SDG ACTION

COP 28 EDITION

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Taking stock

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Time to face the facts

COP28 is a pivotal moment for the Paris Agreement. The first global stocktake presents a comprehensive view of progress towards the goals of the agreement. The synthesis report released in September makes it clear we are falling well short. The science is clear and, collectively, we have the knowledge and resources to deliver. Now it is time for political leaders to unite behind a common plan to address the climate crisis

By Phoebe Koundouri, Professor, School of Economics, Athens University of Economics and Business; Professor, Department of Technology, Management and Economics, Technical University of Denmark (DTU); Chair, UN SDSN Global Climate Hub; Co-Chair SDSN Europe; Director, SDU ATHENA Information Technologies Research Center

The upcoming 28th Conference of the Parties (COP28), to be held in Dubai between November 30 and December 12, is a critical turning point for global climate action as the world approaches a tipping point of positive transformation. The first global stocktake under the Paris Agreement invites us to evaluate our goals and assess our progress.

I have the honor of leading the Global Climate Hub (GCH or simply Hub) of the Sustainable Development Solutions Network (SDSN) under the auspices of the Secretary-General of the United Nations. The GCH is at the forefront of this transformation. By conducting pioneering research and joining forces with other global actors and stakeholders, we contribute to the Decade of Action's call of achieving the Sustainable Development Goals (SDGs) by 2030 and tackling the most critical issues of our times, such as gender inequality, poverty, and climate change, as well as reducing the financial gap between rich and poor.

▲ The ministerial 'family photo' at Pre-COP in Abu Dhabi, UAE

COP28's agenda will focus on four main areas:

- accelerating the energy transition and cutting emissions prior to 2030
- creating a new financial framework to revolutionize climate funding

- centering climate action around the needs of people, the environment, and their livelihood
- organizing the most inclusive COP to date

The work of the UN SDSN GCH supports all these thematic areas.

Energy transition

First, the energy transition needs to be accelerated. Since the scientific evidence is clear, we need to act with intensity to cut emissions drastically and keep a 1.5°C pathway achievable. Importantly, we must do this in a just manner, particularly for the Global South.

In the GCH we develop comprehensive decarbonization pathways for energy systems, addressing the dual challenges of reducing emissions and managing energy demand in a way that fosters sustainable development. In GCH's first report, published recently, we describe in detail our work, which includes:

- a thorough review and assessment of potent integrated assessment models
- the delineation of:
  - a first set of sustainable pathways on the EU energy sector
  - the deployment and effects of the renewable energy transition in Southeast Asia
  - the development of sustainable pathways for land use and food systems in Greece

The GCH's role in fostering dialogue and co-designing these pathways with stakeholders ensures that the transition is not only scientifically sound but also socially equitable and economically beneficial. We are turning the moral imperative of a just transition into a tangible opportunity for climate-positive growth and development.

Climate finance

Second, the promise of climate funding must be turned from intention into fact. The need for a revised financial architecture is highlighted by the fact that emerging and developing nations require investment of USD 2.4 trillion by 2030. Donor nations have pledged to mobilize USD 100 billion per year toward this gap, which is a negligible portion of what is required. Despite intense pressure, they still fail to meet their obligation.

The GCH is substantially contributing to the transformation of financial pledges into tangible investments. Our work revolves around exploring innovative financing models that blend public and private funds. This is intended to cover the capital needs of both developed and emerging economies, particularly on the climate adaptation and resilience front.

For this, the GCH not only identifies viable financing pathways but also actively engages with financial stakeholders to unlock the funds necessary for a large-scale climate response. This approach ensures that financial resources are allocated effectively, helping to overcome the economic barriers to climate action and turning finance into a force that empowers global climate efforts.

A critical part of our work is the valuation of ecosystem services, enhancing corporate sustainability reporting by integrating SDG performance with environmental, social, and corporate governance (ESG) indicators, and incorporating natural capital valuation into financial assessments. In the Horizon 2020 ARSINOE project, the ATHENA Research Center in Information, Communication, and Knowledge Technologies (ATHENA RC, one of the hosting institutions of the GCH) leads the financial work package, creating a portfolio of financing solutions to boost regional resilience.

This involves identifying financial innovation paths, co-developing stakeholder-specific financial strategies, designing financial instruments, and developing a hybrid financial reporting model that balances profit with ESG criteria. These efforts ensure effective allocation of financial resources, overcoming economic barriers to climate action.

Adaptation and resilience

Third, adaptation and resilience must be at the heart of the global climate response. Investing in societies and nature, addressing loss and damage, and advancing adaptation finance must be central to our agenda.

Adaptation and resilience form the cornerstone of the GCH's strategy, aligning perfectly with the urgent need to invest in these areas. The Hub's systemic approach to integrating climate resilience into development pathways provides a blueprint for managing the risks associated with climate impacts. By supporting the creation of packages of measures to assist vulnerable communities, the Hub is actively contributing to the operationalization of financial assistance to vulnerable countries, like the loss and damage funds agreed during COP27 in Sharm El Sheikh, Egypt.

Its emphasis on both mitigation and adaptation ensures that the Hub's pathways are not just reducing emissions but are also enhancing the capacity of societies to withstand and recover from climate-induced negative factors. This addresses loss and damage and advances the cause of adaptation finance.

Supporting our commitment to adaptation and resilience, GCH is actively involved in key, relevant projects through its hosting institutions (the Athens University of Economics and Business (AUEB) and ATHENA RC). These projects include Horizon EU's Pathways2Resilience and (as previously mentioned) Horizon 2020's ARSINOE.

Pathways2Resilience focuses on co-developing transformative pathways for climate-resilient regions in Europe, integrating economic and social development with net-zero commitments. This project aims to empower over 100 regions and communities to create long-term, locally led visions for climate resilience.

Concurrently, ARSINOE, with a budget of EUR 15 million and involving 41 partners across 15 countries, seeks to revolutionize regional pathways

to resilience. It delivers innovative, systemic solutions for adapting to climate change across Europe. These projects exemplify the GCH's strategic approach to enhancing societal and environmental resilience, by fostering systemic and innovative adaptation measures.

Inclusion

Finally, inclusion is the foundation upon which we need to base our success at COP28. My experience in many different research projects through the years teaches me how powerful interdisciplinarity and diverse perspectives are in driving transformations, innovation, and solution-building. And this is particularly relevant for challenges of global scale such as climate change.

Hence, our workstreams must be in favor of the diversity of voices, ensuring a gender-balanced and youth-inclusive approach, recognizing the unique contributions of indigenous peoples, local communities, and all non-state actors.

The GCH has a solid commitment to participatory methods and ensures that its pathways are co-designed with an array of stakeholders, including those from underrepresented groups. This dedication to inclusivity not only enriches the climate dialogue but also ensures that the resulting policies and strategies are rooted in the needs and wisdom of all parts of society, reinforcing the shared commitment needed to tackle the climate crisis effectively.

In its commitment to inclusion, the GCH, through AUEB and ATHENA RC respectively, is involved in Horizon 2020's IMPETUS and IntelComp projects, both pivotal in advancing inclusive climate action.

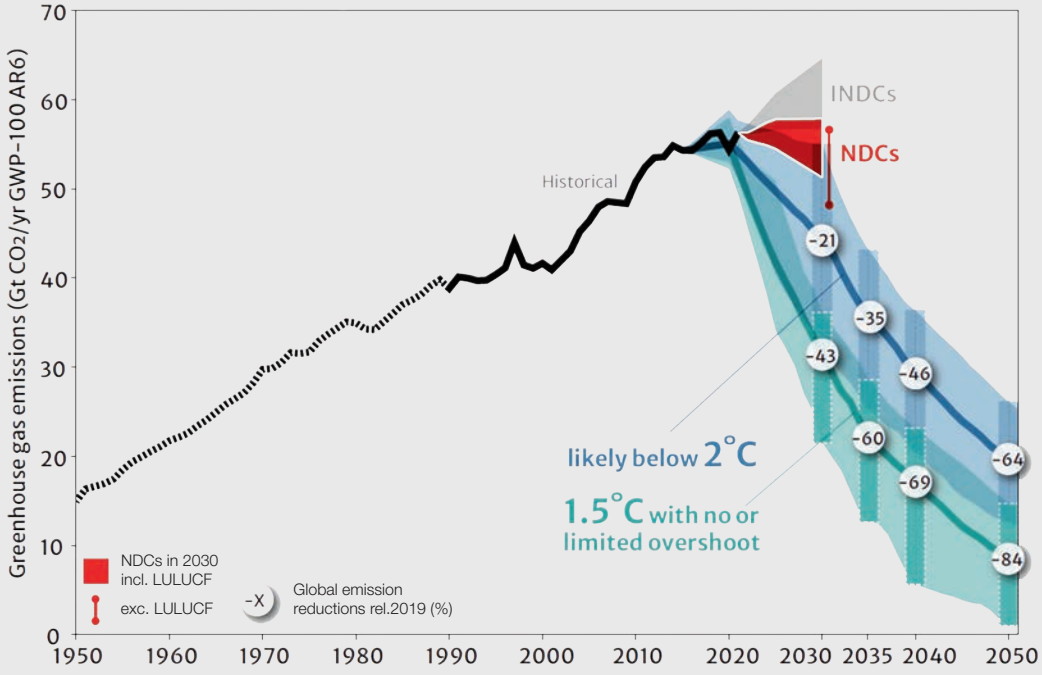
IMPETUS focuses on creating an all-encompassing climate change adaptation framework, emphasizing community-wide involvement and consensus, while fostering a diverse stakeholder community through "Resilience Knowledge Boosters."

IntelComp leverages artificial intelligence to support European policymakers in developing data-driven science, technology, and innovation policies, using a "living labs" approach to engage various stakeholders. Together, these initiatives highlight the GCH's commitment to inclusive, collaborative approaches in shaping effective climate strategies.

A pivotal moment

COP28, like any other COP, is not just a conference, but a pivotal moment of accountability and opportunity. Our commitment at COP28 as the citizens of this planet must go beyond discussions and evolve into concrete, impactful actions that pave the way toward a sustainable, equitable, and prosperous future for all. ■

FIGURE 1: Historical emissions from 1950, projected emissions in 2030 based on NDCs, and emission reductions required by the Sixth Assessment Report of the IPCC



LULUCF = land use, land-use change and forestry

Sources: Technical dialogue of the first global stocktake, FCCC/SB/2023/9, UNFCCC

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Supporting climate action in least developed countries

Despite their limited means, many of the world's poorest countries are leading the way in cutting emissions and taking bold action on adaptation. The rest of the world must step up support for LDCs – and follow their example

By Cassie Flynn, Global Director of Climate Change, UNDP

Climate change is a global crisis that transcends borders, affecting nations regardless of their economic size. However, the impacts of climate change are particularly acute for least developed countries (LDCs) – a group of 46 low-income countries that are highly vulnerable to economic and environmental shocks.

Further impacting their ability to tackle climate change, almost two-thirds of LDCs and low-income countries are either in or at high risk of debt distress. Some of them are facing economic crises and all of them are facing fiscal constraints.

Specific climate challenges facing LDCs

There are several major challenges that limit the ability of LDCs to respond to the impacts of the climate crisis:

1. High levels of climate vulnerability

Despite only accounting for 3.3% of global greenhouse gas emissions, LDCs face some of the greatest impacts from climate change shocks. Due to their unique circumstances, these countries face immense challenges to prevent, mitigate, and recover from these shocks. In fact, more than two-thirds of deaths caused by climate-related disasters worldwide have occurred in LDCs.

2. Lack of access to public and private finance

More than a decade ago, high-income and high-emitting countries committed to provide USD 100 billion every year

◂ Lake Malawi provides diverse ecosystem benefits, is a major source of food, and supports tourism and numerous other economic activities. UNDP's M-Climes initiative is an early warning system that protects the lives and livelihoods of the fishing communities that live around the lake

by 2020 to fund climate action in lower-income countries. However, this pledge remains unmet.

Most climate finance needs in LDCs are related to climate change adaptation. However, 90% of climate finance currently goes to mitigation actions, despite the proven returns and strong economic rationale to invest in adaptation. The adaptation finance gap in developing countries is likely five to ten times greater than current international finance flows, and continues to widen.

LDCs are burdened with immense need for finance while having the least access to private funds. Private investors may see LDCs as too risky or too small and, as a result, LDCs draw fewer investors.

For example, only 2% of private investments in clean energy over the past 30 years have been in African countries, despite the potential the continent carries for powering the world with clean energy. Such blind spots become a huge lost opportunity for LDCs and the world.

3. An international financial system that isn't fit for purpose

Due to their circumstances, LDCs are hugely dependent on official development assistance and public funds. There needs to be a bigger conversation on the global financial system and how it can meet the needs of LDCs. What does it look like to invest in an LDC in a practical way? How can international financial institutions play a bigger role in catalyzing more concessional loans, debt forgiveness, debt-for-climate swaps, and other innovative financial tools? If we want LDCs to be able to get the types of finance that they need to be able to keep their populations safe, it will require a restructuring of the international financial system alongside highly strategic use of public funds.

Not victims of climate change, but champions of climate action

Through UNDP's flagship initiative Climate Promise, which provides support to more than 120 countries on revising and implementing their nationally determined contributions (NDCs) on cutting emissions and adapting to climate impacts, we have seen that LDCs and small island developing states (SIDS) have been the most ambitious in their climate pledges.

Both groups of countries stepped up and did what the world asked them to do, even though they are not high emitters and despite their limited means. The innovation and leadership of LDCs needs to be not only recognized but also rewarded.

For example, Rwanda has demonstrated significant leadership on ambition, as the first African nation and LDC to submit a more ambitious NDC. The country committed to a 38% reduction in emissions by 2030, taking into account its ongoing vulnerabilities.

In Malawi, a project supported by UNDP and financed by the Green Climate Fund known as M-Climes is supporting participatory climate services, advanced lightning detection, solar-powered weather stations, and other advanced technologies to protect lives and build resilience.

In addition, over the past two decades, UNDP has supported developing countries, including LDCs and SIDS, to implement their adaptation priorities – from enhancing food and water security, to increasing the protection and restoration of vital ecosystems, to rolling out vital early warning systems.

Building on the experiences and lessons from a portfolio of over USD 1.6 billion in adaptation projects and programs across 94 countries, including 17 SIDS and 44 LDCs, UNDP continues to support countries to access public and private finance to implement their adaptation priorities, based on the established science and data.

With the support of UNDP, vulnerable LDCs such as Bangladesh, Democratic Republic of the Congo, South Sudan, Sierra Leone, Timor-Leste, Chad, and the Central African Republic have developed their National Adaptation Plans (NAPs) to help reduce vulnerability and strengthen resilience.

Most recently, Bhutan released its NAP, which covers sectors such as agriculture, biodiversity, human health, ecosystems, and several other thematic areas. The NAP includes detailed adaptation actions, with the cost of implementation estimated at USD 14 billion.

It's also critical for LDCs to bring their experiences to the global dialogues on climate change. Through its Progressive Platforms project, UNDP supports LDCs to participate in climate and environment negotiations and mainstream NDC implementation across different sectors. The project has been made possible thanks to the support of the European Commission since 2018 and Norway as of 2022. The program has supported more than 100 representatives from the LDC group.

We have seen strong and tangible results, notably an increase in the number of LDCs and SIDS members participating in international meetings related to climate action. For example, in Senegal and Côte d'Ivoire, civil-society organizations have received training on climate diplomacy, enabling them to effectively participate in the meetings and discussions where their future is being decided.

It's important to remember that while LDCs are acutely vulnerable to climate change, they are also leaders. They are on the frontlines of climate action with ambition and innovation. What the world must do now is follow suit. Developed nations and high emitters must not only recognize LDCs for their creativity and leadership on climate action and follow their example, but also meet the financial commitments they have made to help LDCs scale up their ambitions. ■

Can the Paris Agreement deliver climate justice?

Eight years on, the Paris Agreement's ambition to achieve climate justice appears woefully off course. Can the Sustainable Development Goals, with their emphasis on empowering the most vulnerable communities, help steer the COP process toward redressing the inequity of climate change?

By Yamide Dagnet, Director, Climate Justice, Global Programs, Open Society Foundations

As the first treaty under the global climate regime to mention the concept, the Paris Agreement certainly aspires to deliver "climate justice." Yet, despite the progress made so far, climate plans are insufficient to keep global temperature increase below 1.5°C. The world keeps breaking all records: high-category hurricanes, wildfires, flooding, climate-induced displacements. We are also entering into new territories, with monitoring and early warning systems being tested to the limit, increases in climate-induced diseases, and sea-level rise affecting the statehood of atoll nations.

While no country is immune to the wrath of a warming planet, vulnerable countries and marginalized communities who contributed the least to the problem are suffering the most. This is leading to both global and national climate injustice. Such injustice would be worse without the progress triggered by the Paris Agreement, since every fraction of a degree matters to mitigate the already dire consequences of our planet's warming, including the associated and exacerbated inequality.

The question becomes, therefore: is the Paris Agreement's design enough to achieve the intended just outcomes at scale and at adequate pace?

The answer is no. But the Paris Agreement is not the only forum or process with a role in delivering these outcomes. In fact, its goals were never meant to be achieved in a vacuum, but rather in the context of the Sustainable Development Goals (SDGs) – with all hands on deck!

The Paris Agreement's pre-conditions of success

The Paris Agreement was not conceived to fulfill its promise only with the 200 governments who signed it but rather on a broader ecosystem.

On the one hand, the non-binding nature of the national commitments made the agreement vulnerable to national politics and governance. Countries are not legally required to reduce emissions or achieve the other targets and objectives included in their nationally determined contributions. This means that lack of leadership at the national level can directly undermine the agreement's effectiveness.

On the other hand, the Paris Agreement's binding accountability processes – through its enhanced transparency framework, compliance mechanisms, and global stocktake – relied on a range of domestic and international stakeholders to trigger the right level of pressure on governments, and required enhanced governance and participation, to generate an effective, evidence-based decision-making process. This will be tested through the Paris Agreement's first global stocktake at COP28.

The spirit of solidarity was and still is a critical ingredient to galvanize diplomacy, in good faith, while building trust. Through COP28 the trust and global solidarity deficit on climate must be reduced: the Green Climate Fund should meet its replenishment floor of USD 10 billion, while developed countries' 2009 commitment to mobilize USD 100 billion per year from 2020 must be achieved.

There is heightened expectation for operationalizing and possibly capitalizing the loss and damage fund, which took three decades to be established. All of this is at a time when we should be mobilizing trillions for a green, sustainable, and resilient future. A great chunk of those trillions is out there but must be aligned with the Paris Agreement and SDGs, including phasing out damaging subsidies and retrieving illicit financial flows, while creating fair fiscal space for countries to make the necessary investments for the needed transformation.

By embracing the principles of equity and common but differentiated responsibility, respective capability was essential to transition from the mitigation-focused Kyoto Protocol (with requirements only for developed countries) to a universal agreement. This universal agreement embraced other priorities from vulnerable communities and countries (particularly on adaptation and loss and damage).

© UNICEF/David Hogsholt

▲ A child sits in the ruins of his home on Bohol island, the Philippines. Virtually all the houses in the district were destroyed by Typhoon Rai. It was estimated that 13 million people in the Philippines were affected by this tropical cyclone

Bringing the 5Ps to bear on COP

At the heart of the 2030 Agenda are the five critical dimensions known as the 5Ps:

- People
- Prosperity
- Planet
- Partnership
- Peace

To deliver climate justice, these principles should be fully embraced within the COP process.

People

For decades, climate efforts have been driven by a highly technocratic and carbon-centric approach. This approach has failed to mobilize the hearts and minds of a wide range of stakeholders and leaders to drive systemic change.

A people-centered approach starts by integrating adaptation and the limits to adaptation (tackling losses and damage) along with efforts to cut greenhouse gas emissions. Then, to scale and accelerate the green energy or agriculture transition, we should think of the people who demand and consume the energy or agricultural products, the people who produce and supply them, the people disproportionately affected by the harms caused by our dependence on fossil-fuel-based energy systems, and the unsustainable food system.

We should also pay attention to the people who may be affected by transitioning away from business as usual. This means helping to address past damages and injustices, maximizing women's rights, sharing the benefits for workers and communities, and fostering intergenerational justice. All this needs to be translated into national, local, and global communication strategies, storytelling, and campaigns based on movement-building and organizing.

Prosperity

A renewed sense of solidarity is paramount to move from a burden-sharing mindset toward a vision of shared prosperity.

To achieve this vision, we know that we need to mobilize and make accessible finance, specific technologies, human capacity, and know-how. But, as highlighted under the Bridgetown Initiative and by the Vulnerable Group of 20 (V20), equitable mobilization and access to investments

at adequate scale and speed will not be possible without a profound, structural reform of the financial and debt system (which currently relies on colonial legacy). It will also require a fairer distribution of windfall profits from fossil-fuel companies and other carbon-intensive sectors. Trade, a significant contributory factor to climate change, must also be harnessed to share prosperity while also furthering climate action.

Meanwhile, we cannot ignore the risk of creating new injustices and vulnerabilities if we fail to address pre-existing structural drivers of injustice in energy markets, industrial supply chains, or land ownership and rights. It is therefore imperative to include greater engagement with social justice issues when reforming or establishing procedures and institutions. This should be done through enhanced participation, country and community ownership of strategies and implementation plans, and effective accountability mechanisms.

Planet

If we are serious about protecting the planet, we cannot keep on using "more physical resources and produce more emissions than nature is capable of supplying in a sustainable manner" (to quote 'The Limits to Growth'). We need a different approach to managing our planet's natural resources, one that promotes a more circular economy and supports the needs of both present and future generations. This approach cannot rely on technology alone – doing so risks delaying the fundamental and necessary consumption and behavioral changes, as well as the decision-making, needed to prevent us spiraling into more unsustainable territories.

It also means creating the right guardrails and global governance to minimize the unintended adverse effects that climate-action measures and technologies could have. For example, critical transition minerals needed to scale up the use of renewable energy highlight the need to take a people, prosperity, and planet-centered approach. This sector holds immense potential for economic growth in resource-rich nations. However, past experiences have linked natural-resource sectors to human rights abuses, economic exploitation, and governance failures. A just transition necessitates new economic models and policies, focusing on value addition in mineral supply chains and technology transfer. Yet it must also reconcile with the protection of activists, the welfare of vulnerable communities, people's rights in land use, labor rights, protection of conservation areas and cultural sites, and the equitable participation of resource-rich nations in decision-making.

> ***"The success of Paris depends on interconnected global efforts and commitments***

Partnership

Climate change also pushes us to contemplate collaborative and integrated governance across diverse governmental levels and societal sectors. Given that climate change is a global predicament demanding collective action across borders, conventional governance structures may lack the capacity for such extensive collaboration. It will be critical to strengthen these structures while also strengthening or fostering new transformative coalitions (or clubs) to create "a race to the top."

Meanwhile, 2,180 climate-related litigation cases have been filed in 65 jurisdictions as of December 2022, with a steady increase from 884 in 2017 to 1,550 in 2020. Children, youth, women's groups, local communities, and indigenous peoples are leading these cases and driving climate change governance reform in more countries. Litigating climate justice at the national and international level is a promising, alternative civil (or complementary regulatory) channel to pursue specific climate-justice causes.

Peace

This dimension requires a better understanding of the nexus between climate, conflict, fragility, and development. Indeed, as highlighted in the Intergovernmental Panel on Climate Change's 2023 Synthesis Report, climate change can be a conflict multiplier as it could trigger unforeseen conflicts or exacerbate existing ones. This is particularly evident when climate effects constrain resources: droughts or floods can create drinking water scarcity or impact food supply, heightening poverty. These effects are felt disproportionately by those already in the most vulnerable and conflicted situations.

Least developed countries and small island developing states are on the frontlines of the climate crisis. Many of these countries' people and communities are affected by fragility or conflict, or face high humanitarian needs and insecurity. They also have the least resources to cope with and adapt to such shocks and stressors. This issue will be highlighted for the first time prominently by the COP28 Presidency to foster investment in anticipatory action and adaptive development in these communities.

A new Marshall Plan

In conclusion, while the Paris Agreement is a key tool in combating climate change, it is not enough to achieve global transformation alone. The success of Paris depends on interconnected global efforts and commitments: not just governmental compliance but also active participation involving a wide range of stakeholders.

