Imperial College Business School | Centre for Climate Finance & Investment

IEA

Energy Investing: Exploring Risk and Return in the Capital Markets

A Joint Report by the International Energy Agency and the Centre for Climate Finance & Investment

June 2020, 2nd Edition

Table of Contents

Executive Summary

Going into the COVID-19 crisis, the trend towards renewable power was accelerating. Renewables accounted for nearly two-thirds of additions to the power sector last year and renewable power capacity had been increasing at over 8% annually over the past 10 years. Yet, despite enormous advances in the cost-competitiveness of renewables over the past decade, investments in clean energy are still falling short of the level needed to put the world's energy system on a sustainable path.

Capital allocation decisions in the private sector hinge upon expectations. Given the inherent challenges of seeing into the future, investors often rely on history as a guide. Has investing in clean energy made financial sense over time? Was the recent crash in fossil fuel commodity prices positive or negative for renewables? To shed light on this debate, we investigate the historical risk and return proposition to investors in the energy sector. Our study examines the financial performance of listed companies engaged in fossil fuel supply as compared to those active in renewable power over the past 5 and 10 years. Our two-fold aim is to document the characteristics of this evolving investment universe and set the stage for a more advanced analysis of investment attractiveness in future reports.

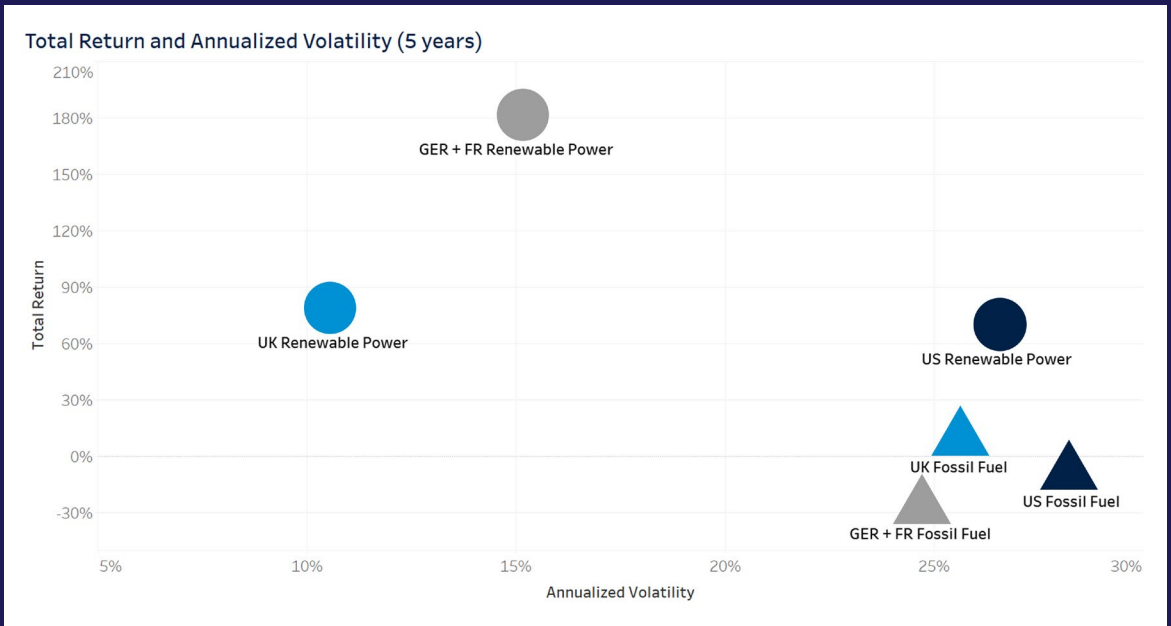
We constructed hypothetical investment portfolios in three countries/regions: 1) the United States, 2) the United Kingdom, and 3) Germany & France. We calculated the total return and annualized volatility of these portfolios over 5 and 10-year periods. Figure 1 shows the 5-year results, which is more complete in terms of data. The numbers for the 10-year view are broadly similar, and can be found in the Results section.

Our results indicate that renewable power shares offered investors higher total returns relative to fossil fuels. Just as importantly, annualized volatility (a measure of investment risk) for the renewable power portfolio was lower across the board.

The complexion of financial markets changed dramatically this year. Unprecedented economic conditions have led to deteriorating fundamentals in the energy sector. An updated look at the US portfolios over the first 4 months of 2020 shows that the renewable power companies have held up better than fossil fuel companies during this period of severe stress and volatility. Our analysis demonstrates a superior risk/return profile for renewable power in both ordinary market conditions and a recent tail risk event.

Given the apparent financial attractiveness of renewable power, why hasn't financing via public markets taken off? As we explore in this report, risk and return are the cornerstones of investment beliefs. However, to mobilize listed equity investors toward the objective of decarbonization, strong performance may not be sufficient. Additional measures will be required to prepare the industry for full-fledged support from global capital markets.

Figure 1 – Summary of Key Findings



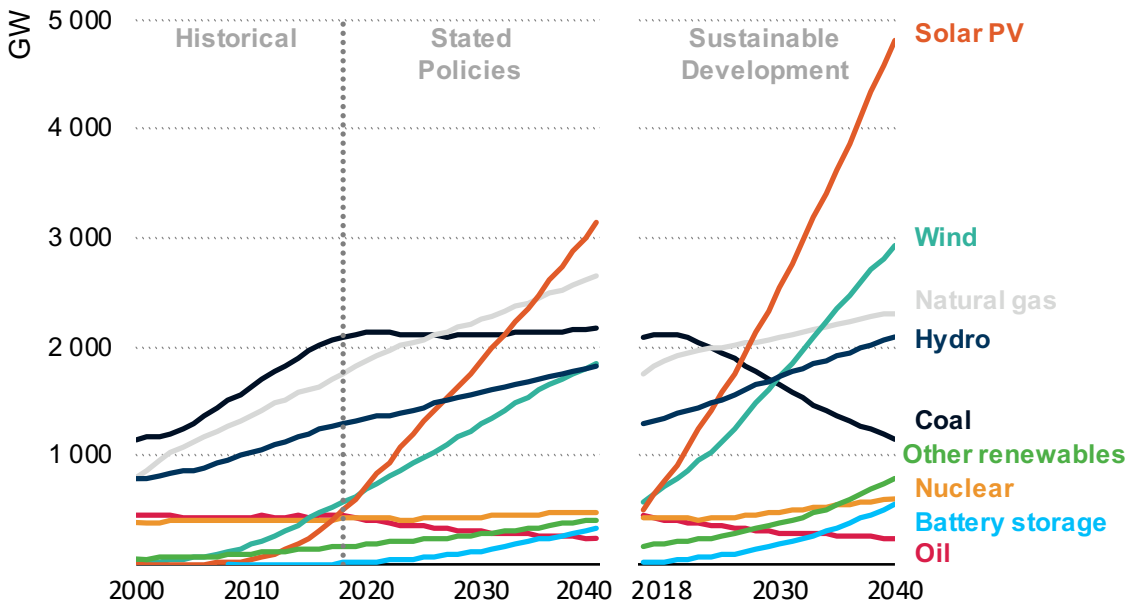
Introduction

While the growth rate of renewable power capacity has remained robust at over 8% over the past decade, global capital expenditures have expanded more moderately[1]. This stems in large part from continuous falls in technology costs for solar PV and wind. Yet, despite the improved maturity of renewable energy technologies, increased economic attractiveness, new political commitments, and a low interest rate environment, capital markets have not yet fully mobilized to meet the challenges of the Paris Agreement. Does this point to some fundamental weakness of renewables as a private sector investment proposition?

Significant reductions in global greenhouse gas emissions will require a fundamental transformation of the global energy sector. Greater awareness of the changes required in primary energy supply to address climate change may have contributed to an outperformance of clean energy shares in 2019. According to IEA projections, the share of renewable power in global power capacity will rise from 35% today to 55% in 2040. In the Sustainable Development Scenario (SDS), renewables – mostly solar PV and wind – comprise 80% of power additions to 2040.

Whatever way the world's energy system evolves, total investment will need to increase significantly. But investment gaps differ starkly by sector and scenario, reflecting variations in differing pathways for energy security and sustainability. To align with long-term energy transition goals for the power sector, a more dramatic reallocation of capital towards renewables would be needed. Indeed, academic research has shown that emission pathways in line with the target of the UNFCCC's Paris agreement always assume a strong increase in wind and solar capacity[2]. As shown in Figure 3, renewable power spending will need to increase steeply by the end of this decade, with additional investments in electricity networks and electricity storage to facilitate system integration.

