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FINAL REPORT

THE RISK & RETURN OF SEI METRIC EQUITY PORTFOLIOS

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About the Sustainable Energy Investing Metrics (SEI Metrics) project: The project aims to develop a climate performance framework and associated investment products that measure the exposure of financial portfolios to the 2°C economy. The metrics, benchmarks, and tools will enable investors to align their portfolio with decarbonization roadmaps. The project runs from March 2015 to March 2018 and mobilizes over €2.5m in funding. Consortium members in the project include the 2° Investing Initiative, CIRED, WWF Germany, Kepler-Cheuvreux, Climate Bonds Initiative, Frankfurt School of Finance & Management, CDP, WWF European Policy Office and the University of Zurich.

List of Abbreviations and Acronyms

2ii	2 Degree Investing Initiative
CAPM	Capital Asset Pricing Model
Dvd	Dividend
G20	Group of Twenty
GICS	Global Industry Classification Standard
HLEG	High-level Expert Group on Sustainable Finance
ICE	Internal Combustion Engine
IEA	International Energy Agency
kWh	Kilowatt Hour
PORT	Portfolio & Risk Analytics
P / B	Price / Book
P / CF	Price / Cash Flow
P / E	Price / Earnings
P / S	Price / Sales
RV	Relative Valuation
SEI	Sustainable Energy Investment
Wght	Weighted

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1. INTRODUCTION

A new climate change framework has been agreed to slow down climate change and adapt to its already unavoidable consequences in December 2015 in Paris. Substantial efforts from various economic sectors are required to achieve a real economy transition and the goal of the Paris Agreement. In this context, the role of the financial sector in relation to climate-related issues draws more and more attention.[1] The underlying assumption that the financial sector should take an active role to support the real economy transition by its financing and investment decision is controversially discussed. However, many institutions in the financial sector expressed willingness to contribute to the long-term climate goals. In particular, 15 financial centres agreed to drive action on climate change and sustainable development in the Casablanca statement in September 2017;[2] 5 more financial centres joined in December in the same year.[3]

Mechanisms estimating and analysing the required transition is also a central subject of interdisciplinary research. The International Energy Agency (IEA) roadmaps mapped 2 °C pathways that limit global temperature to 2 °C above pre-industrial level by 2050 based on technologies on the production level. The "Sustainable Energy Investment (SEI) Metrics Project" financed by the European Commission proposes a type of metric measuring the consistency of financial markets with climate goals.

There is a general consent that the consequences of climate change do not only affect our environment but will also impair the productivity of the global economy, in particular a number of sectors highly vulnerable to the global transformation e.g. automotive, energy etc. If this assumption holds true, investments into conventional assets would signify a higher risk for all kinds of

[1] Various activities that urge or require the financial sector to take actions on climate-related issues are on-going, e.g. the recommendations on the climate-related financial disclosures from the Group of Twenty (G20) Task Force, the French Act 173 energy transition law and the EU strategy on sustainable finance proposed by the High-level Expert Group on Sustainable Finance (HLEG).

[2] The 15 centres include Astana, Casablanca, Dublin, Hong Kong, Milan, London, Luxembourg, Milan, Paris, Qatar, Shanghai and Stockholm. Source: Lebada, A. M., 2017. Financial Centres, Social Enterprise World Forum Launch New Initiatives on Sustainable Finance. [Online]
Available at: http://sdg.iisd.org/news/financial-centers-social-enterprise-world-forum-launch-new-initiatives-on-sustainable-finance/

[3] The 5 centres are Frankfurt, Geneva, Shenzhen, Toronto and Zurich. Source: United Nations Environment Programme, 2017. Accelerating Financial Centre Action on Sustainable Development: How International Cooperation Can Scale Up Green and Sustainable Finance, Switzerland: UN Environment.

investors. Thus, there is a natural interest to compare the risk / return profiles of conventional portfolios with those consistent with a 2 °C scenario. This will help to understand how risk and return patterns will shift and facilitate improved investment strategies. There might be financial interests for the investors to evaluate the climate impacts of the investments.

Though it is currently not known how big the impact of climate-related risks on investment portfolios is, it is likely that the climate-related risks on portfolios could be mitigated by making investment portfolios consist with 2 °C compatible pathways. As part of the SEI project, this report compares the performance of a more 2 °C compatible portfolio (named as 2 °C screened portfolio) to a conventional benchmark (MSCI World).[4] We use the Bloomberg Risk & Portfolio Analytics tool for a period of 5 years. The aim is to measure the price (in terms of additional risk or reduced return) of making the MSCI World portfolio consistent with a 2 °C pathway.

This report shows that climate-related risks in the investment portfolios could be mitigated at a small price, if any at all in an example of a more consistent portfolio in the back-testing period. Results indicate that there is no observed trade-off between climate impacts and risk-adjusted returns between the 2 °C screened portfolio and the MSCI World portfolio taken as benchmark.[5] In addition, our analysis shows the difference of climate impacts between the 2 °C screened portfolio and the MSCI World portfolio in terms of their 2 degree consistency. In Annex I, we show that the 2 °C screened portfolio is substantially more consistent with a 2 °C pathway than its benchmark.

In the following, Chapter 2 presents the back-testing results of the 2 °C screened portfolio compared to the benchmark MSCI World portfolio. Chapter 3 presents the back-testing results of a portfolio composed of the stocks that are selected out (named as high-carbon portfolio) compared to the same benchmark. The last chapter gives a summary and an outlook into future research areas.

[4] The 2 °C screened portfolio is constructed by the 2 Degree Investing Initiative.
[5] Based on the previous work of the 2 Degree Investing Initiative, it is shown that the 2 °C screened portfolio is sectorial compatible with a 2 °C pathway as indicated in the IEA roadmaps with the exception in the automobile sector. The MSCI World portfolio is not sectorial compatible with 2 degree pathways.

2. BACK-TESTING THE 2 °C SCREENED PORTFOLIO

THE 2 °C SCREENED PORTFOLIO AND THE BENCHMARK

The 2 °C screened portfolio is a fictional portfolio that allocates 100% of the portfolio assets in equity. The portfolio is constructed by excluding 6 fossil fuel company stocks, 25 power company stocks and 23 automotive company stocks from the MSCI World constituents in December 2015 based on a number of exclusion rules.[6] The 2 °C screened portfolio consists of 1595 stocks and has a total asset value of $ 1.26 billion as of 31.10.2017. The 2 °C screened portfolio is assumed to be a fixed portfolio that an investor holds continuously across the back-testing period without rebalancing (31.10.2012 – 31.10.2017).

The 2 °C screened portfolio is compared to the MSCI World portfolio (benchmark). The market capitalisation of the MSCI World portfolio is of $ 1.32 billion as of 31.10.2017. In the context of this report, the MSCI World portfolio is a portfolio obtained in December 2015 where the free-float shares from Bloomberg terminal database are used for each constituent in MSCI World; the benchmark is also assumed to be fixed without rebalancing during the period from 31.10.2012 to 31.10.2017.[7]

This report uses the Bloomberg Risks & Portfolio Analytics tool to analyse the 2 °C screened portfolio's returns over the medium term (5 years) and the risk-adjusted return of the 2 °C portfolio against the benchmark MSCI World portfolio.[8]

CHARACTERISTICS

Table 1 shows the top 15 holdings of the 2°C screened portfolio and MSCI World portfolio. The top 15 holdings are identical and have only implicit weight differences in the 2°C screened portfolio and MSCI World portfolio.

Table 1: Top 15 Holdings of the 2 °C Screened Portfolio

	2°C Screened	MSCI World

[6] Please see Annex 2: Methodology for more information on portfolio construction.
[7] It is important to note that the MSCI World portfolio constructed here have fixed constituents throughout the back-testing period, and thus differs from the MSCI World index, whose constituents are adjusted periodically by MSCI. Some instruments could appear inactive in certain periods in the MSCI World portfolio; no proxy is used in any period to replace the inactive instruments in that period. We thank 2 Degree Investing Initiative for providing MSCI constituents of December 2015.
[8] The period 31.10.2012 to 31.10.2017 covers both bull markets and bear markets in the economic cycles, e.g. 2013 (up) and 2015 (down).

APPLE INC	2.54%	2.44%
MICROSOFT CORP	1.68%	1.61%
AMAZON.COM INC	1.16%	1.11%
FACEBOOK INC-A	1.03%	0.98%
JOHNSON & JOHNSON	1.02%	0.98%
JPMORGAN CHASE & CO	1.00%	0.96%
EXXON MOBIL CORP	0.93%	0.89%
ALPHABET INC-CL C	0.84%	0.80%
ALPHABET INC-CL A	0.80%	0.76%
BANK OF AMERICA CORP	0.76%	0.73%
WELLS FARGO & CO	0.74%	0.71%
NESTLE SA-REG	0.71%	0.68%
PROCTER & GAMBLE CO/THE	0.62%	0.60%
CITIGROUP INC	0.59%	0.57%
PFIZER INC	0.58%	0.56%
Total	**15.01%**	**14.38%**

Note: The figures are calculated based on asset value of active stocks as of 31.10.2017.[9]

The 2°C screened portfolio is constructed by excluding 54 stocks from the MSCI World portfolio. The weight of the Top 5 excluded stocks in the MSCI World portfolio is presented in **Table 2**. The Top 5 excluded stocks are in the range of 18th to 51th place in MSCI World portfolio holdings. In total, all excluded stocks represent 4.21% of weight in the MSCI World portfolio.