Achieving equity and shared prosperity requires a comprehensive integration of the SDGs into the COP process and adherence to the 5Ps. As COP28 approaches, renewed global commitment and solidarity – like a new Marshall Plan – are required to address the urgent needs of vulnerable communities and ensure a sustainable future. ■

Planning for an orderly exit from fossil fuels

As energy systems decarbonize, ensuring a smooth transition to renewables will be critical for the economies and workers that currently depend on fossil-fuel-based generation. How can we move quickly while leaving no one behind?

By Wei-Jen Lee, Professor, Department of Electrical Engineering, The University of Texas at Arlington; and Jaideep Sandhu, Chief Technology Officer, Renewables Global Business Unit, ENGIE

In its 2018 special report, the Intergovernmental Panel on Climate Change warned that to limit the average global temperature rise to 1.5°C, the world would need to achieve net-zero carbon emissions by 2050. Many countries have pledged to

▲ The monumental sculpture, Angel of the North, sited on a former colliery in Gateshead, UK. The artwork is intended as a memorial to coal mining, which dominated the region for 200 years. The UK's former coal-mining areas suffer higher rates of poverty and people out of work decades after the pit closures

take the necessary steps to curb the temperature rise to 2°C. Others have gone further and committed to action to reach the 1.5°C target set at the UN climate summit in Paris.

COP26 in November 2021 concluded with nearly 200 countries agreeing the Glasgow Climate Pact to keep 1.5°C alive and finalize the outstanding elements of the Paris Agreement. On the opening day of COP27, a year later, UN Climate Change Executive Secretary Simon Stiell called for aligning "every corner of human activity" with the 1.5°C goal, saying: "Paris gave us the agreement and Katowice and Glasgow gave us the plan. Sharm El Sheikh shifts us to implementation."

With that 1.5°C goal now front of mind, the transition to a more sustainable, low-carbon future is accelerating. Central to this is the energy transition: the progressive replacement of carbon-based fuels with alternative energy, notably renewables and nuclear.

The International Atomic Energy Agency notes that there are over 80 types of small modular reactor (SMR) designs and concepts under development, albeit in a few countries. But these SMRs are not likely to be available at scale until the 2030s.

Renewables are therefore the most important alternative energy resources at present.

Why orderly?

An orderly exit of fossil-fuel generation is a crucial step toward creating a sustainable and decarbonized energy system. A disorderly exit, by contrast, could lead to a range of negative consequences, from mass unemployment to power blackouts.

Yet exit we must. However, various barriers exist to moving away from fossil fuels, including:

- the fact that fossil-fuel infrastructure has a remaining usable life
- the need to achieve a return on investment
- contractual commitments, such as existing power purchasing agreements
- the need to achieve cost-effective flexibility in production
- the need to achieve energy system stability and adequacy

"Moving from fossil-fuel to renewable generation will change the pattern of the power flow. We will need to upgrade, expand, and improve the management of existing transmission and distribution infrastructure

Addressing and navigating these complex issues will require careful management. We will need to establish policies, regulations, and financial models to achieve an orderly exit. We will also need to apply a variety of new technologies, such as:

- carbon capture, usage, and storage
- hydrogen-blended natural gas, or hydrogen generation
- (in some cases) blending biomass and hydrogen-based fuels in coal-fired plants

An orderly, managed transition of fossil-fuel generation should therefore be seen as a necessary step in the overall transformation of energy. Ultimately, it will help to deliver the transformation more quickly and cost-effectively, and ensure the stability, adequacy, and resiliency of the networks until other technologies (such as energy storage, extensive demand-side management, and smart grids) have been deployed at the scale necessary to fully support a decarbonized energy system.

Moving from fossil-fuel to renewable generation will also change the pattern of the power flow. We will need to upgrade, expand, and improve the management of existing transmission and distribution infrastructure. And, to improve the efficiency and reliability of the system, we will need to deploy smart grid technologies such as intelligent electronic devices, flexible alternating current transmission system (FACTS) devices, dynamic line loading management, digitalization, and energy storage systems.

Renewable challenges

Deploying renewable energy technologies is the right and inexorable pathway to achieving the goal of zero-carbon emissions. However, simply deploying more weather-reliant technologies, mainly solar and wind, presents challenges to power system reliability and resiliency for normal operations.

One such challenge is maintaining stability if parts of the system fail. Traditional power systems – based on fossil, nuclear, and hydropower – store energy in their rotating generators, a feature called inertia. When large power plants fail, inertia causes them to continue rotating and generating power. This only happens for a few seconds but it is sufficient time for the grid to detect the failure and respond. Current grids tend to have an abundance of inertia.

However, many renewables are integrated into the grid through inverter-based resources that do not inherently provide inertia. In addition, while inverters provide new dimensions of controllability, they also increase the complexity of operating the grid. High-level penetration of inverter-based renewable energy therefore poses challenges to system operation and protection. So it's critical that we understand and provide solutions for running stable, low-inertia power systems.

Battery energy storage systems (BESS) and hydrogen-based power

systems are considered game-changers. They have huge potential to capture renewable energy whenever it's available and use it on demand. In other words, they can transform the intermittent nature of renewable energy into dependable sources. Through proper control, storage systems can provide very fast voltage or frequency support and offer synthetic inertia to reduce rates of change of frequency (RoCoF).

Adding the required amounts of storage, however, will require regulatory support and suitable grid connections, and will take time. It will be very expensive to achieve full network storage support in the near to mid-term future. In specific cases, it may be feasible to convert existing fossil-fuel generation into carnot batteries (that hold electricity through thermal storage) or into synchronous condensers.

The market share of standalone and hybrid systems (combined renewables, hydrogen, and battery) continues to rise. These systems will play an increasingly important role in the energy market, helping to reduce greenhouse gas (GHG) emissions, providing dependable, zero-carbon energy, and improving the reliability and resiliency of the system (by boosting virtual inertia and reducing RoCoF).

Ethics of innovation and implementation

Even when technology is backed by good intention, history shows us that it can have unintended consequences. Mark Zuckerberg didn't start Facebook anticipating that third-party abuse and political interference would run rampant on the platform.

It's therefore important to establish guiding principles to create socially responsible innovation and implementation. The energy transformation must ensure:

- justice and equity for workers and energy users
- sustainable development
- science-based decision-making
- collaboration and partnership
- transparency and accountability

Providing access to renewable energy to all communities is obviously the ethical, sustainable, and environmentally responsible approach. Yet we should also keep in mind several sector-specific factors if we want to ensure as smooth a transition as possible, minimizing unintended consequences.

// Achieving an orderly and seamless exit from fossil-fuel generation will take a coordinated and sustained effort. Establishing a holistic approach… will help ensure the transition is successful

For example, renewable energy projects have social and economic impacts on local communities. These can include making energy less affordable for low-income households or creating redundancies in traditional sectors like coal mining. We must ensure that communities benefit from the opportunities the transition will offer, such as the creation of new jobs and the development of workforce skills needed to build and operate the low-carbon means of generation.

Other concerns include land acquisition, a serious problem that can arise in the context of renewable energy development. Multifunctional land use can be an effective strategy for developing renewable energy while minimizing land-use conflicts. And it's also critical that the transition avoids carbon leakage (where a reduction in emissions in one country or sector leads to an increase in emissions in another).

New skills, new jobs

Traditional, carbon-based electrical generation may play a significant role in some nations' and regions' economies and job markets. Exiting from these industries will require dedicated efforts at reskilling workers and in local industrial development. It also offers an opportunity to create a raft of new jobs.

How the energy transition proceeds over time will determine which skills and jobs are needed through the various phases. Many of the jobs required for the energy transition, such as those in renewable energy, energy storage, and digital solutions, require specialized skills that are not currently widely available in the workforce.

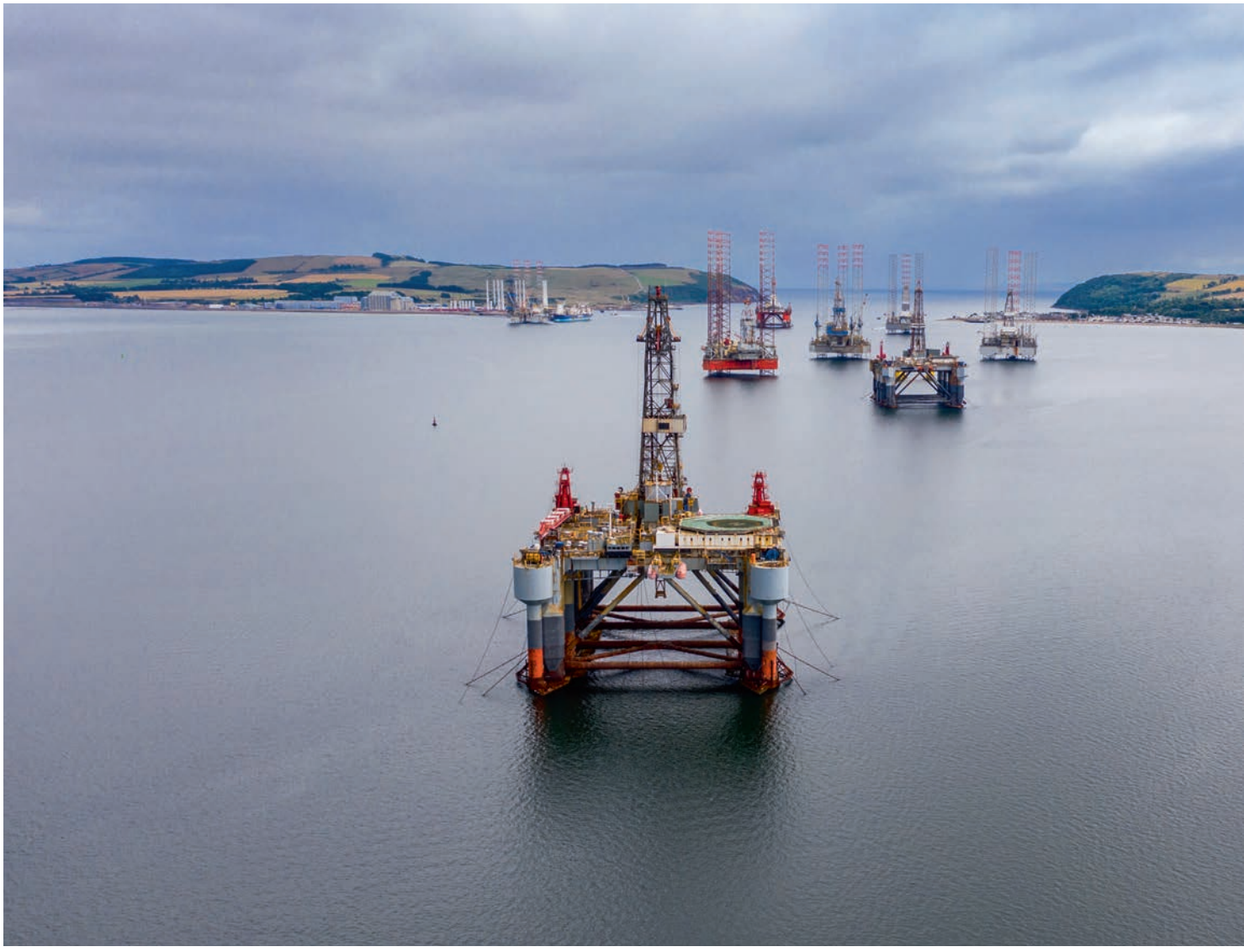
Developing trained, qualified, and certified workers is critical to achieving a successful, timely, and sustainable transition. Bridging the skills gap will require targeted training programs, apprenticeships, and upskilling opportunities. At the same time, these should also foster workforce diversity, alleviate regional disparities, enable innovation, and accelerate digitalization.

Building a skilled workforce for the energy transition therefore requires significant coordination and corporation among governments, universities, training institutions, and the private sector to ensure certified development programs for the workforce will be delivered.

Conclusion

Transitioning to renewable energy generation is a multifaceted process that requires careful planning and execution. Achieving an orderly and seamless exit from fossil-fuel generation will take a coordinated and sustained effort.

Establishing a holistic approach, one that creates roadmaps to meet the needs of specific nations or regions based upon local conditions, will help ensure the transition is successful. While the challenges are significant, rising to them is essential if we're to mitigate the impact of climate change and create a sustainable energy future. ■



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The false dilemma between economy and planet

There is a growing chorus calling for delays to net-zero initiatives, blaming climate action for the current cost of living crisis. In reality, green investment can offer a path out of the economic troubles that have been building since the start of the century

◂ Oil rigs awaiting decommissioning or maintenance in Cromarty Firth, Scotland. The UK, in response to its struggling economy, has recently reneged on previous net-zero commitments and approved new drilling licenses for the Rosebank oil and gas fields, located off the Shetland Islands

By Phoebe Koundouri, Professor, School of Economics, Athens University of Economics and Business; Professor, Department of Technology, Management and Economics, Technical University of Denmark (DTU); Chair, UN SDSN Global Climate Hub; Co-Chair SDSN Europe; Director, SDU, ATHENA Information Technologies Research Center; Dogan Keles, Professor, Department of Technology, Management and Economics, DTU; Konstantinos Dellis, Postdoctoral Researcher, Athens University of Economics and Business; Postdoctoral Researcher, SDU, ATHENA Information Technologies Research Center; and Conrad Landis, Research Fellow, Athens University of Economics and Business

Almost two decades on from the period aptly described as the Great Moderation for advanced economies (the mid-1980s until around 2007), the global financial crisis of 2007–09, the COVID shock, and the resurgence of inflation have ushered in a new era of uncertainty, underpinned by the ever more imminent climate crisis.

// A bold and targeted policy response from governments and international institutions could turn the energy crisis into an opportunity for catalyzing the green transition

Inflationary pressures in the developed world, especially in the EU, have been predominantly triggered by the surge in energy prices in the second half of 2021 and early 2022. An array of factors (discussed below) contributed to a significant overshoot of inflation targets in the EU and the US.

The implications are severe for all economic sectors and are also putting at risk critical green investment. Government support to citizens in times of need, combined with monetary tightening, is putting the transition to net zero in peril. A resurgence of austerity in advanced economies is also expected to provoke resistance to necessary measures for the green transition, such as carbon taxes.

Nonetheless, a bold and targeted policy response from governments and international institutions could turn the energy crisis into an opportunity for catalyzing the green transition. The high costs of fossil fuels and supply disruptions have strengthened the spread and competitiveness of renewable energy sources such as wind and solar power. Targeted policies, incentives for increases in renewable energy capacity, and international cooperation could alleviate the adverse impact of high energy prices and align with climate goals toward net zero.

A perfect storm

Gas prices began to skyrocket in the summer of 2021. Indeed, the price of gas on the major European gas trading hubs had tripled by October 2021 compared with a year earlier, even before the invasion of Ukraine in February 2022 pushed prices still higher. The primary reason was the worldwide economic recovery after COVID-19, which increased global gas consumption, while investments in upstream gas production had remained constant since 2015.

The onset of war exacerbated worldwide gas shortages, since supplies from Russia to its primary import zone of Central Western Europe (CWE) initially fell to a tiny percentage of pre-war levels – and eventually ceased entirely after the Nord Stream pipelines were attacked. The unexpected decline in supply resulted in unprecedented shortages in gas markets and a price spike to over EUR 300/MWh (15 times pre-crisis levels). This, in turn, had an adverse impact on European electricity prices.

Combined with power plant maintenance shutdowns (almost half of France's nuclear capacity was out of service for extended periods in the fall and winter of 2022–23), this resulted in price spikes of several hundred euros per MWh throughout Europe on the CWE electricity market. The massive

spike in wholesale market prices also resulted in rising consumer energy bills, sparking a heated political debate over how to shield EU residents from these turbulences.

To fight rising energy bills, the EU Commission and other member states have suggested or implemented gas price caps at various levels. On the one hand, the EU Commission has proposed a "dynamic price limit" on the TTF (Title Transfer Facility) energy exchange in the Netherlands – the key wholesale market hub for gas. On the other, some member states have proposed gas price caps on retail pricing (for example, Germany imposed a cap for consumer gas prices at 12 euro-cents per kWh under certain conditions). The purpose is to provide affordable electricity to struggling businesses and households. Whether these measures are effective and reasonable in the long term, however, remains open to debate.

Moreover, food prices have increased substantially and have exhibited a lagging effect. Annual food inflation in the EU reached 15.5% in March 2023 and remained in double digits throughout the summer.

Other contributors to inflationary persistence (albeit with declining headline rates) have included:

- on the demand side: robust spending, boosted by widespread income support measures in both the US and EU
- on the supply side: a marked concentration in product markets (less competition) allowing firms to maintain or increase profit margins by passing high input costs onto consumers

The decisive response of monetary policy tightening across the two sides of the Atlantic has tamed inflation to a certain extent. However, it also raises the risk of undermining the economic recovery after COVID. Both the International Monetary Fund and the European Commission have revised their growth projections downwards. Crunching liquidity meanwhile has started to hamper consumption and investment in advanced economies.

> ***"The sharp reversal in lending rates and the concomitant fragmentation in money and capital markets could have the exact opposite effect in a period where financing climate change mitigation and adaptation is so vital***

Sectoral repercussions

The first and most salient effect of surging energy prices is the cost-of-living crisis. Headline inflation rates have been rising across the globe, overshooting the 2% targets set by the US Federal Reserve, the European Central Bank, and the Bank of England. The European Commission expects baseline inflation to stabilize at 6.7% this year and drop to 3.2% in 2024, still notably above the 2% target.

Inflationary pressures have been driven predominantly by the skyrocketing gas prices discussed above, but core inflation has remained above 5% even after the normalization in the second quarter of 2023.

In the EU, particularly, 2023 growth projections have been revised down to 0.8% from 1% in May, based on subpar manufacturing performance, inflationary headwinds, and low external demand, mainly due to China's poor economic recovery.

As policymakers are agile and expect second-round effects driven mostly from wages, the monetary stance is not expected to change over the next year or so, and communication by central bankers is underlining this continuation of monetary tightening.

High (and rising) interest rates hinder investment and can especially deter the financing of the green transition. Projects associated with climate change mitigation and adaptation are characterized by high capital expenditure and elevated uncertainty.

The persistence of exceptionally low interest rates after 2010 was one of the decisive factors fueling unprecedented progress in investment for the green transition. For example, favorable financing conditions following expansionary monetary policy in most economies contributed to the steep drop in the levelized cost of electricity (LCOE) of renewable energies, thus bringing the cost of electricity production from renewable sources to level terms with traditional, fossil-fuel-based power plants.

The sharp reversal in lending rates and the concomitant fragmentation in money and capital markets could have the exact opposite effect in a period where financing climate change mitigation and adaptation is so vital.

According to the International Energy Agency (IEA), the LCOE of a power plant running on natural gas would change only marginally after a 100% increase in discount rates, whereas the increase for a facility using offshore wind following the same rise in rates would be around 45%. These challenges only compound the inherent risks of green investment and the high uncertainties underpinning climate change and its effects on human life.

In addition, regulatory and fiscal measures to support the green transition can create higher costs for private corporations, who may pass these costs onto consumers. This can generate an inflationary feedback loop, which in turn can stifle green innovation and create an unwelcoming environment for key environmental policies.

Finally, surging energy prices and the accompanying cost-of-living crisis faced by many citizens have spurred fiscal measures to support disposable

income. Bolstered by flagship initiatives like the Inflation Reduction Act in the US and the Recovery and Resilience Facility in the EU, governments have allocated non-negligible amounts to citizens. This encouraging development, however, implies that funds are being shuffled away from green investment, where tangible results will only be seen in the long term and entail an element of uncertainty.

As the need to tame high levels of public debt grew during the pandemic-induced "grace period," tight fiscal measures in an inflationary environment are likely to induce public disillusionment toward climate targets. Disenchanted with fiscal austerity, we could well observe increased public resistance to much-needed climate policy interventions such as a carbon tax, and the growing appeal of populists downplaying the effects of climate change.

Accelerating the transition

Despite the multifaceted, adverse impact of the surge in energy prices since 2021, the crisis could offer an opportunity to accelerate the switch to clean energy and align with the green transition and the Sustainable Development Goals (SDGs). As discussed, electricity generation from renewables is already competitive compared with production using fossil fuels.

According to the IEA, battery innovations have driven up the average range of electric vehicles from 127km in 2010 to 349km in 2021. The price of solar panels, meanwhile, fell 99.6% between 1997 and 2020. Even without new, targeted policies, demand for the three fossil fuels (carbon, oil, and gas) is expected to peak during the current decade.

Investment in renewable energy, policies aimed at behavior change, and incentives to shift to production and consumption based on renewable energy can act as the start of a virtuous rather than a vicious cycle. Reliance on fossil fuels, especially natural gas, exacerbated the energy crisis after 2021 and was a result not just of geopolitics but also of short-sighted economics.

To avoid making similar mistakes, we must balance the need to alleviate the cost-of-living crisis with the imperative to avoid an implosion of climate change action. The effectiveness of the green transition will depend on policy design, implementation, and monitoring.

REPowerEU – the EU's plan to rapidly reduce dependence on Russian fossil fuels – is a step in the right direction. It diversifies the EU energy supply, enhances buffers for future shocks, and, perhaps more importantly, provides incentives for renewable energy. In 2022, 39% of EU electricity was produced by renewables. In 2023, the EU raised its binding target for renewable energy as a proportion of total energy consumption to 42.5% for 2030 – almost a doubling of the existing share of renewable energy in the EU.

Meanwhile, the Net Zero Industry Act – also heavily influenced by the energy crisis – aims to promote investment in Europe's manufacturing capacity of net-zero technologies. The act aims to:

- amend regulations to minimize administrative cost for net-zero manufacturing projects
- incentivize green innovation through open access to scientific knowledge and information and regulatory "sandboxes"
- simplify access to public procurement schemes to ensure that green projects are competitive

Across the Atlantic, the Inflation Reduction Act will allocate USD 369 billion over 10 years to support renewable energy capacity, emissions abatement, and environmental justice. The measures include tax incentives and subsidies for electric vehicles, heat pumps, batteries, nuclear power, clean hydrogen generation, wind, and solar energy.

A global effort

The critical shift toward renewable energy, which would have the joint effect of mitigating inflationary pressures and promoting the green transition, cannot be achieved without international cooperation. The need for cooperation is enshrined in the last – but not least – SDG (17) and is of utmost importance in this case.

As the Intergovernmental Panel on Climate Change outlines in its 2023 Synthesis Report: "Climate resilient development integrates adaptation and mitigation to advance sustainable development for all and is enabled by increased international cooperation including improved access to adequate financial resources, particularly for vulnerable regions, sectors and groups, and inclusive governance and coordinated policies."

Incentives for green innovations and renewable energy that are commingled with disincentives for brown technologies and fossil fuels will not suffice in a 21st century beggar-thy-neighbor environment. Bypassing climate legislation by changing jurisdictions cannot be a viable option for polluting firms. International cooperation on a carbon tax and harmonization of carbon markets (as in the EU Emissions Trading System) is a difficult, yet pivotal, task for the international community. ■

> ***"Investment in renewable energy, policies aimed at behavior change, and incentives to shift to production and consumption based on renewable energy can act as the start of a virtuous rather than a vicious cycle***

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The perfect storm: how climate change and malaria converge

Climate change is extending the reach of malaria. Medicines for Malaria Venture (MMV) is working with partners in malaria-endemic countries to adapt, anticipate, prevent, and treat the disease

By André-Marie Tchouatieu, Director, Access & Project Management, Medicines for Malaria Venture; and Doreen Akiyo Yomoah, Communications Officer, Medicines for Malaria Venture

Dorcas Dako from Ségou, Mali, walks several kilometers a day during the rainy season. As a community healthcare worker (CHW), she goes door to door to administer seasonal malaria chemoprevention (SMC), an intervention that protects children in areas where malaria transmission is highly seasonal (transmitted during the annual rainy season typically lasting up to 4 months).

Since SMC was first implemented in 2013 following the World Health Organization's (WHO) recommendation, the intervention has saved the lives of many children in sub-Saharan Africa: in 2022 alone, SMC protected 48 million children from malaria. Preventive interventions like SMC, intermittent preventive treatment of malaria in pregnancy (IPTp), and perennial malaria chemoprevention (PMC), as well as medicines that treat the disease, all contribute to the United Nations Sustainable Development Goals (SDGs), specifically Target 3.3.[1] However, the extent to which these interventions can save lives is under threat due to climate change.

