PICTET
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Asset Management

Climate crunch: a closer look at the transition risks of net zero

INSTITUTE OF INTERNATIONAL FINANCE

This study, the second collaboration between Pictet Asset Management and the Institute of International Finance, is part of Pictet AM's ongoing effort to provide investors with insights on the long-term environmental, technological and societal trends affecting the economy and financial markets.

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ABOUT THE INSTITUTE OF INTERNATIONAL FINANCE

The Institute of International Finance is the global association of the financial industry, with more than 400 members from more than 60 countries. Its mission is to support the financial industry in the prudent management of risks; to develop sound industry practices; and to advocate for regulatory, financial and economic policies that are in the broad interests of its members and foster global financial stability and sustainable economic growth. IIF members include commercial and investment banks, asset managers, insurance companies, sovereign wealth funds, hedge funds, central banks and development banks.

Contents

1805

Overview

Most investors would agree that transitioning to a net zero economy makes financial sense over the long run.

The most reliable climate models show that the future gains of containing global warming far outweigh the investment required to reduce CO_2 emissions to safe levels.

Research conducted by Oxford University for Pictet Asset Management (Pictet AM) in 2020[1] suggests that the world could lose up to half of its potential economic output by the end of this century if effective measures to mitigate climate change are not put in place.

A loss of such magnitude would far exceed the costs associated with developing a sustainable green economy.

Yet even if these long-run assumptions aren't in dispute, there is a serpent lurking within the net zero paradise. The energy transition will cause considerable – if not severe – disruption over the medium term.

History offers some valuable lessons on transition risks.

In his meticulous historical analysis Energy Transitions,[2] the Canadian scientist and Pictet AM advisory board member Vaclav Smil shows that transformations in the energy system are seldom smooth.

They tend to be complex, unpredictable affairs that invariably involve uncomfortable compromises and trade-offs.

Not only have they required vast up-front public and private investments with uncertain pay-offs, but they have also been associated with inefficient capital deployment, the bursting of asset bubbles and adverse changes in economic growth and inflation.

The conclusion to draw from all this is an unsettling one. The world's net zero ambition is vital, but it poses significant risks that demand urgent attention.

This is where our new research could provide some useful guidance.

This report, which Pictet AM undertook with its research partner the Institute of International Finance (IIF), assesses the nature and potential severity of the most pressing risks associated with the energy transition.

The risks we identified fell into three broad categories.

1 Climate Change and Emerging Markets after Covid-19, Pictet Asset Management and Oxford University, 2020: https://am.pictet/en/globalwebsite/global-articles/2020/pictet-asset-management/climate-change-and-emerging-markets-after-covid/tab/Foreword

2 Energy Transitions: History, Requirements, Prospects, Vaclav Smil, 2010, Praeger

A SURGE IN GOVERNMENT DEBT

The first is debt. Increased investment in green infrastructure and clean energy – and the public spending required to ensure the most vulnerable in society are insulated from the costs – will mean adding to the already USD300 trillion of global debt.[3] That will be the case for governments in both advanced economies and emerging markets. Such borrowing will be 'front-loaded', accumulating predominantly in the initial phase of the transition. And it will come with costs attached.

Growing debt burdens are likely to have a negative effect on the credit profiles of the many countries that are already financially stretched in the wake of the Covid pandemic. They could also dampen global economic growth prospects.

ECONOMIC DISRUPTION

A second potential hazard is economic disruption: the early years of the net zero transition could usher in inflation and weaker economic growth.

Take inflation first.

Although economists generally agree that energy prices do not impact inflation as significantly as in the past, carbon abatement policies such as carbon taxes, carbon credits and the EU's carbon border adjustment tariff will inevitably lead to higher energy costs for both households and businesses.

Another source of inflation comes in the form of supply bottlenecks for commodities essential to the energy transition. According to the International Energy Agency (IEA), switching to renewable energy will require a dramatic increase in mining activity. By 2040, the IEA estimates that the world will need a 41-fold increase in nickel production, a 28-fold rise in copper and graphite supply and a 21-fold increase in cobalt availability. Yet on current trends, the mining industry will not reach these production volumes, implying supply shortages and higher prices for transition-critical minerals.

The IEA warns that copper demand could outstrip supply as soon as 2025, and it is a similar picture for many other energy transition materials. Further complicating matters is the introduction of new environmental and labor regulations designed to improve the mining industry's environmental and worker safety standards. These inadvertently extend the timeline for new mines to become operational.

So if metals shortages become a persistent problem, the resulting surge in commodities prices could lead to a significant period of greenflation.

3 See IIF Global Debt Monitor https://www.iif.com/Products/Global-Debt-Monitor

Volatile inflation is not the only economic side effect of the clean energy transition. Our research shows that as countries attempt to wean themselves off fossil fuels they may experience a decline in consumer spending power and increases in unemployment, particularly in the initial years of the transition.

This primarily reflects the impact of elevated energy costs due to higher policy-induced carbon prices and the shift of private energy investment from fossil fuels to renewables. The risks are more pronounced for countries heavily dependent on fossil fuels, whether as consumers or producers.

ASSET BUBBLES

The final risk is the potential inefficient use of capital.

Capital projects, particularly those under the oversight or influence of governments and state institutions are historically viewed by private investors as prone to poor management, especially in countries with weak institutional frameworks.

This situation creates a dilemma for investors seeking to reduce carbon intensity. They might find themselves needing to allocate funds to unproven clean technologies or backing companies with a poor track record in carbon reduction, in the hope of future improvements – or possibly both.

Yet it is difficult to know in advance which of today's brown investments will turn green and which clean technologies will become commercially successful. This uncertainty significantly increases the risk of inefficient capital deployment, leading to the formation of asset bubbles, on the one hand, and unjustifiably undervalued assets, on the other. While this could give rise to numerous tactical investment opportunities in certain industries and in blended finance, it might also result in more frequent and severe bouts of market volatility.

None of this is to downplay the importance of the world's commitment to achieving net zero. Decarbonisation is for the world's future prosperity.

Yet the journey to a net zero economy is complex and fraught with risks. Investors face significant challenges – particularly in the initial phase of the energy transition – that could disrupt economic activity and financial markets. Overlooking these threats could be costly.

BOX 1

Energy transitions through time

The history of energy transitions shows that they unfold over decades, if not centuries. It took more than 600 years for coal to replace pre-industrial biofuels, primarily because the transition saw an exceptionally long exploratory phase.

Although the first commercial use of coal can be traced back to 14th century England, it took a further 500 years for the fuel to reach 5 per cent of the global energy supply.

The subsequent adaptation phase was very quick by comparison. The rapid uptake of coal-fired steam engines for transportation was a tipping point. Coal just needed an additional 40 years to account for 25 per cent of the global energy supply. By around 1905, coal surpassed the 50 per cent mark and became the world's predominant source of energy until the mid-1960s.

> "Crude oil's share [of global energy supply] never reached 50 per cent… and has been on a downward trend since its peak in the mid-1970s."

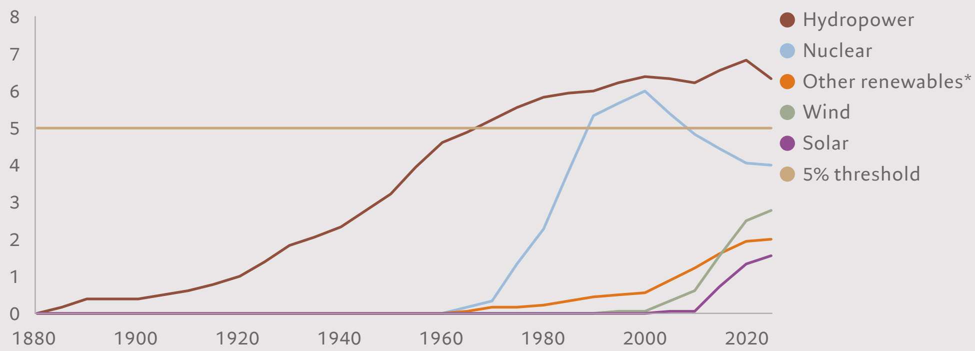
The transition to crude oil took less time: just 105 years for it become the world's largest energy source. The exploratory phase for crude oil was much shorter than for coal, primarily due to its wider range of usage applications. After the launch of the world's first commercial well in the US in 1859, crude oil reached 5 per cent of global energy supply by 1920. The length of the adaptation phase for crude oil was comparable to that of coal, with the exponential growth of the automobile and aviation industries the main driver of the transition. Within the following 40 years, crude oil surpassed the 25 per cent mark and by around 1965, it subsequently became (and has remained) the world's largest single source of energy. Interestingly, however, its share has never reached 50 per cent and has been on a downward trend since its peak in the mid-1970s.