Figure 2 – Global power generation capacity by source and scenario

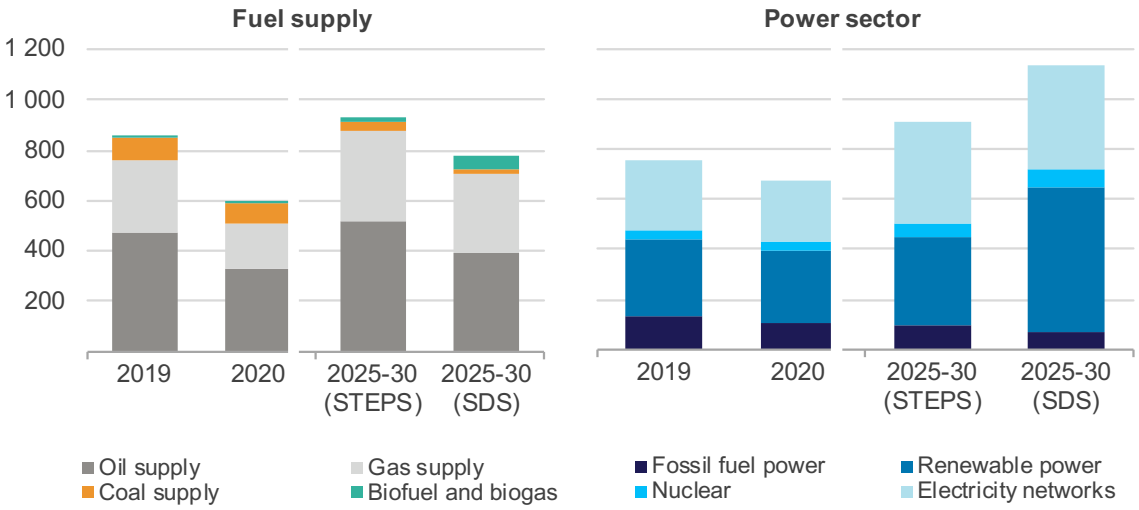


Source: IEA World Energy Outlook 2019

[1] International Energy Agency (2020). World Energy Investment 2020

[2] Luderer et al., 2018. Residual fossil CO2 emissions in 1.5–2 °C pathways. Nature Climate Change. 8, 626–633.

Figure 3 – Global energy supply investment by sector in 2019 and 2020 compared with annual average investment needs 2025–30



Source: IEA World Energy Investment 2020; STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario.

The primary motivation for this research is to respond to the call from investors, industry, and policymakers for robust, transparent analysis that will help support major asset allocation decisions. We employ the basic tools of financial analysis to understand whether exposure to renewable energy would be deemed to add value, to mainstream financial portfolios today. Our work responds to concerns that "limited experience and capacity of policymakers and national financial systems act as a fundamental obstacle to increasing renewable energy investment, even where this would be economically and commercially efficient"[3].

The topic of sustainable finance is now rocketing up the agenda of large asset managers and asset owners. Many are facing heightened scrutiny of investments in the fossil fuel industry. From a purely financial point of view, the primary question for these investors is whether fossil fuels or renewables offer better risk-adjusted returns into the future? While there are many ways to address this question, a common starting point is the evidence offered by recent history. Even if an investor were to pursue divestment from fossil fuels, what should be done with the newly freed-up capital? Would it make financial sense to allocate it all to clean energy? And, if so, is that even possible?

In the ensuing pages, we set out a record of financial performance amongst publicly-traded renewable energy and fossil fuel companies over the past decade. Our study is the first part of an initiative by the International Energy Agency and Imperial College London to inform investors and policymakers about the role of capital markets in a zero-carbon energy transition.

Additional reports in this series will consider stock market performance in non-OECD countries (e.g. India), and undertake a deep-dive on investment returns in the unlisted infrastructure space. These studies will be published by the end of 2020.

Although the social and environmental benefits of clean energy are well documented, their financial characteristics remain poorly understood. The growing interest in renewable energy amongst corporates, as well as institutional and retail investors, has so far not been matched by publicly-available research documenting the financial and risk considerations that drive decision processes in the private sector. For the clean energy to attract capital at scale, there must be a compelling risk-return proposition. The main objective of this report, and subsequent reports in this series, is to explore the crucial areas of context that make that proposition come alive to investors.

Over the past decade, there have been numerous studies by major investment banks, management consultancies, and commercial data providers about the renewables industry. A narrative has been emerging about the benefits of investing in solar PV, wind, and other clean power technologies. This story goes that renewable generation assets, when backed by remuneration based on long-term contracts and policies, offer:

- Financial performance that is less correlated with the economic cycle
- Predictable and stable free cash flows
- Cash yields over long durations
- Hedges against conventional commodity price risks

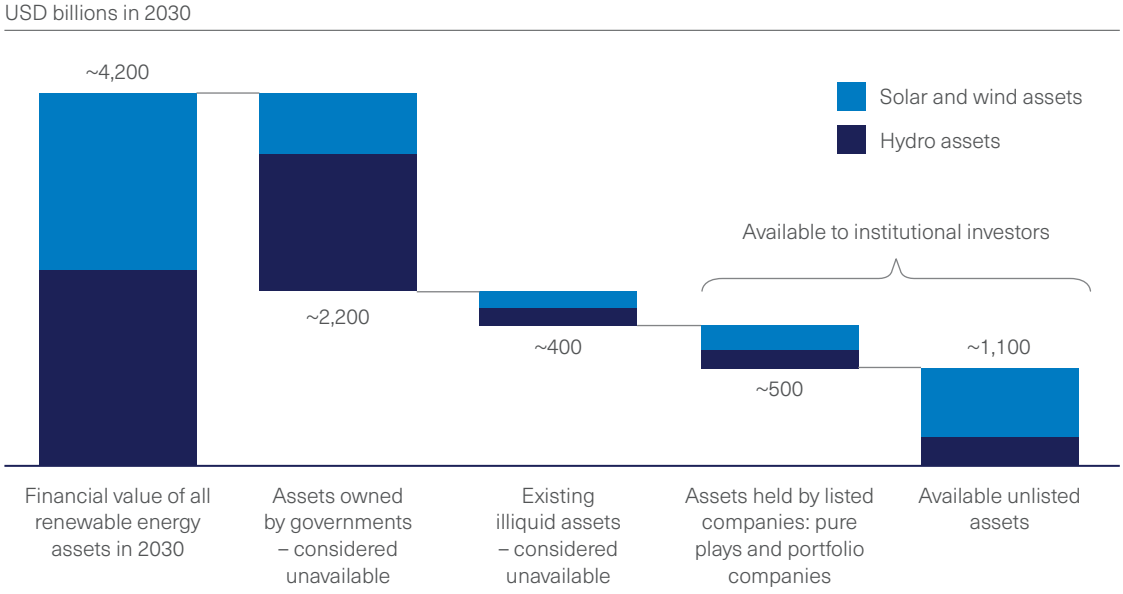
In other words, this ideal-type of renewable power investment offers improved diversification, better liability-matching, and less volatility. Yet this idealized hypothesis about renewables has not received universal support from quantitative assessments. The problem is not just a lack of data. As detailed in this report, there are a series of challenges associated with making a reliable, "apples for apples" comparison.

[3] IRENA (2016). Unlocking Renewable Energy Investment: The Role of Risk Mitigation and Structured Finance

Why We Focus on Stock Market Returns

A study by McKinsey (2018) estimated that roughly $1.6 trillion of renewable power investments will be made available to institutional investors by 2030. Roughly 70% of that investment opportunity will be composed of unlisted assets that do not trade publicly. While the remaining 30% may be accessible through companies that trade on large stock exchanges (like the New York Stock Exchange), as little as 3% of the total investment universe may be made up of "pure-play" companies.

Figure 4 – Value of market available to institutional investors, 2018–2030



Source: McKinsey Global Energy Perspective (reference case 2019)

Given such a lack of dedicated companies in public stock markets, why bother to study them at all? The answer, in short, is that listed markets provide the most transparent method for assessing financial performance. Despite all their well-documented flaws, stock markets remain the critical starting point for finance research.

The entrenched bias in research towards listed capital markets stems from several factors. First, stock markets offer unparalleled price information. Unlike in privately-held arrangements, the market value of a publicly-traded company can be unambiguously known at any moment. Due to the lack of daily traded prices, the question of how to quantify risk and return for privately-held assets is subject to fierce intellectual debate. Listed firms also offer investors well-established practices for financial disclosure and trading liquidity. Transactions carried out on exchanges are well organized and highly regulated.

The depth and breadth of listed capital markets mean they often act as a proxy for rates of return. That said, our focus on listed equity markets in this report also has a forward-looking purpose, which is to establish a foundation for more advanced study. Establishing historical rates of return and associated measures of risk is an important precursor for a more advanced analysis. Our aim here, therefore, is to provide a durable layer of evidence of basic outputs. As can be found in the Results, these outputs include cumulative returns, average yearly returns, and annualized volatility over 5 and 10-year periods.

Analytical Method

Our quantitative analysis calculates measures of risk and financial return for hypothetical investment portfolios based on monthly observations. The time series for the analysis is January 2010 – December 2019, inclusive. To account for recent market dynamics, we also provide an analysis of the first four months of 2020. In contrast to commercial stock indices (e.g. the S&P 500), we place equal weight on each portfolio constituent, regardless of market capitalization. Every company, therefore, has an equal contribution to total returns for their industry segment, regardless of its size. While not without shortcomings, this approach of equal weighting avoids the common outcome whereby single constituents dominate a portfolio's risk and return profile.

Our portfolios are country/region-specific. Companies were selected based on the country of domicile and returns are quoted in the relevant domestic currency ($/£/€). In contrast, commercial indices tend to be more global and take US dollars as the reference currency. While the approach of index providers is useful for many investors, this viewpoint often obscures factors that are driving performance on an individual country level. It also means that returns are heavily influenced by prevailing exchange rates to the US dollar.

