

Closing the Investment Gap to Achieve Paris Agreement Goals

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This study aims to assess the alignment of global sustainable financial flows with transition investment priorities. First, we identify investment gaps based on the difference between the required annual investment to meet global net-zero emissions (NZE) targets and current investment flows. Our assessment reveals that nearly all countries must significantly accelerate their efforts, as their current investment levels fall short of what is required. Second, and perhaps more importantly, investment gaps are particularly large for non-Annex I (developing) countries. Financing these large-scale investments continues to be a major global challenge. The size of global environmental, social and governance (ESG) finance remains low. Specifically, despite their large investment gaps, developing countries receive only a minor share of global ESG funds, where access to conventional finance is already limited.

Introduction

chieving global net-zero emissions (NZE) in line with the goals of the Paris Agreement requires an annual investment of trillions of United States (U.S.) dollars in various clean energy and climate change mitigation technologies. Considering the massive scale of investment needed, raising the required funds remains a major challenge, especially in developing countries where access to finance is limited.

In this contribution to the first global stocktake (GST) under the Paris Agreement, we assess investment gaps across countries. These gaps are defined as the difference between current investment flows and the annual investment required to align with a Paris Agreement scenario. Our assessment is based on the global change analysis model (GCAM) developed by Ou et al. (2021), which focuses on the power sector. While this focus is somewhat narrow and does not capture the entire transition, it provides data suitable for cross-country analysis. The power sector has been the target of decarbonization efforts in many countries. The investment gaps would be much larger if the needs in other sectors, as well as associated adaptation, capacity-building and policy implementation costs, were included.

Our findings reveal two critical points. First, the current investment is substantially below the levels required. Second, and perhaps more importantly, investment gaps are particularly glaring in non-Annex I (developing) countries. Over the current decade, annual investments in these countries aimed at clean energy and hydrocarbons with carbon management technologies will need to increase exponentially—from four to over 12 times the existing levels. This underlines the urgency of meeting the current climate finance target under the United Nations Framework Convention on Climate Change (UNFCCC). It also calls attention to the need for a significantly higher level of ambition for

the new collective quantified goal for climate finance under the Paris Agreement.

Our analysis of financial development differences between developed and developing countries reveals similar gaps. Countries with low financial development—defined as scoring low on the International Monetary Fund's (IMF) Financial Development Index—also tend to have larger investment gaps. In other words, many developing countries with less-developed financial institutions and markets seem less able to attract private capital for decarbonization projects.

In addition to these financial challenges, many developing countries have not yet established local environmental, social and governance ESG frameworks. However, the ESG approach is becoming a global trend that increasingly influences financing decisions for sustainable energy transitions. The analysis highlights the low current annual share of total ESG investments held by non-Annex I countries, with the majority of these funds concentrated in European and North American nations. Given the global importance of ESG and its uneven distribution, the absence of ESG frameworks could constitute a further barrier for developing countries in accessing future transition financing.

Accelerated action and cooperation are needed on multiple fronts to improve financing conditions for sustainable energy transitions, particularly in developing countries. First, most existing ESG guidelines are not fully inclusive or reflective of the wide variety of national and regional circumstances worldwide. This limitation can result in a noninclusive perspective for ESG investors, thereby impeding cost-effective scaling-up efforts. For example, industry structures in many developing countries are currently more carbon-intensive than those in many developed countries, as suggested by the Kuznets curve argument in related literature.1 This disparity creates practical challenges for rapid electrification. In such cases, carbon management technologies—such as carbon capture, utilization and storage (CCUS)-and clean hydrogen fuels, including blue hydrogen and ammonia, should be more explicitly recognized in ESG frameworks. This recognition would also support transitions in hardto-abate sectors globally. Second, international collaboration on climate finance should be expanded along various dimensions, including increased climate finance contributions from developed countries and knowledge sharing among nations. Contributions from international institutions are also necessary and should include capacity building, policy support tools and funding.

The following section outlines the scope of the GST exercise and presents global aggregate investment estimates from various studies under different Paris Agreement-compatible scenarios. Section 3 details our modeling approach and scenarios, along with the resulting transition investment estimates for the power sector. Section 4 identifies investment gaps and presents the distribution of these gaps across various countries and country groups. Section 5 offers similar distributions for financial development and access. Finally, Section 6 concludes with a stocktaking discussion of our results and offers policy recommendations.