As a commercial source of energy, natural gas reached the 5 per cent threshold by 1945 over a period of 60 years. While its importance in the global energy supply continues to increase steadily, the uptake of natural gas during the adaptation phase has not been as fast as that of coal or crude oil (not least due to transportation challenges). It still accounts for less than 25 per cent of global energy supply.

Unlike previous energy transitions, the speed of the switch to clean energy will depend largely on the effectiveness of government policies and investment.

Clean energy spans a diverse range of energy sources, including hydropower, nuclear, wind, solar, clean hydrogen, and modern biofuels. In 2021, they together provided around 17 per cent of global energy supply. However, the uptake for each technology varies significantly from country to country. Hydropower, one of the oldest and largest sources of clean energy, represents only 6 per cent of global energy supply. Challenges to its expansion include potential environmental damage (e.g. from damming river ecosystems) and the rising prevalence of drought.

FIGURE 1
The laboured growth of renewables
Contribution of renewables to world energy supply, %



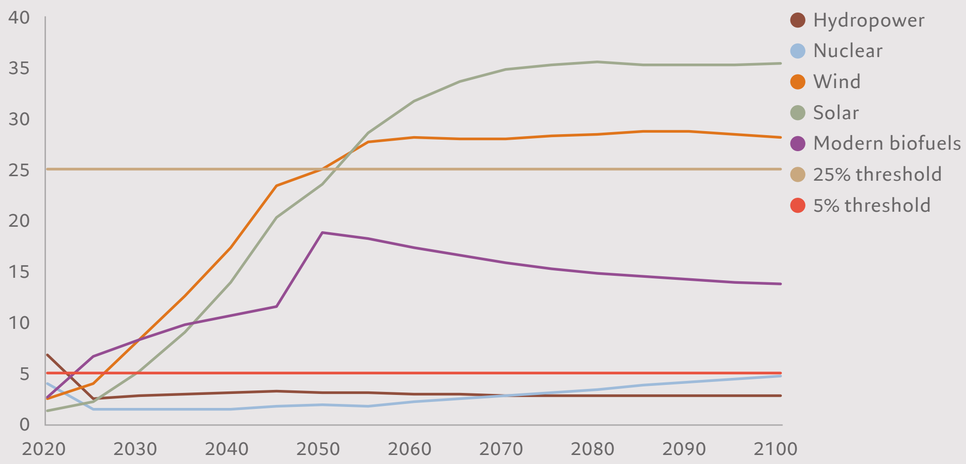
Source: Our World in Data, IIF;
*includes modern biofuels and other renewables; 0% to 5% threshold: exploratory phase of energy transition; data covering period 1880-2021

Nuclear power reached the 5 per cent mark rapidly, in just 25 years, supported by strong policy backing in several countries, including the US, China, France and Russia. The adoption of nuclear power in France was especially swift, reflecting the French government's vigorous efforts to enhance energy security following the oil price shocks of the 1970s. Currently, over 75 per cent of

France's primary energy production is derived from nuclear power. However, since the early-2000s, the prevalence of nuclear power has substantially diminished worldwide – in large part reflecting increased public concerns about safety and radioactive waste disposal.

It was not until the earlier 2000s that wind and solar were added to the energy mix. These fuel sources are still at very early stages of the transition phase, and it remains uncertain whether they can hit the 5 per cent mark as fast as nuclear power did (see FIGURE 2). The speed of this process will largely depend on the magnitude and availability of front-loaded investment – which, in turn, calls for effective government policies to create an enabling environment for private investors to invest at scale. The pace of this transition will also be influenced by the transportation sector. A meaningful surge in the uptake of electric vehicles could significantly shorten the length of the transition from crude oil to renewables.

FIGURE 2
Existing renewable technology the world's best bet
Renewables' contribution to world energy supply, by category, %



Source: Our World in Data, IIF; *from 0% to 5%: exploratory phase; from 5% to 25%: adaptation phase; above 25%: scaling phase; data and forecast covering period 31.12.2019-31.12.2100

While most of the reduction in greenhouse gas emissions will likely come from existing clean climate technologies, such as wind and solar PV, these alone will not be sufficient to achieve net zero goals. It is important to facilitate additional funding for new clean technologies that are still under development. These emerging technologies, such as carbon capture and storage (CCS) are anticipated to play an important role in reducing the carbon footprint of hard-to-abate sectors. However, for CCS technologies to become a major force in the green transition, they will need updating – and these updates will require significant resources. CCS technology has been in existence for around 50 years, primarily used by the oil and gas industry for enhanced gas recovery (EGR) to extract more oil from depleting reservoirs. The utilisation of CCS as a means of dedicated geological storage to address climate change began in the 1990s. Currently, operational CCS facilities capture around 43 million metric tonnes of CO_2 ($MtCO_2$) each year, with nearly 70 per cent of them dedicated to EGR, mainly natural gas processing plants. Moreover, less than 20 per cent of CCS projects currently under construction are dedicated to EGR, suggesting that new carbon sequestration projects are primarily intended to address climate change rather than support an increase in fossil fuel production. That said, while the capacity of CCS facilities is projected to reach some 220 $MtCO_2$ per year by 2030, this will still be 80 per cent less than what will be required to achieve a net zero economy.

More policy incentives are needed to scale CCS technologies: currently, there is a wide range of costs associated with CCS projects due to variables along the value chain; in addition, the lack of long-term data on the effectiveness of newer technologies makes them difficult to price accurately. While CCS is believed to be capable of delivering material emission abatement at costs that are competitive in the long term, the costs associated with existing CCS technologies, including for bioenergy, are still very substantial. Achieving rapid expansion in CCS uptake would thus require strong policy support to incentivise front-loaded investment to make these technologies economically viable. Here, the signs are promising: the pipeline of publicly-supported CCS projects has increased by 50 per cent over the past year. In particular, the US Inflation Reduction Act (IRA) is expected to accelerate CCS deployment; the US is projected to host nearly half of the world's CCS capacity by 2030. Moreover, the development of voluntary carbon markets[4] could provide additional funding for building CCS capacity and advancing other transition technologies.

4 Voluntary carbon markets are markets through which carbon credits are purchased, usually by organisations, for voluntary use rather than to comply with legally binding emissions reduction obligations. Voluntary carbon markets are growing, driven in part by demand from businesses looking to offset their emissions.

1805

CHAPTER 1

Net zero's debt burden

As the urgency of climate action commands global attention, policymakers are increasingly seeking greater international coordination to address this pressing issue.

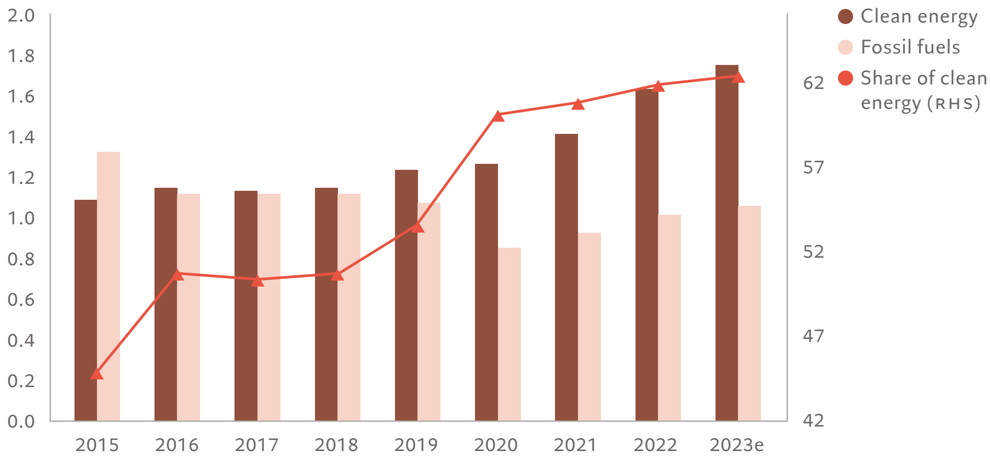
Collaboration between governments and the private sector has made significant strides in recent years, making a considerable contribution to the battle against climate change.

