Shaping a Living Roadmap for Energy Transition

A Report by the International Energy Forum
and S&P Global Commodity Insights

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GESI
Global Energy Solutions Initiative

Preface

Energy transitions have been ongoing since 1709: from wood and other biomass to coal to oil and to natural gas and now to renewables. But the current energy transition is different from all others for it faces a fundamental challenge – to reduce emissions while energy consumption continues to grow, and in as short a time as a quarter century. This imperative of reducing emissions has been translated into the "net-zero" emissions goals.

Yet developments over the last two years have demonstrated that the energy transition is more complicated than has previously been thought. While the transition proceeds, expectations of a linear global transition have been shaken as climate goals coexist with priorities around energy security, energy access, and affordability.

To date the net-zero narrative has been led by the Global North – mainly the industrialized nations of the OECD, with less contribution from the Global South, the developing nations. Over last year, the International Energy Forum along with S&P Global Commodity Insights as our chief knowledge partner has engaged with a wide spectrum of stakeholders around the world, in the Global South and the Global North, to engage with more diverse voices.

This report summarizes the findings from the dialogues. The dialogues expressed a view that expectations of a linear global transition of the energy system following a single net-zero path globally will be very difficult to achieve. Instead, a "multidimensional" approach is required that is inclusive of different situations in different parts of the world, reflecting varied starting points, diversity of policy approaches; and is equitable.

The report aims to bring attention to the issues to be addressed by policy makers, industry leaders, financial institutions, and the expert community and to present different ideas and approaches to enable progress. Its mission is not to offer recommendations or conclusions, but rather to contribute by capturing the wide spectrum of perspectives on the energy transition and what will be required to achieve it.

The COP 28 meeting at the end of 2023 will be of singular importance in addressing the questions that emerged in the GESI process and that are reflected in this report. We hope that this GESI report will contribute to the dialogue at COP 28 and to the endeavor of understanding and meeting the challenges of the energy transition and its durable implementation.

Joseph McMonigle
Secretary General
International Energy Forum

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1. Context and Objectives of the Global Energy Solutions Initiative

Developments over the last two years demonstrate that the energy transition is more complicated than has previously been thought. While the transition proceeds, expectations of a linear global transition have been shaken as climate goals compete with priorities around energy security, energy access, and affordability. A series of shocks, crises and tensions in the global energy system point to the need to develop a transition that is inclusive of different situations in different parts of the world, that reflects a diversity of policy approaches, and is equitable.

The energy price spike that began in the late summer and early autumn of 2021 pushed affordability to the fore, leading to policy challenges in many countries. Described as "the first energy crisis of the energy transition", it resulted from a mismatch between strong demand growth and underinvestment in conventional supplies. The disruption in energy markets arising from Russia's 2022 invasion of Ukraine – spiking prices, shortages, a "cost of living crisis", economic dislocation – not only reinforced the affordability challenge but also put energy security back on the table as a central concern for governments and publics alike. The risks have increased significantly that high energy costs will undermine public support and acceptance for policies and investments to enable the transition to a low carbon economy.

The emergence of a new North-South divide – between the wealthy countries of the Global North and the developing countries of the Global South – has fostered an increasingly sharp debate over the cost and timing of the energy transition, the relative burdens, and its compatibility with other priorities of economic growth, poverty reduction, and improved health. The trilemma of energy security, affordability and sustainability looks very different in Africa, developing countries of Asia, and in Latin America compared to Europe or the US, where per capita incomes are as much as 40 times higher. This divergence makes addressing the gaps in policy, technology and financing a significant challenge across geographies.

And then there are "the new supply chains required for net zero". Beginning around 2021 and continuing today, a host of governments and entities – the United States, United Kingdom, Japan, Canada, the European Union, the World Bank, the International Monetary Fund, and the International Energy Agency – have raised alarms about the adequacy of mineral supply and processing capacity to meet the needs of rapidly growing renewable power and electric vehicles. This question of "the new supply chains for net zero" is further complicated by rising geopolitical tensions.

There is an unfolding shock of a different kind – the end of easy money. Central banks have continued to raise interest rates to tackle stubbornly high inflation. High interest rates raise the cost of capital for all energy investments. For developing economies with already high borrowing costs for energy projects, the higher interest rates make it even more difficult to make good projects commercially viable and attract investors.

Higher interest rates also raise holding costs and result in potentially lower inventories of oil and risk higher volatility.

These issues are part of the evolving framework for the energy transition. But despite the complexity, the political momentum for energy transition continues. Policy actions in US and EU have cemented net-zero ambitions with the launch of the RePowerEU plan in Europe and the Inflation Reduction Act (IRA) in the US. The latter has been described as "generational" in its impact. IRA was just one of the three major pieces of legislation passed by the US Congress. Along with the Infrastructure Investment and Jobs Act (IIJA) and Creating Helpful Incentives to Produce Semiconductors and Science (CHIPS), this legislation will turbo charge investments in a wide spectrum of clean energy technologies in the US. We are witness to a new era of US industrial policy. Over the next decade, US federal spending on clean energy is expected to rise more than threefold from the 2009-2017 period.

Additionally, the EU's Green Deal Industrial Plan is focused on enhancing the competitiveness of Europe's net-zero industry and accelerating the transition. Its objectives include creating a more supportive environment for scaling up the EU's manufacturing capacity for the net-zero technologies and products required to meet Europe's ambitious climate targets.

And, on the ground, the energy transition continues to unfold. According to S&P Global data, 301 gigawatts of new renewable power were installed in 2022.[1] S&P Global expects that 70 to 75 percent of the new generating capacity installed between 2023 and 2050 will be renewable power (although this is variable capacity, typically operating at 25-40 percent of capacity). Progress is being registered on large scale battery storage to enable this growing share of variable power to become baseload power. The rollout of electric vehicles is accelerating. In the first half of 2023, 28 percent of new cars sold in China were EVs; in Europe, 19 percent; and in the United States, 9 percent.[2] Hydrogen, which was hardly on the agenda half a decade ago, has now become a major target for investment and projects, and biofuels and renewable natural gas are also gaining greater scale. Technology advances, government support, regulation, growing private sector support – all of these will continue to push the transition forward.

Within this evolving context, the objective of the International Energy Forum's Global Energy Solutions Initiative (GESI) is to contribute to the global dialogue and encourage a more inclusive approach to developing sustainable energy transitions. It seeks to do so by recognizing the diverse starting positions of countries across the world, promoting a wider dialogue among stakeholders, and building on lessons from the current energy crisis. Under the umbrella of GESI, a series of leadership dialogues were held between October 2022 and March 2023 at major international forums in Africa, Asia, Europe, North and Central America and the Middle East with the aim of

[1] Renewable power includes solar PV/CSP, onshore/offshore wind, biomass and waste, geothermal, ocean and other renewables.
[2] *Pulse of Change: BEV and PHEV sales update report, 06 July 2023,* S&P Global Commodity Insights. Includes BEV and PHEV cars. Sales data compiled for Jan-May 2023, except US where data is available for Jan-Apr 2023.

bringing diverse stakeholders and perspectives to the table. The International Energy Forum (IEF), in collaboration with S&P Global Commodity Insights as Chief Knowledge Partner, provided a neutral and inclusive platform to explore the issues, highlight different perspectives, and seek to identify new approaches that could achieve a sustainable energy transition at the lowest cost and greatest benefit to society. A highlight of the dialogues has been the willingness of participants with differing viewpoints to engage and share their views openly.

This report summarizes the findings from the dialogues. It aims to bring attention to the issues to be addressed by policy makers, energy industry leaders and financial institutions and to present different ideas and approaches to enable progress. Its mission is not to offer recommendations or conclusions, but rather to contribute by capturing the wide spectrum of perspectives on the energy transition and what will be required to achieve it.

We emphasize the timeliness of this report. The COP 28 meeting at the end of 2023 will be of singular importance in addressing the questions that emerged in the GESI process and that are reflected in this report. COP 28 will be the platform both for addressing the greater complexity of the energy transition, including the North-South Divide, and at the same time identifying the technologies, policies, opportunities, and commitments for meeting the urgent needs of the energy transition. We hope that this GESI report will contribute to the dialogue at COP 28 and to the overarching endeavour of understanding and meeting the challenges of the energy transition.

The report summarizes the views of dialogue participants and should not be considered to represent the views of either the IEF or S&P Global.

2. Key Insights from the GESI Dialogues

The GESI dialogues highlighted different perspectives on the opportunities, challenges, and constraints in reducing GHG emissions and in implementing and ensuring an orderly and affordable energy transition. The diverse participation enabled fresh ideas and insights to emerge, as well as new perspectives on existing topics.[3]

Notable discussion points and emerging ideas are summarized in this section. The following overarching themes permeated many of the dialogues and represent observations and comments made by participants:

- First, although the climate science is now clear about the need to reduce emissions, yet there are significantly divergent views on how to achieve climate goals. This is most notable in the different viewpoints of the Global North and Global South, as well as in disconnects between policymakers and the industrial and financial sectors responsible for implementing the policy goals.

"The math of carbon budgets and climate change is unforgiving. But so is the math of meeting the world's energy needs – and energy demand and emissions are both going up, not down."

GESI participant

- Second, setting linear, global targets and pre-defined emissions pathways that do not account for important aspects of the energy trilemma may be counterproductive to meeting climate goals. The current energy transition is complex and multidimensional. Concerns were voiced at the dialogues that focusing on a singular pathway to achieving net zero emissions by 2050 could undermine achievement of other sustainable development objectives, constrain financing for critical energy projects and put at risk the necessary public support for climate policies. Net-zero targets for many countries go beyond 2050. For example, China, Indonesia and Nigeria have net zero targets of 2060 and India 2070. China and India are the first and third largest emitters in the world, although both have strong policies promoting energy transition.
- Third, finance is not flowing fast enough, and notably to the Global South, for a multitude of reasons. This includes optimistic expectations that 'ideal' zero carbon technologies will become commercially viable relatively quickly and could be deployed at scale around the world. There is a need to prioritize progress over perfection and get finance flowing now to rapidly deploy commercially viable technologies.
- Fourth, many participants expressed questions about the speed and comprehensiveness of the transformation of the global energy system. In prior transitions, externalities such as the impact and cost of emissions were not

[3] Views in this report were expressed at the time of the dialogues and may not fully reflect the current situation in some areas.

considered. Moreover, prior transitions led to new energy sources being added to existing sources. No primary energy source has ever been largely or completely phased out, as proposed by some in the current transition. For many participants, these differentiators make this transition more challenging than any previous energy transitions.

- Fifth, at the same time, there was much optimism and confidence among many participants that the pace of technology innovation may continue to accelerate and that costs of new technologies such as CCS, hydrogen and storage will decline rapidly within this decade. That would enable these critical technologies to be deployed at scale. Furthermore, innovations in digital technologies and smart grids will support rapid electrification. Some participants felt that there would be opportunities for the Global South to leapfrog in deployment of new technologies such as green hydrogen and storage.
- Sixth, although the Global South faces many challenges today, participants were optimistic about the future and keen to engage with industry leaders, policy makers and NGOs in the Global North to develop creative solutions for the citizens of the developing economies. There was widespread recognition that the path to net-zero will have to travel via the Global South and therefore it is in everyone's interest to collaborate and cooperate for the shared goals to achieve net-zero.

> According to the *April 2023 Asian Development Bank Outlook* "A billion people in the [Asia] region were still living on less than purchasing power parity of $3.20 a day in 2017 and 940 million lack reliable power supply. Meeting development goals while avoiding catastrophic climate risks cannot be achieved without transforming Asia's growth patterns".

The Climate and Energy Narrative

- There is broad recognition among diverse stakeholders of the urgency of the climate challenge and the need to reduce emissions. However, the prevailing linear energy transition narrative has critical deficiencies, at least from the viewpoint of some participants. These include the needs of the Global South, public concerns over energy affordability and security, and the sheer scale and complexity of the global energy system. Recognizing the multidimensional nature of the transition could create a more effective and inclusive outcome.
- Reaching a global consensus on the energy transition appears more challenging owing to major differences on a number of issues. There are divergent viewpoints among stakeholders on aims, priorities, and speed of net-zero pathways. This is most apparent in the very different perspectives of the 'Global North' (principally the wealthy OECD countries) and the 'Global South' (developing countries in Africa, Asia and Latin America).

- Some believe that the voice of the Global South has not been given due consideration in global climate dialogues. Developing countries believe that they are not responsible for the climate crisis and feel they should be able to develop their own natural resources, including hydrocarbons where appropriate, to support their economic growth. It was noted that in many countries in the Global South, energy transition means moving away from wood and waste to LPG (with better functionality, convenience and avoiding in-door air pollution) and thus "transitioning from not having energy to having energy". The concept of a wholesale global transition from traditional biomass to renewable energy, without taking local conditions into consideration, was considered impractical by representatives from developing countries.

> The *IEA 2022 Africa Energy Outlook* states "More than 5 000 billion cubic meters (bcm) of natural gas resources have been discovered to date in Africa which have not yet been approved for development. These resources could provide an additional 90 bcm of gas a year by 2030, which may well be vital for the fertilizer, steel and cement industries and water desalination. Africa's industrialization relies in part on expanding natural gas use".

- Support was expressed for a "horses-for-courses" approach to energy transition, as each country will have its own opportunities and challenges, and its own way forward. Many believe that there is not a single global one-size-fits-all net-zero pathway. Seeking the application of a single pathway is creating challenges for industries and finance. Developing and evaluating the most effective emission pathway for a specific country, sector or company requires novel and flexible approaches.

A Just Transition

- The concept of a "just transition" has different meanings in different parts of the world. In the United States, it refers to the environmental and employment needs of poor and minority communities in areas of energy production and ensuring that workers in fossil fuel industries and communities dependent on these industries have opportunities for alternative livelihoods. This is exacerbated by a concern that energy assets in the US are disproportionality located in poor communities. In Europe, a just transition also means recognizing and addressing differences among different regions in terms of energy production and consumption. For the developing world, a just transition seeks to ensure that economic development and poverty alleviation are given due consideration in energy policy and investment decisions. A better understanding of the varying concepts of "justice" in energy therefore requires a broad global perspective that encompasses energy industry workers, levelling up in advanced societies, and industrialisation and access to energy in the Global South. From this perspective,

some participants in GESI dialogues asserted that policymakers and investors should be more concerned about "stranded lives" than "stranded assets".

- A just transition requires "just finance". Some dialogue participants argued that finance provided by multilateral development banks and other institutions should not be predicated on prescriptive decarbonization actions, such as shutting down coal-fired power plants when there are no affordable and socially viable alternatives. Just finance should include broader considerations of national economic development and poverty alleviation.