GST and Transition Investment Needs

he GST is a critical component of the Paris Agreement's ambition mechanism, as it assesses collective progress toward achieving the Agreement's purpose and long-term goals. The outcome of the GST assists parties in updating and enhancing their actions, support and international cooperation on climate action, including their nationally determined contributions (NDCs) (UNFCCC 2015).

Assessing progress, needs and gaps in implementation—particularly in financial flows—is vital to the GST. The Subsidiary Bodies' Chairs suggest the following questions for the technical assessment component of the first GST (UNFCCC 2022):

What is the collective progress toward making financial flows consistent with a pathway to low greenhouse gas (GHG) emissions and climateresilient development?

To achieve this alignment and scale up the provision and mobilization of finance from various sources and at different levels:

- What further action is required?
- What are the barriers and challenges, and how can they be overcome at the regional and international levels?

This study aims to address these questions by focusing on the power sector, which accounts for 31.8% of global GHG emissions (Climate Watch 2022).² Although it is equally important to focus on other sectors, our narrower scope is due to the availability of high-quality modeling studies and worldwide data for this sector. We first generate estimates for the cumulative transition investment needs in the power sector in a Paris Agreementcompatible scenario. For this, we use the GCAM under a set of scenarios that reflect current climate targets, including NDCs and NZE targets. We then compare these investment needs to current investment levels to establish country-level investment gaps.

The study also analyzes the relationship between investment gaps and countries' current levels of financial development (as a proxy for access to traditional finance) and access to ESG finance (as a proxy for access to sustainable finance). The paper concludes with recommendations on how to scale up financial resources and realign their distribution with urgent needs.

Over the next several decades, transitions to NZE energy systems worldwide will necessitate a major and accelerated shift in investment allocation and levels. While investment in mature, cost-effective and scalable technologies will continue to expand, other technologies essential for meeting the goals of the Paris Agreement are still in the early development stages. These emerging technologies require significant funding to move them to the market. Investments must be scaled up to sustain and accelerate the deployment of renewable and other clean energy technologies while also enabling a significant ramp-up of CCUS technologies and clean hydrogen.

Recent estimates indicate that the total cumulative investment needed to achieve NZE globally by 2050 ranges between US\$103 trillion and US\$243 trillion. This translates into annual investment needs of between US\$3.4 trillion and US\$8.1 trillion (Figure 1). Although these estimates vary significantly depending on the source, two features of the underlying investment levels stand out.

First, the average required investment is about 2.5 times greater than the amount invested in recent years, which is currently around US\$2 trillion.

Addressing this investment gap and securing the necessary funds at scale demands globally coordinated action. The need to ensure sufficient funding for this transition has prompted various international institutional initiatives aimed at directing capital effectively toward low-carbon assets and technologies, particularly in developing countries. In November 2021, the Glasgow Financial Alliance for Net Zero (GFANZ) gathered 450 major financial institutions from 45 countries, controlling over US\$130 trillion in assets, to commit to coordinating and accelerating investment in a net-zero economy (GFANZ 2021). Second, the projected distribution of investments over the coming decades is uneven. Most NZE scenarios forecast that annual investments must escalate quickly in the next several years and peak by the mid-2030s before gradually declining toward 2050. Meeting this sharp increase in capital investment over the current decade is crucial for achieving NZE, underscoring the need for a rapid increase in capital allocation in the years ahead.



Figure 1. Average annual global investments in selected net-zero scenarios, 2021–2050.

Source: Authors' calculations based on Bertram et al. (2021), IRENA (2021), BNEF (2021), IEA (2021a) and McKinsey & Company (2022).

Note: The reported investment figure for Bertram et al. (2021) is the average investment from five models, assuming linear interpolation up to 2050. Total investments across models range between US\$2.2 trillion and US\$4.6 trillion in 2030 and between US\$3.0 trillion and US\$5.8 trillion in 2050. The reported investment figure for BloombergNEF (BNEF 2021) is the average investment across scenarios, ranging between US\$3.1 trillion and US\$5.8 trillion. The investment value for McKinsey & Company (2022) is based on the reported cumulative investment of US\$275 trillion, excluding forestry.

