LSEG

Investing in the green economy 2024

Growing in a fractured landscape

AUTHORS

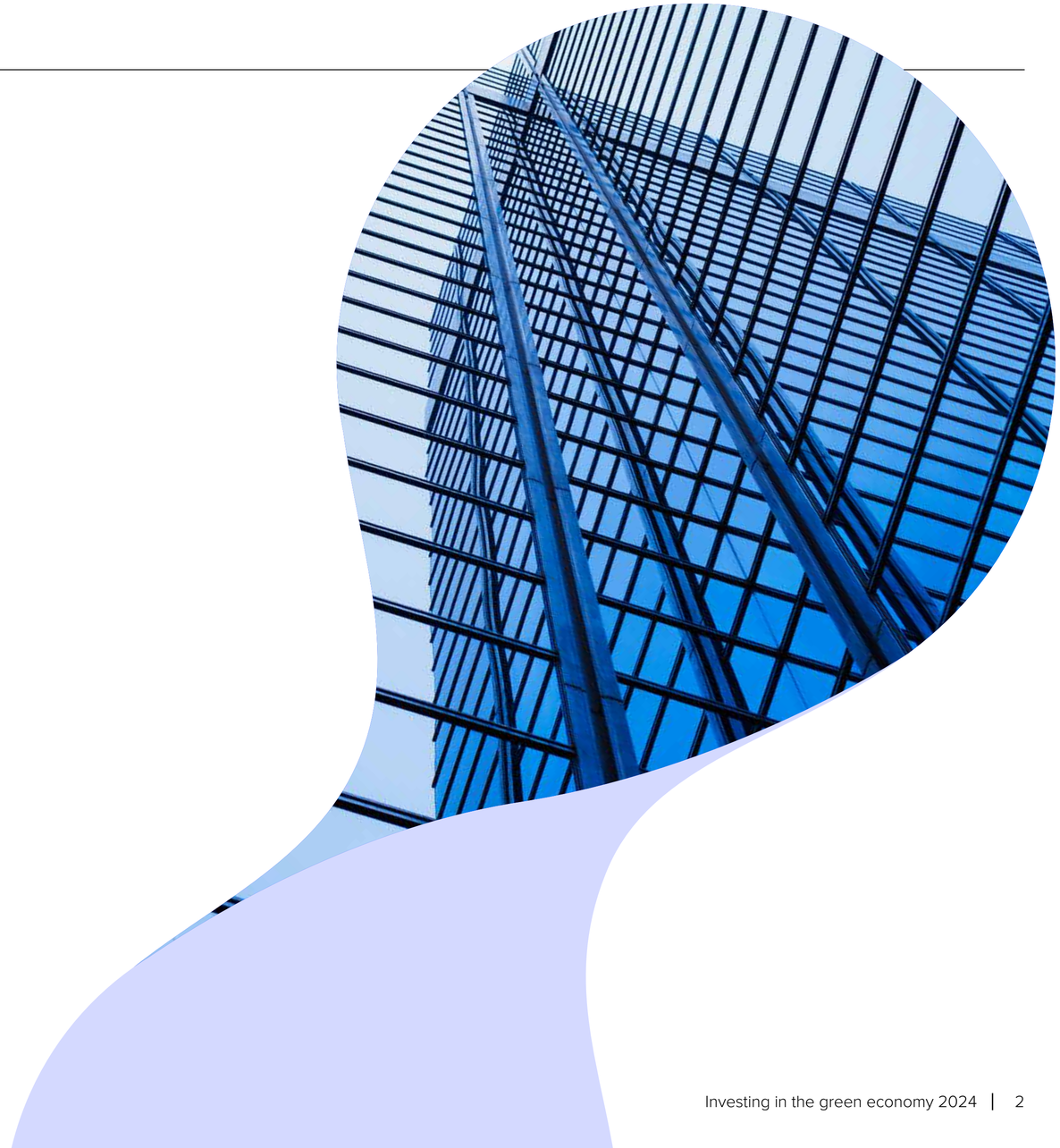
Lily Dai
Senior Research Lead, Sustainable Investment Research

Lee Clements
Head of Applied Sustainable Investment, Global Investment Research

Alan Meng
Research Lead, Sustainable Investment Research

Beth Schuck
Research Analyst, Sustainable Investment Research

Jaakko Kooroshy
Global Head of Sustainable Investment Research



Introduction

Transitioning to a more sustainable economic system that balances economic development with maintaining healthy global ecosystems requires significant investment, with estimates ranging from US$109 trillion to US$275 trillion by 2050 to address climate change alone.[1] These investments flow to products and services that help to reduce emissions and address other global environmental challenges, from renewables and clean water to green transport and waste management, benefitting a broad range of companies and value chains which make up the global green economy.

At LSEG, we have been developing proprietary data, analytics and index solutions to measure company exposure to the green economy since 2008. Our approach includes a bottom-up assessment of more than 19,000 companies globally, with granular green revenue data categorised across 133 green products and services defined by the FTSE Russell Green Revenue Classification System (for more information see Green Revenues data model). These tools help to identify green investment opportunities and track their performance, but also calibrate the exposure of equity and bond portfolios to climate solutions and the green economy.

This fifth edition of our annual Green Economy Report uses these datasets and insights to take stock of the growth, composition and financial performance of the global green economy across asset classes. The report comprises five sections:

1 **SECTION 1**
Update on the state of the green economy, including its size and growth over the short and long term

2 **SECTION 2**
Investment characteristics of the green economy, such as performance, valuation and fund flows

3 **SECTION 3**
Green economy in fixed income, with insights on green bond issuance and allocation of proceeds

4 **SECTION 4**
Spotlight on the Tech sector with its increasing demand for electricity, and interactions with the green economy

5 **SECTION 5**
Granular assessment of the composition of the green economy across industries and global value chains

[1] *FTSE Russell (2022). Green equity exposure in a 1.5°C scenario.*

Executive summary

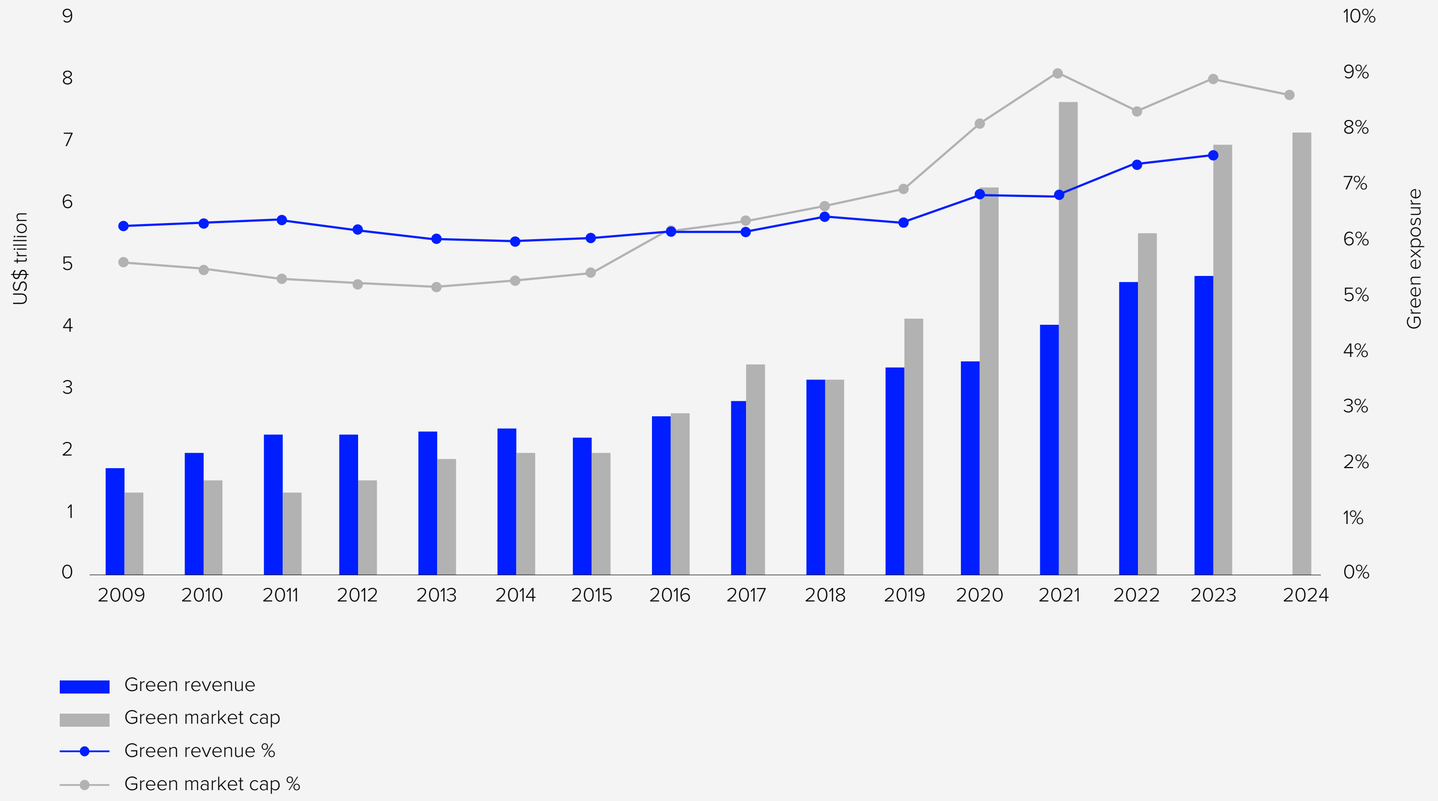
The global green economy, a market providing climate and environmental solutions, has expanded considerably over the last decade, representing a significant investment opportunity. In 2023 it made a strong recovery from a sharp decline in 2022, with its market capitalisation reaching US$7.2 trillion in Q1 2024 (Figure 1).

However, headwinds remain, such as overcapacity issues and trade barriers related to renewable energy equipment and electric vehicle (EV) manufacturing. Following downsizing at some large US green companies earlier this year, the share of the green economy in the market[2] dropped slightly from 8.9% at the end of 2023 to 8.6% in Q1 2024. Despite market volatility and increasingly complex geopolitical risks (discussed in last year's report[3]), the green economy is expanding. Its long-term growth (10-year CAGR of 13.8%) outpaces the broader listed equities market.

If it were considered as a standalone sector, the green economy would have been the second-best-performing industry (represented by the FTSE Environmental Opportunities All Share (EOAS) Index) over the last 10 years, outpaced only by the stellar performance of the Technology sector (Figure 2). During 2023, the EOAS was up 32% versus the 22% of its benchmark FTSE Global All Cap Index.

Between its inception in 2008[4] and the end of March 2024, the EOAS outperformed the benchmark by 82%. However, performance is not evenly distributed across green sectors. Energy Efficiency has been by far the best-performing green sector, as well as the largest (46% of the green economy and 30% of the proceeds from green bonds), covering, for example, efficient IT equipment and green buildings. Renewable Energy, on the other hand, has been lagging, and has underperformed in 2023.

Figure 1. Green economy 2009–2024



Note: Green Revenues data for 2009 to 2015 is extrapolated using Green Revenues 2.0 available from 2016, and minimum and maximum green revenues available from 2009. Green Revenue is calculated by aggregating all the green revenues from companies in the universe. Green Revenue% is calculated by dividing Green Revenue by total revenues from companies in the universe. Green Market Cap is the Green Revenue weighted market capitalisation, calculated by aggregating market capitalisation multiplied by company green revenues. Green Market Cap% is calculated by dividing Green Market Cap by total market capitalisation of companies in the universe. 2024 Green Market Cap and Green Market Cap% data is based on the latest Green Revenues data available (financial year 2022 or 2023) and the free float market capitalisation as of April 2024.

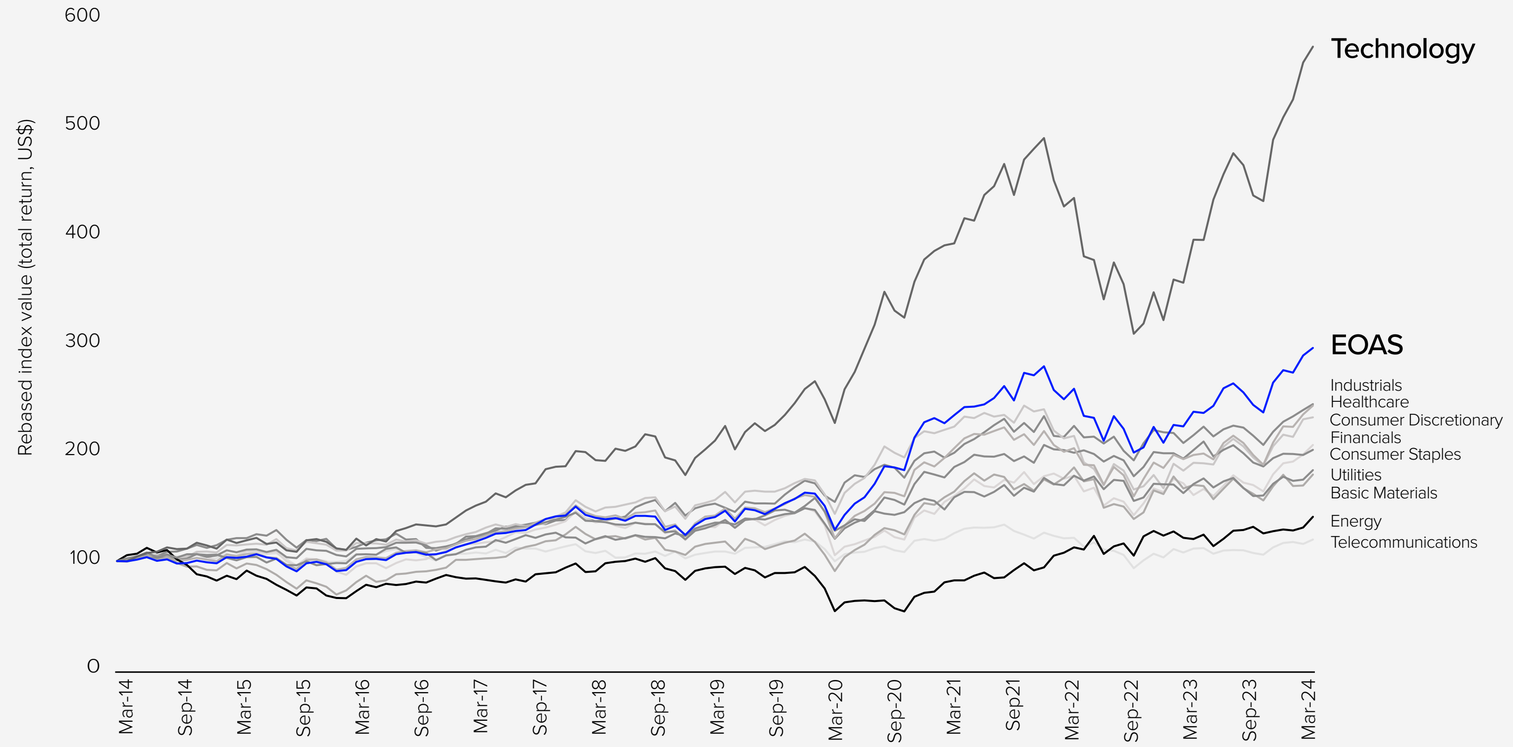
Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024. LSEG Revenue data as of December 2023.

[2] Green revenue weighted market capitalisation versus the total market capitalisation of companies in the universe.

[3] LSEG (2023). Investing in the green economy 2023

[4] Total return in US$.