Financing Low Carbon Energy

- In developed markets, investors are seeking clean energy investments, but there is a shortage of commercially attractive projects as measured against the amount of money available. The incentive-based approach and the large capital available through the US Inflation Reduction Act (IRA) has been welcomed by US domestic and some international companies, and this is reflected in the strong uptake of applications. As of this writing, according to S&P Global's assessment, around $220 billion of new capital investments based on the IRA have been announced.[4] Moreover, according to some estimates total government funding for IRA could be three times the stated $370 billion. Nevertheless, multiple implementation challenges remain, including issuing the detailed supporting tax guidance, streamlining permitting processes to enable projects to progress[5], and availability of trained workers. Further, the international reaction to the IRA has been mixed, with some countries and companies asserting that it disadvantages their own domestic industries, draws investment away, and risks increasing global trade frictions.
- One of the biggest challenges to the financing of clean energy projects is the risk premiums and high cost of capital, particularly in the Global South. In these projects investor risks are primarily policy-driven. Companies have limited experience, tools and methodologies to assess and manage risk in a business environment heavily influenced by policy uncertainties rather than conventional market forces. Unless new approaches are developed, investors will continue to apply high hurdle rates, constraining energy investments in the Global South.

> The *UNCTAD World Investment Report 2023* highlights that developing countries need renewable energy investments of about $1.7 trillion each year but attracted only $544 billion in clean energy FDI in 2022. The report also notes that investment needs in power grids, storage, and energy efficiency vastly exceed requirements in renewable energy generation.

- Finance is required to flow into all elements of the zero- and low-carbon energy value chains. This includes critical mineral supply chains, which are currently, for

[4] *01 May 2023 EnergyView Climate and Cleantech Insight Report*, S&P Global Commodity Insights
[5] Comments reflect the situation at the time of the dialogues; progress has been made recently on both of these issues by the Biden administration.

a number of minerals and metals, highly concentrated and vulnerable to shortages and disruptions.

- Policymakers and investors will have to find ways to resolve the "mining paradox" whereby mining of minerals critical for electrification of the energy system is classified as a 'dirty' activity. As a result, mining is off limits for sustainable finance and incurs local opposition and delayed permitting. The time required to open a new tier one mine is typically 16 to 20 or more years and forecasts indicate that critical mineral supplies may need to increase three- to seven-fold depending on the mineral. As a result, future shortage of metals and/or price spikes will become almost inevitable unless financing and permitting obstacles are urgently tackled.[6]

> The *IEA Critical Minerals Review 2023* notes that "Critical minerals, essential for a range of clean energy technologies, have risen up the policy and business agenda in recent years…. but a combination of volatile price movements, supply chain bottlenecks and geopolitical concerns has created a potent mix of risks for secure and rapid energy transitions."

- To facilitate the development of carbon hubs and a carbon management industry, the business model needs to evolve. Carbon would come to be viewed as a product with value rather than a problem to be solved. This will encourage more robust and standardized carbon pricing mechanisms, facilitate new commercial models and support the development of innovative new businesses.

The Role of Oil and Gas

- There was considerable discussion about the future role of oil and gas. Since the primary aim of the energy transition is to reduce global warming, some participants in the GESI dialogues argued that the focus should be on emissions, not fuel sources, and climate policies should be technology/fuel agnostic. Governments should set a level playing field and let the market decide. Expressed differently, it was argued that an objective should be to decarbonise fossil fuel use rather than "stopping fossil fuels". Nevertheless, other participants highlighted that the technologies to do this aren't (yet) available at the required scale. There was much discussion as to whether and when global fossil fuel demand will peak and then begin to decline and of the rate of decline.
- Continued investment in new oil and gas will be required to avoid significant supply-demand imbalances, given the natural decline rates of existing production. Some participants highlighted that, without new investment, existing oil and gas output could decline by over 75 percent by 2050. Ensuring adequate oil and gas investments while recognizing that demand will decline over the longer term will require innovative investment approaches.

[6] For example, the July 2022 S&P Global study '*The Future of Copper: Will the Looming Supply Gap Short-Circuit the Energy Transition?'* foresees a chronic gap between worldwide copper supply and demand within this decade.

- There is growing recognition that the oil and gas industry needs to be part of the climate dialogue and a key driver of climate solutions, given that it provides 55 percent of the world's energy today, and has the balance sheets, engineering capabilities and ability to execute at scale. The industry's expertise is particularly important in technologies such as carbon capture and storage (CCS) and low carbon hydrogen.

Policy Tools and Frameworks

- The "energy trilemma" of energy security, affordability and sustainability is certainly on the agenda, in part driven by new geopolitical rivalries and conflicts. Energy strategies and policies are being re-aligned with the new geopolitical risks; policymakers will need new frameworks, models and tools for this new geopolitical environment.
- Current frameworks and models tend to be narrowly focused on specific elements of the energy trilemma and specific impacts (climate, societal, or economic). More holistic models, which consider the full range of socioeconomic impacts of energy and climate policies, would help policymakers understand the broader implications. Multidimensional frameworks and models are needed to fully understand a multi-dimensional transition.
- At present, there is a lack of a global roadmap that recognizes and explicitly models the priorities, challenges and constraints that have been highlighted in the GESI dialogues: a Net Zero Roadmap that is tested against realities and that captures the differing pathways for developing countries. Such a roadmap would help policymakers and investors better align policies, strategies and plans with net-zero goals of the Global South.

Collaboration and Engagement

- Conversations around energy transition are taking place in silos, and constructive solution-oriented dialogue among different stakeholders needs to be augmented. There is a genuine need for more listening, education and understanding. Governments, industry and investors need to do more to engage with the general public. And governments could be more transparent with the public about the choices, costs, and trade-offs of this energy transition.
- Meeting the global climate challenge will require a big step up in collaboration within and between governments, and among government, industry and finance. While some areas would benefit from greater global standardization, the more urgent request was deemed to be for policy coherence and stability within countries.

Summarizing the Challenges

In summary, the GESI dialogues have highlighted the diverse challenges and constraints to closing the ambition-reality gap in reducing GHG emissions:

- Geopolitics: tectonic shifts, conflict, trade and supply chain fragmentation
- Policy: inconsistency, uncertainty, variability, technology biases
- Energy trilemma: balancing energy security, affordability and sustainability
- Regulations and permitting: challenges to implement energy, mining and infrastructure projects at scale
- Embeddedness: scale, complexity, inertia of existing energy systems
- Market demand: immaturity, size, uncertainty, cost vs. price gaps, insufficient focus, off-take
- Finance and investments: availability, access, variability between Global North and South, cost of capital, assessment and pricing of risk, inconsistent ESG taxonomies, blanket prohibitions
- Technology choices: costs, commercial viability, scalability and pace
- Business models: need for innovation, collaboration, financing
- Supply chains: adequacy of supplies of critical minerals and other materials, labor and resilience to geopolitical disruptions
- Project delivery: capacity and skills constraints
- Surprises: ability to accommodate shocks, abrupt policy changes, and black swans

Despite the numerous challenges, many dialogue participants expressed a sense of optimism. Renewable energy is now competitive in many locations, deployment of clean technologies is rising rapidly, action on methane emissions is progressing at pace, and there is a sense of growing pragmatism among policymakers. The broadening of the energy transition dialogue - bringing out different perspectives and the diverse pressures shaping them – was seen as a positive step.

3. Overview of IEF GESI Program and Participants

Program

The IEF GESI Program was initiated with a series of regional leadership dialogues held in Cape Town, Bali, Riyadh, Washington DC, Panama City, and Davos between October 2022 and February 2023[7]. The objective of these regional leadership dialogues was to understand how key energy issues are seen from the perspectives of a diverse set of leaders and experts from government, industry, finance, academia and civil society. Choosing a location in Africa for the first dialogue ensured that diverse and inclusive perspectives were streamed into the program from the outset.

The seven leadership dialogues generated open, lively, and robust discussions on energy markets and the energy transition. The learnings in turn formed the inputs for four roundtables at the CERAWeek conference in Houston in March 2023. These four roundtables summarized the key ideas from the leadership dialogues, brought additional insights, and started the process to identify potential pathways and solutions to the opportunities and challenges of energy sustainability and the changing global dynamics of energy security.

The dialogues and roundtables were hosted by the IEF and moderated by energy experts from S&P Global, including Dr Daniel Yergin, S&P Vice Chairman, and Dr Atul Arya, Chief Energy Strategist, S&P Global Commodity Insights. The sessions were conducted under the Chatham House Rule.

[7] Dialogues were held in Cape Town, on the sidelines of Africa Energy Week; in Riyadh, on the sidelines of the Future Investment Initiative conference; in Bali, on the sidelines of the B20/G20; in Washington DC, hosted by the Centre for Strategic and International Studies; in Panama City at the OLADE conference; in Davos on the sidelines of the WEF conference and at the IEF in Riyadh on the sidelines of the IEA-IEF-OPEC Symposium on Energy Outlooks. Solution-oriented roundtables were subsequently held in Houston during CERAWeek by S&P Global.

Participants

350	11	7
Participants	Dialogues and Roundtables	Locations

The leadership dialogues and roundtables brought together a diverse cross-section of senior level stakeholders. These included participants from:

- industry - power companies, renewable developers, oil and gas companies, mining companies, technology and manufacturing companies
- financial institutions
- governments
- academia and research institutions
- NGOs and think tanks

The GESI dialogues also represented regional diversity with participants from Africa, Asia-Pacific, Europe, Latin America, Middle East, and North America, representing both the Global North and Global South.

4. The Emissions Reduction Challenge

The Paris Agreement in 2015 created a new framework for emissions reductions and focus on climate change, with an ambition to limit global warming to well below 2degC, and ideally 1.5degC, compared to pre-industrial times. This has led to actions and commitments around the world by a wide spectrum of countries and companies, including ambitious declarations to achieve net-zero emissions.

But here is the dilemma: While there is a growing sense of urgency from climate science, the realities of the global energy system and the diverse status of global economies create challenges to meeting these goals. According to S&P Global Commodity Insights, the current Nationally Determined Contributions (NDCs) would reduce global emissions by only 10% in 2030 relative to 2019 levels. This compares with the 43% reduction that the Intergovernmental Panel on Climate Change (IPCC) sets as the benchmark required to align with a 1.5degC pathway.[8]

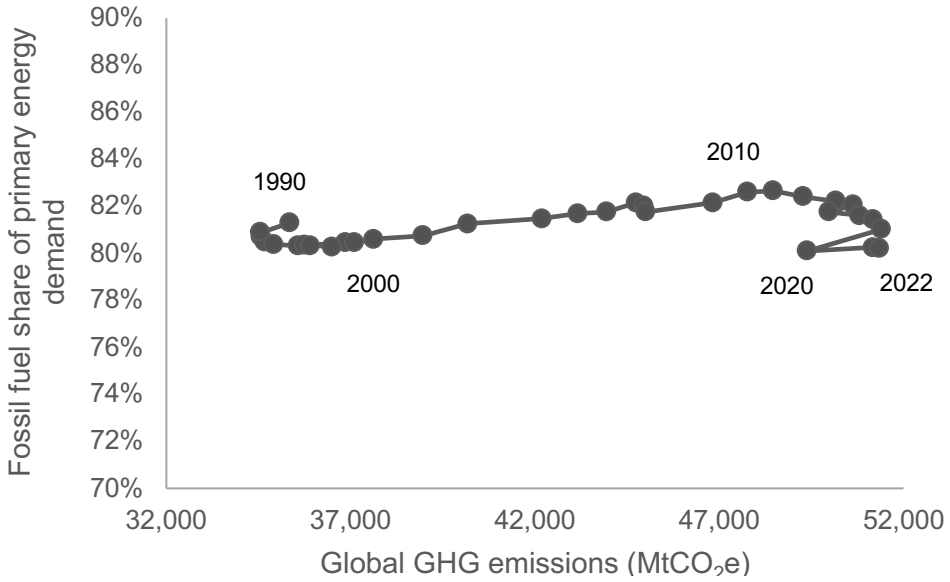
Nevertheless, net-zero declarations continue to grow: 158 countries have stated net-zero targets, with 28 countries embedding the targets into national law. Policy developments with the launch of RePower EU and Green Deal Industrial Plan in Europe, and the troika of the Inflation Reduction Act (IRA), the Infrastructure Investment and Jobs Act (IIJA) and Creating Helpful Incentives to Produce Semiconductors and Science (CHIPS) in the US will turbo charge investments in a wide spectrum of clean energy technologies and mark the launch of a new era of industrial policy, aimed at substantially reducing emissions within this decade.

Despite the rise in climate ambition and supporting policies, in the last 30 years the share of hydrocarbons in the global primary energy mix has hardly changed, from 81% to 80%. Global greenhouse gas emissions are estimated to have increased by 0.9% in 2022, hitting a new record of 52 gigatonnes. Energy demand has continued to grow in most emerging and developing economies as hundreds of millions more people with increased access to reliable and affordable energy have achieved improved living standards.

All countries ranked in the top 10 of the *WEF's Energy Transition Index 2023* are from Western and Northern Europe, and account for 2% of energy-related CO2 emissions, 4% of total energy supply and 2% of global population. There was only one country from Africa in the top 50.

[8] *Climate Change 2022: Mitigation of Climate Change*, Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Global greenhouse gas emissions vs. fossil share of primary energy demand, 1990 - 2022

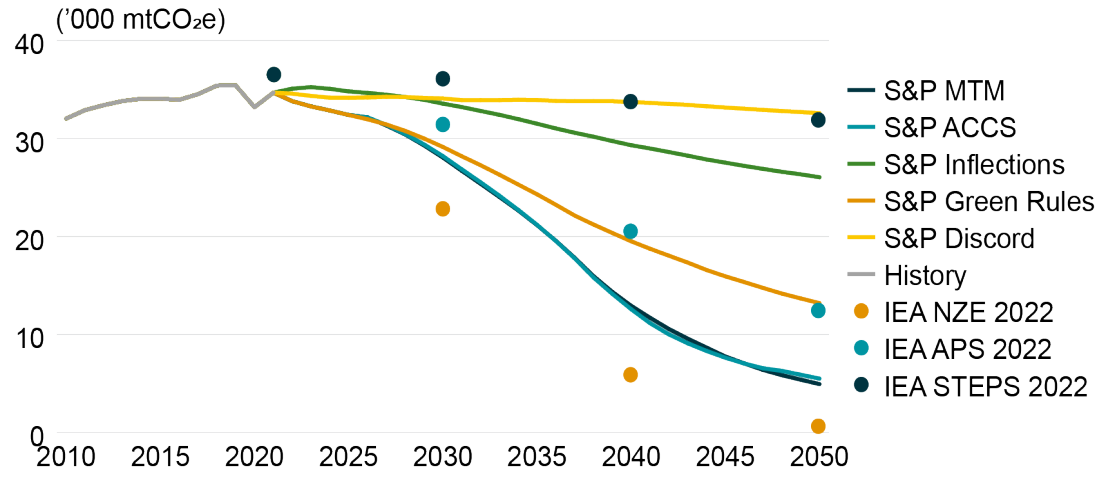


Source: S&P Global Commodity Insights

So, the challenge is how to bend the emissions curve while ensuring economic growth. The climate policies of the Global North will be insufficient to achieve the global goal of net-zero unless there are reductions in emissions from fast-growing developing economies.