Table 2: Top 5 Excluded Stocks Weights in the MSCI World Portfolio

	2°C Screened	MSCI World
CHEVRON CORP	0%	0.56%
ROYAL DUTCH SHELL PLC-B SHS	0%	0.32%
BP PLC	0%	0.31%
ROYAL DUTCH SHELL PLC-A SHS	0%	0.31%
TOTAL SA	0%	0.30%
…	…	…
Total (all excluded stocks)	**0%**	**4.21%**

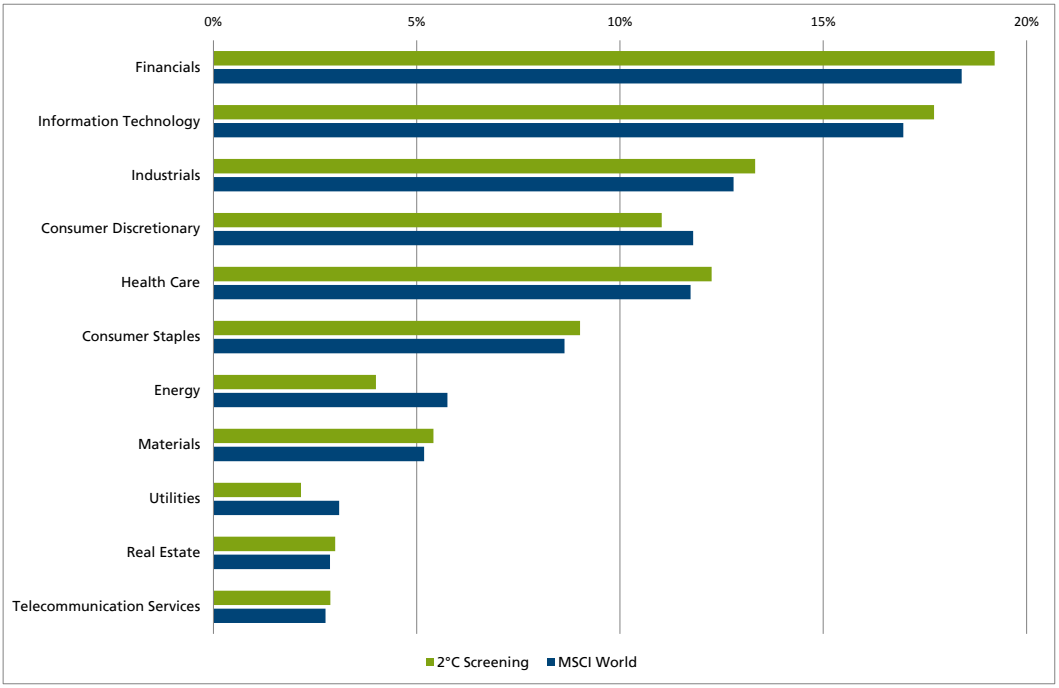
Note: The figures are calculated based on asset value of active stocks as of 31.10.2017. "Total" is the sum of all the stocks excluded from the MSCI World portfolio.

The sectorial distribution of the 2°C screened portfolio and MSCI World portfolio is presented in **Figure 1**. The differences of sectorial distribution between the screened portfolio and the benchmark come from the following three categories: power (in the utilities sector in **Figure 1**), fossil fuels (in the energy sector), and automobile (in the consumer discretionary and industrials sectors) as a number of

[9] The differences between the weight of the remaining stocks in the MSCI World portfolio after exclusion and the 2°C screened portfolio is small. On average, the weight difference for each stock is 0.3 basis point with a standard deviation of 0.6 basis point.

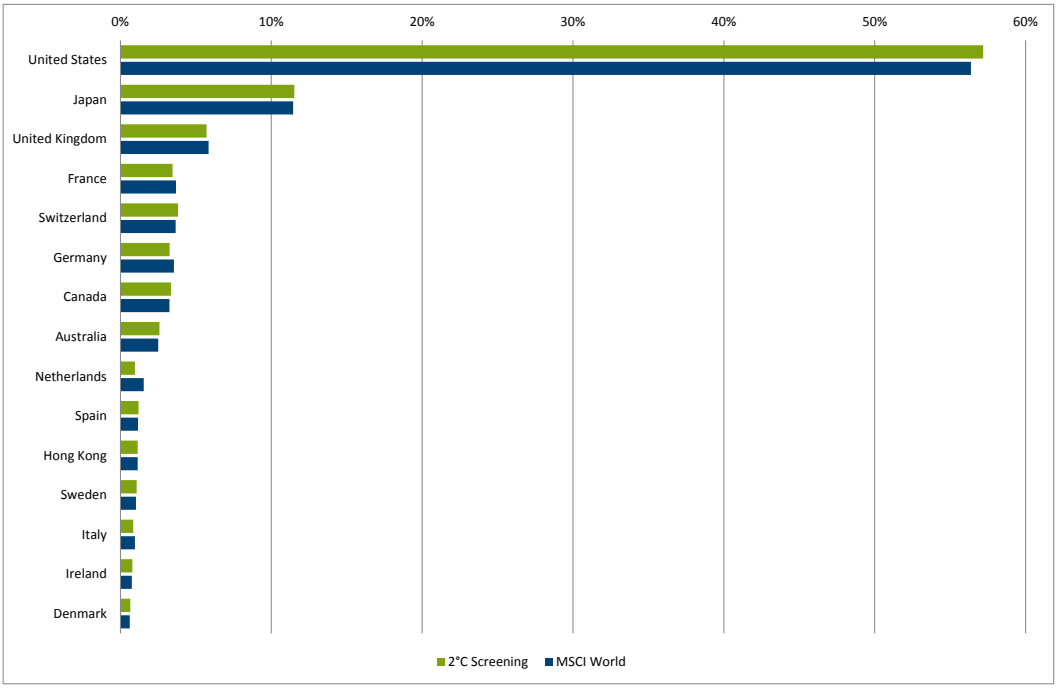
stocks in the power, fossil fuel, and automobile categories are excluded based on defined portfolio construction rules in the 2°C screened portfolio.[10]

Figure 1: Sectorial Distribution of the 2 °C Screened Portfolio vs. MSCI World



Note: Sector classification based on Global Industry Classification Standard (GICS) sectors. The figures are calculated based on asset value as of 31.10.2017.

Figure 2: Top 15 Country Distribution of the 2 °C Screened Portfolio vs. MSCI World



[10] Please see Annex 2: Methodology for more information on portfolio construction.

Note: Top 15 countries account for 98% weight in the 2 °C screened portfolio and MSCI World. The figures are calculated based on asset value as of 31.10.2017.

The Top 15 country distribution of assets of the 2°C screened portfolio and the MSCI World is shown in **Figure 2**. The exclusion rule has an effect on the country distribution of the portfolio. For example, Germany and France have smaller shares in the 2°C screened portfolio due to exclusion of many automobile companies in both countries; the Netherlands have smaller share due to exclusion of the fossil fuel company in the country. With a portfolio constructed using the exclusion rules applied in the 2°C screened portfolio, there would be a larger role in the US stock market and a smaller role for the European market mainly because the climate-related sectors such as power and automobiles have a larger share in the European stock market.[11]

The value and growth measures are shown in **Table 3**.

Table 3: Value & Growth Measures of the 2 °C Screened Portfolio

	2°C Screened	MSCI World	Difference
Price / Earnings	36.71	34.94	1.77
Price / Book	2.32	2.26	0.06
Price / Sales	1.59	1.53	0.06
Price / Cash Flow	12.38	12.03	0.35
Dividend Yield %	2.24%	2.32%	-0.08%
Operating Income Growth% *	-15.93%	-12.93%	-3.00%
Sales Growth % *	5.11%	5.42%	-0.31%
Cash-Flow Growth % *	-0.36%	0.40%	-0.76%

Note: The price ratios are calculated as last price on 31.10.2017 divided by trailing 12 months' denominator item. Dividend yield and other growth ratios * are calculated based on trailing 12 months. The above measures are aggregated to the portfolio level using the index method.[12] The difference is calculated as the ratio of the 2°C screened minus the ratio of the MSCI World portfolio.

To evaluate the scale of change in value measures between the 2 °C screened portfolio and the MSCI World portfolio, a comparison group is formed comprising of 50 global ETF funds that are peers to MSCI World tracking ETF fund.[13] **Figure 3** presents the summary statistics of the comparison group, showing the range of the indicator values and the median. Observing the scale of differences in the

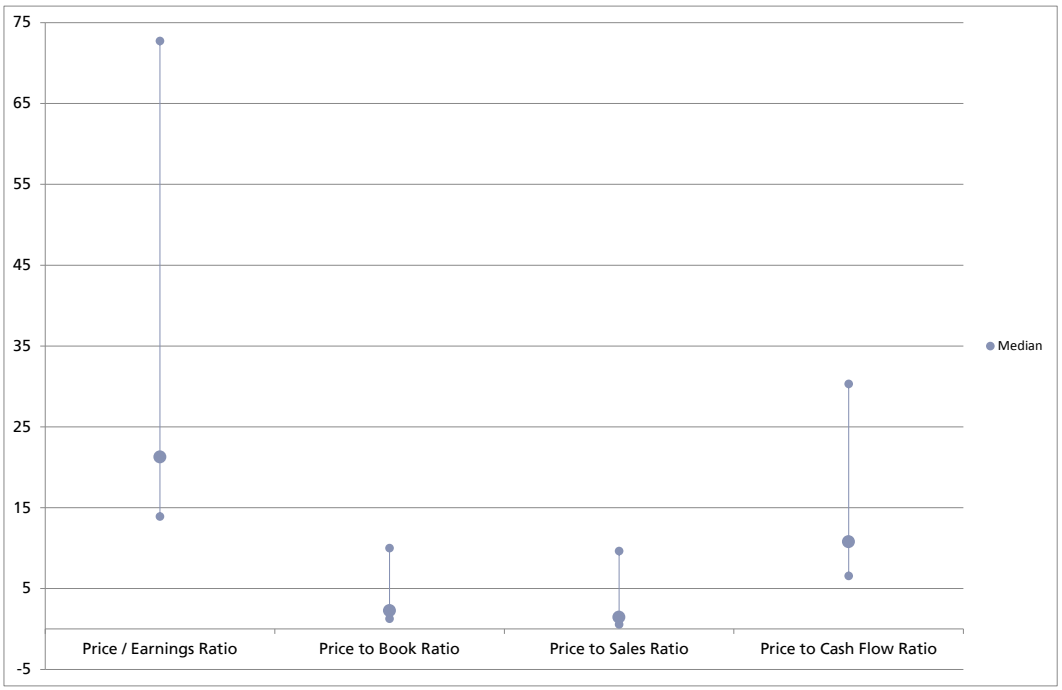
[11] The U.S. has large shares in the non-climate related sectors, e.g. information technology, financials and health care. The asset value weight of information technology of U.S. in the screened portfolio is 14.84%, 8.53% in the financial sector and 8.11% in the health care sector as of 31.10.2017. In comparison, the other countries have asset value share of less than 1% in each sector in the screened portfolio.