Among the successess is a surge in climate finance, which has been on the rise since 2018, exceeding USD2 trillion by 2023 – a substantial increase from USD665 billion in 2020 (see BOX 2 for what constitutes climate capital).

FIGURE 3

Clean energy: a magnet for investment

Investment in clean energy vs fossil fuels, USD trillion and as % of total



Source: International Energy Agency, IIF; data covering period 31.12.2014-31.12.2023

This remarkable growth is primarily down to robust investment in climate mitigation. An analysis of data from the IEA shows that clean energy investment has consistently outpaced spending on fossil fuels since 2016, with over half of the total financing originating from public resources (see FIGURE 3).

Progress has been particularly pronounced in developed markets and China, which have spearheaded a major expansion in renewable energy capacity and energy efficiency-related investment. This surge has been further accelerated by legislative milestones, such as the US IRA of 2022 and Europe's Green Deal Industrial Plan. Moreover, heightened concerns about energy security have been another important factor propelling many other countries to champion renewables and energy savings from efficiency improvements, particularly after Russia's invasion of Ukraine.

BOX 2

Defining climate capital

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate finance as the deployment of local, national, and transnational financing that aims to:

- reduce emissions and enhance sinks of greenhouse gases (mitigation)
- reduce the vulnerability of both human and ecological systems to negative climate change impacts (adaptation).

However, quantifying and obtaining detailed information on climate finance (both mitigation and adaptation) that can be reconciled with the UNFCCC definition presents a significant challenge, for three main reasons. First, there is **no consensus on definitions**. With so many different initiatives seeking to mobilise climate finance, there is limited agreement in practice on what constitutes climate or transition finance (see for example the work of the Glasgow Financial Alliance for Net Zero (GFANZ) on transition finance definitions). The emergence of so many alternative standards and definitions makes climate finance mapping exercises very complex.

The second problem is **data inconsistency**. A host of public and commercial data portals, such as those managed by the IEA, the Climate Policy Initiative (CPI) and Bloomberg New Energy Finance (BNEF), provide information on climate finance.

However, the underlying data in these portals are gathered using different methodologies, often targetting specific subsets of available data, such as project investments, product sales, asset finance and corporate finance. As a result, the breadth and depth of these portals vary significantly, which makes direct comparison challenging.

The third problem is **limited breadth of available data**. Most climate data is sourced from just two sectors: power generation and transport sectors. Data from other high emission sectors, such as buildings, agriculture and industry, remains largely untraceable. The CPI's Global Landscape of Climate Finance Data Portal stands out as the only data source that encompasses a broader set of climate-relevant sectors. However, even this data is incomplete – it is backward looking and does not comprehensively capture climate finance mobilised through private sector channels.

MIND THE INVESTMENT GAP

Despite the encouraging uptick in climate finance across major economies, there are two inconvenient truths about the state of net zero funding:

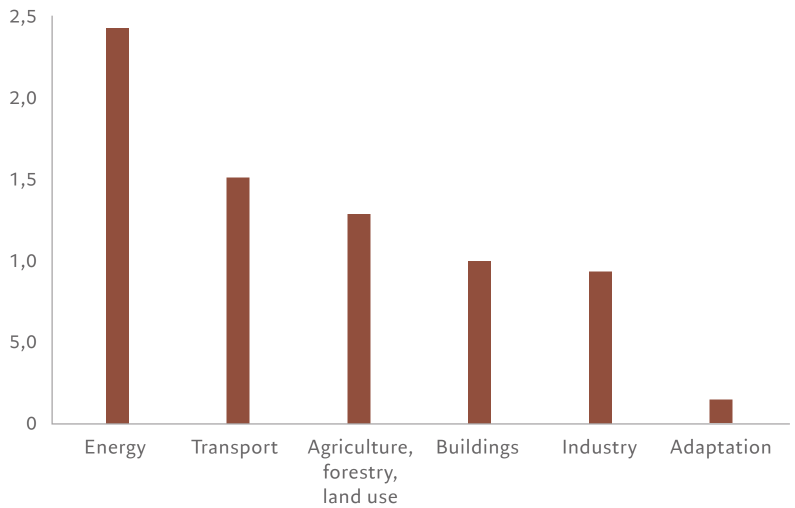
- The current pace and scale of investment are insufficient to achieve the 2050 net zero target, and;
- A dramatic escalation in climate investment is required within the next five to seven years, largely through increased government borrowing, to align with the Paris Accord's climate objectives.

The capital set aside for climate action, while growing, still falls significantly short of the level required to effectively decarbonise the global economy. According to the CPI, an additional annual investment of over USD8.1 trillion is necessary for climate change mitigation and adaptation.

By our calculations, a climate-neutral economy will require continuous increases in low-carbon energy, with the ratio of low-carbon-to-fossil fuel energy supply investment needing to rise to approximately 7 to 1 by 2050.

As FIGURE 4 shows, the investment gaps are significant in several key industries but are particularly large in the energy sector; there, additional spending of nearly USD2.5 trillion is required per year.

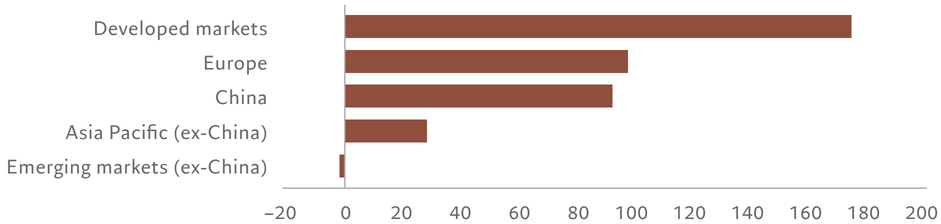
FIGURE 4
Mind the investment gap
Annual net zero funding shortfall, in USD trillion, by sector, through to 2030



Source: Climate Policy Initiative, IIF, forecast period 31.12.2023-31.12.2030

A successful transition also demands a sizable change in the energy investment practices worldwide – notably in Asia and Latin America (see FIGURE 5). While recent years have seen a significant pick-up in low-carbon energy investment in these regions, further progress is urgently needed.

FIGURE 5
Emerging markets lag on clean energy
Change in clean energy investment, USD billion, average202/22 vs 2017/19



Source: IEA, IIF;
data covering period 31.12.2016-31.12.2022

Accelerating climate adaptation is equally crucial. Although the capital shortfall for adaptation is relatively small compared to that of other sectors, the pace of investment for adaptation infrastructure remains worryingly slow. The lack of investment in climate adaptation infrastructure, such as flood defences, anti-landslide protection, and extreme weather early warning systems, is a major concern, particularly in emerging markets. Over 60 per cent of annual climate financing needs for adaptation remain unmet, with funding gaps exceeding 80 per cent in the Middle East and Africa.

Another reality investors must confront is that, for net zero targets to be reached by 2050, a significant portion of total clean energy investment must be made upfront, or within the five to seven years.

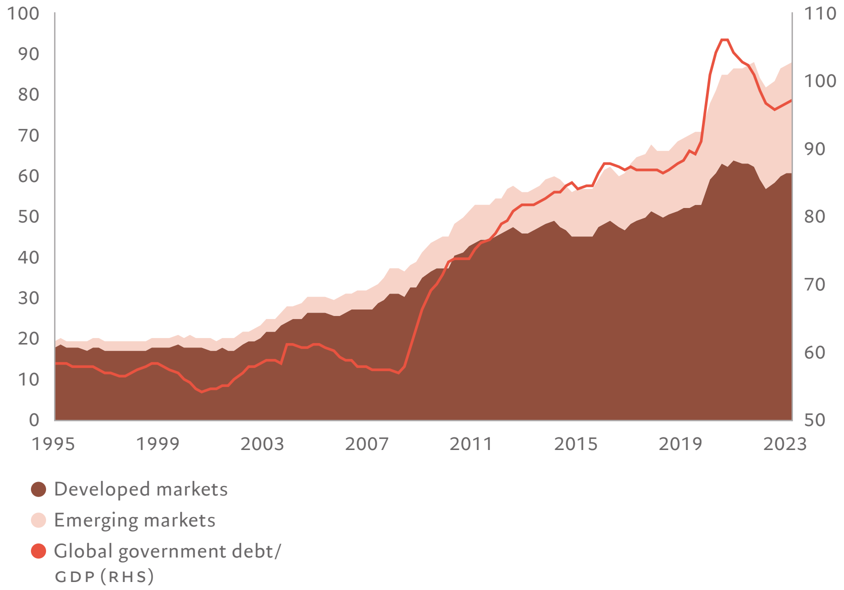
This is essential to ensure affordable access to clean energy technologies and to accelerate their global adoption, a challenge that has been significant in previous energy transition episodes (see BOX 1).

