Index Insights | Sustainable Investment

Decarbonisation in equity benchmarks

Tracking the portfolio carbon transition

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Foreword

This report analyses decarbonisation trends within the FTSE All-World index as a 'reference portfolio'. The UN-Convened Net-Zero Asset Owner Alliance ("the Alliance") welcomes the valuable insights presented in the second edition of the annual series, prepared by LSEG in collaboration with the Monitoring, Reporting and Verification Track of the Alliance.

This year's report explores new areas of carbon exposure analysis—including Scope 3 emissions and product-specific intensities—and emphasises that it's critical to look beyond the headline portfolio data into the underlying drivers of portfolio decarbonisation.

It shows that reported emissions, based on a constant investment universe, remain relatively stable over time. When normalisation factors such as revenues or enterprise value are factored in, it becomes evident that the growth of companies over the last seven years has occurred with emissions from these companies staying roughly constant on a global level. This, however, indicates a split between normalised and absolute emissions; it also highlights that the efforts to lower absolute global emissions were not as successful as required by the IPCC 1.5°C SR scenarios.

A central finding in this year's report is the significant gap in decarbonisation rates between leading and lagging companies, as well as the asynchronous pace of decarbonisation between developing and emerging markets. The Alliance recognises the importance of these challenges and stands committed to addressing them in its own work.

The report also demonstrates that product-specific intensities allow better comparability of companies within a given sector and relate to real-world decarbonisation. For asset owners, these insights underscore the importance of using product-specific intensities to set sector targets, as they allow to address blind spots of finance-related intensity metrics.

The report also shows that corporates reporting their emissions data comprehensively is critical, since unreported data create challenges for asset owners to effectively manage their investment portfolios' contribution towards real-world emissions reductions. This finding underscores the urgent need for heightened reporting efforts; therefore, the Alliance reiterated its call to all corporates to strengthen emissions data disclosure across all three scopes and to set absolute emission targets.

Lastly, the report aptly demonstrates the need for transparent and robust attribution analysis to clearly identify decarbonisation levers in portfolios. This is also critical to maintain customers' trust and mitigate the risk of greenwashing.

The Alliance believes this report can serve as a valuable resource for investors that are monitoring the progress of their decarbonisation efforts while considering developments in the wider public equity investment universe.

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Executive summary

Faced with intensifying climate risk, there is a growing focus on tracking portfolio emissions exposure. Investors are also increasingly setting portfolio level emissions targets and reporting annually on their progress against these targets – often using best practice frameworks such as those suggested by the Net Zero Asset Managers Initiative, or the UN-convened Net-Zero Asset Owners Alliance, with whom we are partnering on this report.[1]

However, challenges abound. Despite extensive research efforts and a plethora of proposed metrics, a consensus has yet to develop among experts and practitioners around the best approach to assessing portfolio carbon exposure. Input data remains patchy and tricky to compare across the investable universe, particularly for Scope 3 and production-based metrics. Meanwhile, each metric is subject to idiosyncratic volatility, driven not only by changing emissions profiles, but also by shifts in index composition, macroeconomic volatility, and estimation methods.

This paper – the second in an annual series – analyses carbon exposure trends and measurement techniques using the FTSE All-World Index as the reference benchmark, an index of over 4,000 large and mid-cap firms in developed and emerging economies, covering over 90% of market capitalisation of listed equities globally. We highlight that portfolio emissions results require careful interpretation and recommend that investors:

- Rely on a dashboard of portfolio emissions metrics instead of a single measure to avoid idiosyncratic biases
- Focus on multiyear trends rather than year-on-year fluctuations given the volatility of most portfolio emissions metrics
- Conduct careful attribution analysis for observed changes to identify real world emissions reductions vs portfolio fluctuations.

Our analysis for the FTSE All-World highlights the following key findings:

- **With a rebounding global economy post COVID in 2021, we observe emissions declines moderating, with typical firm-level emission reduction decreasing from 5% to 1%, and a quarter of reporting index constituents increasing emissions by at least 10% in 2021.**

  Chained absolute emissions for disclosing firms increased by 2%, reversing modest reductions in previous years. Similarly, for intensity metrics, we find a 2% and 0% reduction in WACI and Carbon Footprint respectively (vs. 7% annual decline rates for 2016–2020).

- **Year-on-year intensity changes are often dominated by the attribution factor (i.e., weight and normalisation factor) rather than emissions, as emissions are often less volatile than the normalisation metrics used to calculate carbon intensities.**

  A typical firm reporting emissions witnessed a 7% change in emissions during 2016 –2021, with EVIC normalisation factor exhibiting nearly double the volatility. Changes in the attribution factor drove 10% of the observed 13% WACI reduction from 2017 to 2020, with a 15% contribution from changing weights. The following year, the attribution factor yields a 7% WACI reduction, almost entirely explained by increasing revenues.

- **Our attribution analysis shows that dynamics in high carbon sectors drive portfolio intensity.**

  Reductions in constituent weights in high carbon industries (Energy, Utilities, Basic Materials, and Industrials) account for 64% of the WACI reduction between 2016 and 2021. In 2021, increasing revenues from commodity-driven sectors of Energy and Basic Materials delivered c. 6% reduction in aggregate portfolio intensity, more than compensating for all emissions increases from all industries combined.

[1] NZAOA recommends a target of 22-32% CO_2e reduction by 2025. See UN-convened Net-Zero Asset Owners Alliance, 'Target Setting Protocol', IIGCC, 'Net Zero Investment Framework'. Net Zero Asset Managers Alliance, 'Our Commitment'

– **Scope 3 emissions portfolio metrics need to be interpreted carefully as evolving disclosure practices drive instability in input data.**

  In 2021, one-fifth of reporting firms disclosed more Scope 3 categories than in the previous year, with a quarter of disclosing firms reporting 30% or greater increase in emissions.

– **Sector-specific product intensities (e.g., emissions per tonnes of steel) are now available for a meaningful proportion of portfolio emissions and carry significant comparability advantages.**

  Emissions normalised by a harmonised sector product enable alignment assessments against forward-looking climate scenarios while exhibiting less volatility and greater sector cohesion than monetary-based intensities.

Section 1. Introduction

Against a backdrop of unprecedented climactic events[2] and stubbornly high global emissions,[3] a growing number of investors are looking to align their portfolios with net zero emissions pathways, with many choosing to set ambitious emissions reduction targets for their portfolios.

However, while several useful standards are available (as outlined by TCFD and PCAF, among others), there is no consensus on the best way to track progress against these commitments and compare across portfolios, with investor groups increasingly advocating for a dashboard-approach with a more diverse array of metrics.[4]

Annually disclosed corporate emissions data aligned with the GHG Protocol Corporate Standard[5] is critical in enabling investors to evaluate and track the climate performance of both companies and portfolios. However, their usage is not without challenges. Investors do not yet have consistent access to high-quality carbon reporting for the investible universe, and available disclosures are not always comparable between firms. Finally, a top-line portfolio intensity also depends on other volatile factors, such as revenue and enterprise value.[6]

With many investors and regulators supporting quantitative reduction targets for these derived measures – and holding companies to account for their low-carbon transition plans and use of offsets[7] – this report seeks to help investors understand the trends and nuances underpinning available portfolio metrics.

One year on from our inaugural *Decarbonisation in Equity Benchmarks* paper, we have refreshed our analysis of Scope 1 and 2 carbon emission exposure for global equity markets as represented by the FTSE All-World Index in 2021.[8] This year's report introduces a number of improvements to the investor gauge for portfolio decarbonisation, including:

– An enhanced attribution analysis framework to distinguish real decarbonisation from other factors (index composition, normalisation metric, and estimation methods)

– A discussion of the nuances of alternative carbon metrics – Scope 3 and sector specific product-based intensities – as additions to the investor analytical toolkit.

[2] Hancock, A., Mooney, A. (2023, September 6). World Heat Records "smashed" in northern hemisphere summer, scientists say. Financial Times. https://www.ft.com/content/d8feb379-4427-4b52-94f8-af21b01d7221

[3] IEA (2023), CO_2 Emissions in 2022, IEA, Paris https://www.iea.org/reports/co2-emissions-in-2022, License: CC BY 4.0

[4] See for example IIGCC's paper 'Enhancing the Quality of Net Zero Benchmarks' and the Net Zero Asset Owner Alliance's 'Development and Uptake of Net-Zero-Aligned Benchmarks'.

[5] GHG Protocol, 'Corporate Standard,' accessed 06/05/2022.

[6] Ducoulombier, F. and Liu V. "Carbon Intensity Bumps on the Way to Net Zero." The Journal of Impact and ESG Investing Spring 2021, 1 (3) 59-73; DOI: https://doi.org/10.3905/jesg.2021.1.013

[7] Calel, R., Colmer, J., Dechezleprêtre, A., & Glachant, M. (2021). Do carbon offsets offset carbon? Centre for Climate Change Economics and Policy Working Paper 398/Grantham Research Institute on Climate Change and the Environment Working Paper 371.

[8] See the inaugural *Decarbonisation in Equity Benchmarks* paper. The FTSE All-World Index currently comprises over 4,000 firms from Developed and Emerging markets. See FTSE Global Equity Index Series (GEIS) | FTSE Russell for further details.

Box 1. The comparability gap

The relatively simple methods investors use to calculate carbon exposures hide the complexity behind even the most basic corporate carbon disclosure.[9] Indeed, as investor implementations generally use carbon emissions as a direct proxy for climate performance within a broad industry group, there are several factors that can introduce distortions:[10]

Poor, late, incomplete, incompatible corporate emissions disclosures

Despite significant progress toward disclosure requirements for public entities,[11] companies have significant discretion to set the calculation methodologies and organisational boundaries, often leading to significant reliability concerns.[12] Even without this discretion, small differences between company activity exposures or ownership can cause wide divergences in carbon intensity, not necessarily indicative of overall company climate performance.[13]

Carbon estimations gap due to non-reporters

While disclosure has markedly improved, there are still significant portions of the investible universe for which emissions must be estimated, introducing uncertainty to aggregate measures, particularly among small cap and emerging markets firms.

Non-standardised data treatments applied by investors

Variability is also introduced by methodological decisions regarding data selection, adjustments, and alignment for both emissions data and the metrics used to normalise emissions relative to company size. For instance, historical emissions data can differ depending on the calculation methodologies or whether restatements are accepted for previous financial years. At the same time, not only can normalisation metrics (e.g., revenue or enterprise value) introduce idiosyncratic impacts across sectors and geographies, investors must also decide how to adjust them for inflation, foreign exchange rates, and inconsistent fiscal years across companies.[14]

These issues can create challenges when comparing carbon metrics at the portfolio level.[15] Given these limitations, investors have begun to explore several other metrics and lenses through which to view portfolio decarbonisation,[16] such as:

- Identifying and rewarding realised high-quality reported carbon data, through methods (e.g., the PCAF quality score)[17]
- Considering sector and regional emissions pathways in the investment processes, to properly consider nuances of low-carbon transition for carbon-intensive industries
- Including forward-looking data, such as a company's targets or transition plans[18]

[9] Jia, Jimmy and Ranger, Nicola and Chaudhury, Abrar, Designing For Comparability: A Foundational Principle of Analysis Missing In Carbon Reporting Systems (October 25, 2022). Available at SSRN: https://ssrn.com/abstract=4258460 or http://dx.doi.org/10.2139/ssrn.4258460

[10] Brander, Matthew and Hoepner, Andreas G. F. and Rogelj, Joeri and Saini, Tushar and Schneider, Fabiola, Corporate Carbon Disclosure: A Critical Review (May 1, 2023). Available at SSRN: https://ssrn.com/abstract=4429430 or http://dx.doi.org/10.2139/ssrn.4429430

[11] EFRAG (2023). Interoperability between ESRS and ISSB standards

[12] García Vega, Sergio and Hoepner, Andreas G. F. and Rogelj, Joeri and Schiemann, Frank, Abominable Greenhouse Gas Bookkeeping Casts Serious Doubts on Climate Intentions of Oil and Gas Companies (March 30, 2023). Available at SSRN: https://ssrn.com/abstract=4451926 or http://dx.doi.org/10.2139/ssrn.4451926

[13] Lepere, M., Aikman, D., Dong, Y., Drellias, E., Havaldar, S. D., & Nilsson, M. (2023, Jun 30). Emissions gaming? A gap in the GHG Protocol may be facilitating gaming in accounting of GHG emissions. (No. 1 ed.) King's College London. https://www.kcl.ac.uk/business/assets/pdf/research-papers/kbs-research-impact-paper-1-emissions-gaming.pdf

[14] Ekman C, Hoepner A. G. F., Mannerbjörk P., Morsing T. & Zdanceviciute G. (2023) 'Absolutely sustainable investing across asset classes with Paris-aligned benchmarks: An application to AP2' In Emmanuel Jurczenko (ed.) Climate Investing: New Strategies and Implementation Challenges. 267-293, Hoboken:

[15] Jeffries, E. (2023, October 20). Equities – are Paris-aligned benchmarks a climate gamechanger? IPE.

[16] IIGCC (2022). Enhancing the quality of net zero benchmarks. Asset Owner Alliance (2022) Development and Uptake of Net-Zero Aligned Benchmarks.

[17] PCAF (2022). The Global GHG Accounting and Reporting Standard Part A: Financed Emissions. Second Edition.

[18] Mercer (2022). A landscape overview of transition-oriented climate indexes.

Section 2. Carbon emissions of global equity benchmarks

Despite the complications of corporate carbon emissions data, portfolio and index-level carbon exposure calculations can deliver valuable insights about trends in the underlying constituents and how they relate to those in the market and overall economy.

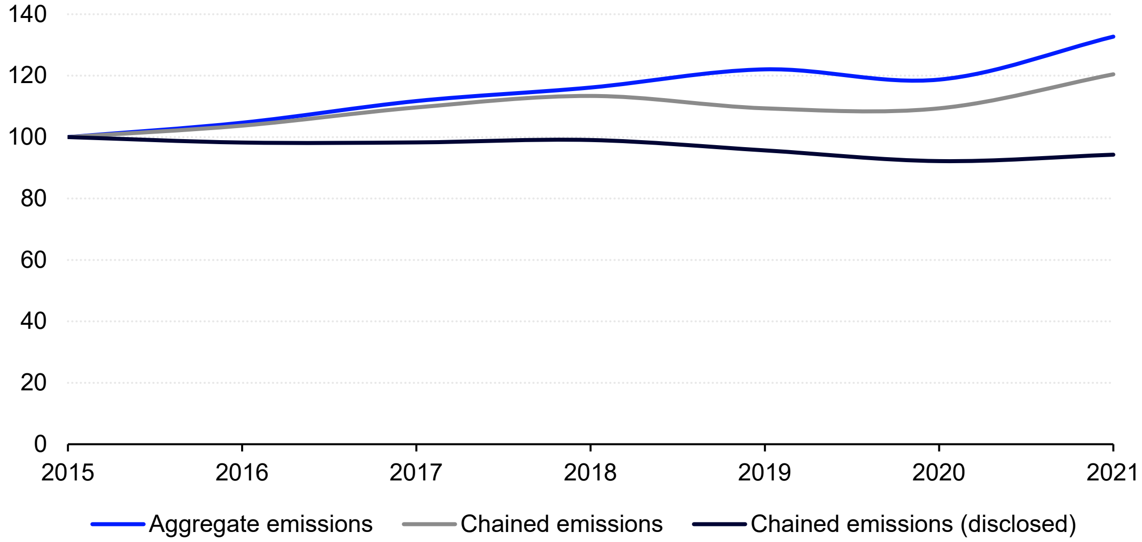
To break down the trends in index decarbonisation, we have refreshed our previous analysis of absolute and intensity-based Scope 1 and 2 emissions metrics to include the 2021 reporting year.[19] Critically, for this year's report, we have also added a discussion on applying these principles for Scope 3, which can often be a substantial portion of a portfolio's emissions profile (see section 4).