[12] The index method in the Bloomberg Portfolio & Risk Analytics (PORT) tool calculates the reciprocal of the weighted average of reciprocal values for price and dividend ratios. It has the good property of preventing weighting high outliers. The companies with negative earnings are included in the calculation.

[13] The peer group is automatically identified by Bloomberg terminal in the relative valuation (RV) section. The maximum number of composites in the peer group is 50.

comparison group, it could be said that the difference in value measures between the 2°C screened portfolio and the MSCI World portfolio is comparatively small.

Figure 3: Comparison Group Value Measures[14]



Note: The price ratios are calculated as last market value on 10.01.2018 divided by trailing 12 months' denominator item.[15] The fund P / E, P / B, P / S and P / CF ratios range from 13.91 to 72.73, 1.26 to 10, 0.56 to 9.63, and 6.56 to 30.32 respectively. The fund dividend yield% ranges from 0.1% to 8.2% with median 2.3%.

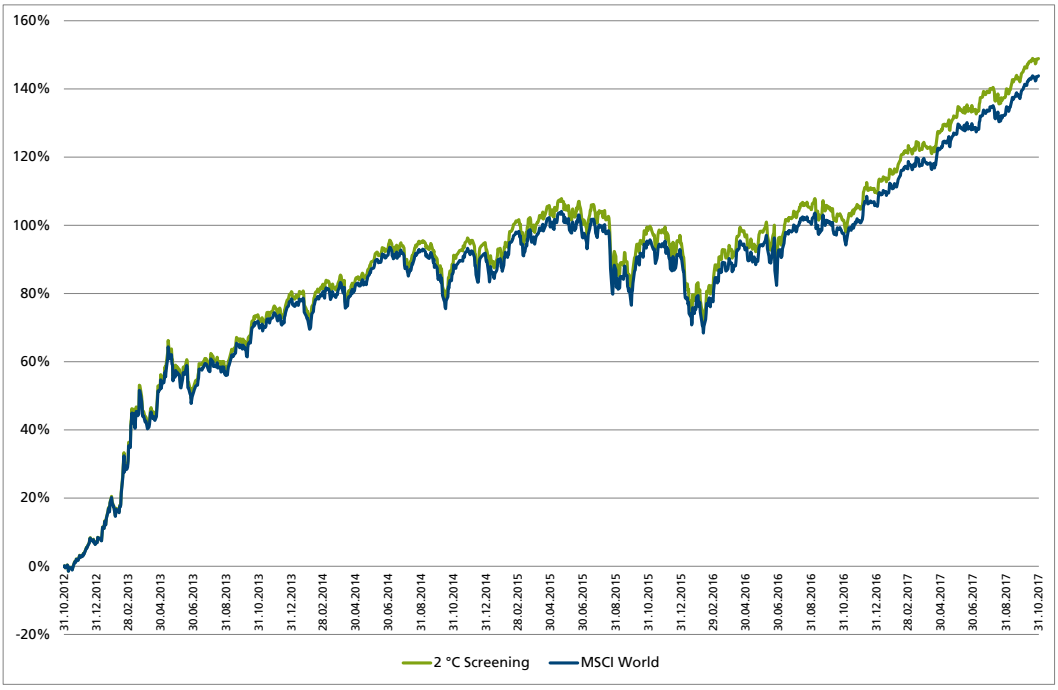
RETURNS

Figure 4 compares the total return (%)[16] of 2 °C screened portfolio and the benchmark across the 5 - year period from 31.10.2012 to 31.10.2017. In the report, transaction costs are assumed to be zero for the 2 °C screened portfolio. The performance of the 2 °C screened portfolio closely tracks the MSCI World portfolio benchmark across the period of evaluation. At the end of October 2017, the period end total return is 149% for the 2 °C screened portfolio, and 144% for the MSCI World portfolio benchmark. Thus, ignoring the risk profile, the 2 °C screened portfolio slightly outperforms its benchmark. Suppose the investor has an initial investment of $10.000 on 31.10.2012 invested in the 2 °C screened portfolio, the initial investment would have given a total gain of $ 14.900[17] if the portfolio is

[14] Abbreviations: Price / Earnings (P / E), Price / Book (P / B), Price / Sales (P / S), Price / Cash Flow (P / CF), Dividend Yield (Dvd Yield). In Bloomberg terminal, the Bloomberg fields are FUND_PE_RATIO, FUND_PB_RATIO, FUND_AVG_PRICE_SALES_RATIO, FUND_AVG_PRICE_CASH_FLOW and FUND_AVG_DVD_YLD.
[15] It is not possible to customize period for the fund aggregate value measures.
[16] Total return includes capital gains, dividends realized over a given period assuming all dividends received are reinvested. It does not take into account any risk factor.
[17] The assumptions behind total return % calculation: No transaction or tax costs; daily dividend information available. The total return index chart is calculated based on: Total Return Index at the End of the Period=Total Return Index at the Beginning of the Period * (1 + Total Return Cumulative from the Beginning to the End of the Period). For more

bought on 31.10.2012 and sold on 31.10.2017 with distributions all reinvested. In comparison with the same amount of initial investments invested in the MSCI World portfolio benchmark, the investor could have expected a total gain of $ 14.400.

Figure 4: Total Return (%) of the 2 °C Screened Portfolio



The historical mean returns of the 2 °C screened portfolio and MSCI World portfolio benchmark are compared in **Table 4**. Investment period of medium-term: 1 year, 3 years and 5 years are considered.[18] Consistent with the result of the analysis of the total return, the 2 °C screened portfolio would have outperformed the MSCI World portfolio benchmark looking at periods 1 year, 3 years and 5 years.

Table 4: Historical Mean Returns (annualized): Medium-term

	1 Year	3 Years	5 Years
2 °C screened portfolio	34.78%	14.11%	30.50%
MSCI World	34.62%	13.83%	29.75%

Note: 1 year (31.10.2016-31.10.2017); 3 years (31.10.2014-31.10.2017); 5 years (31.10.2012-31.10.2017)

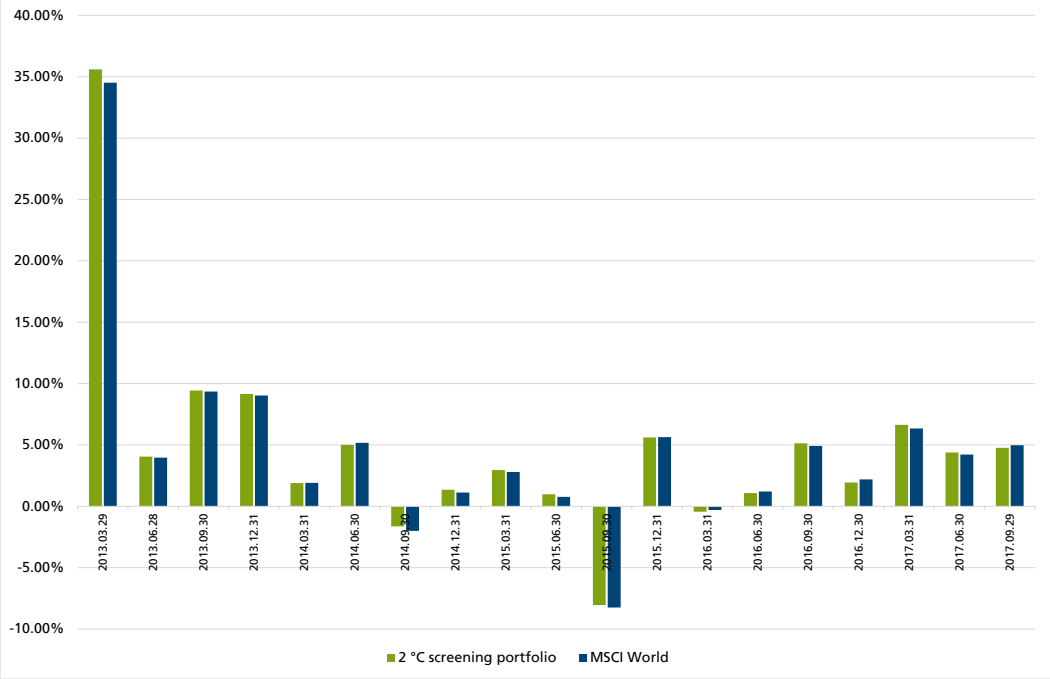
Quarterly total returns (%) for the 2 °C screened portfolio and the MSCI World portfolio benchmark are presented in **Figure 5**. The 2 °C screened portfolio would

methodological information on total return index, please see Morningstar, 2011. Total Return Index, Morningstar Methodology Paper, s.l.: s.n.

[18] We do not report the short-term results on 3-month and 6-month period results because short-term changes are volatile.

have outperformed the benchmark in 12 out of 19 quarters. There were 3 quarters in the period of 31.10.2012 to 31.10.2017 when the returns employing 2 °C screened portfolio would have been negative. The strongest outperformance in the back-test period would have been in the 1st Quarter of 2013. Looking at different short-term time spans in the past, the 2 °C screened portfolio almost consistently outperforms the benchmark.

Figure 5: Quarterly Total Returns Chart of the 2 °C Screened Portfolio



Note: The x-axis refers to the closing date of the quarterly period, e.g. 2013.03.29 refers to the 1st Quarter of 2013.

RISKS

The risks associated with the 2 °C screened portfolio compared with the MSCI World portfolio benchmark are presented in **Table 5**. The annualized standard deviation based on the daily returns in the assessed back-test period for the 2 °C screened portfolio is about 9 basis points higher than the benchmark. The skewness of the 2 °C screened portfolio is 0.03, a right skewness below noticeable skewness threshold.[19] The beta of the 2 °C screened portfolio is 1.01, indicating that the returns using the strategy have a high correlation with the benchmark returns. Given a beta of 1.01, it means that the 2 °C screened portfolio returns on

[19] Skewness describes the degree of asymmetry of the distribution of the daily return in a given period. A skewness value larger than 0.2 is used as a rule of thumb for noticeable skewness. See more in Hildebrand, K. D., 1986. Statistical thinking for behavioural scientists, s.l.: Brooks/Cole.

average increase or decrease by 1.01% for each 1% increase or decrease in the MSCI World portfolio benchmark. This means that the skewness is on a negligible level and the standard deviation and beta for the two portfolios are almost identical.