CLOSING THE DEBT GAP – GOVERNMENTS TAKE THE STRAIN

The need for substantial climate finance is expected to drive further government debt accumulation. Despite significant investments from the private sector, including commercial banks and utility companies, more than half of total climate finance still stems from public sources. If, as we expect, governments maintain their current proportion of climate investment, increased public spending will add to debt loads worldwide which, in turn, could exacerbate debt vulnerabilities and raise fiscal discipline concerns.

Covid-19 related public spending has left many sovereign borrowers more vulnerable to future shocks, pushing global debt to new highs. Although a post-pandemic growth rebound and rise in inflationary pressures initially helped reduce debt-to-GDP ratios, this phenomenon has proved temporary. Government budget deficits remain elevated, well above pre-Covid levels across major countries.

FIGURE 6
A debt mountain
Government debt, in USD trillion, and as % of GDP

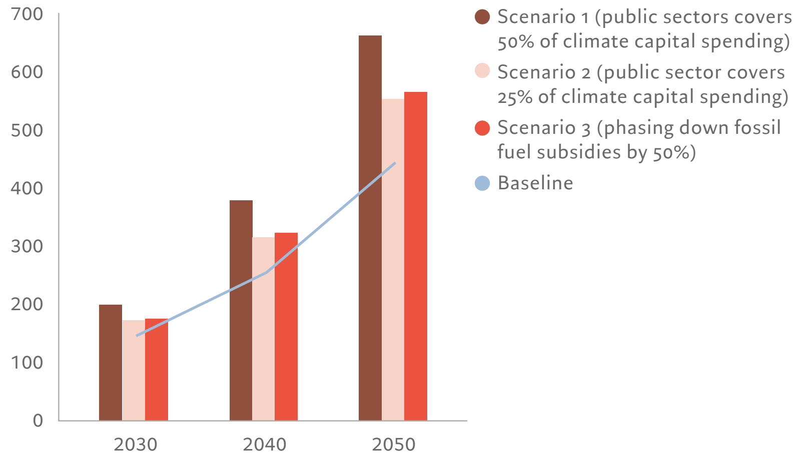


Source: IIF, data covering period 31.12.1994–31.12.2023

At around USD88 trillion, global government debt is more than USD17 trillion above pre-pandemic levels, with emerging markets accounting for some two thirds of that build-up (see FIGURE 6). This debt accumulation is expected to persist due to a combination of factors including aging populations and rising healthcare costs. Excluding net zero investment, global government debt is projected to reach USD145 trillion by 2030 and then surpass USD440 trillion by 2050.

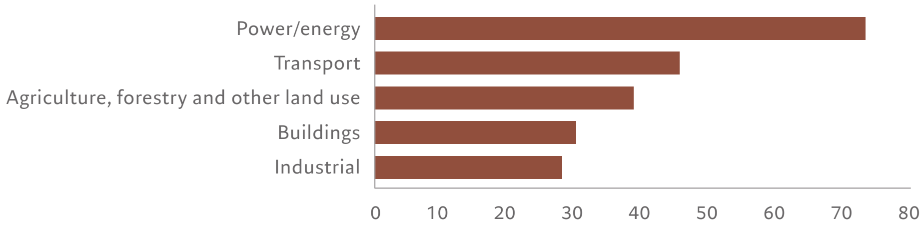
Yet assuming governments continue to fund half of all climate spending globally, net zero investment alone could potentially add over USD50 trillion to governments' debt piles by 2030 and over USD215 trillion by 2050. This would account for over one-third of the projected increase in government debt through 2050 (see FIGURE 7). Most of this increase would come from decarbonising the power generation and transport sectors (see FIGURE 8).

FIGURE 7
Climate spending adds to debt pile
Government debt,
in USD trillion, by scenario



Source: IIF; forecast covering period 31.12.2021–31.12.2050

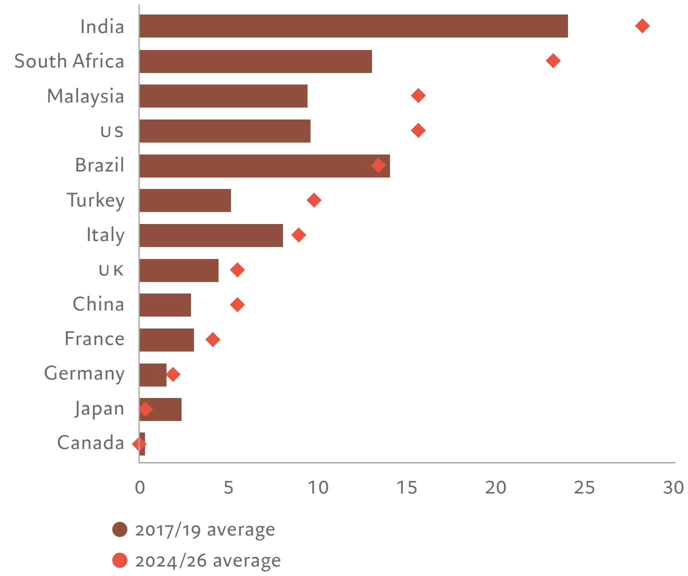
FIGURE 8
Climate spending needs could add USD215 trillion to government debt
Possible increases in net zero government spending by 2050, in USD trillion, by sector



Source: IIF; forecast covering period 31.12.2022–31.12.2050

The prospect of higher debt servicing costs could complicate public funding of net zero. With public sector budget deficits running above pre-Covid levels and central banks having raised interest rates to combat inflation, many governments are allocating a growing share of tax revenues to meet interest expenses. A surge in public debt levels related to climate action could further increase the debt service burden from already high levels, heightening the risk of a political backlash against the net zero transition (see FIGURE 9).

FIGURE 9
Surging debt service costs
Net interest expenses as % of government revenue, selected countries, average 2024/26 vs 2017/19



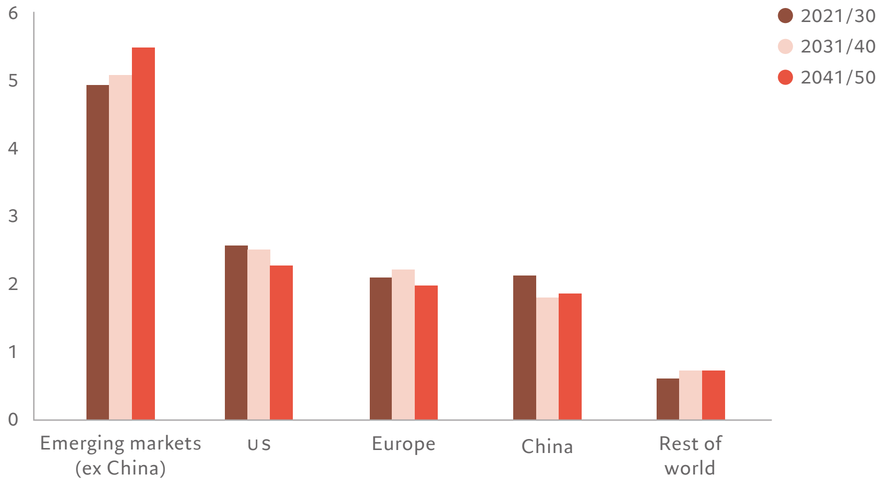
Source: IIF, data covering period 31.12.2016–31.12.2026

A higher-for-longer interest rate environment could weigh on sentiment among fixed income investors, potentially leading to mini boom-bust cycles in global debt markets. This would make climate finance for emerging markets and developing countries even more challenging (see FIGURE 10).

FIGURE 10

Emerging markets to take on most of climate debt

Change in government debt, USD trillion, due to climate-related investment, by decade



Source: IIF; forecast covering period 31.12.2021-31.12.2050

Higher public debt could also crowd out private investment as rising levels of government borrowing lead to tighter financing conditions and austerity measures. This, in turn, can slow economic expansion, further complicating government debt dynamics and creating the conditions for an anti-green political backlash.

