SOLACTIVE
German Index Engineering

TOMORROW NEVER DIES: BOND. RENEWABLE BOND.

White Paper

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Research, Solactive AG

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EXECUTIVE SUMMARY

In this white paper, we attempt to study the historical performance and characteristics of a basket of sovereign bonds weighted according to their issuing country's renewable energy generation capacity (hereinafter referred to as the "renewable capacity strategy"). In the renewable capacity strategy, we weight more heavily bonds issued by countries with a larger amount of renewable energy generation capacity relative to the Solactive Broad Global Developed Government Bond Index (hereinafter referred to as the "benchmark"). The renewable capacity strategy was, on average, more diversified than the benchmark, whilst exhibiting both higher total returns and lower volatility, between October 2008 and June 2019.

Through the historical performance of the renewable capacity strategy during the considered period, we observe the following:

- Canadian and European bonds were overweighted by 11.59 and 6.37 percentage points respectively, relative to the benchmark, largely in lieu of US and, particularly, Japanese bonds (which had a 5.15 and 21.95 absolute percentage point historical underweight in the renewable capacity strategy).
- The historical numerical credit rating of the renewable capacity strategy was, on average, above that of our benchmark by half a notch, whilst always remaining better rated.
- The renewable capacity strategy exhibited, on average, a 0.5 lower modified duration than the benchmark during the historically-simulated period.
- The Sharpe Ratio of the renewable capacity strategy was 0.84 vs. 0.54 of the benchmark during the considered period, driven by an almost 0.5 percentage point higher annualized return and an over 2 percentage point lower annualized volatility between October 2008 and June 2019.

INTRODUCTION

Renewable energy is collected from resources naturally replenishable during the lifespan of a human, such as sunlight, wind, or rain, amongst other sources. Despite mankind's over-reliance on it throughout most of human history, in 2018, less than 27% of global electricity was generated through the means of renewable sources,[1] whilst over 80% of the electricity produced in the world's largest economy, the US, was generated from either fossil fuel, natural gas, or nuclear energy.

Nonetheless, research shows that there is a positive correlation between renewable energy and economic growth. Namely, an increase in renewable energy consumption – both in absolute terms and relative to the countries' overall energy mix – is correlated with an increase in overall and per capita GDP.[2]

Therefore, it should not be surprising that investors might prefer to increase their exposure to Australia's thriving solar energy industry, Canada and Norway's robust hydropower infrastructure, or Germany's notorious wind farms. This assumption would follow from market participants seeking to benefit from the economic performance of countries better suited to face the green-shift in global energy demand.

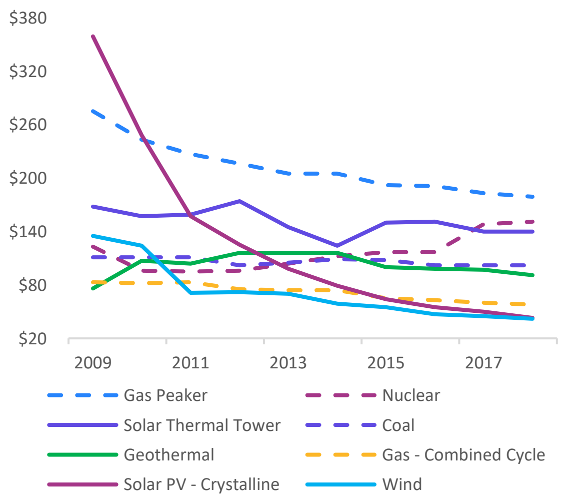
In this white paper, we attempt to construct an index of a renewable-capacity-weighted basket of sovereign bonds, and analyze its performance relative to that of a market-value-weighted one.

RENEWABLE ENERGY: HOW GREEN CAN THE WORLD BECOME?

The recent bidding war entailed by Chevron Corporation and Occidental Petroleum for the acquisition of Anadarko Petroleum resulted in one of the largest M&A deals of 2019, so far. It ended with "Oxy" agreeing to pay USD 53 billion in enterprise value for Anadarko, and reflects the ever-increasing relevance of the Permian Basin's rich oil reserves within the global energy minerals space. However, the 4.1 million barrels of oil produced there per day, as of April 2019, come at a high cost: hydraulic fracturing (i.e. fracking), a key process for oil extraction in the area, has a large toll on the environment as well as on public health. This externality follows from the considerable amount of water the process consumes, and from its reliance on proppants and other – potentially toxic – substances that may in turn lead to water and air pollution.