The widening gap between current emissions trajectories and the pathway required to achieve net-zero by 2050 is illustrated by emissions scenarios developed independently by the IEA and by S&P Global Commodity Insights.[9]

Emissions scenarios from IEA and S&P Global (Energy-related CO_2 emissions, 2010-2050)



Source: S&P Global Commodity Insights

[9] Note: IEA NZE 2022 and S&P MTM and ACCS scenarios are back cast from a 1.5degC objective, i.e., what would be required to achieve this goal? Other scenarios are forward projections based on current or anticipated changes to policies and markets.

Current trajectory / baseline scenarios project that emissions will fall by less than 25% by 2050; achieving the 1.5degC goal will likely require a reduction of 90% or more.

In large measure, closing the gap between climate ambition and actual emissions trajectories will be dependent on scaling low-carbon technologies and on continuing advances in technologies. According to S&P Global Commodity Insights, investment in renewable power and energy storage amounted to around $477 billion in 2022 and will average $700 billion per year through to 2030 – with the majority of investments currently centered in a handful of countries and regions (China, European Union, and North America).[10] Nevertheless, there could be a $25 trillion cumulative funding gap between forecast spending and the investment needed to achieve net-zero by 2050.[11]

A further manifestation of the current gap is in funding pledged for mitigation and adaptation for developing countries. At COP27 in November 2022, the Parties acknowledged the lack of progress on the collective climate finance pledge of $100 billion (made originally at COP15 in 2009) and urged developed countries to meet the goal. Developing countries continue to express frustration at the lack of capital available for conventional energy development that they state is needed to promote economic growth and reduce energy poverty. Reflecting the fact that energy security was a top priority for nations ahead of COP27, the Implementation Plan emphasized the need to move toward “low-emission” energy in addition to renewable energy.

[10] *How will global investments in clean energy evolve to 2030?* S&P Global Commodity Insights, May 2023
[11] *Energy Transition: Gaps in the Pathways*, S&P Global Commodity Insights, January 2023

5. Focus Areas for Consideration

Introduction

The main purpose of the GESI dialogues was to explore the issues and challenges around transitioning the global energy system to a lower carbon future while maintaining stability, security and affordability of energy supplies. During this exploration process many ideas were expressed around potential focus areas for solutions. In this section we summarize the key ideas expressed by participants in five broad areas:

- Unlocking Finance
- Meeting the Needs of the Global South
- Tackling Infrastructure and Supply Chain Bottlenecks
- New Frameworks and Tools
- Collaboration, Partnerships and Engagement

The report authors have not assessed the costs and feasibility of the ideas aired in the discussions and summarized here, so they are **offered as questions and subjects for consideration** rather than recommendations from the initiative.

Unlocking Finance

ESG and Green Finance Criteria

- **Do 'sustainable' finance criteria need to be more holistic and pragmatic?** Industry and finance could jointly create achievable, holistic criteria that consider a broad range of UN Sustainable Development Goals (SDGs) and not just emissions, and that recognize the need for 'sustainable', 'viable' and 'orderly' energy transitions. This means giving consideration to energy access and affordability as well as climate. For example, putting greater emphasis on emission outcomes rather than fuels would support a more balanced approach considering all aspects of the energy trilemma and might better facilitate funding for critical technologies such as CCUS and DAC. Would using the term "energy transformation" (making energy sources clean) rather than "energy transition" be a helpful step, emphasizing a focus on emissions and a goal to decarbonise emissions from fossil fuel use rather than to "stop investment in all fossil fuels"?

  "We should be more concerned about stranded lives than stranded assets"

  GESI participant

- **Would harmonization and greater inclusivity of ESG/Green Finance assessment methodologies improve their usefulness?** The myriad different taxonomies and criteria appear to be constraining investment. Greater

harmonization appears to be beneficial. However, it is also important to acknowledge the differences among business sectors in their ability to decarbonize, and therefore the need to accept diverse pathways and timelines towards sustainability.

- **Would more granular and flexible benchmarking criteria improve assessment of companies' decarbonization performance?** This includes considering the specific locations in which companies operate and the nature of their operations. Industry and finance could jointly establish realistic emission pathways tailored to each sector and region, ensuring that different approaches and strategies can be recognized and valued appropriately. Taking these factors into account means, for example, that different benchmarks would be applied to a company predominantly operating in Sub-Saharan Africa compared to a company operating in Europe.

> **"ESG assessment methodologies need to better recognize the complexity of the global energy system, and the regional differences in decarbonization pathways"**
>
> *GESI participant*

- **What should be the role of natural gas in sustainable emissions pathways?** This is most pertinent where gas is displacing coal, or where the development of local gas resources will significantly boost economic development and poverty reduction, or where gas is needed for power generation to balance the variability of renewable power. Gas is also an important fuel for industrial applications, heating and cooking. There was broad consensus that gas has a significant role to play for the foreseeable future if methane emissions associated with gas value chain are brought down as agreed under the Global Methane Pledge. There will be increasing need for elimination of flaring, venting and fugitive emissions - and (longer term) carbon capture, utilization and storage (CCUS).

> The *2023 Global Gas Flaring Tracker* report from the IBRD / World Bank highlights that "Global gas flaring decreased by three percent to 139 bcm in 2022 from 144 bcm in 2021, the lowest level since 2010. If put to productive purposes, the amount of gas flared in 2022, could generate as much electricity as Sub-Saharan Africa currently produces in a year"

- **Could changes to funding rules within Multilateral Development Banks (MDBs) accelerate decarbonization?** MDBs could take a holistic approach to funding oil and gas projects instead of a blanket moratorium. There are oil and gas investments that would be critical for meeting SDGs or help reduce emissions by transitioning from coal to gas or by eliminating use of diesel for power generation. Such projects could provide significant near-term benefits at relatively low cost.

Finance and Cost of Capital

- **What new approaches are needed to assess and manage credit risk and reduce cost of capital for renewable energy projects, especially in the Global South?** One of the challenges hindering the flow of finance into zero- and low-carbon projects is the limited understanding of risks and the commercial dynamics of these projects among banks and other financial institutions, compared to conventional fossil fuel projects. This can be addressed by increased awareness and knowledge-building to ensure that financial institutions can accurately assess and manage risk.
- **Could regional funding pools facilitate energy development in the Global South?** For example, a new energy fund for Africa. Such regional sources of finance can better assess credit risks for sustainable investments and potentially reduce the associated cost of capital. Pooling regional resources and expertise would also provide a centralized mechanism to facilitate and support private investments in renewable energy projects.

> "85% of global renewable energy investment benefitted less than 50% of the world's population and Africa accounted for only 1% of additional capacity in 2022", *IRENA World Energy Transitions Outlook 2023*

- **Are new risk assessment methodologies needed for clean energy projects?** A significant amount of funding is available for low-carbon projects, but there is a shortage of bankable projects that meet current risk criteria. This is in part because renewable energy projects typically can carry significant policy risks, which companies struggle to price and manage compared to conventional market risks. To increase the portfolio of projects, investors will need to be willing to make decisions based on a different and potentially greater set of uncertainties.
- **How to address the problem of lack of assured offtake agreements constraining investment?** This is especially relevant for projects involving low carbon hydrogen for which many new projects are being announced. Will market demand materialize at sufficient speed to support a multitude of projects, and what are the methods to stimulate sustainable market demand?
- **Seed money from MDBs could unlock many multiples in private finance** – but more effective collaboration will be required to achieve this. MDBs can also assist developing countries in building stronger institutional frameworks and reducing risks associated with renewable investments.
- **The challenge of timing and supply chains.** Participants observed that some renewables projects are being delayed owing to rising supply chain costs and are behind held in abeyance on the expectation that supply chain costs will fall. Developers will have to assess the degree of cost risk they are willing to assume if solar and wind deployment is to continue at the required pace. Onshoring and

'friend' shoring of clean energy supply chains may also cause delays in project execution and increase costs.

- **Transparent and competitive bidding processes** could reduce the (perceived and actual) country risk of projects in the Global South. Such a level-playing field where different investors and technologies have an equal opportunity to participate will facilitate financing from MDBs and private capital.

Financing New Technologies

- **Can the IRA be adopted as a template for supporting clean energy technologies in wealthier nations?** Financing "first-of-a-kind" or other commercially risky projects presents significant challenges, emphasizing the need for strategic investments and funding sources that understand the unique nature of these initiatives. Currently, the 'carrot' approach of the Inflation Reduction Act appears to be more effective at driving investment into clean energy projects than regulatory 'sticks'. Mechanisms such as the IRA could enable new technologies to be de-risked in the richer Global North (through piloting and scale up) before deployment in the Global South.

> **"Government policy support is key to de-risking of new low carbon technologies provided it is appropriately targeted and formulated"**
>
> *GESI participant*

- **New business models may be needed to drive deployment of emerging technologies.** Even where technologies are on the path to scale, business models to commercialize them at scale may not yet be fully road-tested and available. A prime example is the creation of CCUS value chains.
- **Should there be more focus on, and funding for, carbon removal technologies?** There is growing realization, as highlighted by the IPCC, that carbon removal and utilization/storage technologies must be part of the technology mix for Net Zero, as emissions mitigation efforts alone will fall short. For such technologies to be viable at scale, current CO2 capture costs will have to fall, carbon prices will have to rise, and/or significant subsidies provided – and technology development to proceed.
- **Maintaining a balanced and realistic perspective on technology will encourage progress.** Being overly optimistic about future technology deployment and waiting for an ideal solution can delay meaningful short and nearer-term investments – "the perfect is the enemy of the good". Immediate progress will require prioritizing quick wins, balancing innovation and practicality, and action sooner

> **"Energy transitions are fundamentally technology transitions"**
>
> *GESI participant*

rather than later. This includes focusing on enhancing energy efficiency and lowering the carbon intensity of existing operations.

- **Investment is needed urgently across the entire low carbon energy value chain.** The financing challenge is not limited to end use deployment. Adequate investment in research and development, infrastructure, and supply chains is crucial to drive innovation and facilitate the transition. Capacity ramp-up, and funding, is required in all supply chains.

Meeting the Needs of the Global South

Affordability and Energy Security

- **Affordability and Energy Security are critical in the Global South.** People and politicians in the Global South are very price sensitive as energy accounts for a significant proportion of the cost of living and has great political and social sensitivity. Participants highlighted that affordability and availability take precedence over sustainability, especially in today's inflationary environment. This means that reliable and affordable resources such as domestic coal is preferred over cleaner but more expensive and imported LNG. Countries in the Global South define "energy security" more broadly as providing stable, reasonably-priced energy supplies.

> **"Domestic natural resources are a pillar of energy security for many countries in the Global South"**
>
> *GESI participant*

Decarbonization Pathways

- **Multiple transition pathways for the Global South.** A 'horses-for-courses' approach recognizes that each country will have its own opportunities and challenges, and its own way forward. Regional energy pathways for poorer countries could focus on basic needs in terms of energy access and affordability – and once these are assured, consider more challenging climate goals. To meet these needs, many countries in the Global South want to be enabled, and supported, to build their economic and industrial capacity through conventional fossil fuels, especially gas, both to meet economic growth needs and reduce burning of wood and waste. **"**Technology leapfrog" from traditional biomass to renewables may be appropriate in some circumstances but appears to be a difficult transition pathway for many low-income economies.
- **To what degree will the Global South, be able to set its own pathways?** Can the countries of the Global South develop regional solutions to harness and develop their own energy resources in a sustainable manner? For example, by aligning energy development with social and environmental goals, a regional program could support Africa's energy transition while addressing the unique challenges and needs of the continent.

- **Should financial support to energy projects in the Global South be conditional on the type of fuel or technology?** Should 'just finance' eschew prescriptive and burdensome conditions around use of fossil fuels? And should alternative approaches such as the Just Energy Transition Partnership (JETP) be explored? Some participants considered JETP problematic due to its narrow focus on eliminating (low cost) coal, including where reliable and affordable replacements may not be readily available. Making renewable energy more competitive in the Global South, e.g., through reducing cost of finance, was suggested as a more effective solution.

> **"Africa is endowed with rich natural energy resources, including renewables. But it needs to carbonize before it can decarbonize"**
>
> *GESI participant*

- **Should more funding be directed towards climate adaptation efforts in the Global South?** These regions are often vulnerable to the impacts of climate change and require financial support to adapt and build resilience in infrastructure, communities and ecosystems.
- **Policymakers and project developers could gain public support by tackling local air pollution alongside carbon emissions reduction**. Linking carbon emissions solutions to other imperatives like pollution will offer immediate and tangible benefits and secure wider local support. It is important to ensure that social, local environmental, and climate agendas are in sync.
- **The aggregation of local small-scale renewable energy generation, storage, and demand response initiatives could provide a route to financing**. By combining and scaling up individual microprojects, more substantial and financially viable projects can be established.

Capacity Building in Emerging Economies

- **Reducing risks and facilitating investments in clean tech projects requires capacity-building in multiple areas**, including logistics, legal, policy, and regulatory capacity. Support could also include collaboration in soft financing mechanisms in low carbon such as technology transfer and R&D, in addition to direct financing.
- **How can the necessary new skill sets be developed in local populations?** Efforts need to be stepped up significantly in training local staff - to develop, finance, implement, operate and maintain new low carbon energy systems. This will require cross-sectoral collaboration between governments and industry.

Tackling Infrastructure and Supply Chain Bottlenecks

Energy Infrastructure

- **Governments need to streamline regulatory and permitting processes.** The protracted and uncertain permitting processes in many countries for key energy infrastructure such as siting, pipelines and transmission lines are causing significant delays and leading to project cancellations. Permitting and local challenges need to be appropriately and equitably resolved in a timely way if energy sustainability, affordability and security goals are to be met.

> **"Current permitting processes in the US score 5 out of 10 at best"**
>
> *GESI participant*

- **New commercial models are needed to tackle the "gridlock" of connecting renewable power.** Waiting times for grid connection for wind and solar farms have reached 10 years or more in some countries, which is severely impacting the rate of grid decarbonization. This is partly due to permitting delays but also due to the very different geographical footprint of renewable power compared to conventional fossil fuels.
- **Deployment of distributed generation and improvements in local grid efficiencies is essential to support the growth of renewable energy systems**. While the needs for expanding transmission grids receive significant attention, it is important not to overlook the development of local distribution networks and distributed generation. Neglecting this aspect can lead to downstream bottlenecks and hinder the effective integration of renewable energy sources.