There are, however, some caveats to this assessment. Total public borrowing could be lower than our projections if governments simultaneously reduce subsidies on fossil fuels, which currently total around USD7 trillion per year. Despite the political challenges, phasing down inefficient fossil fuel subsidies and reallocating those funds to climate change initiatives could relieve some anticipated pressures on government budgets.

Moreover, financing green projects can yield substantial economic benefits, potentially surpassing those of traditional public spending. However, predicting the timing of these economic gains is difficult; they are unlikely to be realised before 2030. Most importantly, if policymakers can effectively incentivise private financing for climate action, then total public borrowing could be significantly lower than our baseline estimates. Support could come from various strategies, including blended finance and public-private partnerships, which create attractive risk-return profiles for private creditors and investors. Greater mobilisation of private capital for climate action could reduce the strain on government balance sheets. This approach would limit the crowding-out effect of government debt, enhance coordination between public and private sectors, and maximise the efficiency and effectiveness of climate finance deployment.

Net zero funding and the implications for sovereign debt investors

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Head of Global Bonds

The green transition is likely to make life challenging for bond investors, particularly over the next five years or so. As the IIF argues, net zero will impose very substantial costs on economies, with a significant part of the burden being carried by governments.

We can debate exactly how much it will cost and how the debt will be apportioned, but it seems clear that it will only make already high government debt to GDP ratios swell further. Government deficits rocketed in response to the pandemic, and are proving very slow to come back down. Add in the costs of new energy infrastructure and other climate mitigation and adaptation measures, and the debt burden will begin rising once more, leading to a rise in risk premia for many fixed income assets.

A large US government deficit – it was near 6 per cent of GDP in 2023, against a post-war average of 2.2 per cent – is already making the US Federal Reserve's job of controlling inflation increasingly difficult. Markets are not only overly optimistic about how quickly and how far interest rates will fall but also seem to be in denial about the costs of building a sustainable economy: the green transition means the era of zero interest rates is in the past.

So how should bond portfolios adjust to a world embracing net zero?

Higher bond yields and steeper yield curves certainly present new challenges.

Investors will have to manage the duration and curve exposure of their fixed income portfolios much more actively. Given that traditional bond benchmarks have an inherently long bias, this implies a more benchmark agnostic approach.

At the same time, investors should also expect an increase in the dispersion of returns across individual markets given central banks' differing attitudes to inflation and the differing costs of net zero.

Central banks' efforts at reconciling weak growth – not least as fossil fuels begin to be phased out – sticky inflation and net zero targets could well shorten interest rate cycles. It would also tend to lead to higher interest rate volatility than investors grew used to during the past two decades. At the same time, central banks' experience with quantitative easing could see them use these alternative means of providing liquidity where financial market accidents threaten – think the Credit Suisse and Silicon Valley Bank failures – even as they keep key real interest rates at positive levels.

> Investors should also expect an increase in the dispersion of returns across individual markets given central banks' differing attitudes to inflation and the differing costs of net zero.

In light of sticky inflation and fiscal laxness, investors would be wise to add a 0.5 percentage point premium to what they demand from 30-year Treasury bonds above what 10-year Treasuries yield. Investors in European government bonds would do well to add a small premium for the risk that the European Central Bank will allow inflation to run slightly hot – reflecting higher energy costs in Europe – for a while, suggesting 10-year German Bund yields of on average 2.5 to 3 per cent for the rest of the decade.

1805

CHAPTER 2

The economic disruption of net zero

A transition to a low carbon economy will undoubtedly leave the world better off in the long term. Over time, clean energy should become cheaper while the worst physical effects of climate change will be mitigated. In other words, business as usual is no longer an option.

Still, the shift to net zero is likely to cause considerable economic disruption, particularly in the early years of the transition, which is when most of the green investment, climate-friendly policymaking and changes in consumption habits need to take place. And that's not least because many of the world's economies are today overwhelmingly reliant on fossil fuels.

With around 75 per cent of the global energy supply still coming from oil, coal and gas, the magnitude of the required change cannot be underestimated. Limiting global warming to 1.5°C implies leaving around 60 per cent of existing oil and gas reserves untapped.

A rapid and poorly-managed transition from fossil fuels to low-carbon energy supplies carries the inherent risk of a significant increase in stranded assets within a relatively short time frame; resources and infrastructure linked to fossil fuels that could be abandoned well before they reach the end of their anticipated economic lifespan. Such a scenario would see substantial volatility in energy prices and disrupt labour markets, resulting in inflationary pressures and adversely impacting economic activity.

"The shift to net zero is likely to cause considerable economic disruption, particularly in the early years of the transition, which is when most of the green investment, climate-friendly policymaking, and changes in consumption habits need to take place."

Moreover, without policy measures to mitigate the cost of net zero, the energy transition could exacerbate social tensions due to its effect on household income. This, in turn, could undermine political support for the energy transition. While growth and employment-friendly policy strategies that focus on redistributing the costs of the energy transition in the short to medium-term can help, this would come at the cost of higher debt levels (see CHAPTER 1).

CARBON PRICES AND THEIR EFFECTS ON THE COST OF ENERGY AND INFLATION

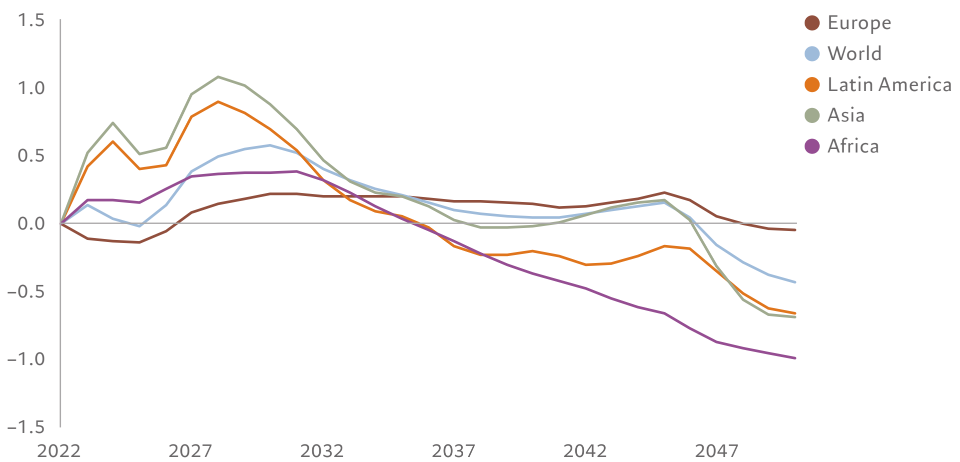
Carbon pricing is essential to accelerate global decarbonisation efforts. A feature of the net zero scenarios developed by the Network for Greening the Financial System (NGFS) is a rapid increase in global carbon prices.[5] NGFS estimates that carbon prices will need to reach over USD125 per mt by 2030, rising to USD1150 per mt by 2050. That is a radically different picture from the one we see today.

Although the adoption of some form of carbon pricing is projected to expand across sectors, regions and countries in the coming years our calculations currently show that only about 23 per cent of global emissions are subject to a carbon tax or an emissions trading scheme. Equally discouraging, the average carbon price is currently just USD24 per mt, a worryingly low level that suggests the uptake of carbon prices may not unfold as rapidly as posited by existing net-zero climate scenarios.

Yet if carbon prices do rise in line with the NFGS trajectory, the economic consequences could be considerable.

Consider the impact on energy prices and inflation. NGFS scenarios suggest that the initial impact of higher carbon prices on inflation will be significant before easing over time (see FIGURE 11).