The Bloomberg Industry Classification Systems (BICS) was used to establish representative portfolios for each country/grouping. We restricted the investment universe to equity securities in three country groupings: The United States (US), the United Kingdom (UK), and Germany (GER) / France (FR). The BICS classification is based on revenue, operating income and segment assets as published in public reports and related company data. The classification is derived from the primary activities and business models of the companies. It includes factors such as industry risk and market perception. Other industry classifications, such as the Global Industry Classification Standard (GICS) developed by MSCI and S&P Dow Jones, could have been used. Our primary motive for employing the BICS is that it seemed to offer the clearest separation of renewable energy from fossil fuel, within the energy industry.

The Fossil Fuel portfolio was constructed from the BICS sub-sectors definitions shown in Table 1. It includes companies in different parts of fuel supply and at different points of the value chain; though it does not include fossil-fuel power generation, which is not separated in the BICS. Companies involved in the supply of oil and gas are most prevalent, but this industry includes a diverse mix of corporate structures and governance models, from small enterprises to the world's largest corporations. In the United States, the sample reflects the inclusion of integrated oil and gas majors, who have historically focused on large, capital-intensive projects around the world, alongside smaller, independent exploration and production companies. The latter of which may have focused on assets of less interest to the integrated majors, such as medium-size declining fields or frontier areas. This group includes shale independents, a relatively new group of companies that focus almost exclusively on developing shale gas and tight oil resources, and whose business model has relied on higher leverage than integrated oil and gas majors.

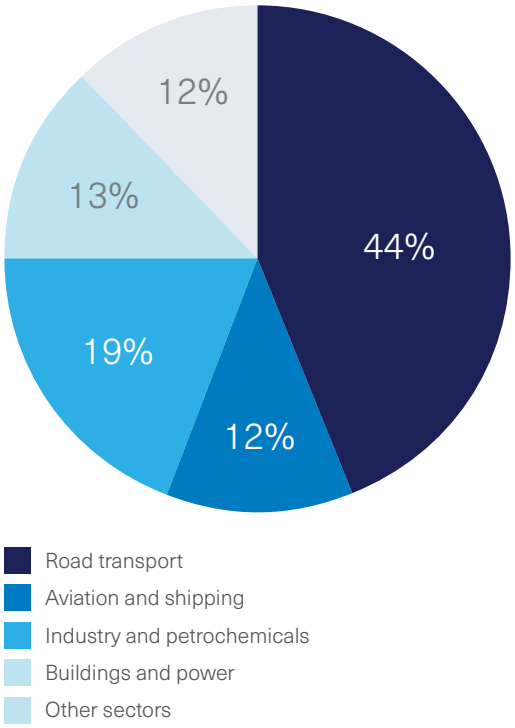
Table 1 – Overview of Sectors and Sub-Sectors included in our Fossil Fuel Portfolio

Sector	Sub-sector
Fossil Fuel	– Coal Operations
	– Exploration & Production
	– Integrated Oils
	– Midstream – Oil & Gas
	– Oil & Gas Services and Equipment
	– Refining & Marketing

Source: Bloomberg, Centre for Climate Finance & Investment

The total market for oil and gas far exceeds that for renewables. Over half of total primary energy demand in 2018 was met by oil and gas, while wind and solar accounted for around 2%. Cross-sector linkages are growing, but as of today remain limited. For example, electric mobility represented only 1% of transport demand in 2018, while oil demand in sectors like aviation and shipping is difficult to electrify. Oil and gas companies have increased their investments in non-core areas, such as renewable power, but these represent less than 1% of total capital expenditure. Simply put, shifting from oil and gas to renewable power on a widespread basis does not yet represent a straightforward trade for the global energy system, nor the companies themselves.

Figure 5 – Breakdown of Global Oil Demand in 2018



Source: IEA World Energy Outlook 2019

The allocation of investment along the coal value chain is very different from oil or gas. The power sector, the largest user of coal, accounts for the bulk of it. However, coal is being steadily squeezed out of the energy mix in many advanced economies by a mixture of environmental policies and competitive pressures from increasingly cost-competitive renewables. Around 70% of today's global coal power capacity – the primary consumer of coal supply – is found in Asia. Over the past decade, the coal industry in the United States and Europe has witnessed dramatic restructuring in conjunction with declining domestic demand. Only one US company remains among the top ten global coal suppliers.

The Renewable Power portfolio is comprised of BICS sub-sectors (RE Equipment Manufacturing and RE Project Developers). Based on a review of industry literature, we added two additional sub-categories (Green Utilities and Yieldcos) to the portfolio. The inclusion of these sub-sectors was necessary to capture the diversity of primary activities and business models within the renewable power segment.

Table 2 – Overview of Sectors and Sub-Sectors included in our Renewable Power Portfolio

Sector	Sub-sector
Renewable Power	– **RE Equipment Manufacturing** (BICS)
	– **RE Project Developers** (BICS)
	– **Green Utilities** – Companies that derive more than 50% of revenue from renewable power activities
	– **Yieldcos** – Holding companies for operational renewable power projects

Source: Bloomberg, Centre for Climate Finance & Investment

The Renewable Power Portfolio includes not just manufacturers of equipment, but also project developers and operating companies. In aggregate, they constitute a broad-based exposure to key themes in the decarbonization of the power sector, but may not be fully representative of all technologies, such as those in grid infrastructure, needed to facilitate successful system integration.

Our sample was constrained by a minimum market capitalization threshold. Companies with a market cap below $200 million (at prevailing exchange rates) as of 31 December 2019 were not included in the final data set. This threshold was set to capture the viewpoint of institutional investors, who rarely invest in companies below small capitalization. Micro- and nano-cap stocks were therefore excluded from the analysis.

Index providers, such as Standard & Poor's and FTSE Russell report, market caps for their smallest and largest constituents. The S&P SmallCap 600 Index (S&P 600) includes companies with a total market capitalization that ranges from $600 million to $2.4 billion. As of 31 January 2020, the index's median market cap was $1.13 billion and covered roughly 3% of the total US stock market. The range of capitalization for the companies covered by the Russell 2000 Small cap index is broader, ranging from $169 million to $4 billion. Our $200m cut-off adopts a definition of small caps more in line with this lower range.

As will be seen in the results, the $200 million market cap threshold resulted in a radically reduced set of portfolio constituents. We took the view that this step was necessary for an "apples for apples" comparison, as it would have been misleading to include a group of firms that are simply too small to be on the radar screen of mainstream financial investors. On a more technical level, having too few companies in the data set would result in portfolio measures dominated by idiosyncratic risks. Nonetheless, our choice does not solve the problem of heterogeneous samples that include industries and sectors (e.g. coal mining with integrated oils / solar PV manufacturing with "green" utilities) that have different business models. Often, these companies cater to distinct sources of demand. Indeed, it raises new problems that will be revisited in future work.

These challenges in building a dedicated Renewable Power portfolio call attention to several underlying issues. It is not surprising that many investors still consider the renewable power sector as a nascent area. There are too few pure-play companies, too little information about those companies, and relatively short trading histories. While there is a body of literature developing on the specific investment risk factors associated with renewable energy[4], the body of empirical evidence remains limited. The eventual goal would be to apply standard methods for quantifying market risk factors using well-established asset pricing models[5].

There would be a much larger sample of companies to draw upon if the inclusion criteria were expanded to companies whose primary activities include not only clean energy supply and associated technologies, but also energy efficiency and fuel-substitution measures. In an even broader view, there is compelling evidence to suggest that a carbon risk premium has already emerged in U.S. equity markets[6]. There is, of course, a tension here. By making the sample more inclusive, we dilute the intended focus on renewables. Furthermore, these samples would require screening criteria and measures that have not yet become widespread, nor easily comparable. This is the aim of ongoing efforts, such as the recommendations of the Task Force on Climate-Related Financial Disclosures, to improve transparency and standardization for the kind of data that will be needed for more advanced studies.

Definition of Key Terms

In the next section, we report on the results of our portfolio analysis at the country level. Brief definitions of key research outputs are provided below.

Total Return
Total return measures the total percentage change in the financial value of a portfolio over a given period. It includes changes in underlying securities prices, as well as income from distributions and dividends. Total return assumes constant reinvestment of income.

Average Annual Returns
Average annual returns (AAR) represent the implied yield over a specified period. Following academic convention, these are calculated as geometric mean returns.

Best and Worst Monthly Returns
These represent the largest monthly appreciation or depreciation of a portfolio's total value in a single month.

Annualized Volatility
Volatility is a range of prices for a security or portfolio of securities. We have adopted here a definition of volatility as the standard deviation over the stated period. Given monthly data observations, an appropriate adjustment has been made to arrive at annualized figures.

[4] See, for example, Egli (2020). Renewable Energy Investment Risk: An Investigation of Changes over Time and the Underlying Drivers, Energy Policy, Volume 140, May 2020.

[5] Such as those used in Fama, E. and French, K. (2012). Size, Value, and Momentum in International Stock Returns, Journal of Fincancial Economics, Volume 105, Issue 3, September 2012.

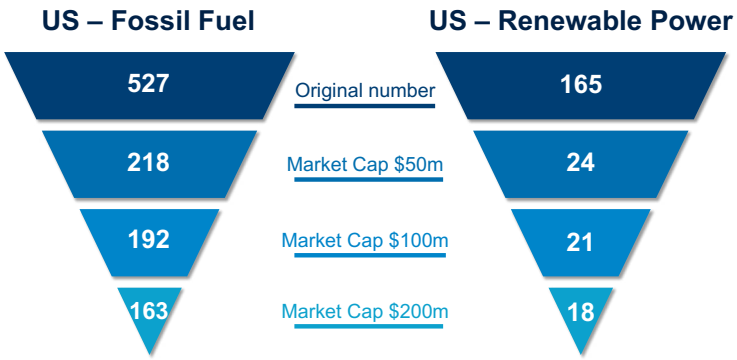
[6] Bolton, P. and Kacperczyk, M. (2020). Do Investors Care About Carbon Risk? Centre for Economic Policy Research, April 2020.

