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COP 26—EXAMINING THE BABALNCE BETWEEN AMBITIOUS PLEDGES AND REALISTICS EXPECTATIONS

INTRODUCTION

James Henderson

The 26th Conference of the 197 Parties (COP) who make up the UN Framework Convention on Climate Change will take place in Glasgow, Scotland, from 1 to 12 November 2021. Negotiations will be conducted in the shadow of the dire conclusions reached by the Intergovernmental Panel on Climate Change (IPCC) in their Sixth Assessment Report, published in August 2021. This categorically reaffirmed that human activity is warming the planet and that 'climate change is already affecting every region on Earth, in multiple ways. The changes we experience will increase with additional warming.'[1] It also urged that 'stabilizing the climate will require strong, rapid and sustained reductions in greenhouse gas emissions and reaching net zero CO_2 emissions.' As a result, this COP is already being seen as one of the most important international gatherings for decades, with consequences which could impact not only the global environment but also political and commercial relationships between all the countries and regions involved.

The gathering in Glasgow will be important in its own right, as countries gather to discuss key issues around their environmental objectives and strategies, but significant work is also being done in advance of the COP as countries announce their updated nationally determined contributions (NDCs), which pledge their individual commitment to the overall targets for reducing global emissions. The initial NDCs were set after the Paris Agreement at COP 21 in 2015 and were due to be reviewed and updated every five years. The COVID pandemic interrupted the process in 2020, and so 2021 has become the year when most countries are submitting new plans, with an increasing number committing to net-zero-emission targets. A number of individual country and regional strategies will be discussed in articles in this edition of the *Forum*.

However, while commitment to new NDCs is clearly a vital part of the COP process, implementation and the mechanisms to help achieve that will be the main areas of negotiation in Glasgow. A number of these have been carried over from COP 25 in Madrid in 2019 because they were too difficult to resolve then, and so they promise to be areas of contention again.

The first concerns carbon market mechanisms, which would allow countries and companies to trade both carbon credits and carbon offsets across borders. The potential terms of this trade are outlined in Article 6 of the Paris Agreement, but issues over definition, measurement, reporting, and verification have meant that no proposals have been accepted by all the parties to date. However, as carbon trading is seen as essential to the success of a cooperative global effort to reduce emissions, it will certainly be a topic of major interest in Glasgow, and a number of the articles in this edition touch on this issue.

Another area of significant contention is finance, both to help fund the energy transition in developing countries and to pay for damage caused by climate change and investment needed to adapt to it. Discussions over the $100 billion of annual funding promised, but as yet never delivered, by developed countries are already being framed as vital to unlock negotiations with less developed countries, and these same countries also remain dissatisfied by the lack of a promised mechanism to fund payments when vulnerable countries experience loss or damage from climate change. It is certainly possible that failure to agree on these issues could derail the whole COP, and again a number of articles in this edition address this topic.

Other important subjects will include a debate around the role of nature-based solutions, CCUS and other new technologies in helping to reduce emissions, with some seeing them having a vital part to play while others see them as an excuse for hydrocarbon producers and consumers to maintain the role of hydrocarbons for as long as possible. In addition, there will be a discussion around the time frames for NDCs, with the question being whether they should target change over a five- or ten-year period. Those looking for greater ambition and scrutiny are keen to see a shorter time period mandated. Finally, there will also be a focus on the topics introduced by the UK, as president of this COP, which include the following:

- **Adaptation and resilience—**helping people, economies, and the environment adapt and prepare for the impacts of climate change
- **Nature—**safeguarding ecosystems, protecting natural habitats, and keeping carbon out of the atmosphere
- **Energy transition—**seizing the massive opportunities of cheaper renewables and storage
- **Accelerating the move to zero-carbon road transport—**ensuring that by 2040 over half of new car sales worldwide are electric
- **Finance—**unleashing the funds which will make all of this possible and power the shift to a zero-carbon economy.

[1] IPCC Press Release, 9 August 2021, "Climate change widespread, rapid and intensifying"

The articles in this special edition of the *Oxford Energy Forum* aim to provide both an overview of some of the key themes that will be addressed at COP 26 and an in-depth analysis of some of the core issues. The edition opens with an article by *Malcolm Keay*, who provides a review of some of the key developments in the climate debate since the Paris Agreement was signed in 2015 and also looks at some of the key challenges that lie ahead after COP 26. He concludes that the issue of climate change is being taken much more seriously now by many constituencies, and that there is an awareness that concrete action is needed. However, the bad news is that the challenges are complex and intractable, requiring significant coordination between sectors. Furthermore, the need for huge amounts of investment, especially in developing countries, is paramount and could prove to be a very difficult negotiating issue.

Mari Luomi then offers her thoughts on what to expect from COP 26 and highlights the fact that the conference will progress along three key tracks. The first concerns intergovernmental negotiations, which will address the implementation of existing climate agreements. The second, which is linked to the first, will see high-level diplomacy aimed at raising the climate ambitions of countries across the world through a series of new agreements and pledges. The third will then address the need for multi-stakeholder cooperation around specific themes and sectors, which will involve NGOs and other participants promoting key initiatives such as the Race to Zero campaign. However, the key question will be whether any of these three tracks can deliver concrete results, and Luomi argues that the credibility of the COP process relies on the outcome.

Alessandro Terzulli and Carlo Papa continue the theme of the challenges facing COP 26 by outlining their thoughts on how the conference can be made a turning point for the climate debate. They argue that the COVID pandemic has helped to focus the minds of politicians and policymakers on the role of the state in taking key, entrepreneurial, decisions while also paying attention to ensuring equity in society. Furthermore, a realization of the impact that human activity has on the planet and the need to change our behaviours has emerged along with an understanding of a need for better risk assessment around climate issues. These lessons can be taken into the COP 26 negotiations and provide some hope of a positive outcome.

In the next article, *Jorge Blazquez* provides some important context for the COP 26 negotiations by examining five key lessons that can be learnt from the IPCC net zero scenarios. The first is that huge improvements in energy intensity are needed over the next three decades; the second is that renewables will actively replace gas and coal, but the link with oil is less clear; thirdly, natural gas will act a bridge in the transition process, especially over the next decade; fourthly, carbon capture, utilization, and storage (CCUS) will be a key technology to achieve net zero emissions; and finally, there is more than one pathway to a net-zero outcome and as a result multiple options and technologies need to be considered.