Table 5: Deviation, Skewness, and Beta in the Period 31.10.2012-31.10.2017

	Standard Deviation (annualized)	Skewness	Beta (ex-post)
2 °C screened portfolio	12.53%	0.03	1.01
MSCI World	12.44%	-0.01	1.00

The downside risks of the 2 °C screened portfolio and the MSCI World portfolio benchmark in the period 31.10.2012-31.10.2017 are compared in **Table 6**. The 2 °C screened portfolio would have generated negative return in the same number of months as the benchmark. The mean return in negative months would have been on average 2 basis points less negative than the MSCI World portfolio benchmark. The annualized downside risk of the 2 °C screened portfolio is 4 basis points higher than the benchmark. And it means that the difference between the two portfolios in terms of downside risks is minor in the given period.

Table 6: Downside Risks in the Period 31.10.2012-31.10.2017

	Number of Negative Months	Mean Negative Return	Downside Risk (annualized)
2 °C screened portfolio	17	-2.45%	8.84%
MSCI World	17	-2.47%	8.80%

Note: 60 months in total.

RISK-ADJUSTED RETURNS

Table 7 compares the risk-adjusted returns of the 2 °C screened portfolio and the MSCI World portfolio benchmark. Observing the Sharpe ratios, the 2 °C screened portfolio is shown to have outperformed the MSCI World portfolio benchmark in the 3 years and 5 years' period, and exhibited similar performance in the 1-year period. When using the Jensen Alpha to account for risk-adjusted returns, the 2 °C screened portfolio has positive Jensen's alphas in the 1, 3 and 5 years' period. When adjusting for the tracking error risk[20], the information ratios of the 2 °C

[20] Tracking error risk refers to the standard deviation of the active returns, which are the return difference between the portfolio and the benchmark.

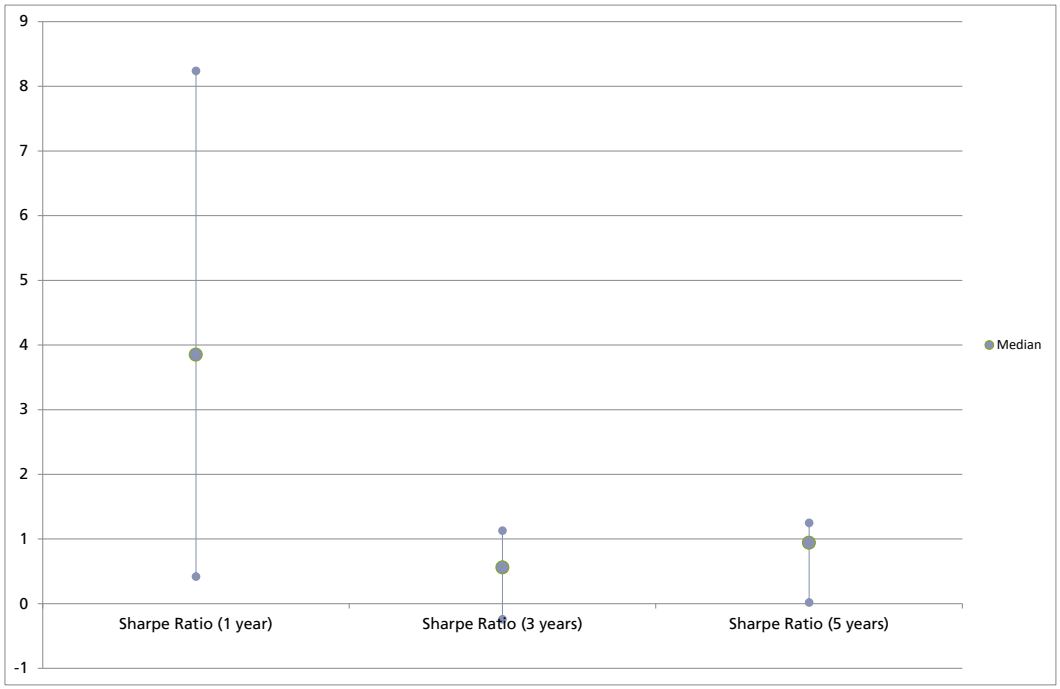
screened portfolio are positive in the 1, 3 and 5-year period.[21] Consistent with the quarterly returns in **Figure 5**, the 2 °C screened portfolio seems to consistently over-perform the benchmark in the given period.

Table 7: Risk-Adjusted Returns of the 2 °C Screened Portfolio

	Sharpe Ratio (2 °C screened)	Sharpe Ratio (benchmark)	Jensen Alpha[22]	Information Ratio[23]
1 Year	3.63	3.63	0.01	0.35
3 Years	0.84	0.82	0.23	0.48
5 Years	1.66	1.63	0.37	1.10

Note: 1 year (31.10.2016-31.10.2017); 3 years (31.10.2014-31.10.2017); 5 years (31.10.2012-31.10.2017)

Figure 6: Comparison Group Fund Sharpe Ratios



Note: The Fund Sharpe ratio is calculated based on gross monthly returns on a trailing basis. The trailing end date is 10.01.2018.[24] The ranges of the Sharpe ratio in 1 year, 3 years and 3 years are 0.42 to 8.24, -0.24 to 1.13 and 0.02 to 1.25 respectively.

The Sharpe ratios in 1-year, 3-year and 5-year period in the comparison group as discussed in the value & growth measures above are shown in **Figure 6**. Observing the scale of differences in the comparison group, it could be again said that the difference between the Sharpe ratios of the two portfolios is small. In particular,

[21] A rule of thumb suggests that information ratio higher than 0.5 is considered to be good. See more in Goodwin, T. H., 1998. The information ratio. Financial Analysts Journal, 54(4), pp. 34-43.
[22] The Jensen alpha calculates the actual return of the portfolio above the return indicated by the Capital Asset Pricing Model (CAPM). It is calculated as „return of the portfolio – [(risk free rate + beta * (return of the benchmark – risk free rate)]". The returns are annualized mean of daily returns.
[23] The information ratio calculates the excess return over the benchmark per unit of tracking error volatility. It is calculated as „ annualized mean excess return / annualized tracking error". It measures the consistency with which the portfolio is beating the benchmark.
[24] It is not possible to customize period for the fund Sharpe ratio.

the 2 °C screened portfolio outperforms the MSCI World portfolio in the 3-year and 5-year period on a small scale.

Taking the above ratios into consideration, the risk-adjusted returns generated by the 2 °C screened portfolio is more favourable in 3 years and 5 years' time frames in the back-testing period compared to the MSCI World portfolio benchmark.

SUMMARY

The 2 °C screened portfolio would have generated an annualized mean return of 30.50% in the period 31.10.2012-31.10.2017, while the MSCI World portfolio benchmark would have generated an annualized mean return of 29.73% in the same period.[25] The 2 °C screened portfolio has slightly higher risks (9 basis points higher in standard deviation and 4 basis points higher in downside risk) than the MSCI World portfolio benchmark. The risk-adjusted returns that would have generated by the 2 °C screened portfolio are more favourable in the 3-year and 5-year time frames in comparison to the benchmark in the back-testing period.

In the back-testing period 31.10.2012-31.10.2017, there is no observed trade-off between climate impacts and risk-adjusted returns. The 2 °C screened portfolio shows similar performance in the 1-year period, and better performance compared to the benchmark in the 3-year and 5-year periods on a small scale.

In total, results indicate that the difference between risk / return profile of the 2 °C screened portfolio and the benchmark are rather marginal. Based on this empirical analysis, it could be confirmed that there are measures to make a portfolio substantially more consistent with (2 °C target) which do not come at the cost of a significant less attractive risk-return profile.

[25] Comparing total return% in the period 31.10.2012-31.10.2017, it is 149% (2 °C screened) to 144% (benchmark).

3. BACK-TESTING THE HIGH-CARBON PORTFOLIO

THE HIGH-CARBON PORTFOLIO

The high-carbon portfolio is a fictional portfolio that allocates 100% of its portfolio assets in the asset class: equity. The portfolio consists of the 6 fossil fuel company stocks, 25 power company stocks and 23 automotive company stocks which are excluded from the MSCI World portfolio described in Chapter 2 to form the 2 °C screened portfolio.[26]

The high-carbon portfolio consists of 54 stocks. It has a total asset value of $ 55.46 million as of 31.10.2017. The high-carbon portfolio is assumed to be a fixed portfolio that an investor holds continuously across the back-testing period without rebalance (31.10.2012 – 31.10.2017). The MSCI World portfolio as described in the last chapter is used as back-testing benchmark. The Bloomberg Risks & Portfolio Analytics tool is used to analyse the high-carbon portfolio's returns over the medium term (5 years) and the risk-adjusted return of the high-carbon portfolio against the benchmark MSCI World portfolio.

CHARACTERISTICS

Table 8 shows the top 15 holdings of the high-carbon portfolio and the MSCI World portfolio. The top 15 holdings in the two portfolios are completely different, which is a direct result of the exclusion rule. In addition, the high-carbon portfolio exhibits higher concentration in top holdings than the high-carbon portfolio, with Top 15 holdings comprising 72% of the total assets in the portfolio.