Absolute emissions

Absolute emissions are the simplest way to measure a portfolio's carbon exposure. It is calculated by summing all constituent emissions at a given time, assuming 100% of each firm's emissions are attributable to the portfolio.[20]

Figure 1. Absolute emissions trends in global equities

Aggregate and chained absolute emissions, FTSE All-World Index (2015=100)



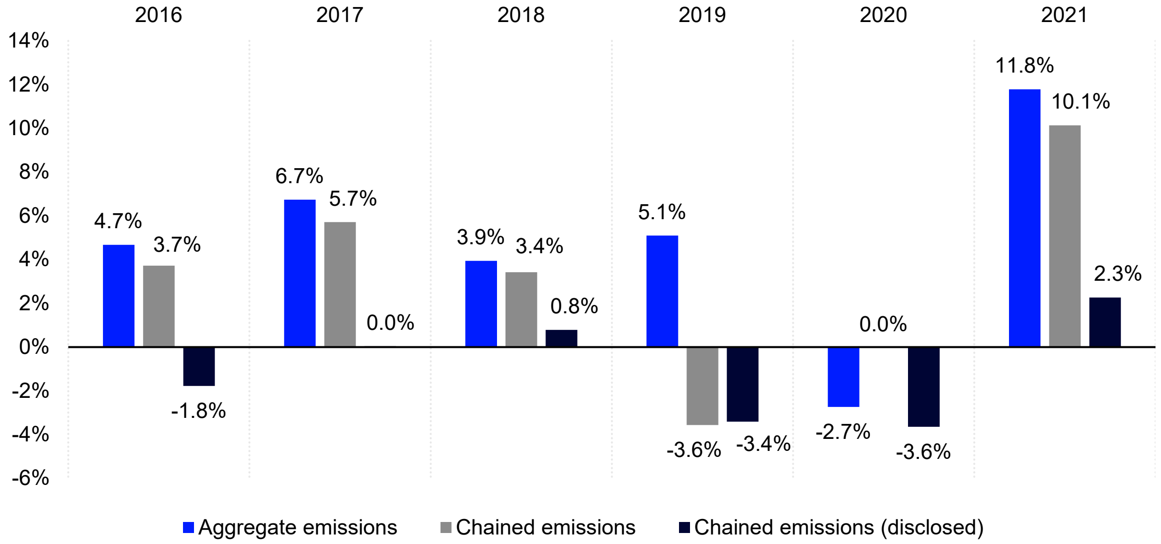
Source: FTSE Russell, September 2023.

[19] Aggregate portfolio metrics are provided until 2021 in line with available carbon data, with only 19% of firms to date reporting FY2022 carbon emissions.

[20] Absolute emissions do not consider relative weight or proportion of ownership for these emissions and therefore are difficult for investors to use, particularly in the context of smaller portfolios, or a high rate of turnover.

Figure 2. Large absolute emissions increase in 2021

Annual change in total and chained absolute emissions



Source: FTSE Russell, September 2023.

We find absolute emissions of the FTSE All-World have gradually increased by c.2% in the last year (see figure 2), when we consider persistent index constituents, which consistently report emissions – a method we refer to as 'chained disclosed emissions.'[21] This method is designed to comparably reflect real-world emissions changes by avoiding distortions associated with universe expansion and estimated emissions.[22] Over the longer run, we see a modest rate of decarbonisation between 2015 and 2021, at around 1% per year for this measure.

Expanding chained emissions to include emissions estimates for companies that have yet to disclose emissions, we observe much higher estimated absolute emissions growth for the FTSE All-World index of c.10% (see figure 2). Total aggregated emissions, which does not adjust for constituent churn and includes estimated emissions, would see an even higher annual increase of 12% to c. 11.9 billion tonnes of CO_2e, significantly outpacing the average annual growth rate of c. 5% between 2015 and 2021.

This illustrates the difficulties of accurately tracking absolute emissions in portfolios with a significant share of non-disclosing companies. A reliance on estimates likely causes an underestimation of emissions reduction, while ignoring non-disclosing firms likely returns an optimistic view of corporate climate performance. A higher rate of emissions increase for the 'non-chained' metric reflects the impact of structural changes to index membership (see box 2), as well as the conservative approach of estimation models, which generally err on the side of overestimation.[23]

[21] We calculate chained emissions as the change in absolute emissions each year for persistent constituents only – i.e., firms that were also in the index prior to a given year. Read more about the intensities/chained emissions and contribution in our previous iteration of the report: Decarbonisation in Equity Benchmarks | FTSE Russell

[22] The greater changes of aggregate emissions for non-disclosing companies are partially explained by the deployment of estimation models that often rely on intensity-based models which, while reliant on disclosure trends, also broadly assume that company emissions are tracking their increasing revenues. This affect can be accentuated by broad commodity inflation which generally will impact higher carbon sectors.

[23]The precautionary principle suggests that additional measures should be taken to avoid the underestimation of emissions for non-reporters. While our in-house carbon models are generally conservative (typically resulting in overestimations before companies begin to report), we have previously observed that application of the precautionary principle can create additional distortions in emissions estimation if not properly implemented. See our blog for more details: Proceed with caution: Challenges in embedding the precautionary principle in Paris-aligned benchmarks | FTSE Russell

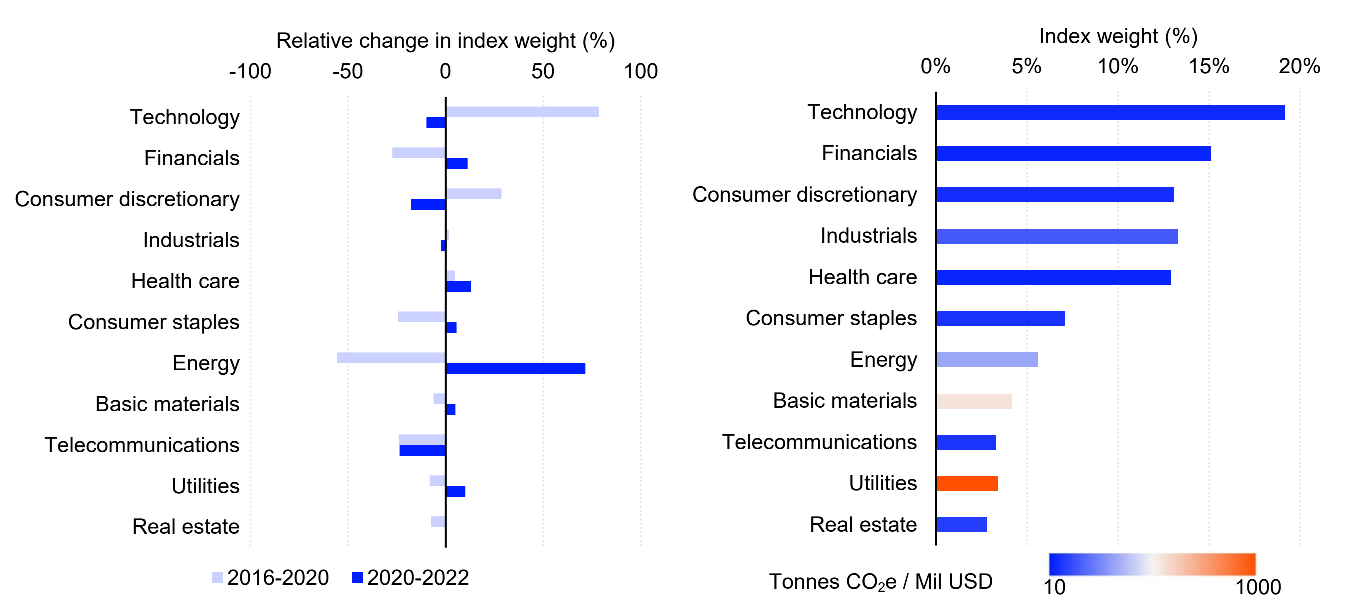
Box 2. Tracking global markets through the FTSE All-World

Global market dynamics can significantly change portfolio carbon exposure, with diverse impacts depending on the metric used. For this paper, we use the FTSE All-World Index as a proxy for global markets, representing over 90% of the world's investible market capitalisation through c.4000 large and mid-cap stocks.[24] Since 2020, global markets have seen significant volatility, not least stemming from the recovery from the COVID pandemic and the invasion of Ukraine.[25] This has led to a number of developments with far reaching impacts for index level carbon metrics:

- Supply constraints led to commodity price volatility across sectors. This can be seen explicitly in the increase in Energy firm inflation-adjusted revenues, which increased by 53% between FY2020 and FY2022, up from a typical increase of 9% from FY2015–2022 of the FTSE All-World.
- Carbon intensive sectors, after absorbing steady declines in weights of the index from 2016–2020, have rebounded significantly between 2020 and 2022, with Energy increasing index weight by 54% in the period.
- Conversely, relatively carbon-light sectors such as Telecommunications, Consumer Discretionary and Technology have reduced their overall index weight significantly between 2020 and 2022 – by 24%, 10%, and 15% respectively.

Figure 3. Rotation reversal into energy likely to drive up portfolio carbon intensity

Industry index weight, level and relative changes, FTSE All-World 2016–2022



Source: FTSE Russell, September 2023.

[24] Over time, constituents are added and removed depending on their size in the equity market, investability of their shares, as well as additional governance constraints. Please see FTSE Russell, FTSE All-World Factsheet as of 31 August 2023.

[25] For more details on the impact of these events on financial markets, see Impacts of the Russian invasion of Ukraine on financial market conditions and resilience : Assessment of global financial markets | OECD iLibrary (oecd-ilibrary.org).capitalisation[26] Even the globally diversified FTSE All-World is not immune to volatility due to changing index constituents. In 2019, for example, the addition of more than 600 China A firms led to an increase of more than 750 million tonnes of carbon (c. 7% of annual aggregate emissions). Looking ahead, we anticipate that the removal of 29 Russian firms in 2022, predominantly in carbon intensive industries, will also lead to a marginal reduction in absolute emissions.

Emissions intensity

For most investors, absolute emissions do not allow easy comparisons over time or against other portfolios due to their sensitivity to portfolio size and its number of constituents.[26] To make comparisons more flexible across diversified portfolios, investors calculate a carbon intensity by normalising emissions relative to a proxy for the size of the emitting entity before aggregating to a weighted average value of the portfolio.

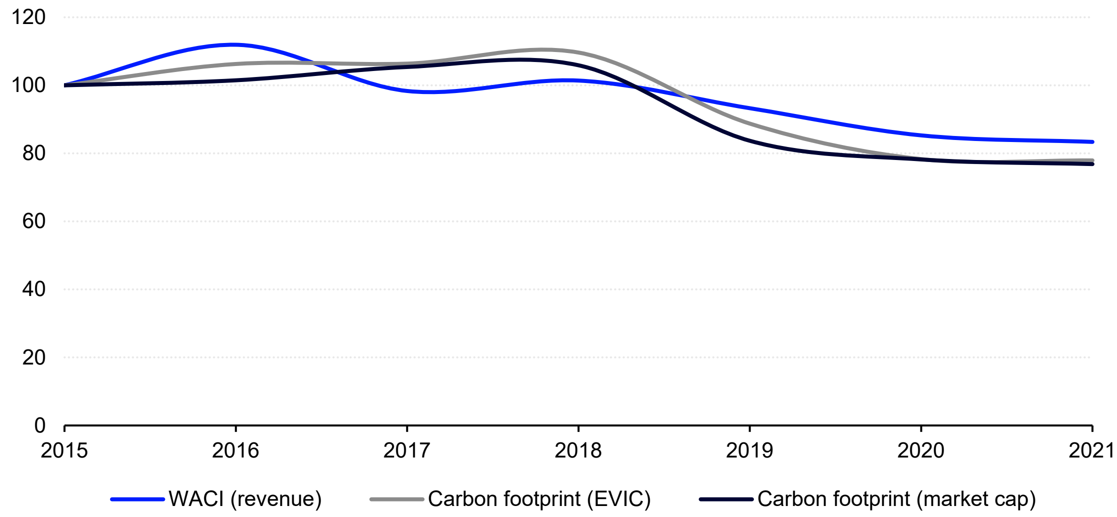
Common normalisation factors are summarised in figure 6, with the methodological differences significantly impacting portfolio-level results. Intensities based on economic output (e.g., revenues) deliver an assessment of how efficiently a company operates relative to the carbon it emits. By contrast, carbon footprint here refers to intensities normalised by assessed value (e.g., enterprise value), which, when multiplied by portfolio weight, approximate the proportion of a firm's emissions that are 'directly owned' or financed by the investor (i.e., the value invested relative to total firm value acts as a proxy for the percentage of firm emissions attributable to the investor).

Building on last year's report, our analysis tracks these established measures of inflation-adjusted carbon intensities in the FTSE All-World[27] – weighted average carbon intensity (WACI) by both revenues and by market value, as approximated here by both EVIC and market capitalisation.[28]

Our survey shows a modest decrease of 2% carbon intensity (WACI – by revenue) for global equities in 2021, with carbon footprint measures holding relatively constant. This is set against the backdrop of relatively consistent reductions in carbon intensity since 2018, decreasing at roughly 3% p.a. over the past six years, from 158 to 132 tonnes per million US$ (see figure 4).[29]

Figure 4. Carbon intensity, three ways

Scope 1 and 2 intensity, FTSE All-World (2015=100)



Source: FTSE Russell, September 2023.

[26] Even the globally diversified FTSE All-World is not immune to volatility due to changing index constituents. In 2019, for example, the addition of more than 600 China A firms led to an increase of more than 750 million tonnes of carbon (c. 7% of annual aggregate emissions). Looking ahead, we anticipate that the removal of 29 Russian firms in 2022, predominantly in carbon intensive industries, will also lead to a marginal reduction in absolute emissions.

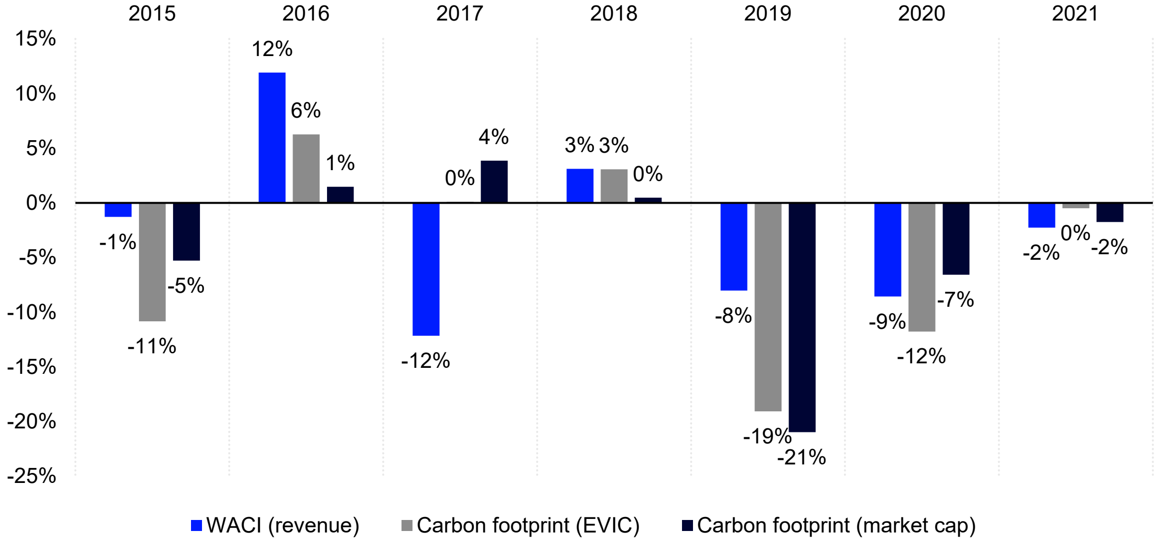
[27] The FTSE All-World Index currently comprises over 4,000 firms from Developed, and Emerging markets. See: https://www.ftserussell.com/products/indices/geisac

[28] The two metrics of assessed value differ in terms of consideration of debt. Normalisation by market capitalisation reflects the proportion of the company owned by the investor, while normalisation by enterprise value considers the proportion of financing (of all types) for which the investor is 'responsible.' Enterprise value has gained wide-spread utilisation due to the ability for investors to calculate carbon exposure equity and fixed income investments according to a common framework. This choice of metric will impact carbon intensity results. For example, all else being equal, a company which is heavily financed by debt will have a greater enterprise value than market capitalisation resulting in a lower investment intensity with the same level of notional investment.