According to the above-cited estimates, approximately 3% to 6.6% of the world's gross domestic product (GDP) needs to be dedicated to financing the NZE transition.³ Global investments account for roughly a quarter of the annually generated GDP; therefore, between 13% and 26% of the investment effort would go toward funding the NZE transition.⁴ While future investment patterns indicate the mobilization of large financial flows, the cost, compared to already pledged policies, appears more moderate. Indeed, the actual capital cost of the NZE transition lies in the incremental investment needed to decarbonize the energy system, aligning it with the NZE target rather than its total investment needs. Overall, although the required effort is considerable, it remains achievable. Current policies outlined in national pledges contain substantial investment, which mitigates the NZE funding that can be attained at an additional cost ranging between 33% and 110% (IRENA 2021; McKinsey & Company 2022). However, as previously highlighted, the capital spending gap between these policies and current investment levels is substantial. Financing energy system decarbonization necessitates a significant push in deploying clean energy and carbon management technologies, several times what has been observed in recent years. The required investment scale-up by 2030 for breakthrough technologies-i.e., CCUS, hydrogen and bioenergy-is tenfold higher than the current investment amount (World Economic Forum 2021). Investment in these technologies has remained at only US\$2 billion to US\$3 billion over the last two years (see Figure A1 in the Appendix). Investment in abatement measures with significant mitigation potential continues to fall short of requirements. For example, investment in energy efficiency would need to increase two to seven times the current level to close the sector's capital gap (IPCC 2022).

At the regional level, most NZE scenarios reveal significant disparities, with developing countries having higher exposure to transition risks due to their reliance on carbon-intensive sectors and lack of scalable access to finance. Developing countries would require investments of over 5% to 10% of GDP, while developed economies would need much lower rates, at 2% to 4% of GDP (IPCC 2022). The scale of the funding effort remains unbalanced across economies, and the necessary global investment acceleration through the midterm-i.e., up to 2030-could exacerbate disparities across regions. Developed countries would need a relatively manageable yearly increase of two to five times current investment levels. In contrast, while the absolute investment levels in developing countries remain moderate, the required increase is massive. Investment in developing countries, on average, must increase by four to eight times current flows, with more sizable needs in Africa (7 to 16 times current flows) and the Middle East (12 to 23 times current flows) (IPCC 2022).

As we move forward with implementing policies to reach the goals of the Paris Agreement, the lack of funds and appropriate financing mechanisms for developing regions could threaten their transition. A delayed transition in developing countries could, in turn, jeopardize the achievement of a smooth, balanced and fair global shift. The gap between regions could widen as investment needs in emerging economies become substantial, underscoring the need for action. According to some estimates, emerging economies would require US\$1 trillion per year through 2030 to achieve NZE by mid-century. This is over 10 times the funding pledged from developed markets to support emerging economies' transitions (BlackRock 2021). The persisting financial challenge is to provide clean and affordable energy to regions that have little to no energy access yet are highly populated—such as sub-Saharan Africa and Southeast Asia. However, these regions still lack tailored regulations, capacity and institutional frameworks to attract the necessary investments, notably private capital. This highlights the complexity of closing the funding gap for a sustainable energy transition.

Modeling NZE Pathways: A GCAM Approach

he GCAM is a globally integrated assessment model (Calvin et al. 2019) widely used in major integrated climate-energy-economic assessments (Calvin et al. 2017; Clarke et al., 2014; Thomson et al., 2011). It is a dynamic-recursive market-equilibrium model calibrated to a historical base year, 2015. The model simulates the evolution of socioeconomics, energy, agriculture and land, water, and climate systems and their interactions over time to 2100. It encompasses a detailed technology energy model with representations of supply and demand. Additionally, it includes a land and agriculture submodule that provides projections of commodity supplies and prices as well as land use and cover changes. The model also contains a water module that tracks demand in six major sectors and represents supplies from renewable and non-renewable resources. A reduced-complexity climate model within GCAM can translate GHG emissions into temperature estimates.

While the model tracks the co-evolution of all these systems consistently, our investment analysis focuses on capital stock turnover in the power sector. The GCAM assumes that generating technologies have a prescribed lifetime, and investments in new plants are added by vintage (i.e., the period in which the investment is made) at a pace that allows sufficient generating capacity to meet demand. Each power plant operates until it reaches the end of its lifetime or is retired if its operating costs exceed the electricity market price. New technology investments compete for a share of the energy market based on cost differences among competing options (Santos da Silva et al., 2021; Zhao et al., 2021). Thus, the model can estimate new installations and capital investments driven by future changes in the power sector under any devised scenario.