Table 8: Top 15 Holdings of the High-carbon Portfolio

High-carbon portfolio	
CHEVRON CORP	13.18%
ROYAL DUTCH SHELL PLC-B SHS	7.55%
BP PLC	7.35%
ROYAL DUTCH SHELL PLC-A SHS	7.31%
TOTAL SA	7.19%
DAIMLER AG-REGISTERED SHARES	4.85%

MSCI World	
APPLE INC	2.44%
MICROSOFT CORP	1.61%
AMAZON.COM INC	1.11%
FACEBOOK INC-A	0.98%
JOHNSON & JOHNSON	0.98%
JPMORGAN CHASE & CO	0.96%

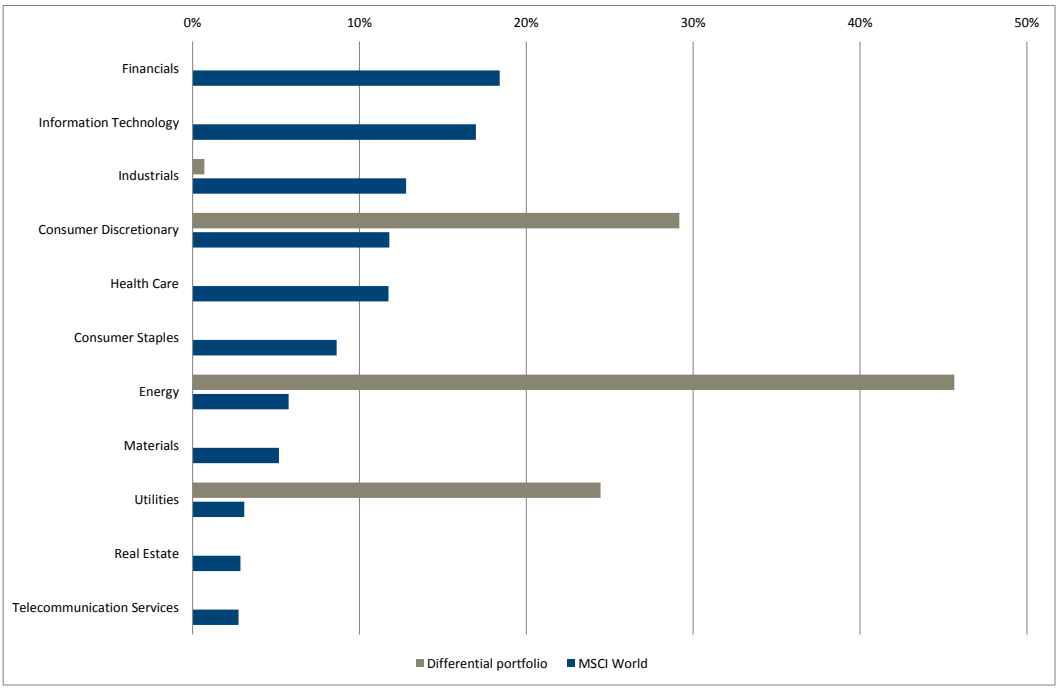
[26] Please see Annex 2: Methodology for more information on portfolio construction.

GENERAL MOTORS CO	3.69%	EXXON MOBIL CORP	0.89%
DUKE ENERGY CORP	3.63%	ALPHABET INC-CL C	0.80%
HONDA MOTOR CO LTD	3.01%	ALPHABET INC-CL A	0.76%
SOUTHERN CO/THE	2.84%	BANK OF AMERICA CORP	0.73%
FORD MOTOR CO	2.71%	WELLS FARGO & CO	0.71%
ENI SPA	2.46%	NESTLE SA-REG	0.68%
AMERICAN ELECTRIC POWER	2.17%	PROCTER & GAMBLE CO/THE	0.60%
BAYERISCHE MOTOREN WERKE AG	2.02%	CITIGROUP INC	0.57%
VOLKSWAGEN AG-PREF	1.98%	PFIZER INC	0.56%
Total	**71.93%**	**Total**	**14.38%**

Note: The figures are calculated based on asset value as of 31.10.2017.

The sectorial distribution of the high-carbon portfolio and MSCI World portfolio is presented in **Figure 7**. The high-carbon portfolio is distributed in the following three categories: power (in the utilities sector in **Figure 7**), fossil fuels (in the energy sector), and automobile (in the consumer discretionary and industrials sectors). The energy sector has the majority share with 46% asset value in the portfolio, followed by 29% in the consumer discretionary sector and 24% in the utilities sector.

Figure 7: Sectorial Distribution of the High-carbon Portfolio vs. MSCI World

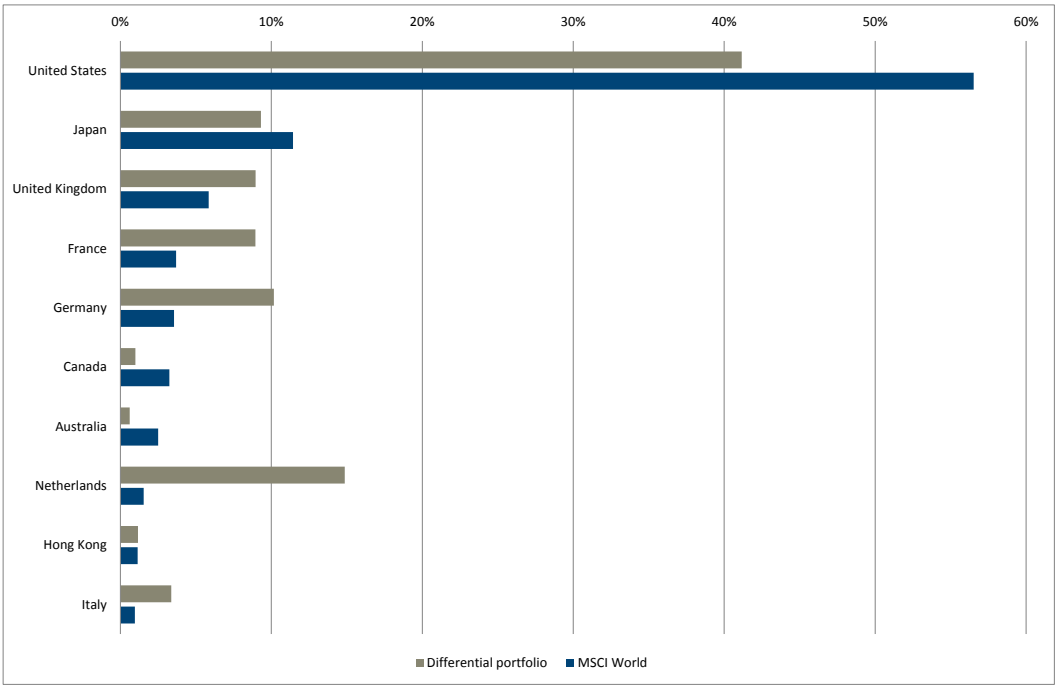


Note: Sector classification based on GICS sectors. The figures are calculated based on asset value as of 31.10.2017.

The Top 10 country distribution of assets of the high-carbon portfolio and the MSCI World is shown in **Figure 8**. The high-carbon portfolio has assets allocated

exclusively in the United States, the Netherlands, Germany, Japan, United Kingdom, France, Italy, Hong Kong, Canada and Australia.[27] The top 3 countries are United States with 41% of asset value, the Netherlands with 15% and Germany with 10% asset value in the portfolio.

Figure 8: Top 10 Country Distribution of the High-carbon Portfolio vs. MSCI World



Note: Top 10 countries account for 100% weight in the high-carbon portfolio and 90% weight in the MSCI World. The figures are calculated based on asset value as of 31.10.2017.

The value and growth measures are shown in **Table 9**.

Table 9: Value & Growth Measures of the High-carbon Portfolio

	High-carbon Portfolio	MSCI World	Difference
Price / Earnings	16.55	34.94	-18.39
Price / Book	1.39	2.26	-0.87
Price / Sales	0.79	1.53	-0.74
Price / Cash Flow	7.46	12.03	-4.57
Dividend Yield %	4.16%	2.32%	1.84%
Operating Income Growth% *	88.34%	-12.93%	101.27%
Sales Growth % *	9.08%	5.42%	3.66%
Cash-Flow Growth % *	10.68%	0.40%	10.28%

Note: The price ratios are calculated as last price on 31.10.2017 divided by trailing 12 months' denominator item. Dividend yield and other growth ratios * are calculated based on trailing 12 months. The above measures are aggregated to the portfolio level using the index method. The difference is calculated as the ratio of the 2°C screened minus the ratio of the MSCI World portfolio.

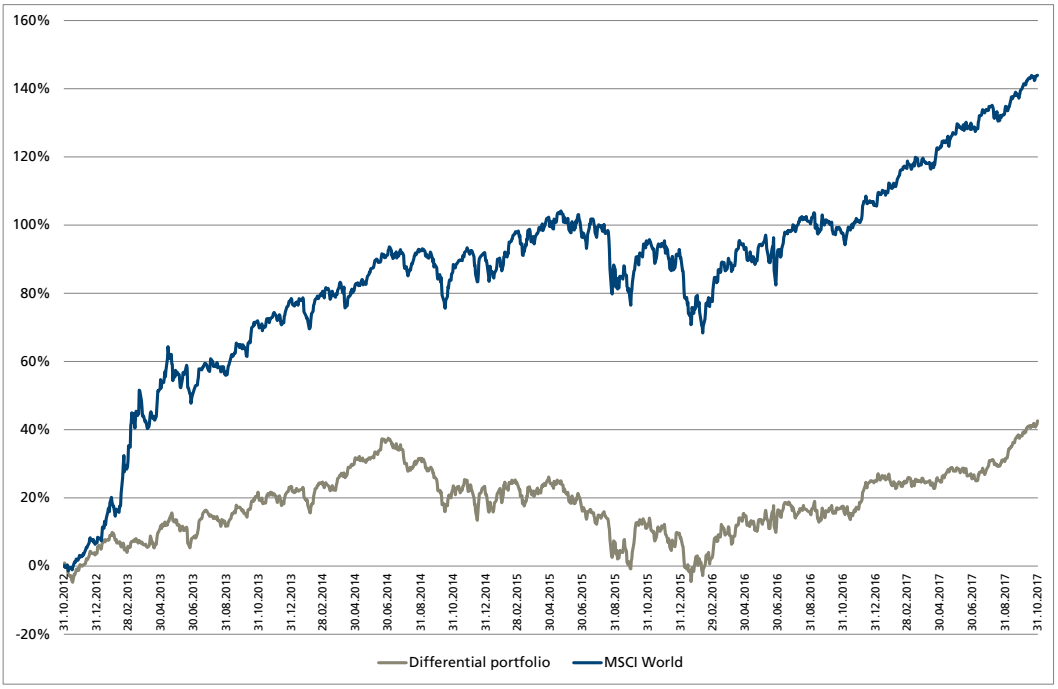
[27] The country list is ranked / ordered from the highest share of asset value to the least share of asset value in the portfolio.