Results

United States

The US provided the largest data set. From a potential pool of 165 companies, our $200 million market cap filter reduced the sample for the Renewable Power portfolio to 18. While the same threshold was made to the Fossil Fuel portfolio, it generated a less dramatic reduction in the sample. Post-filtering, the average market cap for constituents in the Renewable Power portfolio is just about a quarter of the average market cap for the Fossil Fuel portfolio.

Figure 6 – Data set construction for the US



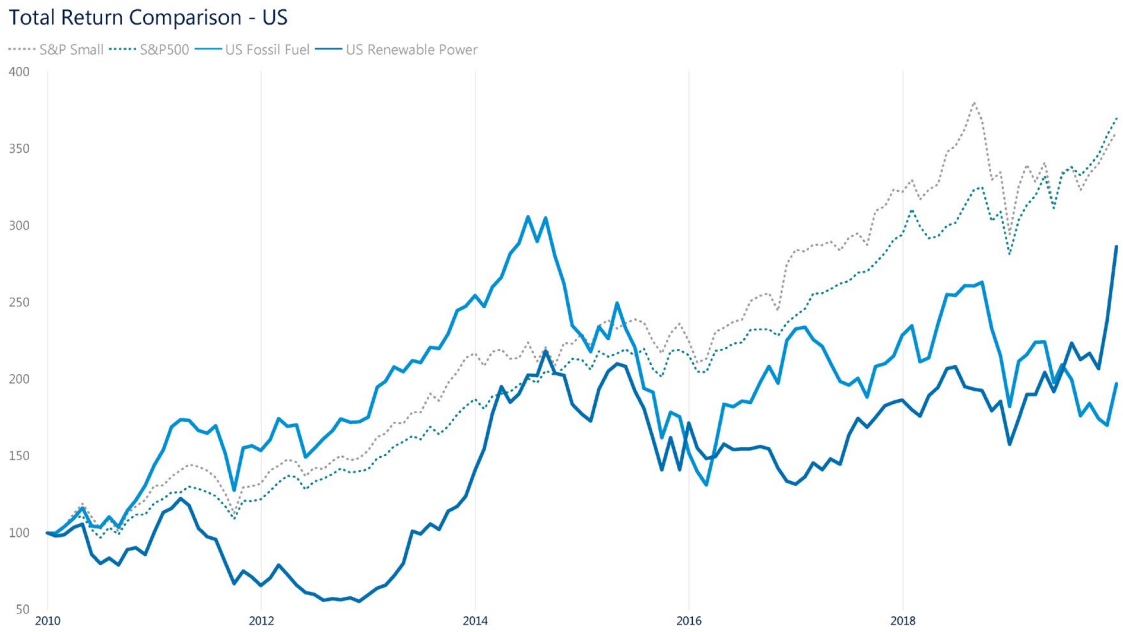
		Fossil Fuel	Renewable Power
Market Cap $200m	Median market cap of portfolio	$ 1,555,171,840	$ 2,134,760,702
	Average market cap of portfolio	$ 9,897,422,574	$ 2,482,187,543

Key findings are summarised in Table 3. Over 10 years, the Renewable Power portfolio generated higher returns and higher volatility than the Fossil Fuel portfolio. However, this changed for the period of the last five years, which coincides with a fall-off in oil prices and stronger investment in renewable power. In this shorter time window, the Renewable Power portfolios delivered higher returns with less risk than the Fossil Fuel portfolio.

Table 3 – Key Results for US Portfolios

US		
	Fossil Fuel	Renewable Power
10 Years		
Total Return	97.2%	192.3%
AAR	7.0%	11.1%
Annualised Volatility	25.4%	28.6%
Best Monthly Return	21.6%	26.2%
Date	Oct. 2011	Jan. 2013
Worst Monthly Return	-15.7%	-18.5%
Date	Sept. 2011	May. 2010
5 Years		
Total Return	-9.6%	65.6%
AAR	-2.9%	10.1%
Annualised Volatility	28.3%	26.7%
Best Monthly Return	19.3%	21.5%
Date	Mar. 2016	Dec. 2015
Worst Monthly Return	-15.5%	-15.1%
Date	Sept. 2015	Dec. 2018

Figure 7 – Total Return Profile for the US



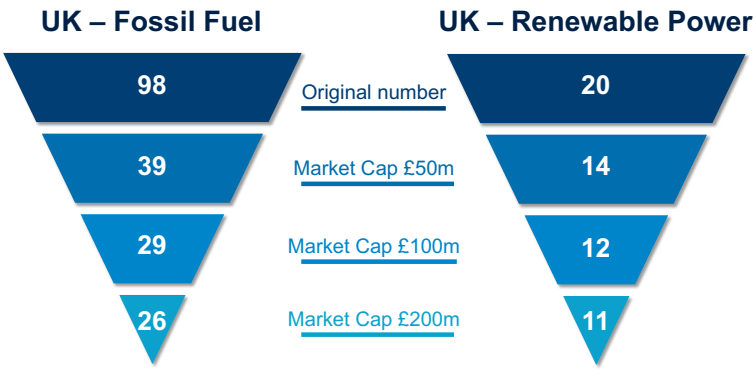
In Figure 7, the returns of the two representative portfolios are plotted against the S&P 500 index (US large-cap companies) and the S&P 600 (US small-cap companies). From 2016 onwards, we see significant appreciation for the US renewable segment relative to other segments and industries. Price appreciation further accelerated from the end of 2018, with growth steepening again from mid-2019 onwards.

These trends reflect underlying fundamentals observed in the US market. A downturn in oil prices from 2014 resulted in a period of lower returns on invested capital and dramatic cost-cutting by oil and gas companies. The US shale sector was hit particularly hard, resulting in bankruptcies and persistently negative free cash flow. A run-up in capital expenditures by oil and gas companies in the first half of the decade was followed by a 75% decline in the years 2014-16. The outperformance of renewable power from 2015 onwards coincides with a period of improving fundamentals. Steep consistent reductions in technology costs, federal tax credits, and improved availability of power purchase agreements from utilities and corporate buyers drove improving cost-competitiveness. More ambitious renewable portfolio standards and clean energy standards adopted by several states have provided better long-term visibility for the sector.

United Kingdom

The market cap filter of $200m reduced the total sample for the Fossil Fuel portfolio from a total of 98 companies to 26. For the Renewable Power portfolio, the sample declined from 14 listed companies to 11. Descriptive statistics of the two portfolios are summarized in Figure 8.

Figure 8 – Data set construction for the UK



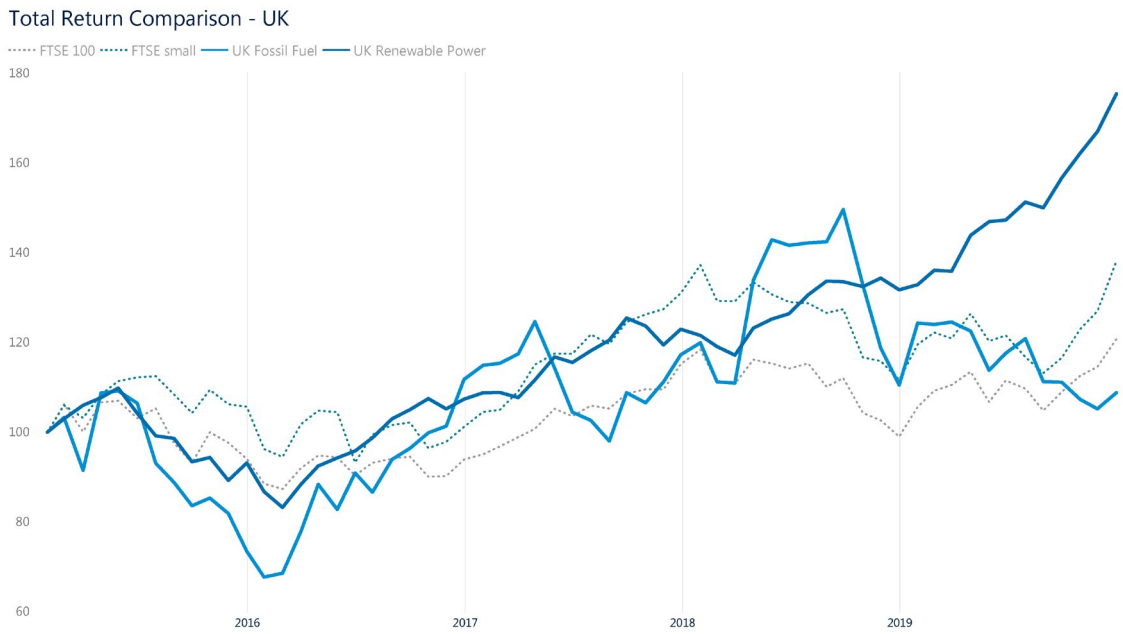
		Fossil Fuel	Renewable Power
Market Cap £200m	**Median market cap of portfolio**	£ 828,817,952	£ 803,980,655
	Average market cap of portfolio	£ 6,290,930,159	£ 1,281,927,017

Table 4 summarises the key results, with a focus on just the past five years due to a lack of listed companies in the period 2010-2015. The Renewable Power Portfolio had a higher average annual return and half the volatility, when compared to the Fossil Fuel portfolio. Monthly best and worst performances are consistent with these findings.