James Dyke, Wolfgang Knorr and Robert Watson pick up the theme of net-zero scenarios, but they challenge their usefulness in the COP 26 negotiations. They fear that net-zero targets place an excessive reliance on carbon reduction technologies to achieve climate objectives, and that assumptions around the development and use of these technologies create a 'burn now, pay later' mentality which could actually do more harm than good. They urge policymakers to avoid making ambitious assumptions about speculative technologies and to focus on the need to actively reduce emissions throughout the global economy.

Raphael Heffron then takes the debate in a slightly different direction by underlining the importance of discussion of a just energy transition at COP 26. He argues that all the stakeholders in the climate debate must work together to find solutions and that to ensure this the diplomatic and policymaking community must appreciate the different starting points of many countries, some of whom are, and will remain, reliant on fossil fuels for some time. He also argues that courts may also have a key role to play in enforcing climate justice, especially to enforce rules around decarbonization and the impact of emissions on future generations.

Two more articles continue this theme of equity and cooperation. *Arunabha Ghosh and Vaibhav Chaturvedi* provide a view from India and highlight that if net zero ambitions and targets are to have global legitimacy then they must avoid widening inequalities both within and across societies. Climate justice needs to become an integral part of the toolkit in environmental negotiations, with past actions and new opportunities being considered in the context of a just transition. *Grzegorz Peszko* then outlines his thoughts on a theory of change for global cooperative climate action, in which the focus must be on the need to incentivize countries which are most reluctant to change, with international assistance likely to be needed to encourage low-income and politically fragile fossil-fuel producers to cooperate.

The second half of this special edition then focuses on regional and country plans ahead of the COP 26 meeting, outlining and explaining pledges that have been made and negotiating positions that are likely to be taken in November. We start with the EU,

which has led the climate debate from a policy perspective, and *Klaus-Dieter Borchardt* provides a view on the bloc's perspective on the challenges of COP 26 and achieving net zero targets. He discusses the key policies that the EU is in the process of implementing and argues that these will be presented at COP 26 as an invitation to other countries, in particular China and the US, to join in the endeavour and to catalyse cooperation at a global level. He highlights the Carbon Border Adjustment Mechanism (CBAM) as a key tool which the EU plans to use to initiate negotiations with its trading partners, and *Alex Barnes* picks up this topic with his article on the potential consequences of the CBAM. He points out the need for a mechanism to avoid carbon leakage and suggests that the CBAM could become a catalyst for global carbon pricing, although he acknowledges that getting agreement within the EU, never mind in the broader global community and with the WTO, will be challenging.

Moving slightly outside the EU, *Antony Green* then provides a corporate perspective from the UK, highlighting a number of new policies that have been put in place to achieve a net-zero goal. The announcement of a hydrogen strategy in August 2021 is one major driver of action, and is an example of the UK government's hope that the energy transition can drive a green industrial revolution. However, as Green points out, for this to work in the UK and elsewhere, clear policy direction will be needed and incentives will need to be provided to encourage rapid change.

Moving outside Europe, *Ken Koyama* provides a perspective on the position of Japan in the light of the country's ongoing revision of its strategic energy plan. More ambitious targets for emissions reduction by 2030 and 2050 are expected to be set, but again uncertainties remain around the future role of nuclear power and the development of key technologies for renewable energy, hydrogen production, and energy efficiency improvements. In addition, Koyama notes that Japanese society must be prepared for both higher costs and changes in behaviour, which could be difficult to implement politically.

Adnan Shihabeldin and his co-authors continue the discussion on nuclear power and its role in the energy transition in a more general article in which they make the case for this source of low emission electricity. They discuss its current role within the energy system and its potential for expansion but also note that it has not been acknowledged within the COP negotiations. They argue that it should not be excluded from consideration and suggest that its climate benefits can be obtained without major safety or cost implications.

Michal Meidan then looks at China's climate ambitions and their view of the COP26 negotiations. Following the country's commitment to a net zero emissions target by 2060, China has laid the groundwork for it to play a leading role in climate negotiations, but its position as the world's largest GHG emitter also places it in a difficult position. In addition, geopolitical differences with the USA and other western and Asian nations also complicate the negotiations around environmental targets and the global policies needed to achieve them, and as a result Meidan concludes that China's position at COP 26 may be rather ambiguous.

Brazil starts from a different position, as it is already a major producer and consumer of renewable energy. *Clarissa Lins and Bruna Mascotte* describe a dichotomy in the country's position as it approaches COP 26, because it is both a leader in low emissions and a laggard because deforestation has now become a major issue. The authors argue that Brazil must address this latter issue, in particular with regard to the Amazon rainforest, as well as addressing the issues raised by the growth of its oil and gas industry, if it is to regain a position as a leader in climate diplomacy and exploit the opportunities that could be available in the trading of carbon offset credits.

Irina Gayda and Tatiana Mitrova then provide a perspective from Moscow, in which they suggest that, after a long period when the Kremlin largely ignored climate change, it is now being seen as an important issue and potentially an opportunity, both commercially and geopolitically. The threat to the country's hydrocarbon exports is now acknowledged, but Russia's potential as a provider of clean energy (including hydrogen and renewable electricity) is being explored. Furthermore, the country is keen to promote its potential role as an expanding carbon sink, but at COP 26 it is more likely to focus on preventing policy choices that undermine its position than on making bold statements about its climate ambitions.

Noura Mansouri and Aisha Al-Sarihi outline the stance of Saudi Arabia on climate negotiations, with the central view being that the interests of all participating nations should be taken into account. They argue that specific energy sources should not be targeted, but that the focus should be on a technology-neutral strategy for reducing carbon emissions. Saudi Arabia is promoting a circular carbon economy approach which considers different national circumstances with the priorities being to reduce, reuse, recycle, and remove carbon within the economic cycle.

Bassam Fattouh, Wolf Heidug, and Paul Zakkour provide further thoughts on this theme as they consider CCUS and the role of oil- and gas-exporting countries. They argue that, although CCUS has not begun to play a major role as yet, it should be included in discussions at COP 26, where the question of sharing the costs between producers and consumers should be considered. In this way exporters will be incentivized to play a more active role in the energy transition, and the cost of CCUS can be brought down over time as its use is expanded.