Critical Minerals

- **How will a projected global supply shortage of critical minerals and the current supply chain risks impact the energy transition?** Governments are starting to give this urgent attention but delays in addressing the issue may result in future price spikes, shortages and cost increases for key metals – and thus act as a brake on the energy transition.
- **Resolving the 'mining paradox' will be important for an orderly and timely energy transition.** Mining and metals investments are seen by some only through a "sustainability lens" and not as a key part of the decarbonization solution. They are therefore shunned by ESG-oriented investors and other investors under ESG pressures. However, it was proposed that ESG investors should take a more holistic view on the "net carbon benefits"

> **"A circular economy approach is needed for critical minerals: move towards 100% recovery of mineral ores, minimize waste generation, recycling"**
>
> *GESI participant*

from mining and processing the minerals critical to the energy transition. Mining companies will need, in turn, to convey their action and progress more clearly on sustainable operating practices.

- **Industrial consumers, particularly in the OECD, will need to accelerate efforts to develop long term sourcing strategies and plans for critical minerals**. Reducing supply chain risks will require diversification of globally concentrated supply sources.

New Frameworks and Tools

The Need for New Policy Frameworks and Tools

- **Policy makers would benefit from new frameworks to progress the energy transition within the new geopolitical environment.** For example, will the 'electrify everything' approach need to be reassessed when supply chains appear vulnerable to geopolitics and capacity bottlenecks? Should there be more focus on technologies with less geographically concentrated, and therefore less geopolitically vulnerable, supply chains such as hydrogen and CCUS?

> **"Energy security and affordability can no longer be taken for granted"**
>
> *GESI participant*

- **Stakeholders need a more complete macroeconomic and socioeconomic understanding of the multi-dimensional Energy Transition and its implications**. Issues should not be addressed in silos but rather considered in an integrated manner, recognizing the interdependencies and synergies among different aspects of the energy transition. It will therefore be important for policymakers to adopt more holistic models that capture systemic interactions and system-wide impacts. There needs to be deeper macroeconomic understanding of the energy transition to avoid adverse supply shocks and economic disruptions that undermine public support.
- **Mechanisms are needed to support appropriate levels of investment in oil and gas supply to avoid future shocks and disruption while also providing for carbon abatement.** There is much debate about future oil and gas demand. While a smaller part of the overall mix in the future, oil and gas is expected to continue to play a significant role in meeting energy needs. About half the automobile fleet in 2050 will likely be oil-powered because of the time it takes to turn over the auto fleet, and natural gas will be required in an electrified world to stabilize systems relying on renewables – at least until long duration storage becomes commercially viable and implemented at scale. In addition, the annual 4-5 percent natural decline in existing oil and gas resources requires ongoing investment. The fear of "stranded assets" is one factor causing historically low investment in new oil and gas supply.

Scenarios and Roadmaps

- **Better understanding and utilization of scenarios** will enable policymakers to effectively address the challenges and complexities of the energy transition. This entails recognizing the drivers, identifying gaps, and exploring potential solutions within different scenarios.
- **There is a need for energy transition scenarios / roadmaps that reflect the Paris ambition while capturing the complexities and constraints to achieving it**. These include issues of energy access and affordability (especially in the Global South), availability and rate of deployment of finance, supply chain capacities, geopolitical drivers and constraints, competitiveness and deployment rate of new technologies, permitting delays, indigenous peoples' concerns and local challenges. Additionally, accepting that considerable use of Carbon Capture, Utilization, and Storage (CCUS), Negative Emission Technologies (NETs) and Nature-Based Solutions (NBS), will be needed longer term to achieve the goals of the Paris Agreement. Such pragmatic transition scenarios can help support a robust policy framework for an orderly and balanced transition - one that can also deliver energy security and affordability while occurring at a much faster pace than past transitions.

> **"Energy transition roadmaps must have an element of wealth creation into local economies, not just focus on reducing emissions."**
>
> *GESI participant*

- **In particular, realistic forecasts for the supply and demand of critical minerals should be incorporated into transition scenario models**. This entails considering various factors such as mining production capacities, timelines to bring new mines and processing capacity onstream, geopolitical dynamics, and technological advancements that may affect demand and availability. Adequate minerals supply is often treated as a given in scenario models.

Investment Decision Approaches and Criteria

- **New investment decision frameworks may be needed** whereby organizations accept emission reduction goals as a given and seek the most economic ways to achieve them. Conventional project investment metrics such as IRR hurdle rates may be of less relevance when there is an overarching non-financial objective.
- **Companies may need new approaches to assess and manage policy risk** in a business environment heavily influenced by policy rather than free-market forces. Businesses must adapt to the dynamic policy landscape and develop strategies to navigate potential regulatory changes and uncertainties.

- **Is there a need for a broader decision metric than Levelized Cost of Electricity (LCOE)?** When assessing power project economics, policymakers may need to look beyond LCOE and conduct a comprehensive analysis of the entire value chain. By evaluating the lifecycle costs and benefits, including social and environmental aspects, investors can gain a more complete understanding of the overall economic implications. Projects may be evaluated both against alternatives and against the cost of inaction.
- **Better models could enable investment evaluation across all SDGs.** To achieve a comprehensive understanding of the implications of an accelerated energy transition, it would be constructive to generate holistic and integrated frameworks and models that encompass multiple SDGs. This includes such goals as universal energy access, poverty reduction, and improved health. Capturing economy-wide impacts requires integrating economic, energy, industrial, mobility, and social aspects. Incorporating a wide range of factors enables more informed decisions about the allocation of resources.

Collaboration, Partnerships and Engagement

Public-Private Sector Collaboration

- **What should be the role of governments in identifying the most effective approaches to achieve emissions goals?** The US is adopting a hands-on approach with the IRA, which is supporting a range of technologies. Will such an approach help to accelerate collaboration between industry and finance across a wide range of key technologies – renewables, carbon removal, storage, hydrogen – in the effort to accelerate technology scale-up and deployment?

Cross-Sector Collaboration

- **Financial investors need to work with industry to jointly develop new evaluation models for decarbonization projects** to demonstrate their long-term value proposition and risk manageability**.** To overcome information asymmetry, industry can help investors understand the technology parameters and risk criteria for new technology projects such as CCUS and hydrogen which have little or no historical data (banks better understand the parameters and risks of oil & gas projects through extensive historical data).
- **More collaboration forums and mechanisms are needed between energy suppliers and energy buyers**. Energy suppliers and buyers have complex interactions as they impact each other's Scope 2 and 3 emissions. One example of such a collaboration is the Asia Clean Energy Coalition, launched by a group of manufacturers with the aim of driving better alignment among energy buyers, project developers, financiers and policymakers.

Government-to-Government (G2G) Collaboration

- **G2G collaboration efforts such as the Clean Energy Ministerial** could provide a growing platform for knowledge sharing around what works in practice. An example is the UK partnering with other governments to share policy frameworks, business models, and model contracts for CCUS and hydrogen, based on the development of the UK's hub-based model.
- **Other governments will be looking carefully at the learnings from the design and implementation of the US IRA.** One clear question is the impact of an incentive-based policy approach versus a regulatory compliance approach. Also, the learnings from the practical application of the IRA will be studied closely, since on-the-ground project delivery is the ultimate yardstick of success.

> **"To encourage investment, carbon needs to be viewed as a valuable tradable product rather than waste"**
>
> *GESI participant*

- **More G2G collaboration is needed around carbon markets and carbon accounting.** Efforts should be directed to creating more robust carbon markets, which would have a meaningful impact on emissions. Regulators will need to facilitate the standardization and development of methodologies for carbon accounting including standard assessment of carbon intensity of products. This will become a critical issue with the wider roll out of the EU Carbon Border Adjustment Mechanism (CBAM), which is likely to stir much discussion and debate with the Global South.
- **Cross-regional interconnection of power grids will move to the front as issues, but their implementation is complex.** This will become increasingly important as renewable power takes a larger share of the energy mix. However, development of such grids will encounter many challenges, including regulatory and legal, coordination and sovereignty, and investment.
- **To support the COP process, should forums of the major global emitters collaborate to jointly tackle the issues?** Besides COP, other forums including the G-20 and the Major Economies Forum on Energy and Climate (MEF) are likely to be necessary to reach meaningful consensus around some objectives, roadmaps, and actions.

Engaging the Public

- **More regular and timely engagement with publics** will help reduce the information asymmetry around the challenges of energy transition. Publics require more clarity and information from their governments about costs, prices, timelines and impacts. This will mean more transparency from

> **"The battle for hearts and minds will be waged and won with the public"**
>
> *GESI participant*

governments about costs and dislocations from energy transitions, and more discussion around what is, and is not, doable. Energy transition should not be seen as a threat to jobs in economies heavily dependent on fossil fuels. Bringing NGOs and publics into the conversation about the actual mechanics of the energy transition would be constructive.

Appendix-I. Dialogue Perspectives on Climate, Emissions and Energy Transition

The main section of this report provides a synthesis of the ideas expressed in the dialogues. This Appendix includes key contextual information and analysis shared with participants in pre-dialogue briefing papers plus more detail on the specific comments made. The Appendix groups participant comments under eleven discrete headings but there are many areas of interlinkage and overlap.

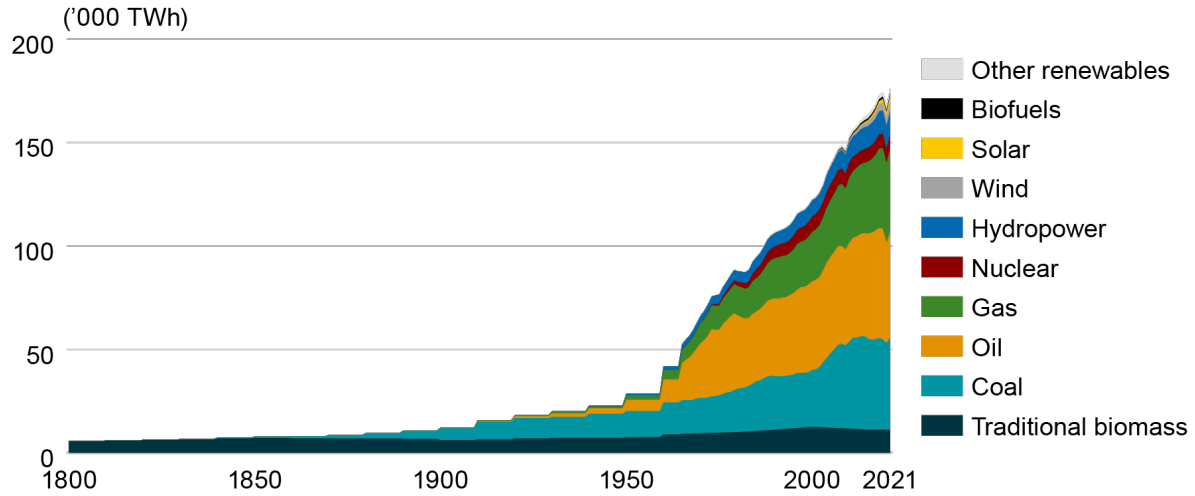
Note that, except for the Context sections, all "participant perspectives" reflect the comments of GESI participants and should not be considered the views of the IEF or S&P Global. Further, participant perspectives do not represent a consensus view, and alternative and sometimes sharply different viewpoints were expressed.

A.1. The Energy Transition Narrative

Context

'Energy Transition' is the change in the composition (structure) of primary energy supply. The global energy system has been in transition since 1709 as it has moved from traditional biomass to coal, oil, natural gas, nuclear and most recently to renewable energy.[12]

Global primary energy consumption by source (1800 – 2022)



Source: Our World in Data based on Vaclav Smil (2017 and BP Statistical Review of World Energy

Historically, it has taken decades for a new energy source to gain a significant share in the overall energy mix; and each historical energy transition has taken longer than the prior one to reach at least 20% market share. Newer sources, such as coal replacing wood, had better functionality at a lower or competitive cost, and past

[12] Daniel Yergin, *The New Map: Energy, Climate, and the Clash of Nations* (New York: Penguin, 2021), chapters 41 and 45.

transitions have typically been mainly driven by technological developments and economic advantage rather than government policy. The current transition is mainly policy-driven, generated by the need to address an externality (climate change) where the investments are required up front and the benefits will accrue over a long period of time - and mostly to future generations. The policies have in turn promoted innovation in wind, solar, and batteries.

However, with geopolitical conflict back to the fore, it is now evident that there cannot be a successful energy transition without energy security. The warning signs were already there as energy markets tightened in the late summer and fall of 2021 with the strong rebound in global economy and the resulting growth in energy demand after Covid lockdowns. New supplies of oil and gas did not materialize due to several reasons including 'pre-emptive underinvestment' due to concerns of stranded assets, government policies, ESG constraints and poor returns from the oil and gas sector in recent years. As a result, the pre-2022 narrative of an orderly and straightforward phase out of fossil fuels is being replaced by a more complex and nuanced discussion around the continuing role of fossil fuels in providing affordable energy, and a realization that the transition could be slower and more difficult than previously anticipated. Case in point: while Germany continues to promote renewables and shift to hydrogen, it has also quickly embraced LNG imports to replace Russian natural gas supplies.

There is also recognition that the gap is widening between what is needed to meet climate goals and the current efforts to change a multi-trillion dollar global energy system. Despite global commitments and efforts to combat climate change, existing actions are not keeping pace with the scale of the challenge. Emissions are going up, not down. Energy demand is going up, not down. The current energy mix of around 80% hydrocarbons has hardly changed in the last 30 years. A segment of investors has shifted back to oil and gas in the quest for returns. This recognition of a widening gap has triggered a sense of urgency among various stakeholders grappling with the complexities, and a "transition" in thinking about energy transition.

Participant Perspectives

- Ultimately, markets, not models and scenarios, drive energy solutions. Expectations about demand peaking have not yet been met, and energy prices spiked in 2021 and 2022, raising fears that high prices could lead to a loss of public support for transition policies.
- There is a sense on the part of many participants that the narrative on the Energy Transition has been dominated by the Global North, which is the leading consumer of energy and responsible for most GHG emissions. The global discourse does not, in general, reflect the interests or realities of the Global South, whose per capita income may be less than 5% that of developed nations.