In this study, we build on the GCAM emission scenarios developed by Ou et al. (2021). More specifically, we focus on four scenarios that reflect alternative climate policy pathways and their associated global GHG emissions in gigatonnes of carbon dioxide (Figure 2: Panel A). These scenarios also reflect the resulting global mean temperature change, in degrees Celsius (°C), above pre-industrial levels (Figure 2: Panel B). The reference scenario (black line) portrays a world with no climate policies (i.e., a counterfactual scenario rather than a forecast or most likely scenario). The current climate policies scenario (blue line) is a world where countries maintain their decarbonization efforts beyond 2030 at the same rate as implied in their current policies between 2015 and 2030. The updated NDC scenario (red line) reflects a world where updated NDCs to 2030 and NZE pledges are accounted for. For regions without NZE pledges, a 2% annual rate of improved performance in carbon dioxide (CO2) emissions per unit of GDP is assumed. The scenario for updated NDCs with increased ambition (green line) is similar to the previous one but increases ambition in the second half of the century to align with the Paris Agreement and a world in which temperatures are limited to 2°C above pre-industrial levels. The discussion here focuses on the Paris Agreement-compatible scenario results (green line). Extended results for all scenarios are displayed in Table A1 of the Appendix.

Panel B

2080

2100



Figure 2. Model scenarios and results (in global GHG and global mean temperature change).



Note: GtCO2eq = gigatonnes of CO2 equivalent.

A significant portion of the effort to reach NZE relies on the power sector as a decarbonization lever. According to the International Energy Agency (IEA 2021a), the deployment of renewable energy-mostly solar and wind-combined with the electrification of end uses, notably in the transport and industry sectors, could represent 41% of the carbon abatement needed by 2050. Other technologies provide critical, cost-effective support for meeting carbon reduction goals over the next few decades. For instance, CCUS in fuel supply, power generation and industry could mitigate exposure to stranded assets while decreasing carbon emissions by about 14% by 2050 (IEA 2021b).

By that horizon, our GCAM-based modeled electricity share of the final energy demand is double its current level, representing 42% of the final energy consumption in the Paris Agreementcompatible scenario (Figure 3).



Figure 3. Electricity as a share of final energy consumption under the Paris Agreement-compatible scenario.

Source: Authors based on GCAM simulations.

Over the next few decades, most decarbonization investments will occur at the power system level. Electrifying end-use and upgrading infrastructure to accommodate intermittent sources and energy storage requires capital flows higher than current levels. By 2030, the power sector should mobilize two to five times the current investments (IPCC 2022). The accelerated shift toward low-carbon technologies for power generation highlights an ongoing trend driven by renewable energy. The current power mix remains a significant source of emissions in most countries. However, renewable energy deployment, in particular, has been increasing rapidly. In 2015, it overtook nonrenewable capacity additions as solar and wind came on par with conventional generation sources in many markets worldwide (Gielen et al. 2021). Financing for carbon management technologies, such as CCUS in the power sector, has remained at low levels. Up to 2050, most NZE scenarios associate energy systems' deep decarbonization with massive power sector investments. Globally, annual investments in power generation and its underlying infrastructure, including grid flexibility, often exceed US\$2 trillion. This represents between a quarter and two-thirds of the mobilized funds under the NZE scenarios.

Identifying Investment Gaps

Building on the earlier discussion, the investment needs for sustainable energy transitions are immense. Achieving targeted levels can be difficult for many regions, considering the heterogeneity of various key enabling factors across regionsparticularly access to appropriate financial resources. Therefore, based on the GCAM model, we first identify the required level of investment to align with the Paris Agreement. We then compare these required investment levels with countries' current investment levels to diagnose the investment gaps. As explained above, we employ the GCAM model and the scenarios developed by Ou et al. (2021) to achieve this. The GCAM model allows us to compute the required level of annual investment flows to comply with the Paris Agreement at both the country and regional levels. Our scenario analysis covers the implementation of the NDCs and NZEs announced as of September 2021, in line with Ou et al. (2021). We focus on the power sector in our investment gap assessment because power sector decarbonization efforts are common in many countries. This provides useful data for cross-country comparisons. While this approach does not provide a full picture of transition investment gaps (i.e., it does not account for other sectors, such as transportation, or other costs, such as adaptation or policy costs), it is still a useful case study to present existing gaps across countries. Our discussion focuses on the Paris Agreement-compatible scenario results. The extended results for all scenarios are displayed in Table A1 of the Appendix.