Nonetheless, just as the valleys are deep, the peaks are high: it is estimated that in over half of the state of Texas, including metropolises such as Dallas and Houston, renewable technology sources of electricity are now less expensive than non-renewable ones.[3] Indeed, material declines in the pricing of system components (e.g., panels, inverters, turbines, etc.) and improvements in efficiency, amongst other factors, have resulted in a dramatic historical unsubsidized levelized cost of energy (i.e. lifetime energy costs divided by production) decline of 69% and 88% from 2009 until 2018 for wind and solar photovoltaic energy, respectively.[4]

Exhibit 1: Unsubsidized Megawatt per Hour Cost of Generating Electricity (USD) by Source, Estimate

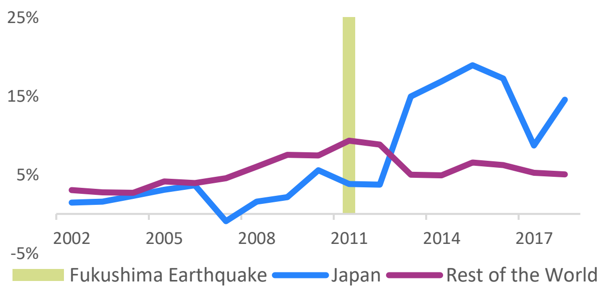


Source: Lazard.

This cost reduction's impact on the feasibility and willingness to transition towards renewable sources of energy has been accentuated in certain geographies by measures such as the following:

- shifting taxes, like the environmental tax reform in multiple European countries,
- shifting or reducing energy subsidies from non-environmentally friendly sources of energy like coal,
- multinational initiatives, such as the Paris Agreement,
- or by the aversion towards potential spillover caused by non-renewable energy sources, like that generated by the Fukushima nuclear disaster.

Exhibit 2: Year-on-Year Japanese and Rest of the World Renewable Generation Capacity Growth Rate pre- and post-Fukushima Earthquake



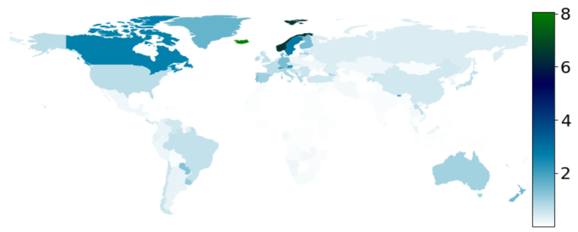
Source: Solactive and IRENA.

Moreover, recent research has shown that the introduction of renewable energy consumption into the total energy mix not only benefits the environment, but also positively correlates with overall, and per capita GDP growth both in emerging [5] and OECD economies [2]. This observation may serve as a strong basis for policy makers worldwide to design measures that foster the usage of renewable energy. Furthermore, it has been claimed that the potential long-term impact of climate change can amount to a yearly reduction of over 20% of the World's GDP in a worst-case scenario, which, as of the World Bank's 2018 nominal GDP estimate, would amount to an over USD 16 trillion year-on-year loss of wealth.[6]

Given this wide array of factors, it is not surprising to observe that the world's renewable energy generation capacity has increased by over 217% between 2000 and 2018, whilst being expected to become the largest source of global power generation by 2040.[7] Particularly, wealthier nations with a larger degree of economic stability, as well as societal and environmental awareness amongst its citizens (key drivers for renewable energy demand [8]) are poised to benefit the most from the industry's growth; given the relatively high installation costs required to build infrastructure for renewable energy production, storage, and distribution.

Countries like Norway and Canada have already been able to channel their resources into renewable energy infrastructure, which amounted to 97% and 68% of their total energy generation capacity in 2017, according to the CIA World Factbook.[9] They have largely been able to do so via hydropower, which boasts 95% and 81% of Norwegian and Canadian renewable capacity infrastructure, respectively.[10] Other geographies have also been leading the way. Such is the case for Germany, whose wind energy installations represent close to half of its total renewable ones. On the other hand, Australia has been able to leverage its extensive and constantly sunny outback to install solar farms that now stand for over 40% of its renewable generation capacity.