FIGURE 11
Inflation spike looms in early years of clean energy transition
Difference in inflation rate, percentage points, net zero vs no mitigation scenario



Source: IIF, Network for Greening the Financial System; forecast period 31.12.2021-31.12.2050

5 For more detail on NGFS scenarios, see: https://www.ngfs.net/ngfs-scenarios-portal/

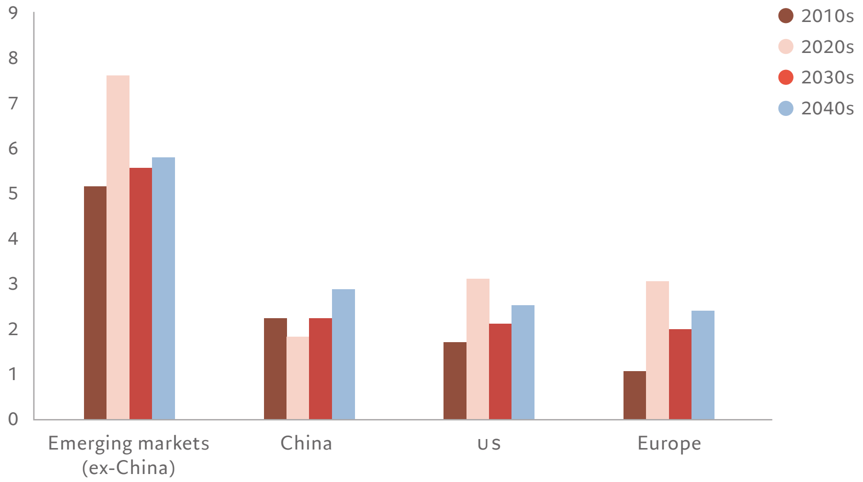
These scenarios assume that carbon prices will change relative prices, increasing the cost of products and services with a high carbon footprint but without inducing a broad surge in overall consumer prices. In other words, the scenarios assume that a change in relative prices will cause a shift in consumer preferences towards relatively cheaper climate-friendly products and services, thereby containing headline inflation.

Recent empirical estimates have shown results that align to some extent with the long-term projections contained within NGFS scenarios. They suggest that a USD10 increase in carbon prices per mt could lead to a 0.8 percentage point increase in energy inflation but only a 0.08 percentage point increase in headline inflation after one year.

A simple extrapolation of these empirical estimates suggests that while overall energy prices (fossil and non-fossil fuels combined) could potentially see a cumulative rise of over 150 per cent by 2050, headline inflation would only rise around 10 per cent during that entire period.

The near-term outlook for inflation under the NGFS scenario is less benign, however. As FIGURE 11 shows, they forecast a surge in inflation during the early years of the transition.

FIGURE 12
Energy transition to keep inflation elevated over medium term
Average inflation, by decade and region under net zero scenario related investment, by decade



Source: IIF; data and forecasts covering period 31.12.1999-31.12.2050. The baseline inflation figures until 2028 reflect IMF WEO estimates. From 2028 onward, inflation figures are extrapolated as a moving average of the preceding five years. The contribution of carbon prices to baseline figures is computed under the assumption that a USD10 increase in carbon prices per ton will lead to a 0.08 percentage point increase in baseline inflation after one year. The trajectory of carbon prices is computed based on the NGFS net-zero scenario, assuming that the uptake of carbon prices will be more gradual and slower than NGFS scenarios

Our own research also points to rising inflation but at a more moderate pace than the NGFS forecast. We see headline inflation rates rising from 2.7 per cent in the 2010s to some 3 per cent by the 2030s and exceeding 3.3 per cent in the 2040s, assuming major central banks maintain a relatively accommodative policy stance. Inflation is projected to be considerably higher in emerging markets, given their generally greater reliance on fossil fuels (see FIGURE 12).

The IIF's own forecasts differ from those of the NGFS because we expect the impact of carbon prices on overall price pressures to be more contained in the early stages of transition and align with historical averages. This primarily reflects our assumption of a slower uptake of carbon prices and a lower level of policy support to incentivise global decarbonisation. We further assume that the prevailing macroeconomic environment – characterised by higher borrowing costs – will pose significant obstacles to the implementation of large-scale green stimuli over the next several years. In tandem with a potential political backlash, this could limit the introduction of large-scale green subsidies and public investment into clean infrastructure and technologies. What is more, we expect a decline in non-energy inflation thanks to a contraction in household incomes and corporate profits resulting from higher carbon prices amidst lower output levels.

As a result, the influence of higher carbon prices on headline inflation is likely to be curtailed throughout the remainder of this decade.

THE OTHER INFLATION RISK: A SUPPLY CRUNCH IN GREEN METALS

That said, there is one reason why inflation could overshoot our forecast in the medium term: a shortage in the supply of green metals.

Higher carbon prices will inevitably increase demand for metals that are essential for clean energy technologies. Industry estimates suggest that demand for energy transition metals will increase five-fold by 2050. However, there is no guarantee that supply will be able to keep pace. This means that the adoption of clean energy technologies and the development of the necessary sustainable infrastructure could cause a rise in metals and minerals prices.

For example, the rapid expansion of global power grids, essential for accelerating electrification, is expected to boost demand for copper for decades, while the the growing uptake of electric vehicles is expected to do the same for aluminium and rare earth minerals. Then there's the world's increasing reliance on wind energy. This is likely to put additional upward price pressure on a range of energy transition metals, particularly copper and rare earths. The continued buildout of solar photovoltaic (PV) supply chains, meanwhile, can be expected to boost demand for silicon, a key input into solar supply chains.

> "Many energy transition scenarios point to demand excesses for most energy transition metals in the years to come."

To meet this growing demand, a correspondingly large supply-side response will be required. Yet many energy transition scenarios point to demand excesses for most energy transition metals in the years to come.

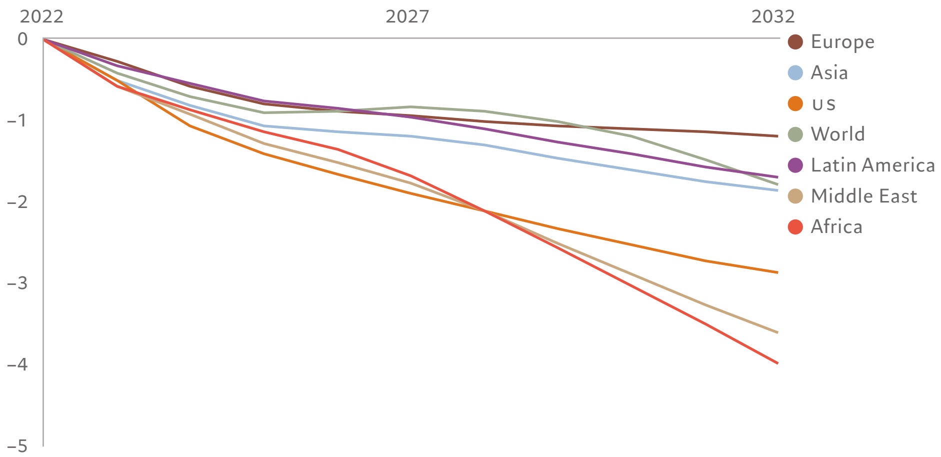
Particularly problematic is the high level of policy uncertainty. In a well-functioning market with long-term planning security, high demand for transition minerals would support substantial future investment; working on this assumption, many mining companies are increasing their exposure to energy transition metals, with exploration spending on these metals rising by 20 per cent in 2022. However, given the risks associated with these long-term investments – such as changes in environmental regulations or protectionist measures aimed at securing supplies of critical clean energy materials – there are growing concerns that supply might not be able to keep pace with demand. Supply-demand imbalances could, in turn, lead to a surge in the price of transition metals, potentially lifting overall inflation.

CARBON PRICES AND ECONOMIC GROWTH

Net zero scenarios through to 2030 anticipate moderate economic output losses compared to a scenario where no climate change mitigation measures are implemented (see FIGURE 13). This reflects both the impact of elevated energy costs due to higher policy-induced carbon prices and the reallocation of private energy investment from fossil fuels to renewables. An increase in the unemployment rate is anticipated in regions and countries dependent on fossil fuel production. Globally, however, the employment outlook should become balanced over time as the expanding clean energy sector will also create new jobs, offsetting job losses elsewhere and mirroring the developments seen in the US following the implementation of the IRA.

Our analysis shows that the potential magnitude of economic output losses varies significantly across nations and regions. We find that changes in labour productivity depend on country-specific fundamentals such as temperature pathways, carbon price levels, population growth and the degree of dependence on high-carbon energy consumption and production. While all these scenarios include some form of policy stimulus (funded by carbon taxes) to counterbalance the adverse implications of higher energy prices in the short term, these efforts are still predicted to fall short in offsetting losses in output, labour productivity and household disposable income over the medium term in many countries. It is important to note, however, that productivity losses are likely to be concentrated in the early years of the transition and ease gradually over time as the efficiency gains from new clean energy technologies start to materialise.