Health and climate change are inextricably linked

The links between health, disease, and climate change are inextricable. According to WHO, climate change affects the social and environmental determinants of health. Several factors determine the degree to which an individual's or a community's health is at risk, such as where they live; their gender, race, and age; what they do for work; and their socio-economic status.

The effects on people's health have already been observed by experts. Unjustly, those who are the most at risk of climate-change-related ill effects on their health are those who have the least wealth and have contributed the least to climate change while also risking being left behind by climate adaptation and mitigation measures. This phenomenon is known as a "triple injustice." As the global health community reckons with its inequitable history, people in developing nations must not continue to bear the brunt of the changing climate.

Natural disasters that exacerbate health inequities are occurring with greater frequency, especially in developing nations that may not have the infrastructure to cope with the aftermath. Extreme flooding like that observed in Pakistan in 2022 and following Cyclone Freddy in Madagascar, Malawi, and Mozambique resulted in increased cases of malaria and other water-borne diseases, straining resource-stretched health systems even further.

Even in the absence of extreme natural disasters, shifts in rainy and dry seasons, and changes in where disease-carrying vectors can survive have resulted in expansion of disease.

Malaria and the climate

Despite progress over the last two decades in eliminating malaria, there were 247 million people affected by malaria and over 600,000 deaths in 2021 according to the latest World Malaria Report. Ninety-five per cent of these cases and deaths are in Africa and primarily affect children under the age of five.

The relationship between malaria and climate change is a complex one. Malaria, a mosquito-borne infectious disease caused by the *Plasmodium* parasite, is highly influenced by both temperature and precipitation levels. Experts estimate that by 2027, annual average global temperatures are likely to reach 1.5°C above pre-industrial levels. Consequently, malaria is projected to be seen in highland East Africa and at higher latitudes in Southern Africa, while its prevalence in West and Central Africa will decrease as temperatures become too hot for mosquitoes to survive.

At the same time, changes in rain patterns can create fertile breeding sites for the *Anopheles* mosquitoes that transmit malaria, and in combination with increased temperatures, could lead to an extended transmission season. In addition, the migration of *Anopheles stephensi*, a mosquito species that carries the malaria parasite and is native to South Asia, has been observed in East and West Africa. Unlike other malaria-carrying species, it thrives in urban areas, exposing more people in different geographies to illness.

While malaria is both preventable and treatable, administration of SMC, IPTp, PMC, and other preventive interventions, as well as providing medicines to treat the disease, requires resources and infrastructure. If the necessary infrastructure is not in place, millions more could be at risk of this deadly disease.

Addressing climate change in malaria control and elimination

Achieving the SDGs, which will expire in 2030, requires all hands on deck. Complementary actions that strengthen disease prevention measures must be taken in parallel to adapt to climate change.

First, investment in data collection to enable a better understanding of climate patterns will enable countries to optimize the timing and duration of prevention campaigns. Second, although there are several effective methods of preventing and treating malaria, such as indoor residual spraying, use of insecticide-treated bed nets, prevention campaigns, and effective case management, there is no silver bullet that will eradicate it. Continued investment in R&D to develop flexible, adaptable, and complementary tools to prevent and treat malaria is necessary to save lives, while national health programs must be supported to adapt key interventions to evolving needs resulting from climate change.

Medicines for Malaria Venture (MMV) is a product development partnership whose mission is to reduce the burden of malaria in disease-endemic countries by discovering, developing, and facilitating delivery of new, effective, and affordable antimalarial drugs. In collaboration with partners, MMV is working to model malaria transmission patterns and better tailor campaigns to help adapt to the effects of shifting climate patterns on malaria transmission.

Climate change has the potential to undo years of progress against malaria. To avert a major crisis, governments, global health actors, climate and meteorology experts, and the international development community must ensure that sufficient investment, political commitment, and strong coordination between stakeholders are established to be able to put an end to malaria. ■

1. By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases.

MMV Medicines for Malaria Venture

SDG Action thanks MMV for its generous support for this publication

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Bridging the SDG funding gap in cities

The global development finance system is failing cities, yet it's in urban centers where much of the work on climate action and sustainable development must happen. Bold, urgent, and practical solutions – including new, city-focused funds or institutions, MDB reform, and other global, national, and local reforms – could expand and improve urban SDG finance

By Eugénie L. Birch, Nussdorf Professor and co-Director, Penn Institute for Urban Research, University of Pennsylvania; Mauricio Rodas, Visiting Fellow, Penn Institute for Urban Research, University of Pennsylvania; Former Mayor, Quito, Ecuador; and Eamon Drumm, Senior Program Officer, SDG Transformation Lab, Sustainable Development Solutions Network (SDSN)

◂ Work on the regional rapid transit system (RRTS) network between Delhi and Meerut in Uttar Pradesh, India. Delhi is among the fastest-growing cities in the world. Delhi's conurbation has an estimated population in excess of 32 million, growing by over 800,000 per year

In 2019, UN Secretary-General António Guterres stated that "cities are where the climate battle will largely be won or lost." He based this declaration on the facts that the world's population is increasingly urban: by 2050, 68% of the global population – or 6.6 billion people – will live in cities. Most of this growth will take place in cities in Asia, Africa, and Latin America.

Economic activity and its impacts are concentrated in cities, which generate both 80% of global gross domestic product and 75% of CO_2 emissions. The Organisation for Economic Co-operation and Development (OECD) estimates that 65% of the 169 Sustainable Development Goal (SDG) targets cannot be achieved without involving subnational governments, including cities.

Rapidly growing cities need to provide housing, facilities, and services for residents while also mitigating and adapting to the impacts of climate change. Infrastructure – from drainage and wastewater treatment facilities to transportation and logistical systems, flood protection, urban landscape design, and a range of other built and nature-based solutions – must simultaneously contribute to the sustainable development of cities and itself be resilient, faced with climate change. Yet, there is a critical lack of financing for such projects.

Why are urban projects underfunded?

The answer lies in several reasons. First, an inadequate amount of money is flowing to cities for sustainable development projects. The World Bank estimates that, globally, cities need to invest USD 4.5 to 5.4 trillion per year, including a "9% to 27% premium to make this infrastructure low emission and resilient to climate change impacts."

Much of this demand is concentrated in cities in developing countries: the International Finance Corporation estimates that USD 29.4 trillion will be needed in cities in emerging economies between 2018 and 2030 to meet climate targets. At current levels of investment, this represents a shortfall of USD 350 billion per year. There needs to be a large increase in public, private, and philanthropic financing for it to be met.

Second, cities face institutional, fiscal, and regulatory challenges as well as administrative constraints that can hamper investment. Many cities have difficulty or are legally unable to borrow, raise taxes, or mobilize private investment. Municipalities sometimes lack technical capacity to develop and deliver projects, nor do they always have development plans aligned with the SDGs and Paris Agreement.

Finally, cities frequently do not have adequate creditworthiness levels to access finance, something that is particularly visible in the developing world. And their dependency on transfers from national governments means funding for infrastructure projects can be jeopardized by differing local and national political priorities.

Moreover, political rivalries between national and local authorities often prevent cities from receiving national sovereign guarantees required for international borrowing. There are many instances of local-level political leadership on this issue, but coordination and cooperation at the national level and internationally remain challenging in the face of vested interests.

Indeed, national governments are the main beneficiaries of finance for sustainable development. Multilateral development banks (MDBs) were designed with countries in mind, not cities. (A few development banks have city-oriented programs, such as the European Bank for Reconstruction and Development's Green Cities program, but they are still small in scale).

Yet it is cities that are increasingly on the frontlines of climate change. They are close to the needs of their populations and understand how investment can contribute to tangible sustainable development outcomes. The question now is how to scale up and institutionalize reforms to expand cities' access to finance.

Finding practical solutions for urban SDG finance

Fortunately, now is the right time for practical proposals. World leaders are discussing reforms to the global financial architecture. UN Secretary-General Guterres called on the G20 to commit to a decisive SDG Stimulus.

The Summit for a New Global Financial Pact in June 2023 focused on making the global financial architecture work better for developing countries, following the demands of the Bridgetown Initiative. And encouragingly, in September 2023, the G20 Leaders' Declaration mentioned cities as key stakeholders for the first time. It called for innovative urban development and financing models and advised development finance institutions and MDBs to follow guidance from the G20-OECD report on 'Financing Cities of Tomorrow.'

These matters demonstrate that national governments are slowly acknowledging the critical role cities can and will increasingly play in delivering sustainable development.

Turning this momentum for reform into practical recommendations is the work of the new SDSN Global Commission for Urban SDG Finance. Launched during the recent Summit for a New Global Financial Pact, the commission is chaired by Anne Hidalgo, Mayor of Paris, Eduardo Paes, Mayor of Rio de Janeiro, and Jeffrey Sachs, President of SDSN.

The commission's Secretariat is hosted by the University of Pennsylvania's Institute for Urban Research. The commission convenes 12 mayors from cities in high, middle and

lower-income countries, a wide range of researchers and scholars, climate and finance experts from both public and private sectors, and city network leaders to develop and champion innovative ideas and solutions for increasing urban SDG finance.

The commission will issue initial recommendations ahead of COP28, where city and other subnational government leaders will discuss sustainable finance at the Local Climate Action Summit. Its final report will be delivered by summer 2024 in advance of the UN Summit of the Future, the G20 meeting in Brazil, and COP29.

Governments, finance institutions, UN leaders, and the private sector need clear action items for how to expand and improve urban SDG finance. Multi-level and sectoral governmental cooperation and coordination – essential features for meeting climate and development goals – require meaningful financial support. To this end, the commission will deliver specific recommendations in the following critical areas:

1. Reforming MDBs to better address city needs

The current MDB reform process becomes an opportunity to increase funding to cities. This should involve risk-reduction mechanisms and technical assistance to increase subnational government creditworthiness. It calls for tools that incorporate blended finance, expanded use of guarantees, and new direct financial facilities for cities. The commission will examine how these recommendations align with current proposals to reform the global financial architecture, including the Bridgetown Initiative, the Report of the Independent High-Level Expert Group on Climate Finance, and with MDBs' country-level strategies.

2. Strengthening existing funds and institutions – and creating new ones

Bold reforms to institutional structures and enabling environments for cities are also in focus. Existing institutions (such as the Green Climate Fund, the Global Environment Facility, and the International Monetary Fund's Resilience and Sustainability Fund) could increase their funding to subnational governments.

New funds to offer greater direct investment to subnational governments through public utility companies, special purpose vehicles, and public–private partnerships are also a subject of discussion. Finally, an examination of the possibility of creating a city-focused financial institution is underway.

All these funding sources have the potential of offering cities direct concessional credits, loan guarantees, blended finance packaging, lending in local currencies, technical assistance for project preparation, and a curated pipeline of robust projects for private sector investment, among other services.

3. Attracting more private investment

Under the right conditions, a larger part of the USD 133 trillion bond market could be dedicated to green, social, and sustainability bonds. The private sector – pension funds, insurance companies, investment funds – philanthropies, and multilateral and national development banks can be players in this market.

Reinforcing mechanisms for delivering city-focused private investment are under study. These include de-risking through better data, such as that provided by the Global Emerging Markets Risk Database, and energizing the repo markets as exemplified by the African-oriented Liquidity and Sustainability Facility.

4. Developing an effective advocacy strategy

A wide range of stakeholders can leverage a strong narrative and powerful messages to promote these reforms during a particularly critical year. The commission will recommend and help implement a strategy for and involving city networks, G7 and G20 engagement groups (particularly the U20), national financial ministers, key agencies of the UN, private-sector industry groups, civil society, and others.

5. Taking diverse geographies and country contexts into account

One of the challenges of urban SDG finance is the diversity of city and country contexts and their enabling environments. Effective reform means employing an effective diagnostic mechanism when developing financing recommendations. It means advancing specific proposals that are appropriate to particular places, recognizing the level of development and capacities and the range of urban governance structures. For example, cities and their remits can overlap with and include regions, provinces, states, metropolitan areas, and towns.

6. Ensuring an adequate balance of financing for mitigation and adaptation

While climate mitigation and adaptation initiatives exist on a continuum, project developers conceive them as distinct efforts and seek separate funding streams. The commission's aim is to distinguish which instruments are appropriate and available for mitigation and which for adaptation – while making both compelling to investors and addressing the current imbalance in projects financed (for example, by improving revenue models for adaptation projects, or aggregating mitigation and adaptation-focused projects under attractive investment packages).

In the coming months, the commission members will engage in wide discussions in global convenings to produce a list of actionable recommendations in these six areas. Their aim is to gain support to transform access to financing sustainable development in cities, increasingly a critical nexus for achieving the SDGs. The task will be to move the world's nations' embryonic recognition of this idea to a re-imagined, city-conscious, global financial architecture for climate and development finance. ■

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Clear regulation for sustainable finance

Scratch beneath the surface, and so-called green investments often reveal to be contributing to environmentally harmful activities. With voluntary pledges shown wanting, governments and regulators must urgently mandate for better transparency and accountability in sustainable investing

By Helena Viñes Fiestas, Chair, EU Platform on Sustainable Finance, and Commissioner, Spanish Financial Markets Authority

The realm of global sustainable finance is experiencing unprecedented growth, boasting a staggering USD 1.8 trillion in cumulative issuances of labeled bonds. A substantial transformation is evident, with sustainability-related financial products now commanding a formidable USD 35.3 trillion, claiming a 36% share of all professionally managed assets (according to the Global Sustainable Investment Alliance's 2020 review).

However, beneath this impressive façade lies a pressing question: are we genuinely reflecting the essence of sustainable investments? The industry, shaped in part by voluntary initiatives, often spearheaded by the industry itself, has undoubtedly made strides. Yet, a closer look reveals a potential pitfall – a subtle misrepresentation of

▲ Coal-fired power plant, Raichur, India. The recent sale of Sembcorp's Indian coal power plants has highlighted distortions in the green bond market. The deal enabled Sembcorp to avoid higher coupon rates on its sustainability-linked debt, despite the fact that it would continue to finance the plants for the next 15 years

green bonds and funds. Some bonds bear the label while directing proceeds to emissions-reducing endeavors for refineries, inadvertently extending the economic lifespan of fossil-fuel-based assets and perpetuating emissions.

Amid the surge of financial products flaunting their environmentally friendly credentials (by, for example, pledging to exclude fossil fuels), a disconcerting trend emerges upon closer inspection. The touted commitment to eschew coal production often unravels through subtle loopholes, such as setting exclusion benchmarks at 10% of revenues from coal. The catch? Many of today's major coal producers generate less than this threshold from coal, casting doubt on the sincerity of these ostensibly green investments. This nuanced play on criteria highlights the challenge investors face in deciphering genuine environmental commitments amid the complex landscape of sustainable finance.

The statistics remain elusive, but a non-negligible amount of these bonds and products may be funneling funds into ventures that are far from sustainable. This raises doubts about the authenticity of our commitment to green finance and emphasizes the crucial need for transparency and accountability in the pursuit of authentically sustainable investments.

Sorting the green from the grey

Since March 2018, Europe has been spearheading the transformation of sustainable finance with its groundbreaking sustainable finance regulatory package. This places a pivotal focus on establishing a taxonomy to categorize sustainable economic activities.

The EU taxonomy serves as a definitive guide, akin to a dictionary, identifying sustainable economic activities under specific conditions. To earn the green label, an activity must genuinely contribute to one of six environmental objectives without causing significant harm to others. Companies must disclose in their annual reports the share of revenue derived from taxonomy-aligned activities and the portion of their capital expenditure allocated to activities meeting the criteria, expanding those activities, or achieving taxonomy compliance.

While the former (revenue) sheds light on the environmental sustainability of a company's activities, the latter (expenditure) provides investors with a window into the company's strategic direction and future path.

This reporting extends to investors, who must use the taxonomy as a universal tool to gauge the greenness of their portfolios, promoting consistent measurement across all environmentally marketed financial products. At the financial product level, the taxonomy is complemented by additional disclosure requirements related to information on broader environmental, social, and corporate governance (ESG). It also serves as the foundation for the EU green bond standard, striving to eliminate greenwashing in the green bond market by setting itself as the benchmark.

Albeit in its early stages and still evolving, the taxonomy is already making an impact, as revealed by first-year reporting. Major European companies such as those on the STOXX Europe 600 index are averaging around 23% for capital expenditure, 24% for operational expenditure, and 17% for revenues. While revenue alignment is anticipated to be low, there is a notable surge in capital expenditure alignment, especially in high-emission sectors, indicating that some companies are really investing in transitioning to more sustainable business models.

For example, the utilities sector reports a substantial 70% average aligned capital expenditure compared with 40% aligned revenue, highlighting noteworthy investments in transitioning power generation to near net zero. The taxonomy, beyond transparency and accountability, serves as a catalyst for increased investment in environmentally sustainable activities, actively redirecting capital to bridge crucial investment gaps and propel Europe toward a sustainable economy.

While the EU and China have been frontrunners in developing sustainable finance taxonomies, the concept is enjoying widespread success and proliferation. Dubbed "taxomania," more than 40 taxonomies have either been developed or are in the making – for example, in the UK, ASEAN (Association of Southeast Asian Nations), Canada, South Africa, South Korea, Chile, Columbia, and India, to name a few.

Reporting standards: completing the picture

The evolving taxonomies serve as a valuable tool to gauge the environmental sustainability of activities and assets at a granular level. However, to holistically evaluate companies, even on environmental issues alone, entity-level disclosures are imperative.

While taxonomies operate at the activity and asset level, they lack the breadth needed for a complete overview of a company's overall environmental sustainability performance. Other essential considerations include the governance of climate change within a company. Additionally, recognizing the significance of social and governance aspects is imperative for a holistic evaluation.

The solution lies in mandatory and standardized sustainability reporting standards. In the EU, the forthcoming but already adopted European Sustainability Regulatory Standards (ESRS) will require companies to disclose information on sustainability performance, policies, risks, and targets, covering a wide array of ESG topics.

These standards include specific requirements for reporting on climate matters, such as transition plans. Transition plans emerge as a key focal point in assessing a company's commitment to achieving net-zero objectives.

Many, though not all, of the new requirements align with recommendations from the UN High-Level Expert Group (HLEG) report

'Integrity Matters'. The HLEG was established to develop stronger and clearer standards for net-zero emissions pledges by non-state entities to put an end to greenwashing, and its report addresses key areas of environmental integrity, credibility, accountability, and the role of governments. The alignment of the ESRS requirements with the HLEG report emphasizes the integration of transition plans with overall business strategy, financial planning, capital expenditures, and taxonomy alignment.

Despite commendable net-zero pledges from various entities, challenges persist. Only one-third of major, publicly traded businesses have committed to net zero, leaving gaps, particularly among private and state-owned enterprises. Many pledges lack substance and standardized reporting, raising concerns of greenwashing.

To address this, the UN HLEG stressed the importance of annual progress reporting and independent, third-party verification for transition plans and progress reporting. The new EU standards propose moving from limited to reasonable assurance in a few years, placing climate reporting on a par with financial reporting.

Finance is of course global and often operating across borders. The newly issued International Sustainability Standards Board (ISSB) Standards create a worldwide framework for sustainability-related disclosures, particularly focusing on climate-related financial information. While a notable step toward harmonization, there is a need for continued reinforcement, especially in areas like transition plans. Therefore, standards such as the ESRS play a crucial role in raising the bar and ensuring comprehensive benchmarks.

A global approach

The current taxonomy landscape though remains fragmented. An increased international coherence in sustainability standards and sustainable finance taxonomies could help reduce market fragmentation and accelerate the flow of global capital to sustainable finance.

Many taxonomies are developed under governmental auspices, primarily focusing on climate mitigation. Some extend to cover climate adaptation, while the European taxonomy addresses the entire environmental spectrum. However, there is untapped potential for future extensions to incorporate social taxonomies. This expansion could seamlessly align with the Sustainable Development Goals, encompassing both social and environmental dimensions. Such a holistic approach, attuned to local goals and needs, would markedly contribute to advancing sustainability within specific regional contexts.

Currently, the EU stands out as the only jurisdiction where the taxonomy is complemented by mandatory reporting at both corporate and financial product levels. The ISSB could play a pivotal role by developing revenue and capital expenditure taxonomy-reporting indicators for companies in other jurisdictions. This would empower companies to adhere to and report against their respective national or regional taxonomies, promoting consistency and comparability in sustainability reporting.

The International Platform on Sustainable Finance, jointly chaired by China and the European Commission, serves as a catalyst for global collaboration among authorities from 20 jurisdictions, representing more than half of the world's population and greenhouse gas emissions, to advance sustainable finance. It aims to identify common elements among global green taxonomies to enhance comparability.

While recognizing the indispensable role of jurisdictional taxonomies in reflecting local context and goals, a global framework facilitates consistent sustainability benchmarking. Equivalence mechanisms and metric mapping address challenges in translating standards across jurisdictions. Harmonizing key environmental metrics globally is pivotal for achieving a unified understanding in sustainability reporting frameworks.

Stricter, clearer regulation

The critical challenge of greenwashing within financial markets remains a significant obstacle to urgently decarbonizing credit and investment portfolios. It hinders the redirection of capital toward genuinely sustainable investments, undermining global efforts to combat climate change. While voluntary initiatives from civil society, industry, and multi-stakeholder groups have made strides, the time has come for regulators and policymakers worldwide to address greenwashing definitively. This involves establishing robust regulatory frameworks that guide the transition to sustainable business models and facilitate access to capital for transformation.

> ***"The critical challenge of greenwashing within financial markets remains a significant obstacle to urgently decarbonizing credit and investment portfolios***

Furthermore, there is a need to enhance the quality of net-zero pledges and transition plans, holding corporates accountable. Realistically, voluntary processes may not suffice, necessitating credible transition plans, aligned progress reporting, and taxonomy-compliant capex.

As countries move toward regulating net zero, regulators, starting with high-impact emitters, should mainstream net-zero reporting and set standards for transition plans in line with the UN HLEG recommendations, transitioning from reporting to behavioral regulation. ■

Wrestling with hypernumbers

The promise of trillion-dollar sustainable finance initiatives rests on a triple fallacy: that we can make sense of them, that they are a measure of money that is available to finance or support climate-related causes, and that someone has structured and organized control over these amounts. It's time to accept their extremely limited utility and move on

By Jérôme Tagger, Partner and Co-founder, WhiteLabel Impact; Chief Executive Officer, Preventable Surprises

At COP26, Mark Carney launched the Glasgow Financial Alliance for Net Zero (GFANZ), pledging USD 130 trillion to decarbonization and mitigation. Par for the course for observers of the private-sector response to the climate crisis. Financial institutions' commitments to climate change and sustainability have been a hallmark of the last two decades, and their sponsors often manifest their scale through the total financial assets overseen or managed by these institutions. Other examples include the Principles for Responsible Investment, with its USD 121 trillion of committed assets under management, or the Net-Zero Banking Alliance with its stated USD 70 trillion of assets.

Mobilizing big figures for huge challenges: this sounds promising and necessary. After all, large amounts of capital need to flow to address climate change and shift the make-up of entire economic sectors such as energy, food, and agriculture, or human behaviors such as land use, and to redress exacerbated inequalities in the face of the climate crisis. Unfortunately, these mind-boggling figures are sometimes misguided, often misleading, and too consistently create a false sense of comfort.

In 2013, philosopher Tim Morton coined the term "hyperobjects" to describe phenomena such as climate change that exceed human apprehension but whose manifestations are constantly apparent, and that challenge any assumption of human control. One way to think about the oversized asset figures of finance initiatives is that they are "hypernumbers," on par with hyperobjects, and an ultimately failed effort to try and affirm human mastery over sustainability challenges.

Indeed, the ongoing rise of global greenhouse gas emissions calls time on their significance. They must have served a purpose, but we should now best ignore them, or give them a much narrower place in our understanding and imagination.

Less than the sum of its parts

To be sure, there is a role for data to measure change in the financial sector. But it is the attempt at aggregation that means nothing and is counterproductive. These hypernumbers are sums of apples and oranges, and every other food item in the pantry, with very different potential impacts on climate mitigation or adaptation.