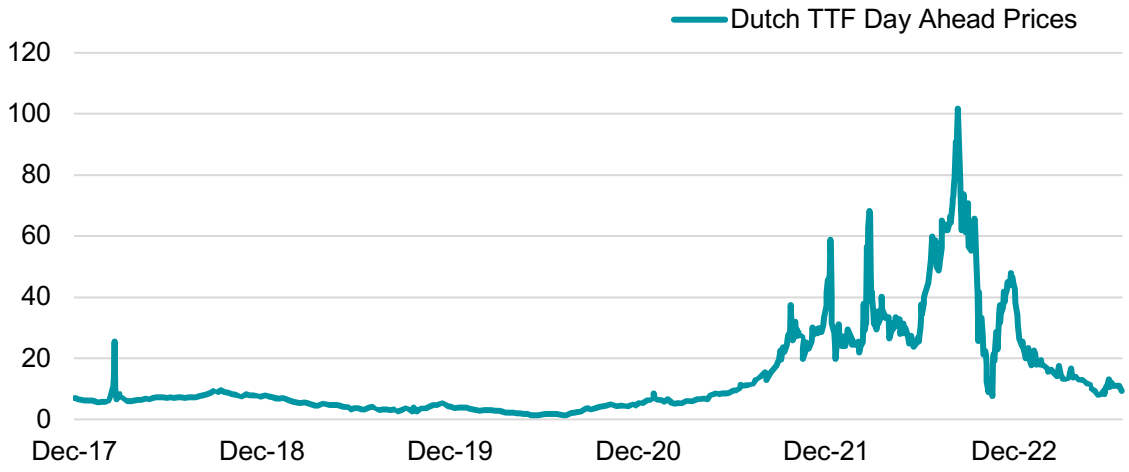
- Conversations take place in 'echo-chambers', and constructive dialogue and understanding among different groups is lacking. Communication gaps exist at multiple levels: between the Global North and Global South; among governments, financial institutions, industry – and the public. Some averred that there is too much preaching and not enough true communication.
- A more holistic transition narrative is emerging that recognizes the world will be using hydrocarbons for decades, and there will be oil & gas in a Net Zero world. Fully decarbonizing sectors such as transportation and heavy industry, as well as power generation, will take many decades. But usage will come with carbon abatement, reducing emissions. Carbon removal technologies such as carbon capture, utilization, and storage (CCUS) as well as direct air capture (DAC) will be necessary to decarbonize these sectors.
- Nevertheless, it was emphasized by some that hydrocarbon supply will fall to achieve climate goals, although there were many different views on the magnitude of the decline. Adoption of technologies such as CCUS, DAC and use of nature-based solutions (NBS) will be too slow, too limited in scale and too expensive to mitigate or offset all of the current levels of hydrocarbon emissions.
- The application of a single 'linear pathway' is creating multiple challenges for industry and finance. Determining and evaluating the most effective emission pathway for a specific country, region or sector requires novel and flexible approaches that take into account various factors, including energy security, reliability and affordability.
- The notion of energy security is expanding to include access to clean energy technologies and distributed supply as well as critical minerals. The geographical concentration of critical minerals and their processing, and the earlier Covid supply disruptions, have raised concerns about replacing one form of energy dependence and insecurity with another.

A.2. Balancing the Energy Trilemma

Context

The pandemic in 2020/2021 brought accelerated investor interest in climate and ESG and fuelled the narrative around the decline of fossil fuels as oil demand fell and prices hit new lows. In 2022 these trends reversed. The war in Ukraine revived concerns in a very stark way about energy security and affordability as energy prices skyrocketed and governments had to step in to shield consumers from unaffordable energy prices. As Russia cut its gas supplies to Europe, some European countries re-started coal-fired power plants. LNG imports surged as countries led by Germany built floating terminals to import gas.

Natural Gas prices in Europe last 5 years
(USD/MMbtu)



Source: S&P Global Platts Dimensions Pro

Some asked whether that has been too much focus on energy transition and whether the current energy crisis was the first of many to come. ESG investing underwent some rethinking as it became a subject of political controversy. Some investors, seeking to enhance returns, shifted part of their portfolios back to oil and gas.

While the direction of travel may not have changed — decarbonizing the global economy — the pace now seems less certain and more complex. Consideration has returned to the full trilemma of energy security, affordability, and sustainability, and the need to balance the energy transition with continued investment in conventional fuels to assure energy security, avoid shortfalls and crises, and meet the needs of developing countries. Climate-focused policies remain uneven globally despite net-zero commitments covering over 90% of global GHG emissions. For investors, the correlation between sustainability and market performance is less clear, raising challenges about how to generate returns while meeting demands for sustainable portfolios.

Participant Perspectives

- Energy transition sits on a three-legged stool of geopolitics, policy, and technology. A few years ago, policy and technology were driving the transition, now geopolitics is also recognized as a major leg, creating risk of significant instability.
- The energy trilemma looks different in Africa. More than half the population in Africa has no access to electricity and a billion Africans have no access to clean cooking. With high population growth, there is a race against time to deliver against growing needs. The reality, at this point, is that *Zero Poverty* and *Zero Emissions* appear to pose incompatible objectives for many nations in the Global South.

- The energy trilemma is not just an issue for the Global South. Many citizens of rich nations are struggling to pay their energy bills, including in Europe where the linear transition narrative is strongest and where most effort to support it has been applied.
- Energy transition cannot only be a risk story. It needs also to be seen as a social benefit story. There is a value side to energy access – how many lives are positively impacted and how development goals are addressed? Roadmaps need to focus on raising incomes and reducing poverty, not solely on reducing emissions. This will prove to be a particular challenge for the multilateral development banks, which have been under great pressure to focus only on renewables and avoid support for natural gas. With the MDBs, the ESG conversation often seems to stop at "E" – environment, and carbon emissions – without regard for "S" – the social dimension. Some developing nations find a discordant note when European banks refuse to finance natural gas development and yet European governments ask the same countries to supply them with LNG.
- The energy trilemma does not mutually cancel out. Policies are needed to support all three elements – affordability, security and sustainability. Energy transition is an opportunity to deploy capital to create wealth from low carbon energy sources.

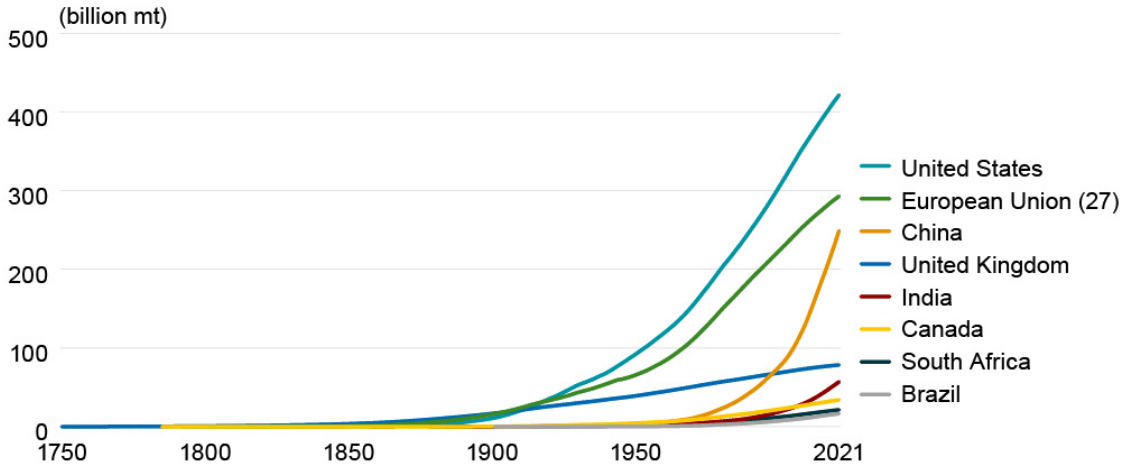
A.3. Pathways for the Global South

Context

Global warming is driven by accumulated greenhouse gas emissions in the atmosphere, principally anthropogenic CO2 emitted since the start of the industrial age. The United States and EU (excluding UK) combined account for 62% of global cumulative CO2 emissions since pre-industrial times. China's current emissions are now the highest of any country[13], and cumulative emissions will soon overtake the EU's. By contrast, Africa and South America have contributed 3% each to global cumulative emissions.

[13] On a per capita basis US emissions are still two times higher than China

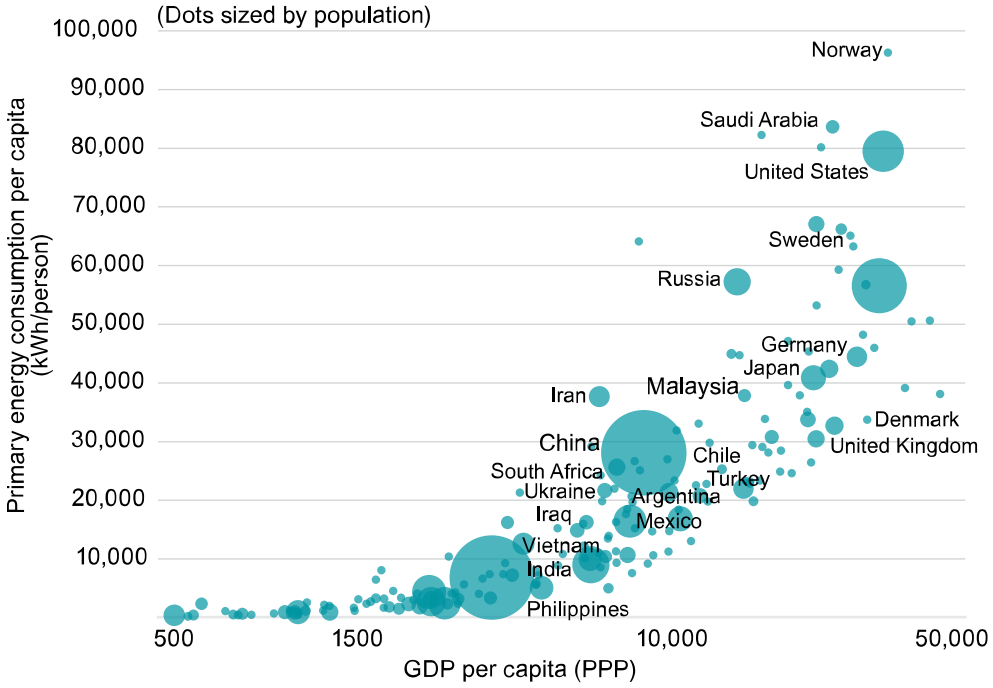
Cumulative CO2 emissions



Source: Our World in Data

Furthermore, there are significant disparities between the developed and developing countries in terms of energy use per capita and GDP per capita (the chart below is on a log scale). Even after decades of economic growth, many people around the world, particularly in Africa and parts of Asia, remain impoverished economically and in their energy use. To give just a single comparison, in 2020 the average annual per capita energy use of about 40 percent of the world's population (3.1 billion people, which includes nearly all people in sub-Saharan Africa) was no higher than the rate achieved in both Germany and France in the year 1860.[14] About 700 million people in the Global South still lack access to electricity, including 600 million in Africa alone.

Energy use per person vs GDP per capita, 2020



Source: Our World in Data based on BP, EIA and World Bank
This chart uses logarithmic scale to plot the data

[14] *Beyond Magical Thinking: Time to Get Real on Climate Change*, Vaclav Smil, May 2022, published at the Yale School of the Environment

Developing economies will drive growth in energy demand for the next 30 years. Depending on their access to energy resources both indigenous and imported, financing needs and geography, many of these countries need access to hydrocarbons to raise their standard of living – very likely resulting in an increase in their emissions for the rest of this decade (or longer) before their emission trajectories change. China, the world's largest emitter and India, the third largest, are on this trajectory. To change the emissions trajectories of developing countries will require a break in the historical relationship between economic development and energy consumption and/or a dramatic technology leapfrog from traditional biomass to modern renewable energy sources, combined with the capabilities to manage the fluctuations. Moreover, while 2050 is the cited target for net zero in many countries, the goals of China, Indonesia, and Nigeria are 2060, and India's is 2070.

At COP15 in Copenhagen in 2009, developed countries committed to a collective goal of mobilizing $100 billion per year by 2020 for climate action in developing countries (both mitigation and adaptation). COP27 addressed some longstanding issues such as loss and damage, but at the same time prompted new questions on how the promises will be implemented. The Parties acknowledged the lack of progress on the collective climate finance pledge of $100 billion and urged developed countries to meet the goal.

Participant Perspectives

- In many parts of the world, especially Africa, energy transition realistically means "transition from no energy to energy", and Africa needs to carbonize before it decarbonizes. Enhancing the affordability of energy is a key priority, which requires not only lower cost energy but also a big uplift in the ability of African citizens to pay for it. Building modern economies and industrialization requires widespread energy access and energy security. This will require the use of hydrocarbons in Africa for the foreseeable future until alternatives are developed.
- Climate justice, some participants said, needs to be the center of our conversation: who needs to cut, who needs to pay. A certain group of countries have emitted beyond their 'fair share', developing their economies using fossil fuels. They have reduced their emissions to a certain extent but are still utilizing a disproportionate share of the carbon budget. Developing regions such as Africa are impacted by climate change but are the smallest contributors to emissions. Africa has been responsible for only about 3% of global emissions, yet it is being constrained from development of its own fossil fuel resources, which are essential for economic and industrial development, and alleviation of poverty.
- Energy transition must also be a transition out of poverty. Economic growth and energy consumption have a direct relationship, and hence advancing on clean energy transition pathways would not simply be about replacing one energy source

with another, or one molecule with another. It must build on the indigenous resources of each country, support economic development and societal welfare.

- There is growing discord between developing and developed countries on where investment dollars should flow, including finance for gas projects. Developing countries believe their energy access issues are being overlooked, while the global North continues to fund fossil fuel investments. Further, the developing world's fiscal space for climate change investment is constrained due to prioritization of pandemic and social spending. Without strong investment fundamentals it will be difficult to attract foreign investment into low carbon energy projects.
- For developing countries 'climate finance' often comes with strict decarbonization mandates (e. g., shutting down coal-fired generation) that can ultimately result in significant lost revenues and higher costs. The multilateral development banks and other investors should recognize that a Just Energy Transition, from the viewpoint of the Global South, must allow those countries in the Global South to develop their own resources for economic and social development – and that they need time.
- There are sharp differences on natural gas. While gas may be regarded as a bridge fuel for the Global North, it was described as key to the long-term economic development of Africa and parts of Asia. The window for gas should not be lost in the expectation that green hydrogen will quickly replace it. Underscoring the role of gas in the energy transition, the advantageous position of gas in Africa and Asia was highlighted due to its technological maturity and ability to integrate with renewable power. In the context of the energy transition being re-framed as an emissions transition, the focus should be on switching from coal to gas, to reduce both CO2 and methane emissions.