Table 4 – Key Results for UK Portfolios

UK		
	Fossil Fuel	Renewable Power
10 Years		
Total Return	7.1%	N/A
AAR	0.7%	N/A
Annualised Volatility	23.0%	N/A
Best Monthly Return	20.7%	6.2%
Date	Apr. 2018	Mar. 2016
Worst Monthly Return	-12.6%	-6.9%
Date	Jul. 2015	Jan. 2016
5 Years		
Total Return	8.8%	75.4%
AAR	0.2%	11.1%
Annualised Volatility	25.6%	10.6%
Best Monthly Return	20.7%	6.2%
Date	Apr. 2018	Mar. 2016
Worst Monthly Return	-12.6%	-6.9%
Date	Jul. 2015	Jan. 2016

Figure 8 – Total Return Profile for the UK



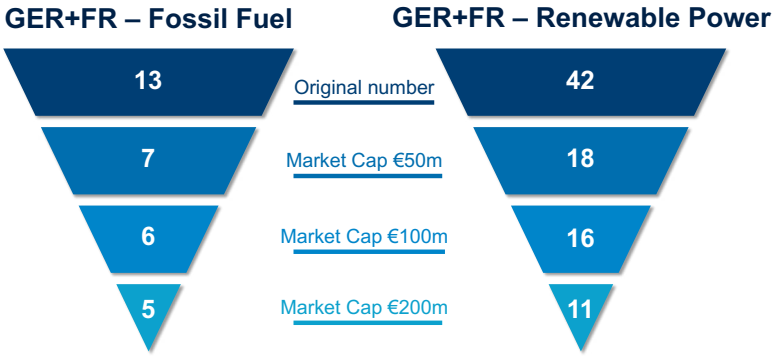
To compare the returns with broad market trends, the FTSE 100 index (UK large-cap companies) and the FTSE Small (UK small-cap companies) have been included.

After a short period of decline between 2015 and 2016, the UK Renewable Power portfolio started to appreciate from 2016 onwards. This may stem in part from the introduction of the renewables auction scheme towards the middle of the decade, which provides long-term pricing for renewables projects under contracts for difference, and has helped spur the development of the world's largest offshore wind market. The Renewable Power Portfolio outperformed the Fossil Fuel Portfolio, as well as the FTSE 100 and FTSE Small throughout 2019.

Germany & France

France and Germany were combined to provide a decent Central European sample. The Fossil Fuel sector in Germany is negligible from a listed equity perspective. Large coal mines in Germany tend to be operated by the utility sector. France, on the other hand, has a significant oil and gas industry, dominated by companies like Total. The Renewable Power portfolio was comprised of 11 companies. Descriptive statistics of the two portfolios are summarized in Figure 9.

Figure 9 – Data set construction for Germany + France



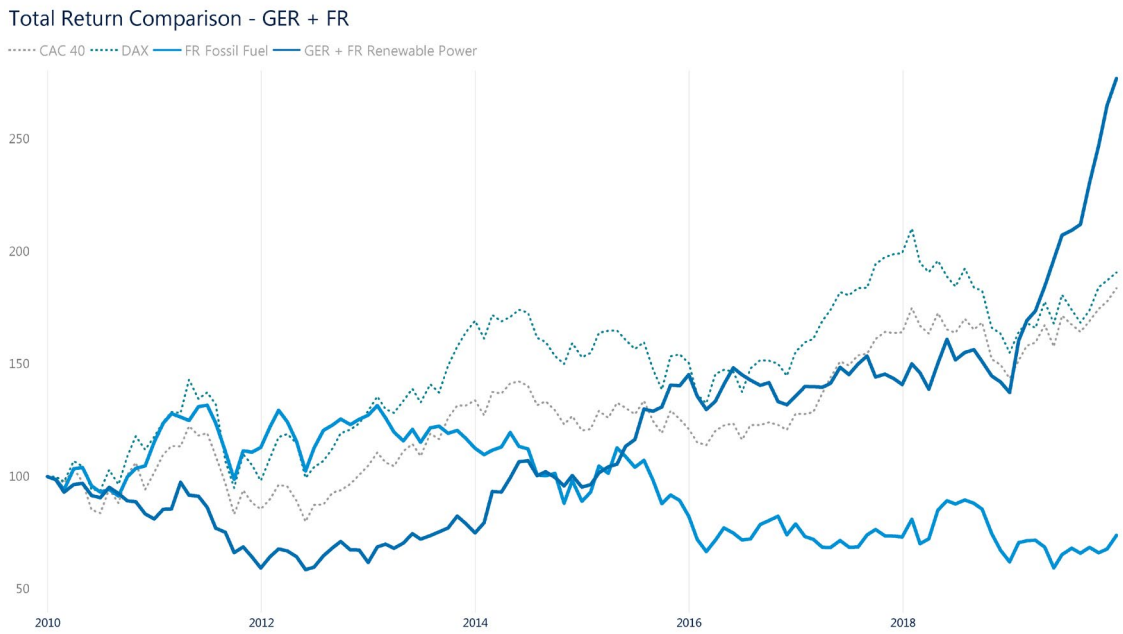
		Fossil Fuel	Renewable Power
Market Cap €200m	**Median market cap of portfolio**	€ 2,087,282,432	€ 989,728,832
	Average market cap of portfolio	€ 24,929,281,344	€ 1,147,155,425

The portfolios' performances are summarised in Table 5. The Renewable Power portfolio exhibits higher returns and lower volatility over both the ten-year and the five-year periods. As with the other geographic portfolios, the best and worst monthly performance is in line with these findings.

Table 5 – Key Results for Germany + France Portfolios

GERMANY + FRANCE		
	Fossil Fuel	Renewable Power
10 Years		
Total Return	-25.1%	171.1%
AAR	-3.0%	10.3%
Annualised Volatility	22.8%	17.7%
Best Monthly Return	17.6%	15.9%
Date	Apr.2018	Feb.2014
Worst Monthly Return	-13.4%	-11.9%
Date	May. 2019	Sept.2011
5 Years		
Total Return	-20.7%	178.2%
AAR	-3.7%	23.0%
Annualised Volatility	24.7%	15.0%
Best Monthly Return	17.6%	14.7%
Date	Apr. 2018	Jan. 2019
Worst Monthly Return	-13.4%	-7.3%
Date	May. 2019	Jan. 2016

Figure 10 – Total Return Profile for Germany + France



To compare the returns of the two-sector portfolios with the broader market trends, the CAC (French large-cap companies) and the DAX index (German large-cap companies) were included.

The Renewable Power portfolio is driven by German stocks known to be representative of the Energiewende. Long-term policy support has underpinned a steady appreciation of shares since 2012. Uncertainties regarding auction schemes and the presence of persistent project-level risks for solar PV and wind (e.g. related to permitting, grid integration), have weighed on performance at times.

A surge starting towards the end of 2018 coincides with the publishing of the long-term European Union target of 32% renewable energy in final energy consumption by 2030 and the initial public offering of pure-play renewable developer Neoen. Compared to the 10-year total return of -25% for the Fossil Fuel portfolio, the Renewable Power portfolio exhibits a return of 171%.

Review of Recent Events

An analysis of the US portfolio over January – April 2020 shows that the Renewable Power portfolio has held up better than the Fossil Fuel portfolio. Again, it exhibited higher returns with less volatility. Over this period, the renewable power sector also showed a higher level of return than the S&P 500. This result likely stems from the revenue buffer that solar PV and wind projects with long-term power purchase agreements benefit from. Nevertheless, the sector has also displayed higher volatility than the market benchmark. This may reflect the influence of companies involved in equipment manufacturing, where near-term supply chain uncertainties have grown.