RETURNS

Figure 9 compares the total return (%) of high-carbon portfolio and the benchmark across 5-year period from 31.10.2012 to 31.10.2017. In this analysis, transaction costs are assumed to be zero for the high-carbon portfolio. The performance of the high-carbon portfolio differs largely from the MSCI World portfolio across the period of evaluation. At the end of October 2017, the period end total return is 43% for the high-carbon portfolio, and 144% for the MSCI World portfolio. Thus, the high-carbon portfolio importantly underperforms compared to the benchmark.

Suppose the investor has an initial investment of $10.000 on 31.10.2012 invested in the high-carbon portfolio, the initial investment would have given a total gain of $ 4.300 on 31.10.2017 after holding it across the 5 years' periods. In comparison with the same amount of initial investments invested in the MSCI World portfolio benchmark, the investor could have expected a total gain of $ 14.400.

Figure 9: Total Return (%) of the High-carbon Portfolio



The historical mean returns of the high-carbon portfolio and MSCI World portfolio are compared in **Table 10**. Investment period of medium-term: 1 year, 3 years and 5 years are considered. The high-carbon portfolio would have underperformed the benchmark in all periods.

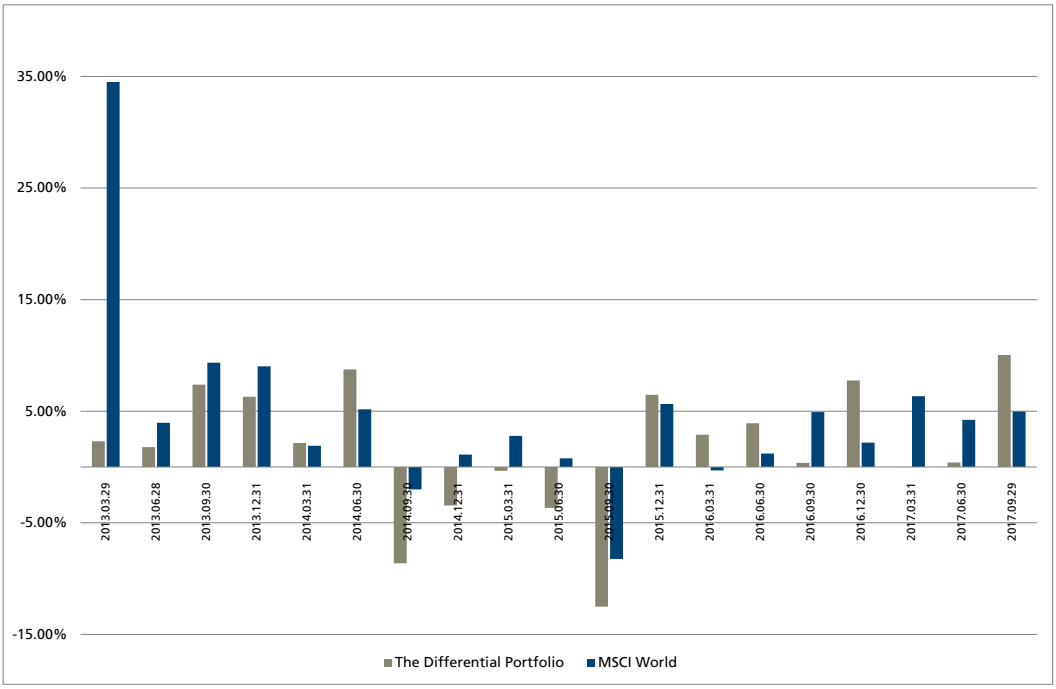
Table 10: Historical Mean Returns (annualized): Medium-term

	1 Year	3 Years	5 Years
High-carbon Portfolio	31.64%	8.57%	11.79%
MSCI World	34.62%	13.83%	29.75%

Note: 1 year (31.10.2016-31.10.2017); 3 years (31.10.2014-31.10.2017); 5 years (31.10.2012-31.10.2017)

The quarterly returns for the high-carbon portfolio and the MSCI World portfolio benchmark are presented in **Figure 10**. The high-carbon portfolio would have outperformed the benchmark in 7 out of 19 quarters. There were 6 quarters in the period of 31.10.2012-31.10.2017 when the returns employing the high-carbon portfolio would have been negative. The strongest outperformance in the back-test period would have been the 4th Quarter of 2016.

Figure 10: Quarterly Total Returns Chart of the High-carbon Portfolio



Note: The x-axis refers to the closing date of the quarterly period, e.g. 2013.03.29 refers to the 1st Quarter of 2013.

RISKS

The risks associated with the high-carbon portfolio compared with the MSCI World portfolio benchmark are presented in **Table 11**. The annualized standard deviation based on the daily returns in the assessed back-test period for the high-carbon portfolio is about 76 basis points higher than the benchmark. The

skewness of the high-carbon portfolio is -0.53, a left skewness above noticeable skewness threshold.[28]

The beta of the high-carbon portfolio is 0.76, indicating that the returns using the strategy have a relatively high correlation with the benchmark returns. Given a beta of 0.76, it means that the high-carbon portfolio returns on average increase or decrease by 0.76% for each 1% increase or decrease in the MSCI World portfolio benchmark.

Table 11: Deviation, Skewness, and Beta in the Period 31.10.2012-31.10.2017

	Standard Deviation (annualized)	Skewness	Beta (ex-post)
High-carbon Portfolio	13.20%	-0.53	0.76
MSCI World	12.44%	-0.01	1.00

The downside risks of the high-carbon portfolio and the MSCI World portfolio benchmark in the period 31.10.2012-31.10.2017 are compared in **Table 12**. The high-carbon portfolio would have generated 25 compared with 17 negative returns in months. The mean return in negative months would have been 15 basis points more negative than the MSCI World portfolio benchmark.

The annualized downside risk of the high-carbon portfolio is 92 basis points higher than the benchmark.

Table 12: Downside Risks in the Period 31.10.2012-31.10.2017

	Number of Negative Months	Mean Negative Return	Downside Risk (annualized)
High-carbon Portfolio	25	-2.62%	9.72%
MSCI World	17	-2.47%	8.80%

Note: 60 months in total.

RISK-ADJUSTED RETURNS

Table 13 compares the risk-adjusted returns of the high-carbon portfolio and the MSCI World portfolio benchmark. Observing the Sharpe ratios, the high-carbon portfolio is shown to have underperformed the MSCI World portfolio benchmark in the 1 year, 3 years and 5 years' periods. When using the Jensen's Alpha to

[28] Skewness describes the degree of asymmetry of the distribution of the daily return in a given period. A skewness value larger than 0.2 is used as a rule of thumb for noticeable skewness. See more in Hildebrand, K. D., 1986. Statistical thinking for behavioural scientists, s.l.: Brooks/Cole.

account for risk-adjusted returns, the high-carbon portfolio has positive Jensen's alphas in the 1-year period and negative alphas in the 3 years and 5 years' periods. Adjusting for the tracking error risk[29], the information ratios of the high-carbon portfolio are negative in all periods.[30]

Taking the above ratios into consideration, the risk-adjusted returns generated by the high-carbon portfolio is not favourable in any of the back-testing periods compared to the MSCI World portfolio benchmark.

Table 13: Risk-Adjusted Returns of the High-carbon Portfolio

	Sharpe Ratio (high-carbon portfolio)	Sharpe Ratio (benchmark)	Jensen Alpha	Information Ratio
1 Year	2.4	3.63	0.64	-0.24
3 Years	0.39	0.82	-4.46	-0.41
5 Years	0.61	1.63	-7.27	-1.04

Note: 1 year (31.10.2016-31.10.2017); 3 years (31.10.2014-31.10.2017); 5 years (31.10.2012-31.10.2017)

SUMMARY

The high-carbon portfolio would have generated an annualized mean return of 11.79% while the MSCI World portfolio benchmark would have generated an annualized mean return of 29.74% in the period 31.10.2012-31.10.2017.[31] The high-carbon portfolio has higher risks (76 basis points more in standard deviation and 92 basis points more in downside risk) than the MSCI World portfolio benchmark. The risk-adjusted returns that would have generated by the high-carbon portfolio are less favourable in all time frameworks in comparison to the benchmark in the back-testing period.[32]

These findings are consistent with analysis results comparing the 2 °C screened portfolio and the benchmark as well as with the previous assumption that assets that are more vulnerable in terms of climate risk have also unfavourable risk / return profiles for investors.

[29] Tracking error risk refers to the standard deviation of the active returns, which are the return difference between the portfolio and the benchmark.
[30] A rule of thumb suggests that information ratio higher than 0.5 is considered to be good. See more in Goodwin, T. H., 1998. The information ratio. Financial Analysts Journal, 54(4), pp. 34-43.
[31] Comparing total return% in the period 31.10.2012-31.10.2017, it is 43% (differential portfolio) to 144% (benchmark).
[32] Note: no transaction costs are assumed for the 2 °C screened portfolio or the differential portfolio; it is important to note that the back-testing results in this report only reflect the performance between 31.10.2012 and 31.10.2017.

4. CONCLUSION AND OUTLOOK

Portfolio performance has two aspects, namely the portfolio manager's ability to increase portfolio return via future security price prediction, and the portfolio manager's ability to minimize the insurable risk born by the portfolio holders.[33] In this report, we neglect the first aspect and solely investigate how the risk / return profile of a portfolio changes if it is consistent with a 2 °C scenario in one particular way.[34]

Consistent with prior research on similar topics [35] that analysed green or environmental friendly portfolios, the results of this report reveal basically two major findings. First, a portfolio example which is more consistent with a 2 °C pathway has a similar risk / return profile as the conventional benchmark. It is even indicated that the portfolio slightly outperforms the benchmark while showing nearly identical values across different risk indicators.[36] As a consequence, there is hope that 2 °C compatible or green investments would become mainstream investment practices. Results indicate that such investments are not necessarily riskier or less profitable as frequently proclaimed in public.