[29] Normalisation metrics (and as a result carbon intensity) have been controlled for inflation by adjusting historical data relative to most recent completed year, 2021. Revenues have been adjusted against the US GDP deflator, while assessed value metrics have been adjusted relative to the average annual value in the index under consideration, in this case the FTSE All-World. Please see the Appendix for more information.

Figure 5. Volatile shifts in index carbon intensity

Annual change in index carbon intensity



Source: FTSE Russell, September 2023.

Figure 6. Intensity normalisation methods

	Name	Normalisation factor	Applicability	Aggregation method	Inflation-adjustment
Economic output	Product intensity	A sector-specific product or KPI (e.g., tonnes of steel)	Can enable more granular analysis across firms, but only applicable for small proportion of high-emitting firms (see section 4)	Sectors cannot be aggregated without significant simplifying assumptions	None required
	Weighted Average Carbon Intensity (WACI)	Revenues	Equity and fixed income	Weighted average	Real value currency adjustment
Assessed value	Carbon footprint (market capitalisation)	Market capitalisation	Equities only	Weighted average	Asset value adjustment
	Carbon footprint (EVIC)	Enterprise value[30]	Equity and fixed income	Weighted average	Asset value adjustment

Across metrics, observed changes often diverge significantly on a year-to-year basis (see figure 5); for example, in 2019, the carbon footprint intensity metrics decreased more than 10 percentage points more than WACI by revenues. Over the longer term, these declines are relatively consistent across intensity metrics, with all three metrics decreasing by 10 to 20% cumulatively between 2015 and 2021 (see figures 4 and 5), while showing similar levels of volatility over that same period, with an average median change of c.7% (see figure 7).

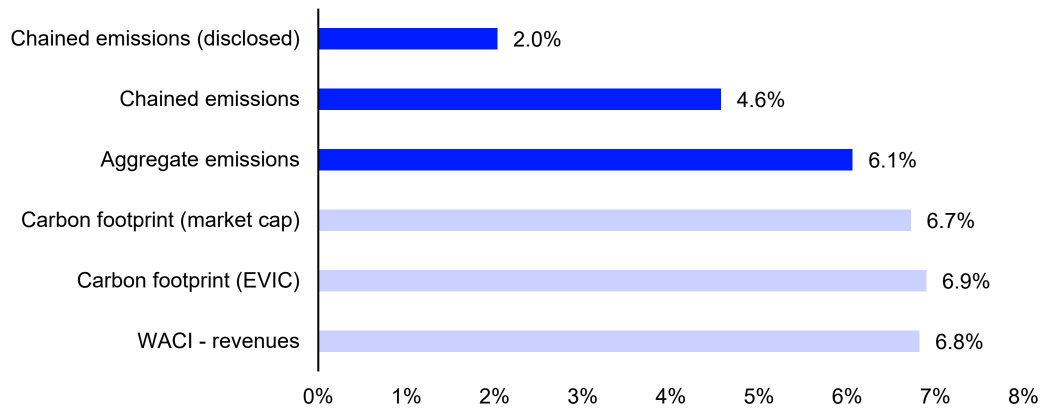
High year-on-year volatility in intensity at the top-level is typically heavily influenced by changes in a few carbon-intensive sectors which, while comprising a small proportion of the index, emit a high proportion of its carbon (i.e., Energy, Utilities, Basic Materials, and Industrials; see figure 8). For instance, Utilities only reflect c. 3% of index weight, but make up over 40% of portfolio WACI, significantly greater than its

[30] In their Handbook for the construction of Paris Aligned and Climate Transition Benchmarks, the Technical Expert Group of the EU Commission recommends a carbon intensity calculation with enterprise value as a normalisation factor; it is further suggested to add back in cash and short-term securities to avoid the complication of negative values, resulting in Enterprise value including cash, or EVIC. See EU Handbook of Paris-Aligned Benchmarks, accessed on 22nd August 2023.

25% contribution to carbon footprint (EVIC). This can make portfolio level intensity particularly sensitive to changes in the component factors (i.e., carbon, index weight, and revenues) of these sectors. For instance, in the median year, the contribution of the Utilities industry will change by amount equivalent to 5% of the top-level WACI. Please see Section 3 for a more detailed study on attribution carbon intensity changes.

Figure 7. High annual volatility in index intensity

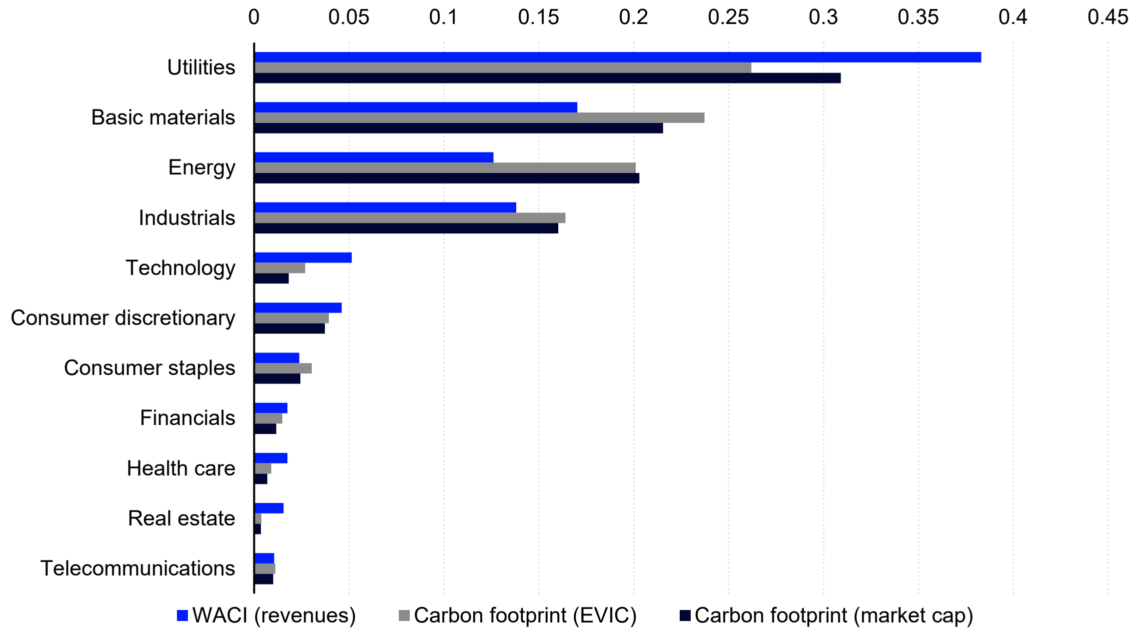
Absolute mean change of carbon metrics 2017–2021



Source: FTSE Russell, September 2023.

Figure 8. What makes up a portfolio carbon intensity

Proportion of contribution to Scope 1 and 2 intensity, by Industry[31]



Source: FTSE Russell, September 2023.

[31] While Utilities are the greatest contributor to portfolio operational (Scope 1&2) emissions intensity, a full accounting of carbon exposure including Scope 3 would likely show Energy companies as a more significant contributor, due to emissions associated with downstream consumption of fossil fuels.

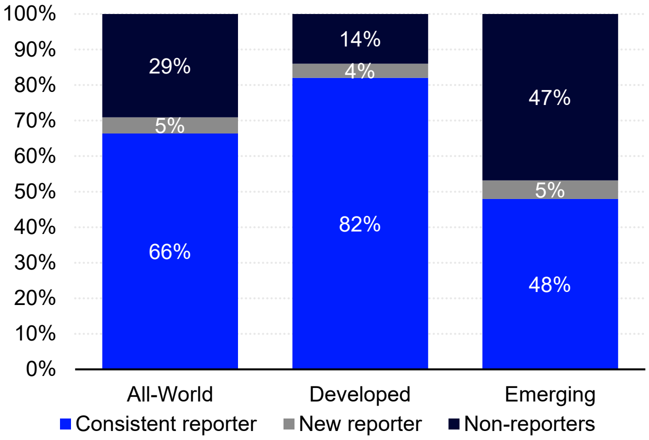
Company-level emissions

Company-level emissions trends also offer critical insights for investors on the evolution of their carbon exposure. In our analysis, we make a careful distinction between reported and estimated emissions data (noting that estimated emissions can have a large impact on portfolio-level results) to focus as much as possible on real-world changes in emissions.

Firms that disclose their Scope 1 and 2 emissions (comprising more than 69% of FTSE All-World firms) tend to report marginal reduction in their annual emissions.[32] Every year from 2016 to 2021, more than 50% of reporters recorded reductions in carbon emissions from the previous year, with the median rate of reduction for this group reaching a peak of -5% in 2020 during the COVID contraction. However, in most years, the median reduction is limited (only 1% in 2021), and only around 25% of reporting firms that are reducing emissions reported reductions greater than 9% per year (See figures 9 and 10).[33]

Figure 9. Disclosures continue to improve

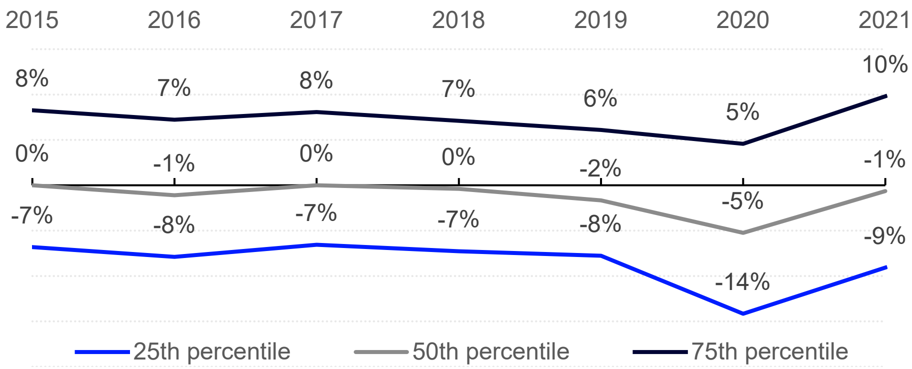
Proportion of companies by source of emission in 2021



Source: FTSE Russell, September 2023.

Figure 10. Marginal reductions observed at firm level

Annual change distribution in reported Scope 1 and 2 emissions



Source: FTSE Russell, September 2023.

[32] This tendency of consistent reporters to decrease their emissions year over year is not consistent within Scope 3 emissions, likely due to the relative immaturity and complexity of Scope 3 disclosures. See Section 4 for more information.

[33] The UN Environmental Programme's Emissions Gap Report 2019 found that: 'to get in line with the Paris Agreement, emissions must drop 7.6 per cent per year from 2020 to 2030 for the 1.5°C goal and 2.7 per cent per year for the 2°C goal.' While this figure has been updated with more recent research, the size of the remaining 1.5°C carbon budget is relatively small compared to its overall uncertainty. Please see the following article for a discussion of the latest data: Lamboll, R.D., Nicholls, Z.R.J., Smith, C.J. *et al.* Assessing the size and uncertainty of remaining carbon budgets. *Nat. Clim. Chang.* (2023). https://doi.org/10.1038/s41558-023-01848-5

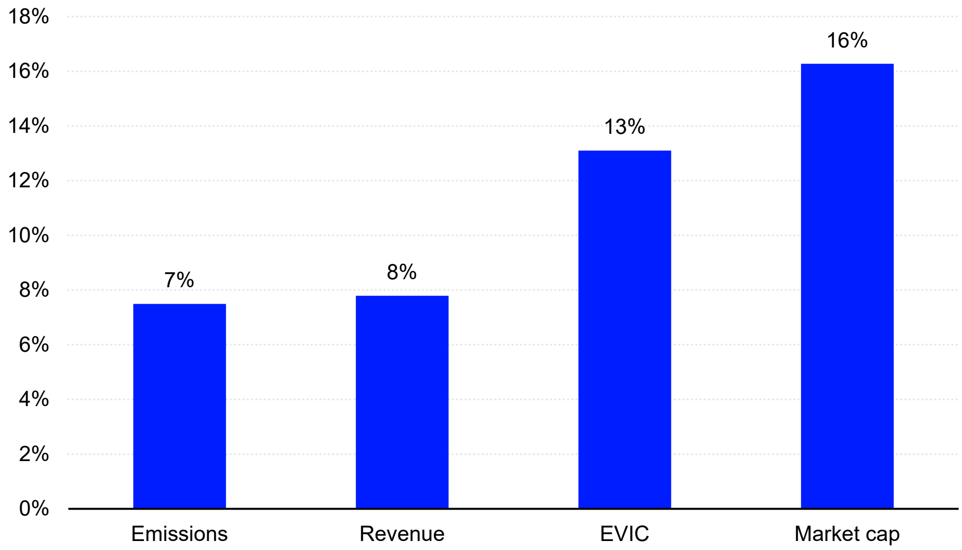
In contrast, emissions estimations (for non-reporting firms) tend to slowly increase over time along with overall firm sizes, with the median emissions estimation increasing by 2% in each of the last 3 years.[34] There can also be significant changes in emissions when companies first start reporting; most of the estimates are conservative overestimates and more than 60% of all first-time disclosures over the last three years report carbon below the estimations from the previous year.

Restricting ourselves to consistent reporters (i.e., companies disclosing emissions each year and the previous year), we can further examine emissions trends:

- Though the proportion of disclosing firms is relatively high among large and mid-cap All-World firms, c.5% of the universe begins to disclose every year, relatively consistent across developed and emerging markets (see figure 9).
- The emissions performance of the universe has widened since the beginning of COVID, with the inner quartile range increasing from 14% to 19% in 2020 and 2021, showing a greater divergence in company carbon emissions trends. In FY2021, the top 25% of the universe increased their emissions by 10% while the bottom reduced their emissions by 9% (See figure 10).
- Though the median firm across the sample reduced their emissions (and has done so over the past 4 years), carbon-intensive industries such as Utilities, Energy, Basic Materials, and Industrials, show a relative rebound since 2020, with the median firm increasing emissions by 1% (see figure 32 in Appendix).
- This divergence can also be seen within developed and emerging markets. While developed markets consistently decarbonised over 2019–2021, emerging markets were more volatile over the period, with a median increase of over 4% in 2021 (see figure 12).
- Reported emissions are generally less volatile over time than the normalisation metrics used to calculate intensity. A typical firm reporting emissions witnessed a 7% change in emissions during 2016–2021, with EVIC and market cap exhibiting nearly double the volatility (see figure 11).

Figure 11: Reported emissions less volatile than normalisation metrics

Median firm-level absolute relative change (2016–2021)

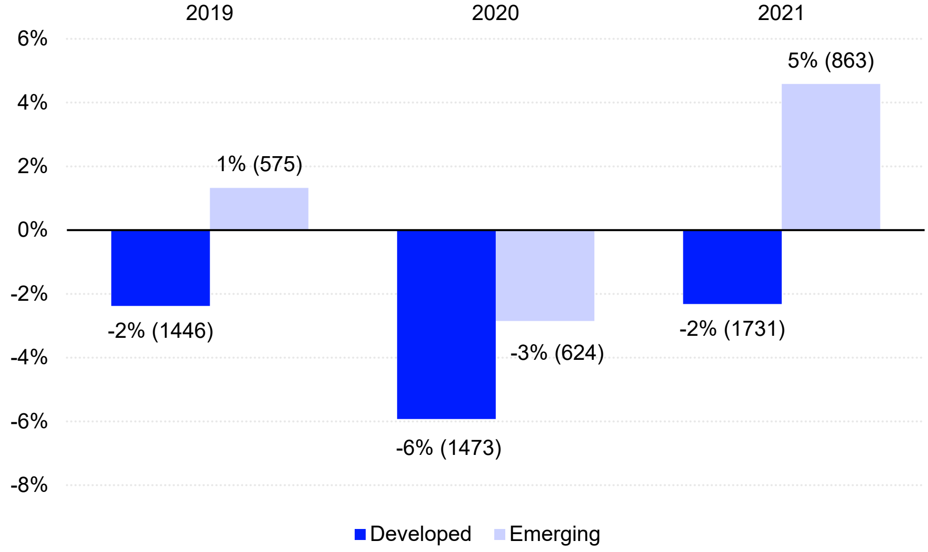


Source: FTSE Russell, September 2023.