Figure 2. Performance of the green economy against other ICB industries[5]



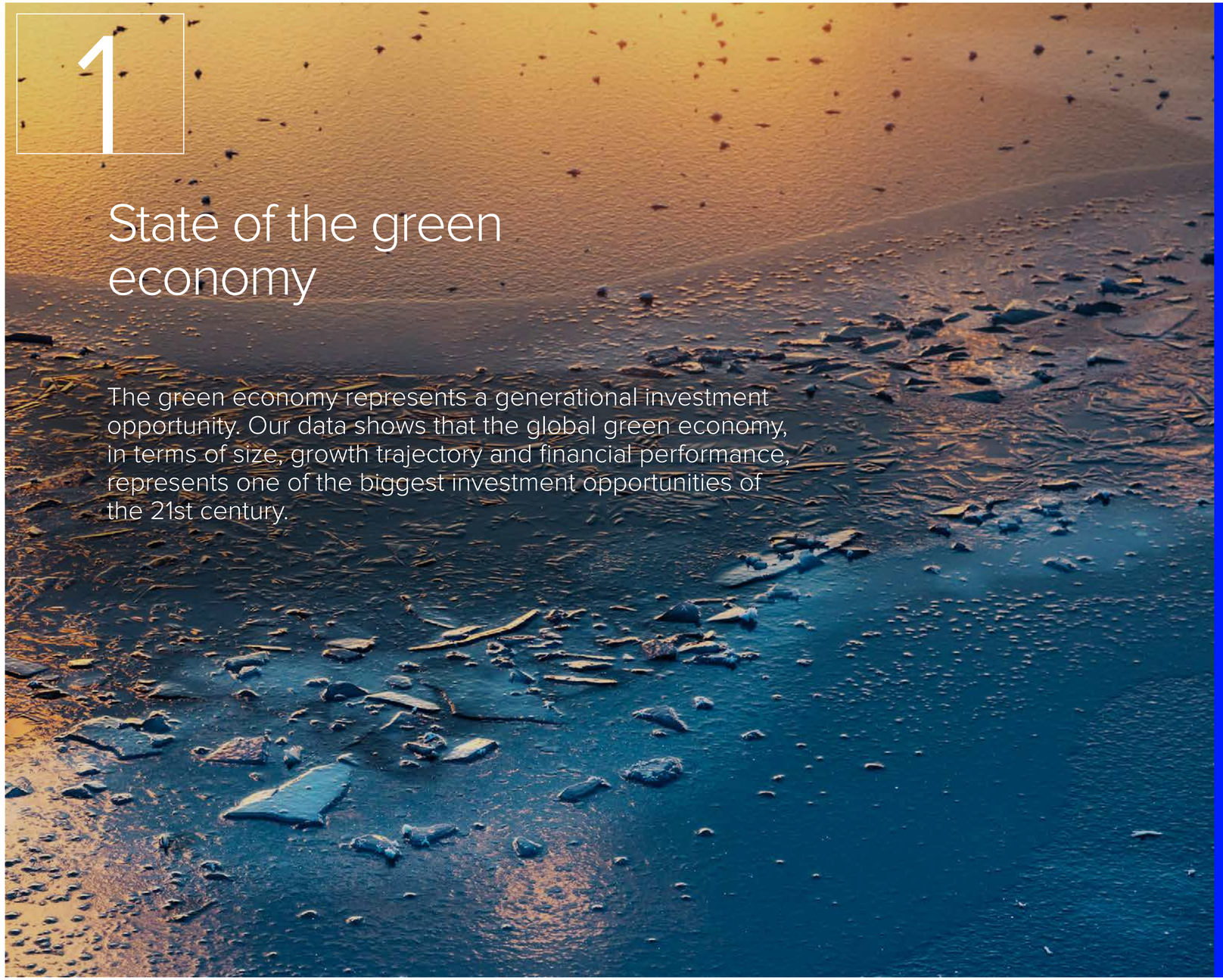
Source: LSEG

The green economy is diverse, spanning industries and global value chains. Almost all industries generate green revenues. Technology is by far the largest sector (US$2.3 trillion of market capitalisation) and Automobiles has the highest green penetration rate (42%). While more than 50 developed and emerging markets contribute to the green economy, the US is the largest market in 2024 (due to the sheer size of the US equity market and large companies such as Tesla), followed by Taiwan (due to the semiconductor industry) and China.

In the fixed income asset class, the **green bonds market sustained momentum with US$540 billion issued in 2023** despite high interest rates. Although green bond annual issuance in 2023 was still lower than the peak in 2021, it had bounced back from the weaker 2022 level. Newly issued green bonds now account for around 6% of the total bond offerings each year. However, outstanding green bonds only represent 2% of the bond market (US$2.5 trillion in Q1 2024); meanwhile carbon-intensive bond issuance is approximately 2.5 times higher than green bond issuance each year.[6] There is potential for further growth in the green bond markets if the low-carbon transition accelerates.

The unprecedented growth of digital technologies, notably artificial intelligence (AI) and data centres, may become a new driver for further growth and development of the green economy. Tech giants are concerned with their increasingly significant energy consumption and environmental footprints and are becoming the largest buyers of renewable energy. Microsoft recently set the record for the single largest corporate clean energy power purchase agreement (PPA)[7] – US$10 billion for 10.5GW of solar and wind energy.[8] In addition, more energy-efficiency improvement, which is another area of potentially rapid growth, is needed in areas including chips and servers, cooling systems, hyperscale data centres and energy-demand management.

[5] *FTSE Russell Industry Classification Benchmark (ICB) industries.*
[6] *LSEG (2024). Tracing Carbon-intensive debt – Identifying and calibrating climate risks in corporate fixed income.*
[7] *Purchasing power agreement, a contract to purchase clean energy at a predetermined price and quantity.*
[8] *Microsoft signs biggest-ever corporate PPA for green energy*



1

State of the green economy

The green economy represents a generational investment opportunity. Our data shows that the global green economy, in terms of size, growth trajectory and financial performance, represents one of the biggest investment opportunities of the 21st century.

Revenue pool almost

$5T

Market cap

>$7T

2nd

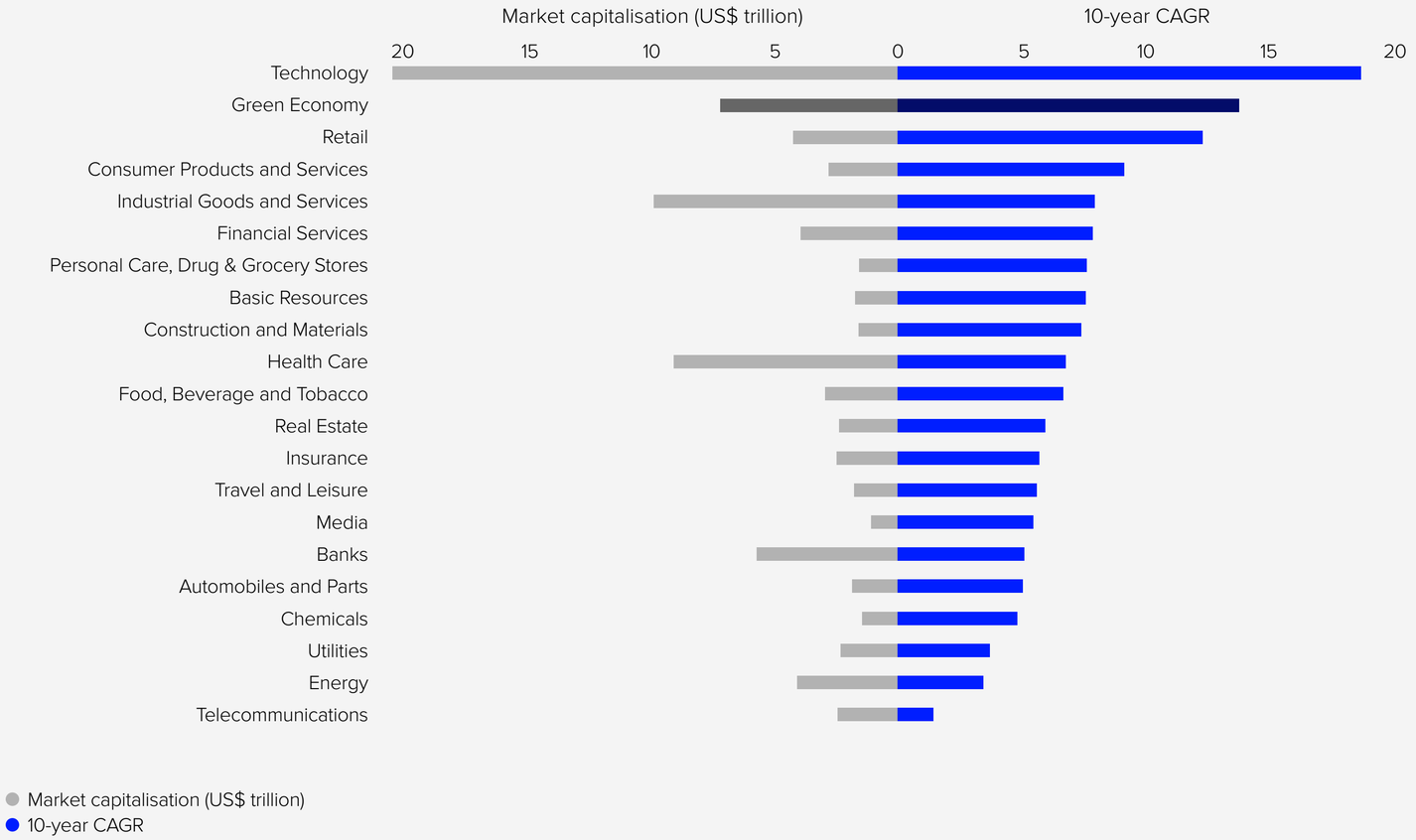
best performing industry over the last 10 years

13.8%

10-year CAGR

- If viewed as a standalone sector, the listed part of the green economy would have been an annual revenue pool of almost US$5 trillion in 2023, with a market capitalisation in excess of US$7 trillion. This amount would make it the fourth largest sector, ahead of Banks, Retail and Energy, and only surpassed by Health Care, Industrials and Tech (Figure 3).
- In terms of growth and financial performance over the past decade, the green economy has been second only to the Technology sector. If the green economy, represented by the FTSE Russell Environmental Opportunities All Share Index (EOAS), were an ICB Industry in its own right, it would have been the second-best-performing industry over the last 10 years, outmatched only by the stellar performance of the Tech sector. The EOAS has been outperforming the benchmark FTSE Global All Cap by 82% since 2008, in particular during 2020–2021 (see section 2).
- The market capitalisation of the green economy has expanded at a 10-year compound annual growth rate (CAGR) of 13.8% versus 8.3% for global equity markets (Figure 3).[9] Revenues from the green economy have grown at 7.6% CAGR over the past decade, more than two percentage points higher than the growth rate of combined revenues from all companies in the universe (5.3% CAGR).
- Within the green economy, Energy Management and Efficiency has been the largest and best-performing green sector. Having grown at 17% CAGR over the last five years, it now accounts for 46% of the green economy in listed equities and 30% of proceeds from green bonds. The sector has been leading the outperformance of the EOAS compared to other green sectors such as Water and Renewable Energy.

Figure 3. Market capitalisation value and 10-year growth rate – Green Economy compared with ICB sectors[10]



Note: Green revenue-weighted market capitalisation, calculated by aggregating market capitalisation multiplied by company green revenues. Based on the latest Green Revenues data (financial year 2022 or 2023) and the free-float market capitalisation as of April 2024.
Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

[9] Global market capitalisation is calculated by summing free-float market capitalisation of companies in the universe. 10-year time period from 2014 to 2024.
[10] Super sectors under the FTSE Russell Industry Classification Benchmark (ICB).

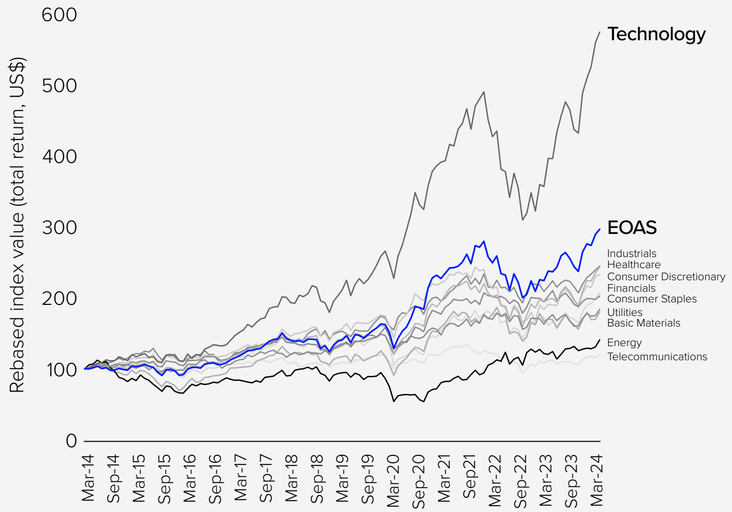
Post-pandemic performance has remained volatile

A combination of supply chain disruptions, cost inflation and higher interest rates, as well as increasing geopolitical fragmentation and green protectionism, have underpinned a volatile green-economy performance since 2020. After a rapid expansion in 2020 and 2021, followed by a significant drop in 2022, the market capitalisation of the green economy recovered throughout 2023 and early Q1 2024, reaching just under 9% of global market capitalisation (Figure 5).

As discussed in last year's report, the global green economy has become a critical consideration in geopolitics, as policymakers seek to tackle climate change and other environmental challenges, alongside energy security and economic development. Large-scale subsidies and trade restrictions continue to be deployed widely as governments attempt to 'onshore' strategically important green industries. For example, the US and the EU have both recently announced plans for significant tariffs (of 100% and 17%–38% respectively) on electric vehicles imported from China.[11,12]

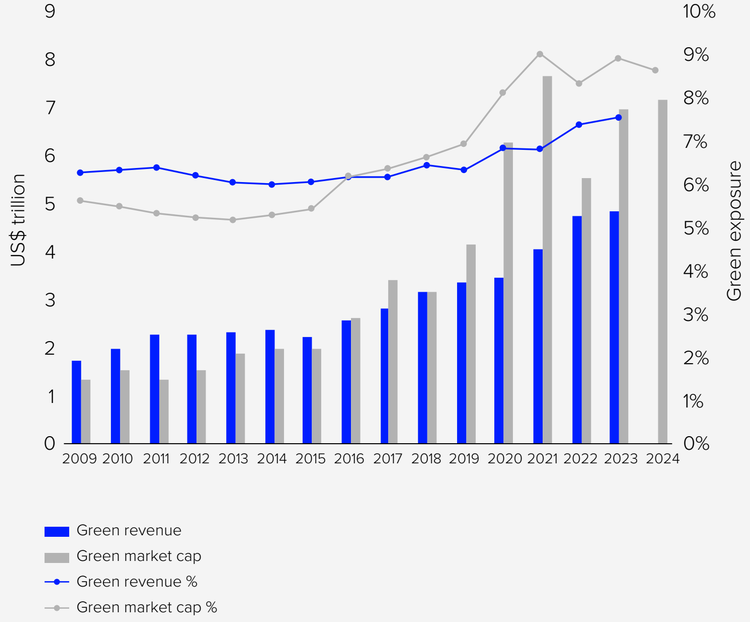
Meanwhile, headwinds remain, and the decoupling of global supply chains risks introducing structural and cost inefficiencies and delaying the green transition. During 2023, strong green revenue growth from companies in the Autos, Industrial Goods & Services, and Construction & Material sectors was offset by contracting green revenues in the Utilities, Chemicals, and Basic Resources sectors, notably in Europe. As a result, the growth of green revenues from 2022 to 2023 was relatively minor, reaching US$4.8 trillion in 2023, or 7.5% of combined revenue of the companies in the universe.