COP 26: THIS TIME IT'S SERIOUS

Malcolm Keay

This article looks back at developments since the Paris Agreement was adopted in 2015 at COP 21, and forward to the challenges which will be facing governments, consumers, and voters following COP 26 in Glasgow this November. It does not directly assess the likely course of COP 26 itself (which is the subject of other articles in this edition of the *Forum*), though it does try to bring out the potential scale and implications of the commitments which may be entered into then. The general message of the article is that this time it's serious. Serious in two senses—first, that there are many signs that governments, companies, and consumers are now taking the climate threat more seriously than in the past; but second, that the challenges they are facing are now more serious, and it is not clear that all concerned are yet conscious of the full scale of the problems involved.

Developments since Paris

Perhaps the most positive development since COP 21, from a climate perspective, is that the issue seems now to be taken much more seriously. A previous edition of the *Forum* (OEF 105), analysing the Paris Agreement, commented that, while rapid change was already under way for the electricity sector, 'for the oil and gas industries the challenges seem to be more to do with the medium- to longer-term. Perhaps as a result, investment markets seem distinctly uninterested in either the challenges or the opportunities offered by the low-carbon transition.'

It also noted that most governments were still picking the easiest options—what might be regarded as the low-hanging fruit:

> At present, energy policy for decarbonization has a fairly narrow focus—support for renewable sources (particularly in electricity) and energy efficiency feature in most countries' plans. But these measures alone will not deliver the emissions reductions the Agreement says are needed, and the narrow focus could create distortions within the energy sector, add to the cost of the transition, and delay progress. The suspicion must be that governments are concentrating on this narrow set of measures because they raise fewer problems, in particular in relation to consumer acceptance.

The Paris Agreement was based around the idea that emissions targets would steadily tighten over time in successive meetings of the Conference of the Parties. Since these targets are nationally determined and there is no specific enforcement mechanism to ensure tightening, some were at the time uncertain whether the process would be robust enough to ensure the necessary acceleration of effort. But there have been signs that progress is being made:

- A new goal has emerged, of reaching net zero carbon emissions. Although new, this goal is ultimately driven by the Paris Agreement, which aimed at 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels'. As a target, net zero was formalized in 2018, when the Intergovernmental Panel on Climate Change (IPCC) produced a report entitled *Global Warming of 1.5° C*. The report introduced the objective of reaching and sustaining net zero global anthropogenic CO_2 emissions in order to meet the Paris target. Countries representing nearly three-quarters of global output have now committed to net-zero targets, most by 2050. The recent publication of the latest and most alarming IPCC Assessment Report can only increase the pressure to strengthen these undertakings during the negotiations at COP 26.
- Governments and vehicle manufacturers have now made firm commitments to the introduction of electric vehicles (EVs)—in the UK, for instance, sales of new gasoline and diesel vehicles will be banned from 2030. Many manufacturers have also made strong commitments to EVs—for instance, Jaguar Land Rover intends to sell electric vehicles only by 2025.

- The investment community, and many national courts, are now alert to climate risks. Both Chevron and ExxonMobil have recently had to respond to shareholder pressure over their failure to set out convincing strategies for a low-carbon future, while Shell has been required by a Dutch court to set tighter emissions targets. Around half of global funds under management have now committed to net-zero targets.
- Serious discussion is now taking place on other sectors, like industry, and on the options available for decarbonization, like hydrogen.

Challenges following COP 26

In the normal course of events, one could expect those concerned to consider the consequences of any commitments they take on. But it is not entirely clear that governments, companies, or consumers have fully recognized how challenging the goals described above are—as a result of the time scales involved (relatively short in energy terms) and the zero-emissions targets, which leave little room for manoeuvre.

This applies even to the low-hanging fruit described above, renewables and energy efficiency. These may have seemed like easy options when emissions targets were relatively distant or appeared readily attainable, but in the light of the net-zero targets they present more fundamental challenges.

- For instance, when intermittent renewables are first introduced to a conventional electricity system, they can be accommodated without much difficulty. But as the penetration increases, the problems of system balancing also increase, and over time lead to radical change. When targets were less stringent, operators could rely on retaining a few fossil plants on the system to provide flexibility. But with the zero-emissions targets, many systems are now facing the prospect of 100 per cent renewables generation, which necessitates a completely new mindset. For instance, the UK System Operator has said that, while it believes it can cope with zero-carbon electricity production, it will need to 'fundamentally change how we plan, analyse and operate the electricity system'. Moving to zero carbon is more than just a matter of changing the sources used; it means changing every other aspect of the system too—including electricity markets, company business models, and consumer behaviour.
- Similarly, energy efficiency is acceptable enough when it just means better insulation or more efficient appliances. But to meet zero-carbon targets, much more fundamental changes might be needed—reducing use of private transport and shifting to different transport and heating modes, new approaches to urban planning and house design, and new work patterns. Governments have not highlighted these issues, and there are few signs that consumers are yet willing to accept the implications of more ambitious targets—witness, for instance, the June referendum in Switzerland which rejected the idea of a wide-ranging carbon tax, and the recent nervousness in UK political circles about the planned phasing out of gas and oil boilers in the mid 2030s.

But these problems are relatively manageable when compared with the wider issue facing governments of fundamentally rethinking their whole approach to energy policy. If the electricity industry is gradually realizing that it needs to reconsider every aspect of its activities, the energy sector is the electricity sector writ large. As with electricity, decarbonization is more than just a matter of changing the sources used; everything about the way the system operates will need to change. The big difference is that while electricity has always been recognized as a system, energy has usually been approached in terms of the individual fuels and sources. So the need for new thinking will be even greater, and there are as yet no signs that most governments have recognized the problems, much less responded effectively.

In the past, sectoral interactions in energy have been very limited. Transport has been dominated by oil, appliances by electricity, and process energy by the dominant fuel in the country concerned (coal, gas, or oil, depending on availability and acceptability). Policy could be made for individual sectors without much need to consider the wider consequences. But in the zero-carbon future, all sectors will be interlinked, whether by electricity or hydrogen or some combination of sources. The whole energy system will have to be planned, analysed, and operated in an integrated fashion. Governments will have to take these difficult steps not just at the national level, but in an international context—the whole world will have to make the zero-carbon transition if serious damage to the climate is to be avoided or mitigated.