[34] This may be driven by inherent sensitivities of estimates to changes in a firm's revenues, particularly exacerbated by periods of high inflation or volatile commodity prices.

Figure 12. Diverging trends amongst developed and emerging markets

Median change in reported emissions for consistently reporting companies by region



Source: FTSE Russell, September 2023.

Section 3: Attributing changes to portfolio exposure

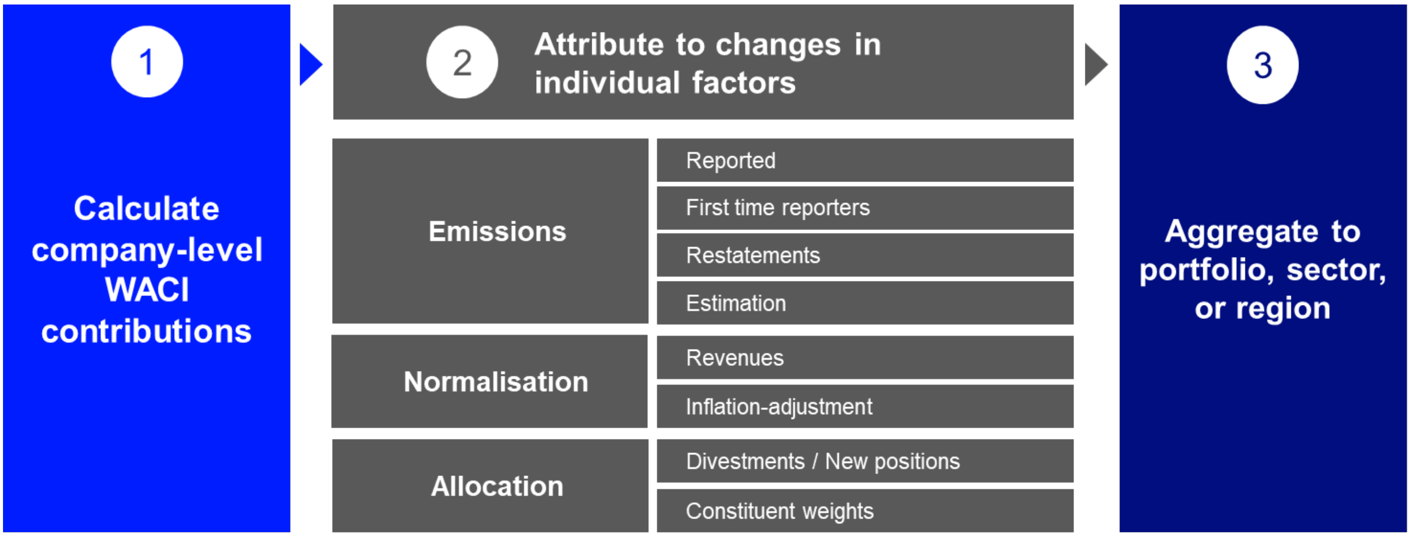
Portfolio attribution

As the previous section shows, portfolio-level carbon intensities can be sensitive, changing year-on-year with several factors at play beneath the surface. In last year's report, we demonstrated that changes in portfolio carbon exposure can be broken down into input components on the constituent level, revealing volatile, offsetting dynamics within the individual carbon factors.

Using logarithmic ratios between the past and present values of each factor (see Annex for more information), we can attribute changes of each constituent's contribution to changes in the underlying multiplicative factors – index weight, carbon emissions, and the normalisation factor (i.e., revenues for the standard WACI).[35]

Figure 13. Contribution analysis breaks down factor influences on a constituent level

Steps of contribution analysis



Source: FTSE Russell, September 2023.

This simple approach[36] can be tailored to meet the needs of different carbon exposure metrics, with breakout categories available for each factor. As shown last year, changes in weight can be segmented to identify impact from changing constituents, while changes in the normalisation factor revenues, and EVIC (or in the case of financed emissions, portfolio size) can be separated from the impact of inflation (See Annex). However, the chief goal of attribution exercises is to begin to understand the role that real decarbonisation plays at the portfolio level, separate from changes in carbon estimates, normalisation factors, and other accounting idiosyncrasies.[37]

[35] For a financed emissions attribution an additional multiplicative factor for portfolio size would be added (portfolio size multiplied by constituent weight yields the notional invested in each security). An explicit financed emissions calculation is excluded from this paper; without an independently varying portfolio size, it would vary commensurately with the carbon footprint (i.e., Tonnes per unit invested) due to the proportional inflation adjustment.

[36] The above methodology simplifies typical attribution outputs by avoiding interaction affects (essentially distributing contribution from both changing multipliers).

[37] The approach is tailored to the methodology as implemented in the FTSE Russell Carbon Emissions dataset, where high quality disclosures are favoured over general estimations. See our paper 'Mind the Gaps: Clarifying corporate carbon' for more information.

Against this backdrop, we have categorised changes emissions through the following breakouts:

– **Consistent disclosure:** Emissions changes where emissions were previously disclosed are more likely to reflect real-world, realised decarbonisation. However, changes can also result from changes to a company's assets or organisational boundary condition or even a methodological adjustment [38]

– **First time disclosure:** For companies where emissions were previously estimated, contribution from changing emissions reflects the difference between the estimated value and its current disclosure, rather than changes in company emissions.

– **Estimates:** Changes in estimates stem from a variety of sources depending on the details of the estimation methodology; this can include changes in company revenues or other metrics, reassignment of a sector or segment taxonomy, or marginal changes in the carbon disclosures of peer firms.[39]

From 2020 to 2021, increases in emissions of constituents have driven a 6% increase in portfolio carbon intensity, 3% of which can be linked to increased emissions for disclosing firms, with the remainder stemming from increases in estimates or first-time reporters.[40]

These changes from carbon data are often counterbalanced by changes in weight and the normalisation metric. Multiplied together, these two metrics form the attribution factor, i.e., the proportion of a given firm's emissions that contributes to the portfolio.[41] Over the long term, increases in the size-related normalisation metrics can offset commensurate increases in index weight, resulting in a consistent proportion of a company's emissions impacting the portfolio.[42]

However, the attribution factor – constituent weights and inflation-adjusted revenues – has consistently driven the most significant impacts to the top line portfolio intensity. Changes in the attribution factor are responsible for 10% of the observed 13% WACI reduction between 2017 and 2020, consisting of a 15% contribution from changing weights. Between 2020 and 2021, changes in the attribution factor all else being equal will result in a 7% WACI reduction, driven principally by increasing revenues.

[38] For example, disclosure of Scope 2 location-based value, where previously only a Scope 2 market-based value was made available, can result in significant volatility year over year.

[39] Please see the Annex for more information on the estimation methodology.

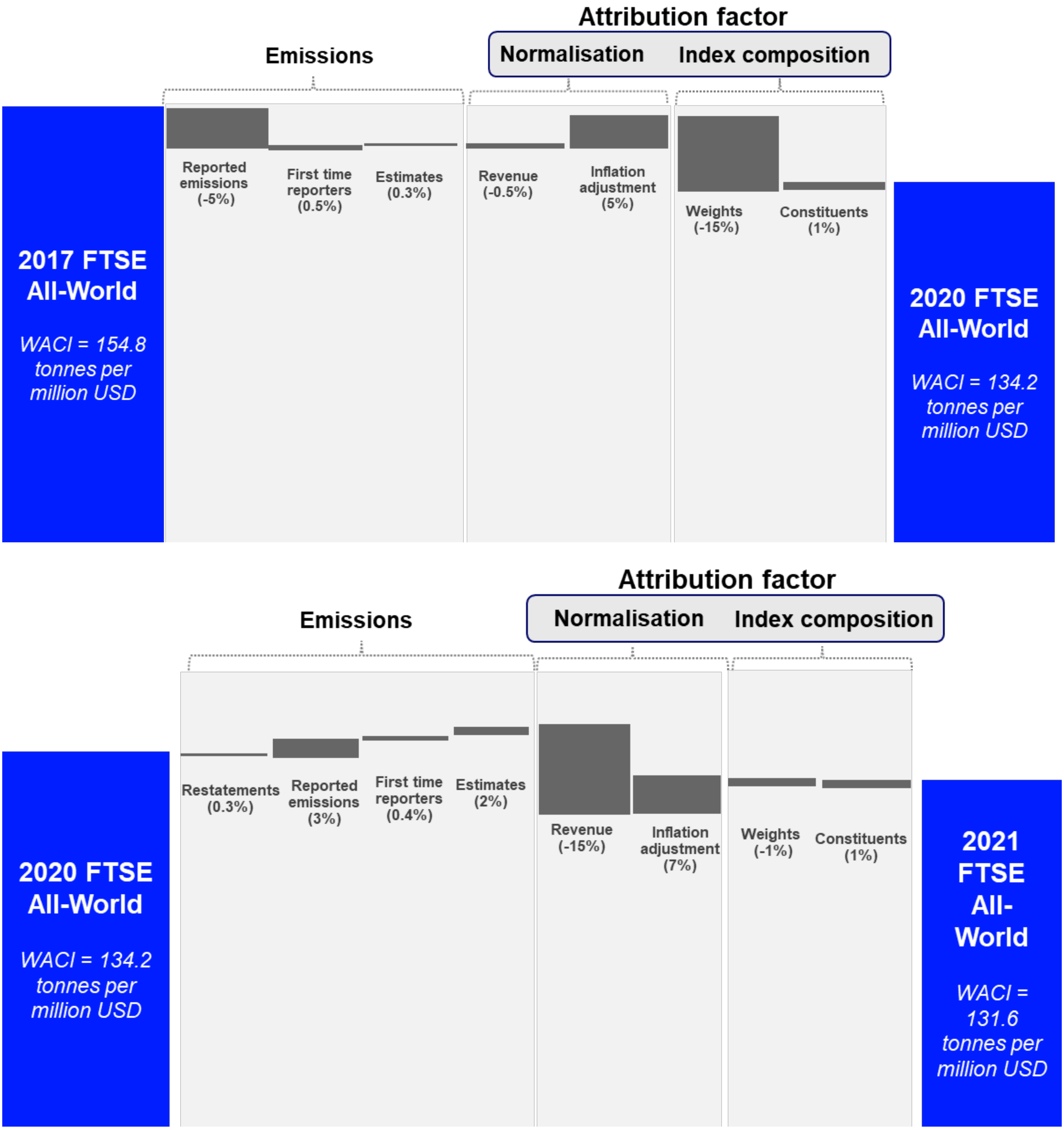
[40] This year's results also reflect the impact of new carbon data for FY2020 – specifically from company restatements and new emissions data sources since last year's report was published, further contributing a 0.3% increase to portfolio intensity.

[41] The attribution factor is a more direct and intuitive concept when using a value-based metric, such as EVIC – where weight divided by assessed value is a direct proxy for the proportion of the company financed by equity owned.

[42] Index weight will generally increase as a company's size (by way of value or output) increases. In practice, relative timing of the changes in weight and the normalisation factor can lead to short term dislocations. For example, if business conditions for a sector improves, the investor-assessed value of an industry will generally rise before a company's revenues rise; similarly changes to market capitalisation and index weight might appear before enterprise value, due to the dependency of enterprise value on balance sheet metrics, which are disclosed relative to a firm's fiscal year.

Figure 14. Disaggregating portfolio carbon intensity changes for Scope 1 and 2

Contribution by category to the change of WACI (2017–2021)



Source: FTSE Russell, September 2023.

Sector attribution

As the contribution framework emphasises the changes for influential companies to the top-line carbon intensity, aggregating contributions from each factor to the industry level can help us spotlight the disproportionate impact from dynamics within heavy-emitting industries**.** Chiefly, we observe the following.

High carbon industries drive most portfolio level changes

Net changes in Energy, Utilities, Basic Materials, and Industrials industries consistently drive the vast majority of changes in top-line WACI, accounting for more than 98% of the 25% reduction between 2016 and 2021, 76% coming from Energy and Utilities alone.

Sector rotations are a predominant source of variability

Recent years have shown a rotation out of carbon-intensive industries and into the high-performing but low-intensity industries, such as Technology (see figure 15), with reductions in constituent weights in high carbon sectors accounting for 64% of the WACI reduction between 2016 and 2021. This trend has reversed in 2022,[43] with increases in weight for Energy, Utilities, Basic Materials, and Industrials delivering a combined 13% increase to top line WACI.

Increases in revenues for high carbon industries obscure impact from changes in emissions

From 2016 to 2021, increases in inflation-adjusted revenue in these four industries have similarly overshadowed reductions in carbon emissions, delivering an 8% reduction in top-line WACI, compared to 1% for emissions. Impacts from commodity driven sectors are particularly variable; in 2021, increasing revenues from Energy and Basic Materials delivered a 5.6% reduction in aggregate portfolio intensity year over year, more than compensating for all emissions increases from all industries combined.[44]

The balance of the attribution factor is particularly impactful

Up until 2021, declining attribution factors for high-intensity industries have led to significant reductions in top-line carbon intensity (see figure 16). This is set to sharply reverse in 2022, signifying that changes in index weight of a security are not immediately balanced by changes in the normalisation factor. Notably, Energy and Utilities have increased their index weight out of proportion of observed revenue increases (contributing to about a net 5% increase in topline WACI), with the attribution factor derived from EVIC being notably less volatile in the near term (see figures 16 and 17).[45]

Apart from Utilities, there are few signs of consistent emission reductions from carbon-intensive industries

Between 2019 and 2022, only Utilities demonstrate signs of consistent decarbonisation (contributing an 3% decrease in top-line WACI), with the other three carbon intensive sectors contributing observed emission increases. This picture is complicated by the recovery from the COVID economic contraction; looking at the past year of fully reported carbon data (FY2021), increased contributions from disclosed emissions are visible in 8 of 11 industries in the last year, with particularly stark near-term increases from Utilities and Basic Materials.