Figure 4. Performance of the green economy against other ICB industries



Source: LSEG

Figure 5. Green economy 2009–2024



Note: Green Revenues data for 2009 to 2015 is extrapolated using Green Revenues 2.0 available from 2016, and minimum and maximum green revenues available from 2009. Green revenue is calculated by aggregating all the green revenues from companies in the universe. Green Revenue% is calculated by dividing Green Revenue by total revenues from companies in the universe. Green Market Cap is the Green Revenue weighted market capitalisation, calculated by aggregating market capitalisation multiplied by company green revenues. Green Market Cap% is calculated by dividing Green Market Cap by total market capitalisation of companies in the universe. 2024 Green Market Cap and Green Market Cap% data is based on the latest Green Revenues data available (financial year 2022 or 2023) and the free-float market capitalisation as of April 2024.

Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024. LSEG Revenue data as of December 2023.

[11] *Financial Times (June 2024). What the EU's tariffs on electric vehicles mean for China (ft.com)*
[12] *BBC News (May 2024). Biden hits Chinese electric cars and solar cells with higher tariffs - BBC News*

2

Green investment trends

As mentioned previously, the green economy, represented by the FTSE Environmental Opportunities All Share Index (EOAS), has been outperforming the market benchmark over the long term, with strong performance in 2023 that marked a recovery from a 2022 decline.

Performance was not evenly distributed across green sectors. Energy Efficiency has been the best-performing sector. By contrast, Renewable Energy, the most visible sector of the green economy, has been a conspicuous laggard. Comparing performance against valuation with P/E ratio, the premium of green companies to the broader market began to fall during 2023, having peaked at 40% in 2021. The attribution analysis of the EOAS shows that the long-term performance of the index is largely driven by selection effects rather than allocation effects.

FTSE Environmental Opportunities All Share Index in 2023

▲32%

Leading sector

Energy Efficiency

Underperforming sector

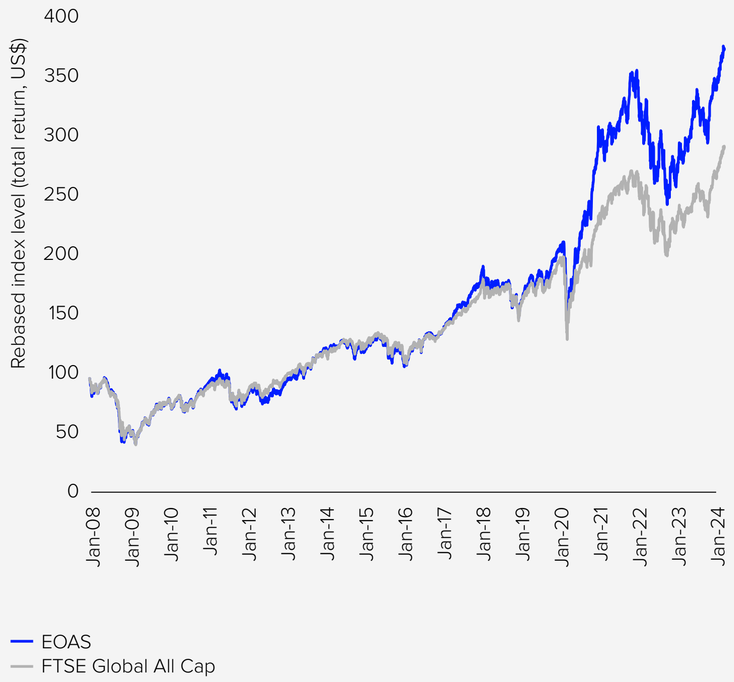
Renewable and Alternative Energy

Performance of green companies

Green companies performed strongly in 2023, as shown by the FTSE Environmental Opportunities All Share Index (EOAS) – powered by FTSE Russell Green Revenues data – which was up 32% versus 22% for the benchmark FTSE Global All Cap Index. Since its inception in 2008, the EOAS has outperformed the benchmark by 82% to the end of March 2024,[13] with particularly strong outperformance in 2020 and 2021, vindicating the position of the green economy as an attractive investment theme after the underperformance of the market in 2022.

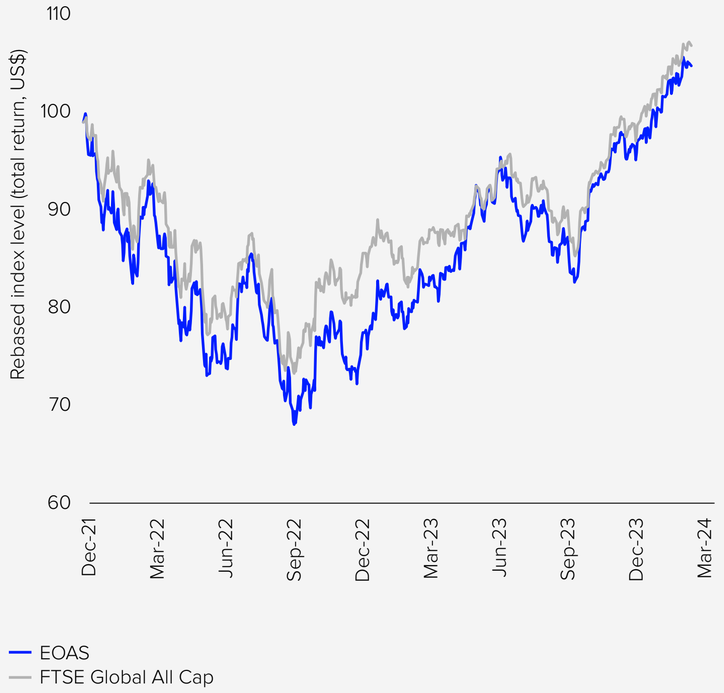
Throughout history, the green economy has seen multiple periods of both outperformance and underperformance, typically between ~+-10%, except for the very strong outperformance in 2020 (peaking at 31%). EOAS performance suffered in 2022 as high-growth companies, and the Technology sector in particular (where the EOAS is overweight), were negatively impacted by rising interest rates. However, it made a strong recovery in 2023, particularly in the first half of the year.

Figure 6. Long-term performance of the green economy vs the market



Source: LSEG

Figure 7. Short-term performance of the green economy vs the market



Source: LSEG

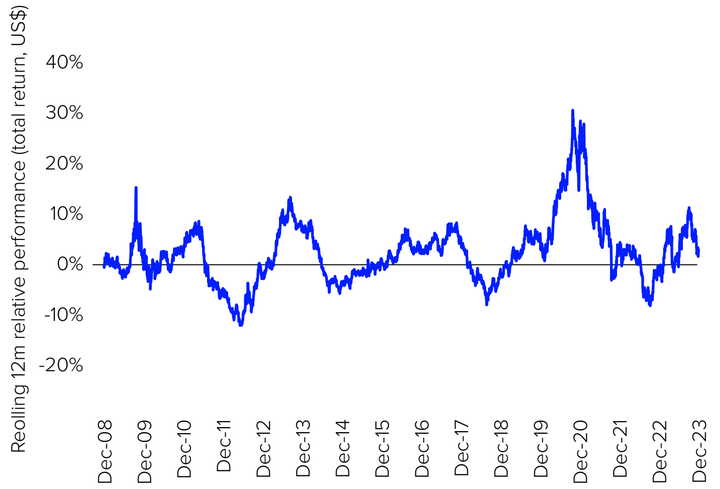
[13] *Total US$ return.*

With the exceptional performance of the green economy in 2020–21, followed by the volatility in the broader market from 2022, the tracking error of the EOAS rose substantially. It then fell through 2023 and into 2024 but has not yet returned to its pre-COVID levels.

The green economy's strong performance has been predominantly driven by the Energy Efficiency sector, while the highly visible Renewable Energy sector has seen significant pressure on profitability, leading to notable underperformance. Energy Efficiency has been by far the best-performing green sector, propelled by the cost-effectiveness of many energy-efficiency solutions and the presence of leading Technology companies in the sector (combined with the demand to improve the efficiency of the rapidly growing and energy-hungry IT sector). By contrast Renewable and Alternative Energy, the most visible area of the green economy and an area of focus for many green thematic investing products, has historically been a laggard in terms of performance and has suffered underperformance in 2023 despite record renewables installations.

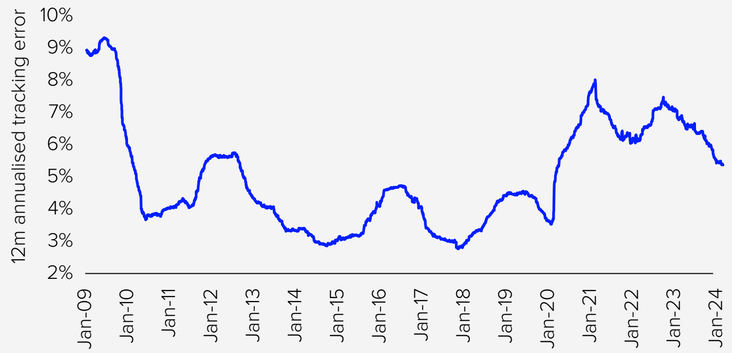
Geographically, the US has been the best performing part of the green economy in 2023. Although this is closely tied to the strong performance of the broader US equity market and the Technology sector over this period.

Figure 8. 12m-rolling relative performance of the green economy vs the market



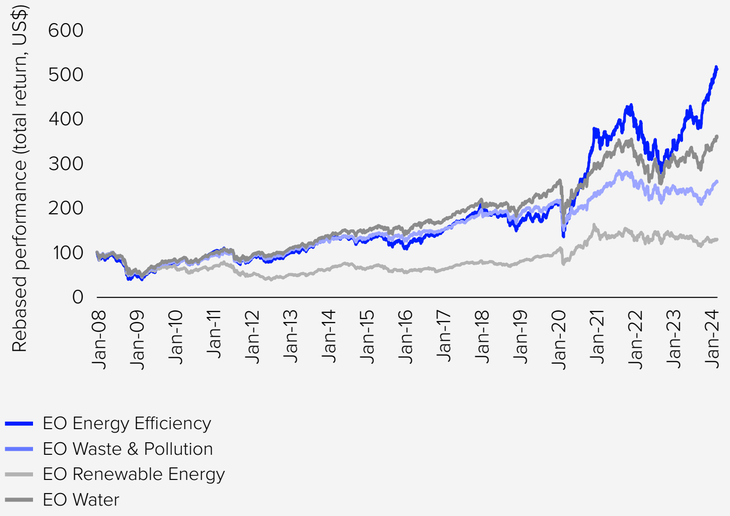
Source: LSEG

Figure 9. 12m-rolling tracking error of the green economy vs the market



Source: LSEG

Figure 10. Performance by green sector



Source: LSEG

Valuation of green companies

Green economy companies have traditionally been traded at a premium to the broader market, making them one of the most expensive areas of sustainable investment. This premium reached almost 40% in 2021 as strong performance and strong capital flows drove up valuations. In 2023, valuations started to come down significantly as forecast EPS growth increased, particularly for renewable energy companies recovering from a collapse in profitability.

Where does the performance come from?

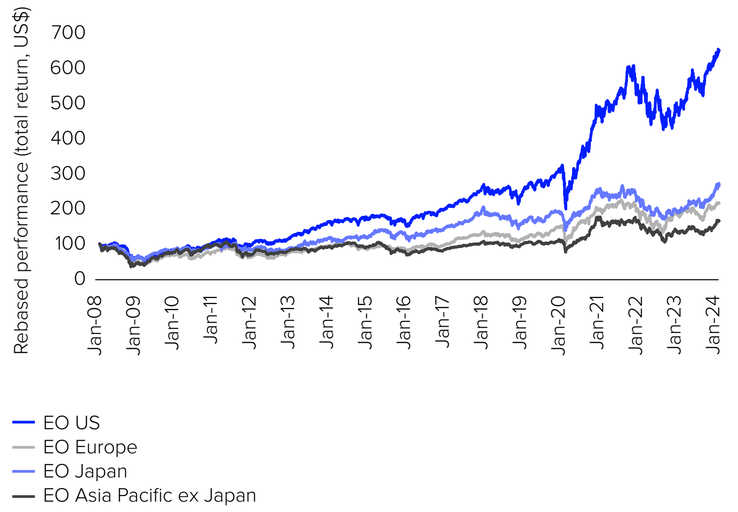
While the green economy is substantial and growing, with its impact being felt throughout the broader economy, companies with a substantial focus on the green economy remain a distinct subset of listed equities. As such, an index focused on the green economy, such as the EOAS, has a large active share versus the broader market. The differences form a combination of both a distinctly different weighting of industries versus the broader market, and a different spread of companies within industries. Overall, the EOAS is around 86% different (active share) from the broader global equity market.

The EOAS's largest overweight is to Industrials, with many industrial companies producing equipment or services to enable greater efficiency and green solutions. There are also strong overweights to Technology and Utilities. The largest underweights are in Financials, Healthcare and Consumer Staples.

In the 12 months to March 2024, performance of the EOAS was slightly ahead of the broader market, with roughly equal impacts from allocations and selection. This comes despite allocation effects having played the larger part in the EOAS underperformance in 2022 and outperformance in 2023. The overweight in Technology and the underweights in Consumer Staples, Financials, Healthcare and Energy drive the positive allocation effect, while negative selection effects came from not including certain high-performing Technology names, combined with a large weighting in Tesla.

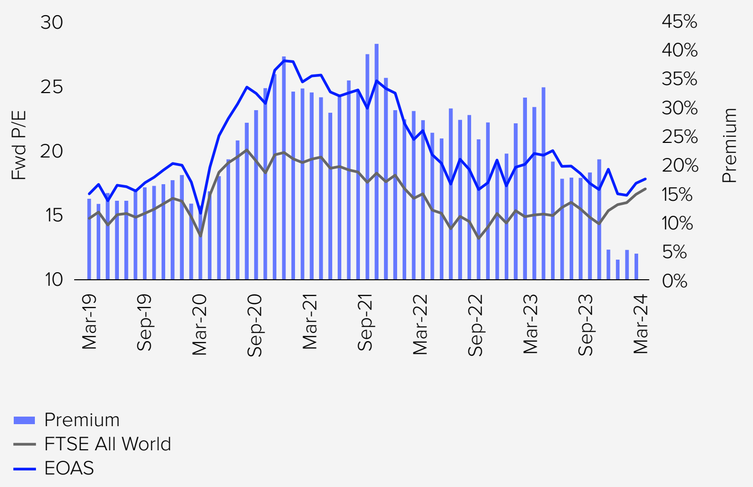
However, examining a longer period, the selection effect becomes much more important than the allocation effect i.e., it is the selection of specific companies that is more important than companies falling conveniently within the industries allocated by the index. Over both five-year and 10-year horizons, ~80% of EOAS outperformance comes from selection effects, predominantly from companies in the Industrial and Consumer Discretionary sectors.