The model estimates that roughly US\$1 trillion to US\$1.6 trillion in sustainable energy transition investment is needed annually for the power sector alone. The vast majority of this investment will be in clean energy, particularly renewable energy, as well as fossil fuels with carbon management technologies like CCUS. Wind and solar are the two key renewable technologies receiving the most attention globally.

To identify investment gaps, we compare the required investment levels, based on the GCAM model, with realized annual investment flows using power sector investment data from BloombergNEF. It is worth noting that our investment definition only covers physical infrastructure costs, such as power generation infrastructure. To construct developed and developing country groups, we use the UNFCCC Annex classification. Figure 4 shows the results for the investment gaps across the two country groups, Annex I and non-Annex I.^{5,6} More specifically, in the figure, the realized investment bars display the average annual investment flows for the last three available years, 2019-2021. The required investment levels, derived from the GCAM model, show the average annual investment flows required over the current decade (i.e., 2021–2030). Therefore, the investment gap is defined as the difference between the two numbers. The gaps are displayed in Figure 4, which also shows the needed increase in the annual realized investment flows.

Identifying Investment Gaps





Source: Authors' calculations from Bloomberg, the World Bank and Ou et al. (2021).

Note: Realized investment represents the average sustainable energy transition investment flows into the power sector between 2019 and 2021, as taken from Bloomberg. According to the model, the required investment is the average investment flow needed to achieve a Paris Agreement-compatible scenario. The symbol Here, "x" denotes the additional investment needed to reach the required level. Annex classification is based on UNFCCC guidelines. Investment figures in the diagram include hydro, geothermal, bioenergy, solar, wind and nuclear investments. Investments in CCUS are not included due to data shortages. "Excl" = excluding; "bn" = billion.

According to Figure 4, investment realization levels for Annex I economies are higher, relative to their required investment levels, than those for non-Annex I economies. Put differently, developed countries will need 2.1 times more investment to align with the Paris Agreement, while developing nations will need significantly more, around 2.6 times the current level. Among developed countries, the U.S. lags behind the group average, requiring 2.6 times more investment. This figure is roughly double that of China, which requires only 1.2 times more investment (see Figure 5). Among developing countries, China shows considerable success, demonstrating high levels of transition investment in its power sector. Excluding these two countries from their respective groups doubles the investment gap between the two groups: specifically, the gap decreases to 1.8 times the current levels for developed countries and increases to 4.8 times for developing countries. In Figure 5, we present a breakdown of the sustainable energy transition gap in the power sector, highlighting some major economies and regions. Consistent with the earlier discussion, regions primarily composed of non-Annex I countries display larger gaps compared to those consisting mainly of Annex I countries. More specifically, sub-Saharan Africa records the highest investment gap, with realized investment needs increasing to

about 15 times the current level. The Middle East and North Africa (MENA) region shows the secondlargest gap among the selected groups, followed by India. Among developing countries, China stands out as the leader, with a relatively small gap. The average realized annual investment flows in China amount to approximately US\$116 billion, compared to an annual requirement of US\$138.4 billion.



Figure 5. Sustainable energy transition gaps by region.

Source: Authors' calculations from Bloomberg, the World Bank and Ou et al. (2021).

Note: Realized investment represents the average sustainable energy transition investment flows into the power sector between 2019 and 2021, as sourced from Bloomberg. The required investment is the average investment flow needed to achieve a Paris Agreement-compatible scenario, according to the model. Here, "x" indicates the additional investment needed to reach the required level. "RoW developing" refers to the rest of the developing countries, while "RoW-developed" refers to the remaining developed countries. "sub-Saharan Africa" includes all of the continent except the north, which falls under "MENA." "EU15" comprises Austria, Belgium, Germany, Denmark, Spain, Finland, France, the United Kingdom, Gibraltar, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Sweden. Clean investment figures include hydro, geothermal, bioenergy, solar, wind and nuclear investments. CCUS investments are not included due to data limitations. "Excl" means excluding; "bn" stands for billion.