This does not necessarily mean central control by governments (which might well be the least effective option). But it does require government decisions on many fundamental issues:

- **Infrastructure:** If we are not going to end up by default in an all-electric energy system (not necessarily the optimal solution), new infrastructure will be needed—for instance for hydrogen and perhaps for carbon capture, use, and storage. Governments will inevitably have a role to play, given the natural monopoly characteristics and environmental implications of such infrastructure. They will have to create the conditions for developing the necessary networks—even those countries now committed to liberalized markets developed their gas and electricity networks under some form of monopoly protection and/or subsidy, and little thought has been given to other routes. So it is likely that governments will have to take a view on the right type, location, and mix of infrastructure—and do so on a system basis, across the whole energy sector. For instance, transport may need to be a mix of electric and hydrogen vehicles (hydrogen seems at the moment a more likely option for heavy freight). Similarly, in the UK, a 'hybrid' approach to residential heating is under discussion, which would involve heating homes mainly by heat pumps but with peak demand met by hydrogen boilers. Whether it is a question of planning the energy sector as a whole, or of devising policies to ensure the efficient and coordinated development of new infrastructure, governments will be in completely new territory.
- **Coordination and optimization:** When it comes to the operation of this new, more complex energy system, governments do not need to undertake the necessary optimization themselves. But if they expect markets to do it for them, they need, at a minimum, to ensure a consistent approach to pricing and taxation across and within sectors. At present, we are far from such an approach in most countries. For instance, the costs of renewables support in most countries are borne by electricity consumers; gasoline is taxed more highly than other fuels; many industrial consumers enjoy special treatment in terms of carbon taxation. These inconsistencies distort decision-making—for instance, the policy costs incorporated in electricity prices make switching to electricity unattractive for many fuel users, yet governments expect electricity to form the backbone of the decarbonized energy economy. So governments will need to make clear their vision, not just for the infrastructure itself, but for how it will be coordinated and optimized, what changes to pricing and taxation will be involved, and so on. They will have to come clean about the extra costs involved for consumers or taxpayers, and the changes in behaviour and technology use which will be required.
- **Financing:** The decarbonized energy system will not necessarily be more expensive in the long run than a fossil-fuel-based system, but it will certainly require enormous amounts of investment as the transition takes place. The International Energy Agency (IEA) puts the investment needs at $4 trillion a year in the 2030s, roughly three times the current level. Governments do not have to finance all the investment themselves, of course, but they will have to create conditions in which the necessary funding is forthcoming—and goes to the right places. Given that much of the investment needed is not economic under the current price regime, some sort of public underpinning will be required at the national level, whether in the form of carbon taxes or targets, subsidies, or secure revenue streams like feed-in tariffs. At the international level, the problems are even more acute, especially for poorer developing countries, which are unlikely to have access to the necessary funding. To get agreement on sufficiently rigorous global targets at Glasgow, the rich countries will have to make a firm commitment to help finance decarbonization in the developing world, but unfortunately there is already a climate of distrust about their good faith. As part of the Paris Agreement, rich countries committed to provide $100 billion per year to developing countries by 2020 and extend that commitment for another five years, to 2025. It is not clear whether this target is being met—only around $80 billion was being provided in 2018, and more recent figures are affected by the COVID crisis. In any event, even $100 billion per year is a relatively small amount compared with the IEA estimates. This could well prove one of the most difficult aspects of the Glasgow negotiations.

These are major tasks, but the consequences of failure could be enormously expensive. For instance, in the UK the National Infrastructure Commission produced a report on *Smart Power* in 2016 which calculated that, within the electricity sector alone, choosing the right mix of storage, interconnection, generation, and demand response could save the country £8 billion a year by 2030. The potential savings are even greater in the longer run, as cross-sector coordination becomes more important. A report by the Carbon Trust for the Business, Energy and Industry Department in May 2021 estimates that flexibility across the whole energy system could save £10 to 17 billion a year by 2050.

Furthermore, despite the extra investment involved in building the new infrastructure for a zero-carbon economy, a recent study for the UK Climate Change Committee on *Accelerated Electrification and the GB Energy System* showed that an integrated approach across the whole energy system could actually lead to lower prices: 'While rapid deployment of electric vehicles and

hybrid heat pumps and new renewable generation capacity will require new investments, together they could reduce the cost per kWh of electricity.' If such opportunities are foregone, the cost of (and political opposition to) the changes needed in the transition to zero carbon could prove insurmountable.

Conclusion

There is therefore good news and bad news for the policymakers who are shortly due to assemble for COP 26. The good news is that the world now appears to be taking the climate challenge more seriously: all energy sectors, along with the investment community, show awareness of the need to take action. However, there is also less welcome news—that the challenges which will face governments after COP 26 are much more complex and intractable than those they have encountered hitherto. Promotion of renewable electricity sources and energy efficiency will no longer be sufficient; policy will need not only to address the sectors which are more difficult to decarbonize, but also to evolve mechanisms for optimization and coordination between the sectors, nationally and internationally. This is a new frontier for most governments, and they have not in most cases even started to develop appropriate policy tools to meet the challenge.

While the negotiations at the Glasgow meeting are likely to be difficult enough in themselves, it may be possible to get to a positive outcome via the traditional diplomatic tools of compromise and the use of finance to ease the way to agreement. But the challenges thereafter, in actually delivering on the commitments agreed, will be of a different order, and the world's future well-being may depend on how successfully governments rise to these challenges.

WHAT TO EXPECT FROM COP 26 ON ENERGY AND EMISSION TARGETS

Mari Luomi

Will energy and net-zero emissions targets be at the core of the talks at the 2021 UN Climate Change Conference? Yes and no. Will the conference deliver major outcomes in these two areas? Most likely not.

Setting realistic expectations for the next UN Climate Change Conference, also known as COP 26, is a nuanced task. Creating the impression that the conference will deliver major outcomes with direct impacts on national and corporate policies has both its advantages and disadvantages: if well managed and coordinated, a perception of a milestone event can push actors to raise the bar on their climate change pledges. However, overestimating what a COP can deliver can also lead to disillusionment with, and eventually loss of credibility of, the multilateral climate regime. Think of Copenhagen 2009 or Madrid 2019.

What does this mean in practice as we approach the next session of the Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC COP), expected to be held in Glasgow in November 2021? This short article unpacks how the UNFCCC deals with energy and net-zero targets—and how it doesn't—and what this means for COP 26.