Figure 11 – Total Return Comparison for January – April 2020

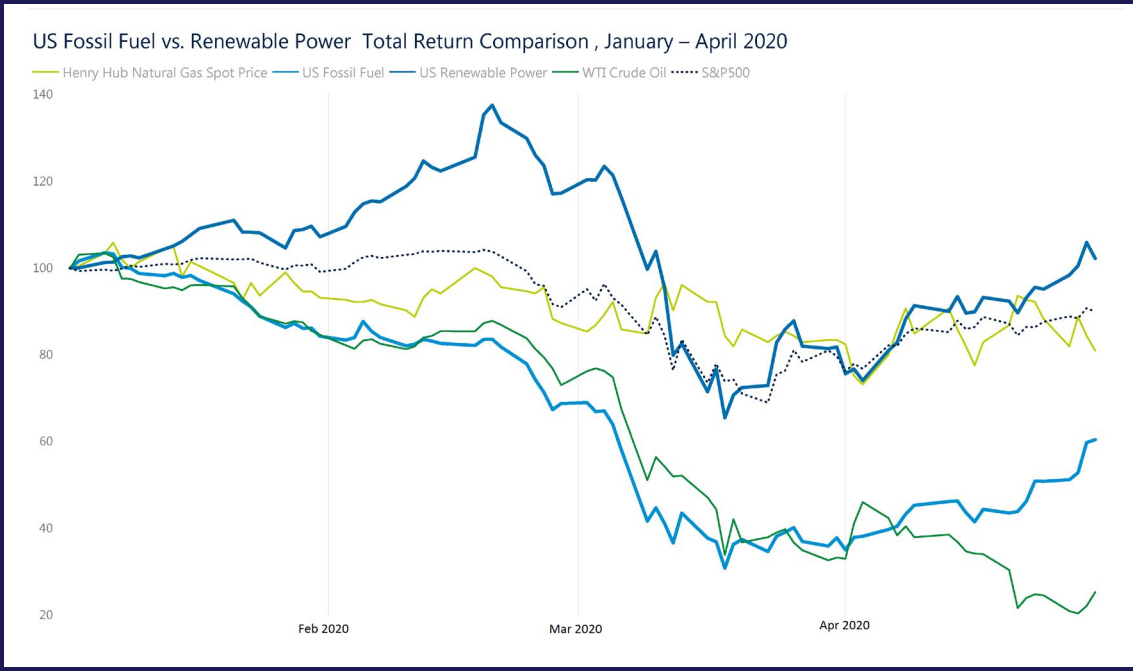


Table 6 – Key Results for the US, January – April 2020

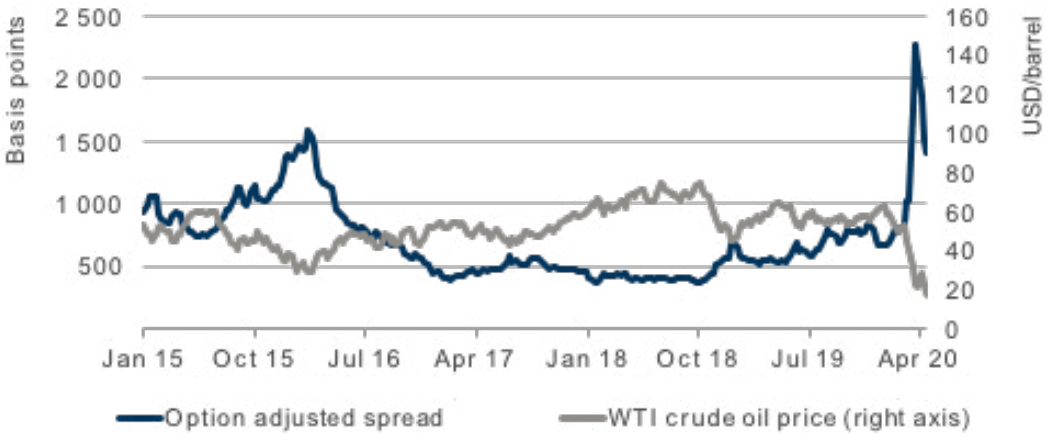
US					
	Fossil Fuel	Renewable Power	S&P 500	WTI Crude Oil	Henry Hub Natural Gas Spot Price
Total Return	-40.5%	2.2%	-9.4%	-75.5%	-19.4%
Best Daily Return Date	18.7% 13. March	13.6% 24. March	9.4% 24. March	24.7% 2. April	9.8% 10. March
Worst Daily Return Date	-28.2% 9. March	-16.2% 12. March	-12.0% 16. March	-28.9% 21. April	-8.9% 2. April
Volatility	58.5%	44.3%	30.7%	71.7%	38.9%

The Covid-19 pandemic has suppressed the demand for oil and generated unprecedented losses for the industry. Based on the International Energy agency forecast, global oil demand is expected to fall by a record 8.6 mb/d year-on-year in 2020 and the recovery to be gradual. Without the traditional balancing mechanism of increased consumption from lower prices, oil and gas companies have slashed capital expenditure guidance upwards of 25% for the year, with potentially larger cuts on the horizon. Given this backdrop, it comes as no surprise that the fossil fuel portfolio has posted the worst daily returns and highest volatility, second to only the oil price itself.

From the 40% drop in return for fossil fuel companies over the period is reinforced by more existential financial challenges emerging for the US shale sector to an oil price of USD 30/bbl or less, the outlook for many highly-leveraged companies looks bleak. Despite improving finances and efforts to pay down debt over the past four years, a widening of credit spreads effectively closed the vital channel of high-yield debt issuance in early 2020 (Figure 12). Companies are trying to extend bond maturities and keep revolving credit facilities open, but many banks are cutting their exposures. Credit downgrades and debt restructurings are ongoing as investors re-assess their reserved-based lending practices and cash flow expectations.

The most recent shock highlights the importance of risk management and portfolio diversification. An important question for further quantitative research is the exact degree to which renewable power provides such diversification to investors and the expected dampening of future drawdowns in volatile market conditions.

Figure 12 – Option-adjusted credit spread for US high-yield energy sector corporate bonds and crude oil price



Source: IEA

Conclusions

This report compares the risk/return profiles of hypothetical investment portfolios in different segments of the energy industry over the past decade. Our main findings are:

- Listed Renewable Power portfolios have outperformed listed Fossil Fuel portfolios in all geographies.
- During periods of high market and oil price volatility, Fossil Fuel portfolios experienced larger drawdowns than Renewable Power portfolios.
- Annualized volatility for the Renewable Power portfolios was similar, or lower than, the Fossil Fuel portfolios

Renewable Power Portfolios performance has significantly improved over the last five years and their volatility has decreased. These are crucial signals for investors. As fiduciaries of assets, investors need to manage portfolio risks. An improvement in risk and return profile makes the asset type more attractive and provides a basis for a re-evaluation of strategic asset allocation to the renewable power sector. That said, our study suffers from several limitations:

- Our sample size is in the renewable power portfolios is well below what would be considered sufficient for rigorous academic research. The presence of many tiny companies may help explain why renewable power has struggled to attract the attention of large asset managers.
- The Renewable Power portfolio is not a perfect substitute for the Fossil Fuel portfolio. Coal, oil and natural gas companies operate in different parts of the energy value chain, often with only a loose relationship to the power sector.
- Similarly, there is a high degree of heterogeneity within each portfolio. By combining sub-industries and sectors (e.g. coal mining with integrated oils, or renewables manufacturing with green utilities) we mix companies with different business models and catering to different sources of end demand.
- Due to the underlying characteristics of these portfolios, we have limited ourselves to the most basic return and risk measures. The analysis does not represent the level of sophistication undertaken by many professional investment managers. Our next study in this series will develop additional insights from fundamental factor analysis, thereby developing a more holistic approach to asset pricing across long-term economic and market regimes.

This analysis has, nonetheless, yielded useful insights. Based on this work, we identify below a set of challenges for investors seeking to increase stock market allocations towards renewables.

The renewables listed universe today is small-cap / low liquidity

Large asset managers, asset owners, and other institutional investors, such as pension funds need ample liquidity to enter a position. It is easier to allocate a meaningful percentage of their assets under management (AUM) to renewables if the market is deep and liquid. Currently, that is not the case. Most asset managers and institutional investors face certain requirements concerning the liquidity of their stock holdings. The vast majority of renewable energy securities in the market today would not be deemed eligible investments due to their size and daily traded volume.

There is a lack of depth in the listed renewables universe

Many investors treat renewables as a developing thematic area. As of today, their choices within that theme in listed equity markets are highly limited. The study by McKinsey described at the start of this report demonstrated that the listed universe only accounts for a small fraction of all investment possibilities in renewable energy. There is an urgent need for greater transparency for unlisted investments. This is a challenge we will tackle in the next report of this series.

The future value of renewables may be embedded in larger energy companies

The oil industry has built up a large global supply chain over many decades, while wind and solar are at an earlier stage of that process. However, the rapidly improving competitiveness of renewable power is creating new opportunities and spillover effects into other industrial sectors. The electrification of transport and heat are examples, as well as the increased interest by industry players in the production of low-carbon gas, e.g. clean hydrogen, from renewable-powered electrolysis. There are already considerable synergies between the oil and gas industry and some renewable power technologies, such as offshore wind and geothermal, with several integrated oil companies already investing in these sectors. Around 40% of the full lifetime costs of a standard offshore wind project have overlap with the offshore oil and gas sector (IEA World Energy Outlook, 2019).

The dramatic fall in the oil price over the first four months of 2020 has upended many assumptions about the financial returns on new exploration and production projects. This re-evaluation may signal a new opportunity for the clean energy sector to grow and build scale within the oil and gas industry. Some players (in particular, the European majors) have announced plans to step up their spending in renewables areas in the coming years. Yet, in the way these companies are currently structured, shareholder risk exposures will continue to be dominated by oil and gas no matter how fast their renewable power businesses grow in the decade ahead.

Final thoughts

By calling attention to the characteristics of prototypical investment portfolios, our aim in this report has been to address the lingering ambiguity about the investment attractiveness of renewables. In summary, we find that renewable power has outperformed fossil fuels in US & European stock markets. That said, our work has also revealed important limitations in making a direct substitute of one for another. Additionally, like all investment analysis, historical performance provides no guarantee of a structural advantage going forward – particularly with uncertainties over the current economic downturn and the speed of transformation in the global energy system.

The appreciation in renewable power share prices observed over the past decade, alongside an acceleration of observed flows to debt instruments like green bonds, demonstrates clear investor interest. Yet, harnessing the benefits of the capital markets for renewables investment will require a better, shared understanding between investors and policymakers. As the renewable energy industry continues to develop, it may converge with the conventional energy sector, or stay quite separate from it. This report has demonstrated that the challenge of defining, from a listed market perspective, a "pure-play" renewable power sector remains just as difficult as it was a decade ago[7]. A key question going forward is whether dedicated renewable power companies can achieve the scale required to absorb large volumes of capital from public markets. How existing norms in the investment industry can now be changed to adapt to the funding needs of this relatively immature industrial sector should be an important consideration for policymakers going forward.