Annex I countries in Figure 5 display moderate gaps. The EU15⁷ will need only an additional 44% increase in its current investment levels to align with the goals of the Paris Agreement. This figure stands at roughly 89% for the rest of the group, excluding the U.S. and the EU15. As previously mentioned, the U.S. lags in investment performance; its transition investment needs in the power sector are projected to reach US\$145 billion annually through 2030. However, its current average annual investment levels fall significantly short of this target, at approximately US\$55 billion.

The Role of Finance in Addressing Investment Gaps

The discussion above reveals an important finding: Almost all countries face significant investment gaps, particularly acute in developing countries. The relevant academic literature discusses several factors that can potentially contribute to these gaps, such as challenges related to policies and technological development (e.g., Bourcet 2020). However, raising the necessary finance for the required investment appears to be the most daunting challenge, especially for developing countries (e.g., Anton and Afloarei Nucu 2020; Best 2017; Lin and Omoju 2017).

While finance can, in principle, come from various public and private sources, mobilizing private financial resources is crucial to meeting the unprecedented size of investment requirements. This is conditional on the development of domestic financial institutions. Without achieving a certain level of financial development-defined by the IMF as a combination of financial access, market efficiency and financial depth-mobilizing foreign and domestic private finance will be challenging. Financial development is, therefore, an important factor affecting countries' current and future investment levels. To better illuminate this argument, we present the current financial development levels for Annex I and non-Annex I countries in Figure 6. Financial development is measured by the Financial Development Index, developed by Svirydzenka (2016) of the IMF. This index accounts for multiple dimensions of financial development at the country level, including financial access, depth and efficiency.



Figure 6. Average financial development by country group.

Source: Authors' calculation from the IMF Financial Development Index.

Note: The Annex classification is based on the UNFCCC categories.

As displayed in Figure 6, the average Financial Development Index score among developing nations (25%) is less than half of the average score for developed nations (58%). This implies that many non-Annex I countries lack the necessary financial development to mobilize the private financial resources needed to undertake their sustainable energy transitions. This is better visualized in Figure 7, which displays financial development by selected major economies and regions. Notably, while the largest investment gaps were found in the sub-Saharan Africa and MENA regions, these regions also have the lowest financial development levels. In line with academic findings, there appears to be a direct correlation between countries' clean investment levels and their financial development levels.



Figure 7. Average financial development by region.

Source: Authors' calculations from the IMF Financial Development Index.

Note: "RoW-developing" refers to the rest of the developing countries, and "RoW-developed" refers to the remaining developed countries. "sub-Saharan Africa" includes all of the continent except the north, which is covered in "MENA." "EU15" comprises Austria, Belgium, Germany, Denmark, Spain, Finland, France, the United Kingdom, Gibraltar, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Sweden.

A further challenge in financing the global net-zero transition is that traditional financial instruments often neglect many of the risks and opportunities associated with sustainable energy transitions. This is primarily because these instruments focus on short-term financial return maximization. In contrast, sustainable finance emphasizes long-term returns and places greater focus on ESG issues in financing decisions. As a result, it offers lower financing costs and encourages greater investment and asset allocation toward projects compatible with Paris Agreement goals. In particular, the "E" pillar of ESG finance has garnered significant attention in recent years from various institutional investors, such as pension funds, hedge funds and sovereign wealth funds worldwide. The general expectation is that scaling up ESG finance will become increasingly important for raising the funds necessary for sustainable energy transitions (OECD 2021). Despite their vital role, many developing countries have yet to attract significant ESG flows, which are highly concentrated in developed economies (Figure 8).



Figure 8. Share of ESG funds by country group.

Source: Authors' calculations from BloombergNEF.

Note: Annex classification is based on the UNFCC's categories. The figure shows the group shares of the average ESG flows for the last three available years (2019, 2020 and 2021) in the data source. The instruments included in the calculations of average ESG flows are green bonds, social bonds and sustainability-linked bonds and loans.

Figure 9 shows the share of ESG flows by selected economies and regions. Despite its relatively higher investment performance and financial development, China receives only 6% of its global flows. India and other developing countries in sub-Saharan Africa and the MENA region receive only negligible shares of these flows. In contrast, EU15 accounts for about half, and the U.S. alone attracts 19%. Given that ESG is expected to play an increasingly prominent role in financing sustainable energy transitions, the current allocation of flows is concerning. Many developing nations already face challenges in raising the investment funds required to realize their NZE ambitions. The shift in financial markets toward ESG may further impede their access to finance in the near future.