Exhibit 3: Global Megawatt Renewable Capacity Per Capita (x 1000)



Source: Solactive, the World Bank and IRENA.

Global renewable energy generation capacity growth has also been able to materialize thanks to Asian nations' close to 500% increase in capacity since the turn of the century, making them hold close to half of the world's total share of renewable capacity. During this timeframe, the largest relative capacity growth by energy source worldwide has been in solar and wind, which have risen from 1,227 to 486,085 and from 16,926 to 563,659 megawatt of generation capacity, respectively.

DATA AND METHODOLOGY

We use the bond universe of the Solactive Broad Global Developed Government Bond Index as the baseline for our study. It includes all liquid local currency bonds issued by the central governments of the US, Ireland, Canada, the UK, Germany, Italy, Spain, Belgium, France, Israel, Slovakia, Portugal, New Zealand, Finland, Austria, Luxembourg, the Netherlands, Singapore, Australia, Switzerland, Denmark, Greece, Japan, Norway, Sweden, Slovenia, and Cyprus.

The index follows a standard market value weighted approach and holds a historically-simulated history going back to October 2008. It is calculated in Euro and contains no hedging of currency risks in its plain vanilla version. As of June 2019, the benchmark index includes 27 different countries and 1064 bonds.

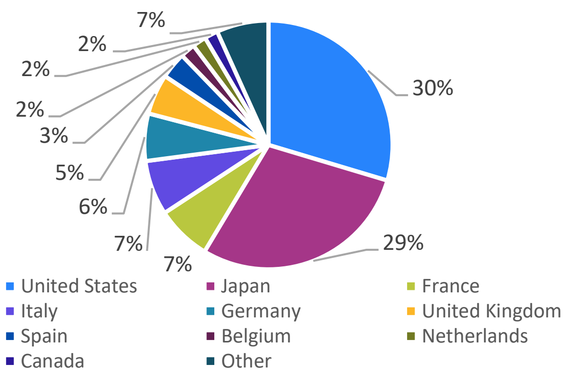
Total country-level renewable energy generation capacity data is obtained from the International Renewable Energy Agency (IRENA) – which is an official United Nations observer and an inter-governmental organization whose goal is to support countries in their transition to sustainable energy. Since 2015, IRENA has published historical world data regarding both renewable energy generation capacity and consumption on a yearly basis. Both time series go back to 2000.

Throughout the paper, we rebalance the renewable energy generation capacity weighted portfolio on the last trading day of July each year. The rebalancing is based on renewable capacity data from the end of previous year. Each country's sovereign bond basket is weighted proportionally to its relative renewable energy generation capacity with respect to the total renewable energy generation capacity of the country universe. We use daily bond returns from October 2008 to June 2019 for our historical simulation.

HISTORICAL PERFORMANCE

In Exhibit 4, we can observe the average historical country weights of the benchmark. Given the weighting scheme of the index, as well as its constituents, it is not surprising to see that the US and Japan represent on aggregate almost 60% of the strategy's historical weight. On the other hand, European countries hold 37.90% of the portfolio's weight.

Exhibit 4: Average Historical Country Weights of the Solactive Broad Global Developed Government Bond Index

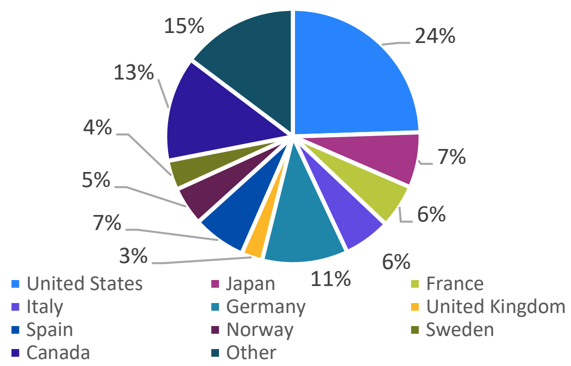


Source: Solactive.

When it comes to the renewable capacity strategy, the country historical average weight is relatively more widely diversified across different geographies, as can be observed in Exhibit 5. The strategy exhibits a particularly large exposure to European countries, which represented an average weight of over 51% during the considered period. This fact should come as no surprise, as these countries hold 23% of the world's total renewable energy generation capacity despite hosting less than 8% of its total population.