It does not help that most of these initiatives are voluntary, and that commitments are made about a diffuse and hypothetical long term, leaving ample time to forget the commitments and move on to other pressing issues.

For one, not all financial assets can effectively support the critical transition to a sustainable, climate-friendly future. Some, like money-market investments, are largely irrelevant. Some follow investment strategies with no or weak links to sustainability and climate. Many financial institutions are conflicted, pursuing climate-friendly strategies with one part of their assets, while supporting oil and gas expansion elsewhere. Each trade has two sides: a buyer and a seller. Sell an oil rig and someone will usually snatch it if both sides can agree on a price. Different types of assets also mean different forms of control and influence over the strategic orientations of companies – but even when they have influence, such as through proxy votes, investors are reluctant to utilize them.

Equally importantly, no single entity exerts hierarchical control over where money flows. For all the shared regulation and incentives, decisions are made in decentralized ways by distinct individuals in distinct institutions and in distinct countries. There are attempts at coordinated efforts, and voluntary initiatives such as GFANZ are one of them. There should be more, and much more specific, coordination efforts – for example, from investors leveraging their influence on the demand side of energy (utilities) to shift fossil-fuel consumption. It is worth noting that opponents of climate action have identified this as a point of leverage and are trying to stymie these efforts by invoking antitrust or competition law, particularly in the US.

Lastly, often, these hypernumbers provide the illusion of being a suitable response to hyperobjects. But many of the necessary responses to the climate crisis are political, cultural, and behavioral, with changes required of a different and hardly measurable magnitude.

▲ Mark Carney, United Nations Special Envoy for Climate Action and Finance at the World Economic Forum. Ahead of COP26, Carney launched the Glasgow Financial Alliance for Net Zero (GFANZ), making the claim that "over USD 130 trillion of private capital is committed to transforming the economy for net zero."

Reality check

So, if we look past the hypernumbers, what meaningful change could one look out for to assess the behavior and response of the financial sector?

Real capital flows obviously matter and are a core indicator. The Climate Policy Initiative's 2023 'Global Landscape of Climate Finance' estimates them at USD 1.3 trillion – continued progress, but only still a fraction of needs. Tellingly, only about a fifth of this amount came from institutional finance, the rest being public, corporate, and household sources. And most of this capital is still geared toward developed economies. There is, therefore, still a long way to go for institutional finance to make a meaningful investment impact into climate. Hypernumbers tend to obfuscate this picture.

While deeper, generational, and foundational cultural work is ongoing, it is also useful to consider the enabling environment for climate finance, including in policy.

Real change can come from transformative industrial policy, such as the US Inflation Reduction Act, or the EU's commitment to spend 30% of its budget on climate-related projects (typically investments or subsidies).

Real change can come from reforming international institutions, those such as the World Bank and International Monetary Fund with the mandate and capacity to channel financial resources to where they are most needed, including the Global South. Barbados Prime Minister Mia Mottley's Bridgetown Initiative calls for a transformative agenda to enable institutional reform and the creation of new financial instruments.

Lastly, our economic system's failure to respond to and address global issues such as the climate crisis suggests the need to take a hard look at the frameworks that define the obligations of institutional investors, such as fiduciary duty. Since 2006 and the Freshfields Report, advocates have made tremendous efforts to demonstrate that fiduciary duty is compatible with the consideration of environmental, social, and governance (ESG) issues in investment decision-making. That is all good and fine, but today demonstrably insufficient. What else, we might ask, should articulate the obligations of investors and their beneficiaries to society? Some investors, inspired by Preventable Surprises and spurred by the actions of The Shareholder Commons or The Investment Integration Project, are beginning to adopt a more systemic understanding of how their existence depends on systemic issues like climate change. Much more needs to happen.

What place for hypernumbers then? That of an internal success indicator of voluntary initiatives, but beyond this too often a distraction from taking on real challenges. They are a reminder that there is no simple, global, technocratic solution to wicked problems, only the patient work, sweat, and tears of the dedicated few at the forefront of a societal movement – within, but crucially beyond, finance. None of this is easy work, but all of it is necessary. ■

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Beyond domestic emissions

Critics of the UN Framework Convention on Climate Change's focus on production-based emissions argue that it ignores "carbon leakage." How might a consumption-based approach, looking beyond national borders, improve climate mitigation strategies?

By Grayson Fuller, Manager, SDG Index and Data, Sustainable Development Solutions Network (SDSN)

In the lead-up to COP28, the conclusions of the first global stocktake show that the world is far off track for limiting warming to 1.5°C. More ambitious mitigation measures and targets will be essential. Specifically, phasing out all unabated use of fossil fuels and scaling up renewables will be (to quote the authors of the global stocktake's technical dialogue) "indispensable elements of just energy transitions to net-zero emissions."

Countries have used a variety of tools to reduce their emissions, including carbon taxes, cap-and-trade systems, energy efficiency standards, subsidies for renewable energy, and renewable portfolio standards. By using different mixes of these policies, all G7 countries have reduced – by varying degrees – their per capita CO_2 emissions from fossil fuels since the turn of the century (Figure 1). Of course, the current rates of emissions reduction in these countries need to accelerate. However, these emissions reductions do not capture the entire picture, since not all emissions generated by countries happen within their borders.

Supply or demand?

In a globalized world where trade consists of international production processes, it is essential to quantify the emissions that a country's consumption generates beyond its borders. Those offshore impacts, referred to as externalities or "spillovers," are now measured with the consumption-based accounting (CBA) approach. In short, production-based accounting measures all impacts that happen within a country's borders, which a government can address with local supply-side measures. Conversely, CBA measures all impacts associated with a country's consumers, be they domestic or international. CBA is therefore useful for identifying the appropriate demand-side interventions, particularly by adjusting consumption patterns.

Using CBA to measure and monitor spillover effects is important to ensure countries do not simply offshore their emissions to other countries. Take the example of Greece in Figure 2 (overleaf). While domestic greenhouse gas (GHG) emissions have decreased since 2016, emissions happening overseas to satisfy Greek consumption have risen and are projected to potentially overtake domestic emissions based

◂ Korea versus Uruguay at the FIFA World Cup in Doha, Qatar. Per capita, Qatar has the highest carbon emissions in the world when measured on a production or consumption basis. Its consumption is almost six times the world average. Its neighbours in the Gulf are also among the highest per capita consumers

on the latest growth rates (see figure note). In Switzerland, by contrast, the GHG emissions generated domestically are already very low but are far outnumbered by the country's upstream emissions occurring abroad (Figure 3, overleaf). This underscores the need for countries to monitor both their domestic and offshore emissions.

Curbing offshore emissions

In addition to monitoring their overseas emissions, there are several policy options for countries to curb their offshore emissions:

- target-setting
- supply chain regulation
- trade regulation
- cross-border carbon pricing

Target-setting

Rich countries in particular should consider consumption-based targets and monitoring systems to track the emissions and other environmental impacts from their consumption beyond national borders. Last year, Sweden announced its intention to become the first country to integrate imported CO_2 emissions within its national climate targets. These targets can be downscaled to firms as well: the Science Based Targets initiative (SBTi) provides research and guidance to companies aiming to reduce their GHG emissions in a way that is consistent with the goals of the Paris Agreement.

Supply chain regulation and due diligence

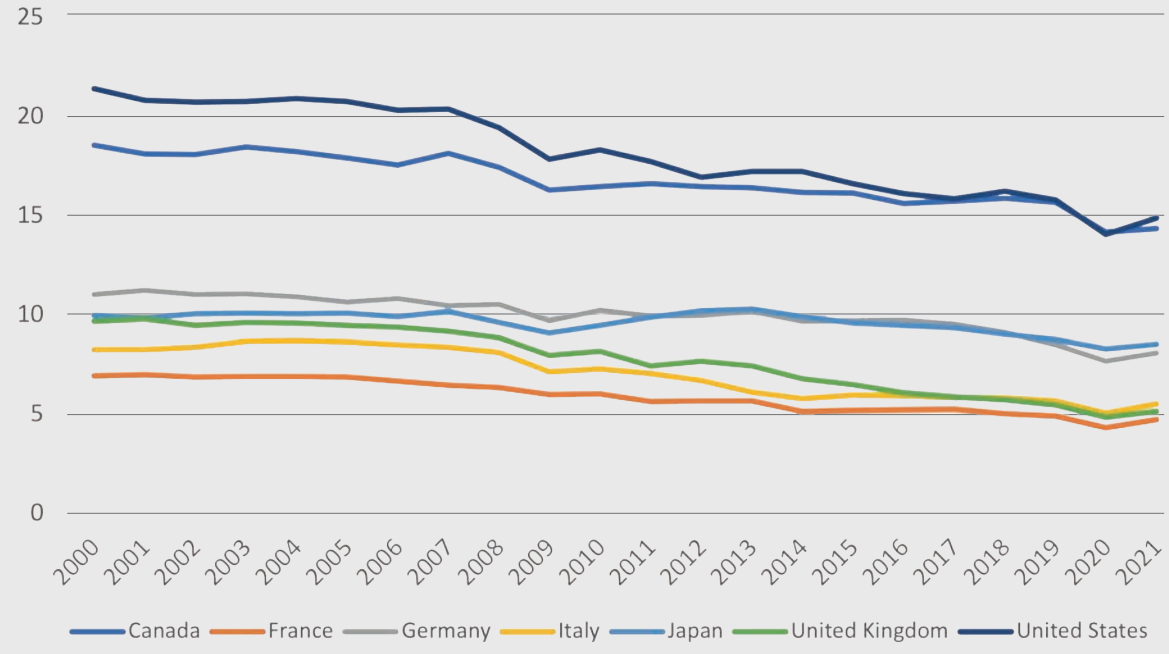
National governments can curb overseas emissions by requiring businesses to do due diligence on their suppliers. Due diligence legislation often includes clauses to ensure that overseas suppliers are respecting human rights, paying workers a fair wage, and producing goods in an environmentally sustainable way. These laws, adopted so far in only a handful of countries, mostly apply to large companies and can provide sanctions and penalties for countries that fail to comply.

Although many of these due diligence laws cover social issues, such as child labor, modern slavery, occupational safety, or the right of association and unionization, they can also include environmental standards, including emissions, deforestation, and pollution. While legislation is important for due diligence requirements, so too is enforcement. France, for example, introduced its corporate duty of vigilance law in 2016. Yet there are cases of large French companies not doing any reporting whatsoever and others where businesses are flagrantly violating the law.

Trade regulation

As trade agreements govern the rules of imports and exports between trading partners, they can be an important

FIGURE 1: Decline in CO_2 emissions (tonnes/capita) from fossil-fuel combustion and cement production in G7 countries



Source: Friedlingstein et al., Global Carbon Budget 2022

tool for countries and regional blocs to manage their overseas emissions. There are an increasing number of environmental and sustainability provisions integrated into international trade agreements.

In the case of the EU, since 2011, all modern EU trade agreements contain chapters on trade and sustainability. These chapters notably contain clauses requiring the effective implementation of international conventions on environmental and labor standards.

At the international level, there are initiatives for reform of the World Trade Organization (WTO), which will be discussed at the WTO's next ministerial conference in February 2024. The 'Remaking the Global Trading System for a Sustainable Future' project recently published its recommendations for WTO members, including a net-zero emissions target in international trade.

Carbon pricing and carbon border adjustment mechanisms

In many countries, carbon trading schemes establish a cap and a price on carbon emissions. These incentivize companies to emit less by increasing their production costs. However, if not all countries have the same carbon price, businesses may be incentivized to offshore production to countries where the absence of climate mitigation legislation allows for cutting these costs. The widespread adoption of adequate carbon pricing mechanisms globally would prevent this so-called "carbon leakage."

In the absence of an internationally adopted carbon price, the EU has introduced the Carbon Border Adjustment Mechanism (CBAM). It works by extending a carbon price to goods that are manufactured abroad and then imported into the EU. However, there are valid concerns that CBAM is protectionist and puts an additional burden on developing countries that are the least responsible historically for climate change.

Cooperation not contention

CBA and the offshoring of GHG emissions calls for scrutinizing our current system of international trade and global value chains. International trade can be a powerful source of growth and social prosperity for developing countries, but sustainability criteria and legislation are key to make sure it happens in a way that is consistent with the goals of the Paris Agreement. Net-zero targets and strategies need to account for global supply chains and do so in a way that encourages cooperation – not contention – between the Global North and South. ■

FIGURE 2:
Projected GHG emissions in Greece (tonnes/capita), domestic vs imported

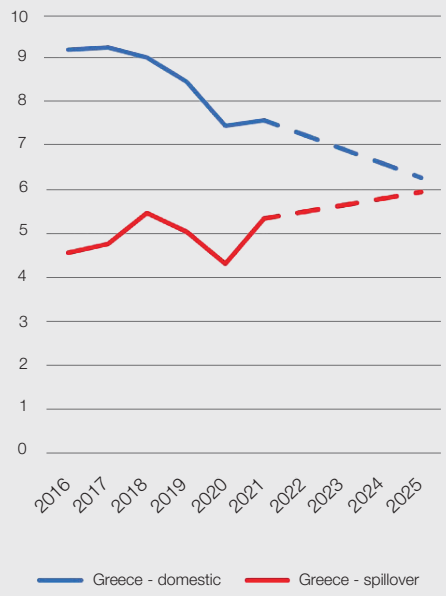
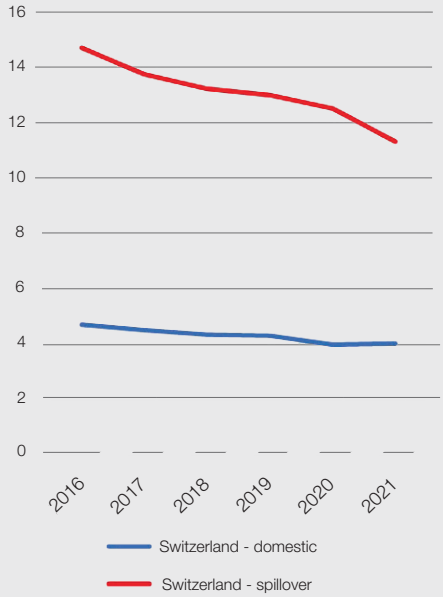


Figure 2 note: projections to 2025 are based on linear annual average growth rate from 2016 to 2021. The dip in 2020 is from the contraction in demand from the COVID-19 pandemic.

FIGURE 3:
GHG emissions generated by Switzerland (tonnes/capita), domestic vs imported



Source: Release 057 of the GLORIA global environmentally extended multi-region input-output (MRIO) database (Lenzen et al. 2022), constructed in the Global MRIO Lab (Lenzen et al. 2017)

Guiding climate action through Earth observation

With their unwavering gaze from above, satellites are an increasingly powerful tool to identify and monitor anthropogenic emissions, right down to pinpointing individual sites. Using this data to inform policy and direct climate action everywhere must be an urgent global priority

By Simonetta Cheli, Director of Earth Observation Programmes and Head of ESA ESRIN establishment, European Space Agency (ESA)

Satellites have revolutionized scientists' grasp of the climate and its evolution over recent decades. These orbiting marvels have provided the observational records to validate and improve the Earth system models used to predict future change.

Beyond supporting the science, satellites are becoming critical tools in the quest to tackle climate change and monitor progress toward a lower-emissions and more resilient world.

Reducing emissions of greenhouse gases (GHGs) such as carbon dioxide (CO_2) and methane is clearly paramount to avoid the worst impacts of climate change. The Intergovernmental Panel on Climate Change (IPCC), the body responsible for assessing the state of the climate, warned earlier this year that immediate and dramatic emissions cuts are needed to limit global temperature rise to 2°C – and even 1.5°C as best effort – relative to the pre-industrial era, reiterating the urgent need for all nations to decarbonize.

▲ Wildfires in Greece, captured by the Copernicus Sentinel-2 satellite constellation

Emerging scientific methods and technologies from the Earth observation (EO) sector are playing a growing role in guiding actions that can curb emissions in two important aspects.

First, new methods allow comparison of GHG inventories against independent space observations to track national progress toward lower emissions. Second, the latest high-resolution satellite missions provide new capabilities that enable detection and quantification of emissions hotspots resulting from fossil-fuel combustion down to the region, city, or even plant scale. This can inform and direct effective action and policies aimed at curbing carbon emissions.

Taking stock of global climate action

Later this year, the international community convenes at the COP28 climate summit in Dubai to conclude the first global stocktake. This five-yearly assessment cycle reviews global action to curb emissions and inform where nations need to increase and accelerate initiatives to maintain progress toward the Paris Agreement's warming goals.

For the process to be robust, accurate and consistent reporting is needed at the national scale. Currently, the national GHG emissions inventories, which are reported to the UN Framework Convention on Climate Change (UNFCCC) as part of the stocktake process, are compiled using emissions factors and national statistics. In essence, the inventories are scaled-up estimates of national carbon emissions and removals.

To increase the accuracy and confidence in these inventories, the IPCC encourages countries to verify reported emissions against independent measurements. If compared against EO data, for example, this offers greater confidence that emissions reporting reflects the real-world situation – as well as improving transparency.

New research ('Comparing national greenhouse gas budgets reported in UNFCCC inventories against atmospheric inversions') conducted via the ESA-funded Regional Carbon Assessment and Processes (RECCAP-2) project developed a framework to directly compare national inventories against state-of-the-art satellite observations.

The project researchers combine satellite-derived observations and in-situ measurements with inversion models that help to factor the "flux" or movement of GHG emissions between land and atmosphere. This top-down approach offers a full picture of the emissions that accumulate in the atmosphere at the country scale. This is then used to check national inventories to enhance GHG reporting. Currently, only large, high-emitting countries can be assessed. But with denser satellite sampling anticipated in the coming years, more countries are set to benefit.

This work has highlighted inconsistencies between national emissions reporting and observations. For example, methane emissions, particularly for Gulf states that extract oil and gas, and forest carbon stocks in northern hemisphere countries were generally underreported when compared with observations. Such insight and checks will enable increased accuracy and confidence and consistency in GHG emission reporting and progress toward nationally determined carbon reduction commitments.

As Philippe Ciais of the Laboratoire des Sciences du Climat et de l'Environnement (LSCE) and RECCAP-2 science leader notes: "If regularly applied, the methods will not only improve transparency in the accounting process but will also improve the effectiveness of mitigation policy and progress by individual countries to meet their pledges as part of the Paris Climate Agreement."

Building on similar research methods, ESA is developing World Emission. This emissions-monitoring service leverages satellite data from the European Commission's Copernicus program, from space agencies such as the Japan Aerospace Exploration Agency (JAXA) and NASA, and complementary ground-based measurements.

This unique global coverage project will generate global maps for CO_2, methane, and several atmospheric pollutants. It will provide essential information for policymakers, governments, national reporting agencies, and subsidiary bodies to enhance pollutant and GHG emissions inventories. It's just one example of how EO can demonstrate its uniqueness and excellence to complement traditional information, contributing significantly to the overall drive for climate change mitigation.

Enhancing carbon markets

Carbon markets, both compliance and voluntary, offer another fundamental system to stimulate the shift toward net-zero emissions. The role of EO to improve quality and transparency, provide solutions globally, and increase trust in these growing markets was made clear at the recent ESA-organized EO for Carbon Markets Forum 2023.

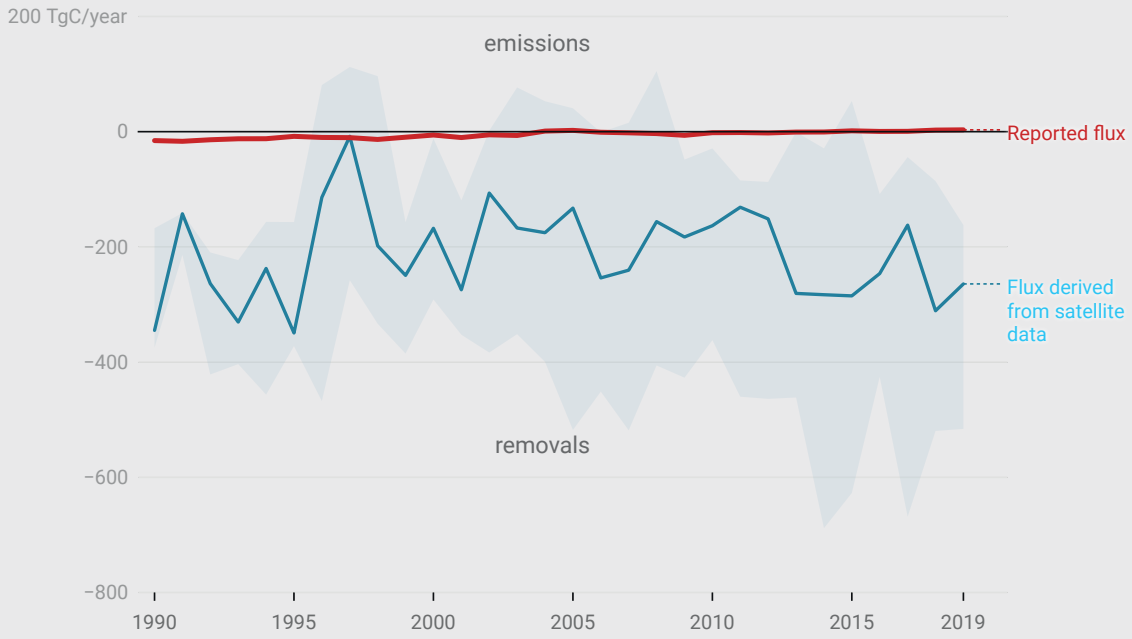
The forum convened representatives from the European Commission's Directorate-General for Climate Action and Joint Research Centre, along with certification bodies, public agencies, finance and insurance entities, carbon project operators, the EO industry, non-governmental organizations, and academia.

Existing projects are already demonstrating the relevance of EO to support carbon credits certifications. For example, the ESA Forest Carbon Monitoring project develops EO-based, user-centric approaches to support forestry stakeholders to meet the requirements of both compliance and voluntary carbon markets. The project involves developing a prototype cloud processing platform that offers a selection of biomass and carbon monitoring approaches for both large and small areas.

Satellites to detect and monitor anthropogenic emissions

Anticipated for launch in 2026, ESA is developing the Copernicus Anthropogenic Carbon Dioxide Monitoring (CO2M) mission on behalf

FIGURE 1: Carbon dioxide flux from managed land in Canada



Carbon dioxide absorbed by the land is counted negatively, while carbon dioxide emitted to the atmosphere is counted positively.

Chart: European Space Agency. Source: Deng et al. 2021

of the EU, as one of the six Copernicus Sentinel Expansion missions.

These new missions aim to bolster the scope of the EO component of Copernicus, with CO2M providing CO_2 monitoring capability to support decarbonization efforts across Europe and beyond.

Forming a constellation of two satellites, each carrying a near-infrared and shortwave-infrared spectrometer, the CO2M mission will provide a global picture of atmospheric CO_2 concentrations at high spatial resolution every four days. These data will feed into the new CO_2 Monitoring and Verification Support capacity being developed by the European Centre for Medium-Range Weather Forecasts. Once operational, the mission will reduce uncertainties in estimates of emissions of CO_2 from the combustion of fossil fuel at local, national, and regional scales.

CO2M will be the first mission to monitor anthropogenic carbon emissions and is anticipated to provide data to support the second global stocktake that concludes in 2028, as well as the dramatic decarbonization of Europe's economies needed to deliver the Green Deal.

By providing a unique and independent source of information, CO2M will be key to assessing the effectiveness of policies aimed at curbing emissions at both national and global scale, enabling countries to track and show how they are progressing against their decarbonization commitments. The ability to detect and quantify major CO_2 emission hotspots within national borders, at the city or plant scale, is anticipated to help coordinated efforts to tackle major emissions sources.

Indeed, satellite observations are already playing a pivotal role in the global effort to combat climate change. The Copernicus Sentinel-5P mission, launched in 2017, is delivering global maps of anthropogenic methane concentrations to guide climate action on a daily basis.

Researchers from SRON (the Netherlands Institute for Space Research) can now identify and quantify major industrial methane leaks from oil, gas, and landfill sites. In 2021 alone, researchers discovered nearly 3,000 methane plumes, equivalent to the annual total GHG emissions of the Netherlands, according to SRON research ('Automated detection and monitoring of methane super-emitters using satellite data').