The long road to COP 26

But first, how did we get here? Why are expectations around COP 26 so high? The year 2020 was supposed to be a 'super year for nature': on the climate governance front, it marked the first year of implementation of the Paris Agreement. A large number of countries were expected to table new or updated nationally determined contributions (NDCs) with higher targets for greenhouse gas (GHG) emission reductions. Instead, with the COVID-19 pandemic, the global climate agenda was largely reduced to calls for green stimulus and recovery measures. Prospects of badly needed increases in climate finance from developed to developing countries fell through the floor.

There have been some bright spots on the way. In September 2020, China announced a carbon neutrality target for 2060. In the US, Joe Biden's election victory in November 2020 meant a strong return the global climate governance table by the leading historical emitter. The US government is now working hard on many fronts: to catch up on four lost years of federal-level policy, to rebuild international credibility as a leader, and to bring other major emitters on board with more ambitious medium- and long-term targets. Also during the past year, net-zero emission targets have risen to become a central signalling and trust-building tool for governments and industrial players alike, alongside the medium-term NDCs.

Despite concerns around convening thousands of international participants at a single venue, COP 26 is expected to take place physically in Glasgow, UK, in November 2021. At the time of writing, in July 2021, the UK government and the UNFCCC Secretariat have indicated plans to go ahead with an in-person event and are working to ensure both vaccines and entry to the country for all delegates.

This would mark the first major physical multilateral environmental governance gathering since the start of the pandemic. Developing countries are opposed to formal negotiations taking place virtually, because of the access-related challenges many delegates continue to face and because many developing-country groups operate through daily coordination meetings, which are more complicated in an online setting. Face-to-face negotiations are therefore the only way to advance the multilateral regime.

Beyond this pandemic-related logistical milestone, both the UK government and the UN have sought to brand COP 26 as a crucial event. Numerous other governments and non-state actors too have worked to keep up the momentum on raising ambition of pledges and action. As a result, a general expectation seems to be that something big either could or should happen at this year's conference, particularly around ambition in mid- and long-term emission targets. But exactly what can COP 26 be expected to deliver, and how?

Not one but several conference tracks

The key to understanding how the UNFCCC COPs currently operate is to view them as three partly intertwined conference tracks, each with a different set of actors and purpose. First, at the core are the intergovernmental negotiations, which take stock of the implementation of the existing UN climate agreements (the UNFCCC, Kyoto Protocol, and Paris Agreement) and explore ways to further strengthen the multilateral response.

These negotiations involve diplomats, lawyers, and other technical experts, and focus on a pre-agreed agenda, which itself is often the subject of difficult negotiations as it needs to reflect and respect everyone's interests. Due to an absence of agreement on voting rules, this negotiating process relies on consensus-based decision-making and consequently often moves at a glacial pace—the main source of frustration for most observers of the process.

Second, intertwined with the intergovernmental negotiations are growing numbers of high-level events and platforms that take place around and during the two-week COP sessions. Energy, environmental, and other ministers' role at COPs has traditionally been to unlock unresolved issues in the final days of the negotiations, but a large number of bilateral and other meetings also take place in the sidelines, involving discussions beyond the nitty-gritty of the UNFCCC negotiations. Many of these talks relate directly to national-level climate and energy policy. Recent years have also seen the emergence of a heads-of-state-level meeting organized at the start of the COP, with the stated aim of raising ambition ahead of the negotiations.

Third, climate COPs also mark the major annual global climate fair, which brings together a diverse array of stakeholders from governments, civil society organizations, researchers, businesses, and international organizations around knowledge exchanges, networking, and, perhaps most importantly, informal coalition-building. This function is known in academic literature as orchestration: faced with a scope of action far exceeding its mandated focus on national governments, the UNFCCC has sought ways to remain at the centre of global climate governance by creating a multitude of platforms for so-called non-party stakeholders to coalesce around to raise ambition and showcase action.

So how is each of these tracks expected to take up energy, NDCs, and net-zero targets at COP 26?

First track: the intergovernmental negotiations

From a strictly technical perspective, among the most important tasks of COP 26 is to finalize the implementation rules for the Paris Agreement, which became operational in 2020. This entails agreeing on the rules for cooperation on market and non-market mechanisms under Article 6, working out the specific formats for country reports on climate action and support, and setting common time frames for NDCs.

From a more political perspective, COP 26 also needs to show some progress on issues that developing countries regard as crucial to enable them to reduce emissions and cope with climate impacts. Based on statements made at the virtual June 2021 sessions of the UNFCCC Subsidiary Bodies, the key to unlocking agreement on many of the previously cited rulebook-related items will be progress on adaptation, loss and damage (namely, impacts of climate change on societies that societies cannot cope with), and finance.

Starting negotiations on a new collective goal for climate finance for developing countries post-2025 will be one step in this direction, as are advanced discussions on the Global Goal on Adaptation and making the delivery of support to vulnerable countries already suffering from loss and damage more concrete. For oil-exporting countries, giving sufficient attention to the issue of response measures (the knock-on effects of other countries' climate action, including to reduce fossil fuel consumption) will also be crucial.

None of this is directly related to countries' national climate targets or their energy policies. On the intergovernmental negotiations track, little should therefore be expected around long- or even short-term emissions targets. This is an important distinction to make, as failing to understand this—or a failure by a COP presidency to communicate this—can lead to misplaced expectations regarding what the UNFCCC process can deliver.

What the Paris Agreement mandates and what it does not

While energy accounts for 73 per cent of total global GHG emissions, and most of the issues under negotiation involve changes to how we produce and consume energy, the Paris Agreement itself does not contain a single substantive reference to energy. Under the agreement, domestic energy policies and climate plans are a matter of countries' own determination.

As for medium-term emission targets, while the Paris Agreement sets some rules and boundaries for how and when countries are expected to communicate and implement their NDCs, it does not mandate assessments of how ambitious individual countries' plans are and does not formally require most countries to raise the ambition of their pledges until 2025. The first global stocktake, where countries' efforts are looked at collectively, will only take place in 2023, to inform NDC updates in 2025.