Figure 11. Performance by country



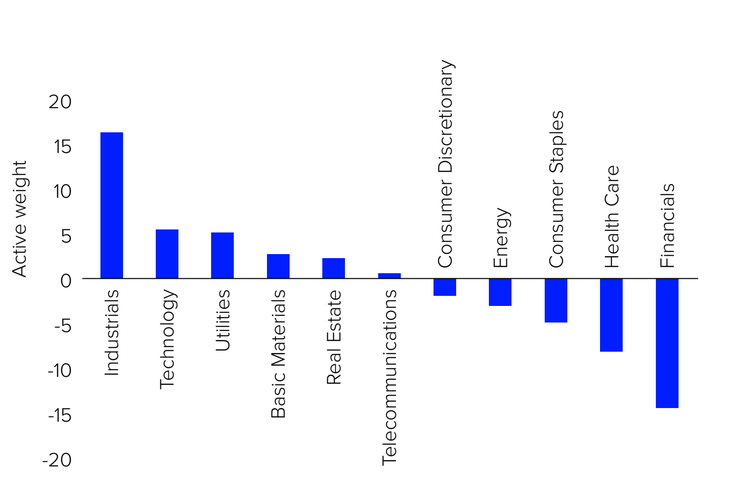
Source: LSEG

Figure 12. Forward P/E Ratio and Premium



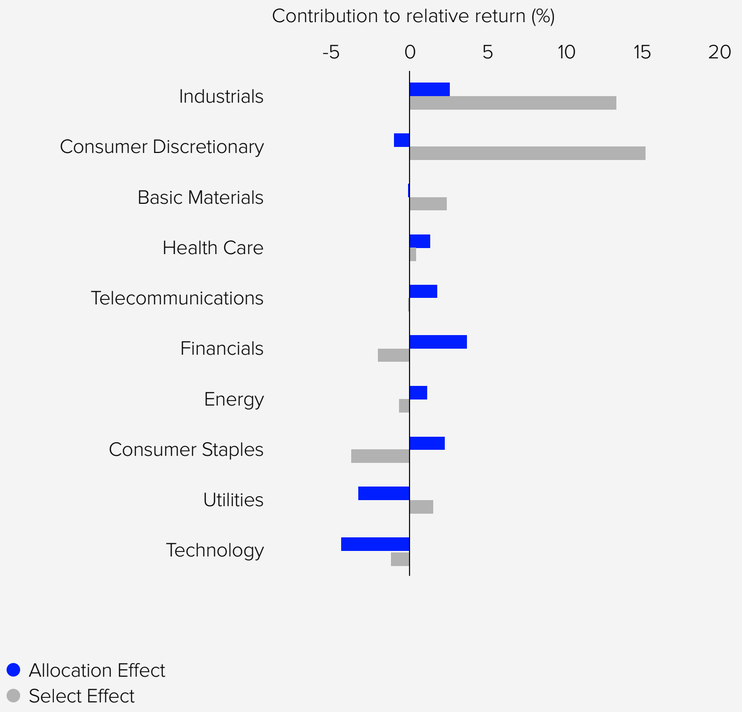
Source: LSEG

Figure 13. EOAS active weights by ICB Industry



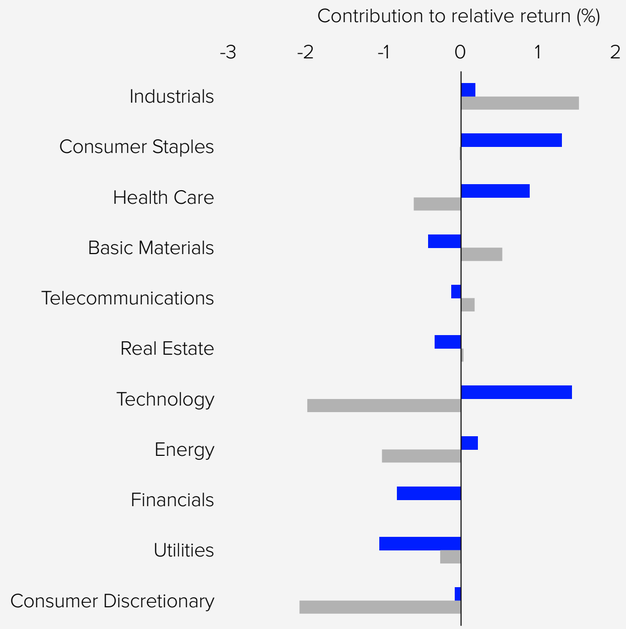
Source: LSEG

Figure 14. 5-year EOAS attribution by ICB Industry



Source: LSEG

Figure 15. 10-year EOAS attribution by ICB Industry

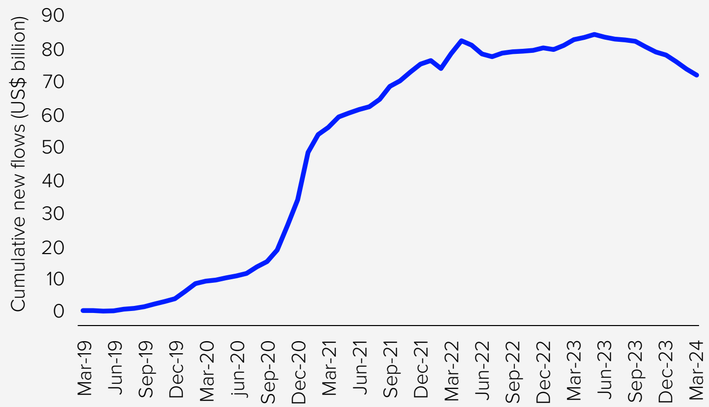


In line with the broader market, the majority of the performance of the EOAS in both the short and long term has come from the US, where it is overweight.

Fund flows

Despite a strong performance recovery in the green economy in 2023, investors, particularly those with exposure to the underperforming Alternative Energy sector, started to pull funds out of exchange-traded funds (ETFs) and mutual funds specialised in those themes.

Figure 16. Cumulative fund flows in alternative energy & water thematic equity ETFs and mutual funds

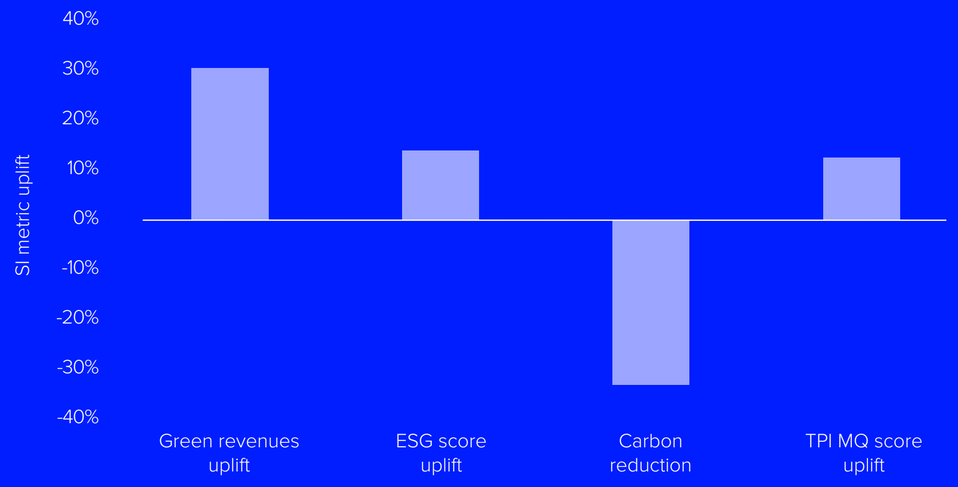


Source: LSEG

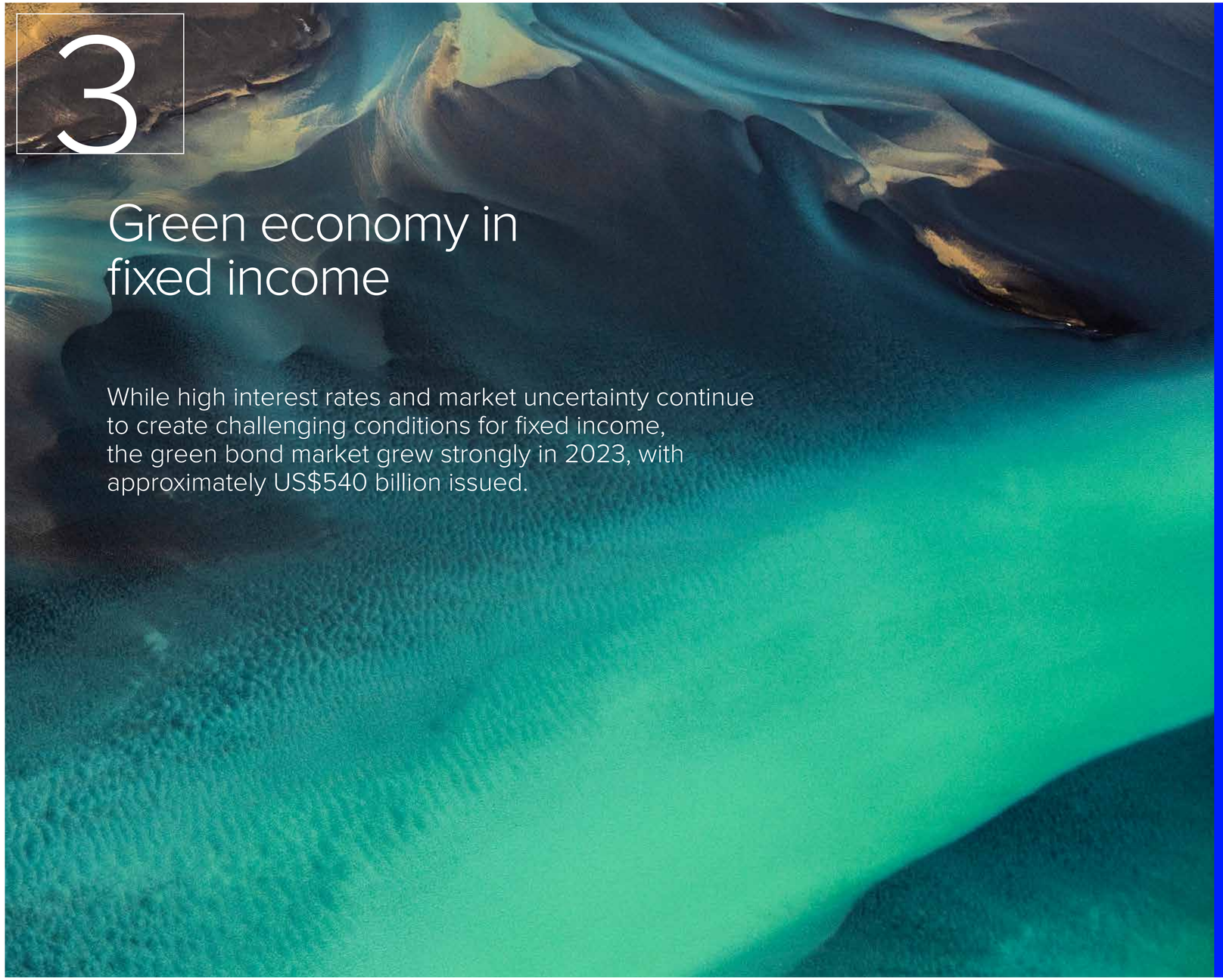
Sustainable Investment metric uplifts of the EOAS

In addition to the benefit of gaining exposure to the green economy, green thematic indices, such as the EOAS, also exhibit strong sustainable investment (SI) characteristics on other metrics. Alongside a 31% uplift in exposure to the green economy, the EOAS shows strong uplifts in ESG score and TPI MQ score, the highest of the five main FTSE Russell global SI indices (see Sustainable Investment Insights - April 2024 | LSEG). Carbon intensity is the main challenge for green thematics, with the industry differences leaving little exposure to low-carbon-intensity industries like Financials and Healthcare, leading to an increase in carbon intensity versus the benchmark.

Figure 17. EOAS SI metric uplifts vs benchmark



Source: LSEG



3

Green economy in fixed income

While high interest rates and market uncertainty continue to create challenging conditions for fixed income, the green bond market grew strongly in 2023, with approximately US$540 billion issued.

Green bond issuance in 2023

~$540B

2023 issuance vs 2022

▲7%

DEU

Germany is the leading country with outstanding green bonds

64%

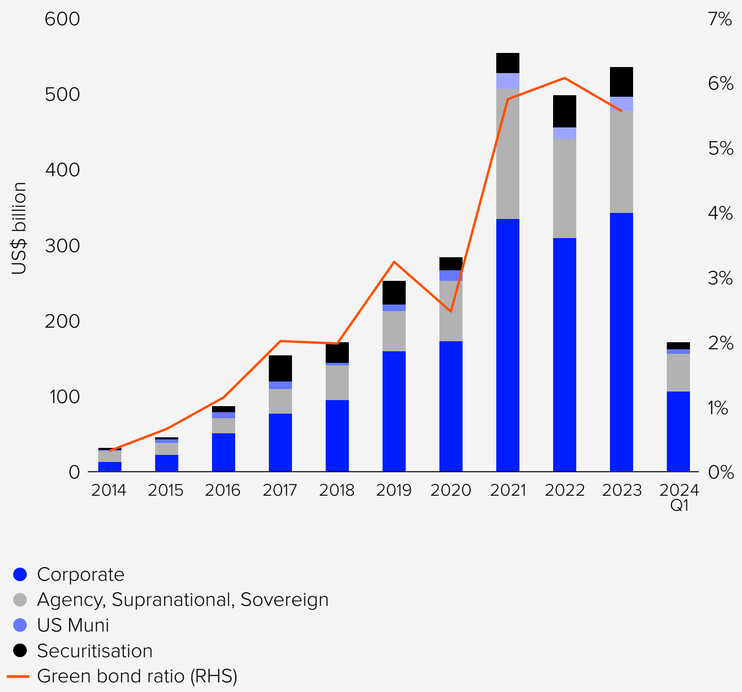
of new green bonds were issued by corporates

Despite experiencing a 5% decline in annual issuance from the 2021 peak, the 2023 issuance represented a 7% increase from 2022, and more than doubled in relation to pre-pandemic issuance levels. Corporate issuers continued to play an important role, accounting for 64% of new green bond offerings in 2023.

The amount of outstanding green bonds globally reached US$2.5 trillion at the end of Q1 2024. Although this only represents a fractional 2% of the overall bond market, the green bond ratio – the proportion of new green bond offerings among overall bond sales each year – remained robust at around 6%.

On a country basis, Germany ranks top with over US$300 billion worth of green bonds outstanding, followed by Mainland China and France with US$270 billion and US$245 billion respectively. In the green bond market, supranationals such as multilateral development banks have been key players; if considered a standalone category, they would rank fifth. While issuers from 39 emerging economies and 43 advanced economies issued green bonds during the period examined, the market is still dominated by advanced-economy issuers, whose bonds represent 82% of the current outstanding green bond universe.

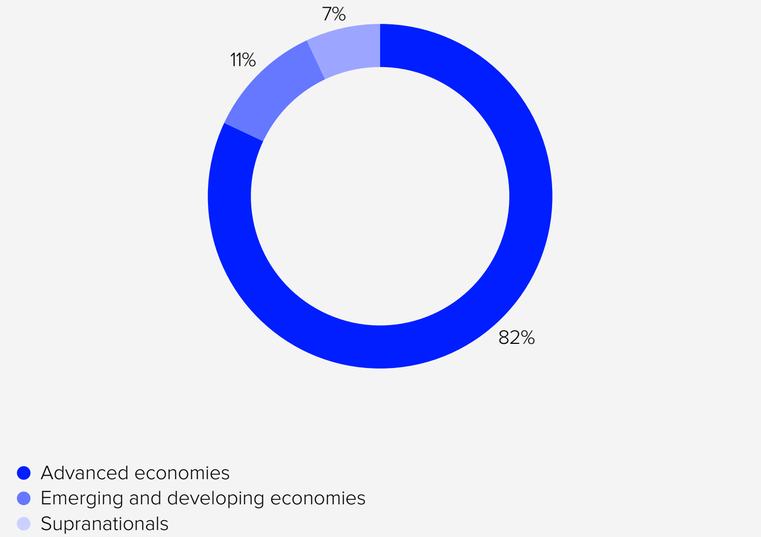
Figure 18. Annual green bond issuance 2014-2024[14]



[14] Note: Green US municipal bond (US Muni) and securitisation figures are based on Climate Bonds Initiative data. Green bond ratio represents the principal amount of green bonds as a share of the overall newly issued bonds in each year, and it does not include US Muni bonds and securitisations. Other figures in this green bond section have also excluded US Munis and securitisations.