As industrial methane leaks are relatively simple to fix, space-borne detection offers a golden opportunity to cut emissions, with the UN International Methane Emissions Observatory using this data to find solutions with companies and authorities.

Swift, deep, and sustained climate action is needed to avoid the worst consequences of climate change. Advances across the EO sector are playing a growing role to help transition to a lower-emissions, net-zero world. ■

Surviving extreme weather

As temperatures creep higher, extreme weather events are becoming the new normal. What should we expect as we approach 1.5°C, and how can governments and wider society prepare?

By Leon Hermanson, Expert Scientist, Predictability Research Group, Met Office

For the weather and climate community, 2023 is a very unusual year. It started in March when ocean surface temperatures started warming up to levels never seen before, and by a big margin. Temperatures over land soon followed. July was the hottest month ever recorded.

Then we saw the hottest August and September ever recorded. Regionally, this meant heatwaves and forest fires, but also record wind speeds due to the heat fueling super-powered tropical cyclones. The warmer the atmosphere is, the more water it can hold, and so more heat also means more rainfall. Sometimes, such as in Australia in 2022, this means drought and forest fires can be quickly followed by flooding.

These events are unusual, even unprecedented, but not unexpected. In 1998, governments came together in Paris and agreed to limit dangerous climate change and keep global temperature increases well below 2°C, preferably below 1.5°C. These are increases compared with before when humans had a strong influence on climate, a baseline usually taken to be the average over the years 1850 to 1900.

The global mean temperature increase between then and 2023 is approximately 1.3°C. This number and the 1.5°C level do not refer to a single month or year, but to a long climate average of 20 years or longer, which evens out the natural, interannual variability of temperatures.

It is very likely that 2023 will be the warmest year on record and 2024 is likely to be an extremely warm year as well, potentially beating 2023. It is almost inevitable that we will reach 1.5°C, probably within about a decade.

The World Meteorological Organization put out a report in May stating that there is a 66% chance that at least one year in the next five will be warmer than 1.5°C. This will not mean we have reached 1.5°C in the long-term average, but it is a warning that we are getting close. In a 1.5°C world, we should expect more of the unusual weather of 2023, which will, of course, no longer be unusual.

What can we expect?

Changes in weather will not be uniform across the globe. Land warms faster than the ocean and land at high latitudes in the northern hemisphere warms the fastest. It is not just the mean temperature that changes. The intensity, frequency, and duration of heatwaves also increase.

Regions such as the Mediterranean, Southwestern USA, northeast Brazil and southern Africa are more prone to drought than other regions and this may change life and agriculture there. Rainfall will decrease in some regions but will increase in more regions. When the mean increases, so does the amount of heavy precipitation.

An increase in the mean can also mean that the number of days with rainfall decreases, but that the rainfall is more intense when it does occur. We may experience fewer storms, but when they occur they will be stronger than before and carry more water, which is often the most damaging aspect after the high winds have abated.

Many more people will be impacted by extreme weather than have been in the past. Nature and the services it provides to humans will also be affected. Many land and ocean ecosystems have already changed and the services they provide to humans have reduced. Heat-stressed forests sequester less carbon, while wetlands that used to buffer against floods may not be sufficient as rainfall amounts increase.

Solutions not blockers

It is worth doing as much as possible to limit climate change. Every tenth of a degree of warming stopped is a reduction in extreme and dangerous weather. The Intergovernmental Panel on Climate Change published a report showing that there is a clear difference between a global warming of 1.5°C and one of 2°C. Heatwaves are avoided, heavy precipitation reduced, droughts lessened. Fewer species become extinct and ecosystems we rely on for our survival are impacted less.

Compound impacts, where multiple hazards happen at once (heat and drought; wind and rain) have a larger impact on water, food, and energy systems than when acting alone, and these compound impacts are less likely in a cooler climate.

The only solution with guaranteed results is to cut greenhouse gases (GHGs), but progress on this front is hampered by political inertia and vested business interests (often in collusion).

Solar radiation management, also known as geoengineering, involves technological solutions to reduce the incoming heat to the Earth. It is not a solution on its own, but best used as

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▲ Sindh province, Pakistan. The extreme rainfall and heavy flooding in 2022 affected 33 million people and caused thousands of deaths. This event could have been predicted weeks in advance, in time for government and aid agencies to prepare

a supplement to strong reductions in GHG emissions. There is a danger of unintended consequences (such as changes in rainfall patterns affecting food production), and it is best implemented with global agreement, which could be difficult in today's political situation of increasing regionalization.

The severity of the impact of a tropical cyclone in a particular country can be predicted by that country's gross domestic product and the quality of its institutions. Corruption, low capacity, and lack of experience all contribute to reducing the efficiency of rescue and restoration operations. If there is time to prepare for an extreme event, the rescue effort is better and less costly.

In 2022, Pakistan was hit by extreme rainfall, leading to widespread flooding and thousands of deaths. In hindsight, this event could have been predicted weeks in advance. Early warning would have given the local authorities a chance to buy in supplies, make evacuation plans, and ask for help from aid agencies in advance of the event. The World Meteorological Organization is building an early warning system called Early Warnings for All, which will use weather forecasts with the aim of protecting everyone on Earth.

There is also potential for machine learning to play an important role in building resilience in society to the shocks from weather extremes. It is a useful tool for planning, routing, and scheduling, which would help manage climate migration. In the future, migration could involve the movement of hundreds of millions of people, as living in a region becomes economically unviable or even directly dangerous.

Machine learning may be able to enhance existing extreme weather warnings by increasing resolution and quantifying uncertainty. It can also be used to accelerate research and speed up climate models. It may help us better understand compound risks. For example, we need to know which chain of events might lead to crop failures across the world and how we can reduce the chance of this happening.

Building resilience to extreme weather

Climate change information is often presented as changes in average temperature and average rainfall, but that masks the large changes in extreme events such as storms, droughts, and floods that accompany a shift in the climate. We already have many of the technologies we need to reduce the impacts of extreme weather, but they need to be supported and scaled up.

Economic efficiency has lifted millions of people out of poverty. But a lack of resilience, including against climate-change-induced extreme weather events that cost USD 140 billion a year, risks undoing the economic and societal gains made in recent years. We must not let that happen, whatever headline average temperature rise we reach. ■

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Whose bioeconomy, whose knowledge, and whose profit?

The nascent concept of "bioeconomy" offers a new sustainable paradigm where economic growth supports nature rather than plunders it. Can bioeconomies genuinely transform regions like the Amazon, plagued by decades of resource extraction and exploitation, in the face of powerful, global, corporate interests?

By Simone Athayde, Department of Global and Sociocultural Studies and Kimberly Green Latin American and Caribbean Center, Florida International University; Member of the Science Steering Committee of the Science Panel for the Amazon (SPA); and Luciana Villa Nova Silva, Founder, Mangara Innovation and Sustainability; Member of the Science Steering Committee of the Science Panel for the Amazon (SPA)

Bioeconomy is a multifaceted concept, under development and dispute. It's seen by many as a key component of the future world economy, as humanity fights climate change and struggles to move away from fossil fuels through low-emissions development.

However, to date there has been a lack of a shared understanding

◂ Collecting acai fruit in the Amazon, Brazil. As a non-timber forest product, the fruit is a rich source of outside income. However, it may also threaten biodiversity if intensively cultivated

of bioeconomy between academic disciplines, policy sectors, and other knowledge systems. The direct economic impact of bio-based products, services, and processes is estimated to be around USD 4 trillion per year globally over the next 10 years.

Is bioeconomy inherently sustainable or fair? Not at all. Due to the lack of consensus on the term, there are risks associated with its use as a synonym for the green economy or as a panacea. These risks involve prioritizing low-value, high-volume products (such as sugarcane and other monoculture plantations) at the expense of low-volume, high-value chains and services (including ecotourism, pharmaceuticals, and superfoods).

History is a powerful witness and a teacher. In addition to the potential environmental harm of unregulated bioeconomy activities, playing by market rules can lead to biopiracy, elite capture, overexploitation of local people's labor, and high value added to biodiversity products far from the hands of local producers and the lands from where such bioproducts originate. In this new bioeconomy wave, are we prepared for turning the key, or it is just going to be more of the same?

Since the 2010s, some authors have sought to present the field of bioeconomy from three perspectives: biotechnological, bio-resources, and bioecological. The bioecological vision brings a new sustainable dimension in the relationship with nature and at the same time in the integration of human life in this context. It provides a more systemic approach to the bioeconomy, including integration of sustainable production parameters, and innovative forms of production to reconcile land use and biodiversity conservation. It can generate opportunities for valorization and social inclusion of Indigenous peoples and local communities (IPLCs), and local family producers.

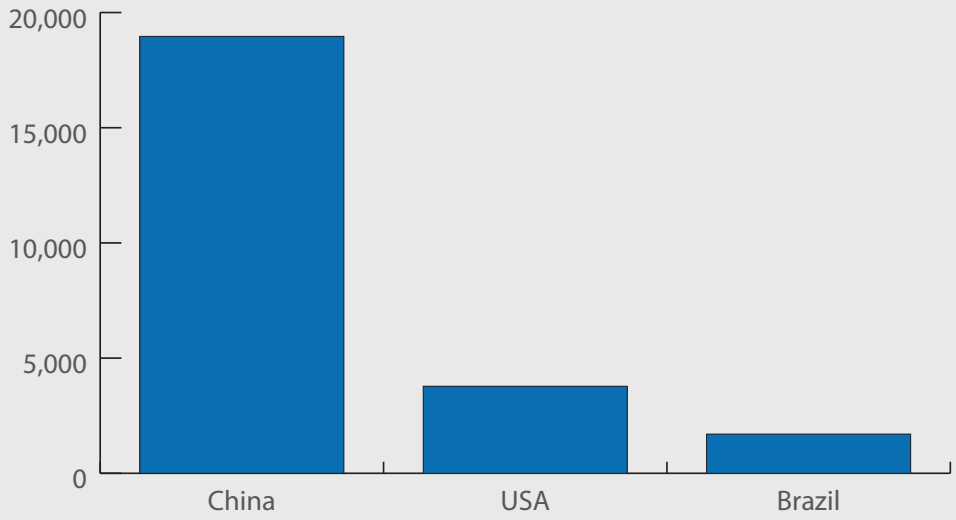
Challenges for Amazonian bioeconomies

Recently, bioeconomy has emerged as one of the most important vectors for a sustainable future for the Amazon. The promotion of an economy based on the potential of its rich biodiversity and local knowledge offers a compelling alternative to established models of a predatory economy.

Some biotechnology and bioresource models developed through conventional market practices can compromise the rights and well-being of IPLCs in the Amazon, where local livelihoods, rural–urban dynamics, and socio-cultural identities are products of intricate social–ecological connections and flows.

Unethical access to IPLCs and global use of biodiversity compounds is happening in an escalating manner. For example, large international corporations abroad dominate patent applications for innovations from Amazonian biodiversity. Around 43,000 patents for innovations with the Amazon flora had been filed worldwide by 2022, with significant leadership

FIGURE 1: Number of patents for Amazonian botanical products designed by companies filed by 2022



Source: Adapted from Adeodato, S. Corrida das Patentes, Biodiversidade, Valor Econômico, 2023

from China and the USA, as shown in Figure 1.

Many industrialized countries, due to their academic capacity, technological infrastructure, and resources, dominate the main industries for transforming biodiversity resources. Less-developed countries, meanwhile, play the role of suppliers of primary inputs, without adequate remuneration for the genetic, natural, and social capital acquired from IPLCs.

A series of regulations have increasingly sought to protect and, at the same time, give due value to the collective knowledge of IPLCs, who have co-evolved with Amazonian biodiversity since time immemorial. Despite the worldwide adherence to the Convention on Biological Diversity and the Nagoya Protocol, only a few countries have established local policies, most of them in the Global South. These countries face great difficulties in policy development and implementation, with significant differences among them in terms of regulations around benefit-sharing of access to genetic patrimony and traditional knowledge.

In 2015, Brazil established its Biodiversity Law to regulate access to genetic heritage and to associated traditional knowledge. Despite the law, there are still a series of challenges in its implementation. For example, a recent report found that only 9% of the registration of new biodiversity-based products by the Brazilian Ministry of the Environment included access to traditional knowledge in their scope. This reduces the possibility of increased benefit-sharing with IPLCs.

The economy of "socio-biodiversity," the most widespread term in Brazil, includes the dimension of the diversity of socio-cultural systems. The term socio-biodiversity was defined in 2009 by the Brazilian National Plan for the Promotion of Socio-Biodiversity Product Chains (PNPSB) as a "concept that expresses the interrelationship between biological diversity and the diversity of sociocultural systems."

The so-called "economy of socio-biodiversity" or "socio-bioeconomy" is a proposal to enhance "the economic manifestations of traditional peoples and communities that are based on an inseparable relationship with nature, surrounded by respect and socio-cultural interaction with ecosystems and biodiversity, valuing different production and reproduction strategies, and based on the sustainable use of biodiversity" (see 'Policy recommendations for the development of the economy and sociobiodiversity').

These approaches, highly applicable to territories such as the Amazon, seek to highlight the socio-cultural aspects involved in any process of transition of production models, with the socio-productive inclusion of vulnerable populations. Additionally, investments, policies, and safeguards underpinning socio-bioeconomy initiatives should reinforce sustainable and just values and the principles promoted by several Sustainable Development Goals (SDGs), including:

- No poverty (SDG 1)
- Good health and well-being (SDG 3)
- Gender equality (SDG 5)
- Reduced inequalities (SDG 10)
- Sustainable cities and communities (SDG 11)
- Life on land (SDG 15)
- Peace, justice, and strong institutions (SDG 16)

Regarding gender, a recent report produced by the Amazon Partnership Platform (PPA) found that 75% of impactful, community-based businesses mapped in the Brazilian Amazon had women in leadership positions and included gender issues in their portfolio's assessment.

Toward bioeconomies of equal partners

The significant evolution of the socio-biodiversity economy will depend on the effective promotion of science and innovation. This should be based on a new approach of intercultural knowledge equity.

We need to focus on generating quality of life for urban and rural residents through plural valuation, conservation, and sustainable use of Amazonian biodiversity.

We need investment not only in research and development, but also to support and provide technical assistance to guarantee the viability of local businesses.

We need business models that expand the capabilities of IPLCs to produce their own products and services by respecting their self-determination, rights, local lifeways, and values, and promoting good quality of life and well-being under their own terms.

To this end, sustainable, territorial development policies must promote technological innovations that provide the structuring conditions, such as water security, health, education, internet access, logistics, and transportation, combined with innovation hubs.

Moving from business as usual toward just and sustainable Amazonian bioeconomies will require equitable forms of knowledge articulation and exchange between IPLCs, science, and policy. Indigenous peoples and local communities must become equal partners in the planning, construction, and management of socio-bioeconomies' policies and businesses, and not just as suppliers of knowledge and products in value chains. ■

> ***"We need to focus on generating quality of life for urban and rural residents through plural valuation, conservation, and sustainable use of Amazonian biodiversity***

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Solving the energy storage problem

Energy storage is a critical flexibility solution if the world is to fully transition to renewables. While many technical, policy, and regulatory barriers remain, there are already a range of maturing solutions that we can leverage

◂ Lithium mining in the Atacama desert, Chile. Over half the world's lithium reserves are in the salt pans of the "Lithium Triangle" that includes the Atacama and neighboring areas in Bolivia and Argentina. Lithium is one of the critical minerals on which the expansion of battery storage depends

By Csinszka Bene, Energy Consultant, Trinomics; Arne Ellerbeck, Energy Consultant, Trinomics; João Gorenstein Dedecca, Energy Consultant, Trinomics

The global energy transition will be driven by two key factors: energy efficiency measures that reduce consumption, and the deployment of renewables – electricity-based but also renewable fuels and heat.

Multiple studies confirm that 100% renewable systems are feasible in the long run, as the Intergovernmental Panel on Climate Change's (IPCC's) 6th Assessment Report indicates. However, most renewable sources are intermittent – they vary in time, and production cannot be perfectly predicted. Sources that are both renewable and controllable do exist, but their potential varies per country and is limited by technical, economic, environmental, and social factors.

This means we will increasingly require flexibility solutions to manage this intermittency, from the short run (milliseconds to weeks) to the long run (weeks to multiple years). Energy storage is one such flexibility solution (along with others), as the IPCC highlights. Storing energy allows us to integrate renewables at a lower cost and reduces price volatility in energy markets. Developing energy storage is therefore highly attractive for policymakers – it not only offers opportunities for decarbonization, technology leadership, and economic growth, but also increases energy security (an aspect particularly relevant given the ongoing energy crisis).

Storage varies per technology (electrochemical, mechanical, thermal, and others) but also according to the energy carrier it helps to store (electricity, gas, thermal energy) and application – for example, in large power systems (whether directly connected or on-site within a building or renewable energy installation) or off-grid. The suitability of the different storage technologies for each application will depend on:

- investment and operational costs
- efficiencies (for charging, storing, and discharging)
- design lifetime of the asset
- other aspects, such as the potential revenues that the storage operator can obtain

Many storage technologies are commercially proven and increasing in competitiveness. There is already some electricity storage deployed globally, particularly in the form of hydropower reservoirs and, increasingly, batteries. BloombergNEF indicates that global electricity storage capacity will reach almost 2 terrawatt hours (TWh) by the end of 2023. But gas storage capacity is already much higher (over 4,000 TWh globally in 2022 according to Cedigaz), as is thermal energy storage capacity.

Barriers to energy storage persist

Our economy is therefore highly dependent on energy storage, and current power systems can already integrate a significant amount of renewables. But further storage capacity will be necessary. When storage and other flexible resources are not available, measures such as curtailing renewable generation or, even worse, limiting electricity consumption become necessary. This can lead to significant economic inefficiencies.

And yet, important barriers remain to reaching the capacity we will need. In the realm of short-term storage, while notable progress has been made, there is still limited storage capacity and insufficient system flexibility overall. Looking to the future, the ability to store energy over extended periods becomes crucial if we are to rely primarily on intermittent renewable sources. Developing effective, cost-efficient, long-term storage solutions is therefore vital, but many such technologies are not yet commercially mature.

Regulatory barriers pose big challenges to storage deployment. Policies and regulations must be adapted and streamlined to encourage the widespread adoption of energy storage technologies. In many regions, market design issues as well as outdated network planning, connection, and permitting procedures contribute to delays in the deployment of energy storage systems.

Economic and financial barriers further complicate the deployment of energy storage. The impact of the ongoing uncertainty over renewable projects and energy markets more

broadly often makes investments unattractive for companies. Energy markets often fail to adequately provide the price signals that would allow developers of energy storage to make returns by taking up excess electricity when prices are low, and selling it back to the market when prices are high. Challenges such as the opening up of capacity remuneration mechanisms to storage and other non-conventional flexibility solutions, critical for incentivizing investments in long-term energy storage technology, prevail. Bottlenecks in manufacturing, as well as inflation, the high cost of capital, and prolonged payback periods contribute to the economic complexities of energy storage implementation.

Considering the social and environmental impacts is also paramount when relying on large deployment of storage in the future. The most notable example is reservoir-based hydropower. As mentioned, this is the most widely deployed form of electricity storage, but its significant social and environmental disruptions need to be considered.

Additionally, the mining and manufacturing processes needed to produce batteries, a growing form of energy storage, pose challenges around potential negative impacts. With batteries targeted to reach production levels of 965 gigawatt hours a year in Europe by 2030, the mineral demand for storage-related materials will increase drastically.

In navigating the path to widespread energy storage adoption, it is also essential to recognize that storage is part of a broader discussion on flexibility needs. Flexibility solutions, including those still in their infancy such as demand response of low-voltage assets, should not be pursued in isolation. Rather, we need them to be integral components of a sustainable energy ecosystem.

Expanding proven solutions

Achieving a fully modernized and decarbonized energy system undoubtedly hinges on expanded storage capacity. Yet we can also reduce the need for flexibility solutions through measures such as:

- improved energy efficiency
- higher connectivity
- so-called “dispatchable” renewables that can be deployed quickly to compensate for intermittent sources such as wind and solar
- demand response (using technical and policy measures to shift demand to times when power is more plentiful)

These solutions are complementary to energy storage, and should be pursued whenever cost-efficient.

The challenge of advancing storage involves both short and long-term strategies. In the long term, a regulatory and economic framework must support research, development, and deployment of seasonal storage technologies. Some thermal energy solutions, like aquifer and pit thermal energy storage, are already mature, but others can be incentivized.

For electricity storage, several technologies are still in development, such as utility-scale, zinc-bromide batteries. This emphasizes the crucial role of increased research and innovation activity and the need to avoid focusing on only a few solutions. As different technologies are necessary for different contexts, their potential can be limited in certain locations, and it is still uncertain which technologies will be most appropriate where. It is crucial, then, that when advancing these technologies we must also consider the environmental and social hazards they pose. Otherwise, negative impacts might simply be shifted, rather than reduced.

In terms of short-term solutions, given the urgent need for storage in the drive to achieve net zero, we must rapidly increase the deployment of commercially available technologies. Such innovative technologies that can boost energy efficiency and reduce costs include:

- smart charging of electric vehicles (EVs), allowing vehicles to charge at times of low demand and even supply power back to other appliances when needed
- giving discarded EV batteries a “second life” by assembling them in battery packs to store energy to power stationary applications
- flexible operation of thermal energy storage, including boilers or even new technologies such as thermal batteries

Rolling out technologies like these will empower citizens to engage in the energy transition, and will also therefore foster broader support for climate action. However, policymakers must also address fairness issues – for example, ensuring that support is provided to consumers who do not have the financial means to switch to these new technologies themselves.

In conclusion, advancing toward a modern and decarbonized energy system requires expanding storage capacities and fostering innovation. While short-term deployment of available technologies is essential, it should not impede the development of promising, long-term solutions. Staying open to various approaches, accumulating experience, and balancing short-term and long-term strategies with attention to the environmental and social impacts will significantly accelerate our progress toward a sustainable energy future. ■

// Policymakers must address fairness issues, ensuring that support is provided to consumers who do not have the financial means to switch to these new technologies

Every watt we save brings us closer to net zero

Improvements in energy efficiency are a critical component in our quest to reach net zero by 2050. While rapid technological advances suggest the transformation is possible, we must also direct efforts to overcome the many challenges – from financial to behavioral – that remain

By Emi Minghui Gui, System Lead – Energy, Climateworks Centre and Gill Armstrong, Senior Project Manager, Climateworks Centre

Achieving net zero by mid-century calls for all high-emitting sectors to bring down emissions intensity across the board. This will include electricity generation, heating, and electrifying hard-to-abate industrial sectors and the transportation sector. Across the spectrum of existing and emerging solutions, renewable energy and energy efficiency have proven the most fundamental and promising. Importantly, by harmonizing these two technologies we can provide

▲ Transmission lines from the Kali Gandaki 'A' Hydroelectric Project in Nepal. Typically, developing countries lose a large portion of their generated power in transmission: Pakistan, for example, can lose up to 35%

great benefits to society, helping to lower energy bills, saving billions in infrastructure investments, and strengthening energy security.

Energy efficiency is recognized as a "no regrets" option, contributing the most cost-effective mitigation actions in the race to net zero. However, complexities associated with business models, technical and financing challenges, as well as behavioral changes mean that energy-efficiency measures have, thus far, failed to reach adequate levels in many parts of the world.

Energy efficiency, in physical terms, can relate to the ratio between the useful output and input of an energy conversion process, through thermal, electrical, chemical, or luminous processes. In behavioral terms, energy efficiency can relate to minimizing the amount of energy used for a given, constant energy service. It also refers to energy conservation, or reducing energy consumption by using less of an energy service. It is a useful measure and indicator for the efficiency of a product, process, or behavior. In broader terms, energy efficiency can be improved throughout the whole energy supply chain in generation, transmission, and distribution, as well as from the demand side.

Technology is ramping up supply-side efficiency

Generation efficiency is important to bringing down unit costs of clean energy generation, and this can be achieved through technological advancement. Examples include more efficient solar cells and panels, wind turbines, development of the most productive sites for renewable energy, and increased grid flexibility for better utilization of renewable energy with more energy storage or smart grids.

Technological research and innovation has helped progress the development of more efficient solar cells, such that they are now surpassing 30% efficiency (10% more efficient than commercial panels used today), by using perovskite-on-silicon "tandem" cells, and other advanced technologies. If successfully scaled up, they could be commercialized within five years, helping to bring down the unit cost of solar electricity and enabling faster deployment of solar technology.