[7] For an early study in this field, see Donovan, C. and Núñez, L., (2012). Figuring What's Fair: The Cost of Equity Capital for Renewable Energy in Emerging Markets. Energy Policy, 40.

Appendix 1 – US Fossil Fuel Portfolio

	Constituent Name	Bloomberg Ticker
1.	EXXON MOBIL CORP	XOM US Equity
2.	CHEVRON CORP	CVX US Equity
3.	CONOCOPHILLIPS	COP US Equity
4.	ENTERPRISE PRODUCTS PARTNERS	EPD US Equity
5.	SCHLUMBERGER LTD	SLB US Equity
6.	EOG RESOURCES INC	EOG US Equity
7.	KINDER MORGAN INC	KMI US Equity
8.	PHILLIPS 66	PSX US Equity
9.	OCCIDENTAL PETROLEUM CORP	OXY US Equity
10.	VALERO ENERGY CORP	VLO US Equity
11.	MARATHON PETROLEUM CORP	MPC US Equity
12.	ENERGY TRANSFER LP	ET US Equity
13.	ONEOK INC	OKE US Equity
14.	WILLIAMS COS INC	WMB US Equity
15.	MPLX LP	MPLX US Equity
16.	BAKER HUGHES CO	BKR US Equity
17.	PIONEER NATURAL RESOURCES CO	PXD US Equity
18.	HESS CORP	HES US Equity
19.	HALLIBURTON CO	HAL US Equity
20.	CHENIERE ENERGY PARTNERS LP	CQP US Equity
21.	CONCHO RESOURCES INC	CXO US Equity
22.	CHENIERE ENERGY INC	LNG US Equity
23.	MAGELLAN MIDSTREAM PARTNERS	MMP US Equity
24.	DIAMONDBACK ENERGY INC	FANG US Equity
25.	PHILLIPS 66 PARTNERS LP	PSXP US Equity
26.	PLAINS ALL AMER PIPELINE LP	PAA US Equity
27.	CONTINENTAL RESOURCES INC/ OK	CLR US Equity
28.	APACHE CORP	APA US Equity
29.	NOBLE ENERGY INC	NBL US Equity
30.	MARATHON OIL CORP	MRO US Equity
31.	DEVON ENERGY CORP	DVN US Equity
32.	WESTERN MIDSTREAM PARTNERS L	WES US Equity
33.	TARGA RESOURCES CORP	TRGP US Equity
34.	NATIONAL OILWELL VARCO INC	NOV US Equity
35.	HOLLYFRONTIER CORP	HFC US Equity
36.	HESS MIDSTREAM LP - CLASS A	HESM US Equity
37.	CABOT OIL & GAS CORP	COG US Equity

	Constituent Name	Bloomberg Ticker
38.	TALLGRASS ENERGY LP-CLASS A	TGE US Equity
39.	TEXAS PACIFIC LAND TRUST	TPL US Equity
40.	EQM MIDSTREAM PARTNERS LP	EQM US Equity
41.	PARSLEY ENERGY INC-CLASS A	PE US Equity
42.	WPX ENERGY INC	WPX US Equity
43.	CIMAREX ENERGY CO	XEC US Equity
44.	DCP MIDSTREAM LP	DCP US Equity
45.	SHELL MIDSTREAM PARTNERS LP	SHLX US Equity
46.	HELMERICH & PAYNE	HP US Equity
47.	ENABLE MIDSTREAM PARTNERS LP	ENBL US Equity
48.	MURPHY OIL CORP	MUR US Equity
49.	CVR ENERGY INC	CVI US Equity
50.	PBF ENERGY INC-CLASS A	PBF US Equity
51.	VIPER ENERGY PARTNERS LP	VNOM US Equity
52.	TRANSOCEAN LTD	RIG US Equity
53.	ANTERO MIDSTREAM CORP	AM US Equity
54.	PLAINS GP HOLDINGS LP-CL A	PAGP US Equity
55.	MURPHY USA INC	MUSA US Equity
56.	EQUITRANS MIDSTREAM CORP	ETRN US Equity
57.	MAGNOLIA OIL & GAS CORP - A	MGY US Equity
58.	SUNOCO LP	SUN US Equity
59.	TC PIPELINES LP	TCP US Equity
60.	NUSTAR ENERGY LP	NS US Equity
61.	WORLD FUEL SERVICES CORP	INT US Equity
62.	BLACK STONE MINERALS LP	BSM US Equity
63.	ENLINK MIDSTREAM LLC	ENLC US Equity
64.	NEW FORTRESS ENERGY LLC	NFE US Equity
65.	GENESIS ENERGY L.P.	GEL US Equity
66.	RATTLER MIDSTREAM LP	RTLR US Equity
67.	KOSMOS ENERGY LTD	KOS US Equity
68.	HOLLY ENERGY PARTNERS LP	HEP US Equity
69.	DELEK US HOLDINGS INC	DK US Equity
70.	APERGY CORP	APY US Equity
71.	NOBLE MIDSTREAM PARTNERS LP	NBLX US Equity
72.	CRESTWOOD EQUITY PARTNERS LP	CEQP US Equity
73.	EQT CORP	EQT US Equity
74.	MATADOR RESOURCES CO	MTDR US Equity
75.	PATTERSON-UTI ENERGY INC	PTEN US Equity

	Constituent Name	Bloomberg Ticker
76.	BP MIDSTREAM PARTNERS LP	BPMP US Equity
77.	DRIL-QUIP INC	DRQ US Equity
78.	USA COMPRESSION PARTNERS LP	USAC US Equity
79.	TELLURIAN INC	TELL US Equity
80.	CALLON PETROLEUM CO	CPE US Equity
81.	PDC ENERGY INC	PDCE US Equity
82.	OCEANEERING INTL INC	OII US Equity
83.	TALOS ENERGY INC	TALO US Equity
84.	NGL ENERGY PARTNERS LP	NGL US Equity
85.	ARCHROCK INC	AROC US Equity
86.	ALLIANCE RESOURCE PARTNERS	ARLP US Equity
87.	CNX RESOURCES CORP	CNX US Equity
88.	COMSTOCK RESOURCES INC	CRK US Equity
89.	HELIX ENERGY SOLUTIONS GROUP	HLX US Equity
90.	NEXTIER OILFIELD SOLUTIONS I	NEX US Equity
91.	CHESAPEAKE ENERGY CORP	CHK US Equity
92.	PBF LOGISTICS LP	PBFX US Equity
93.	SM ENERGY CO	SM US Equity
94.	NOW INC	DNOW US Equity
95.	CENTENNIAL RESOURCE DEVELO-A	CDEV US Equity
96.	LIBERTY OILFIELD SERVICES -A	LBRT US Equity
97.	RANGE RESOURCES CORP	RRC US Equity
98.	MRC GLOBAL INC	MRC US Equity
99.	PAR PACIFIC HOLDINGS INC	PARR US Equity
100.	SOUTHWESTERN ENERGY CO	SWN US Equity
101.	PROPETRO HOLDING CORP	PUMP US Equity
102.	NABORS INDUSTRIES LTD	NBR US Equity
103.	ARCH COAL INC - A	ARCH US Equity
104.	BRIGHAM MINERALS INC-CL A	MNRL US Equity
105.	CNX MIDSTREAM PARTNERS LP	CNXM US Equity
106.	OASIS PETROLEUM INC	OAS US Equity
107.	SRC ENERGY INC	SRCI US Equity
108.	RPC INC	RES US Equity
109.	SELECT ENERGY SERVICES INC-A	WTTR US Equity
110.	OIL STATES INTERNATIONAL INC	OIS US Equity
111.	QEP RESOURCES INC	QEP US Equity
112.	DIAMOND OFFSHORE DRILLING	DO US Equity
113.	PEABODY ENERGY CORP	BTU US Equity

	Constituent Name	Bloomberg Ticker
114.	THERMON GROUP HOLDINGS INC	THR US Equity
115.	KIMBELL ROYALTY PARTNERS LP	KRP US Equity
116.	NORTHERN OIL AND GAS INC	NOG US Equity
117.	DELEK LOGISTICS PARTNERS LP	DKL US Equity
118.	NATIONAL ENERGY SERVICES REU	NESR US Equity
119.	NEXTDECADE CORP	NEXT US Equity
120.	ANTERO RESOURCES CORP	AR US Equity
121.	W&T OFFSHORE INC	WTI US Equity
122.	BERRY PETROLEUM CORP	BRY US Equity
123.	TIDEWATER INC	TDW US Equity
124.	DORCHESTER MINERALS LP	DMLP US Equity
125.	GLOBAL PARTNERS LP	GLP US Equity
126.	DMC GLOBAL INC	BOOM US Equity
127.	SOLARIS OILFIELD INFRAST-A	SOI US Equity
128.	DENBURY RESOURCES INC	DNR US Equity
129.	LAREDO PETROLEUM INC	LPI US Equity
130.	SABINE ROYALTY TRUST	SBR US Equity
131.	CROSSAMERICA PARTNERS LP	CAPL US Equity
132.	MATRIX SERVICE CO	MTRX US Equity
133.	OASIS MIDSTREAM PARTNERS LP	OMP US Equity
134.	FALCON MINERALS CORP	FLMN US Equity
135.	WHITING PETROLEUM CORP	WLL US Equity
136.	CLEAN ENERGY FUELS CORP	CLNE US Equity
137.	NEWPARK RESOURCES INC	NR US Equity
138.	RIVIERA RESOURCES INC	RVRA US Equity
139.	BONANZA CREEK ENERGY INC	BCEI US Equity
140.	PENN VIRGINIA CORP	PVAC US Equity
141.	CALIFORNIA RESOURCES CORP	CRC US Equity
142.	US SILICA HOLDINGS INC	SLCA US Equity
143.	CONTANGO OIL & GAS	MCF US Equity
144.	SPRAGUE RESOURCES LP	SRLP US Equity
145.	EARTHSTONE ENERGY INC - A	ESTE US Equity
146.	GULFPORT ENERGY CORP	GPOR US Equity
147.	CALUMET SPECIALTY PRODUCTS	CLMT US Equity
148.	NACCO INDUSTRIES-CL A	NC US Equity
149.	PACIFIC DRILLING SA	PACD US Equity
150.	SUMMIT MIDSTREAM PARTNERS LP	SMLP US Equity
151.	CONSOL ENERGY INC	CEIX US Equity