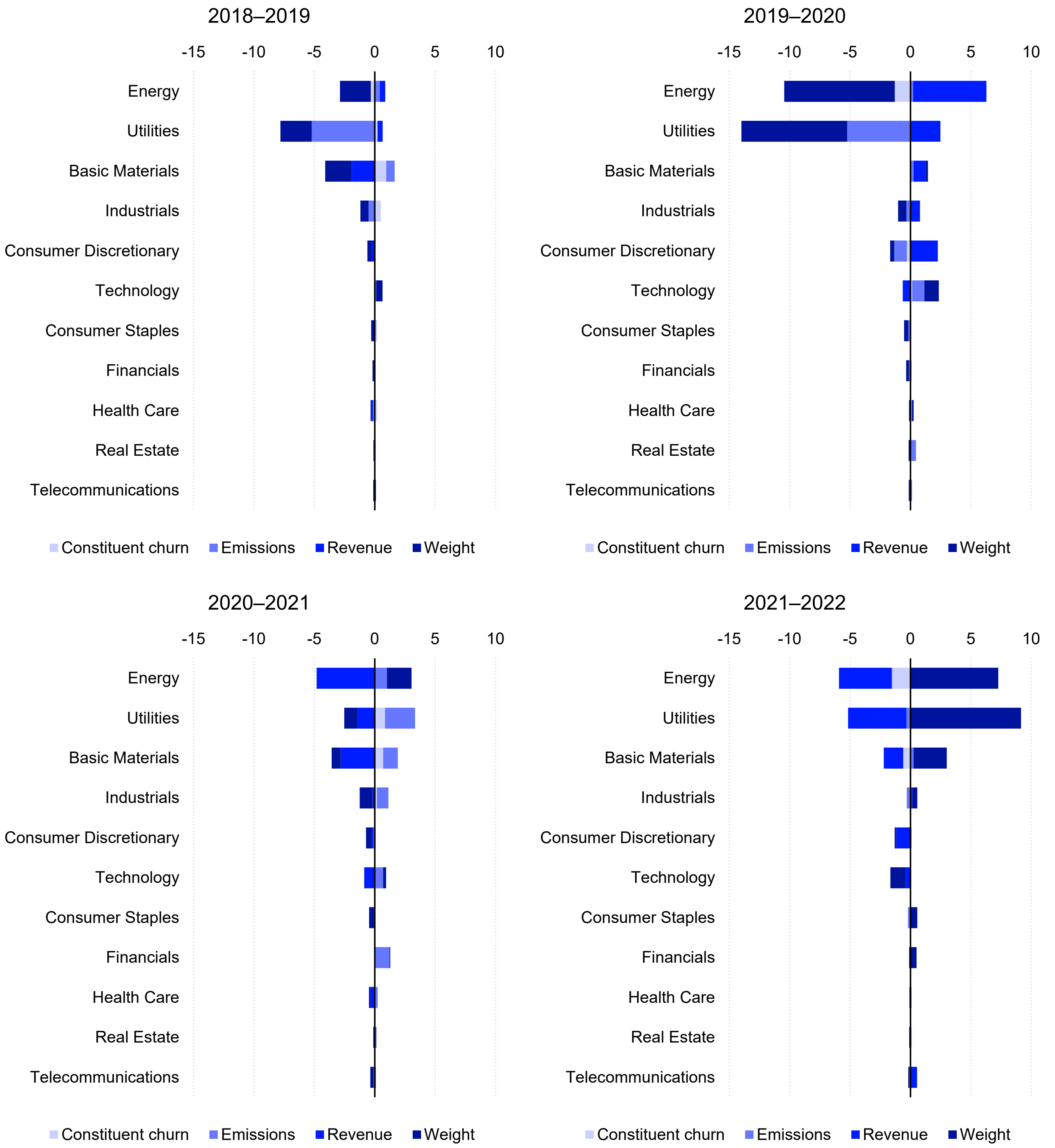
[43] While we only have sufficient reported carbon data to finalise results up to FY2021, we have included contribution analysis for FY2022, focusing mainly on projected changes due to changing constituent weights and normalisation factors.

[44] Increases in revenues, EVIC, or Market Cap, in excess of the adjustment factor, will lead to a reduction in carbon intensity all else being equal.

[45] The revenue, unlike EVIC, does not directly consider market dynamics or investor-assessed value, and therefore changes are less likely to align with changes in weight on a yearly basis, resulting in a more volatile attribution factor over the near term for certain sectors.

Figure 15. Weight changes in high-carbon Industries deliver highest contribution

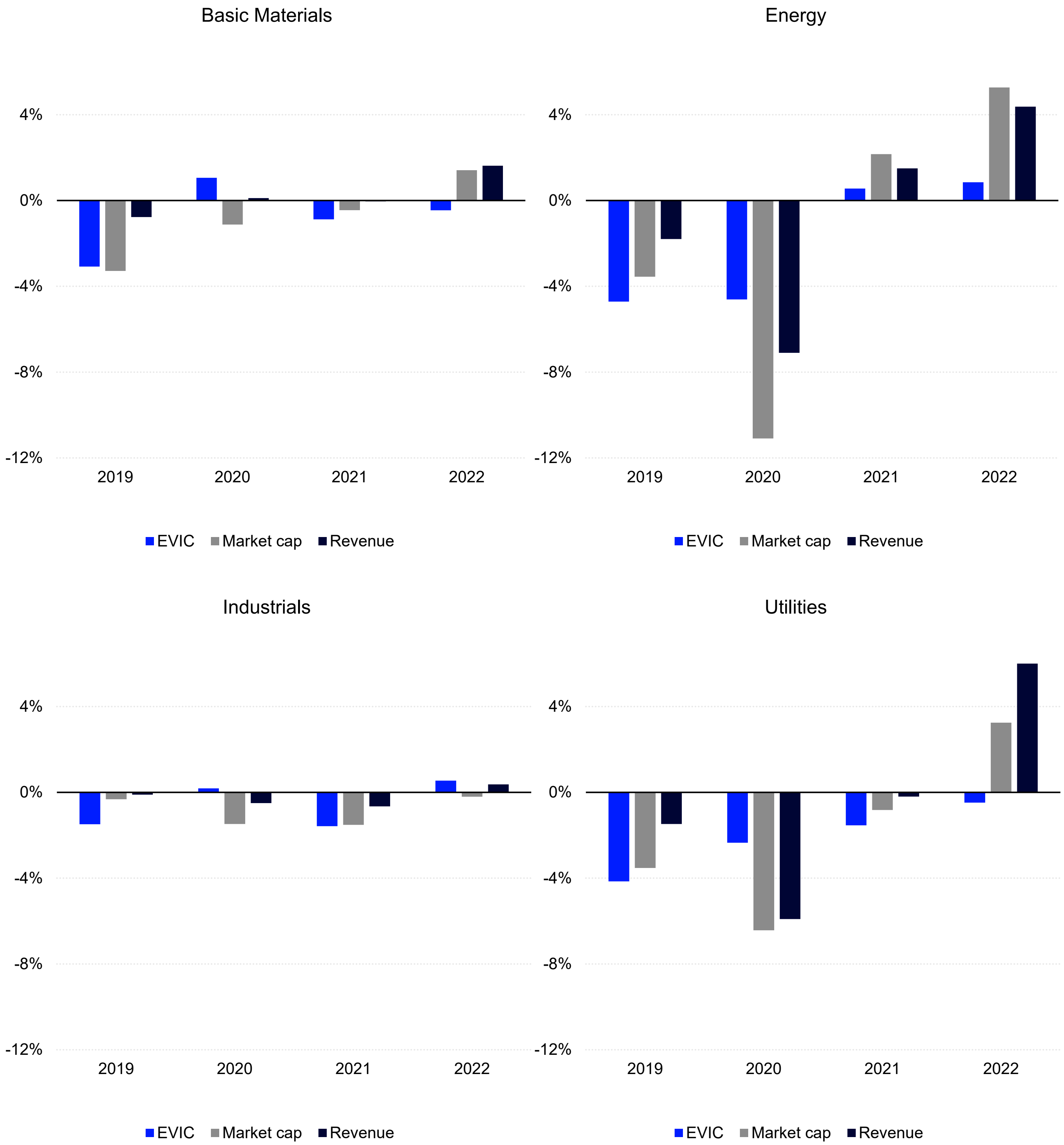
Contributions of portfolio WACI (by revenue) change, by industry



Source: FTSE Russell, September 2023.

Figure 16. Attribution factor trends recently reversed for high-intensity sectors

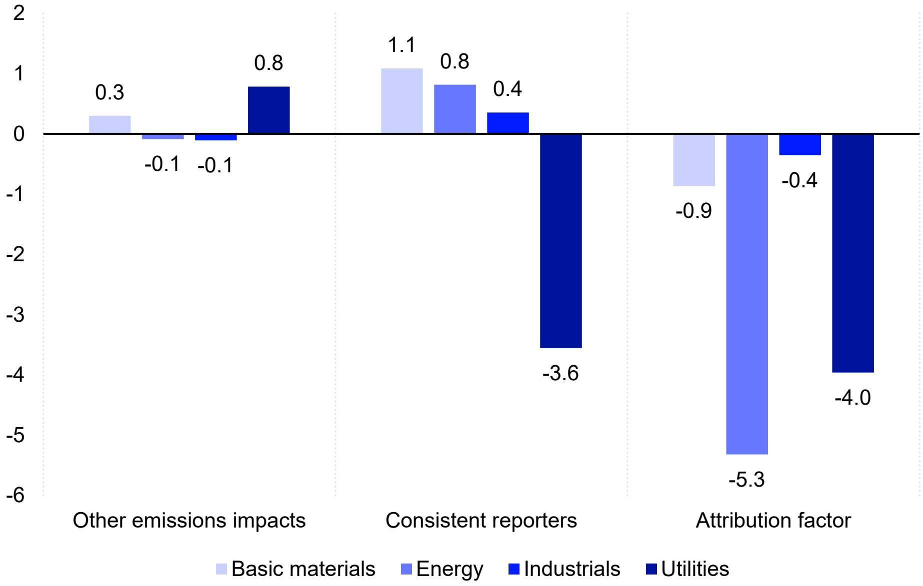
Percent contribution to change for attribution factor, by industry



Source: FTSE Russell, September 2023.

Figure 17: Only Utilities firms show significant contribution from changing reported emissions

Contributions to WACI (2019–2022)



Source: FTSE Russell, September 2023.

Section 4: Adding to the investor carbon toolkit

Due to the limitations of classic Scope 1 and 2 operational emissions and derived intensity metrics (see box 1), investors and portfolio target setting frameworks have consistently expanded their analytical lenses to include a wider array of metrics and sector specific treatments. Below, we explore the advantages and disadvantages of two prominent carbon exposure metrics to portfolio level analytics: Scope 3 emissions and sector-specific product intensities.

Scope 3 emissions

As Scope 1 and 2 disclosure matures, investors, regulators, and other stakeholders have turned their focus to a more complete accounting of indirect emissions exposures, with the goal of including Scope 3 metrics to portfolio analytics.

Scope 1 and 2 assumes that direct ownership of emissions-intensive processes is an effective proxy for corporate climate performance. However, Scope 3 emissions can add to this perspective by linking an entity's operations to emissions produced along its product value chain (see box 3). Indeed, decisions of whether to directly own a particular leg of the value chain may drastically change the emissions profile for identical industrial processes.[46] By only examining Scope 1 and 2, investors could inadvertently incentivise the outsourcing of carbon-intensive activities often outside the listed securities space,[47] sometimes described as 'carbon leakage'.

Box 3. Accounting for corporate carbon exposure

To quantify emissions exposure, most companies and disclosure frameworks have adopted the standards set out by the GHG Protocol. The corporate guidance states that firms should report emissions relative to equity stake or either operational or financial control of operations, with emissions divided into three categories depending on the relation to the reporting entity. While Scope 1 and 2 emissions are clearly defined and straightforward to calculate, Scope 3 can require complex assumptions involving external counterparties, where a company may have limited visibility.[48]

Source		Definition
Direct	**Scope 1**	Emissions from sources that are owned or controlled by the reporting company.
Indirect	**Scope 2**	Emissions from consumption of electricity, heat, steam and cooling. These can be calculated via two methods (See Appendix): – **Location-based**: Calculated through emission rates of the local power grid – **Market-based**: Calculated based on purchasing agreements with suppliers
	Scope 3	**Upstream**: Emissions embedded in the value chain that contribute to a company's activities **Downstream**: Emissions from customers using a company's products and services

[46] For example, a semiconductor firm, by outsourcing the fabrication of their products, would effectively push many of their operational emissions to the greater value chain,

[47] The exclusion of Scope 3 can hinder the assessment of relative carbon intensity of a business activity. This can also be ameliorated through sector-specific product intensities (see next section).

[48] Frédéric Ducoulombier, Understanding the Importance of Scope 3 Emissions and the Implications of Data Limitations. The Journal of Impact and ESG Investing. 09 April 2021.

In an ideal process, investors would use Scope 3 emissions to track emissions exposure where a company is at least jointly responsible for emissions over which it does not have ownership or control. However, investors face a myriad of challenges when deriving and tracking a meaningful and consistent Scope 3 carbon exposure value for their portfolios:[49]

Disclosures are patchy

Around 37% of companies disclose Scope 3 emissions (compared to 71% for Scope 1 and 2), with about 5% of the universe newly disclosing this year. Notably, c. 60% of disclosing firms do not disclose their two most material categories for their given sector,[50] with Financials showing particularly poor disclosure of emissions from their investments, despite the widespread adoption of PCAF standards.[51] A greater proportion of portfolio Scope 3 emissions need to be derived from estimations (39% versus 25% for Scope 1 and 2)[52], which generally have a lower confidence than those for Scope 1 and 2 emissions.[53]

Comparability cannot be assumed

Scope 3 emissions are defined via 17 mutually exclusive categories – each with its own set of estimation challenges as well as inconsistent applicability across different business activities and ownership structures. This means that small differences in calculation methodology or business line can result in disproportionate changes in Scope 3 disclosures. While these issues also occur in Scope 1 and 2,[54] calculating Scope 3 involves a much wider array of emissions sources, which must be estimated with a high degree of uncertainty. This generally results in a larger carbon emissions dispersion among peer groups for Scope 3 relative to Scope 1 and 2, by 7% and 15% for upstream and downstream, respectively (see figure 30 in Appendix).

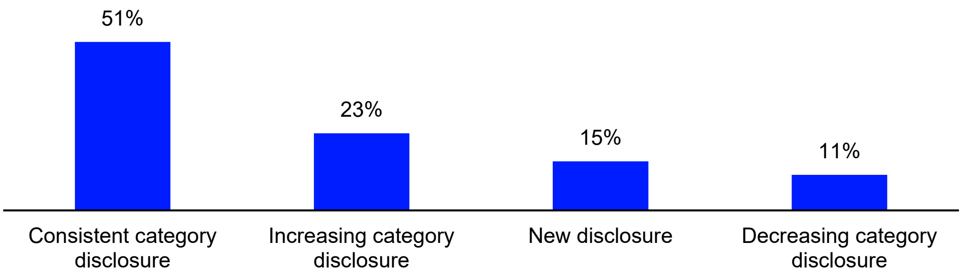
Standards and practices continue to evolve

Expansion and improvement of Scope 3 calculation methodologies as well as emissions and category coverage are evident across the investible universe, with over one-fifth of consistent reporters reporting more categories than in the previous year (see figure 19). These disclosure improvements result in high volatility at the company and portfolio level and consistent positive changes in both reported emissions and estimations based on disclosures; the median firm reports 5% more emissions than the previous year and 25% of firms increase their emissions more than 30% (see figure 20).

Scope 3 gives investors a detailed view of the indirect carbon exposure of the corporate universe and fills an important gap left by Scope 1 and 2. However, disclosure is not yet mature enough for consistent tracking of value chain emissions in portfolios. Without significant improvement in the consistency, quality and coverage of reporting, it will be difficult for investors to quantify their Scope 3 exposure and set meaningful portfolio decarbonisation targets.

Figure 19. Categorical expansion

% of firms reporting more Scope 3 categories in 2021



Source: FTSE Russell, September 2023.

[49] For instance, the Net Zero Asset Owner Alliance – while not requiring the explicit setting of targets for the Scope 3 emissions of investments, requires that members track the Scope 3 emissions of portfolio companies for their sector targets. For more information, please see the following: https://www.unepfi.org/wordpress/wp-content/uploads/2023/01/AOA-Target-Setting-Protocol-Third-edition.pdf

[50] Based on all disclosing public firms for FY2021, utilising both CDP and public disclosures. This analysis will be further expanded upon in a dedicated Scope 3 report to be published in 2024.

[51] For a discussion on issues facing disclosure of Scope 3 emissions for financials, please see EDF (2023) Carbon Conundrum.