The largest offshore wind turbine now has nearly 20 megawatts capacity. Offshore turbines can take advantage of more stable wind resources over the sea (as opposed to land-based wind), to replace fossil fuel baseload power. Offshore wind technology can also benefit from being located close to large demand centers, which are often in coastal areas. Project scale, turbine size, and performance improvements have been shown to reduce the overall levelized cost of energy (LCOE), now averaging USD 0.13 per kilowatt hour (kWh).

The technology and cost of battery storage has also improved in recent years. It is now often considered as a practical solution to complement the variability of renewable energy sources such as solar and wind, and to increase the flexibility and stability of the grid.

Challenges, however, remain. Multifaceted barriers for large-scale renewable energy developments such as offshore wind and battery storage may include:

- complex technical requirements
- grid connection challenges
- regulatory uncertainty
- investment challenges
- governance issues related to contracting

Another strategy relates to optimizing spatial planning through the co-location of hydro-floating solar, wind and solar storage technologies, or other hybrid technologies, including nuclear and geothermal. This can help improve production and cost efficiencies by sharing sites, grid connection, and high-voltage transmission lines.

Achieving supply-side efficiency will require maximizing the utilization of zero or low-marginal-cost generation assets, and avoiding the curtailment of renewable energy outputs. Energy storage and co-location strategies aim to strengthen system-level optimization to improve the utilization of variable renewable energy assets, and thus the bankability of these projects.

Reducing loss through transmission and distribution (T&D) efficiency

Delivering electrical energy can incur energy losses en route, through heat (the joule effect), magnetic losses, and the dielectric effect (where energy is absorbed into the insulating material), as well as commercial losses. Average grid losses among Organisation for Economic Co-operation and Development (OECD) countries currently sit at around 7%, while in developing nations transmission losses can be as high as 20%.

Further, distribution losses can reach up to 50% due to inaccurate or inadequate metering, power theft, and other issues. Pakistan, for example, has seen some of the highest T&D losses in the Asia-Pacific region. Through issues including a weak grid, mismanagement, and weak governance in its power sector, Pakistan can lose up to 35% of the electrical energy it generates.

A Stanford University study indicated that reducing T&D losses by 1% could allow 1.6% to 5.4% of existing fossil-fuel plants around the world to be retired. Currently, there are over 2,000 gigawatts (GW) of coal-fired power plants still operating worldwide. Over 500 GW of these are located in developing nations that bear grid losses higher than the OECD average. This suggests that, on average, every 2% reduction in T&D losses would enable around 50 GW of coal-fired power plants to be retired. That would be equivalent to the capacity of the entire coal fleet in Indonesia or South Africa.

In a weak grid, system efficiency losses from renewable-energy curtailment (reduction of power production) can also be significant. This acts as a deterrent to renewable-energy investment in many developing regions. Better energy connectivity and grid efficiency can allow the transportation of renewable energy from more productive

sites to demand centers. For example, a UN ESCAP study on the 'Electricity Connectivity Roadmap for Asia and the Pacific' suggested that a fully developed power grid interconnection in the ASEAN (Association of Southeast Asian Nations) region could help reduce the average electricity cost by USD 0.02/kWh, while increasing the share of renewable energy to 62% of electricity supplied by 2050.

Key challenges for developing a regional grid that connects across countries include:

- multiple countries or stakeholders not acting in everyone's best interests
- the challenge of securing financing when costs, benefits, and risks cannot be allocated equitably
- political hesitancy in instances where national energy security would be dependent on other countries

Increasing demand-side efficiency

While it is essential for industry, the built environment, and the transportation sector to achieve net zero, demand-side energy efficiency can be delivered in various forms.

Despite hard-to-abate industries such as cement and steel depending on high heat and energy-intensive processes, new technologies or process improvements can be effective. For example, LC3 (limestone calcinated clay cement) requires lower temperatures for clinker (an intermediate output during the production process). This can reduce costs by up to 25% and reduce emissions by 40% compared with ordinary Portland cement (OPC). Another strategy is to utilize local or on-site renewable energy and electrification. If combined with a flexible, demand-side response, further efficiency gains and cost reductions can be achieved.

Other sectors, such as the built environment, present a different set of challenges. However, the adage of "reduce, reuse, and recycle" remains key to better efficiency. In a changing climate, buildings contribute a unique, synergistic role that is central to the survival of many. Energy-efficient buildings enable humans to adapt to a warming climate, while also mitigating climate change. A fabric-first approach prioritizes the energy performance of the thermal shell (external walls, floor, and roof) so that less renewable energy is needed to offset demand from appliances. For cities, this means all new buildings will have lower "upfront" embodied energy that are designed-in from the very beginning. On the other hand, existing buildings can be retrofitted or adapted and repurposed.

> *"To encourage long-term behavior change toward energy-efficiency practices from households and businesses, we need to address a range of motivations*

A key barrier to improving demand-side energy efficiency is for households and businesses to understand the true costs and benefits of energy-efficiency investments. This is not always immediate: an upfront cost is often involved for energy-efficiency upgrades, and economic gains from such investments accrue over a 10-to-15-year time frame. Attractive business models, often supported by government incentives or subsidies, are therefore critical to incentivize energy-efficiency actions.

The economics of these models can be further improved through enabling demand response across all sectors, to reduce peak energy demand. This, in turn, will help avoid the need to invest billions of dollars in T&D grid infrastructure and in additional generation capacity.

Efficiency and renewables go hand in hand

Without doubt, energy efficiency and renewable energy will need to progress in tandem for the world to achieve both Sustainable Development Goal (SDG) 7 (affordable and clean energy) and SDG 13 (climate action). Harmonizing both energy efficiency and renewable energy will not only improve energy security for nations. It will also help address energy affordability and optimize energy-related investments.

We need urgent and effective decision-making and wide-scale behavior change related to energy-efficiency solutions and practices. These can be promoted through regulations, policies, and incentives, such as minimum mandatory standards and energy labels. Financial institutions must also play an important role, not only through improving energy efficiency and renewable energy finance flow, but also developing green taxonomies and environmental, social, and governance (ESG) standards, and innovative financing products.

To encourage long-term behavior change toward energy-efficiency practices from households and businesses, we need to address a range of motivations. Additionally, accessibility of information and education will be essential to supporting decision-making processes in adopting energy-efficiency solutions and practices.

Vitally, supplying affordable and clean electricity for all people must be treated as a priority when tackling sustainable development, economic uplift, and poverty alleviation. Through coherent energy planning and national development planning, governments can view the inevitable, low-carbon energy transition as an opportunity to support socio-economic and environmental goals and development objectives. Achieving this equitably and efficiently calls for a holistic approach and a conducive enabling environment. We have every opportunity – but we now have no time to waste. ■

Green industry in middle-income countries

How can MICs, currently driving much of the world's growth, ensure that their rapid industrialization is sustainable?

By Yuen Yoong Leong, Director of Sustainability Studies, UN Sustainable Development Solutions Network (SDSN); Professor, Sunway University

Middle-income countries (MICs) are a diverse group of nations representing about a third of global output and nearly two-thirds of the world's poor. Many MICs are experiencing rapid economic growth and are making significant progress in reducing poverty and improving living standards, education, and technological innovation. They are increasingly integrating into the global economy, providing access to new markets and resources.

The choices that MICs make at this juncture will determine whether they progress upward to higher income, culture, intellect, biodiversity, and spirituality, or stagnate in the middle-income trap, or slide downward. If MICs choose and steer wisely, they might be able to decouple economic growth and emissions.

As wealthier countries offshore their industry and manufacturing, much of the burden of finding ways to decarbonize will fall to MICs. The greatest challenges lie in the mindsets of both sets of countries. This will determine what kind of transfer happens, how the transfer is designed and operationalized, and the kind of inputs that would be drawn from the wider international community. A higher consciousness must lead the mindset.

In 'Meaningful Manufacturing', Jim Platts (1945-2022) asked the question: "Why do we make things?" right at the beginning. This question must be answered by those who act.

Developed countries' mindset

When developed countries offshore their industry and manufacturing to MICs, the former has a moral duty to consider and mitigate the environmental and social impact of their move. They must not think that these problems will now be in a foreign country, and thus no longer their concern.

Those who know have an ethical obligation to act. How they act depends on their consciousness. Until Germany banned uranium mining in the country in 1990 due to economic, environmental, and social concerns, the country was the fourth largest uranium producer in the world. For the same reasons, France also stopped uranium mining on their soil in the early 2000s.

To supply 8,000 tonnes of natural uranium per year for France's 18 nuclear power plants and 56 nuclear reactors,

◂ Wind farms in Quang Tri province, Vietnam, funded by green loans from the Asian Development Bank (ADB). Within one generation, Vietnam has risen from being one of the world's poorest nations to being a middle-income economy

uranium mining was moved overseas. Niger, a lower MIC, has been supplying the French nuclear fuel cycle group Orano Cycle from its Somair mine for over four decades. The giant mine is 63.4% owned by Orano Cycle and 36.6% by Niger state mining assets company SOPAMIN.

Uranium mining and transportation are energy-intensive activities that draw heavily from fossil fuels. Large amounts of tailings (the waste material that remains after uranium is extracted from the ore) are produced and often stored in open pits or ponds (so-called industrial sediment ponds). These can release greenhouse gases (GHGs) such as methane and carbon dioxide. Not only that, uranium tailings can retain up to 85% of the ore's original radioactivity. Unsafe disposal of radioactive waste and water pollution have caused serious environmental concerns in Niger.

As France's nuclear power generation is set for substantial expansion in the coming years, so will the need for uranium. Access to uranium supply topped the agenda of French President Emmanuel Macron's historic visit to Mongolia – another lower MIC – in May 2023. Will France do better in Mongolia than it did in Niger?

Less developed countries have less financial and technological resources and weaker governance to control emissions and to solve toxic waste and systemic pollution problems. In a partnership, trustworthiness of the stronger partner is critical for the cooperative relationship to shine.

The definition of a developed country usually includes criteria such as high income, industrialization, high standard of living, and advanced technology. Besides these material criteria, development should also be measured in terms of moral leadership.

MICs' mindset

If a country has a climate target and is serious about it, it will need to be discerning about the kind of industry it welcomes and proactively minimize the negative environment and social impact. To synchronize a country's climate strategy and foreign direct investment strategy, government leaders need to be clear about their development priorities and goals, and develop the virtues of judgement and strength. Contradiction between the two strategies could be seen in the shift of Chinese steel production capacity to Southeast Asia in recent years.

MICs should seek out education and training for their policymakers, regulators, researchers, and business leaders on green industrial policies and practices. Technical assistance in developing green business models, supply chains, and national green industry strategies in MICs are also valuable. UK Partnering for Accelerated Climate Transitions (UK PACT) and the Stockholm Environment Institute (SEI) are shining examples of capacity builders.

Research collaboration that focuses on developing clean technologies for use in MICs can simplify technologies for local implementation, reduce cost, and improve accessibility. Besides this, databases and clearinghouses of clean technologies that are accessible to MICs can provide curated and actionable information and resources to businesses, policymakers, and the public. MICs should also leverage the Paris Agreement Technology Mechanism to access lower-cost financing for deploying climate technologies.

Dutiful enforcement of environmental laws will deter companies from polluting and ensure that they are held accountable for any environmental damage they cause. Where environmental standards are lacking, MICs should set strong ones.

Creating a green future

If MICs want to avoid competing downward to be a dumping ground for polluting industries from wealthier countries, they need to identify the kind of opportunities that offer big returns on investment. They must create technology roadmaps toward sustainable energy, health, medicine, and employment.

For example, the tropical soils of Southeast Asia were never glaciated and are a rich, untapped resource of microorganisms that have huge potential for use in industry, agriculture, and conservation. Mobilizing the knowledge communities to get this research going in Southeast Asia and drawing people to work here would be a highly worthwhile pursuit.

Road ahead

Everyone is part of the carbon problem, and everyone is part of the solution too. Increasing international cooperation on green industrial policies should be pursued at the upcoming COP28. These policies can include subsidies for renewable energy and modal shift from road to rail, tax breaks for energy-efficient businesses and green infrastructure investment, and regulations that limit emissions from industrial processes. Debt relief can also provide MICs with the financial resources they need to invest in green industrial policy.

International cooperation on green industrial policies can level the playing field between countries and create a more conducive environment for businesses that are investing in clean technologies. Diffusion of best practices, innovation, and effective green industrial policies will also increase in a collaborative and peer learning environment, as illustrated by the High-Level Regional Environmentally Sustainable Transport Forums in Asia. Policy dialogues are key to ensuring that investments and capacity-building support tomorrow's policies rather than yesterday's priorities.

Fundamentally, movers and shakers need to keep returning to Jim Platts' question of "Why do we make things?" Philosophy only has meaning in action. This requires confronting power, learning to recognize power in action, and responding, also with action. ■

Achieving net zero through innovation

Dimeta is a joint venture between SHV Energy and UGI International to advance the production and use of renewable and recycled carbon dimethyl-ether (DME), a low-carbon sustainable liquid gas, to accelerate the LPG industry's transition to net zero

By Frankie Ugboma, CEO, Dimeta; Chair, International DME Association

In light of COP28, the United Nations has shared a report on the progress towards the Paris Agreement. With only seven years left to meet the goal of the Paris Agreement of reducing emissions by 43% globally by 2030, the report shows that the world is not on track to meet net zero emissions by 2050.

One of the critical pillars of minimizing environmental and public health challenges is the need to move away from fossil fuels. Over one billion people live and work in rural, remote areas not connected to the main gas grid.

In these off-grid areas, gas and electricity networks are limited, leading to a heavy reliance on high carbon fossil fuels such as oil or coal, or cleaner liquified petroleum gas (LPG), for daily activities and operations such as heating, hot water, cooking, or generating power.

Another critical pillar is ensuring energy solutions contribute to improving air quality to protect the well-being of communities globally. Almost the entire global population (99%) still breathe air in their local environment that exceeds WHO air quality limits and severely impacts health.

There is no one silver bullet to achieving these aims. Instead, we must embrace a multi-solution approach and provide pathways to cater to the diverse energy needs of different locations and varying social and environmental factors across the globe.

Harnessing the potential of renewable liquid gases

One such solution is renewable liquid gases, which will play a significant role in the energy transition. Renewable liquid gases are derived from sustainable sources, providing a cleaner and low-carbon alternative to LPG.

Over 300 million tonnes of LPG are used annually across all six continents, of which 44% is in the domestic sector for applications such as cooking and heating, followed by the chemical sector (28%) and industry (10%).

While LPG emits less CO_2 and other emissions such as particulate matter (PM) than other fossil fuels – there is still a need to mitigate the environmental impact of LPG in the long term. Renewable liquid gases can be used

across various LPG applications as a drop-in solution to decarbonize the LPG industry on a pathway to net-zero emissions.

Circular solutions: Waste-to-DME

Renewable and recycled carbon dimethyl-ether (DME) is a sustainable liquid gas produced from a wide range of proven technologies and sustainable feedstocks, such as municipal waste. Renewable and recycled carbon DME can reduce greenhouse gas emissions by up to 85%, reaching over 100% savings if carbon capture is used. Future production pathways, including 'Power-to-X' utilizing CO_2 and renewable hydrogen, can cut emissions even further.

Renewable and recycled carbon DME is chemically similar to LPG and can be easily transported using the existing LPG supply chain as a liquid in pressurized cylinders and tanks. It can be blended into LPG up to 12% in existing off-grid heating, cooking, and industrial applications without modifying equipment or appliances.

DME can also be used in 100% pure form, particularly for large commercial and industrial users, with minor modifications to infrastructure and a dedicated DME boiler. Such is the attractiveness of DME as fuel for the future that leading global manufacturers are exploring 100% DME-dedicated appliances, including hot water production systems, boilers, and dryers.

Waste management in a circular economy

By 2050, worldwide municipal solid waste generation is expected to have increased to 3.4bn metric tonnes and according to the World Bank, almost two-thirds of this will end up in landfills and open dumps. The total municipal solid waste generation globally is 2.01 billion tonnes annually, of which nearly 33 per cent needs to be managed safely for the environment.

Each year, many countries worldwide export loads of recyclable waste to other countries, as this approach is more cost-effective than developing local recycling facilities. The global waste trade was worth approximately $98.3 billion from 1988 to 2016 for importing countries. Waste management is critical to the circular economy in helping minimize waste generation, promote resource efficiency, drive maximum value, and reduce the environmental impact of landfills on local communities.

In a waste-to-DME model, waste can be taken from the area local to a DME production plant and used as a feedstock to produce the molecule. The resulting DME can provide energy in the region while managing the feedstock supply chain, and producing the new fuel can also create long-term local jobs.

This circular approach makes 'waste-to-DME' a much more sustainable use of waste resources, prevents local pollution associated with landfills – especially in developing countries, which may lack the infrastructure and resources for safe disposal – and creates a low-carbon fuel that can power hard-to-electrify sectors.

Dimeta's first waste-to-DME plant in Teesside, UK, follows this innovative approach. This facility will produce over 50,000 tonnes of DME per year, equivalent to decarbonizing a quarter of the domestic LPG heating market. Moreover, this project will create job opportunities, with 250 roles during construction and 50 permanent positions when production begins, and will support indirect jobs in the feedstock and fuels supply chain.

Moreover, Dimeta is partnering with Enerkem on two large-scale projects, with each project anticipated to produce approximately 165,000 tonnes of renewable and recycled carbon DME per year from mixed residual waste expected to be located in Northwest Europe and the United States's Gulf Coast.

Renewable liquid gases can fuel a more sustainable and inclusive future. Converting waste to fuels is an innovative approach that can result in multiple socioeconomic and environmental benefits and offer an alternative energy source for the hard-to-abate sector.

We must do everything possible to protect public health and safeguard the Earth. After all, it is only through collective global efforts that we can secure a sustainable tomorrow for generations to come. ■

Dimeta

www.dimeta.nl

SDG Action thanks Dimeta for its generous support for this publication

► Mockup of Dimeta's first waste-to-DME production facility, which will be built in Teesside, UK

The snowball effect of supplier engagement

Scope 3 emissions, those outside an organization's direct control, are proving the most stubborn to reduce. Key to success is more companies working with their suppliers to adopt science-based targets throughout the whole value chain

By Maria Outters, Chief Impact Officer, Science Based Targets initiative

This year alone, we've experienced four of the hottest months on record and seen extreme weather events decimate local communities and economies. From floods in Greece that have caused billions of dollars in damage to Canada's worst wildfire season, everyone is feeling the Earth's final warning: cut emissions now before it's too late.

The Intergovernmental Panel on Climate Change (IPCC) established 1.5°C of global warming as the limit that our planet can tolerate before the effects of the climate crisis become irreversible. The pathway to prevent overshoot is clear: halve emissions by 2030 and reach net zero by 2050. Failure to do so could shave 11% to 14% off global economic output by mid-century. That amounts to as much as USD 23 trillion – around the size of the entire US economy – in reduced annual global economic output worldwide.

To remain within the 1.5°C temperature boundary while mitigating the human and economic cost of the climate crisis, we need ambitious action from the private sector.

That's what science-based targets are for: to enable businesses to set ambitious emissions-reduction targets in line with the latest climate science. The Science Based Targets initiative (SBTi) publishes criteria and guidance to help businesses understand how quickly and by how much they need to cut emissions to align with the IPCC's 1.5°C threshold.

But not all industries are the same. That's why the SBTi's sector-specific guidance ensures that businesses consider the unique context of their industry when developing targets. Recent guidance for the steel sector, heavily reliant on coal, acknowledged that the rate at which the sector can decarbonize may differ from the overall rate of decarbonization possible by industry as a whole.

Likewise, the International Energy Agency calls on sectors like maritime shipping – a major part of the global economy's scope 3 emissions – to decarbonize at a faster pace due to their impact on and interconnectedness to other sectors. The SBTi's maritime guidance takes that into account to enable shipping companies to align with net zero by 2040, rather than by 2050 as for most other sectors.

The scope 3 challenge

Setting and progressing against emissions-reduction targets for scope 1 (greenhouse gas emissions from sources an organization controls directly) and scope 2 (those it causes indirectly) is quickly becoming a reality for businesses across all sectors and regions. Yet scope 3 emissions (those outside of an organization's direct control, like those from its supply chain) remain a real challenge.

According to CDP, scope 3 emissions are 11.4 times larger on average than direct emissions. From data limitations to influencing suppliers, businesses have cited scope 3 as one of the biggest hurdles to setting and achieving science-based targets. Yet, as companies increasingly set those targets, they must account for their scope 3 emissions.

The first movement of businesses setting targets through the SBTi was concentrated in Europe, where market saturation of science-based targets remains high to this day. But the same companies quickly realized that addressing scope 3 emissions meant putting pressure on suppliers to cut carbon emissions, creating a snowball effect with global implications.

A supplier snowball effect

If you are onlline, consider the device you are using to read this. It had an origin story: it started its life in lots of little pieces, spread across different factories that potentially spanned countries and continents, sourced from ingredients gathered all over the world. Most likely assembled in China or somewhere in the region, the device was shipped to you wherever you happen to be. It's the origin story of most devices: a vast proportion of products originate

▶ Shanghai Port, China, the world's busiest port. An estimated 30% of global supply chains originate in China

© iStock

in some shape or form in Asia. Indeed, an estimated 30% of supply chains originate in China alone.

Until COVID-related disruptions, the fast-paced globalization that defined trade flows had a singular focus on cost. Although change was already afoot, the focus on costs for global supply chains is now giving way to an emphasis on resilience and sustainability.

Pressure on suppliers up and down value chains is already having a demonstrable impact, shown by the growth of science-based targets from the world's biggest supplying nations. In 2022, Japan had the highest number of companies setting targets, while China saw the steepest growth (194%) in the number of businesses with validated targets.

Tackling scope 3 through supplier engagement targets

That's why, in 2023, the SBTi launched its Supplier Engagement Guidance for working with suppliers to tackle scope 3 emissions. Welcomed wholeheartedly by end users and raw material purchasers alike, the guidance identifies key steps, including getting buy-in, identifying and assigning roles and responsibilities, and tracking progress.

The guidance is designed for companies that are considering, or have already set, supplier engagement targets. These targets commit a company to sourcing a certain percentage of goods and services from companies that have also set science-based targets with the SBTi.

By focusing on engagement with a defined set of suppliers in the near term, supplier engagement targets enable businesses to deliver on scope 3 ambition, even when granular emissions data is challenging to track or unavailable. Working through the guidance, businesses can evaluate, develop, and set supplier engagement targets, implement engagement programs, and fully understand what it takes to achieve these goals.

The benefits of such targets extend beyond emissions reduction – they can also result in higher-quality supplier relationships, which will enhance efficiency, transparency, and resiliency. This, in turn, can build credibility with investors, customers, and employees, who increasingly expect companies to take broader responsibility for impacts across their value chain.

Companies have also found supplier engagement targets easier to track, as they only need to take stock of which suppliers have set targets aligned to SBTi criteria.

Supplier engagement champions

AstraZeneca and H&M Group, two seemingly unrelated companies, have something deeply meaningful in common: both implemented supplier engagement programs to help rapidly cut scope 3 emissions around the world.

AstraZeneca's target states that 95% of its suppliers (by spend) covering purchased goods and services and capital goods, and 50% of its suppliers (by spend) covering upstream transportation and distribution and business travel will set science-based targets by 2025. By developing and executing its Sustainability Champions Network engagement program, AstraZeneca has been able to clearly communicate expectations for suppliers while also creating dedicated resources for supporting suppliers to set their own targets.

Securing top-down, internal buy-in was key to AstraZeneca implementing clear and prescriptive standards for suppliers. It has enabled the business to develop a host of resources for its supply chain. Organizing an annual supplier conference, offering internal webinars and training, and sharing clear reporting expectations has already prompted an 18% bump in the number of AstraZeneca's suppliers reporting emissions to CDP. This is especially significant given the low growth of science-based targets in the biotech, healthcare, and pharma sector.

H&M, meanwhile, has committed to reduce absolute scope 3 emissions by 56% by 2030, and is also using its own supplier engagement program to achieve absolute reductions. Suppliers submit emissions-reduction roadmaps to the company's sustainability team, including detailed achievement plans. This enables H&M to provide the support necessary for its supply chain to set science-based targets and start rapidly decarbonizing.