Canada is also heavily weighted in the renewable capacity strategy relative to the benchmark, which can be expected, as it boasts over 4% of global renewable generation capacity despite containing less than 0.5% of its population. The historical over-representation of this set of countries comes at the expense of the US, and, in particular, Japan. American and Japanese bonds had a historical underweight of -5.15 and -21.96 percentage points, respectively, relative to the benchmark.

Exhibit 5: Average Historical Country Weights of the Renewable Capacity Strategy



Source: Solactive and IRENA.

Given the renewable capacity strategy's tilt, we can observe that it significantly overweights most of the universe's currencies but for the British Pound, the Israeli New Shekel, the Japanese Yen, and the Singaporean and US Dollar; as shown in Exhibit 6.

Exhibit 6: Average Historical Currency Weights of the Renewable Capacity Strategy and the Benchmark

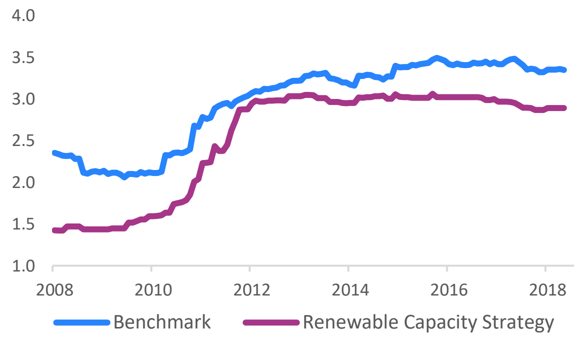
Currency	Renewable Capacity Strategy	Benchmark	Difference
EUR	37.41%	31.05%	6.37 pp
AUD	2.17%	1.09%	1.09 pp
CAD	13.34%	1.74%	11.59 pp
CHF	2.24%	0.45%	1.79 pp
DKK	0.87%	0.55%	0.32 pp
GBP	2.68%	5.25%	-2.57 pp
ILS	0.06%	0.16%	-0.11 pp
JPY	7.03%	28.98%	-21.95 pp
NOK	4.88%	0.21%	4.67 pp
NZD	1.06%	0.19%	0.87 pp
SEK	3.75%	0.39%	3.35 pp
SGD	0.03%	0.31%	-0.28 pp
USD	24.48%	29.63%	-5.15 pp

Source: Solactive and IRENA.

Credit rating-wise, it is noticeable that the renewable capacity strategy had a better numerical rating – estimated as the average of the countries' S&P and Moody's numerical credit ratings (i.e. AAA = Aaa = 1, AA+ = Aa1 = 2, …, etc.) – during the entirety of the considered period, by an average of half a notch.

The main contributor of this divergence can partially be attributed to the extremes: the three most heavily overweighted countries by the renewable capacity strategy were Canada, Germany, and Norway, which cumulatively added to an almost 21 percentage point overweight relative to the benchmark. These countries had a numerical credit rating of 1 during all of the considered period. On the other side of the coin, Japan's weight was 21.96 percentage points lower than that of the benchmark, whilst having an average numerical credit rating of 4 during the same timeframe.

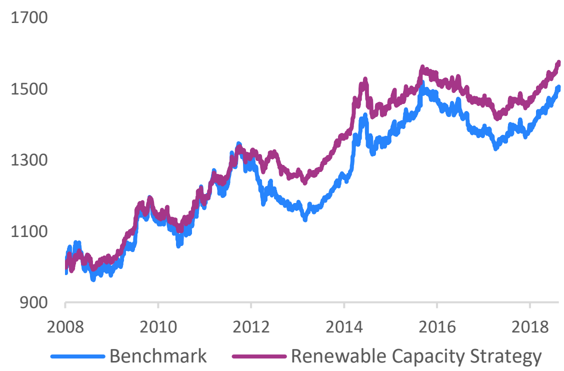
Exhibit 7: Weighted Average Historical Numerical Credit Ratings of the Renewable Capacity Strategy and the Benchmark



Source: Solactive and IRENA.