Figure 9. Share of ESG funds by region.

Source: Authors' calculations from BloombergNEF.

Note: The figure displays the group or country shares of average ESG flows for the last three available years (2019, 2020 and 2021) in the data source. The instruments included in the calculations of average ESG flows are green, social and sustainability-linked bonds and loans. "RoW Developing" refers to the rest of the developing countries, and "RoW-Developed" refers to the remaining developed countries. "sub-Saharan Africa" includes all countries on the continent except those in the north, which are covered under "MENA." "EU15" includes Austria, Belgium, Germany, Denmark, Spain, Finland, France, the United Kingdom, Gibraltar, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Sweden.

Stocktaking and Policy Recommendations

s a contribution to the first GST of the Paris Agreement, this study aimed to assess the investment gaps that must be closed to achieve the Agreement's temperature goals. First, we reviewed estimates of global energyrelated investment requirements, drawing from different scenarios, such as those provided by the IEA and the International Renewable Energy Agency. Second, we identified investment gaps-the difference between the required and actual annual investment levels-based on a modeling study by Ou et al. (2021). Our analysis focused on the power sector, which is commonly the initial target of decarbonization efforts. Therefore, the necessary data for a cross-country comparison were readily available. To enable similar exercises and more accurate economy-wide estimates, more and better data on other sectors are urgently needed.

Our investment gap analysis revealed that significant gaps persist in nearly all countries on the road to achieving the Paris Agreement's goals. A more profound shift in both investment scale and focus is essential, particularly in developing countries, where the effects of climate change are projected to be the most severe. While various factors can contribute to these results-such as policies and technology access-finance-related enablers appear to be key. Our findings showed that the geographic distribution of financial development levels is inversely related to investment gap distribution: Higher investment gaps are found in financially less developed countries. The greater costs of raising funds and accessing finance contribute to increasing the investment gap in these countries. Indeed, due to the weakness of financial markets and the higher domestic risks in developing countries, private investors often require high-risk premiums, making the transition more costly for these nations. As a result,

low-carbon transition investment in developing countries remains below potential, as it competes with other priorities. Profound transformation and structural changes are needed to distribute capital more equitably among countries. Policy initiatives aimed at reducing the capital costs of low-carbon investments can significantly aid the transition, especially in developing countries where the need for capital is greatest.

Importantly, our study highlighted that ESG finance is highly unequal. Broadly defined, ESG finance refers to capital flows directed toward low-carbon initiatives with direct GHG mitigation benefits, a crucial element of the energy transition finance puzzle. Developing countries generally receive a very small portion of ESG financing. According to the data reviewed, approximately 83% of recent ESG flows have gone to developed economies.

Furthermore, considering the rising importance of ESG finance as a source of transition investment in the coming years, many developing countries may encounter additional difficulties in securing the necessary financing. To tackle this challenge, globally harmonized ESG standards-currently being pursued by the international community under the International Sustainability Standards Boardshould clarify existing ambiguities around green taxonomy. These standards should also recognize structural differences and diverse circumstances across countries and regions. Additionally, they should account for the challenges most developing countries face in attracting and scaling up funding for their energy transition investment projects. Such challenges include a higher dependency on hard-to-abate sectors, energy access and equality issues, and lower technological and institutional capacities. In this regard, renewable energy, carbon management technologies (e.g., carbon capture

and utilization methods), decarbonization initiatives (e.g., switching to lower-carbon fuels) and emerging technologies (e.g., clean hydrogen) should be considered. Globally established ESG standards should explicitly and appropriately address these elements to recognize and realize their potential in the global NZE transition.