  There was a contrasting viewpoint expressed that gas should not be developed as a long term or bridge fuel. In this view, gas could be considered a potentially more unreliable and insecure energy source than renewable power due to the complexity and geographical spread of its value chain.
- Coal remains a primary energy source for many countries, and the phasing out of coal has many societal, technological and financial barriers. For example, coal phase out in Indonesia has been extended from 2030 to the mid-2040s to avoid a large economic loss. Coal was also foreseen as continuing to play a significant role in, for example, the Australian economy due to lack of alternatives, especially for industry - both domestic industry and importers of Australian coal. Conversely, the high dependence on coal fired power is causing challenges for some international manufacturers seeking to locate in Asia, as they are increasingly looking for 'green power' supplies to meet their own decarbonization targets. There is therefore a need to focus on technologies such as CCUS to decarbonize

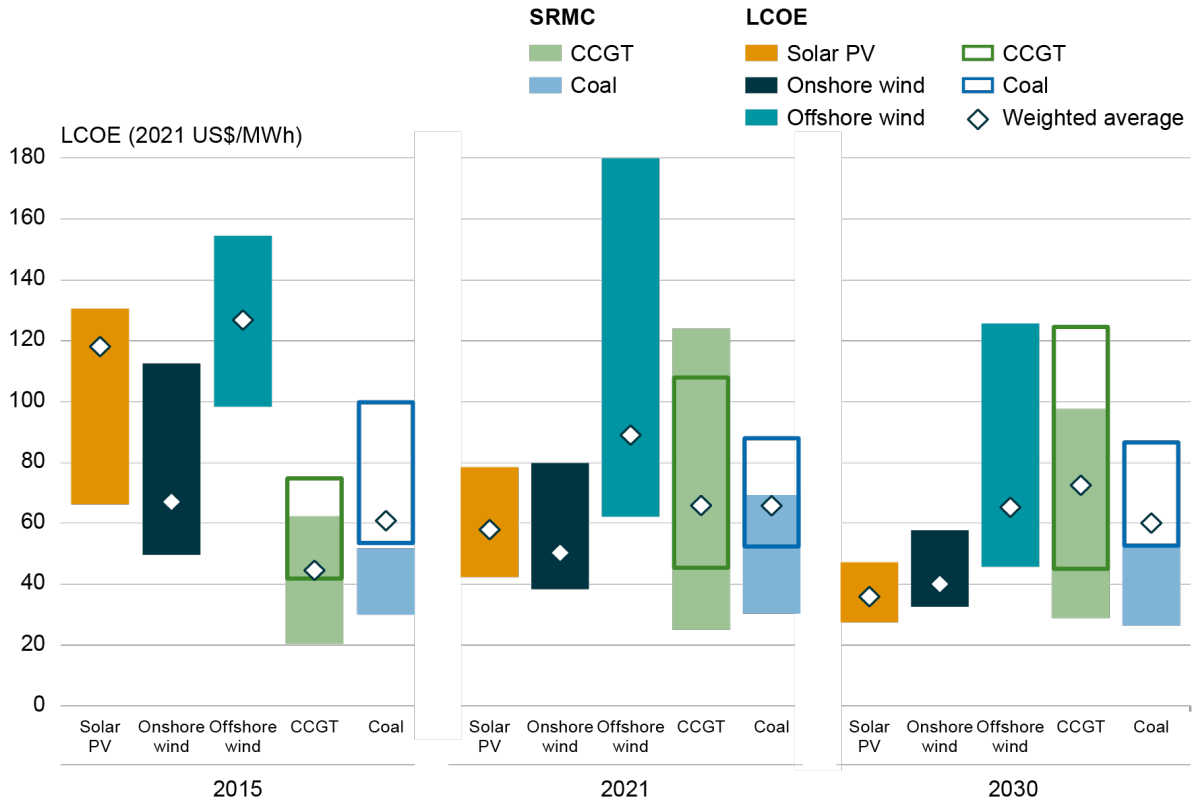
coal, as it would be difficult to require the developing world to shut down coal as a source of electricity generation.

A.4. Competitiveness of Low Carbon Technologies

Context

Despite the energy crisis of 2022, the move towards clean energy accelerated and over 300GW of clean energy sources were added globally.[15] This will continue, as most of the global reductions in CO2 emissions by 2030 can come from technologies readily scalable today. S&P Global estimates that 70 to 75 percent of new electric generating capacity added between 2023 and 2050 will be solar PV or wind. Solar PV and onshore wind are already among the cheapest options for generating power across the world today on an LCOE basis, and costs are projected to fall further by 2030.

LCOE and marginal cost ranges for renewables and conventional fuels



SRMC= short run marginal cost is the sum of annual fuel prices, variable prices and carbon prices, where applicable.
Ranges represent the 10th to the 90th percentile of values for the markets analyzed for this report.
Averages are weighted by annual gross capacity additions.

Source: S&P Global Commodity Insights

However, to achieve net-zero by 2050, the world will have to increasingly rely on clean technologies that are currently at the demonstration or early adoption stage such as grid scale batteries for electricity storage, green hydrogen (through electrolyzers), and

[15] *How will global investments in clean energy evolve to 2030?,* S&P Global Commodity Insights, May 2023

carbon capture technologies. This is particularly the case for hard to abate sectors such as steel, cement, fertilizers, heavy-duty transport and non-energy sectors such as agriculture.

Technologies such as Direct Air Capture (DAC) and other negative emissions technologies – which were regarded as speculative only a few years ago - are now drawing significant interest. Nevertheless, the DAC projects in the active pipeline would only capture around 8.5 million metric tons of CO2 per year by 2030, mostly located in the United States and the United Kingdom. Though levelized CO2 capture costs currently range from USD300 to USD600 per metric ton of CO2 captured, costs are projected to come down to USD100 by 2040. This will require massive policy support, further technology developments, and new supply chains and infrastructure.[16]

In pursuit of these yet-to-be-commercially scaled technologies, the world may risk a case of techno-optimism[17], which was described as "the belief that technological progress will enable us to reach zero carbon emissions while continuing to enjoy our existing standards of living, and indeed while bringing all people across the world up to the living standards which rich countries currently enjoy".

Participant Perspectives

- Several participants emphasized that renewable power can provide a significant share of the power mix with high reliability. For example, it was suggested that the US could expand the share of wind and solar from the current 12% to a ceiling of around 80% (with storage), without negative impact on security or reliability. An argument was made that significantly accelerating deployment of solar PV and onshore wind around the world is likely to have the biggest impact on reducing emissions between now and 2030.
- Others pointed out that plans do not necessarily translate easily into deployed projects, as there are many issues to address – infrastructure needs, intermittency of renewables, supply chain issues, permitting (often in multiple jurisdictions or with multiple regulations), and integration into the network.
- Nascent technologies need time and significant sums of money to make them commercial and deployable, often requiring strong policy support and incentives.
- There is expectation of declining future costs for new low carbon technologies, similar to the dramatic reductions witnessed for wind and solar. However, it is not clear that new low and zero carbon technologies such as green hydrogen, sustainable aviation fuel, e-methane and CCUS will see the same sort of cost reduction curves as has played out with solar PV. This is due to fundamental differences in these molecule-based process technologies and their supply chains. It will be a few years before there is clarity on the cost curves.

[16] *Direct air capture: The race to scale up a technology that can remove CO2 from the air*, S&P Global Commodity Insights, November 2022
[17] *Techno-optimism, behaviour change and planetary boundaries*, Adair Turner, Keele World Affairs Lectures on Sustainability, November 12th, 2020

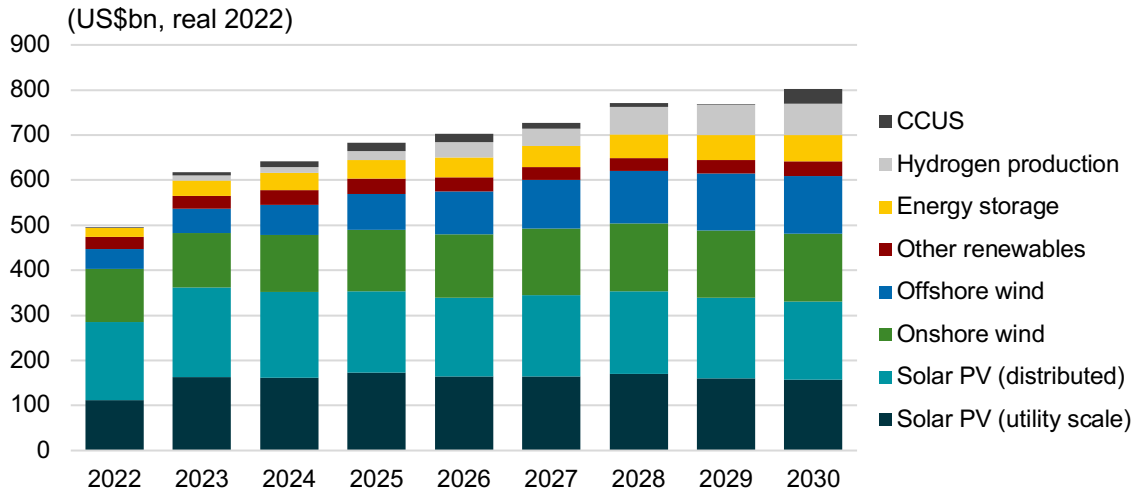
- There was considerable debate as to how long it will take low carbon hydrogen to scale up. Of critical importance for new technologies such as hydrogen are markets - offtake agreements – which are currently largely missing. A “build, and they will come” approach is problematic, so until global demand and robust pricing mechanisms are established, and buyer confidence increases, large scale supply projects will face challenges. Moreover, transportation systems need to be developed. In Asia ammonia is being viewed by some as the most feasible long-distance hydrogen carrier, but the necessary transportation infrastructure is not yet in place.
- The concept of "Geological Net-Zero" may gain traction as fossil fuel demand remains high and concerns regarding the credibility of nature-based offsets persist. This concept hypothesizes that the biosphere cannot provide robust long-term storage of anthropogenic CO2 captured from the atmosphere, so the only long-term solution (beyond reducing CO2 emissions) is to put the carbon back into geological storage.

A.5. Financing Low Carbon Energy

Context

Global investment in renewable power totalled USD455 billion in 2022 and this is forecast to step up to over USD700 billion per year on average through to 2030.[18]

Spending in renewable power and storage, by technology



Source: S&P Global Commodity Insights.

The sources of capital have been diverse – governments, private sector, institutional investors, private equity, industry and international financial institutions. Limited fiscal space and other competing interests will constrain governments’ ability to finance the required investments in new clean energy projects, so the majority of investment will need to come from the private sector, largely in the form of ‘sustainable finance’.

[18] *How will global investments in clean energy evolve to 2030?* S&P Global Commodity Insights

Sustainable investing has increasingly come into focus over the last decade with a rapid increase in "ESG investing" globally. However, there are many different definitions of "clean", "sustainable" and "green" along with a vast ecosystem of companies, regulators and governments involved in different aspects of ESG investment reporting, measurement and rankings. Taken together with the different approaches to rating companies on their ESG performance, there is much debate and confusion in the market over what is considered a 'green' or low carbon technology. This was evident in the EU's wranglings over "green taxonomy" in 2022, as the energy world on which it was predicated disappeared with the war in Ukraine.

Participant Perspectives

- Meeting the 1.5 degrees Celsius target will require a massive and immediate scale up in low carbon investments. Although estimates varied, ranging in the trillions of dollars per annum, the enormity of the global financial challenge was broadly recognized. Banks alone cannot provide sufficient financing for low carbon projects. This will require collaboration across industry, the financial sector and governments.
- It is important to recognize that lack of finance is often an effect rather than a cause. Money seeking low carbon solutions is very active but there is a lack of sufficient finance-ready projects in clean technologies which are capable to scale up and meet investment criteria. If projects can demonstrate attractive returns on investment, finance will naturally follow. Therefore, it is essential to focus on creating viable business models and financial structures that offer compelling returns to potential investors.
- Unlike previous transitions, this energy transition is mainly policy-driven not market-driven. Yet businesses are challenged in assessing and managing policy risk, hence are reluctant to invest where policy uncertainty is high. They are much more confident with managing conventional market risk.
- Some argued that the financial sector went too far, too fast with green investment mobilization criteria and needs to reconsider. Historically the financial sector used to focus on identifying risks and opportunities, but the focus has now shifted to setting outcome targets for emissions. There is no common basis to evaluate sustainability in the absence of standard, measurable, verifiable metrics, made more complex owing to significant policy uncertainty. This erodes investor confidence and constrains investment.
- A view was expressed that ESG criteria tend to favor investments in businesses close to end consumers, while the extraction, production and manufacturing industries that supply them are less favored.

- Returns from clean energy projects often fall below required hurdle rates. This is in part due to the high risk premiums driving up cost of capital, particularly in the Global South.
- The critical minerals space also faces a substantial underinvestment, which poses significant challenges for various industries. It was suggested that the projected shortfall in critical minerals could be comparable to a 20 million barrels per day shortfall in oil production. This deficit emphasizes the urgent need for increased investment and attention in the critical minerals sector to support sustainable development and technological advancements.

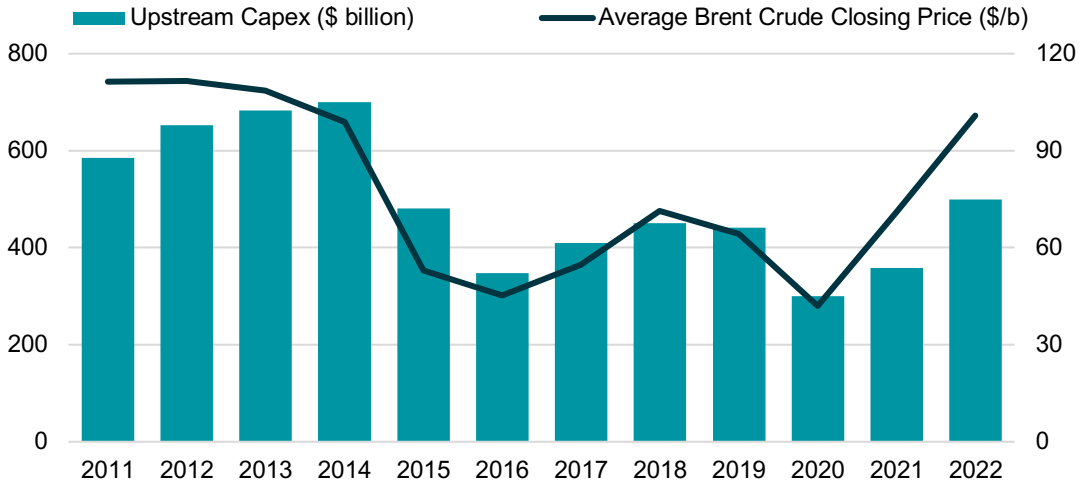
A.6. Financing Fossil Fuels

Context

Historically, increases in oil prices have been followed by increases in upstream spending; however, this relationship has been weakened in recent years. Reasons include policies by governments and multilateral agencies to reduce support for oil and gas developments, financial sector inhibitions on investments in hydrocarbons, capital discipline by companies in order to return money to investors, and concerns that a fast pace of energy transition means no new investments in oil and gas are necessary, with the resulting specter of “stranded assets”.