The renewable capacity strategy achieved both a higher annualized return and a lower annualized volatility than the benchmark. On an annual basis, the former was almost 0.5 percentage points higher (4.31% vs. 3.87%), and the latter was over 2 percentage points lower (5.10% vs. 7.17%) than the return and volatility of the Solactive Broad Global Developed Government Bond Index. These figures led the renewable capacity strategy to have a Sharpe ratio of 0.84, compared to the benchmark's 0.54.

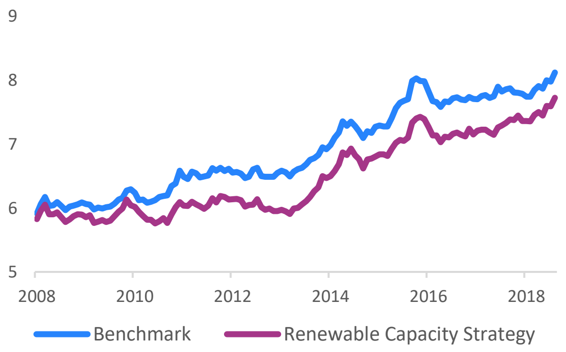
Exhibit 8: Historical Total Return of the Renewable Capacity Strategy and the Benchmark



Source: Solactive and IRENA.

The renewable capacity strategy consistently exhibited a lower duration than the benchmark. On average, during the entire historically-simulated period, the renewable capacity strategy's modified duration was 0.5 lower than that of the benchmark. Thus, it was exposed to a lesser degree to duration risk, while simultaneously performing better than the benchmark in an environment of falling interest rates.

Exhibit 9: Historical Modified Duration of the Renewable Capacity Strategy and the Benchmark

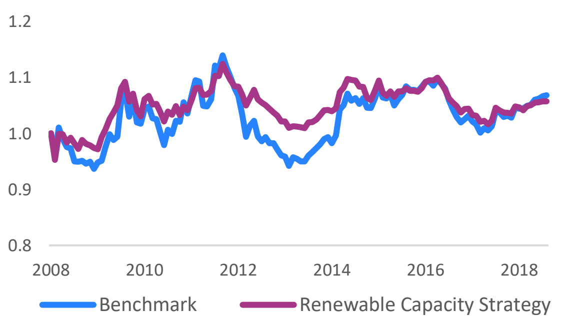


Source: Solactive and IRENA.

ROLE OF JAPAN IN THE INDEX

Both the renewable capacity strategy and the benchmark were affected in a non-trivial way from the local currency nature of their bond baskets.

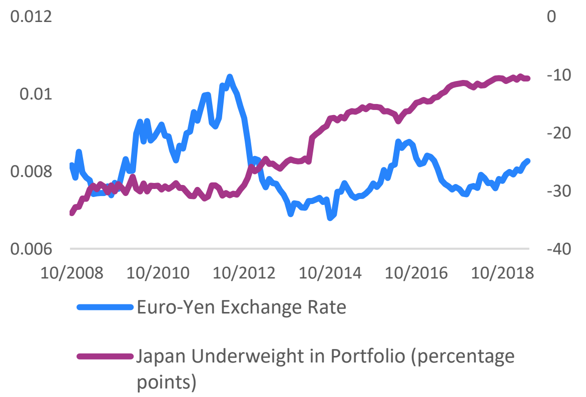
Exhibit 10: Renewable Capacity Strategy and Benchmark Currency Portfolio's Fluctuation with Respect to the Euro



Source: Solactive and IRENA.

As the renewable capacity strategy heavily underweighted Japan during most of the historically-simulated period, with an average weight of less than 7% between June 2012 and October 2014, it was largely unaffected by the 35% Yen depreciation during this time frame. In contrast, over 31% of the benchmark's weight during this period was invested in Japanese sovereigns, whose loss in value resulted in the benchmark taking a large hit.