FIGURE 13
The economic cost of the energy transition
% difference in real GDP under net zero scenario, by region



Source: IIF, Network for Greening the Financial System; forecast period 31.12.2021-31.12.2050

Overall, output losses could be more pronounced in emerging markets and developing countries. In developed markets, the NGFS scenarios suggest that losses could potentially be greater in Canada and the US largely owing to their high reliance on fossil fuel production and consumption.

Equity markets and the initial phases of the green transition

ARUN SAI
Senior Multi Asset Strategist

The IIF's research lays bare the economic disruption that will confront equity investors during the initial phases of the green transition. Inflation could be more volatile over the next five to seven years than it has been for much the time since the financial crisis of 2008, remaining above central bank targets in many countries. GDP growth, meanwhile, will trail the long-term average as the gains in productivity that will come from investment in green technology are unlikely to materialise until the latter stages of the journey to net zero.

The lacklustre growth and erratic inflation brought about by the net zero transition could weigh on corporate profitability, and ultimately on dividends and shareholder returns over the next five to seven years.

A decline in households' disposable income will result in lower aggregate demand and a fall in company revenues. Add to that a rise in input costs and the burden of more stringent environmental regulations, and the conditions are in place for a steady but persistent contraction in profit margins. Factoring this into our models, we find that annual returns from equity markets will, in aggregate, be in the low single-digit range in inflation-adjusted terms through the remainder of the 2020s.

No two sectors of the equity market will experience the economic effects of net zero in the exactly the same way.

But the broader picture masks wide divergences across countries and industries. No two sectors of the equity market will experience the economic effects of net zero in the exactly the same way.

One important conclusion to draw from the analysis is that the US stock market might lose much of its effervescence. That is a view we have held for some time and for several reasons. But clearly, the considerable cost of net zero for the world's largest and most carbon-heavy, economy is a primary factor. US companies will find that policy measures such as the pursuit of green technology self-sufficiency and more punitive carbon pricing will crimp profits. In the absence of financial transfers from the developed to the developing world, emerging market equities could also struggle particularly in countries that are reliant on fossil fuels.

Consumer-facing companies are also susceptible to declines in household spending. Expect their share prices to underperform the broader market. Energy companies that are slow to transition and face the prospect of owning stranded assets are also vulnerable.

By contrast, shares of companies operating in the materials sector should fare well as demand for green metals and other commodities outstrips supply. Industrial and semiconductor businesses supplying infrastructure and equipment critical to the net zero transition can also be expected to deliver market-beating investment returns.

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CHAPTER 3

Going green and the risks of capital misallocation

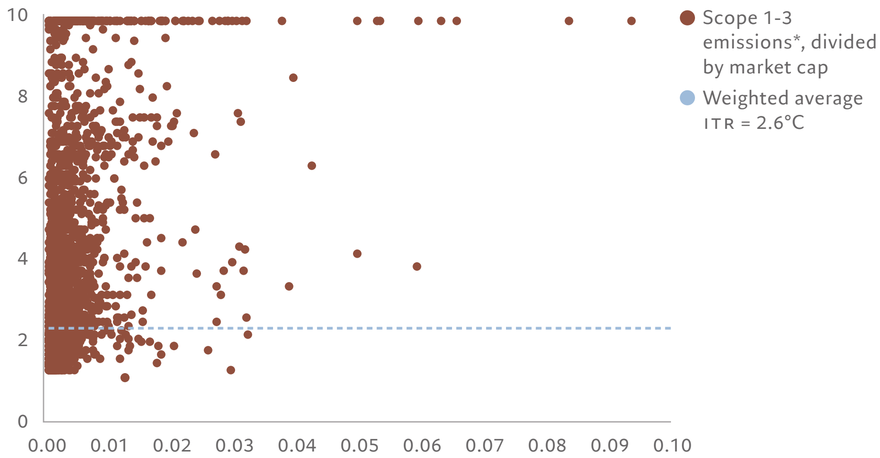
The clean energy transition is poised to be as disruptive as the steam and railway revolution of the 1820s, the electricity revolution of the 1870s, and the oil, car and mass production revolution of the 1900s.

As such, it will pose significant challenges for private investors, potentially giving rise to asset bubbles and periods of market instability. Factors such as firms' limited progress towards their climate goals, the increasing participation of public entities in climate finance and enduring difficulties in obtaining reliable, high-quality and comparable climate data may hinder investors' ability to effectively manage the risk of the clean energy transition, increasing the likelihood of costly missteps.

FIGURE 14

Most businesses not aligned with net zero

Corporations scope 1, 2 and 3 carbon emissions, divided by market cap



Source: MSCI, IIF; each dot represents a businesses' total emissions/market cap vs its implied temperature rise (ITR); ITR is a forward-looking metric, expressed in degrees Celsius, designed to show the temperature alignment of companies, portfolios and funds with global temperature goals, scope 1 emissions are those attributable to a company's own operations, scope 2 emissions are those attributable to a company's energy provider, scope 3 emissions are those attributable to a company's suppliers and customers: its entire value chain

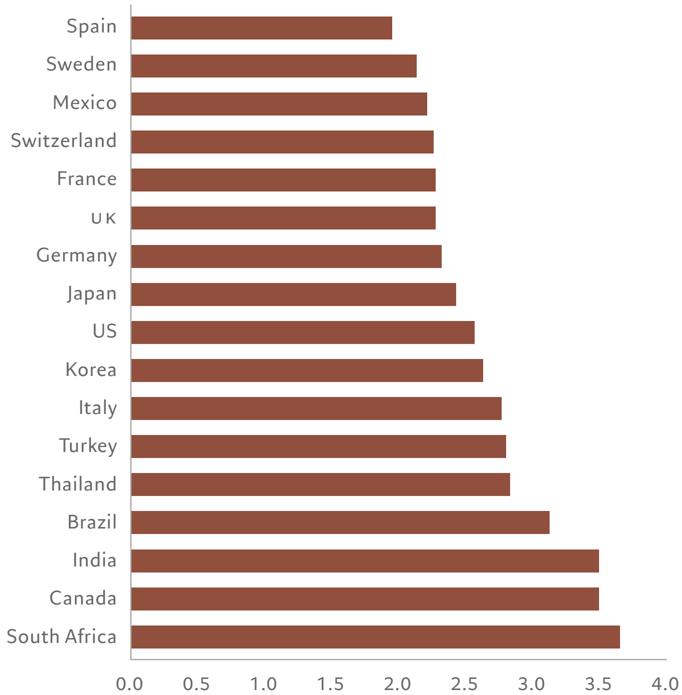
A successful net zero transition will require a radical change in corporations' production, investment and trade practices. Yet while a growing number of companies are adopting ambitious net zero goals, many are still behind in revamping their operational frameworks. As FIGURE 14 shows, even though a widely-used gauge of corporate carbon emissions – scope 3 emissions divided by a firm's market cap – paints a positive picture, more than half of the world's listed companies continue to operate in a business-as-usual mode : the implied temperature rise (ITR) of their day-to-day activities is higher than the 2°C safety threshold.

This misalignment is particularly pronounced in countries with publicly listed firms heavily involved in carbon-intensive activities, such as South Africa, Canada, India and Brazil (see FIGURE 15). Consequently, the longer these changes are deferred, the greater the risk of encountering costly errors, particularly for companies with already stretched financial resources.

FIGURE 15

Companies still some distance away from net zero

Listed companies'* impact on global warming, by country, expressed as implied average temperature rise attributable to corporate activities



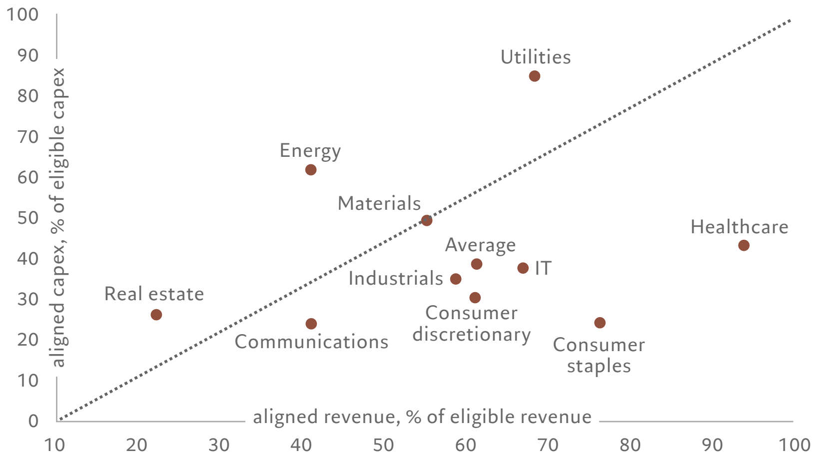
Source: IIF, Bloomberg, MSCI;
*excludes financial and Chinese companies;
data at 31.12.2023

This situation could lead to an abrupt surge in corporate borrowing, especially in sectors significantly misaligned with global temperature goals, such as utilities, materials and energy.