In parallel with global efforts, local governments should engage more with the global community to expand their ESG finance infrastructure, particularly in developing countries. This involves developing local ESG standards for debt markets—such as green or sustainability bonds and loans—and equity markets, such as green stocks. These standards should align with global ESG architecture. Capacity building and knowledge transfers are essential steps in this development process. More active participation from international institutions, including the World Bank and the IMF, can support these efforts. They can offer practical solutions to meet developing countries' capacity-building and knowledge-transfer needs. Fulfilling the thus far unmet promise of delivering US\$100 billion per year in climate finance for developing countries is a crucial starting point. Also important is significantly increasing the ambitions of the new collective goal on climate finance, which is currently under negotiation. These efforts are essential for delivering the energy transition investment that the developing world needs. Additionally, public climate finance flows can substantially catalyze the scaling up of ESG funds in developing countries. While the size of these funds is relatively small-especially compared to massive investment requirements-they can mobilize additional private funds to flow into developing countries. Multilateral international investment institutions, such as the World Bank's Multilateral Investment Guarantee Agency, can further facilitate this process by assessing country-specific risks and providing hedging mechanisms for private investors. The continued dynamic involvement of these institutions could potentially leverage the environmental character of multinational corporations and stimulate low-carbon activities.

Endnotes

¹ See Yilmaz et al. (2022) for a detailed discussion.

- ² The figure includes electricity generation and heat.
- ³ Lowest and highest shares from reported sources in Figure 1.

⁴ According to the World Bank, gross fixed capital formation accounted for 25.9% of the world's GDP in 2020.

⁵ We also construct the same figure based on the developed and developing country classifications used in the United Nations (2020) report. The figure reveals almost identical investment gaps across the developed and developing countries, as can be seen in Figure A2 of the Appendix. Only four countries, Belarus, Russia, Turkey and Ukraine, are listed as developing countries by the United Nations (2020) report and are listed under Annex I by the UNFCC. We therefore use the two groupings interchangeably in the report.

⁶ In Figure 4, we present the investment gaps based on the Paris Agreement-compatible scenario. The same gaps are presented in Table A1 of the Appendix for all the other scenarios.

⁷ The EU15 contains Austria, Belgium, Germany, Denmark, Spain, Finland, France, the United Kingdom, Gibraltar, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Sweden.

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Appendix A: Data

Figure A1. Global emerging technology investments.



Source: Authors' calculation from Bloomberg Transition Investment.

Figure A2. Investment gaps in sustainable energy transition for the power sector, categorized by developed and developing countries.



Source: Authors' calculations from Bloomberg, United Nations (2020) and Ou et al. (2021).

Note: Realized investment refers to the average sustainable energy transition investment flows into the power sector between 2019 and 2021, as sourced from Bloomberg. The required investment is the average investment flow needed to achieve the NZE-compatible scenario in the model. Here, "x" represents the additional investment needed to reach the required level. Development classification is based on the United Nations (2020) report. Sustainable energy transition investment numbers in the figure include hydro, geothermal, bioenergy, solar, wind and nuclear investments. CCUS investments are not included due to data unavailability. "Excl." = excluding; "bn" = billion.

Table A1. Investment gaps for other scenarios.

Country groups	Updated NDCs scenario with increased ambition scenario (Paris Agreement compatible)	Updated NDCs scenario	Current climate policies scenario	Reference scenario
Annex I	2.135	2.137	1.338	1.055
Non-Annex I	2.599	2.600	2.503	2.267
Developed	2.107	2.109	1.273	1.015
Developing	2.602	2.604	2.505	2.247

Source: Authors' calculations from Bloomberg, United Nations (2020) and Ou et al. (2021).

Note: The investment gap is defined as the additional "realized investment" needed to achieve the "required investment level." Realized investment refers to the average flow of sustainable energy transition investment into the power sector between 2019 and 2021, sourced from Bloomberg. The required investment is the average investment flow needed to reach a Paris Agreement-compatible scenario in the model. Annex classification is based on the UNFCCC categories. Development classification is based on the United Nations (2020) report.







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About the Project

The purpose of this project is to provide a snapshot of global oil inventories at any given time and to identify whether global or regional markets can be considered balanced. Such a snapshot will help identify the potential regional or global surpluses (or shortages) of crude oil supplies and inventories that can trigger a price reaction and the subsequent rebalancing of world oil markets. The equilibrium "market balancing" level of world oil inventories could have changed significantly in recent decades under the influence of factors including (a) the shale revolution and the resulting rapid response of shale oil supplies to changes in world oil prices; (b) the expansion of global oil refining and consuming centers; and (c) the buildup of strategic petroleum reserves in non-OECD countries. Therefore, it is essential to determine the optimal level of inventories that will rebalance world oil markets under the new market paradigm. This project aims to answer the following questions: 1) How high do inventories have to be before world oil markets become oversupplied? 2) Are current inventory levels so high that they have put the market at risk of another price shock?



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