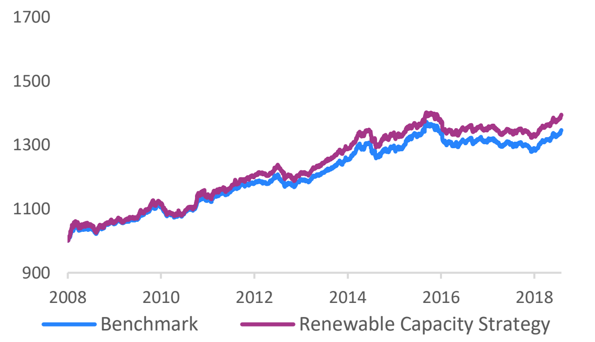
Exhibit 11: Euro-Yen Exchange Rate (left axis) and Historical Japanese Percentage Point Underweight in Renewable Capacity Strategy vs. Benchmark (right axis)



Source: Solactive and IRENA.

Therefore, the renewable capacity strategy exhibited a 4.1 percentage point annualized excess return, as well as a 1.9 percentage point lower annualized volatility over the benchmark during that 28-month time span. Nevertheless, the Yen – as well as USD – subsequently appreciated against the Euro, representing a positive tailwind for the unhedged benchmark. This contrast can be reflected by the narrowing performance gap between the renewable capacity strategy and the benchmark, once hedged index levels were estimated (taking into account monthly forward currency hedging costs). After currency hedges were taken into account, the annualized excess return of the renewable capacity strategy shrunk to 34 basis points. Meanwhile, the renewable capacity strategy's annualized volatility exceeded that of the benchmark by 0.73 percentage points.

Exhibit 12: Monthly Forward (Currency) Hedged Historical Total Return of the Renewable Capacity Strategy and the Benchmark



Source: Solactive and IRENA.

It is relevant to highlight that the significant depreciation of the Yen between 2012 and 2014 partially reflected the lack of success of the Japanese government in their attempts to fight deflationary pressures (i.e. "liquidity trap") from the late 1990s until the 2000s. These attempts led instead to the cause of the heavy overweight of Japanese government bonds in the benchmark.

Between 1997 and 2010, Japanese prices deflated on average by 0.3% on a yearly basis, in spite of policies intended to stimulate the economy during this time span, such as the zero-interest rate policy (implemented between February 1999 and August 2000), quantitative easing (implemented between March 2001 and March 2006), and credit easing. All of these factors significantly contributed to the high degree of indebtedness of the Japanese government.[11]

As a last-resort to spur inflation in Japan, in 2012 Shinzo Abe – then opposition party leader – proposed an ambitious set of economic policies (now known as "Abenomics"), which included an aggressive monetary policy entailing the central bank to commit to purchase large amounts of foreign currency.[11]

A Yen depreciation followed as a result of the aggressive Japanese monetary policy and the diminished global risk-aversion. Furthermore, the Yen's loss in value may have been further exacerbated by the 2011 Fukushima earthquake, which caused a deterioration of the Japanese Balance of Payments.[11]

CONCLUSIONS

In this white paper, we observe that European and Canadian Sovereign Bonds have historically been more heavily weighted in the renewable capacity strategy relative to the Solactive Broad Global Developed Government Bond Index, reflecting a high amount of renewable capacity in Europe and Canada.

Over our analyzed period from October 2008 until June 2019, an unhedged, periodically rebalanced renewable-capacity-weighted sovereign bond strategy outperformed a market-value-weighted one both risk- and return-wise, yielding a Sharpe Ratio 0.31 higher than that of the benchmark. Furthermore, the renewable capacity strategy continuously exhibited a better credit rating and a lower modified duration than the benchmark.

Finally, we notice that a significant degree of the excess-returns generated by the renewable capacity strategy between 2012 and 2014 could be attributed to its relatively low exposure to the Yen. However, the posterior Yen and USD appreciation against the Euro represented a positive tailwind for the benchmark.

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SOLACTIVE
German Index Engineering

CONTACT

Solactive AG
German Index Engineering
Platz der Einheit 1
60327 Frankfurt am Main
Germany

Tel.: +49 (0) 69 719 160 00
Fax: +49 (0) 69 719 160 25
Email: info@solactive.com
Website: www.solactive.com

Timo Pfeiffer
Head of Research & Business Development
Tel.: +49 (0) 69 719 160 320
Email: timo.pfeiffer@solactive.com

Dr. Axel Haus
Team Head Qualitative Research
Tel.: +49 (0) 69 719 160 319
Email: axel.haus@solactive.com

Fabian Colin
Head of Sales
Tel.: +49 (0) 69 719 160 220
Email: fabian.colin@solactive.com