Source: LSEG, Climate Bonds Initiative

Figure 19. Green bond outstanding amount by issuer group



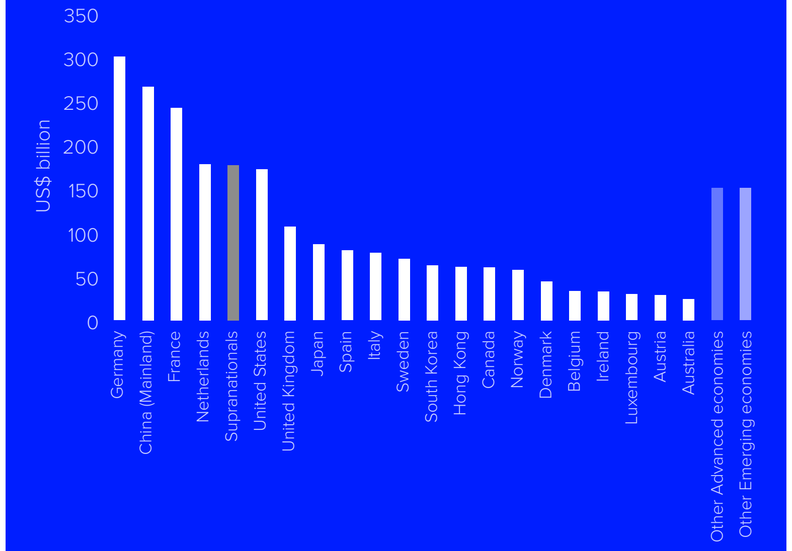
Source: LSEG

Classified by the green economy sectors,[15] Energy Management and Efficiency accounts for 30% of the cumulative proceeds from green bonds, consistent with it also being the largest green economy sector in the listed equities markets. Green bond issuance in the sector is typically geared towards funding commercial, residential and public building efficiency improvements, as well as providing support for equipment updates in industrial sectors. Energy Generation and Energy Equipment together form the second largest green bond use-of-proceeds category (16%), followed by Transport Solutions and Transport Equipment (13%).

While there has been an exponential increase in green bond volumes in the last decade – with green bonds being considered a means to hedge against climate change risks – bond financing of carbon-intensive economic activities remains an important feature of global fixed income markets.

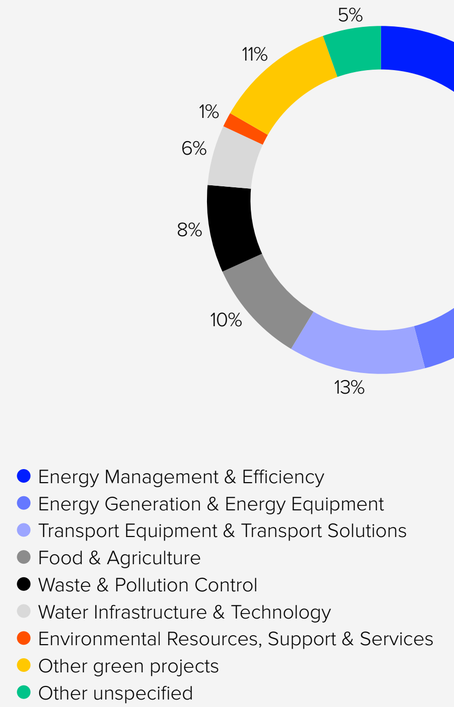
In 2022 alone, 1,950 entities in carbon-intensive sectors issued over 35,000 bonds with a total volume of US$1.4 trillion at issuance. This amount accounts for approximately one-third of total non-financial corporate bond issuances and is approximately 2.5 times higher than the total green bond issuance (including those issued by sovereigns, financial institutions and multilateral lenders) in the same year.[16] The gap highlights the potential opportunity for rapid growth in the green and transition bond markets if the low-carbon transition accelerates.

Figure 20. Green bond outstanding amount by country



Source: LSEG

Figure 21. Allocation of green bond proceeds



Source: LSEG

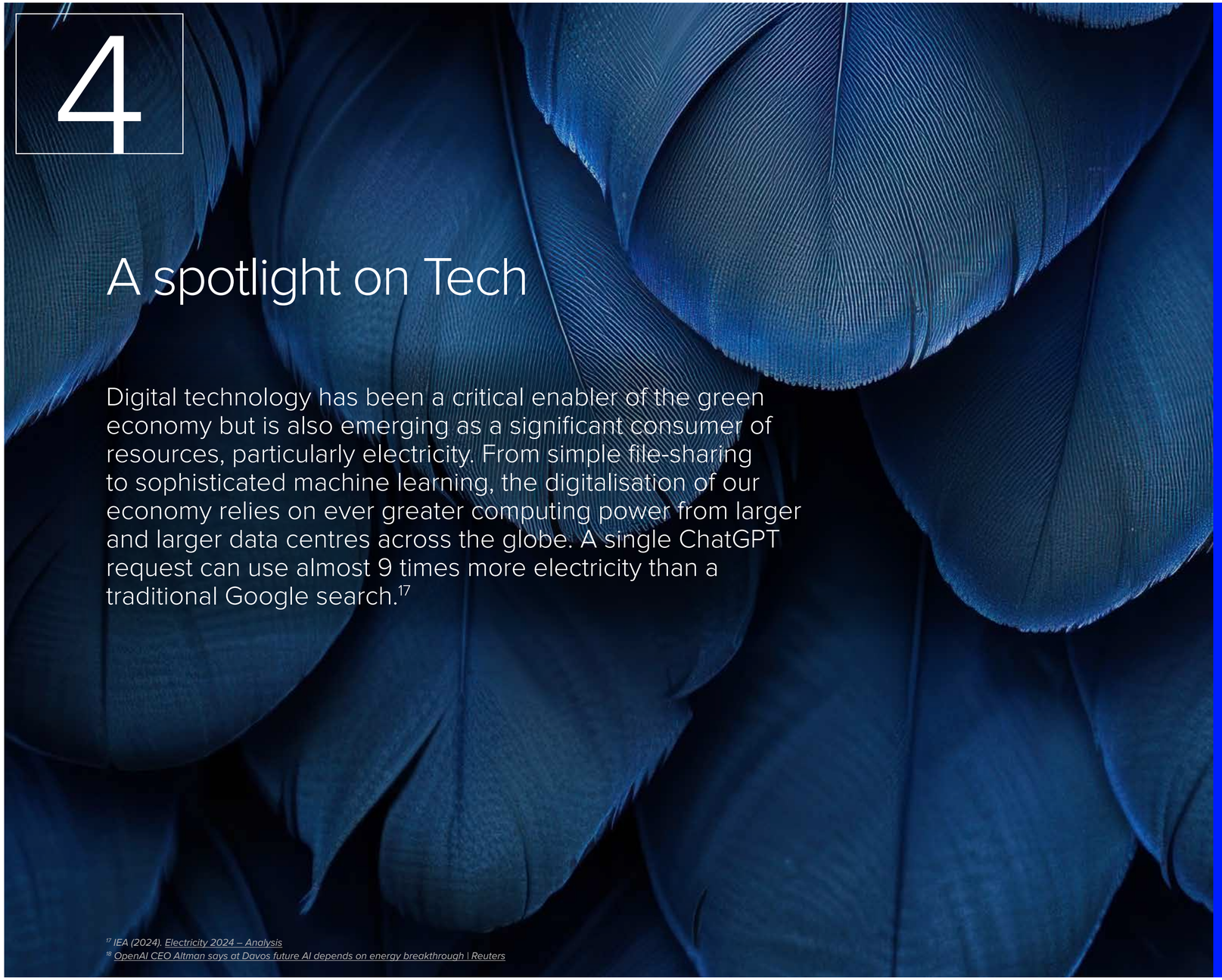
[15] *The green bond use of proceeds data is based on the LSEG Data & Analytics green bond database, and a high-level mapping between green bond use of proceeds categories and green economy sectors has been conducted to produce the green bonds proceeds allocation. Where an issuer's disclosure on the detailed proceeds allocation amount or percentage is not available, an equal weighting of each use of proceeds category has been applied, and the allocation calculation has been conducted using the principal amount of each bond.*

[16] *LSEG (2024). Tracing Carbon-intensive debt – Identifying and calibrating climate risks in corporate fixed income.*

4

A spotlight on Tech

Digital technology has been a critical enabler of the green economy but is also emerging as a significant consumer of resources, particularly electricity. From simple file-sharing to sophisticated machine learning, the digitalisation of our economy relies on ever greater computing power from larger and larger data centres across the globe. A single ChatGPT request can use almost 9 times more electricity than a traditional Google search.[17]



> An energy breakthrough is necessary for future artificial intelligence, which will consume vastly more power than people have expected.

OpenAI CEO Altman
World Economic Forum
January 2024[18]

[17] IEA (2024). Electricity 2024 – Analysis
[18] OpenAI CEO Altman says at Davos future AI depends on energy breakthrough | Reuters

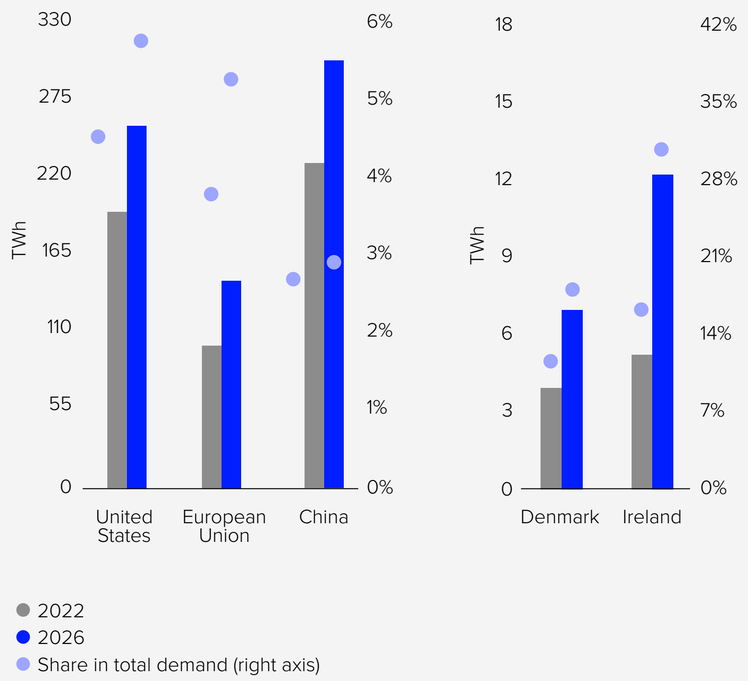
The need to store an exponentially growing volume of data, while running the ever-larger volume of computations that are required for machine learning and large language models (LLM), is beginning to materially impact global power demand.

In 2022, data centres used about 350TWh of electricity, up from just 71TWh in 2005 and already accounting for 1.5% of global power demand.[19] This share is even higher in countries with large tech sectors and countries that serve as hubs for data centres. In the US and China, the share is c. 4.5% and 3% of electricity use respectively. In countries such as Denmark and Ireland, data centres are becoming the main driver of energy demand, representing 30% and 20% of the total predicted electricity need respectively in 2026 (Figure 22).[20] Data centres and cryptocurrencies together are expected to consume another 340TWh by 2026 (Figure 23), or even more in a more aggressive AI roll-out scenario.[21]

What does this data centre energy demand mean for the climate? Assuming an electricity carbon intensity of 460gCO2e/kWh,[22] data centres could generate 294 million tonnes of carbon emissions in 2026, almost as much as France.[23] Amazon, Alphabet (Google's parent company), Meta and Microsoft alone generated 32 million tonnes of carbon emissions (Scope 1 and 2) in 2022. Although the Technology sector has a relatively low carbon intensity compared to other sectors such as Utilities and Basic Materials, it is growing much faster, with a 5-year CAGR of over 16%.[24]

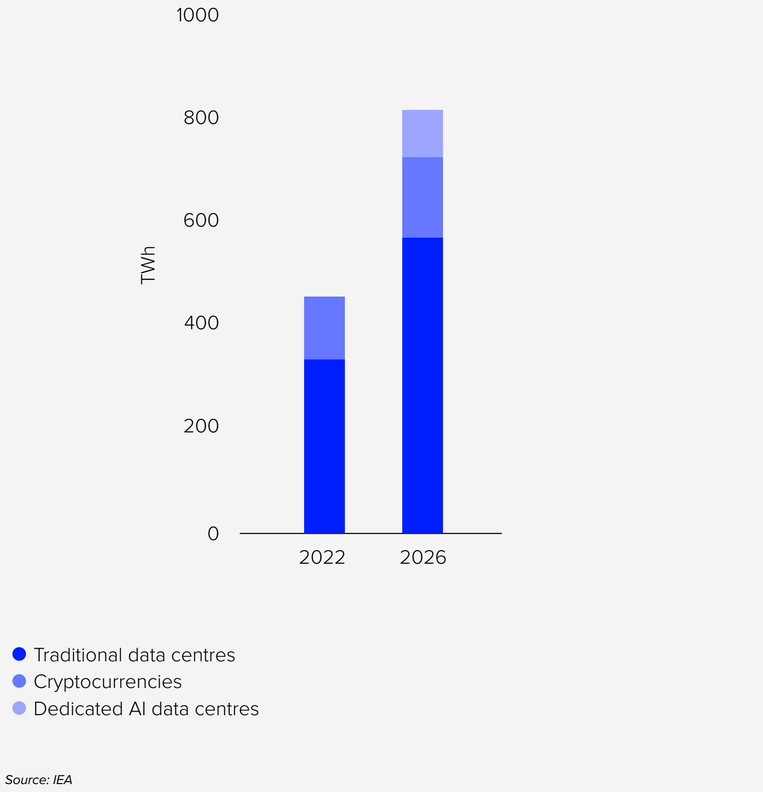
Unsurprisingly, while investing heavily in AI and data centres, Technology companies are actively deploying and developing green technologies to counteract this rising electricity demand. This takes a number of forms, such as decarbonising the electricity consumed, as well as making the data centres and IT processes themselves more efficient. By February 2023, Amazon was by far the largest buyer of renewable energy, with a total purchase of 24.8GW, followed by Meta, Microsoft and Google (Figure 24).[25] Microsoft has recently signed a US$10 billion renewable PPA, through which 10.5GW of renewable energy will be procured between 2026 and 2030.[26] Tech companies are also investing in low-carbon energy and storage solutions that are not yet commercially viable, such as nuclear fusion or hydrogen solutions.[27]

Figure 22. Data centre electricity demand in the US, EU and China



Source: IEA

Figure 23. Electricity demand from data centres, AI and cryptocurrency 2022 and 2026



Source: IEA

[19] *IEA (2024). Electricity 2024 – Analysis , Jonathan G Koomey (2008). Worldwide electricity used in data centers. Environmental Research Letter 3 034008. https://iopscience.iop.org/article/10.1088/1748-9326/3/3/034008*
[20] *Ibid.*
[21] *IEA (2024). Electricity 2024 – Analysis*
[22] *Average carbon intensity of electricity generation globally in 2022. Source: IEA (2023). World Energy Outlook 2023. Based on data centre energy demand in IEA's 'base case' scenario.*
[23] *Based on total carbon emissions from countries in 2022. Source: EDGAR (2023).*
[24] *Based on investable market capitalisation in FTSE Global All Cap.*
[25] *Bloomberg New Energy Finance (2024). Tech Firms Seal US Dominance in Corporate Clean Power Purchasing | BloombergNEF (bnef.com)*
[26] *Microsoft signs biggest-ever corporate PPA for green energy*
[27] *The Economist (2024). Data centres improved greatly in energy efficiency as they grew massively larger*

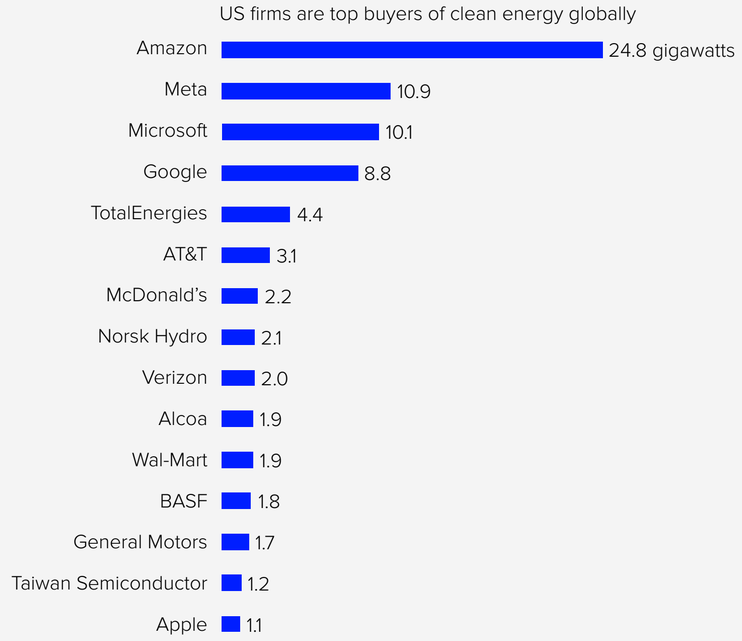
Furthermore, energy efficiency improvement of data centres over the last two decades has helped limit energy demand growth. Average power usage effectiveness (PUE), which measures the amount of energy used for computing functions versus non-computing functions such as cooling at data centres,[28] has improved by 38% compared to 2007 (Figure 25). Large hyperscale data centres have become particularly effective, and the movement of IT processes from onsite facilities to cloud infrastructure has been responsible for limiting the rise of IT-related carbon emissions.