Meeting individually with suppliers each year, H&M can effectively communicate requirements for suppliers and in return provides consultations and audits to identify the biggest opportunities and challenges. To enable reductions from its suppliers, the company supports suppliers with sourcing renewable electricity and explores how to make it more readily available to them.

In its advocacy work, H&M works with governments in its production markets to raise awareness that access to renewable electricity will become a fundamental competitive advantage over the next few years, and urges them to take the necessary steps for reforming the energy markets.

From snowball to avalanche

The need for more ambitious climate action from the private sector is growing by the day. The supply chain can seem intimidating when it comes to sustainability – but it might also be where a company's biggest impact can be made.

We may be witnessing highly promising developments on scope 3, but now is not the time to slow down. We must accelerate, magnify, and multiply the snowball effect and drive exponential change, so that this flurry of activity becomes an avalanche.

The SBTi now calls on all companies and leaders: it's up to you to kickstart the avalanche of corporate climate action by engaging with your suppliers to set their own science-based targets, and for those suppliers to then engage their own value chain.

Together, we must reach a critical mass of exponential decarbonization to avoid the worst effects of climate change. ■

Prince Sultan Bin Abdulaziz International Prize for Water

Recognizing Innovation

Winners for the 10th Award (2022)

Creativity Prize

1) The team led by Thalappil Pradeep (Indian Institute of Technology, Madras, India)
for the creation and successful deployment of environmentally friendly "water positive" nanoscale materials for the affordable, sustainable and rapid removal of arsenic from drinking water. Team members include Avula Anil Kumar, Chennu Sudhakar, Sritama Mukherjee, Anshup, and Mohan Udhaya Sankar.


Dr. Thalappil Pradeep

2) The team led by Dionysios D. Dionysiou (University of Cincinnati, USA)
for the development of innovative advanced oxidation technologies and nanotechnologies for environmental applications, particularly in the removal and monitoring of emerging contaminants. Team members include Wael H.M. Abdelraheem, Abdulaziz Al-Anazi, Jiong Gao, Ying Huang, and Vasileia Vogiazi.


Dr. Dionysios D. Dionysiou

Surface Water Prize

Dennis D. Baldocchi (University of California Berkeley, USA)
for the development and implementation of effective models to understand, evaluate and predict evapotranspiration and water-use efficiency in various environments under climate change conditions.


Dr. Dennis D. Baldocchi

Groundwater Prize

Linda M. Abriola (Brown University, USA)
for pioneering research on toxic Dense Non-Aqueous Phase Liquids (DNAPLs) in groundwater, ranging from the simulation of their fate to effective methods for cleaning contaminated sites.


Dr. Linda M. Abriola

Alternative Water Resources Prize

The team of Menachem Elimelech (Yale University, USA) and Chinedum Osuji (University of Pennsylvania, USA)
for wide-ranging advances in nanostructured materials for next-generation water purification, focusing on implementation issues like manufacturing, sustainability, self-assembly, and biofouling.


Dr. Menachem Elimelech


Dr. Chinedum Osuji

Water Management and Protection Prize

The team led by Matthew McCabe (KAUST, Thuwal, Saudi Arabia)
for employing CubeSat constellations in the sustainable management and security of linked water-food systems, along with estimates of agricultural water use at unprecedented spatial and temporal resolutions and with global coverage. Team members include Bruno Aragon (KAUST) and Rasmus Houborg (Planet Labs, USA).


Dr. Matthew McCabe

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CCS: smokescreen, white elephant, or linchpin?

After decades of research, CCS has delivered only small carbon savings and has largely been utilized to extract more fossil fuels. But with most mitigation pathway models including CCS, what are its prospects – and ramifications?

By Ali Abdelshafy, Head, Climate-neutral industries research group, Chair of Operations Management, RWTH Aachen University; Grit Walther, Head, Chair of Operations Management, RWTH Aachen University

Carbon capture and storage (CCS) is one of the key decarbonization technologies, yet it is a highly controversial topic. This is most noticeable in the discrepancy in both the literature and roadmaps about the role of CCS in achieving carbon neutrality. Several pages are needed to explain the background to this conflict, but in this short article we aim to clarify the different standpoints.

For simplification, the industrial and power sectors consume fuels and raw materials to produce electricity, products, and (unfortunately) greenhouse gas emissions (such as CO_2). CCS implies capturing the CO_2 molecules from the flue gas at one location, transporting them a (long) distance, and storing them underground at another location. These locations could be in different countries or, probably, in different continents.

Such operations are not only expensive but are also associated with several technical challenges and social, legal, and environmental risks. For example, many carbon capture technologies are still under development. So far, transporting and injecting CO_2 have been on a small scale. Dealing with the expected immense amounts of CO_2 is unprecedented and there are fears about breakdowns (for example, leakages). Public acceptance is far from guaranteed, many legal issues still need to be resolved, and more standards have yet to be developed.

The three positions on CCS

With all this in mind, the standpoints regarding CCS can be classified into three categories, each with its own logic and reasoning: white elephant, smokescreen, and linchpin.

◂ The Petra Nova carbon capture facility on the right, connected to a coal-fired power plant in Thompsons, Texas, US. The carbon dioxide is used for enhanced oil extraction in an oilfield 80 miles away. Petra Nova was closed between May 2020 and September 2023 because it became economically unviable

The "white elephant" position focuses mainly on the challenges and risks associated with the CCS supply chain. Indeed, this standpoint has a valid logic due to the genuine complexities and uncertainties of the technology. The energy transition and industrial transformation are neither mild nor trivial changes. We are reshaping the industrial sector and reinventing all existing industrial processes and technologies. That's why the challenges and uncertainties are inevitable. Therefore, the goals have to be more realistic. The purpose should be to minimize the risks if we cannot avoid them completely.

The "smokescreen" view looks at CCS with much suspicion. Proponents of this standpoint see CCS as a strategy for the giant oil and gas companies to prolong their activities for as long as possible. It is indeed unfair to look at such suspicions as invalid conspiracy theories. The value of existing oil and gas infrastructure is truly gargantuan, and its owners are willing to go to enormous lengths to keep that infrastructure alive and yielding more profits.

Finally, the "linchpin" position is more pragmatic about decarbonization techniques. It considers CCS as a critical technology for achieving the climate goals. While there are also some extremists on this side, the moderates agree that CCS should be used only if there are no alternatives. A critical question then arises: what is the lower demand boundary of CCS technology?

Is CCS viable?

Let's imagine that today we have enough renewable energy sources to produce green power and fuels and to defossilize all industrial and energy sectors. Do we still need CCS? The answer is undoubtedly "yes," for two reasons.

First, industry generates process emissions that will continue to be emitted regardless of the greenness of the energy inputs. For example, the global cement industry is responsible for around 2.3 gigatonnes (Gt) of CO_2, of which 1.4 Gt are process emissions.

Second, achieving carbon neutrality (including of process or hard-to-abate emissions) is not the end of the story. We have to achieve negative emissions afterwards in order to retrieve the original levels of carbon dioxide in the atmosphere. To achieve this, CCS appears the most feasible option, if not the only one.

In terms of the higher demand boundary of CCS, we must ask another question: are we able to secure the required, significant amounts of renewable energy? The answer is "maybe."

Although the development of renewable energy has enjoyed several successes in the last decades, there have also been various failures. We are behind on some planned milestones, and the costs of some technologies (such as offshore wind) have not fallen as expected.

Upbeat voices may retort: "No problem! We can keep CCS as a back-up plan in case of emergency." Unfortunately, CCS is not like liquefied natural gas, which was called up to replace pipeline natural gas. The fundamental difference here is that CCS does not exist yet, which is probably the major misconception about this theme.

For a long time, the white elephant and smokescreen positions have rejected or ignored the CCS pathway, hoping instead for achieving higher deployment of renewable energy and for breakthroughs in industrial processes. Yet we all know by now that one of the main challenges associated with climate change is time. If we had the luxury of waiting till the end of century, probably other pathways could have been suitable. But we only have 27 years to achieve carbon neutrality in the EU, and even less in some countries (22 years in Germany). From both industrial and societal perspectives, this is undoubtedly a short time. As an extreme example, it took 30 years to build Berlin Brandenburg Airport from conceptualization to realization.

We need time not just to learn and construct, but also to factor in contingencies for unexpected events that the mega projects will undoubtedly include. For example, the demonstration and flagship CCS projects are currently facing several challenges. Therefore, we cannot follow a wait-and-see approach as it could be gambling on the survival of our planet. The urgency and criticality of climate change calls instead for a better-safe-than-sorry approach.

The doubts of the smokescreen position may be logical, but exaggerated claims can have negative impacts. Of course, we are not living in utopia, and there are always opportunists seeking to benefit from any circumstance, regardless of the consequences.

But this should not discourage us from taking the right decisions. Rather, we should take those decisions as well as other, follow-up actions to tackle any side effects that arise from those right decisions.

Concluding, we must urgently define the role of CCS in achieving carbon neutrality. We need relevant stakeholders to engage in transparent and science-based conversations. A wealth of experience has been collected in the last few years while developing renewables. We can therefore draw empirical conclusions about the achievability of the roadmaps for renewables, and the variance between the original plans and what's been implemented.

Similarly, we can derive concrete conclusions about the boundaries of CCS demand, and then let science, business, society, and policy react accordingly. ■

Land: from degradation to restoration

Is it possible to hold back, or reverse, large-scale degradation of land and tackle climate change?

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By Ibrahim Thiaw, Under-Secretary-General and Executive Secretary of the United Nations Convention to Combat Desertification (UNCCD)

We are only as resilient to climate change as our land is. Actions to avoid, reduce, and reverse land degradation can provide over one-third of the climate mitigation needed to keep global temperature increase in check by 2030. Such actions – and the resultant healthy land – can provide positive and lasting contributions to achieving the Sustainable Development Goals (SDGs).

And yet we are moving on an alarmingly wrong trajectory. The droughts, wildfires, and heatwaves we are witnessing around the world are symptoms of the deepening and interlinked climate and nature crises, with land at the heart of both.

Land restoration can be a cost-effective solution for combating climate change and biodiversity loss, as well as achieving food and water security, reducing disaster risks, improving public health, and advancing multiple other SDGs. But only if we act now.

The United Nations Convention to Combat Desertification (UNCCD) has just launched its first data dashboard. Compiling data from the national reports of 126 countries, the figures on the dashboard are staggering. Between 2015 and 2019, more than 100 million hectares of healthy, productive land were degraded every year – adding up to twice the size of Greenland.

If current trends continue, the world will need to restore a staggering 1.5 billion hectares of degraded land by 2030 to reach a land-degradation-neutral world (one that maintains or increases the amount of healthy and productive land resources), a target enshrined in the SDGs.

Latin America and the Caribbean, as well as East and Central Asia, are the worst-affected regions, with at least 20% of their total reported land area already degraded. Meanwhile, sub-Saharan Africa is seeing the rate of land degradation outpacing the global average. Some 163 million hectares of land across sub-Saharan Africa have succumbed to land degradation since 2015, which translates to more than 100 football pitches every minute.

Signs of hope

Despite these alarming figures, there are some "bright spots" that give hope that a resilient future is possible, with examples of countries across all continents effectively tackling desertification, land degradation, and drought.

In sub-Saharan Africa, Botswana has rehabilitated 1.42 million hectares through sustainable land management initiatives. In Central Asia, Uzbekistan carried out saxaul planting on an area of 1.6 million hectares to eliminate salt and dust emissions from the drained bottom of the Aral Sea. The Dominican Republic is restoring 240,000 hectares in the Yaque del Norte River basin and in cocoa production areas in San Francisco de Macoris province.

These examples show that reversing land degradation while tackling climate change and its impacts is indeed achievable. We know that healthy land plays a fundamental role in the fight against climate change.

Restoring degraded land on a global scale could sequester three billion tonnes of atmospheric carbon in the soil each year, offsetting around 10% of the world's current annual, energy-related emissions. These same changes can facilitate the adoption of low-carbon lifestyles, with benefits for health and well-being.

In a promising commitment toward building a more resilient future, 109 countries have set voluntary land degradation neutrality targets for 2030 and 21 more are in the process of doing so. Through large-scale land restoration initiatives in the Sahel, Southern Africa, and the Middle East, to name just a few, countries are mobilizing to restore degraded land and create sustainable jobs and livelihoods.

Investment and ambition

Although investments in land restoration are cost-effective and accessible to all, funding remains woefully inadequate. We need to invest more resources in the fight against desertification, land degradation, and drought, as well as climate change, if we are to achieve our global goals. We must pool our technologies and know-how and adapt our key policies to reverse current trends.

> *"Positive changes in the way we use land have enormous potential to help the world achieve truly sustainable development that is resilient to climate change*

Positive changes in the way we use land have enormous potential to help the world achieve truly sustainable development that is resilient to climate change. We have the power to bring land back to life, to turn degradation into restoration.

For this, we need to scale up ambition and investment. We still have a narrowly closing window of opportunity to reverse the current trends and not only meet, but even exceed, global land targets by 2030. This will give other SDGs – including climate – a much greater chance of being reached. ■

◂ Planting saxaul – a small, drought-resistant tree – to combat desertification in what was the Aral Sea in Uzbekistan. The country has planted 1.6 million hectares of saxaul to eliminate salt and dust emissions

Africa's call for action on adaptation at COP28

African nations have thrown down a united challenge to the world: developed countries must urgently partner with the continent to support a rapid increase in climate adaptation and sustainable development. After too many climate summits that have achieved agreement but fallen short on implementation, Africa needs COP28 to deliver on both

By Olufunso Somorin, Regional Principal Officer, African Development Bank; Linda Ogallo, Climate Information Services Expert, IGAD Climate Prediction and Applications Centre (ICPAC); Debisi Araba, Visiting Research Fellow, Imperial College London; and Tedd Moya, Oxford Martin Fellow, University of Oxford and Advisor, Smart Trade Africa

The global climate discourses and their coalitions are changing, with Africa now at the center of discussions. Two months after the inaugural Africa Climate Summit in Kenya in September 2023, many experts are still reflecting on the summit's key outcomes, particularly for Africa's position as we head to the 28th Conference of the Parties (COP28) in the United Arab Emirates. The summit's primary agenda was to change the discourse that frames Africa as a continent of "being helped" to one of "being partnered with" to take actions for global benefits.

The Africa Climate Summit was clear about its objective of presenting an Africa that is looking at a climate-positive growth trajectory: an Africa that sees itself as part of the global climate solutions framework. As an innovative, multi-stakeholder convergence of its kind, the summit catalyzed actions and strategic partnerships for accelerating the implementation of the nationally determined contributions (NDCs) of its 54 member countries. More importantly, the summit underscored the importance of adaptation and resilience-building as the central priorities for African households, communities, and governments.

"The Africa Climate Summit was clear about its objective of presenting an Africa that is looking at a climate-positive growth trajectory: an Africa that sees itself as part of the global climate solutions framework

As the global community looks forward to COP28, Africa is prepared for a more deliberate engagement with the rest of the world. The key topical issues for negotiation at COP28 are of deep interest to the continent, as they relate to NDC implementation. They include:

- the new collective quantified goal on climate finance
- just energy transition partnerships
- the global goal on adaptation (GGA)
- loss and damage
- nature-based solutions
- carbon markets
- the global stocktake (GST)

To assess global progress on climate action following the Paris Agreement, countries are required to conduct a GST, commencing this year (2023) and recurring every five years. The first GST, released last month, reported that we are not on track to achieve the 2015 Paris goals. The parties will negotiate a collective response to the GST findings at COP28. More importantly, insights from these GST findings could have implications on NDC implementation in-country, particularly on national adaptation actions, which remain the ultimate priority for Africa.

When it comes to adaptation within the GST under the Paris Agreement, two key elements of adaptation resonate deeply with Africa. The first relates to the adequacy and effectiveness of adaptation actions at national and local levels in reducing vulnerability to climate risks and shocks. The second relates to adaptation financing flows, both in quality and quantity, from developed countries to finance transformational adaptation interventions in Africa.

▲ Malamawa village, Zinder Region, Niger. The villagers are taking part in an FAO project testing Sahelian plants for reforestation

Elevating transformational adaptation actions in Africa

Many African countries are making progress with either developing or implementing their National Adaptation Plans (NAPs), which is linked to their NDC implementation. Ahead of COP28, African negotiators are keen to have the GST recognize the intrinsic links between adaptation and sustainable development.

Climate impacts undermine efforts across all the Sustainable Development Goals (SDGs), while implementing the SDGs enhances national and local adaptive and resilience capacities against climate change. That is why the effectiveness of adaptation actions (including elements of risks and vulnerability, planning, implementation, and financing) may not be left to African countries alone.

As we head to COP28, African stakeholders are currently advocating for a GST outcome that supports the operationalization of the GGA in three specific ways.

First, Africa remains consistent in its request for a development space and predictable means of adaptation implementation as the continent seeks to transition its climate-vulnerable economies and sectors into resilient development pathways.

Second, the widening adaptation implementation gaps in many developing countries undermine global climate actions. The Intergovernmental Panel on Climate Change pointed to the scarcity of multiple, transformational adaptation projects. At the same time, countries continue to lose 5% to 15% of their gross domestic product (GDP) to climate change, according to the African Economic Outlook 2022. Third, the anticipated GST decision at COP28 should adopt targets, indicators, and monitoring systems for adaptation action under the GGA framework.

Scaling up adaptation finance in Africa

The big elephant in the room is adaptation finance. At previous COPs, African delegations have pushed for key negotiations on scaling up adaptation finance flows to the continent. Sadly, even when negotiations or agreements have succeeded, implementation has often failed. A case in mind is the USD 100 billion per year committed by developed countries to support climate actions in developing countries during COP15 in Copenhagen in 2009, which is still to be fully mobilized. Financial resources have not matched political commitments and ambition for climate adaptation in Africa.

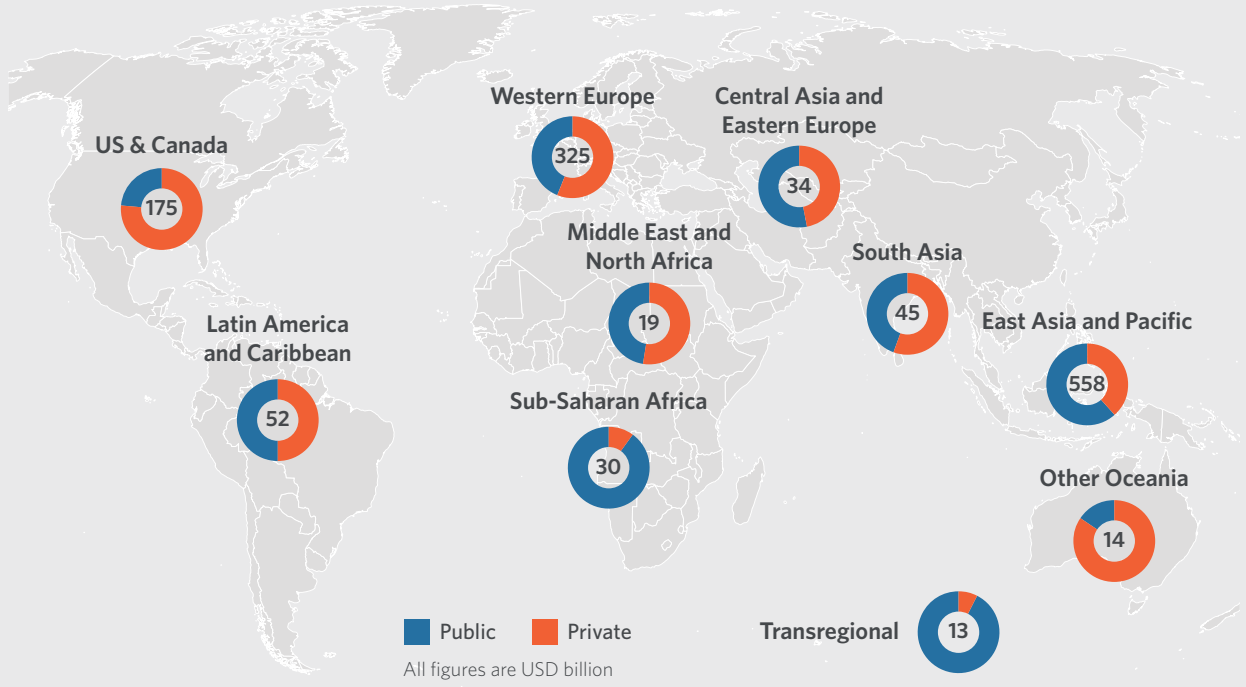
Global climate finance continues to be skewed primarily towards mitigation efforts, which received 91% of the total USD 1.27 trillion climate finance flows in 2021/22, according to the 'Global Landscape of Climate Finance 2023' published by the Climate Policy Initiative. Adaptation finance received a total of USD 63 billion, up 28% from USD 49 billion in 2019/20. But this still falls short of the estimated needs of about USD 300 billion annually for developing countries alone.

On regional distribution, the 50 sub-Saharan African countries received a total of USD 30 billion from both public and private capital. On a positive note, these African countries collectively strike a more balanced spread of financing across climate action areas, with mitigation accounting for 49% of climate finance flows, followed by 39% toward adaptation, and 12% to the dual benefits of both mitigation and adaptation.

Africa has 17% of the global population but contributes just 3.6% of global emissions. It is the most vulnerable to the effects of climate change, yet has received only 3.2% of the global climate finance. Here then is the paradox: the region that needs the most financial resources to respond to the climate crisis receives the least. This is happening at a time when countries' vulnerabilities are increasing as climate impacts are escalating. This is the real crisis of finance.

In our opinion, the cruxes of Africa's adaptation finance crisis in relation to NDC implementation constitute three interrelated points for reflection ahead of COP28 – a summit for which expectations of success are extremely high. The first relates to the total amount of climate finance. Current estimates of the adaptation finance gap in Africa are five to ten times more than the current international flows to Africa. The second relates to the significant impact of lack of private capital for adaptation. Private capital, admittedly, is the difference between mitigation and adaptation finance, not public capital. And the third relates to the criticality of achieving parity between mitigation and adaptation finance if we are serious about meeting global climate goals.

FIGURE 1: Destination region of public and private climate finance



Source: Global Landscape of Climate Finance 2023, Climate Policy Initiative

African leaders and key stakeholders at the Africa Climate Summit called upon the international community to partner with Africa in combating climate change. The continent already spends up to 10% of its GDP on climate response efforts. The summit called for bold and innovative financial mechanisms and instruments to restructure the global financial system that is currently tilted against Africa.

The Africa-Europe Foundation also emphasizes the need to reform the outdated system, stating: "Today's challenge is thus to reform a system that dates back to the 1940s, ensure it is fair, agile, and effective in the disbursement of funds, and bolster it through new sources of investment to match needs."

The upcoming COP28 GST and the recent Paris Summit for a New Global Financing Pact provide the ideal space for achieving a deep course correction, particularly in the redesign of climate finance governance with a focus on adaptation.

Finally, one of the key conversations emanating from the summit concerning adaptation finance flows is the need to develop a new "Compact for Africa's Climate Resilience" in which our NDCs and NAPs must transform into attractive investment opportunities. The African Development Bank, along with other development partners, remains committed to championing this at COP28 and beyond.