	Constituent Name	Bloomberg Ticker
152.	PRIMEENERGY RESOURCES CORP	PNRG US Equity
153.	PARKER DRILLING CO-POST BANK	PKD US Equity
154.	AMPLIFY ENERGY CORP	AMPY US Equity
155.	CONSOL COAL RESOURCES LP	CCR US Equity
156.	HIGHPOINT RESOURCES CORP	HPR US Equity
157.	NINE ENERGY SERVICE INC	NINE US Equity
158.	EXTRACTION OIL & GAS INC	XOG US Equity
159.	NATURAL RESOURCE PARTNERS LP	NRP US Equity
160.	HALCON RESOURCES CORP	HALC US Equity
161.	EXTERRAN CORP	EXTN US Equity
162.	ADVANCED EMISSIONS SOLUTIONS	ADES US Equity
163.	GEOSPACE TECHNOLOGIES CORP	GEOS US Equity

Appendix 2 – US Renewable Power Portfolio

	Constituent Name	Bloomberg Ticker
1.	FIRST SOLAR INC	FSLR US Equity
2.	ENPHASE ENERGY INC	ENPH US Equity
3.	ENERSYS	ENS US Equity
4.	SUNRUN INC	RUN US Equity
5.	SUNPOWER CORP	SPWR US Equity
6.	PLUG POWER INC	PLUG US Equity
7.	VIVINT SOLAR INC	VSLR US Equity
8.	SUNNOVA ENERGY INTERNATIONAL	NOVA US Equity
9.	TPI COMPOSITES INC	TPIC US Equity
10.	GREEN PLAINS INC	GPRE US Equity
11.	FUELCELL ENERGY INC	FCEL US Equity
12.	Pattern Energy Group Inc	PEGI UW Equity
13.	TerraForm Power Inc	TERP UW Equity
14.	Hannon Armstrong Sustainable Infrastruct	HASI UN Equity
15.	8Point3 Energy Partners LP	CAFD UW Equity
16.	P G & E CORP	PCG US Equity
17.	ORMAT TECHNOLOGIES INC	ORA US Equity
18.	NEXTERA ENERGY PARTNERS LP	NEP US Equity

Appendix 3 – UK Fossil Fuel Portfolio

	Constituent Name	Bloomberg Ticker
1.	BP PLC	BP/ LN Equity
2.	SUBSEA 7 SA	SUBC NO Equity
3.	TECHNIPFMC PLC	FTI US Equity
4.	JOHN WOOD GROUP PLC	WG/ LN Equity
5.	NORTHERN DRILLING LTD	NODL NO Equity
6.	ENERGEAN OIL & GAS PLC	ENOG LN Equity
7.	VIVO ENERGY PLC	VVO LN Equity
8.	PETROFAC LTD	PFC LN Equity
9.	VALARIS PLC	VAL US Equity
10.	CAIRN ENERGY PLC	CNE LN Equity
11.	PETRONOR E&P LTD	PNOR NO Equity
12.	PREMIER OIL PLC	PMO LN Equity
13.	TULLOW OIL PLC	TLW LN Equity
14.	AWILCO DRILLING PLC	AWDR NO Equity
15.	HUNTING PLC	HTG LN Equity
16.	SMART METERING SYSTEMS PLC	SMS LN Equity
17.	HURRICANE ENERGY PLC	HUR LN Equity
18.	PHOENIX GLOBAL RESOURCES PLC	PGR LN Equity
19.	GENEL ENERGY PLC	GENL LN Equity
20.	ENQUEST PLC	ENQ LN Equity
21.	GULF KEYSTONE PETROLEUM LTD	GKP LN Equity
22.	SERICA ENERGY PLC	SQZ LN Equity
23.	NOBLE CORP PLC	NE US Equity
24.	AMERISUR RESOURCES PLC	AMER LN Equity
25.	PHAROS ENERGY PLC	PHAR LN Equity
26.	SAVANNAH PETROLEUM PLC	SAVP LN Equity

Appendix 4 – UK Renewable Power Portfolio

	Constituent Name	Bloomberg Ticker
1.	JOHN LAING GROUP PLC	JLG LN Equity
2.	ITM POWER PLC	ITM LN Equity
3.	CERES POWER HOLDINGS PLC	CWR LN Equity
4.	Greencoat UK Wind Plc	UKW LN Equity
5.	Nextenergy Solar Fund Ltd	NESF LN Equity
6.	Foresight Solar Fund Plc	FSFL LN Equity
7.	Bluefield Solar Income Fund	BSIF LN Equity
8.	John Laing Environmental AM	JLEN LN Equity
9.	Renewables Infrastructure Group	TRIG LN Equity
10.	ATLANTICA YIELD PLC	AY US Equity
11.	DRAX GROUP PLC	DRX LN Equity

Appendix 5 – GER + FR Fossil Fuel Portfolio

	Constituent Name	Bloomberg Ticker
1.	TOTAL SA	FP FP Equity
2.	RUBIS	RUI FP Equity
3.	CGG SA	CGG FP Equity
4.	MAUREL ET PROM	MAU FP Equity
5.	ESSO STE ANONYME FRANCAISE	ES FP Equity

Appendix 6 – GER + FR Renewable Power Portfolio

	Constituent Name	Bloomberg Ticker
1.	VARTA AG	VAR1 GR Equity
2.	SMA SOLAR TECHNOLOGY AG	S92 GR Equity
3.	NORDEX SE	NDX1 GR Equity
4.	PNE AG	PNE3 GR Equity
5.	ENERGIEKONTOR AG	EKT GR Equity
6.	7C SOLARPARKEN AG	HRPK GR Equity
7.	2G ENERGY AG	2GB GR Equity
8.	ENVITEC BIOGAS AG	ETG GR Equity
9.	VOLTALIA SA- REGR	VLTSA FP Equity
10.	NEOEN SA	NEOEN FP Equity
11.	ALBIOMA SA	ABIO FP Equity

Acknowledgements

Our sincere thanks to Deirdre Cooper, Mark Fulton, Marcin Kacperczyk, Ashim Paun, Bruno Rauis, and Gireesh Shrimali who provided expert feedback on initial drafts of this report. We would like to thank the expert feedback of IEA colleagues Lucila Arboleya, Alessandro Blasi, Tae-Yoon Kim and Yoko Nobuoka. Special thanks goes to Ryszard Pospiech for providing valuable research assistance. Tim Gould, Head of Energy Supply and Investment Outlooks Division, IEA provided valuable guidance and support throughout the project.

The Centre for Climate Finance and Investment acknowledges access to ESG data that is property of MSCI ESG Research LLC (MSCI ESG) in preparing this report. MSCI ESG, its affiliates and information providers make no warranties with respect to any such data provided. The ESG data provided has been used under license with all rights reserved. The Centre similarly acknowledges access to data assistance from HSBC. The same disclaimer applies.

Authors

Charles Donovan
Executive Director, Centre for Climate Finance and Investment, Imperial College London

Milica Fomicov
Research Associate, Centre for Climate Finance and Investment, Imperial College London

Lena-Katharina Gerdes
Research Assistant, Centre for Climate Finance and Investment, Imperial College London

Michael Waldron
Head of Investment Team, IEA

About the International Energy Agency

The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 30-member countries, 8 association countries and beyond.

For more information, please visit: iea.org

The Centre for Climate Finance & Investment at Imperial College Business School

Set within one of the world's top 10 universities, the Centre for Climate Finance & Investment is working to unlock solutions within global capital markets to the challenges of climate change. Our research and teaching are helping to generate a new understanding of the multi-trillion-dollar investment opportunity encompassing renewable energy, clean technologies, and climate-resilient infrastructure. Combining interdisciplinary expertise with real-world industry experience, the Centre acts as a bridge between finance academics and investment practitioners. The Centre was founded in 2017 with generous support from Quinbrook Infrastructure Partners.

For more information, please visit: imprl.biz/whatisclimaterisk

To get in touch about this report, please email:
climatefinance@imperial.ac.uk

Centre for Climate Finance & Investment
Imperial College Business School
South Kensington Campus
London SW7 2AZ
United Kingdom

Imperial College Business School | Centre for Climate Finance & Investment

imperial.ac.uk/business-school/climate-investing

iea

iea.org

Imperial means
Intelligent Business