Given the natural decline rate of oil fields (around 5% per year global average), with no further investment global supply will decline by over 75% by 2050. This significantly exceeds all but the most aggressive forecasts for global oil demand decline, implying the need for continued investment. US short-cycle production (i.e., shale) has even higher decline rates but offers fast response to price signals, shorter payback and lower risk of long-term asset stranding. Nevertheless, with fiscal discipline prevailing in the US oil patch, high price signals are not having the same impact on production as in previous price cycles. Indeed, some now argue that the only recently-born shale industry is already a mature business.

Global oil and gas upstream capex v average annual Brent crude price



Source: S&P Global Commodity Insights Costs & Supply Chain Service

Emissions from burning of coal account for about 40% of total energy-related emissions and it is hard to see how net-zero goals can be reached in any time frame without significant decline in unabated coal use, especially in Asia. However, coal use increased around the world in 2022, driven by high gas prices that led to gas-to-coal switching in many countries. According to S&P Global Commodity Insights, global coal demand exceeded 6.5 billion tonnes in 2022. If elevated gas prices continue, coal demand could increase further in 2023. China and India together consume double the amount of coal as the rest of the world combined, and demand is rising in both countries. Even in the European Union coal consumption increased by 6.5% in 2022 to about 480 million metric tonnes.[19]

One of the major announcements from the Glasgow COP26 climate talks was a pledge by the Just Energy Transition Partnership (JETP), to provide $8.5 billion to help South Africa transition away from coal. This has been followed by larger agreements with Indonesia and Vietnam to mobilize $20 billion and $15.5 billion respectively in public and private financing over a three-to-five-year period, using a mix of grants, concessional loans, market-rate loans, guarantees, and private investments.

Participant Perspectives

- If financial institutions cut finance to oil and gas projects too quickly the transition will become volatile and energy prices will rise. While the need for adequate investment in the energy sector remains crucial to maintaining affordable energy prices and wider economic stability, there is a significant structural underinvestment across the entire commodity chain. In the past three years, the oil and gas industry has struggled to replace its reserves, with historically low reserve replacement ratios of below 20%. This highlights the substantial underinvestment in the sector and the need for greater financial support to drive an orderly and affordable energy transition. Moreover, still to be seen, is the impact of one of the larger hydrocarbon regions – the Russian Federation – no longer being investable for major international oil and gas companies.
- It was argued that oil and gas supply should not be constrained before constraining demand, as this would accentuate cycles and price spikes. Such volatility discourages investors and benefits neither suppliers nor consumers. Innovative investment and policy approaches are therefore needed to encourage nearer- term oil and gas supply while addressing whether long-life assets will be utilized or stranded.
- Current investment trends in the energy sector indicate that financial institutions often use mixed and somewhat arbitrary criteria to evaluate potential investments. Investments in new ‘low carbon’ oil and gas fields can face significant resistance even if the carbon intensity of production is comparatively low. Views on investments specifically aimed at decarbonizing the oil and gas value chain, e.g. through CCUS or methane emissions reduction, are more

[19] IEA Coal Report 2022

mixed, as some see this only perpetuating the use of fossil fuels. However, blanket bans on financing oil and gas companies and their projects based on ESG criteria may be counterproductive given the opportunities for low-cost emission reduction in the sector.

- Customers ultimately care about cost and reliability of supply, and participants suggested the ability of the fossil industry to deliver affordable reliable energy is underappreciated. The energy crisis of 2021-2022 saw an upsurge in energy prices and market volatility, resulting in demand destruction across many countries (Europe and China in particular). But it is not clear how much of that demand destruction is permanent and how much is the result of temporary fuel switching or ratcheting down of activity.
- From the perspective of the Global South, the technology leapfrog that was witnessed in telecommunications and digital technologies is not likely to be replicated in energy. Fossil fuels will remain the most affordable and reliable fuel sources in many countries for some time and will provide a bridge from biomass to low- and zero-carbon technologies.
- Fossil fuels will remain part of the energy mix going forward due to their importance for energy security and affordability - but will be increasingly low carbon. Based on typical decline rates, global oil supply could be below 20 million barrels per day by 2050 if there is no further investment, which is well below forecast demand in the majority of published scenarios. As scrutiny of carbon footprints becomes more intense, there will be incentives to seek out products with the lowest carbon intensity in production processes. There will also be increasing use of offsets – as evidenced by the launching of 'carbon neutral' LNG cargos.

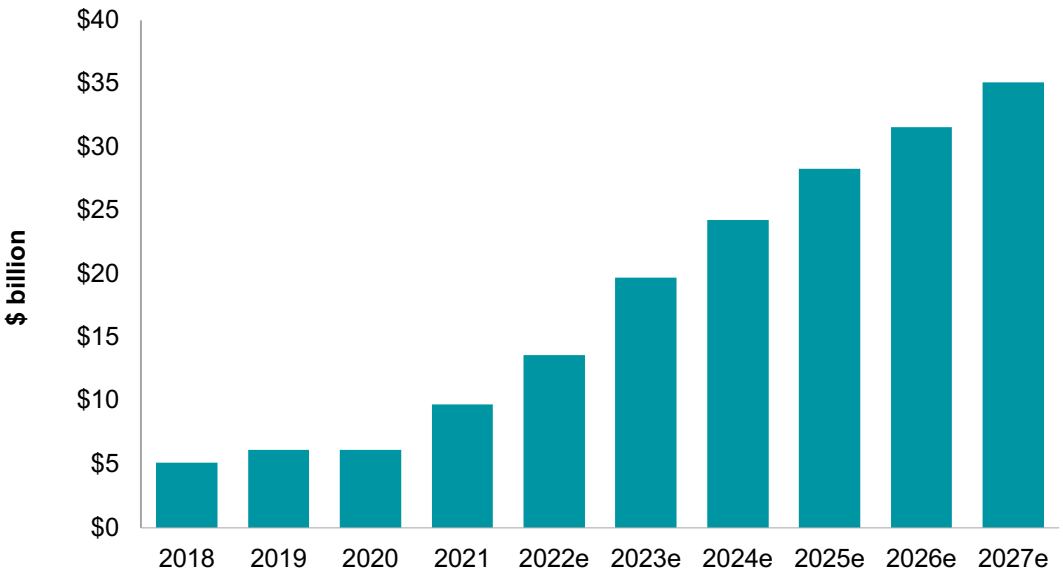
A.7. The Oil and Gas Industry and the Energy Transition

Context

According to S&P Global Commodity Insights, global spending on oil & gas (exploration and production) activities amounted to $505 billion in 2022. The oil and gas industry brings engineering and scientific talent, the ability to work internationally and at scale, and to execute large and complex projects. This is elaborated in the IEA report 'The Oil and Gas Industry in Energy Transitions' (2020) which stated: "The oil and gas industry can play a critical role to scale some of the most important clean energy technologies to reach maturity. These technologies include CCUS, hydrogen, biofuels, and offshore wind. Companies can deploy their large-scale engineering and project management capabilities for this purpose. The oil and gas sector has the experience, skills and knowledge to develop and scale up production of hydrogen from natural gas as a low-carbon, low-cost source of energy."

The oil and gas industry is adopting a range of strategies for the energy transition, and many companies are looking to position themselves to succeed in a low-carbon future. They are variously building on existing core capabilities (e.g., developing and operating offshore wind farms, CCUS value chains) and/or are entering entirely new business areas (e.g., electric vehicle charging networks, hydrogen value chain).[20]

GIOCs: Aggregate organic low-carbon investment (Capex + R&D)



Source: S&P Global Commodity Insights Companies & Transactions Service.

Note: Global Integrated Oil Companies (GIOC) included in the chart are bp, Chevron, Eni, Equinor, ExxonMobil, Shell, and TotalEnergies.

With respect to existing oil and gas operations, the volumes of flaring and methane emissions (CO2e) are substantial and have significant implications for climate change. Reducing them substantially and quickly is also the focus for many companies and industry groups. Nevertheless, Scope 3 emissions from the downstream use of the industry's products typically accounts for 70-85% of total emissions.

Participant Perspectives

- The oil and gas industry has reinvented itself numerous times to take on new challenges due to technological and social changes, government regulations and customer demands. This transition should not be any different.
- Oil and gas companies must be part of the solution – they bring the capabilities and strong balance sheets that are critical to the transition.
- Some of the pressures leading to underinvestment in oil and gas stem from a lack of understanding of the role the industry has played, and continues to play,

[20] *Oil and gas investments in clean tech startups accelerate the industry's energy transition*, 31 Oct 2019, IHS Markit

in economic development, in energy security, and in providing reliable and affordable energy.

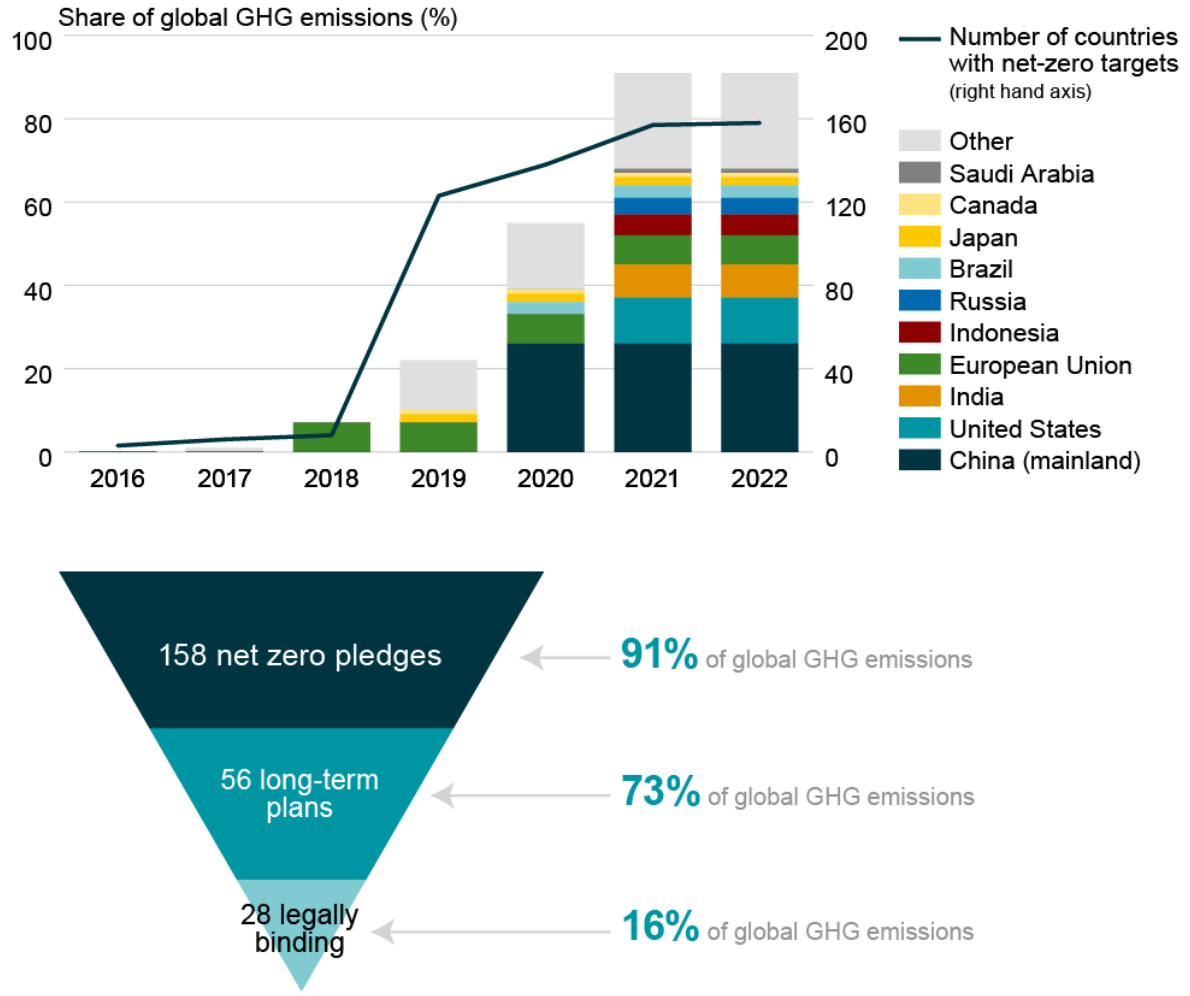
- New clean energy technology solutions are emerging in different parts of the world and diverse technology start-ups are being incubated, including in developing countries. It was recommended that oil and gas companies should widen their aperture on venture capital investments and improve their connections with local business communities.
- Oil and gas companies will take different routes to manage and reduce their carbon footprint. Many are actively working to reduce the carbon intensity of their operations. Others are selling on carbon intensive assets, which doesn't necessarily reduce overall global emissions unless the acquirers pursue lower-carbon strategies.
- Oil and gas companies will need to find different ways of financing low carbon projects than their conventional business, which may lower returns.
- Industry challenges can be solved through industry collaboration, such as the Oil & Gas Climate Initiative (OGCI) which is, amongst others, helping companies reduce methane leakage and is mobilizing venture capital for low carbon investments. In another example, the six largest Canadian oil sands producers have formed the Pathways Alliance to develop and share emissions reduction technologies to drive down emissions.

A.8. Policy Needs, Approaches and Efficacy

Context

Leading up to COP 26 in Glasgow, many countries and companies announced net-zero targets. The majority of the national targets are set for 2050 or beyond – including 2060 for China, Indonesia and Nigeria, and 2070 for India. Even if fully achieved, current national net-zero pledges would fall short of meeting the global goal of carbon neutrality by 2050. Furthermore, out of 158 countries with net-zero targets, only 28 have net-zero goals in law and only 56 have long-term plans with net-zero goals.

Timeline of net-zero pledges by market and share of global GHG emissions



Note: EU member states are included in the count of net-zero goals (line) and excluded from the share of global emissions (bars) after 2018, year of the EU net-zero goal pledge.

Source: S&P Global Commodity Insights

Achieving these net-zero targets will depend on technology development and deployment and further policy interventions, and additional incentives to invest and scale low-carbon technologies. In recent years such government policy interventions have taken the form of initiatives such as the RePower EU plan in Europe and the Inflation Reduction Act (IRA) in the US. At the same time there are concerns that the local sourcing requirements of the IRA pose challenges for the existing global trade and investment rules. The European Union has asserted that the bill gives advantage to American producers, discriminates against European producers, and breaks WTO rules.

Participant Perspectives

- There is a constraining policy ecosystem and lack of 'holistic' policy making which will impact the pace of the energy transition. Overarching aspects such as supply chains need to be fully understood. For example, the minerals supply

chain challenge is underestimated. Mineral supply chains need to increase three-fold to seven-fold, depending on mineral.