Second, industries extremely vulnerable to a 2 °C transition already today underperform the conventional benchmark. Further research is required to verify to what extent this underperformance is related to the material environmental risk associated to these assets. Accordingly, the part of the portfolio in the original portfolio that has been selected out in the screening process (which is particularly

[33] Jensen, M. C., 1968. The performance of mutual funds in the period 1945–1964. The Journal of finance, 23(2), pp. 389-416.

[34] Namely by selection based on the methodology detailed in Annex 2

[35] There is currently no other comparable literature that compares the performance of 2 °C compatible portfolios with conventional benchmarks because constructing 2 °C compatible portfolios is a relatively new trend. Nevertheless, we found some literature on the similar topics: Cohen, Fenn & Konar (1997) finds either no penalty for green portfolio or a positive return from investing in green. A study by Climent & Soriano (2011) focuses exclusively on the performance of environmental funds. In their study, a matched-pair analysis with Carhart (1997) four-factor model shows that environmental funds underperformed conventional funds in the period 1987-2009, but then the environmental funds caught up and achieved adjusted returns not different from the conventional mutual funds in 2001-2009. Sources: Cohen, M. A., Fenn, S. A. & Konar, S., 1997. Environmental and Financial performance: are they related, mimeo, s.l.: s.n. Climent, F. & Pilar, S., 2011. Green and good? The investment performance of US environmental mutual funds. Journal of Business Ethics, pp. 275-287. And Carhart, M. M., 1997. On persistence in mutual fund performance. The Journal of finance, 52(1), pp. 57-82.

[36] The results could be further contextualized in the general literature on divestment. According to Ritchie & Dowlatabadi (2015), there may be substantial investment risks in investing in conventional energy companies subject to changes in climate policies and market conditions. This is an important economic argument for divestment. Among others, index data providers such as MSCI, FTSE, and S&P Global offer fossil fuel free indexes to benchmark the performance of companies that do not have fossil fuel reserves in the respective investment universe. Source: Ritchie, J. & Dowlatabadi, H., 2015. Fossil Fuel Divestment: Reviewing Arguments, Implications & Policy Opportunities, s.l.: University of British Columbia.

incompatible with a 2 °C target) does not perform better than the benchmark; in fact it performs worse in our example. Further research could look into the sub-sectors within the high-carbon portfolio (power, fossil fuel and automobile sectors). In particular, there might be various factors driving the performance such as the oil price. Oil price shocks should explain about 6% of the volatilities in the stock returns.[37] However, the interaction between oil price fluctuations and stock market is complex. Sectorial differences responding to the oil price fluctuations exist. The sector stock indices respond to the changes in oil prices with temporary heterogeneities but the heterogeneities do not persist across time.[38] The relationship between oil price fluctuation and the mid- to long-term stock performance of high carbon sectors could be further studied to gain more insights in the driving factors in the high-carbon portfolio performance.

As with all empirical studies, the analysis presented in this report is subject to a number of limitations. We analysed a stylized 2 °C portfolio which is constructed based on selection only. Looking forward, future work could focus on the risk and return characteristics of various stylized 2 °C portfolios. 2 °C portfolios are not unique and there are different portfolio construction methods that could align portfolios with a 2 °C transition pathway by sector. Complete divestment may not be realisable for all investors. Given the different needs of various types of investors, it is of value to construct and test 2 °C portfolios that have a mixture of screened rules and reweighting and match different stylized 2 °C portfolios with investor types.[39]

Furthermore, this research was limited to the use of the standard Bloomberg Risk & Portfolio Analytics tool in order to produce a piece of applied science. The application of different analytical tools commonly used in academic research could be considered to refine the results. One major challenge was signified by the unavailability of an environmental risk factor within Bloomberg terminal tool that would allow us to also compare the individual risk factors to each other.

[37] Park, J. & Ratti, R. A., 2008. Oil price shocks and stock markets in the US and 13 European countries. Energy economics, 30(5), pp. 2587-2608.
[38] Huang, S., An, H., Huang, X. & Wang, Y., 2017. Do all sectors respond to oil price shocks simultaneously?. Applied Energy.
[39] With regard to constructing stylized 2 °C portfolios, it could be achieved via 100% screened, via 100% reweighting, and via mixed approach (e.g. α% via reweighting and 1-α% via screened).

This report examined just one portfolio that claims to be more consistent with a long-term sustainable path (namely the 2 °C screened portfolio). There are many different ways to construct such a more consistent portfolio. For example, one could use not only avoiding investment in high carbon assets, but also selecting firms which are expected to benefit from a 2 °C compatible pathway. This report does not claim that all of the 2 °C compatible portfolios come at insignificant extra cost or risk. What it does suggest, however, is that there is a way to substantially improve the 2 °C compatibility of the benchmark at insignificant (or in fact negative) costs in terms of risk and return.

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Annex 1: Climate Impact of the 2°C Portfolio

The 2 °C screened portfolio is sectorial compatible with a 2 °C pathway indicated by the IEA roadmaps.[40] More concretely, it means that the sectorial production in the portfolio matches that of the 2 °C compatible sectorial production (consistent). This section illustrates the methodology behind exposure and consistency calculation by sub-sectors in the investment portfolios. In addition, an aggregate climate impact indicator is developed to approximately measure the climate impact differences between the 2 °C screened portfolio and the MSCI World portfolio.

Box i shows the mathematical formulation on the 2 °C portfolio exposure and consistency calculation.

Box i: 2 °C Portfolio Exposure and Consistency Calculation

2 °C PORTFOLIO EXPOSURE CALCULATION

The main assumptions of the 2 °C portfolio exposure calculation are 1) Fair share approach: the economic entity is responsible for the percentage of the market share it has in the build-out/retirement of green/brown productions. 2) Starting point of the benchmark is adjusted to the current market mix to correct the laggard in the listed equity market.

$$\text{Exposure (in \%)} = \frac{P_{\text{Portfolio}} - P_{2°C-\text{Consistent}}}{P_{2°C-\text{Consistent}}}$$

$P_{\text{Portfolio}} =$ Production of the portfolio

$P_{2°C-\text{Consistent}} =$ Production needed under a 2°C transition[41]

2 °C PORTFOLIO CONSISTENCY CALCULATION

The 2°C portfolio consistency is equal to a technology exposure of 0%. The consistency is thus calculated as follows where high-carbon and carbon-

[40] The exception is the automobile sector (sub-sector hybrid, electric and ICE) where under the restriction of owning 2% as maximum in the screened rule, it is not possible to bring the consistency to 100% for each sub-sector.

intensive technologies need to be treated separately:

$$\text{For low} - \text{carbon technologies: } Alignment = Exposure + 1$$

$$\text{For carbon} - \text{intensive technologies: } Alignment = 1 - Exposure$$

High-carbon technologies include renewables, hydro, nuclear in the power sector, hybrid and electric autos in the automotive sector. Carbon intensive technologies include gas, coal in the power sector, Internal Combustion Engine (ICE) in the automotive sector, and coal, gas, oil production in the fossil fuel sector.

Table i: Technology Share and Consistency to a 2 °C Pathway by Sub-sector

Sector	Sub-sector	Tech Share (1)	Consistency (1)	Tech Share (2)	Consistency (2)	Consistency Difference
Utility Power	Renewables	18%	107.80%	11.5%	67.20%	40.60%
	Hydro	16%	145.10%	11.5%	100.90%	44.20%
	Nuclear	10%	113.00%	10.2%	117.50%	-4.50%
	Gas	38%	101.00%	42.0%	93.60%	7.40%
	Coal	17%	121.10%	24.7%	91.20%	29.90%
Auto	Electric	1%	52.70%*	0.4%	22.80%	29.90%
	Hybrid	13%	90.70%*	4.5%	31.20%	59.50%
	ICE	86%	95.80%*	95.1%	80.70%	15.10%
Fossil Fuels	Gas Production	40%	127.20%	43%	73.50%	53.70%
	Oil Production	42%	127.10%	47%	69.00%	58.10%
	Coal Production	18%	142.80%	10%	140.70%	2.10%

Source: Data provided by 2 Degree Investing Initiative. "(1)" refers to the 2 °C screened portfolio and "(2)" refers to the MSCI World portfolio. * Exceptions in the automobile sector under the restriction of owning 2% as maximum in the screened rule. High-carbon technologies are marked green and carbon intensive technologies are marked grey.

Consistency value < 100 % means under-consistency (the portfolio is not consistent with the 2 °C climate target in the sector). Consistency value ≥ 100% means the portfolio is consistent with the 2 °C climate target in this sector (100 % means exact consistency and >100% implies over-consistency).

Table i above shows the technology share and consistency to a 2 °C pathway by sub-sector. The environmental impacts difference between the 2 °C screened portfolio and the MSCI World portfolio by sector is calculated with the formula:

[41] Using the IEA 450S scenario and the current market production mix/intensity scaled to the portfolio size.

$\Delta_{Alignment} = Alignment_{Screening} - Alignment_{MSCI}$. [42] The column "consistency difference" shows that in the large majority of the sub-sectors, the 2 °C screened portfolio is more consistent with the 2°C climate target than the MSCI World portfolio. For example, the 2 °C screened portfolio is 59.5% more consistent with the 2°C climate target in the hybrid automobiles.[43] And it is 58.1% more consistent with the 2°C climate target in the oil production than the MSCI World portfolio.

An aggregate climate impact indicator for each portfolio can be calculated using a weighted technology share approach. The sub-sectors within a sector have the same unit count, which makes it possible to use production data to calculate the technology share of each sub-sector within the sector.[44] For example, in the utility power sector there are five sub-sectors: renewables, hydro, nuclear, gas and coal, whose production has the unit, kilowatt hour (kWh). The technology share data for both portfolios are shown in **Table i** columns "Tech Share (1)" and "Tech Share (2)". The consistency to a 2 °C pathway by sub-sector for both portfolios are calculated based on the methodology illustrated in **Box i** and displayed in the columns "Consistency (1)" and "Consistency (2)" in **Table i**. Using the technology share as weight, the sector weighted average of consistency is calculated by $\sum Technology\ share_i \times Alignment_i$ where i refers to the sub-sectors within a specific sector.