On net-zero emissions targets, the Paris Agreement provides even less guidance: the agreement refers to achieving collectively 'a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century' (Article 4.1) and requires countries to submit 'long-term low greenhouse gas emission development strategies' (Article 4.19). However, there are no explicit references to national-level mid-century net-zero targets. The 2018 Intergovernmental Panel on Climate Change report on Global Warming of 1.5°C had a major role in shaping the current global discourse, which is increasingly focused on net-zero emissions around 2050.

Second track: high-level diplomacy for higher ambition

High-level diplomacy *around* the UNFCCC has been another major force in driving the idea of net-zero targets up the global agenda. It has also delivered stronger calls for countries to update their NDCs. More agile than the consensus-based UNFCCC negotiating process, high-level diplomacy functions as a crucial complement to the multilateral rules-based regime.

UN Secretary-General António Guterres has for years been pushing for governments and non-state actors to raise their level of ambition, including through the 2019 Climate Action Summit and the 2020 Climate Ambition Summit, co-convened with the UK and France. The 2020 summit delivered new commitments from 75 leaders. In April 2021, US President Joe Biden hosted the Leaders Summit on Climate, which delivered further pledges from major emitters.

Most of these pledges have focused on either higher emission-reduction targets for 2030 (in the form of NDC updates) or mid-century net-zero emissions targets. However, a fair share of attention has also been dedicated to discussions and pledges around climate adaptation and finance, in line with longstanding UNFCCC principles and calls from developing countries.

In Glasgow, this high-level diplomacy track is not expected to deliver a new ground-breaking deal or even significant new announcements from many major emitters. As noted above, the next collective NDC-related milestone, the global stocktake, will only take place at COP 28. After Paris, with the proliferation of high-level climate summits, COPs have generally not been the venue where countries come to make major new announcements. The great majority of NDC updates will have been announced far before November 2021.

Most major economies will have also already announced a net-zero target: at the time of writing, countries representing 54 per cent of global GHG emissions had already adopted a net-zero target. With countries considering such targets, this share rises to 73 per cent; some of these might get confirmed at COP 26.

The other types of announcements that can be expected from this COP 26 track include fine-tuning of existing pledges: incremental enhancements, concrete implementation strategies, or possibly some additional climate finance to be provided. Leaders might announce the establishment of a new cooperation platform or issue a political declaration containing some specific actions, for example relating to phasing out coal power, or pledging to keep raising ambition in the years to come. An aggregation of NDC updates or net-zero pledges might also conclude that countries have succeeded in 'keeping 1.5°C alive', which has been one of the main stated goals of the incoming COP presidency.

However, with global GHG emissions expected to rebound to 2019 levels already in 2021, convincing the world that this is enough might be difficult.

Third track: multistakeholder cooperation around themes and sectors

Since at least COP 19 in Warsaw, UN climate change conferences have seen an increasingly active presence of non-state and subnational players showcasing action and ambition. So-called non-party stakeholders—cities, businesses, and investors, among others—are in many cases already taking more ambitious steps to combat climate change than national governments. With this in mind, the UNFCCC Secretariat, along with successive COP presidencies, has sought to make COPs an annual meeting place where these actors can coalesce around various types of sectoral and thematic workstreams and events. Some related initiatives and platforms were even recognized in the UNFCCC decision on the adoption of the Paris Agreement (1/CP.21).

It is this voluntary space in which the largest volume of new announcements can be expected to be made at COP 26. There is an unprecedented level of interest in attending, and contributing to, this global jamboree: in July 2021, the UNFCCC Secretariat received formal side event applications from 1,100 individual observer organizations.

Given the prevailing uncertainties around the number of participants that will eventually be allowed and able to attend the conference in person, it is hard to predict how non-party stakeholder events and coalitions will convene at this COP. Hybrid or virtual-only platforms are likely complements or replacements; but, similar to intergovernmental diplomacy, they can never fully substitute for face-to-face meetings.

Initiatives to keep an eye on include those under the Race to Zero campaign, launched in 2019 and led by UNFCCC High-Level Climate Champions from Chile (the official host of COP 25) and UK (host of COP 26). By COP 26, the campaign seeks to achieve commitments from 20 per cent of key actors in at least 10 economic sectors to transforming their respective sectors in line with a net-zero world.

While momentum has been growing around setting clear quality criteria for non-state and subnational actors' climate pledges, concerns remain around accountability, as these partnerships operate outside the UNFCCC framework, with either no or highly informal reporting and accounting arrangements.

Other challenges include the fragmentation and proliferation of non-party stakeholder partnerships. A UNFCCC portal lists 150 multi-actor cooperative initiatives. Also, many developments of relevance to non-state actors engage in little cooperation with UNFCCC fora: the G20-related Task Force on Climate-Related Financial Disclosures, which has developed leading guidance on corporate climate disclosures, is just one example.

UNFCCC COPs at a crossroads

While energy remains the elephant in the UNFCCC negotiating rooms, energy and emission-reduction targets are a central point of attention in the other tracks evolving under and around its annual COP sessions. With the Paris Agreement now largely operational, the main task ahead for COPs will not be to continue building the regime, but to ensure its so-called ambition mechanism delivers. In simple terms, this means countries submitting increasingly ambitious NDCs in five-year cycles, informed by global stocktakes, also taking place every five years. If these NDCs collectively align with the goals of the Paris Agreement and if they are implemented, the regime will have been successful.

However, getting there involves a significant amount of diplomacy, policymaking, and, most importantly, policy implementation, around and outside the UNFCCC. Whether the COP continues to maintain its role as the central convening place for all this will depend on the ability of the UNFCCC to keep reinventing itself. Most of this work will need to be done in the second and third tracks described above, through less formal high-level diplomacy and with support from non-state and subnational actors.

Finally, communicating clearly what COPs can deliver is crucial to the credibility of the UNFCCC. In this regard, COP 26 should be seen as a water station on a multi-year marathon rather than the finish line of a sprint. Energy and emission targets will be on the minds of all conference delegates, but how Glasgow paves the way for maintaining momentum on climate action and ambition by all actors post-COP 26 and through 2025 will perhaps be the most crucial measure of its success.