The computing efficiency of servers has also been doubling every 2.6 years since the 2000s, although it has slowed down compared to pre-2000 levels.[29] Consequently, data centres' energy use grew more slowly than internet traffic or data centres' workloads between 2015 and 2022.[30] However, there are challenges ahead, as a growing proportion of data centres' energy demand is coming from the chips on which they rely. The demands of complex AI calculations drive the need for chips with greater processing power and therefore greater electricity demand.

Achieving net-zero emissions (NZE) requires greater efforts to decarbonise the grid and improve energy efficiency. According to the IEA, emissions from data centres and transmission must halve by 2030 to align with a NZE scenario.[31] In addition to deploying more renewables, greater energy efficiency is needed in areas including chips and servers, cooling systems, hyperscale data centres, and energy demand management. Policymakers from the EU and China, for example, have established regulations on data centres to increase energy efficiency and reduce environmental footprint.

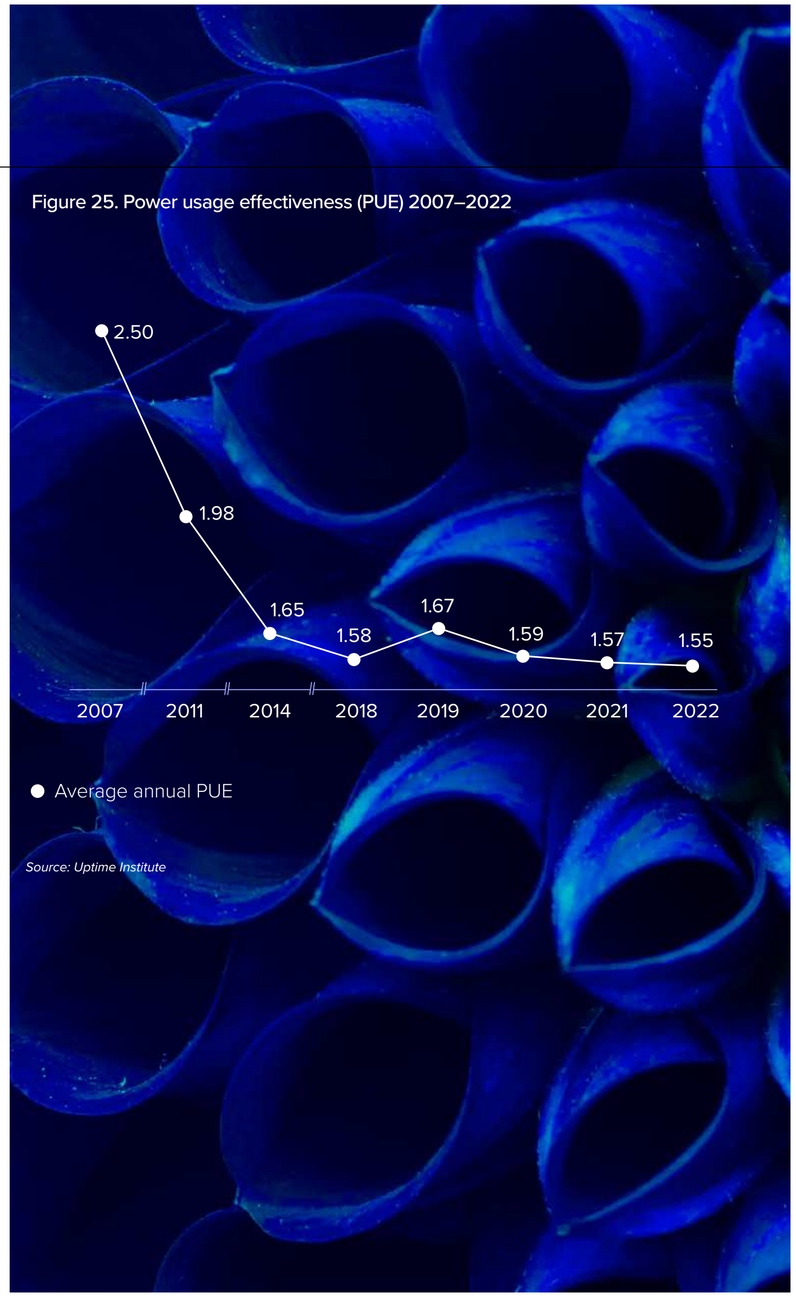
This approach creates potential for the growth of green companies providing energy efficiency products and services for information technologies. Figure 26 shows that revenues from IT-related green technologies, such as cloud computing and cutting-edge semiconductors, have experienced solid growth since 2016, and market capitalisation (Figure 27) has more than tripled over the last five years, reaching US$2.2 trillion in 2024. Alignment with a 1.5°C scenario suggests that with climate investment from both private and public sectors, 16% of the revenues in the technology sector would come from green products and services by 2030, compared to 11% in 2024.[32]

Figure 24. Top corporate buyers of clean energy



Source: BloombergNEF
Note: Cumulative purchases up to 5 February 2023

Figure 25. Power usage effectiveness (PUE) 2007–2022

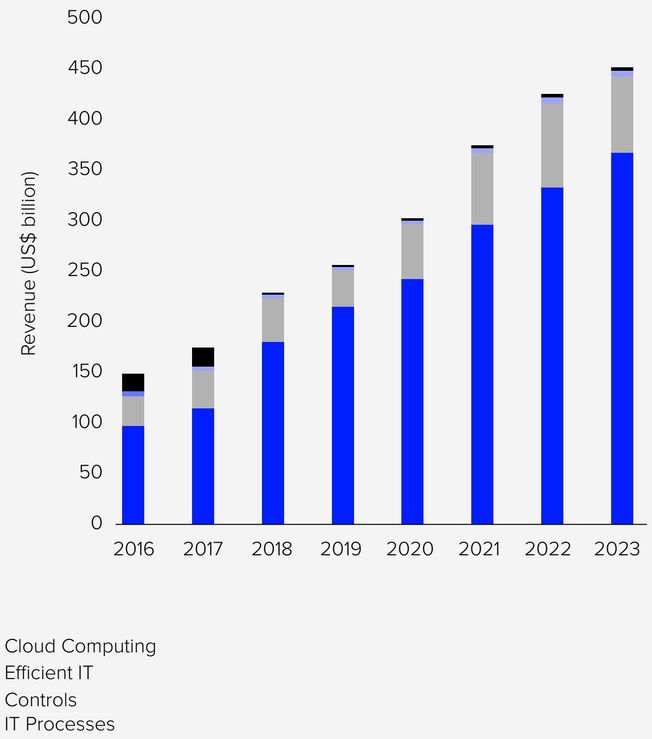


Source: Uptime Institute

[28] *At a data centre, energy consumption comes from computing, storage, network, powering and cooling. The cooling process consumes a large amount of water resources.*
[29] *The computing efficiency is measured by the number of computations per joule of dissipated energy. It doubled every 1.57 years during 1945-2000 according to Koomey's Law. Source: ING*
[30] *Based on IEA data. Data centres & networks - IEA*
[31] *Ibid.*
[32] *FTSE Russell (2022). Green equity exposure in a 1.5°C scenario.*

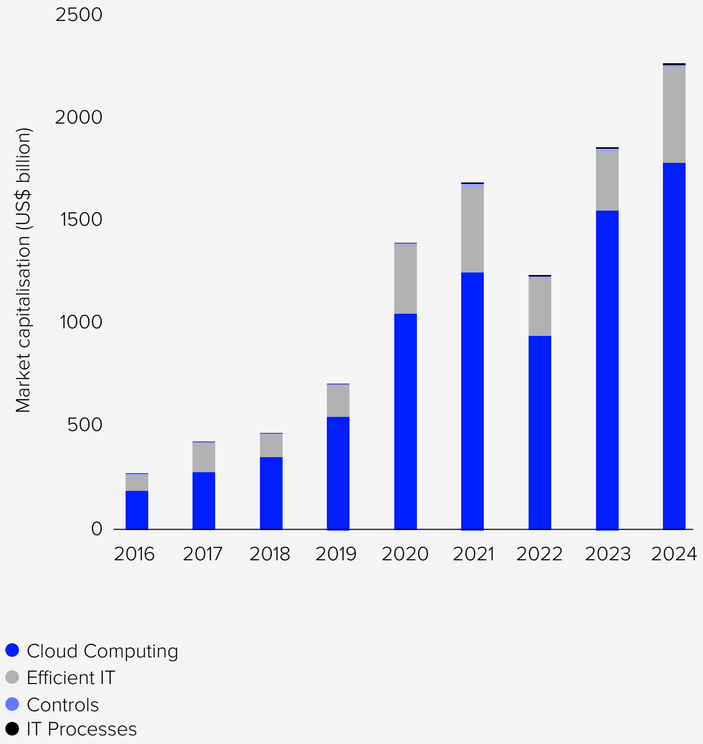
In addition to deploying more renewables, greater energy efficiency is needed in areas including chips and servers, cooling systems, hyperscale data centres, and energy demand management.

Figure 26. Green Economy: Information Technologies revenue



Source: FTSE Russell Green Revenues data as of April 2024. LSEG Revenue data as of December 2023.

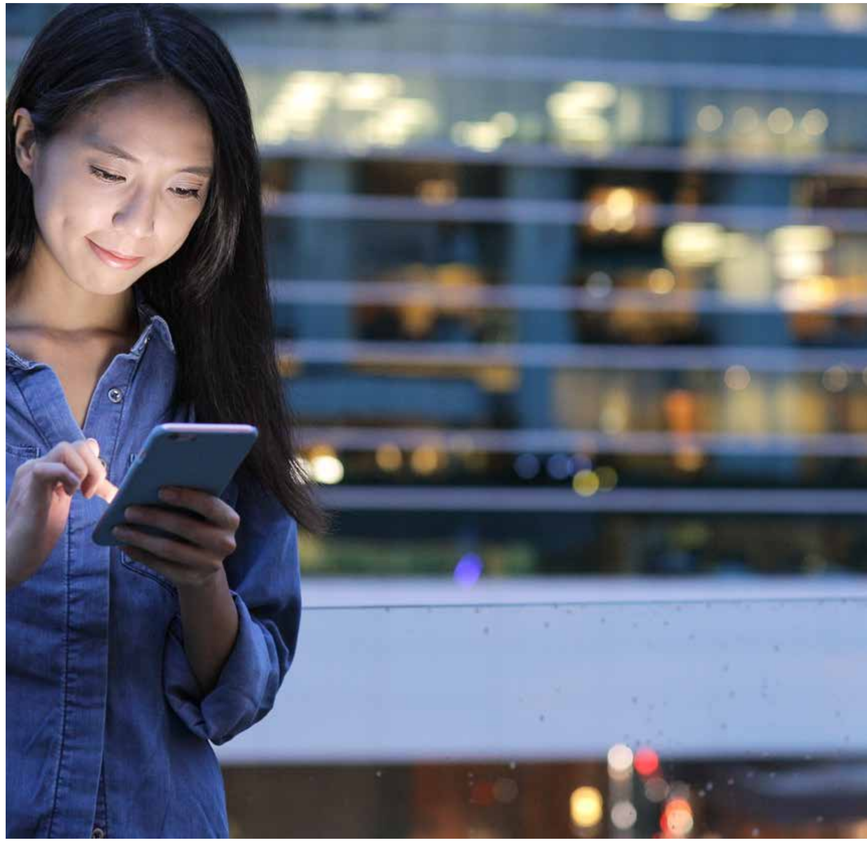
Figure 27. Green Economy: Information Technologies market capitalisation



Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

Table 1. Sectors related to efficient IT under the FTSE Russell Green Revenues Classification System

Sector	Subsector	Micro sector	Description
Energy Management & Efficiency	Controls	Controls (General)	Activities related specifically to the design, development, manufacture or installation of efficient energy manipulation and optimisation systems. Activities include efficient semiconductor controllers and microgrid controllers.
Energy Management & Efficiency	IT Processes	IT Processes (General)	Activities related specifically to the design, development, manufacture or installation of energy efficient information technology products and services.
Energy Management & Efficiency	IT Processes	Cloud Computing	Activities related specifically to the design, development, manufacture or installation of cloud computing products and services. These include infrastructure and underlying platforms but not pure software.
Energy Management & Efficiency	IT Processes	Efficient IT	Activities related specifically to the design, development, manufacture or installation of highly-energy-efficient IT equipment and electronics.



5

Composition of the green economy

The green economy is multifaceted, spanning industries, value chains and jurisdictions. The mapping of the green economy against the traditional industry classification, ICB, shows that almost all industries generate green revenue, although green exposure is not evenly spread. Granular micro-sector-level Green Revenues data demonstrates that the green economy is prevalent in global value chains across more than 50 developed and emerging markets.

Largest sector

Tech

Solar installations (2023)

▲85%

6

industries >10% green exposure

EV unit sales (2023)

▲35%

A total of 133 types of green products and services are identified in the green economy, from mining of key raw materials to equipment manufacturing and recycling. Through a tiering system, green products and services are further differentiated by the significance of their environmental benefits.

The green economy across industries

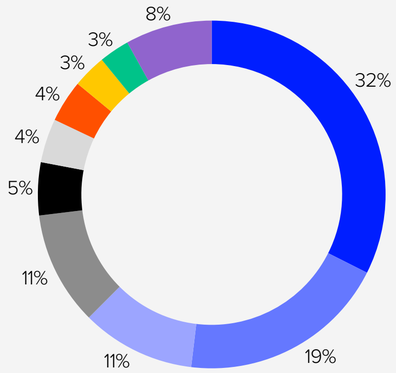
Mapping the green economy against traditional industry categories, our analysis finds that almost all industries generate green revenues.

In terms of the amount generated (Figure 28), four sectors – whose combined green-revenues-weighted market capitalisation makes up over 70% of the green economy – stand out:

- Technology became the largest sector in the green economy in 2020, with green revenue generated from, for example, cloud computing (e.g. Microsoft) and power management semiconductors (e.g. Taiwan Semiconductor Manufacturing Company) reaching US$2.3 trillion.
- Industrial Goods and Services had been the green economy's largest sector for over a decade, until it was overtaken by Technology in 2020. Green revenue in this sector comes from, for example, smart grids, railways, and industrial energy efficiency (e.g. Siemens).
- Utilities has been a key player in the green economy since our data first became available in 2009, delivering renewable energy generation (e.g. Nextera Energy Inc). Having been of a similar size to Industrial Goods and Services for many years, it now accounts for 11% of the green economy.
- Automobiles and Parts has grown rapidly from 4% of the green economy in 2016 to 11% in 2024 (peaked at 15% in 2021), after a small decline during Q1 2024. It is largely driven by EV and battery manufacturing (e.g. Tesla).