FIGURE 16

In many industries, company revenues and capital spending still not aligned with net zero goals

% of corporations' eligible revenue and capex aligned with net zero objectives



Source: IIF, Bloomberg, MSCI, data as at 31.12.2023

THE RISKS OF OVERLY MUSCULAR STATE SUPPORT

In recent years, public investment and initiatives have become an increasingly vital component of transition finance – a trend that is anticipated to gain further momentum (see CHAPTER 1). But increases in public spending do not always lead to the best outcomes. Although crucial for mobilising larger amounts of private capital to facilitate the clean energy transition, particularly during its early stages, public investment and initiatives come with their own set of challenges. The risk of misdirecting resources is a particular concern:

- Historical evidence suggests that, despite being tremendously well-intentioned, government initiatives can be obstructed by bureaucratic inefficiencies, weak financial oversight and political interference. Such factors may lead to the suboptimal use of both public and private resources, undermining the effectiveness of public investment and further exacerbating the risk of costly investment mistakes.
- These public sector efforts also raise concerns about the risk of regulatory fragmentation and the appropriate use of the capital framework – see for example the IIF's 2023 report The Role of the Financial Sector in the Net Zero Transition.
- Poorly devised or implemented policies could trigger large-scale reallocation of investment from high-carbon to low-carbon sectors, resulting in much greater incidence of stranded assets. For instance, phasing out fossil fuel-based infrastructure too early in

emerging markets and developing economies might not be economically feasible due to the relatively young age of their existing coal-fired power plants compared to those in mature markets. This fundamental dilemma highlights the importance of policy frameworks to support a just transition, particularly in emerging markets.

- Equally important is the need for sustained transition investment in high-emission assets to ensure a smooth pathway to a net zero economy. Failing to adequately invest in the transition of the fossil fuel industry could result in an unanticipated surge in inflationary pressures (see CHAPTER 2). This would have significant implications for energy access, affordability – potentially even jeopardising global efforts and political will for the energy transition. Therefore, it is crucial to strike a balance between divestment from high-emission assets and strategic investment in low-emission alternatives, considering the broader macroeconomic and social implications of the transition.
- The effective management of clean energy supply and demand is equally important. As clean energy technologies become more accessible, their prices are expected to decrease, potentially accelerating the global shift towards clean energy. However, supply is only half of the equation: if policy incentives to support demand for clean energy are not in place, the resulting demand-supply imbalance would have highly negative consequences. A prolonged period of oversupply –particularly in key technologies like solar panels and wind turbines – combined with a sharp decline in clean energy prices, would be a significant threat to a smooth energy transition. This risk could impact existing clean energy producers, potentially leading to corporate defaults and failures. But it would also have broader implications for other markets, including commodities, and for financial stability. In such a scenario, new manufacturers could be deterred from entering the clean energy market, impeding much-needed climate investment. Climate policy frameworks are thus crucial to establishing demand-side incentives to drive the needed shifts in corporate and consumer behavior in order to effectively address the risks of oversupply.

DATA GAPS COMPLICATE EFFECTIVE DECISION-MAKING

Large data and research gaps on climate change pose significant challenges for investors, impeding their ability to identify green bubbles or companies at risk of asset stranding. In most cases, corporate climate is not readily available and even when it is, it often lacks the necessary granularity or comparability for informed decision-making. Coupled with the limited information on corporations' transition plans, these substantial gaps hinder investors' ability to effectively assess climate-related opportunities and risks, potentially leading to information asymmetry and market mispricing (see BOX 3). Consequently, this can lead to misleading interpretations of emerging trends and contribute to herd-like behaviour among investors, favouring low-carbon footprint companies over those with higher carbon footprints. Widespread climate herding could undermine the efforts of transitioning companies to decarbonise their business practices and could result in episodes of speculative 'green asset bubbles', increasing the likelihood of disorderly market corrections during the transition to a net zero economy. If such corrections were to be severe, the macroeconomic implications could jeopardise global efforts for climate action and weigh on the political will for a net zero transition.

BOX 3

Addressing market mispricing

Empirical studies highlight that markets do not fully integrate climate change risks and opportunities into asset price valuation. The primary reason for this mispricing has been the lack of comprehensive and widely available climate data. However, expected improvements in corporate climate disclosure practices should help bridge the gap between market pricing and actual climate change risk. In fact, while an analysis of publicly listed firms that report EU climate taxonomy-eligible revenue and capital expenditures suggests broad misalignment, there are also early signs of progress towards better alignment (see FIGURE 16). For instance, companies in the utilities, energy and materials sectors, which are known for their significantly high carbon footprint, are allocating a relatively high portion of their capital expenditure towards EU taxonomy-aligned activities, particularly when compared to the share of taxonomy-aligned revenues. This trend is more pronounced at sectoral level, where the proportion of taxonomy-aligned capex surpasses that of their taxonomy-aligned revenues. This pattern suggests a strategic shift in these sectors, moving towards using proceeds from brown activities to fund taxonomy-aligned capital investments, indicating a commitment to a sustainable transition.

> "Market pricing does not yet reflect the value being created in sectors that are genuinely in transition."

While traditional factors such as growth prospects, expected profitability and quality of earnings, currently play a much more important role than climate-related factors in driving a company's market valuation, available data indicates a positive correlation between corporate valuations and the share of climate-aligned revenues at sectoral level. However, it is important to note that current market valuations do not fully reflect corporate ambition on climate action. For example, climate-aligned capital expenditure – a forward-looking key performance indicator – is still negatively correlated with stocks' price-earnings ratios. This suggests that market pricing does not yet reflect the value being created in sectors that are genuinely in transition, despite their significant levels of capital spending on climate-aligned projects relative to other sectors.

Transition and stock selection: the problems facing investors with sustainability goals

EVGENIA MOLTOVA
Senior Investment Manager, Pictet-Positive Change equity portfolio

It is clear to us that the transition to a sustainable economy is not an option but a necessity. The energy transition is a key component of this overhaul. The IIF's research highlights the many challenges that investors face from that disruption as well as the opportunities that may open up.

We agree there is more to be done to create the conditions to incentivise change in consumer and corporate behaviour. There are signs that this is happening in some industries and markets. But others have been slow to adapt and the delay suggests their transition path will not be smooth. All of which means investors with sustainability goals need to take a more pragmatic approach.

To begin with, investors should recognise that building a sustainable economy will inevitably involve continued investment in many of today's carbon-intensive sectors. Industrial firms, mining companies and utilities have large environmental footprints, they are all essential to net zero. Excluding such companies from portfolios on principle means denying both their potential contribution to the transition and their capacity to reduce their own environmental impact.

Industrial firms, mining companies and utilities have large environmental footprints, they are all essential to net zero. Excluding such companies from portfolios on principle means denying both their potential contribution to the transition and their capacity to reduce their own environmental impact.

There are, in our view, plenty of brown companies whose transition away from unsustainable and carbon-intensive business models has, for one reason or another, gone unnoticed by financial markets. Such firms exhibit both the ability and willingness to adapt their products and services to meet the needs of a sustainable economy. There are many reasons to believe that many of today's brown companies could be the green firms of tomorrow. And as that transition unfolds, financial markets will gradually recognise this improvement, creating value for shareholders.

What this research also highlights is that companies that appear to have impeccable green credentials might not always have the investment appeal to match. Experience tells us that when vast amounts of public and private investments are being made as part of one immense capital project, asset bubbles inevitably build and burst. The more investors gravitate towards what are already expensively priced green companies, the greater the potential for market instability.

This research also implicitly acknowledges the role investor engagement can play in accelerating corporate transitions. Through active ownership and engagement we believe that investors can encourage and accelerate the transition to a sustainable future.

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1805

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