MASTERING THE COVID ZOOM-IN EFFECT TO MAKE GLASGOW A TURNING POINT FOR EMBEDDING CLIMATE CHANGE INTO ECONOMIC AND BUSINESS PRACTICES

Alessandro Terzulli and Carlo Papa

In less than 100 days, the world will be heading—hopefully physically—to Glasgow for the 26th UN Climate Change Conference of the Parties (COP 26). The one-year postponement took all by surprise and left everyone with an entire year of reflection on how to make Glasgow a real turning point in the climate change fight. Forward-thinking governments and institutions such as the EU are making significant progress on climate action at home while handling the COVID-19 storm tails. In many parts of the globe, stakeholders are considering climate diplomacy and seeing climate at the core of many investment processes.

Indeed, COVID has acted as a lens zooming in on the risks already present at country and company level. Through the crisis, the scientific community has been able to consider the links between social factors and the virus effects along different patterns of wealth distribution, clearly defining the present situation as a syndemic rather than a pandemic.[2] This syndemic has ushered in a 'new normal' for the global economy, characterized by two phenomena:

- An unconcealed climate change crisis is directly or indirectly affecting health and health care systems[3] alongside worsening global inequality, triggering an array of physical risks—from Germany's deadly floods[4] to the wildfires in California[5]—for our socio-economic systems.
- An increasingly rapid energy transition with recognized positive effects on the very same variables—health, inequality, and planet boundaries—negatively impacted by climate change.

As a consequence of the many lessons we have learned from COVID, or at least that we are pretending to have learned, there should be an opportunity to reconsider the way we measure systemic risks—including the use of new and more appropriate dimensions and parameters in their calculation—and the need for a fresh look at the methodologies traditionally adopted to do so.

A 2009 report by the Commission on the Measurement of Economic Performance and Social Progress served to remind us of 'classical GDP issues' or problems with using GDP as a unidimensional measure of macroeconomic progress and proxy for economic well-being.[6] However, this was by no means a new critique. The Nobel Prize winning economist Simon Kuznets, who was one of the main originators of the GDP concept, was also well aware of its limitations and believed that the welfare of a nation can scarcely be inferred from a measure of national income (but measurement has to include broader socio-economic and environmental parameters). More recently, while the Nobel Prize in Economic Sciences has been awarded, two years in a row, for work on integrating climate change and technological innovations into long-run macroeconomic analysis,[7] and for experimental approaches to alleviating global poverty, and while the prosperity paradigm is on top of the agenda of international institutions, the risks and opportunities associated with further deterioration of well-being and environmental parameters are not yet widely considered and properly calculated.

Indeed, although ensuring equitable wealth distribution by fighting climate change and speeding up the energy transition—as indispensable preconditions to ensure prosperity for all in the new normal—have become relevant targets for some nations and forward-thinking companies, the risks related to falling short on those targets have not yet become part of the more traditional country risk classification methodologies,[8] while only few of them are reconsidering the role the state can play.

Moving towards COP 26—aware of its importance in driving investment decisions to enable energy transition and tackle climate change effects (and the related socio-economic inequalities)—we designed the idea to find suitable ways to embed the climate issue into economic and business practice, and decided to test a way to improve traditional country risk methodologies by reconsidering and eventually eliminating four fundamental biases, namely:

[2] Syndemics are characterised by biological and social interactions between conditions and states, interactions that increase a person's susceptibility to harm or worsen their health outcomes. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2820%2932000-6/fulltext

[3] https://www.nejm.org/doi/full/10.1056/NEJMp1906035

[4] https://www.nature.com/articles/d41586-021-02330-y

[5] https://www.nature.com/articles/s41598-021-88131-9

[6] https://www.researchgate.net/publication/258260767_Report_of_the_Commission_on_the_Measurement_of_Economic_Performance_and_Social_Progress_CMEPSP

[7] https://www.nobelprize.org/prizes/lists/all-prizes-in-economic-sciences/

[8] http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=td/pg(2004)10/final

- a slow bureaucratic state versus a dynamic private sector
- GDP as a proxy of wealth
- significant weather events categorized as extreme and exceptional
- the energy system as a commodity.

As mentioned, the zoom-in effect of COVID is helping us to re-examine these biases, and together, the Italian export credit agency SACE and the Enel Foundation have worked to build an advanced risks and opportunities model at the country level that allows more precise assessments and enables the formulation of more effective investment plans to ensure sustainable development for all as well as highlighting, and hopefully avoiding, any losses deriving from risks of non-payment and political risks associated with foreign direct investments. We have reached four key conclusions:

- **Entrepreneurial state**—Over the last 12 months we may have come to appreciate more the benefit of an entrepreneurial state and active supranational organization.[9] Only by looking at the hundreds of new vaccine research efforts and massive vaccination campaigns or at the role the EU is taking in accelerating the green energy transition with the Fit for 55 legislative package, we came to realize the essential role states are playing in enabling radical transformation to ensure a sustainable future for all. Clearly, the virus fight and the energy transition are not the only realms in which we can observe public institutions creating value for society rather than being slow bureaucratic entities. If we turn for example to climate change research, nearly all the literature sees public institutions in a leadership role. Indeed, to build back better we need to remember the important role all stakeholders can play, from public entities to private business, provided we avoid the downfall of excessive government interference in market mechanisms, while leveraging debt for stronger physical and digital infrastructures and forward-looking scientific research rather than unproductive subsidies.
- **Wealth—**For around a decade, economists have strengthened the reasoning in and around inequality in the attempt to substantially depart from measures such as income[10] or consumption expenditure[11] towards holistic data sets such as the 11 parameters taken into account by the OECD Your Better Life Index,[12] where health, education, and environment are taken into consideration along with traditional data and subjective well-being measurements such as the Cantril Self-Anchoring Striving Scale. Yet as recently reaffirmed by the Club of Rome, 'societal needs are still unmet, economic gains are shared unequally and the social contract is eroding.'[13] Precisely to start measuring the risks raised by this progressive erosion, exacerbated by the COVID crisis and climate change, we propose to monitor wealth starting with demographic and income composite measurements as baseline and health, education, and jobs as essential instruments to ensure well-being over time.
- **New normal**—Traditional country risk classification methodologies do recognize climate change effects—e.g. cyclones, floods, and tidal waves—as cases of force majeure,[14] in this failing to recognize that we are in a new normal where such events are indeed extreme but not exceptional anymore. Indeed, the dynamic of relevant loss events with reference to climatological, meteorological, and hydrological events shows a threefold growth since 1980, and 2021 disasters around the globe confirm such a progression. Moreover, if we observe the convergence between the different degrees of anthropization—referring to the rapid growth of megacities and more in particular to megacity resource and flows as a percentage of world values—and the geo-localization of natural loss events, it becomes clear how the risk at stake is growing substantially. Analysing all those data and the many more the scientific community is monitoring—from CO_2 emissions to the shrinkage of glaciers from the Andes to the Alps—it is clear a new normal condition, in which humanity around the world is called to operate, is here to stay and it is definitely characterized by increased hazard exposure and vulnerability. This new normal, we believe, has to more decisively make its way out of the scientific realm and supranational organization into government cabinets and boardrooms globally, starting to be factored systematically into country risks assessment. To serve this purpose, the Enel Foundation and SACE have