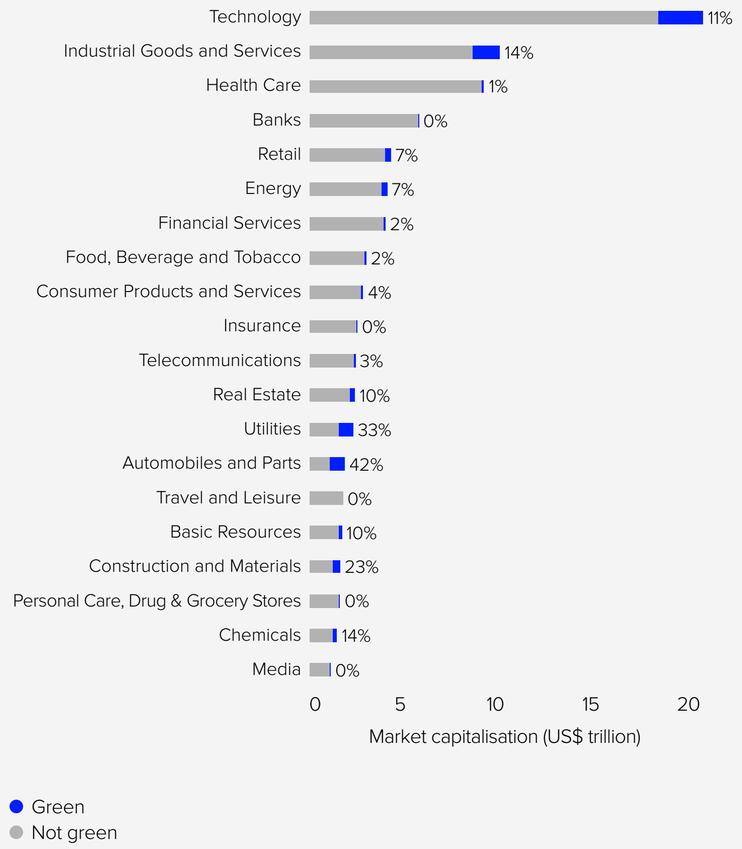
Looking at our analysis of green exposure (Figures 29 and 30), which indicates the penetration of green businesses into a given industry, about one-third of industries have green exposure greater than 10%. Having increased by over 20 percentage points since 2019 and peaked at 47% in 2021, the Automobiles and Parts sector has the highest green exposure (42%), reflecting the rapid penetration of electric vehicles in this market. It is followed by the Utilities sector (33%), buoyed by increased adoption of renewable energy generation, particularly solar and wind. Construction & Material is another sector with green exposure greater than 20%, albeit with a smaller absolute size, supporting activities such as energy-efficient buildings and railway infrastructure.

Figure 28. Composition of the green economy by ICB sectors



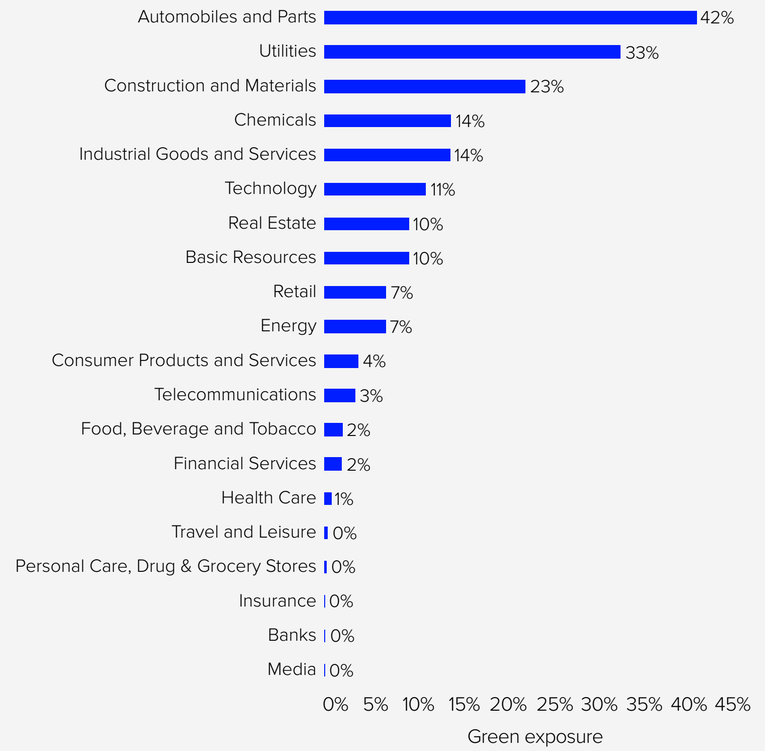
Note: Based on Green Revenue weighted market capitalisation, calculated by aggregating market capitalisation multiplied by company green revenues, with latest Green Revenues data (financial year 2022 or 2023) and the free-float market capitalisation as of April 2024.
Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

Figure 29. Green economy across ICB sectors



Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

Figure 30. Sectoral green exposure



Note: Based on Green Revenue weighted market capitalisation, calculated by aggregating market capitalisation multiplied by company green revenues, with latest Green Revenues data (financial year 2022 or 2023) and the free-float market capitalisation as of April 2024. Green exposure % is calculated by dividing green-revenue-weighted market cap by total market cap of companies.
Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

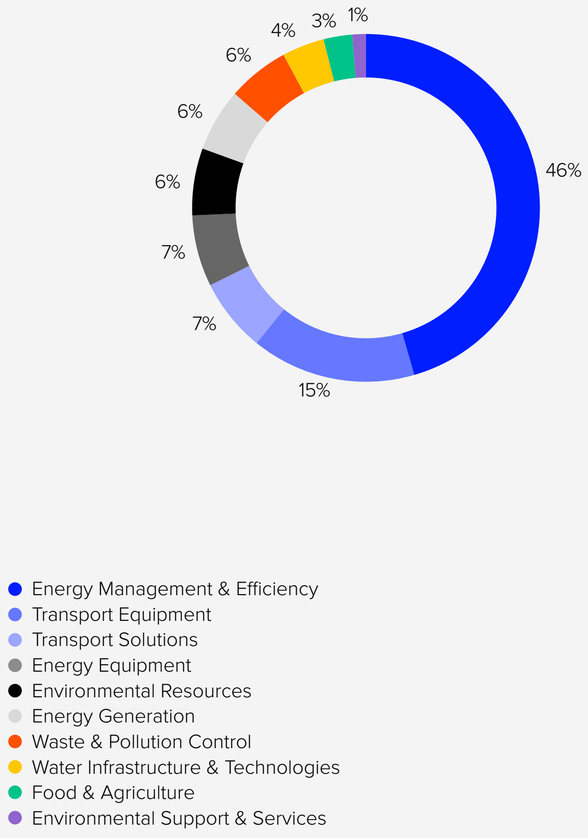
Green products and services across value chains

In addition to traditional industry classifications like ICB, companies' revenues are mapped to the FTSE Russell Green Revenues Classification System to identify green products and services across value chains (Figures 31 and 32).

Energy Management & Efficiency remains the largest green sector (46%), having grown at a five-year CAGR of 17%, and reaching a market capitalisation of over US$3.2 trillion in 2024. Within the sector, for the first time, efficient IT equipment and electronics has overtaken green buildings and become the second-largest subsector, while cloud computing continues to make up the greatest share. The fastest-growing green sector is Transport Equipment (five-year CAGR of 24%), driven by EVs, batteries and railways manufacturing, accounting for 15% of the green economy in 2024 or US$1.1 trillion. Five green sectors covering renewable energy, water, waste, and key materials (such as lithium and cobalt) are of similar sizes. Sustainable Food & Agriculture and Environmental Support & Services (such as environmental consulting and carbon credit trading) are relatively small.

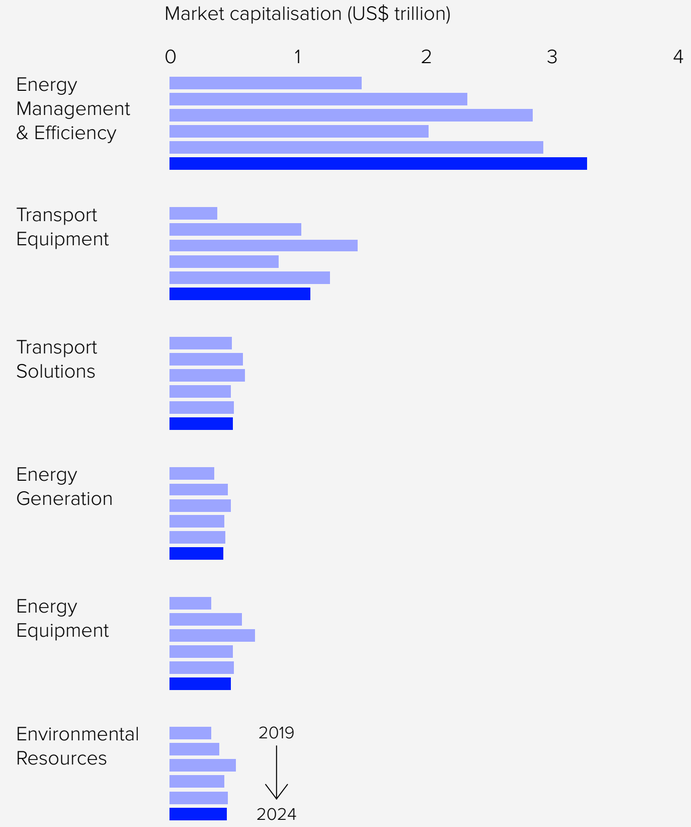
Most green sectors have been recovering from the decline in 2022 (Figure 32), although renewables (classified under 'Energy Equipment') and EVs (classified under 'Transport Equipment') have been facing sustained headwinds.

Figure 31. Composition of the green economy by green sector



Note: Based on Green Revenue-weighted market capitalisation, calculated by aggregating market capitalisation multiplied by company green revenues, with latest Green Revenues data (financial year 2022 or 2023) and the free-float market capitalisation as of April 2024. Due to rounding, values may not total exactly 100%.
Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

Figure 32. Growth of selected green sectors 2019-2024



Note: Based on Green Revenue-weighted market capitalisation, calculated by aggregating market capitalisation multiplied by company green revenues. 2023 and 2024 data are based on latest Green Revenues data (financial year 2022 or 2023).
Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

Renewables

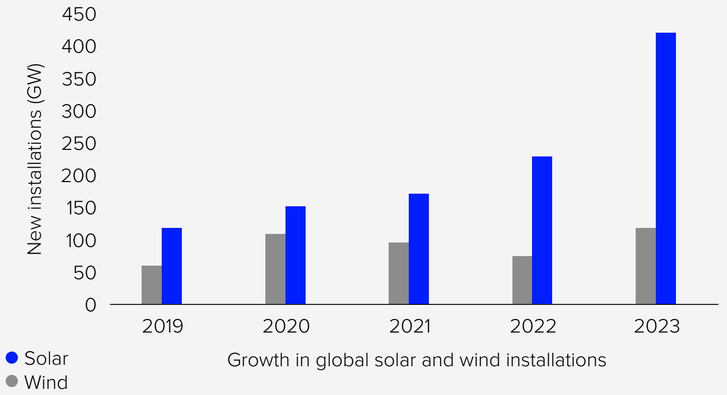
In 2023 there were meaningfully increased installations of solar and wind energy, up 85% and 60% respectively (Figure 33) over 2022. However, the combination of high interest rates, cost inflation and significant production capacity increases[33] has led to overcapacity and collapsing prices. There has been a dramatic reduction in the profitability of renewable energy companies and a continued fall in equity prices, which began in 2022. The Alternative Energy sector of the FTSE All World recorded the worst stock market performance of all sectors in the last 12 months (Figure 34). However, with inflation falling, interest rates appearing to have peaked, and estimates of a lower level of capacity increase in 2024, the sector has by far the highest estimated three-to-five-year EPS growth, albeit from a low base.

Electric Vehicles

Similarly to renewables, electric vehicles have seen substantial growth in unit sales, up 35% in 2023 (Figure 35). However, the majority of this growth was in China, while growth rates in Europe and North America have been less impressive.[34] Particularly in North America, some large auto brands have been slowing down some of their EV capacity plans or focusing on more profitable hybrids. The EV sector has also been plagued by overcapacity, given that growth had been expected to be much higher. This has led to price competition between suppliers and low-priced competition from Chinese makers. While impacting the profitability of automakers, the slower growth, combined with increasing supply as new mines come online, has caused a dramatic fall in battery metal prices (Figure 36).

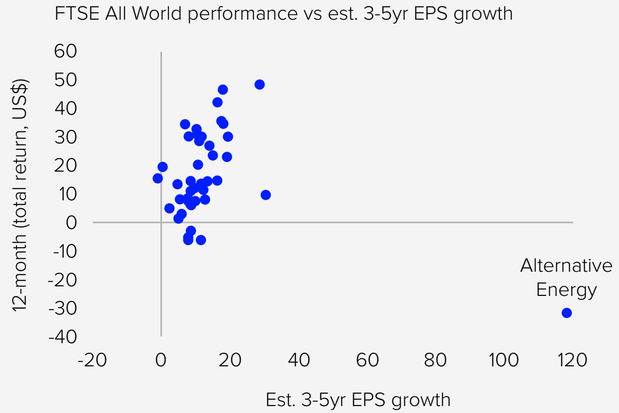
[33] *Chinese solar cell capacity increased by over 400GW in 2023.*
[34] *China accounts for 60% of the EV sales in 2023, followed by Europe (25%) and the US (10%).*

Figure 33. Growth in global solar & wind installations



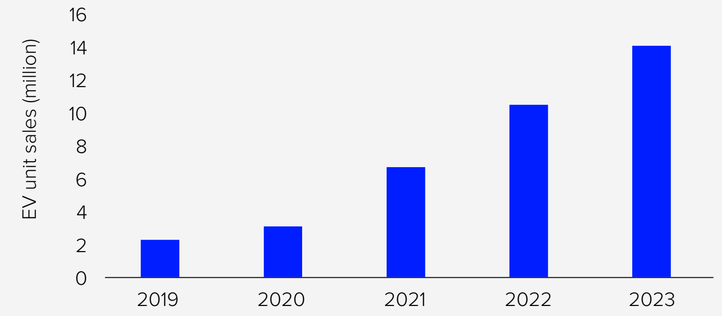
Source: IEA (2024), Clean Energy Market Monitor – March 2024, IEA, Paris https://www.iea.org/reports/clean-energy-market-monitor-march-2024, Licence: CC BY 4.0

Figure 34. FTSE All World performance vs est. three-five-year EPS growth



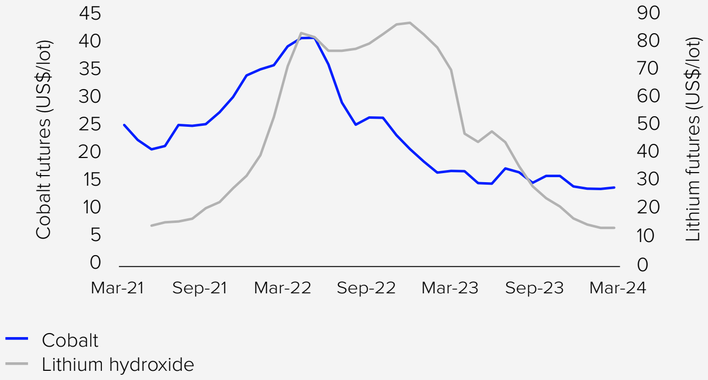
Source: LSEG, March 2024

Figure 35. Growth in EV unit sales



Source: IEA (2024), Clean Energy Market Monitor – March 2024, IEA, Paris https://www.iea.org/reports/clean-energy-market-monitor-march-2024, Licence: CC BY 4.0

Figure 36. Lithium and cobalt prices



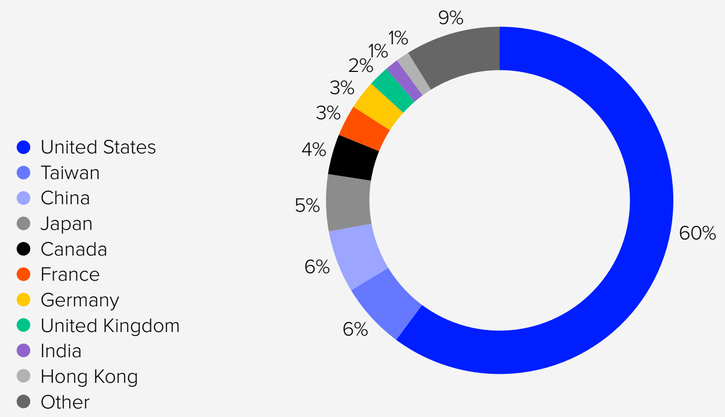
Source: LSEG, March 2024

Size versus exposure of the green economy across more than 50 markets

The green economy spans more than 50 developed and emerging markets. The US accounts for a 60% share of market capitalisation of the green economy in 2024 due to the sheer size of the US equity market. Overtaking China, Taiwan became the second-largest market (6%) in 2024, with key player Taiwan Semiconductor Manufacturing having green revenues of over 60%, and a market capitalisation close to US$600 billion. China's green economy remains within the top three (5%), although it is downsizing given the decline of its equity market (and a large part of its green economy is not listed). India and Hong Kong have entered the top 10, superseding Switzerland and South Korea (Figure 37).