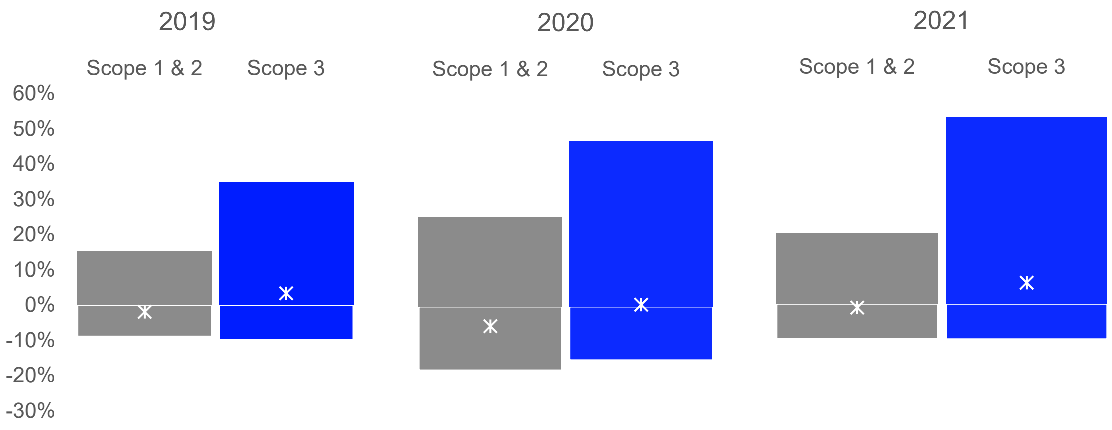
[52] These statistics are renormalised after excluding Financials, due to quality considerations for the Scope 3 disclosures of financial firms.

[53] Busch, T, Johnson, M, Pioch, T. Corporate carbon performance data: Quo vadis? J Ind Ecol. 2022; 26: 350 – 363. https://doi.org/10.1111/jiec.13008

[54] See our paper 'Mind the Gaps: Clarifying corporate carbon' for more information.

Figure 20. Firms are finding more Scope 3 emissions

Yearly change in disclosed emissions by emissions scope



Source: FTSE Russell, September 2023.

Product-specific intensities

Product specific intensities are an important complement to traditional carbon intensity metrics. Instead of normalising emissions against a monetary value, GHG emissions performance is evaluated through the lens of (often physical) production volumes. [55]

These sector-specific production indicators can better constrain the carbon exposure calculation by identifying both a homogenous product line and emissions boundary (i.e., scopes) that are most relevant for a given segment. This enables a more direct and less price-sensitive proxy for economic activity than revenues or EVIC and, if properly implemented,[56] can provide a more comparable intensity for a given peer group, while still covering the heaviest emitters in a portfolio.

However, investors utilising production intensities can face challenges when providing insights on the portfolio level:

– Many of their investee companies do not engage in business activities that can be reduced to comparable product lines (e.g., software, services, luxury items).

– Additional assumptions are required to aggregate across sectors which use different assessment frameworks and output metrics.

Despite these drawbacks, product-specific intensities are still useful both to conduct company comparisons against industry peers as well as to assess firm intensity against sector-benchmarks based on forward-looking scenarios.

For instance, the Carbon Performance framework of the Transition Pathway Initiative (TPI)[57] calculates and projects company product intensities to provide both a near-term and forward-looking sector evaluation framework for over 350 firms across 10 high-carbon industries.**[58]** These product intensities offer an alternative lens to evaluate sector decarbonisation trends, spotlighting rapid reductions as well as hard-to-decarbonise industries (see figure 21). Looking ahead, after projecting product intensities

[55] Many investor-backed groups are specifying the setting of sector-specific targets – often calibrated according to relevant Sectoral Decarbonisation Pathways. Please see 'Target Setting Protocol,' from UN-convened Net-Zero Asset Owners Alliance, for more information.

[56] Product-specific intensity frameworks require that both emissions and production disclosures be harmonised to ensure that all emissions sources relevant to a specific production process are captured relatively consistently across firms. This can often require discretion when company disclosures are not sufficiently granular.

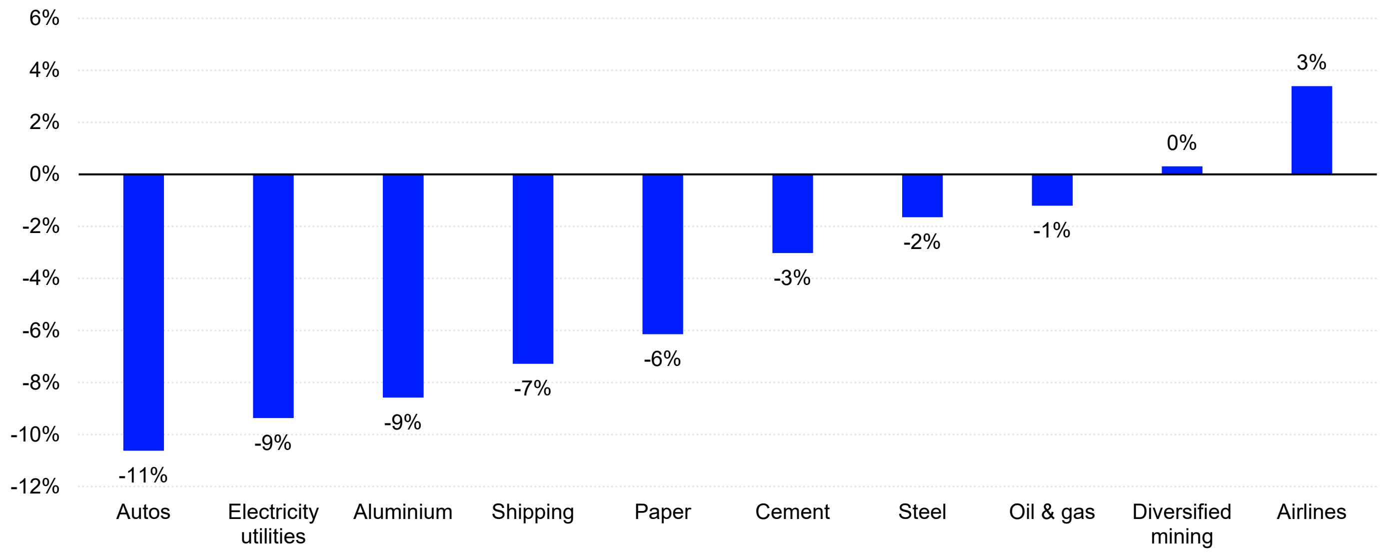
[57] Please see the TPI website for more information: https://www.transitionpathwayinitiative.org

[58] The Carbon Performance methodology follows a Sector Decarbonisation Approach to derive sector carbon budgets behind product-intensity benchmarks. Methodological descriptions for individual sector assessment frameworks can be found on the TPI website. Methodological details and constraints will often differ between sectors. As an example, please see the methodological description for the Steel assessment framework, from TPI.

through carbon reduction targets, alignment can be assessed against sector benchmarks derived from a suite of climate scenarios from sources such as the IEA or OECM[59] (see figure 22).

Figure 21. Product intensity trends

Median change of product intensity by industry (2018–2021)[60]



Source: FTSE Russell, September 2023.

[59] Please see Limiting Warming to 1.5, from the Institute for Sustainable Futures, for more information.

[60] Data downloaded from TPI website as of August 2023. Please note that while TPI has since included an additional sector (Food Producers) in its Carbon Performance framework, this does not within the scope of this paper.

Figure 22. Product array

Product intensity sector frameworks of TPI carbon performance

Sector	Scopes considered in production intensity	Production metric	Number of firms assessed and disclosing, FTSE All-World61	% of firms, FTSE All-World	% Weight, FTSE All-World	% Emissions, Scope 1&2	% WACI Contribution, Scope 1&2	% firms aligned to a below 2 Degree scenario[62]	
								2025	2050
Electricity Utilities	Scope 1 (Owned generation)	MWH of primary energy	62	1.6%	2.1%	16.6%	31.0%	38.7%	82.3%
Oil & Gas	Scope 1, 2, & 3 (Use of Sold Products)	Barrels of oil equivalent	45	1.1%	2.5%	11.3%	7.5%	2.2%	17.8%
Cement	Scope 1	Tonnes of cementious product	20	0.5%	0.2%	4.5%	5.3%	55.0%	50.0%
Steel	Scope 1 & 2	Tonnes of crude steel	24	0.6%	0.3%	7.3%	3.0%	33.3%	54.2%
Diversified Mining	Scope 1, 2, & 3 (Processing & Use of Sold Products)	Tonnes of copper equivalent	14	0.4%	0.8%	1.6%	2.3%	64.3%	50.0%
Aluminium	Scope 1 & 2	Tonnes of aluminium	6	0.2%	0.1%	1.5%	1.0%	16.7%	66.7%
Shipping	Scope 1	Tonnes kilometre	12	0.3%	0.2%	0.9%	0.7%	75.0%	50.0%
Airlines	Scope 1	Revenue tonne kilometre	22	0.6%	0.1%	1.9%	0.7%	95.5%	31.8%
Paper	Scope 1 & 2	Tonnes of pulp and paper	13	0.3%	0.1%	0.6%	0.4%	61.5%	30.8%
Autos	Scope 3 (Use of Sold Products)	Kilometres (new vehicles)	27	0.7%	2.5%	0.5%	0.4%	22.2%	77.8%
Total			245	6.1%	8.7%	46.9%	52.3%	40.0%	53.5%

Source: FTSE Russell, September 2023.

Through this sector-specific framework, we can track the current and projected decarbonisation for both individual companies and entire sectors, demonstrating the following:

Assessments cover a small number of systemically important emitters

While our analysis includes 6% of firms (9% by weight) of the FTSE All-World, this captures a large proportion of high-emitting firms, comprising 47% of portfolio emissions and 52% of carbon intensity contribution for Scope 1 and 2 (31% coming from 62 Electrical Utility firms).

Product intensity metrics enable comparison to forward-looking climate scenarios and sector benchmarks

While investors use dollar-based intensities to analyse relative carbon intensity, trends, and reduction targets, revenue and EVIC-based intensities are not able to directly assess alignment against a real

[61] While the Carbon Performance score includes more than 350 firms – this analysis has been subset to members of the FTSE All-World with both available product-intensity and disclosed operational emissions between 2018 and 2021.

[62] A company is considered aligned with a Below 2 Degree Scenario if its product carbon intensity is lower than that of the Below 2 Degree benchmark, evaluated at either 2025 or 2050. Product intensities for individual firms are projected forward using disclosed decarbonisation targets, subject to sector-specific inclusion criteria. If companies do not disclose decarbonisation targets past a specific year, the product intensity is assumed to be unchanged from last available value.

economy decarbonisation pathway. For instance, electrical utilities have delivered recent intensity reductions through emissions reductions (See Section 3). While this is confirmed through the CP framework (where we can observe a 9% intensity reduction over three years), we also note they are likely underperforming near-term climate benchmarks, with only 38% of electrical utilities outperforming a below 2-degree scenario in 2025 (see figures 21 and 22).[63]

Product intensity metrics are less volatile than company operational emissions or intensity

Sub-selecting the firms that have both three years of product intensity and emissions disclosures, we can examine the distribution of changes across each metric. Across every sector, product intensity shows a lower median absolute yearly change than either Scope 1 and 2 emissions or intensity, by an average of 8 and 10 percentage points, respectively (see figure 23).[64] When volatility does occur, product intensity also shows more cohesive behaviour, with each sector returning a tighter distribution of changes over the period (see figure 24).

Product intensity is more comparable between peers

In 8 out of 10 sectors, a product intensity delivers a lower intensity spread[65] than either operational emissions or emissions intensity by an average of 23 and 25 percentage points, respectively (see figure 25). The two sectors that have a higher intensity spread – Diversified mining and Paper – demonstrate the complexity associated with sector-specific frameworks. Sector-specific frameworks require significant harmonisation to condense an array of product lines to a single indicator (e.g., coal, iron, nickel is converted to tonnes of copper equivalent for Diversified Miners).[66] While on the surface, this could hinder comparability, it also provides a lens to contextualise heterogeneity within the sector, where additional coal exposure would significantly increase a firm's downstream Scope 3 emissions.

[63] For electrical utilities, Scope 1 emissions for owned electricity generation is divided by annual energy output to calculate a carbon intensity per unit of energy generated, before projecting forward via firm-specific targets.

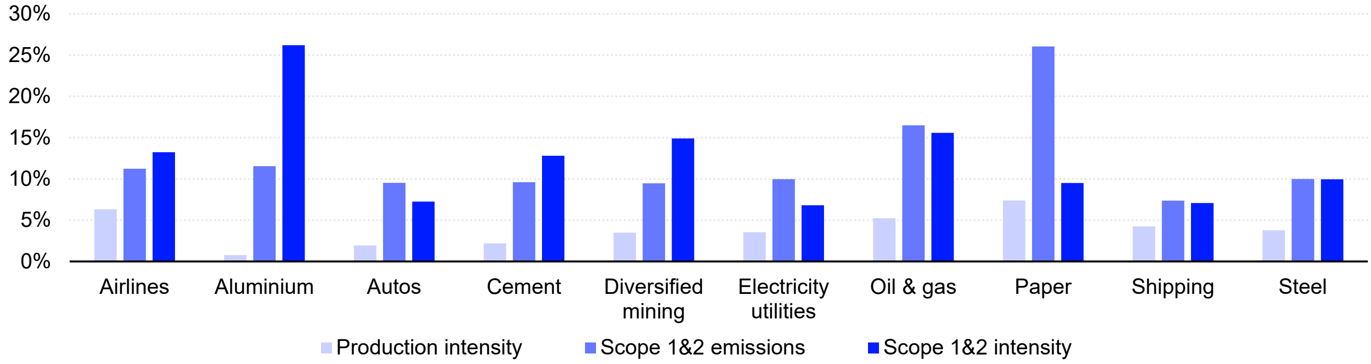
[64] Volatility hotspots can often be intuitively explained by underlying sector dynamics: For example, higher than typical volatility for revenue-based intensities in Oil & Gas firms is likely indicative of near-term volatility in commodity prices; at the same time, higher volatility for Airlines emissions is more likely related to short-term travel interruptions during COVID shutdowns.

[65] Average dispersion equates to normalised inter-quartile range (IQR), dividing the IQR by the sum of the third and first quartiles to allow comparison across peer groups.

[66] Please see Carbon Performance sector assessment methodological description for Diversified Miners for more information

Figure 23. Product intensity appears less volatile than operational emissions metrics

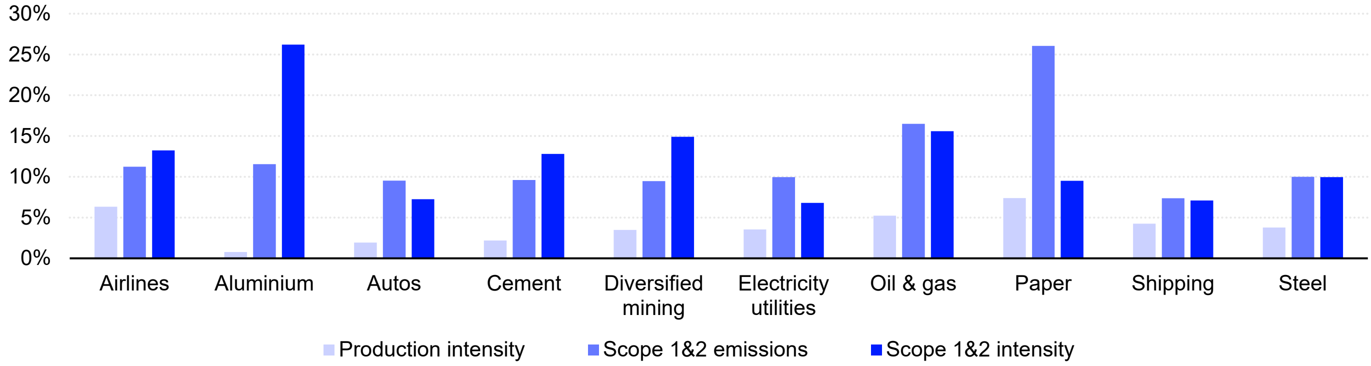
Median absolute relative change (2018–2021)



Source: FTSE Russell, September 2023.