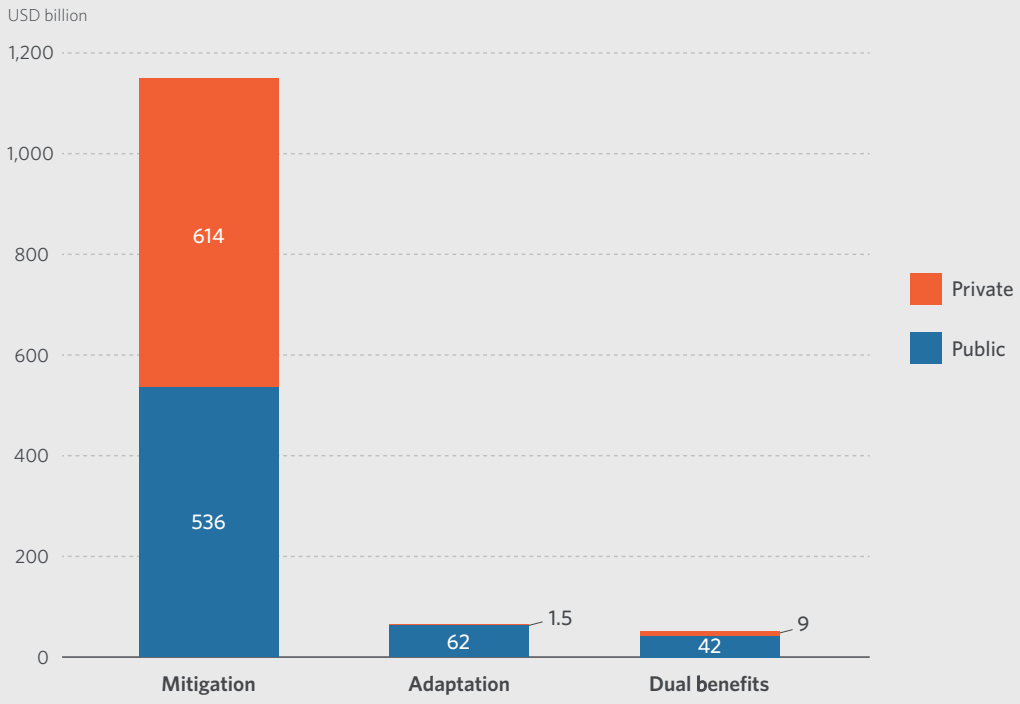
Looking ahead

African stakeholders recognize and prioritize the intersectionality between climate adaptation and the SDGs. The GST calls for transformative adaptation and urgency in climate mitigation. More importantly, this is a race against time. The science is clear: humanity is at the brink of a societal collapse if global climate actions are not rapidly accelerated in terms of scale and speed.

The Nairobi Declaration on Climate Change from the Africa Climate Summit serves as a basis for Africa's common position in the global climate process to COP28 and beyond. The declaration details African leaders' commitment to propelling Africa's economic development in climate-resilient and low-carbon pathways. This will happen through investing in policies, regulatory frameworks, planning, and programs consistent with the NDCs in all African countries.

But more commitment is urgently needed. Africa seeks new strategic partnerships that provide scalable financing mechanisms to support existing and new transformative adaptation interventions. For most Africans, the success of COP28 will be judged by its clarity on an international cooperation framework that truly puts Africa at the center of a financial flow system to drive a low-carbon and climate-resilient development. ■

FIGURE 2: Uses of climate finance with private-public splits



Source: Global Landscape of Climate Finance 2023, Climate Policy Initiative

Harnessing Africa's green minerals

Africa's vast natural wealth includes many critical minerals needed for the green economy. Historically, this wealth has not benefited local populations and resource extraction has caused environmental damage. How can Africa's peoples and environment become the beneficiaries of this natural bounty?

By Vanessa Ushie, Acting Director, African Natural Resources Management and Investment Centre, African Development Bank (AfDB) Group

Natural resources are an important catalyst for achieving the Sustainable Development Goals (SDGs). Most of the SDGs involve natural resource use, a reflection of the critical role of nature in driving economic performance.

In developing regions such as Africa, natural resources play a vital role in financing social amenities, infrastructure, energy, industry, and governance. Africa is rich in natural resources, which make up the continent's largest form of wealth. Indeed, 62% of Africa's gross domestic product (GDP) is composed of renewable and non-renewable natural resources and essential ecosystem services. The continent holds 30% of the world's mineral resources and ample solar, wind, and hydropower resources, as well as the world's highest technical potential for producing renewable energy.

Yet, amid this plenty is want – four in ten Africans live below the poverty line, and Africa has two-thirds of the world's poorest people, more than any other region. The jarring contrast between wealth and poverty has singled out African countries as victims of the "resource curse" – or the contradiction between natural wealth, poverty, growth, and conflict.

© iStock/ Michael Fuller

▲ Open-pit copper mining in Zambia. Africa has significant deposits of green minerals – critical inputs for clean energy technology – including cobalt, lithium, copper, manganese, graphite, and vanadium

It is fair to say that Africa has tried to overcome the gloomy predictions of the resource curse in the last decade, after the end of the "commodity supercycle" in 2015. However, climate change is showing the risks and limits of Africa's growth model of commodity dependence. While Africa has been the least contributor to carbon emissions, it is now the most climate-vulnerable continent. Climate impacts amplify risks to Africa's growth from external shocks like the COVID-19 pandemic, volatile commodity prices, geopolitical turmoil, and humanitarian crises. Building

resilience to climate change and other growth shocks in Africa is crucial if the world is serious about leaving no one behind. And the time to act is now, as the world strives to meet the SDGs by 2030.

Is this Africa's moment?

Africa can create new opportunities for sustainable development by leveraging its greatest form of wealth – nature. Africa holds significant deposits of green minerals that are key to the global transition to a net-zero future. Green minerals are critical inputs for producing clean energy technologies and materials – everything from solar panels, batteries, and electric vehicles (EVs), to green buses and bikes, smartphones, computers, and digital systems. Africa's green minerals include cobalt, lithium, copper, manganese, graphite, and vanadium, among others. Low investment in mining exploration in Africa means that the current publicly known values of green minerals are just the tip of the iceberg.

More than half of African countries have at least one of the green minerals and metals needed for the energy transition, which puts the continent in pole position to generate local economic benefits from clean energy value chains and industries. African countries like the Democratic Republic of the Congo (DRC) could influence global energy supply chains, as the DRC holds just over half of the world's cobalt reserves and produces 70% of the world's cobalt, a metal that is driving the battery and EV revolution. Demand for some green minerals (lithium, cobalt, graphite) is steadily rising and expected to grow fivefold by 2050, at the peak of the net-zero transition.

Despite the great promise of Africa's green mineral wealth, contradictions remain. DRC, like other African green mineral producers, is locked in the primary commodity trap: exporting raw, unprocessed green mineral ores, and losing out on lucrative and strategic value chain segments in downstream processing and manufacturing. The market value of the global battery and EV supply chain is expected to reach USD 8.8 trillion by 2025. Yet Africa's share of that chain remains relatively small, focused mainly on ore extraction, with a predicted market value of USD 55 billion in 2025.

A blueprint for just, inclusive energy transitions

For Africa to exit the commodity trap, a new compact is needed. This vision has been put into a new African Green Minerals Strategy. The strategy was crafted by the African Development Bank in July, is now being validated by the African Union, and will be formally adopted by African heads of state in 2024. The strategy will guide regional cooperation to develop green minerals assets based on four key pillars:

- enabling environment
- skills and technology
- value chains
- minerals stewardship

Success will depend on two factors:

1. Regional cooperation

A common industrial policy will help countries play to their strengths (for example, DRC and South Africa could be green industrial hubs) and reap economies of scale through pooled infrastructure, energy, technology, and exploration finance. The world's largest free trade zone, the African Continental Free Trade Area, which connects 1.3 billion people in 55 countries and boasts a combined GDP of USD 3.4 trillion, can be leveraged to develop end-to-end battery and EVs, renewable energy, and digital value chains in Africa.

2. Smart partnerships

African states, the mining industry, and investors should work collaboratively to define shared-value frameworks that allow Africa to meet clean energy demand in specific external markets, and (equally) build regional value chains for local production of green energy materials such as batteries, EVs and solar panels. This is the win-win outcome that will not leave Africa behind in the energy transition.

Local governance is also vital

The economic benefits of Africa's green minerals can be fairly distributed among local communities and social groups through good governance. Tackling corruption and curbing illicit natural resource outflows will mobilize significant financial resources for local development in Africa. Above all, building an inclusive economy rests on community participation and local ownership in environmental governance, to incentivize responsible resource use, promote resource efficiency and the circular economy, and apply robust standards for investors to "do no harm" to the environment.

From reliance to resilience

We can observe two broad types of nature (or natural resource) dependency in the world today: nature reliance and nature resilience. The distinction between the two lies in the creation of value. Nature reliance is a situation of high nature dependency and low localization of nature's values – which include economic, environmental, biophysical, and social values.

To build nature resilience, countries must then increasingly localize the values of natural assets in their economies. These include the returns from monetizing carbon sequestration asset values, and building regional value chains, local industries, and new jobs from green minerals assets. High levels of commodity dependence in Africa suggest that the continent is very nature-reliant. To build green, sustainable, and climate-proof futures, Africa needs to move from a position of nature reliance to one of nature resilience.

In conclusion, Africa's natural assets are vital to a sustainable future. Its green minerals are powering the global clean energy transition. Let's make Africa's green minerals work for Africa. Let's build an Africa of nature resilience. ■

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Climate exodus? Protecting vulnerable communities

How do we protect the ever-increasing numbers of people forced to abandon their homelands due to the devastating impacts of our warming planet?

By Mariam Traore Chazalnoel, Senior Policy Officer, International Organization for Migration (IOM); and Ileana Sînziana Puşcaş, Thematic Specialist on Migration, Environment, Climate Change and Risk Reduction, IOM

We are now firmly on the front line of the global climate change crisis. In the words of United Nations Secretary-General António Guterres: "The era of global warming has ended; the era of global boiling has arrived." And this has direct consequences on migration. Rich or poor, countries across the world are experiencing and having to manage the movement of millions of people linked to sudden disasters and slow environmental degradation.

A new normal?

Disasters that displace millions of people generate news headlines almost every day. In 2022 alone, over 32 million people were newly displaced by sudden disasters such as storms, cyclones, and floods. Disasters occurred in both developed and developing states. No country is immune to them, and no country can afford to ignore their impacts on the movement of people.

In South Asia, 1.7 million people were displaced by Cyclone Mocha. Storm Daniel wreaked havoc across the Mediterranean in early September, resulting in devastating loss of life and the displacement of 40,000 people in Libya alone. In Canada, in the month of August, 168,000 people were evacuated due to wildfires, the highest figure ever recorded for the country. In Europe, Italy reported its highest disaster displacement figures in more

◂ Sofala Province, Mozambique: people displaced by Tropical Cyclone Eloise wait for food at a temporary shelter

than a decade, as storms and floods hit in April.

Many communities still experience prolonged hardships linked to displacement that occurred in previous years. In Pakistan, for example, displaced communities were still recovering from the 2022 monsoon floods when heavy rains hit in June 2023. This led to an increase in waterborne and vector-borne diseases. Already vulnerable people experienced new displacement.

Slow changes, big impacts

The climate crisis also has insidious and less visible impacts on where, how, and why people move.

In some parts of the world, climate impacts slowly change the environment people live in. Some places are becoming too hot or too cold for humans to survive, seas are rising, and land is degrading. This erodes people's livelihoods, but also their health and their ability to remain in their homes. For many, this means migrating from countryside to cities to look for jobs as agricultural productivity drops, as seen in many sub-Saharan African countries. For others, it means relocating with their entire community away from receding coastlines, as seen in island states in the Pacific.

Slow changes in the environment alter the traditional patterns of mobile communities. We see, for instance, pastoralists leaving the northern Sahel earlier in the season, as rainfall patterns change. These changes can in some cases create conflicts with sedentary communities, as seen in Niger. And soon we might see stateless people, as some small islands slowly become unhabitable.

In most parts of the world, sudden disasters and slow-onset impacts come together, often with devastating impacts for people who might be forced to move to protect their lives and livelihoods.

The cost of immobility should also not be underestimated. In some cases, communities and individuals are trapped and cannot move out of risk's way, due to poverty or lack of social networks.

What lies ahead?

What lies ahead of us is not yet written. We can still choose to develop the policies and implement the programs that will shape the next decades.

1. Early action on climate adaptation is vital to offer people dignified choices

When and where it is still possible, strengthening climate adaptation and scaling up prevention, preparedness, and risk reduction measures increase people's resilience to climate shocks and contribute to sustainable development. These offer people the choice to stay and live dignified and safe lives in their areas of origin.

2. In cases where climate impacts are irreversible, migration needs to be considered within loss and damage plans and policies

The current global negotiations on loss and damage finance offer the international community the chance to create a new climate finance instrument. This new fund can help fill existing gaps and address some of the harmful climate impacts on migration, including by facilitating planned relocation of communities away from danger zones.

3. We need to remember that migration can be an opportunity for countries and individuals

Well-governed migration contributes to human and economic development, including through the USD 647 billion sent in remittances in 2022. To deliver on the promise of migration, governments should look at offering regular migration pathways to populations living in areas most exposed to climate change. This includes labor migration opportunities that support income diversification and boost skills in countries experiencing labor shortages.

Better evidence, more inclusive cooperation

To achieve the above, we need stronger data and stronger partnerships. Evidence and data are needed to help decision-makers respond to current challenges. But we need to look beyond the present and the immediate future and ensure that evidence and data inform anticipatory action. Only then can we avoid the worst of future impacts.

Developing solutions should involve every segment of society, including mobile populations, women, indigenous communities, and youth. With their voices at the table, the international community can develop policies and programs that are connected to the realities on the ground. We don't yet fully comprehend how technological innovations such as artificial intelligence can help address climate impacts on migration. Stronger partnerships with the private sector can help unlock this potential.

The linkages between climate change and migration are complex and far-reaching. Every single Sustainable Development Goal (SDG) is of relevance. For instance, achieving Goal 15 (life on land) can help agricultural communities find alternatives if they do not want to migrate from rural to urban areas. On the other hand, achieving Goal 11 (sustainable cities and communities) can help those who have chosen to migrate to cities live safely and access new educational and work opportunities.

Implementing the SDGs, but also the Paris Agreement on Climate Change and the Global Compact for Safe, Orderly, and Regular Migration, is key to translate global commitments into action that positively changes the lives of communities and individuals on the ground. We cannot afford to fail. ■

What role can carbon markets play in preserving forests?

Evidence is mounting that forest carbon offset credits are not working. Can a new approach, based on countries and companies making wider contributions to climate action beyond offsetting emissions, save the world's forests?

© CIFOR/Marlon del Águila Guerrero

By Tim Clairs, Principal Advisor, Climate and Forests, United Nations Development Programme

Ever since REDD+ (reducing emissions from deforestation and forest degradation) burst on to the international scene at the climate change negotiations in 2008, market-based transactions of forest carbon have been envisaged as a way of transferring billions of dollars of climate finance. The hope was that funds would flow not just to the governments of tropical-forested developing countries but further on to indigenous peoples, forest-dependent local communities, and those protecting forests.

To date, this has not happened. Of the market-based climate finance that has flowed during the past 15 years, it has been primarily through REDD+ projects in the voluntary carbon markets (VCMs). This has not been anywhere near sufficient to ensure the preservation of the world's great forest biomes.

After slowing slightly in 2021, this year's 'Forest Declaration Assessment' reports that global deforestation rates increased in 2022. Some 66,000 square kilometers of forest were lost, putting the world 21% off track to meet the goal of ending deforestation by 2030 set by more than 140 countries at COP26 in Glasgow (after previous pledges of ending deforestation by 2020 were already missed).

With the rapid increase in companies setting net-zero targets and committing to offset their emissions, there was great hope that VCMs, through REDD+ projects, would drive climate finance to forests. However, since an article published in The Guardian in January this year revealed that "more than 90% of rainforest carbon offsets by the biggest certifier are worthless," there has been a steady stream of news reports questioning the integrity – indeed, the validity – of REDD+ VCM credits.

In mid-October, The New Yorker published a long exposé on the Kariba mega-project in Zimbabwe – one of the largest REDD+ projects. Forest carbon projects like this are responsible for about a third of all carbon credits certified by Verra, the world's leading standard setter for VCMs. Now with the reported collapse of the Kariba project and the price of REDD+ project carbon credits at an all-time low, project-level REDD+ offset credits are mortally wounded.

In addition to the issues raised in the press, it is becoming clear that transition plans to net zero that are considered "high integrity" will only allow a small proportion of a company's value chain emissions to be offset with forest carbon project credits. So, while REDD+ project credits might continue to be developed as offsets for residual emissions within value chains, and while project methodologies, monitoring, and carbon accounting data will continue to improve, such credits are unlikely to be highly rated. What's more, there will always be questions regarding the integrity of these carbon offsets.

Yet REDD+ is essential if the global community has any chance of meeting the Paris Agreement targets by 2030. There is certainly a need to reward tropical-forest developing countries for the efforts they make in reducing deforestation and forest degradation.

Are there market mechanisms other than project credits that can direct desperately needed climate finance to these countries to support their Paris Agreement ambitions (referred to as nationally determined contributions, or NDCs) and help preserve forests?

Jurisdictional REDD+ offset units

Under the United Nations Framework Convention on Climate Change (UNFCCC), REDD+ does not include project-level methodologies. VCM REDD+ projects took off separately while the UNFCCC approach was still being negotiated. The UNFCCC takes a "jurisdictional" approach (J-REDD+), where reductions in emissions from deforestation and forest degradation are measured against national, historical levels based on the government's national greenhouse gas (GHG) inventory.

Many of the integrity concerns raised with REDD+ VCM credits are better addressed at the jurisdictional level – for example, leakage, inflated baselines, inflated methodologies, or lack of additionality (GHG reductions are not considered additional if they would have happened anyway without a market for offset credits). Moreover, tropical-forest developing countries have been building their capacities to deliver J-REDD+ results for the past 15 years. J-REDD+, therefore, has the potential to supply the largest volume of high-quality, nature-based climate results.

> *Hopes are high that jurisdictional approaches could be a game-changer in the carbon market, with the potential to deliver large-scale, high-quality issuances*

The market for J-REDD+ is just getting going, with the creation of an international standard for J-REDD+ credits called TREES. There has been initial interest from the market for TREES units, as evidenced by the LEAF Coalition. Hopes are therefore high that jurisdictional approaches could be a game-changer in the carbon market, with the potential to deliver large-scale, high-quality issuances.

However, J-REDD+ still faces issues – such as carbon rights and permanence – that make it hard to scale up as offsets. The first TREES units

◂ View from a community in Picota province, Peru, the site of a CIFOR study on REDD+ safeguards and benefit-sharing

were only issued at the end of 2022 (for Guyana) and these were a particular type of TREES units called "high forest, low deforestation" (HFLD) units – for which there are questions about the appropriateness of using as offsets.

No other TREES units have been issued yet. Furthermore, the TREES standard is not universally accepted. The Coalition for Rainforest Nations has tried to introduce competing "REDD.plus sovereign credits." There have been few buyers for these units, but it has caused confusion and added to the uncertainty about REDD+ in the offset market.

Forest ITMOs

"Internationally transferred mitigation outcomes" (ITMOs) were created under Article 6.2 of the Paris Agreement to allow countries to collaborate on achieving their NDCs (referred to as "cooperative approaches"). What is unique about ITMOs is the requirement to include a "corresponding adjustment" during the transaction – meaning the emissions reductions or carbon removals are deducted from the host country's NDC when they are added to the purchasing country's NDC.

Some think corresponding adjustments can solve the integrity concerns associated with forest carbon, making J-REDD+ a perfect match either for sovereign buyers needing to meet their NDC targets, or even for companies looking for "Paris compliant" credits.

Blue Carbon, a sovereign-backed private company based in the United Arab Emirates, has actively entered the market looking to buy forest ITMOs. It has signed memorandums of understanding with several African countries and has had discussions with Suriname – the first country to announce it will be putting forest ITMOs on the market (4.8 million tonnes of CO_2e HFLD units).

Some debate continues as to whether forests are included within the ambit of an ITMO. This speaks to the esoteric nature of UNFCCC COP decisions. While there are no specific Article 6.2 eligibility limitations, ITMOs still need to meet requirements to ensure the environmental integrity of the mitigation outcome. This includes the requirement that ITMOs are real, verified, and additional – and manage risks of non-permanence. This could make it hard for forest ITMOs to be considered as high integrity.

Although there is currently very little "case law" for either J-REDD+ or forest ITMOs, neither solves the fundamental limitations of forest carbon (especially emissions reductions) being used as offsets. Whether it is a country wishing to use forest carbon offsets to meet its NDC target, or a company wishing to use forest carbon offsets to achieve its net-zero target, both will continue to face the same "greenwashing" risks that have already been exposed with VCM REDD+ projects. It's hard to avoid the conclusion that forest carbon credits are simply not suitable as offsets.

Beyond value chain mitigation

Is there another market-based approach for forest carbon? There is an emerging concept of "beyond value chain mitigation" (BVCM) contributions as complementary to offsets. BVCM is where a company contributes to the collective global effort to reach net-zero emissions. The mitigation action is not used to offset the company's emissions. Instead, the buyer makes a "contribution claim," representing a contribution to both the company's climate goals and to global mitigation efforts.

The rationale for BVCM is that:

- companies should be thinking about their role in the global net-zero transition, beyond abating their own emissions
- companies that do not take clear, credible climate action today – and go beyond commitments, to delivering on targets in line with the goals of the Paris Agreement – risk having their corporate reputation hit
- there are important sources of emissions outside corporate value chains, such as those linked to subsistence agriculture
- government policies are not yet sufficiently ambitious to deliver a 1.5°C future

In this way, a company would not be purchasing J-REDD+ credits to offset its own emissions. Instead, it would decarbonize its own value chain and use the purchased J-REDD+ credits to demonstrate that it is making a contribution beyond its own value chain.

This concept is being advocated by the Science Based Targets initiative (SBTi), widely considered to be the main driver of high-integrity, net-zero targets. SBTi states:

"Companies should take action or make investments outside their own value chains to mitigate GHG emissions in addition to their near-term and long-term science-based targets. Examples include purchasing high-quality, jurisdictional REDD+ carbon credits that support countries in raising the ambition on – and, in the long-term, achieving – their nationally determined contributions."

BVCM is perfect for forests. When J-REDD+ credits are not being used to offset actual value-chain emissions but are being claimed as a "climate contribution," debates such as whether to use emissions reductions versus carbon removals become moot. It also makes the inherent risks (permanence, baselines) more acceptable and questions such as who owns the carbon rights under J-REDD+ more manageable, as a tradeable, commoditized asset is not created.

It is not yet clear if there is a demand for BVCM, but a strong case can be built if BVCM claims are recognized and rewarded. An analysis conducted by Systemiq for SBTi in 2021 found that almost 70% of surveyed companies felt that the private sector should be doing more than abatement of value chain emissions.

If BVCM climate contributions take off, we may finally have found a role that carbon markets can play in preserving forests – and a way to reward tropical-forest developing countries if they can halt deforestation by 2030. ■

SDG ACTION

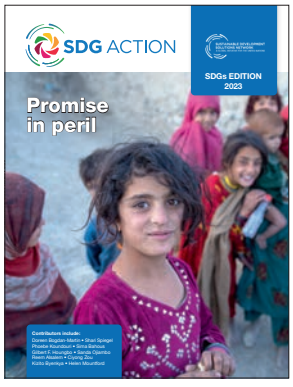
SDG Action was launched in 2021 to support the UN's Decade of Action. Its aim is to encourage cross-sector dialogue and problem solving to accelerate the transition to sustainability.

A resource for sustainability practitioners in all sectors, it brings timely analysis of the most pressing challenges. Its emphasis is on identifying opportunities and providing tangible ways to accelerate progress.

The website (www.sdg-action.org) features articles from world-leading experts on all aspects of the Sustainable Development Goals (SDGs) and climate action.

Two print editions are released annually, to coincide with major global diplomacy events. These editions provide a framework to understand the complex interdependencies between the SDGs, highlight priorities and dilemmas, and suggest ways to make the greatest impact, fast. The print editions are carbon-neutral and sustainably produced. The carbon emissions generated in manufacturing the paper, and printing and distributing the publications are offset. The paper used is FSC-certified from sustainable sources.

Please contact us at info@sdg-action.org if you would like to share feedback and ideas or would like to be involved.



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Science for climate policy

The **Global Climate Hub** (GCH) provides science-based solutions for combating the climate crisis. As an offshoot of the UN Sustainable Development Solutions Network, it harnesses a global network of experts.

The GCH works with all relevant stakeholders to design country-specific action plans. It functions in 9 interlinked units that reflect the stages a country will transition through until it achieves climate neutrality and resilience.

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Located at the ReSEES Laboratory of AUEB and SDU of ATHENA Information Technologies Research Center, the GCH is supported by the Atmospheric Physics Department of the Academy of Athens. The organization is chaired by the world-renowned natural resource economist, Professor Phoebe Koundouri.

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