Even though a given economy makes up a large portion of the global green economy, it does not necessarily mean that it has high green exposure, i.e., that green products and services make up a large proportion of its economic output (Figure 38). Although the US has the largest share of the green economy in absolute terms, its green exposure in relative terms is below the global average of 9%. In contrast, countries like Germany, Canada and China have green exposure higher than the world average, albeit with smaller market sizes.

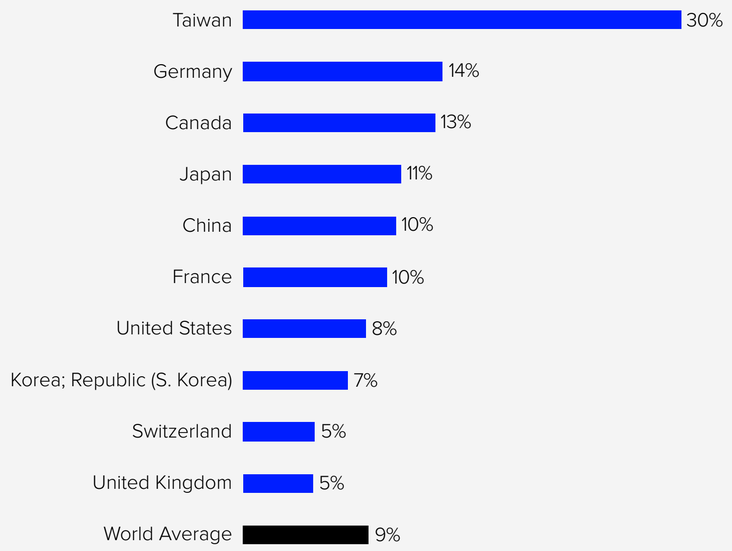
Figure 37. Composition of the green economy by market



Note: Based on Green Revenue-weighted market capitalisation, calculated by aggregating market capitalisation multiplied by company green revenues, with latest Green Revenues data (financial year 2022 or 2023) and the free-float market capitalisation as of April 2024. By country of domicile of listed companies.
Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

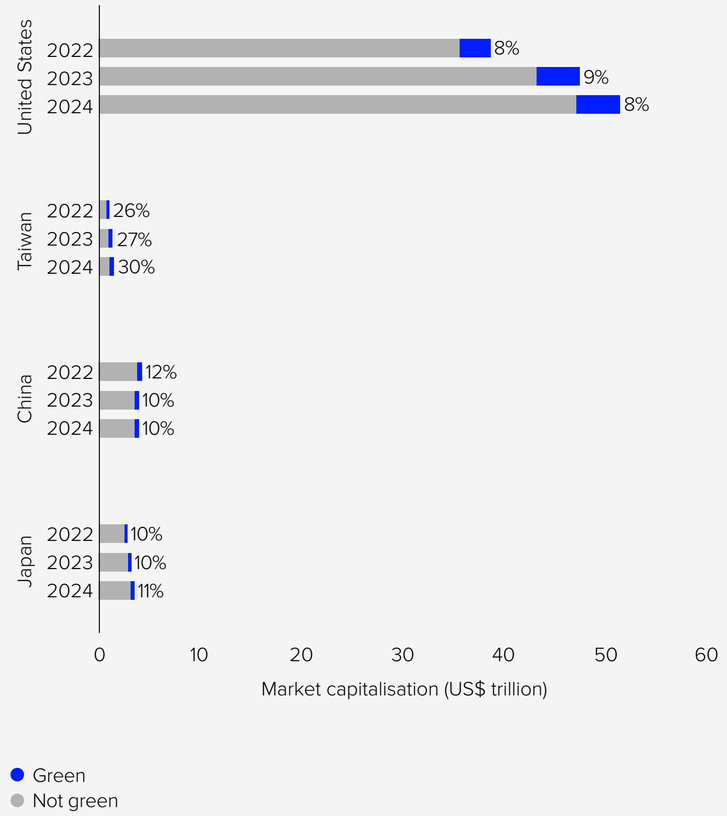
Over the past three years (Figure 39), while the US has shown strong growth in the equity market, the size of the green economy – driven predominantly by Technology and Tesla – has not grown at the same rate. Taiwan has demonstrated growth in the equity market as well as in the green economy. Market capitalisation of listed equities in China has declined between 2022 and 2024, and the Chinese green economy has also decreased in size over this period.

Figure 38. Green economy by market exposure



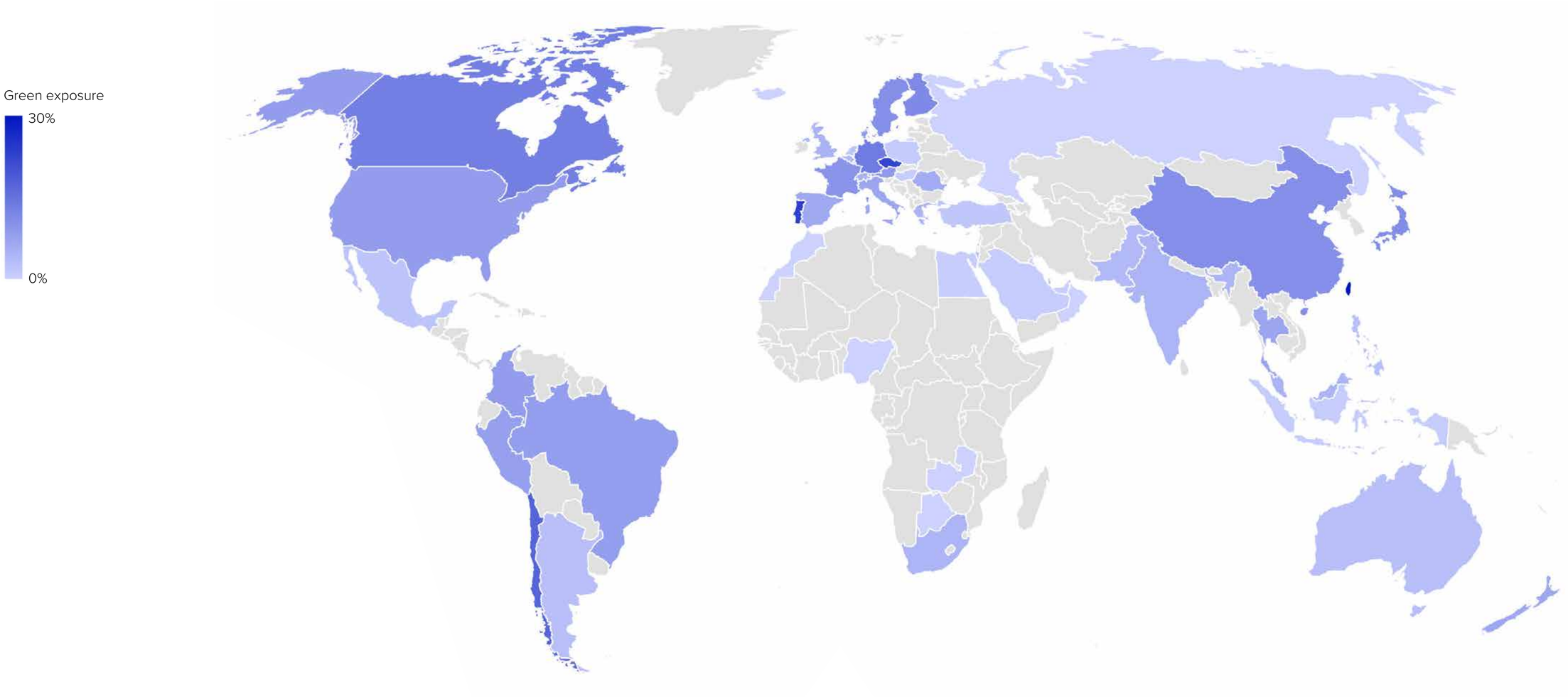
Note: Based on the latest green Revenues data (financial year 2022 or 2023) and the free-float market capitalisation as of April 2024. By country of domicile of listed companies. Green exposure % is calculated by dividing green-revenue-weighted market capitalisation by total market capitalisation of companies.
Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

Figure 39. Changes in size and market exposure of the green economy



Note: Based on the latest Green Revenues data (financial year 2022 or 2023) and the free float market capitalisation as of April 2024. Note: Based on the latest green Revenues data (financial year 2022 or 2023) and the free-float market capitalisation as of April 2024. By country of domicile of listed companies. Green exposure % is calculated by dividing green-revenue-weighted market capitalisation by total market capitalisation of companies.
Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

Figure 40. Green economy: A global perspective



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Note: Based on the latest Green Revenues data (financial year 2022 or 2023) and the free-float market capitalisation as of April 2024. By country of domicile of listed companies. Green exposure % is calculated by dividing green-revenue-weighted market capitalisation by total market capitalisation of companies.
Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

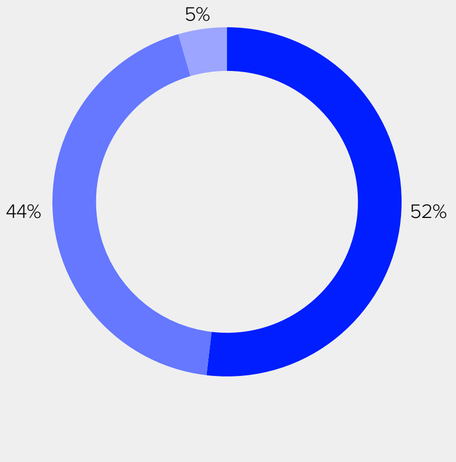
How green is the green economy?

Different green products and services may have varied environmental impacts that can be both positive and negative. Biomass from crops, for example, is an energy source with relatively low carbon emissions compared to fossil fuels in most cases, but it may pose challenges related to land use and biodiversity. To differentiate the 'greenness' of business activities, the FTSE Russell Green Revenues Classification System (GRCS) provides a tiering system.

- **Tier 1 covers green products and services with significant and clear environmental benefits.**
  Example: renewable energy generation and electric vehicles.
- **Tier 2 covers green products and services with more limited but net-positive environmental benefits.**
  Example: large hydropower and cloud computing.
- **Tier 3 covers green products and services which have some environmental benefits but are overall net-neutral or negative.**
  Example: mining of lithium and biomass from energy crops.

The vast majority (95%) of the green economy comprises Tier 1 and Tier 2 activities, with Tier 3 activities making up only 5% by market capitalisation (Figure 41). EV manufacturing continues to be the largest Tier 1 activity, followed by efficient IT and green buildings. Over half of the Tier 2 activities are related to cloud computing, while railways, sustainable building operators and waste management comprise another 20%. Similarly to 2023, nuclear energy generation and lithium mining represent almost half of Tier 3 activities.

Figure 41. Composition of the green economy by tier



Note: Based on Green Revenue-weighted market capitalisation, calculated by aggregating market capitalisation multiplied by company green revenues, with latest Green Revenues data (financial year 2022 or 2023) and the free-float market capitalisation as of April 2024. Due to rounding, values may not total exactly 100%.
Source: FTSE Russell Green Revenues data as of April 2024. LSEG Free Float Capitalisation data as of April 2024.

FTSE Russell Green Revenue Classification System (GRCS)[35]

The GRCS identifies green products and services covering 10 sectors, 64 subsectors and 133 micro-sectors. When any green revenues are identified in a company's activity, they are mapped to one or more micro-sectors and then aggregated at the company level. The dataset is compiled using a thorough research process, including semantic screening, business segment identification, and green micro-sector breakdown.

Table 2. FTSE Russell Green Revenues Classification System (GRCS)

ENERGY GENERATION [EG] 19	ENERGY MANAGEMENT & EFFICIENCY [EM] 13	ENERGY EQUIPMENT [EQ] 22	ENVIRONMENTAL RESOURCES [ER] 11	ENVIRONMENTAL SUPPORT SERVICES [ES] 5
Bio Fuels	Buildings & Property (Integrated)	Bio Fuels	Advanced & Light Materials	Environmental Consultancies
Cogeneration	Controls	Cogeneration Equipment	Key Raw Minerals & Metals	Finance & Investment
Clean Fossil Fuels	Energy Management	Clean Fossil Fuels	Recyclable Products & Materials	Smart City Design & Engineering
Geothermal	Logistics & Support	Fuel Cells		
Hydro	Industrial Processes	Geothermal		
Nuclear	IT Processes	Hydro		
Ocean & Tidal	Lighting	Nuclear		
Solar	Power Storage	Ocean & Tidal		
Waste to Energy	Smart & Efficient Grids	Solar		
Wind	Sustainable Property Operator	Waste to Energy		
		Wind		

FOOD & AGRICULTURE [FA] 17	TRANSPORT EQUIPMENT [TE] 12	TRANSPORT SOLUTIONS [TS] 9	WASTE & POLLUTION CONTROL [WP] 15	WATER INFRASTRUCTURE & TECHNOLOGY [WI] 10
Agriculture	Aviation	Railways Operator	Cleaner Power	Advanced Irrigation Systems & Devices
Aquaculture	Railways	Road Vehicles	Decontamination Services & Devices	Desalination
Land Erosion	Road Vehicles	Video Conferencing	Environmental Testing & Gas Sensing	Flood Control
Logistics	Shipping		Particles & Emission Reduction Devices	Meteorological Solutions
Food Safety, Efficient Processing & Sustainable Packaging			Recycling Equipment	Natural Disaster Response
Sustainable Plantations			Recycling Services	Water Infrastructure
			Waste Management	Water Treatment
				Water Utilities

See the full breakdown of GRCS sectors, subsectors and microsectors here: Green Revenues Classification System

[35] *The roots of the GRCS stretch back as far as 2008, when FTSE Russell and Impax Asset Management launched the FTSE Environmental Markets Index Series.*

Visit our Green Economy Solutions landing page to learn more about the trends defining the evolution of the green economy.

www.lseg.com

London Stock Exchange Group plc
10 Paternoster Square
London EC4M 7LS
Telephone +44 (0)20 7797 1000

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