- Recent geopolitical events require policymakers to address fundamental questions such as:
    - Is there a need to reassess the 'electrify everything' approach when global supply chains appear so vulnerable and face capacity challenges?
    - Should there be more focus on technologies with less geographically concentrated (and therefore less geopolitically vulnerable) supply chains such as hydrogen and CCUS?
- Investors seek robust and stable policy and regulatory frameworks, coupled with efficient implementation mechanisms. This requires significant capacity within government institutions across many new areas, given that policy makers need new frameworks and toolkits to address the new issues. Short term energy security concerns and uncertainties may be forcing policy makers to make decisions that are non-optimized long-term.
- Government policies should not pick winners and losers among technologies. Having broad inclusivity of technologies is not inconsistent with the objectives of the Paris Agreement, which focuses on national emission reduction goals rather than technologies.
- There is a gulf between policy objectives and the reality of how quickly things can be done on the ground. This plays out in frictions between governments that want to accelerate decarbonization and the companies that are tasked to deliver it.
- Policy uncertainty harms the pace of energy transition. While the focus on long-term transition must be maintained, policy makers need to ensure market stability to minimize energy crises in the short term.
- The US Inflation Reduction Act promises to provide momentum to clean energy projects in the United States – though some described it as an incomplete solution owing to impediments. There is an expectation that the impact could be constrained due to permitting delays – at both federal and state level, including for the development of a critical minerals supply chain. Other issues that need to be investigated are workforce readiness and availability, local sourcing requirements, and grid infrastructure constraints for renewables.
- Some commented that the IRA, and the regulatory response from the EU, will take multiple years to implement fully as government agencies develop the complex detailed guidance needed by investors. There is also concern that the current propensity for litigation in the US could, in effect, lead to the courts setting energy policy rather than the elected government.

- The EU cannot simply copy the IRA due to the internal diversity of national tax laws. Also, lack of emissions accounting standards is hampering capital deployment and will be critical for implementation of the EU's Carbon Border Adjustment Mechanism (CBAM) and equivalent regulations elsewhere. Developing countries see the CBAM as imposing European climate policies on the Global South and as protectionist – and likely to be a regulatory quagmire.
- Insufficient attention is being paid to the demand side of the transition. While supply-side constraints are being driven by government policies aimed at long term climate objectives, the demand for fossil fuels/hydrocarbons remains high and is likely to continue to grow on a global basis.
- While the impetus for 'green molecules' (biofuels, hydrogen) has become stronger and stronger, there remains the challenge of creating market demand and off-take arrangements.
- In fast-growing countries such as India, even renewable power build-out is 'running flat out simply to catch up' due to high energy demand growth. In regions such as Latin America, there is insufficient attention to the demand response of energy across residential, commercial and industrial sectors.
- In the case of mining to support the energy transition, it was suggested that a new world scale copper mine will have to be opened every year over the next decade to meet forecast global demand, and this is far from being possible.
- Public-Private Partnerships (PPPs) have challenges but are a key mechanism for de-risking clean energy projects. PPPs can help to find the sweet spot that meets the needs of shareholders and taxpayers. The private sector has a critical role to play.

A.9. Offsets and Carbon Markets

Context

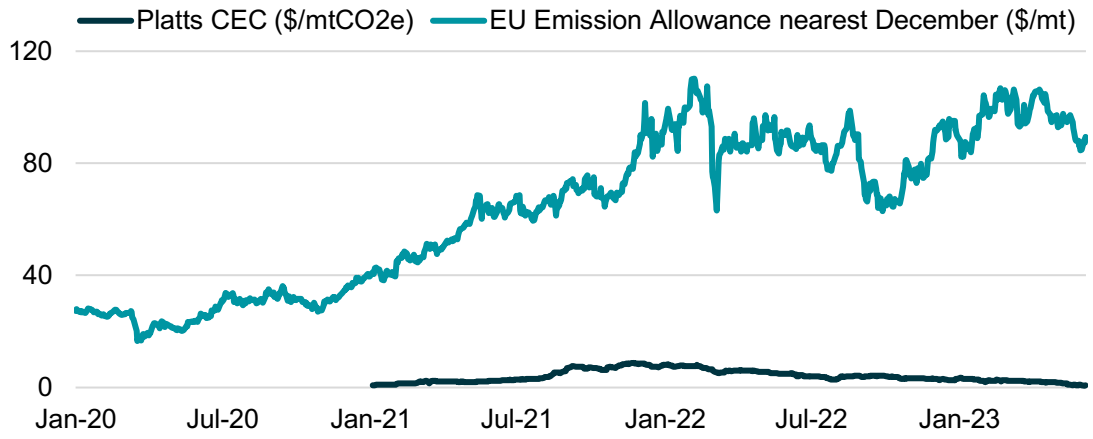
Globally, nations and companies have continued to escalate their climate ambitions. To reach stated targets, emphasis is growing not only on reducing emission levels from sources, but also on carbon removals such as nature-based solutions and Negative Emissions Technologies (NETs). Emissions that are difficult or expensive to abate will increasingly be offset by the purchase of carbon credits in both "compliance" and "voluntary" markets. Within the voluntary carbon markets (VCM), carbon offsets come from a wide range of activities, including agriculture, forestry, and other land use (AFOLU); renewable energy; transport; waste; and carbon capture.

Forest resources have a major role in mitigating climate change. New studies indicate that intact tropical mountain forests store about 150 tonnes of carbon per hectare, over 1.5 times more than they were originally thought to absorb. This underscores a greater role for primary forests in carbon sequestration and regulating climate change impacts.

Undervaluing the role of natural carbon sinks has led to faster deforestation due to the impacts of commercial agriculture, logging and urbanization - and cutting of forests for cooking and heating, which could be abated with the availability of natural gas and LPG, as in India.

Maintaining, and indeed expanding, these natural carbon sinks will require the development of liquid, robust and transparent carbon markets. A recent World Bank report indicated that the global carbon credit markets grew by 48% in 2021, driven largely by voluntary corporate commitments. Nevertheless, the perceived variable quality of credits in the VCMs has been a factor driving the significant under-pricing of VCM credits versus compliance markets such as the European Emissions Trading Scheme (ETS) (shown in the chart below)

VCM vs EU ETS price



Source: S&P Global Platts Dimensions Pro.

Further challenges to the widespread use of carbon offsets lie in the methodologies being promoted for assessing alignment of company emissions targets with a 1.5°C temperature outcome. Such methodologies typically limit or disallow the use of carbon offsets in setting and delivering targets.

Participant Perspectives

- Monetizing and mobilizing natural carbon sinks in developing nations suffers from inadequate funding and needs support from developed economies. It requires the establishment of robust standards, regulations, markets, institutions, and infrastructure, plus a greater acceptance of the role of carbon credits and carbon offsets in tackling climate change.
- Carbon pricing becomes necessary to provide policy certainty for projects and reduce misallocation of capital. If CO2 is viewed as a waste, as opposed to a tradeable product, and without effective carbon pricing, the full potential of CCUS based regional hubs will not be realized.

- Implementing a market-based carbon pricing mechanism at a national level within the US can provide a strong incentive for businesses to reduce their carbon footprint. By putting a price on carbon emissions, it becomes financially advantageous for companies to adopt cleaner practices and invest in sustainable solutions. However, the likelihood of a national carbon price in the United States remains low.
- Ideally, there should be a global carbon market, similar to the global crude market, where there will likely be different qualities and prices. It was suggested that this would require regulators to facilitate the standardization and development of these markets, including methodologies for carbon accounting including standard assessment of carbon intensity of products. It was noted that currently there is a lack of standardized global pricing mechanisms for carbon and low carbon products.
- The voluntary carbon markets are currently small but have significant growth potential. Issues around standardization and compliance mechanisms and regulatory frameworks are currently hampering export of carbon credits and there is also a growing risk of carbon nationalism. While carbon markets are growing fast, 95% of current trades are off-exchange bilateral deals. This makes pricing transparency, participation and financing a very large issue. [21]
- Corporates are leery of the litigation and reputational risks of engaging in these markets. While many companies, including financial institutions and banks, are working on reducing emissions, they encounter the headline risk of being accused of the nebulous and often unspecified charge of “greenwashing”.

A.10. Partnerships, Collaboration and Competition

Context

The Conference of Parties (COP) annual meetings, established under the United Nations Framework Convention on Climate Change (UNFCCC), pioneered government-to-government collaboration to address climate change issues and more specifically, reducing global greenhouse emissions. Outcomes of various COPs led to progressive decisions such as the Kyoto Protocol and more recently the Paris Agreement and accelerated efforts by various countries to move towards net-zero.

Other platforms to advance on the energy transition front have taken the shape of forums such as the Clean Energy Ministerial, which promotes partnerships of countries with businesses, subject experts, and other international organizations to accelerate clean energy transitions.

However, a constant theme from the global climate forums in the past three decades has been the relative lack of a voice from countries in the Global South (especially the poorer ones) about the energy transition, which detracts from the breadth and impact of discussions. This lack of voice can also inhibit the ability of countries to achieve

[21] Joint public and private sector initiatives are ongoing to improve the efficiency and effectiveness of carbon markets.

their stated goals of attracting investment to reduce energy poverty, accelerate economic growth, and provide modern energy services to all citizens.

The economic considerations of the energy transition (who pays for what) have hindered climate collaboration especially on emission reduction targets, and financial responsibilities. Promoting collaboration among countries with different levels of technological advancement, research capabilities, and infrastructure also faces difficulties.

Participant Perspectives

- Though platforms for government-to-government collaboration exist (such as COP, Clean Energy Ministerial) and have been instrumental in advancing climate collaboration, recent geopolitical events are forcing a fundamental rethink around such international partnerships. Industrial policy by individual countries has moved to the fore.
- Efforts at collaboration are complicated by the different degrees of policy analysis and development, and strikingly different levels of per capita GDP, among different countries.
- Meeting the challenges of the energy transition will require extensive collaboration not just between the Global North and Global South but will also necessitate a cross-sectoral engagement across public-private sectors and within the wider industrial sector.
- Such partnerships will result in improved cross-border collaboration on physical energy infrastructure – both in project development and in the flows of energy. More collaboration is also needed around regulatory frameworks and standards, and between the various government ministries and agencies within countries.
- The foundational solutions should be stable energy prices, integrated collaboration, acknowledgement of differentiated starting points across countries, and a realistic assessment of the varying paces of technological development.
- The concept of “friend-shoring” needs more articulation. Cleantech supply chain linkages are very complex and often not well understood at all. Long-standing and deeply-embedded supply chains and economic efficiency are increasingly at odds with geopolitical rivalries. So how feasible, it was asked, is it to dismantle and rebuild supply chains, including building all the required inspection and permitting processes?
- Lack of international collaboration is one of the biggest risks for technology development and deployment. Cross-sectoral collaboration among policy makers, financial sector, energy companies, and the public will facilitate the achievement of climate goals. The climate challenge is too urgent for the energy transition to proceed in divided or siloed conversations. The oil and gas industry,

currently supplying 55 percent of world energy, needs to be part of the dialogue. ESG taxonomies and criteria need to be rethought for a more fit-for-purpose approach.

A.11. Barriers and Bottlenecks

Context

The passage of the Inflation Reduction Act in the United States, with its massive incentives and subsidies for renewable sources of energy, the RePowerEU plan in Europe, and similar initiatives elsewhere will accelerate the demand for the minerals that are the building blocks for renewable energy—required in wind turbines, electric vehicles, solar panels, and power grids. A host of organizations — the IMF, the World Bank, the International Energy Agency (IEA), and various governments (including US, EU and Japan) — have all issued studies on the criticality of those supply chains.

The recent S&P Global study *"The Future of Copper: Will the Looming Supply Gap Short-Circuit the Energy Transition*", focused on copper because the thrust of the energy transition is towards electrification and copper is "the metal of electrification". The conclusion of this analysis is that copper demand would have to double by the mid-2030s in order to meet the 2050 goals. However, the potential gap between worldwide copper supply and demand projected to begin over this decade will have serious consequences across the global economy and could affect the timing of achieving net-zero emissions.

For critical minerals, the chokepoint is supply. At the current rate of supply growth—which encompasses new mines, mine expansion and greater efficiency, and recycling, as well as substitution—there will be an upcoming demand-supply mismatch. For instance, the IEA estimates that it takes 16 years or more from discovery to first production for a major new mine. Some mining companies say more than 20 years, as permitting, political and environmental issues are growing constraints around the world.

In addition to critical minerals, significant investment is needed in increasing the grid capacity and in energy storage systems to keep pace with the buildout of renewable energy, including smart grids to handle these variable energy generation sources. Delays in connecting new renewable energy sources to the grid, and in reinforcing grid infrastructure are particularly acute, with wait times of 5-10 years or more in some locations.

Participant Perspectives

- There is a high risk of structural shortages of critical minerals such as copper, cobalt and lithium due to huge demand growth from electrification and the sustainability challenges facing the mining and processing industries in bringing on new supply. It takes a generation to open a new copper mine, and market

prices are still below levels required to incentivize new supply. Unless mineral mining is recognized as essential to the energy transition, the deployment of renewable power, electric vehicle and green hydrogen technologies will be impaired.

- For supply of 'climate-critical minerals', there are macro and local level challenges, a major constraint in many countries being permitting. Other issues that are proving difficult to navigate include the regulatory framework, and lack of stability/certainty in government strategy, and change of governments in resource countries. Current global project/supply chain delivery capacity is insufficient to support the huge investments and enormous number of projects to achieve the required rate of transition – even if financing is available. Decarbonization scenarios and roadmaps need to take into account this looming bottleneck.
- It is suggested that the mining industry be assessed on its net benefit to global emissions reduction, not purely on its operational emissions, which would facilitate the flow of investment.
- A participant rated the current permitting process in the United States as '5 out of 10 at best' – and highlighted the importance of reform. Permitting around the world remains a major bottleneck in developing new projects, meeting energy needs, and in expediting the energy transition.
- In many locations existing grid infrastructure is not sufficiently flexible to handle increased penetration of variable renewable energy sources and there is insufficient regional grid connectivity. The capacity of current distribution infrastructure is also underdeveloped – future bottlenecks will emerge if the focus is only on transmission grids.
- In regions like Africa, the growth in energy demand will require large scale investment in renewable power generation and extensive power grid development.
- Perhaps one of the biggest capacity bottlenecks will be human capacity – where will all the engineers, technologists and other experts come from? Availability of skilled labor is a major roadblock to scaling up clean technologies, especially for frontline workers and engineers. Shortage of labor, permitting issues, concerns of indigenous peoples, local opposition – all have the potential to extend the lead times for building and expanding the required infrastructure.

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