Figure 24. Product intensity shows more cohesive changes across sectors

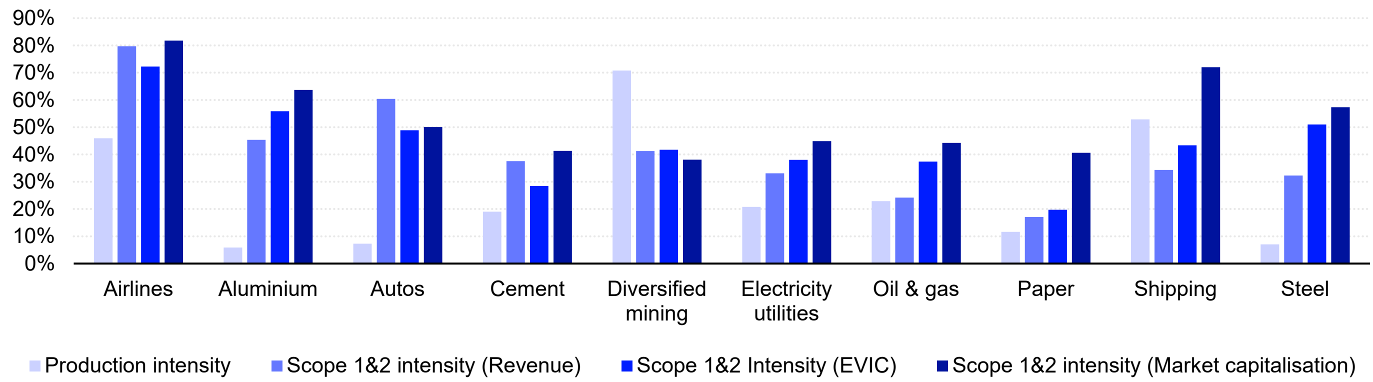
Interquartile range of relative change (2018–2021)



Source: FTSE Russell, September 2023.

Figure 25. Product intensity returns a closer distribution across peers

Intensity Spread (normalised Interquartile range)[54]



Source: FTSE Russell, September 2023.

Appendix I. Data and aggregated metrics

Figure 26. Common metrics for carbon footprinting (Scope 1 and 2)[67] of FTSE All-World Index[68]

	2015	2016	2017	2018	2019	2020	2021
Aggregate emissions (million tonnes)	9,026	9,448	10,085	10,482	11,017	10,715	11,978
WACI (tonnes per million USD sales)	158	177	155	160	147	135	132
Carbon footprint (EVIC) (tonnes per million US$ invested)	74	79	79	82	66	58	58
Carbon footprint (Market cap) (tonnes per million US$ invested)	145	147	152	153	121	113	111
Median carbon intensity (tonnes per million US$)	23	22	23	24	22	20	21
Median carbon footprint (EVIC) (tonnes per million US$ invested)	35	34	32	29	29	30	30
Median carbon footprint (Market cap) (tonnes per million US$ invested)	17	17	17	16	15	13	13

Figure 27. Regional breakdown of WACI and median carbon intensity (Scope 1 and 2, in 2021) of FTSE All-World Index

	WACI	Median carbon intensity	Weight in index
All Region	132	30	100%
China	218	32	4%
Developed Asia Pacific	131	36	11%
Developed Europe	99	16	17%
Emerging Asia, Middle East & Africa (ex China)	351	82	5%
Emerging Europe	711	91	0.5%
Latin America	301	50	1%
North America	110	20	62%

[67] When WACI is taken for a subgroup – such as a particular region or sector – weights are renormalised to obtain a sum of 100% for that subgroup. Therefore, an increasing WACI for a subgroup will indicate either 1) changing carbon intensity of constituents, or 2) increase of weight carbon-intense constituents.

[68] EVIC data used in Carbon Footprint calculation have been adjusted for inflation using the methodology outlined in the EU Handbook for Paris Aligned Benchmarks. The inflation adjustment factor is calculated by dividing average annual EVIC by the average EVIC of the previous year, relative to the reference year, 2021.

Figure 28. Industrial breakdown of WACI and median carbon intensity (Scope 1 and 2, in 2021) of FTSE All-World Index

	WACI	Median carbon intensity	Weight in index
All Industry	132	30	100%
Basic Materials	597	402	4%
Consumer Discretionary	40	23	15%
Consumer Staples	52	50	6%
Energy	455	362	4%
Financials	17	3	14%
Health Care	20	21	11%
Industrials	139	36	13%
Real Estate	70	43	3%
Technology	28	10	24%
Telecommunications	38	37	4%
Utilities	1742	660	3%

Appendix II. Carbon accounting and carbon exposure metrics

In addition to differences that can arise from different data sources (e.g., reported carbon data, estimated carbon data, revenues, enterprise value, market capitalisation), there are several methodological choices involved in the construction of carbon exposure metrics:

1. **Normalisation factors** are often applied to absolute emissions to obtain carbon intensity, increasing comparability between companies and over time. The most common normalisation factors are as follows:
   - **Revenues:** Annual revenues generated during the same time period of emissions provide a universal measure of company output or activity across the investable universe. However, revenues are not a perfect proxy for output across sectors and revenue intensities are sensitive to price changes between sectors or over time (e.g., inflation).
   - **Market value metrics:**
     - **Enterprise value including cash (EVIC):** By dividing emissions by EVIC, the resulting metric links emissions directly to the value of the company an investor owns, rather than tying them to an 'output' metric such as revenues. However, this also exposes the intensity measure to volatility in market valuations, while also rewarding higher debt levels.[69]
     - **Market capitalisation:** By dividing emissions by EVIC, the resulting metric links emissions directly to the value of the company an investor owns, rather than tying them to an 'output' metric such as revenues. However, this also exposes the intensity measure to volatility in market valuations, while also rewarding higher debt levels.
   - **Physical units:** Carbon intensity in terms of physical production units (e.g., per car or tonne of cement) is often seen as a particularly reliable metric of a company's carbon efficiency. However, these units are sector-specific and will not cover the entirety of the investable universe, limiting the usefulness of physical intensities for inter-sector and portfolio level analysis.[70]
2. **Attribution factors** dictate the share of a constituent's emissions, which are included in overall portfolio emissions figures. Where intensity metrics (e.g., WACI) often attribute emissions from each company based on their weight in the portfolio, other metrics calculate the proportion of a firm's activities owned by a portfolio, by dividing the amount invested by total market value of the firm and attributing this proportion of the firm's emissions to the portfolio. The most common attribution factors are as follows:
   - **Weight:** A simple multiplication of portfolio or index weight to the quantity in question.
   - **Ownership by market capitalisation:** This factor captures the current value of a constituent's equity and so is not viable as a metric for fixed income. Allows alignment of individual firms with point-in-time market estimates.
   - **Ownership by EVIC:** EVIC is equivalent to market capitalisation plus debt (cash is kept, avoiding negative values). Point-in-time estimates can be misaligned with respect to market volatility as EVIC values are typically taken for the end of the fiscal year for individual firms.

[69] Enterprise value is normally calculated by adding Net Debt to the Market Capitalisation, which involves the subtraction of Cash and Short-Term investments from the balance sheet. It is often recommended to keep cash to avoid negative numbers when normalising for emissions, however by including cash – a company taking on more debt and cash on the balance sheet will, by definition, increase its EVIC thus decrease its resulting carbon intensity.

[70] Sector-specific targets can still offer insights into alignment of significant portions of a portfolio's emissions. Many investor-backed groups are specifying the setting of sector-specific targets – often calibrated according to relevant Sectoral Decarbonisation Pathways. UN-convened Net-Zero Asset Owners Alliance, 'Target Setting Protocol', accessed 27/04/22.

3. **Inflation adjustments** can increase comparability when the meaning of financial values drifts over time. The most common inflation adjustments are as follows:
   - **Asset values.** As asset values (e.g., market capitalisation or EVIC) are generally volatile year over year, the EU Handbook for Paris Aligned Benchmarks[71] suggests that EVIC can be adjusted by dividing the average EVIC of the current year by that of the previous year. In this year's report, we have also treated market capitalisation similarly for the carbon footprint by market cap. A more recent submission has proposed that an asset value inflation factor should be calculated for each individual constituent, based on the changes in its market value since the initial period of analysis.[72]
   - **Revenues.** As purchasing power decreases over time, the value of a constant amount of revenues declines, thus changing the interpretation of carbon efficiency (or carbon intensity by revenues). This can be adjusted either relative to individual currencies or by converting all revenues to US dollars and applying a GDP deflator to the overall time series. Despite these adjustments, revenues – especially for commodity driven sectors like Oil and Gas – can show significant volatility as seen in the commodity volatility throughout 2022.

Figure 29. Carbon exposure metrics

Description and mathematic formula for carbon exposure metrics

	Description	Formula
Carbon emissions intensity	Normalised rate of carbon emissions per unit of economic activity or asset size. Typically, economic output indicators are used to normalise emissions.	Carbon emissions intensity $= \frac{E_k}{S_k}$ Where E_k is the annual carbon emissions of company k and S_k is the annual output (or size proxy) of company k.
Aggregate emissions intensity	Total emissions divided by total revenues of all investee firms	Aggregate emissions intensity $= \frac{\sum_{k=1}^{n} E_k}{\sum_{k=1}^{n} S_k}$ Where Ek is the annual carbon emissions of firm k, and S_k is the annual output of firm k.
Weighted Average Carbon Intensity (WACI)	Portfolio level average of carbon intensity (by revenues) of investee firms, weighted by portfolio exposure	WACIRevenue $= \sum_{k=1}^{n} W_k \frac{E_k}{R_k}$ Where Ek is the annual carbon emissions of firm k, R_k is the annual net revenues of firm, and W_k is the weight of firm k in a portfolio such that $\sum_{k=1}^{n} W_k = 1$.
Carbon footprint by EVIC	Total emissions owned by portfolio through its investee firms, per million US$ invested.	Carbon footprint $= \frac{\sum_{k=1}^{n}(\frac{(W_k * AUM)}{EVIC_k} * E_k)}{AUM\ (\$M)}$ Where Ek are the carbon emissions of firm k and $EVIC_k$ is the enterprise value including cash of firm k.73
Carbon footprint by market cap	Total emissions owned by portfolio through its investee firms, per million US$ invested.	Carbon footprint $= \frac{\sum_{k=1}^{n}(\frac{(W_k * AUM)}{Market\ Cap_k} * E_k)}{AUM\ (\$M)}$ Where Ek are the carbon emissions of firm k and $EVIC_k$ is the enterprise value including cash of firm k.74
Owned intensity	Total emissions owned by a portfolio divided by total revenues owned by a portfolio.	Owned intensity$= \frac{\sum_{k=1}^{n}(\frac{(W_k * AUM)}{MarketCap_k} * E_k)}{\sum_{k=1}^{n}(\frac{(W_k * AUM)}{MarketCap_k} * S_k)}$ Where Ek are the carbon emissions of firm k, and Sk is the annual output of firm k, and $MarketCap_k$ is the market capitalisation of firm k.75

[71] EU Handbook of Paris-Aligned Benchmarks, accessed on 22nd July 2022.

[72] Please see: EU Commission Platform Recommendations on Data and Usability

[73] EVIC is adjusted for annual change in average asset prices according to the methodology outlined in Appendix III. Along with other reported financial data such as revenues, EVIC is taken as of the end of each company's fiscal year.

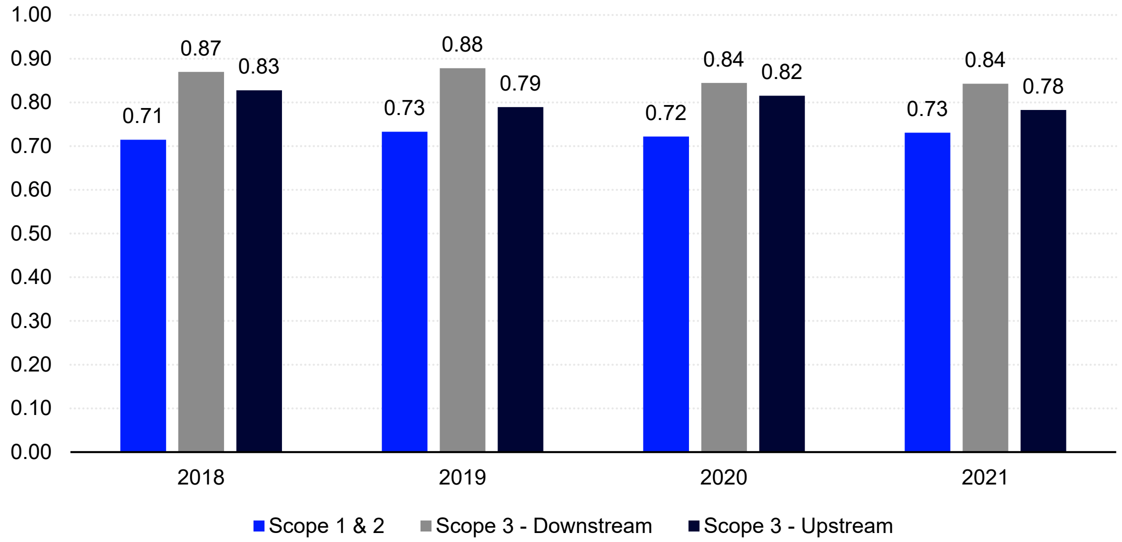
[74] Market capitalisation is adjusted for annual change in average asset prices according to the methodology outlined in Appendix III. Market capitalisation is sampled at the end of each calendar year.

[75] Market capitalisation is sampled at the end of each calendar year.

Appendix III. Additional charts

Figure 30. Scope 3 emissions generally show higher dispersion for given peer groups

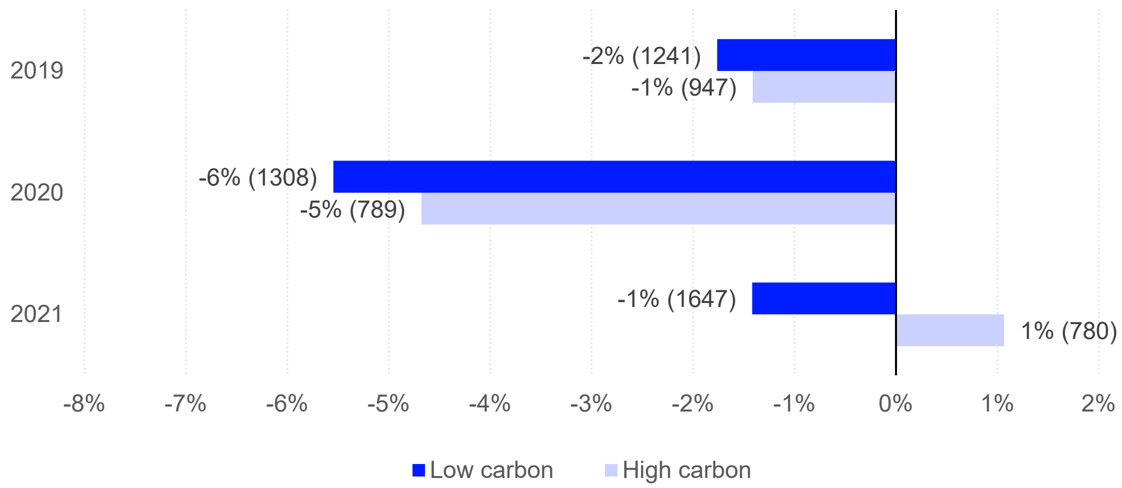
Average dispersion in carbon emissions amongst subsectors[76]



Source: FTSE Russell, September 2023.