The weighted consistency by sector results for both portfolios is presented in the columns "Wght Sector Consistency (1)" and "Wght Sector Consistency (2)" in **Table ii.** The market capitalisation share of the sectors in the portfolios is given in the columns "Market Cap Share (1)" and "Market Cap Share (2)". Using the market capitalisation share as weight, the aggregate weighted average of consistency is calculated for each portfolio by $\sum Wght\ sector\ alignment_j \times Market\ cap\ share_j$, where j refers to the sectors within a portfolio.[45]

The results are presented in the columns "Wght Port Consistency (1)" and "Wght Port Consistency (2)" in **Table ii**. It shows that the 2 °C screened portfolio has an aggregate weighted average indicator of 121.8% while the MSCI World portfolio

[42] We thank Klaus Hagedorn from the 2 Degree Investing Initiative for his valuable ideas in the climate impact measurement calculation, and his inputs in the 2 °C exposure and consistency calculation.
[43] Note that the hybrid automobiles in the 2 °C screened portfolio have 90.7% alignment, which is < 100%. This is an exception in the screened rule.
[44] Note that the calculation needs to be done separately for the 2 °C screened portfolio and the MSCI World portfolio.
[45] Note that the calculation needs to be done separately for the 2 °C screened portfolio and the MSCI World portfolio.

has 82.4%. It can be interpreted as follows: the 2 °C screened portfolio is about 21.8% above the consistency benchmark of a 2 °C pathway. And the MSCI World portfolio is about 17.6% below the consistency benchmark of a 2 °C pathway. In sum, the 2 °C screened portfolio is about 39.3% more consistent than the MSCI World portfolio in comparison.

Table ii: Weighted Sector Consistency and Market Cap by Sector

Sector	Sub-sector	Unit	Wght Sector Align-ment (1)	Market Cap Share (1)	Wght Port Align-ment (1)	Wght Sector Align-ment (2)	Market Cap Share (2)	Wght Port Align-ment (2)
Utility Power	Renewables	kWh	114.17 %	26.09%	121.8%	93.26%	27.80%	82.4%
	Hydro							
	Nuclear							
	Gas							
	Coal							
Auto	Electric	No. of cars	94.70%	11.59%		78.24%	16.70%	
	Hybrid							
	ICE							
Fossil Fuels	Gas Production	Joule	129.97 %	62.32%		78.24%	55.60%	
	Oil Production							
	Coal Production							

Source: Data provided by 2 Degree Investing Initiative. "(1)" refers to the 2 °C screened portfolio and "(2)" refers to the MSCI World portfolio. "Wght" stands for weighted.

Annex 2: Methodology

PORTFOLIO CONSTRUCTION

The 2° screened portfolio is constructed by the 2° Investing Initiative. The MSCI World portfolio is formed based on constituents obtained in December 2015 where the free-float shares out from Bloomberg are used for each constituent in MSCI World without rebalancing.[46] Based on the 2° screened portfolio and the MSCI World portfolio, the high-carbon portfolio is built, which consists of the stocks in the MSCI world portfolio but not in the screened portfolio. The goal of the report is to analyse and compare the characteristics and risk-adjusted performance of the 2° screened portfolio vs. MSCI World portfolio, and the high-carbon portfolio vs. MSCI World portfolio.

THE 2° SCREENED PORTFOLIO

In the portfolio construction process, a set of rules is defined. These are exclusion strategies, in which certain companies in the fossil fuel, power and automobile sectors are excluded from the MSCI World portfolio to generate the 2° screened portfolio. The climate implication of the 2° screened portfolio is that it is a portfolio which is sectorial more compatible to a 2 degree transition pathway.[47]

Ranking criteria to screen companies that are not consistent with climate goals are defined. For each sector, there is a specified ranking criterion. **Table iii** presents a summary on ranking criterion and screened results.

Table iii : Screened Rules in the 2° Screened Portfolio

Sector	Ranking Criterion	Exclusion Results
Fossil fuel sector	fossil fuel additions = $\sum_{Oil,Gas} Production_{2020}$ (J)- $\sum_{Oil,Gas} Production_{2015}$ (J) where J is the company constituent in the MSCI world	Excluding the Top 5 companies with higher fossil fuel additions
Power sector	$TechShare_{Brown}$ =	Excluding the Top 25 utilities with highest brown tech share

[46] This portfolio differs from the MSCI World index whose constituents are adjusted periodically. We thank 2 Degree Investing Initiative for providing the MSCI constituents of December 2015.
[47] The automobile sector will be an exception. Under the restriction of owning maximum about 2% of companies, while still holding a significant percentage of the portfolio in car manufacturers, it is not possible to reach 100% alignment in the automotive sector.

	$\frac{\text{Capacity}_{2020}^{\text{Coal}} + \text{Capacity}_{2020}^{\text{Gas}}}{\text{Capacity}_{2020}^{\text{RE}} + \text{Capacity}_{2020}^{\text{Hydro}}}$	
Automobile sector	$\text{Best in Class Hybrid Cars} = \frac{\text{Production}_{2020}^{\text{Hybrid}}}{\sum_{\text{Technology}} \text{Production}_{2020}^{\text{Technology}}}$ $\text{Bet in Class Electric Cars} = \frac{\text{Production}_{2020}^{\text{Hybrid}}}{\sum_{\text{Technology}} \text{Production}_{2020}^{\text{Technology}}}$	Keeping best in class automobile companies in terms of hybrid and electric cars

Source: 2 Degree Investing Initiative

Companies that are not compatible with the climate goals by definition of the criteria in **Table iii** are excluded. At the same time, the portfolio's consistency to a 2 degree trajectory is monitored by sector.[48] The value weight of the sector allocation is kept as close to MSCI world as possible.[49]

THE HIGH-CARBON PORTFOLIO

The high-carbon portfolio consists of the fossil fuel, power and automobile sector stocks that are screened out of the MSCI World portfolio for the construction of the 2° screened portfolio. The difference of stock composition between the MSCI World portfolio and the 2° screened portfolio is identified. The list of the 54 stocks identified is shown below in **Table iv**. The stock position in the high-carbon portfolio (in terms of number of shares) is taken directly from the allocated portfolio weight in the MSCI World portfolio.

Table iv: Composition of the High-carbon Portfolio

Sector	Stock Tickers	Summary
Fossil Fuel	CHEVRON CORP	• 5 fossil fuel companies • 6 fossil fuel company stocks
	ROYAL DUTCH SHELL A *	
	ROYAL DUTCH SHELL B *	
	BP	
	ENI	
	TOTAL	
Power	AES CORP	• 25 power companies • 25 power company stocks
	ALLIANT ENERGY CORP	
	AMERICAN ELECTRIC POWER	
	ATCO I	
	CALPINE CORP	
	CANADIAN UTILITIES A	

[48] There might be digits differences so "close to" or "meet" the 2° target.
[49] This result is based on the previous work by the 2 Degree Investing Initiative. It is possible for the fossil fuel and the power sectors, but not really possible for the automobile sector.

	CHUBU ELECTRIC POWER CO	
	CLP HOLDINGS	
	DTE ENERGY	
	DUKE ENERGY CORP	
	ENDESA	
	ENTERGY CORP	
	EVERSOURCE ENERGY	
	FIRSTENERGY CORP	
	FORTIS	
	NRG ENERGY	
	ORIGIN ENERGY	
	PINNACLE WEST CAPITAL	
	PPL CORP	
	PUBLIC SERVICE ENT GRP	
	SCANA CORP	
	SOUTHERN COMPANY (THE)	
	TOHOKU ELECTRIC POWER CO	
	WEC ENERGY GROUP	
	XCEL ENERGY	
Automotive	BMW STAMM *	• 21 automotive companies • 23 automotive company stocks
	BMW VORZUG *	
	CNH INDUSTRIAL	
	DAIHATSU MOTOR CO	
	DAIMLER	
	FERRARI (IT)	
	FIAT CHRYSLER AUTOMOBILE	
	FORD MOTOR CO	
	FUJI HEAVY INDUSTRIES	
	GENERAL MOTORS	
	HARLEY-DAVIDSON	
	HONDA MOTOR CO	
	ISUZU MOTORS	
	MAZDA MOTOR CORP	
	MITSUBISHI MOTORS CORP	
	NISSAN MOTOR CO	
	PEUGEOT SA	
	PORSCHE AUTOMOBIL VZG	
	RENAULT	
	SUZUKI MOTOR CORP	
	VOLKSWAGEN STAMM *	
	VOLKSWAGEN VORZUG *	
	YAMAHA MOTOR CO	

Note: *Some companies have more than one type of stocks

Annex 3: PORTFOLIO ANALYSIS TOOL

The portfolio analysis in this report is conducted in the Bloomberg Portfolio & Risk Analytics tool.[50] It is a tool that helps portfolio managers to analyse portfolio's performance, characteristics and market-related as well as security-specific risks compared to a benchmark portfolio. In this report, the portfolios analysed are i) the 2 °C screened portfolio and ii) the high-carbon portfolio against the MSCI World portfolio as benchmark. We compare the performance of the 2 °C screened portfolio and the high-carbon portfolio to the benchmark with respect to the following aspects: i) holdings, ii) characteristics (e.g. dividend yield, price / earnings ratio), iii) tracking error / volatility, and iv) performance. Here we give a brief introduction to each of the aspect.[51]

Holdings: The holdings section provides an overview of the assessed portfolio on its current positions, weights, and allocations across sector and country compared to a selected benchmark.

Characteristics: The characteristics section presents the fundamental characteristics of the assessed portfolio. Measures include dividend yield, price / earnings ratio, debt / equity ratio, etc.

Tracking error / volatility: The tracking error / volatility section analyses the predicted risk of the assessed portfolio with a multi-factor risk model. Tracking error is the annualized volatility of active returns in percentage absolute or relative to a selected benchmark. The analysis can be broken down by factor and by exposure.

Performance: The performance section analyses the historical performance of the assessed portfolio with 1-day return, 1-month return, and Year-to-Date Return. The statistical summary presents risk / return calculations for the assessed portfolio and the benchmark in various periods.

[50] The tool can be accessed in the Bloomberg terminal via PORT <GO>. In the portfolio uploading phase, the portfolio data are cleaned and in particular, outdated Bloomberg tickers are updated.
[51] The descriptions are adapted from Bloomberg manual on using the Portfolio Risks & Analytics tool.

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