (A-)	Denmark
Sungrow power supply co ltd	300.274.SZ	Renewable energy	Renewable Energy Equipment & Services	21.772.283.714,69	81.53 (A-)	China

First solar Inc	FSLR.OQ	Renewable energy	Renewable Energy Equipment & Services	20,499,876,194,66	68.67 (B++)	United States
Tongwei co Ltd	600438.SS	Renewable energy	Renewable Energy Equipment & Services	20,291,220,945,25	77.75 (A-)	China
Enphase energy Inc	ENPH.OQ	Renewable energy	Renewable Energy Equipment & Services	18,118,220,187,38	62.03 (B)	United States
TCL Zhonghuan renewable energy technology co Ltd	002129.SZ	Renewable energy	Renewable Energy Equipment & Services	14,406,171,533,69	62.20 (B)	China
JA solar technology co Ltd	002459.SZ	Renewable energy	Renewable Energy Equipment & Services	12,920,082,428,90	76.32 (A-)	China
Siemens energy AG	ENR1n.DE	Renewable energy	Renewable Energy Equipment & Services	11,796,723,278,98	66.99 (B++)	Germany
Xinjiang Daqo new energy co Ltd	688303.SS	Renewable energy	Renewable Energy Equipment & Services	11,435,922,454,43	45.19 (C+)	China
Trina solar co Ltd	688599.SS	Renewable energy	Renewable Energy Equipment & Services	10,319,015,449,74	79.64 (A-)	China
Flat glass group co Ltd	601865.SS	Renewable energy	Renewable Energy Equipment & Services	9,491,363,275,73	53.00 (B-)	China
Solaredge technologies Inc	SEDG.OQ	Renewable energy	Renewable Energy Equipment & Services	9,180,464,693,12	59.66 (B)	Israel
Xinyi solar holdings Ltd	0968.HK	Renewable energy	Renewable Energy Equipment & Services	7,898,256,568,54	71.03 (B++)	China
Shanghai Aiko solar energy co Ltd	600,732.SS	Renewable energy	Renewable Energy Equipment & Services	5,723,503,031,05	70.69 (B++)	China
Ming Yang smart energy group Ltd	601,615.SS	Renewable energy	Renewable Energy Equipment & Services	5,669,472,687,06	63.67 (B)	China
Goldwind science & technology co Ltd	002202.SZ	Renewable energy	Renewable Energy Equipment & Services	5,577,602,083,85	73.17 (B++)	China
Plug power Inc	PLUG.OQ	Renewable energy	Renewable Energy Equipment & Services	5,164,922,136,66	38.00 (C)	United States
GCCL technology holdings Ltd	3800.HK	Renewable energy	Renewable Energy Equipment & Services	4,899,650,004,05	68.46 (B++)	Hong Kong
Hanwha solutions Corp	009830.Ks	Renewable energy	Renewable Energy Equipment & Services	4,591,603,540,95	70.94 (B++)	South Korea

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