Figure 31. Reversal for carbon-intensive industries[77]

Median change in reported emissions for consistently reporting companies by industry



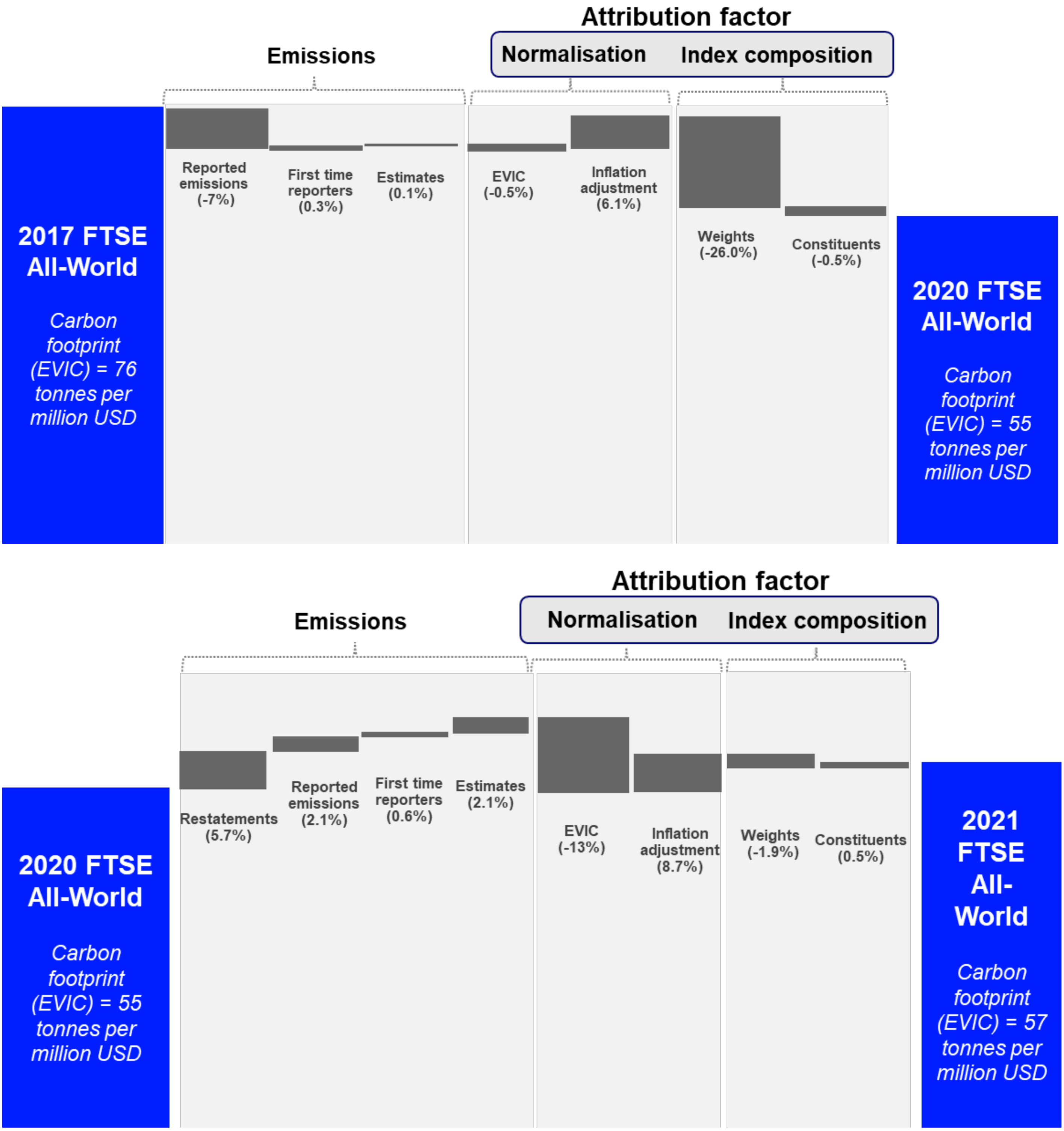
Source: FTSE Russell, September 2023.

[76] Average dispersion equates to normalised interquartile range (IQR), dividing the IQR by the sum of the third and first quartiles to allow comparison across peer groups. Note that the average dispersion is calculated at the subsector level, only including subsectors with more than 10 reported emissions observations. The calculation method is adopted from a recently published article "The challenges of mapping carbon emissions: Scope 3 – Part two". Read The challenges of mapping carbon emissions: Scope 3 – Part two (robeco.com) for more details.

[77] High-carbon intensive industries are defined as Basic Material, Utilities, Industrials and Energy

Figure 32. Disaggregating portfolio carbon intensity changes for Scope 1 and 2

Contribution by category to the change of carbon footprint, EVIC (2017–2021)



Source: FTSE Russell, September 2023.

Appendix IV. Contribution analysis

Contributions to change in WACI are calculated by taking the logarithmic change of individual factors (index weight, carbon emissions, revenues). The contribution to change in WACI from emissions ($CE_{k,t}$) between time **t** and **t-1** for a constituent **k** with greater than 0 index weight **(**$W_{j,t}$, $W_{j,t-1}$**)** is given by:

$$CE_{k,t} = \frac{ln\left(\frac{E_{k,t}}{E_{k,t-1}}\right)}{ln\left(\frac{W_{k,t}}{W_{k,t-1}}\right) + ln\left(\frac{E_{k,t}}{E_{k,t-1}}\right) - ln\left(\frac{R_{k,t}}{R_{k,t-1}}\right)} * (W_{k,t}\frac{E_{k,t}}{R_{k,t}} - W_{j,t-1}\frac{E_{k,t-1}}{R_{k,t-1}})$$

Where:

– $CE_{k,t}$ is contribution to change in WACI from emissions from constituent k at time t,

– $E_{j,t}$ is yearly carbon emissions,

– $R_{k,t}$is annual revenues,

– $W_{k,t}$ is index weight.[78]

Relevant inflation factors (or in the calculation of financed emissions, portfolio size) can be added as additional explicit factors. Individual factors can be further disaggregated once the initial contribution has been apportioned:

– Changes due to emissions can be assigned based on the source of the emission data

– Changes due to changing constituents can likewise be distinguished from general changes due to changing weights.

Appendix IV. Data sources

Financial data

Company-level financial data are sourced from WorldScope as inputs into carbon intensity calculations and estimation strategies. This includes the following metrics:

– EVIC

– Revenue

– Segment revenues (see business segment taxonomy, below)

Revenue estimates for FY2022 were retrieved from I/B/E/S, while market capitalisation was sourced from FTSE Russell.

Reported emissions

Scope 1, 2 and 3 emissions data are sourced from company disclosures (e.g., annual reports, CSR reports) and CDP annual surveys. Scope 2 location-based emissions are used as a default over market-based emissions. Location-based emissions are a more consistent proxy for electricity usage by

[78] In the unlikely event that changes in individual factors exactly cancel (change of contribution to WACI is 0), the relative contributions of individual factors will also be 0.

operations[79] and reflect changes in the underlying electricity mix of the grid and efficiency of company operations.[80]

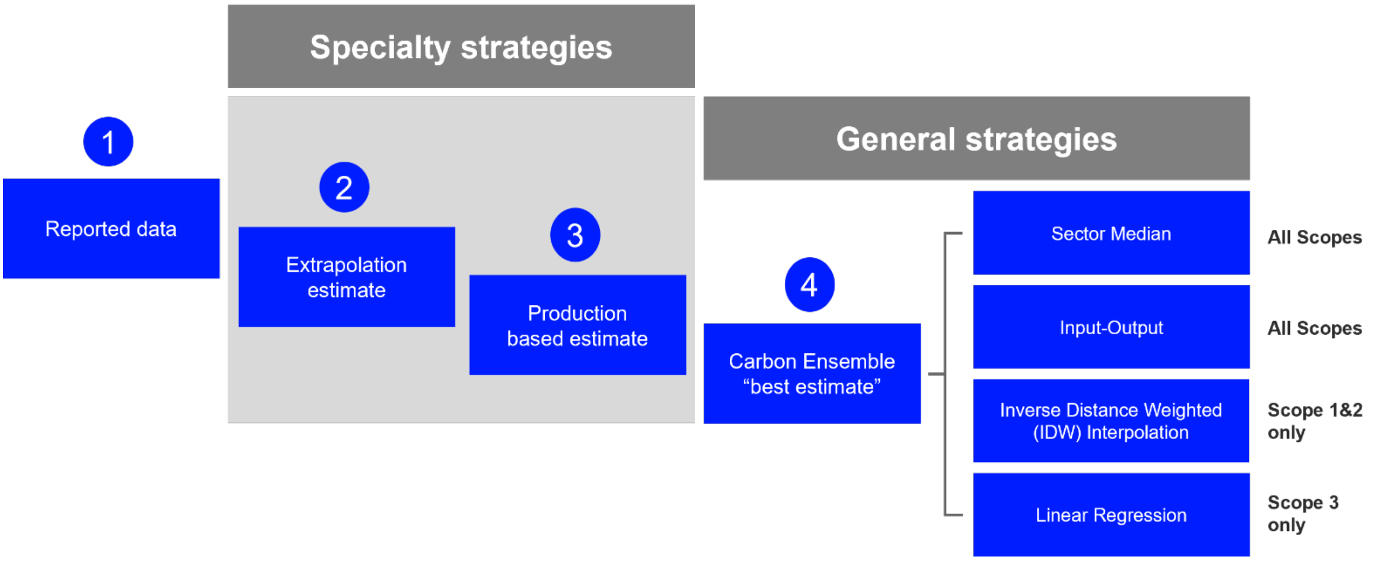
We ask issuers to review the emissions data that we have collected and provide comments if they believe the information is incorrect or incomplete. We review all company feedback and incorporate changes to our dataset where appropriate. Subsequently, all reported data are quality checked for incorrect units, extreme observations and minimum boundary conditions of the observations. As part of this process, a small number of reported datapoints (less than 1 in 200) are typically corrected or screened out.

Scope 1, 2 and 3 emissions data are winsorised at the 5% most extreme observations in terms of carbon intensity for a given fiscal year, emissions scope, and supersector (ICB2). Thus, carbon intensity observations lower than the 5th percentile or greater than the 95th percentile are set to the value of the 5th or 95th percentile respectively. The carbon emissions values are then rederived from the new carbon intensity value by multiplying by net revenue.

Estimated emissions

In practice, calculations are based on both reported and estimated data sourced from the FTSE Russell Hierarchical Multi-model framework (see details below). Due to lags in the publishing of company reported carbon numbers, we are currently utilising fiscal year 2021 as our most recent disclosed sample.

Figure 33. FTSE Russell hierarchical carbon model process uses general estimation models as a last option[81]



Source: FTSE Russell, September 2023.

[79] Matthew Brander, Michael Gillenwater, Francisco Ascui. Creative accounting: A critical perspective on the market-based method for reporting purchased electricity (scope 2) emissions. Energy Policy, Volume 112, 2018, Pages 29-33.

[80] Location-Based Scope 2 emissions use grid-average emissions factors to calculate emissions from electricity consumption, whilst market-based figures use emissions factors based on contractual energy purchase (e.g., via renewable energy credits or power purchase agreements).

[81] FTSE All-World index constituents as at 31/12/2020. Estimated data is generated based on FTSE Russell's hierarchical estimation mode outlined. Calculations consider Scope 1 and 2 quantities separately.

Extrapolation strategy

If emissions data are no longer disclosed, company reported data from previous years are extrapolated to the current year assuming constant carbon intensity over time. In other words, previously reported carbon intensity is multiplied by current revenues to derive an emissions estimate. For this purpose, we consider up to three years of data, selecting the most recent available disclosure.

Energy production strategy

For the Utilities industry, the energy production approach estimates company carbon emissions by applying emissions factors (i.e., emissions per unit energy) to corporate reported energy production. Where a company reports a breakdown of the fuel sources it has used to generate energy (e.g., coal, gas or hydroelectricity), emissions factors used to generate absolute emissions figures from each source are summed to produce an aggregate emissions total from energy generation.

Emissions factors are derived from the IPCC emissions factor database, using the life cycle emissions factor for each resource as the more consistent and conservative value. Energy sources considered include:

- **Fossil Fuels**: Coal, Oil, Gas and/or Combined Cycle Gas Turbines
- **Hydroelectric**
- **Renewables**: Wind, solar, geothermal, biomass, overall renewables (if not otherwise broken down)

Carbon Ensemble ‘best estimate’

Common approaches to estimating corporate carbon emissions draw on a range of inputs and statistical techniques. Most frequently, a company’s sector and region of operation, its reported financial metrics, and the emissions of peer firms are considered through an array of methods (e.g., simple peer comparisons, linear regressions) to generate an estimation of a company’s carbon intensity. Another common technique derives the carbon intensity of industrial activities from environmentally extended input-output (EEIO) tables rather than reported emissions figures.

There is overlap in the core steps followed by common estimation strategies for example, most strategies rely on a sector mapping or revenue classification to appropriately designate a peer group for the firm. However, strategies differ in their statistical method, use of disclosed data, and how they classify and partition these industrial activities. Their effectiveness varies on a sector-to-sector and company-to-company basis, depending on the sector diversity and company activities, or how well strategies model the business context of a given firm.

The FTSE Russell Carbon Ensemble model for Scope 1 and 2 is the median of the sector median, interpolation, and input-output strategies on the level of company and emissions scope. If a value for one or more of the strategies is not available, the median will be completed on the remaining values.

Sector taxonomies

FTSE Russell’s Industry Classification Benchmark[82] (ICB) is used to create peer groups for the sector median estimation strategy as well as in the winsorisation of extreme values.

Business segment taxonomy

Two business segment mappings, US SIC[83] and NACE taxonomies, are utilised to make use of multiple third-party data providers. By default, we utilise US SIC taxonomy to define business segments, and segment revenues are sourced by WorldScope. Exiobase, provider for the input-output data, uses NACE taxonomy to map business activities. We use an internal conversion table to map estimated intensities by NACE code to SIC code.

[82] Industry Classification Benchmark (ICB), FTSE Russell, accessed 10/03/2022.

[83] Standard Industrial Classification (SIC) Manual, Occupational Safety and Health Administration, accessed 10/03/2022

Environmentally extended input-output (EEIO) tables

We use the Exiobase3 table to create Scope 1 and 2 business activity carbon intensities for the input-output strategy and energy-source based emissions intensities for the energy production model. Exiobase is a "multi-regional environmentally extended input-output table" (MRIOT-EE) derived from national resource-usage tables.[84] Exiobase uses its own product and industry classification with any given industry producing one or more different products.

Inflation adjustments

Inflation adjustments have been made in carbon exposure metrics wherever necessary to eliminate the bias of inflation in trend analysis for carbon intensity. Currency and asset inflation adjustments have been made to revenues and EVIC, respectively.

- Values for carbon intensity have been adjusted against the US GDP deflator as retrieved from the World Economic Outlook database of the International Monetary Fund.[85] Company-specific revenue data are converted to US dollars according to the local, point-in-time exchange rate.
- The EVIC adjustment factor is calculated by dividing the average EVIC of the equity universe by that of the average EVIC of 2021, as suggested by the Climate Benchmark Handbook of the EU Commission.[86] A more recent submission has proposed that an asset value inflation factor should be calculated for each individual constituent, based on the changes in its market value since the initial period of analysis.[87]

Regional classification information

We assign companies to a region to create peer groups for several estimation strategies: the sector median and regression strategies. For this, we largely align our regional definitions with those used within the FTSE Global Equity Index Series,[88] but combine classifications for Japan, China and Asia Pacific ex China ex Japan to create a larger dataset of reported data for these regions where disclosure is often more limited.

[84] Exiobase3 Data Download, Exiobase, accessed 08/02/2022.
[85] World Economic Outlook. https://www.imf.org/en/Publications/WEO, IMF, accessed 01/23/2022.
[86] EU Handbook of Paris-Aligned Benchmarks, accessed on 22nd July 2022.
[87] Please see: EU Commission (2022) EU Commission Platform Recommendations on Data and Usability
[88] Global Equity Index Series, FTSE Russell, accessed 07/03/2022.

Figure 34. Regional aggregation

Developed Europe	Emerging Europe	North America	Latin America	Developed APAC	Emerging APAC	Middle East & Africa
Austria	Czechia	Canada	Brazil	Australia	India	Egypt
Belgium	Greece	United States	Chile	Hong Kong	Indonesia	Israel
Denmark	Hungary		Colombia	Japan	Malaysia	Qatar
Finland	Russia		Mexico	Korea	Pakistan	Saudi Arabia
France	Turkey		Peru	New Zealand	Philippines	South Africa
Germany				Singapore	Taiwan	UAE
Ireland					Thailand	
Italy					China	
Netherlands						
Norway						
Poland						
Portugal						
Spain						
Sweden						
Switzerland						
United Kingdom						

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