[9] https://marianamazzucato.com/entrepreneurial-state/
[10] https://journals.openedition.org/oeconomia/319
[11] https://datatopics.worldbank.org/world-development-indicators/themes/poverty-and-inequality.html
[12] https://www.oecd.org/statistics/OECD-Better-Life-Index-definitions-2019.pdf
[13] https://www.clubofrome.org/publication/a-system-change-compass-implementing-the-european-green-deal-in-a-time-of-recovery/
[14] http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=td/pg(2004)10/final

initiated the monitoring of some of the main climate hazards (e.g. floods and heat waves) determined principally by high temperature, hydrogeological fragility, and storms considering receptors' vulnerability in their given environmental and socio-economic context.

- To complete our risk profiling per country, we run scenarios analysis starting from historical data up to 2050 and 2100 projections, by doing so confirming to what extent climate change makes weather extremes the new normal. This, in turns, confirms that we should reconsider the concept of force majeure[15] related to meteorological events in risk analysis—although yet debatable in court cases—precisely because extreme events are no longer unforeseeable, and to a certain extent are not unavoidable. Rather, they can somehow be considered the result of a defendant's inaction in determining a lower footprint for human activities and building a climate-proof society.
- **Energy transition**—The International Energy Agency has confirmed in its forecast[16] the extent to which the COVID crisis has influenced the energy sector globally: probably more than any other crisis in modern time. At times of oil prices below zero for the first time in history, where forward-looking electricity players are starting to eclipse the largest oil majors by multiplying their renewable-energy capacity and transforming the grid to prepare for a full-electric future,[17] we have come to learn that energy systems do not tend to fit any more within the commodity-based paradigm we were all used to. Classical energy supply-storage-demand schemes at a system level tend to be partially, if not completely, replaced by the possibility to decouple energy production and usage from fuel availability and/or cost, with relevant market and geopolitical consequences. Indeed, marketwise increasingly cheaper renewable power compares to any new electricity capacity based on fossil fuels[18]—even if negative externalities of the latter are not accounted for—and is decisively attracting investments, while at country level the transition could reduce import dependence thanks to local renewable energy resources and, at global level, will definitely trigger re-balancing in material flows and international relationships. However, only the active pursuit of the energy transition on all fronts—from policy to regulation, from health to education—will allow countries to benefit most from this opportunity especially in light of a stronger recovery from the COVID crisis. Precisely in order to start assessing the rising risks of following short in the energy transition race—exacerbated by the COVID crisis and climate changes—and the opportunities laying ahead of a decisive move toward the transition, we decided to monitor five variables: fossil fuels in the mix and greenhouse gas emissions, in order to establish a baseline of stranded or potentially stranded assets and flow/stock pollution on one side, and energy efficiency/electrification (on the demand side) and renewable generation (on the supply side) as essential elements to ensure a successful energy transition over time.

We believe the proposed new mindset on country risks and opportunities modelling will enhance the 'catch-all' goals of such exercises—i.e. the ability to grasp the essence of a country system—and we trust we could build consensus to have COP 26 marking a turning point in measuring the new normal condition we are living in to better mitigate and adapt to climate change, leveraging the tremendous opportunities generated by a just energy transition.

LESSONS LEARNT FROM IPCC NET-ZERO ENERGY SCENARIOS

Jorge Blazquez

In August, the Intergovernmental Panel on Climate Change (IPCC) released the first part of its *Sixth Assessment Report on Climate Change*, focused on physical science. This document explains that the world will probably reach 1.5°C of warming by 2040 even in a best-case scenario of deep decarbonization. The scenarios of the IPCC are a set of complex frameworks that link different paths of the energy system with carbon emissions and global warming. These scenarios are more than academic exercises looking at possible energy futures and can have a material impact on climate policy and energy investments. On the one hand, the models tend to describe least-cost transition pathways, so they are a useful benchmark for policymakers. On the other, businesses—from financial firms to industrial companies—explore these scenarios to anticipate future regulation and to make investment decisions.

[15] https://www.dorsey.com/-/media/files/uploads/images/force_majeure_and_climate_change_030420.pdf?la=en
[16] https://iea.blob.core.windows.net/assets/7e802f6a-0b30-4714-abb1-46f21a7a9530/Global_Energy_Review_2020.pdf
[17] https://www.economist.com/business/2020/11/28/how-enel-became-europes-climate-centurion
[18] https://www.irena.org/newsroom/pressreleases/2020/Jun/Renewables-Increasingly-Beat-Even-Cheapest-Coal-Competitors-on-Cost

The IPCC database (the IAMC 1.5°C Scenario Explorer and Data) has more than 400 scenarios. In this article we focus on a sample of 54 scenarios from the IPCC database that reach zero CO_2 emissions from energy and industrial processes before 2060. The year 2060 was chosen as it aligns with the 32 countries and regions that have set themselves a target to reach net zero CO_2 emission by 2060 or sooner, reaching around two-thirds of global carbon emissions. The European Union, China, the US, Japan, the UK, and South Korea are among these countries.

One of the objectives of COP 26 is to 'secure global net zero by mid-century and keep 1.5 degrees within reach.' To achieve this global target by 2050, countries should propose at COP 26 ambitious emissions targets for 2030. In this context, this article explores IPCC scenarios finding common trends and key differences. The common trends, or shared characteristics, can be summarized in the following four lessons. The key differences are presented at the end of this article.

First lesson: unprecedent improvements in energy intensity are needed in the next 30 years, but energy intensity improvements are significantly lower in 2050–2100.

All scenarios in our sample show energy intensity improvements occurring significantly faster than in the past. Energy intensity is defined as primary energy divided by gross domestic product (GDP) for any given period. There are 46 scenarios that report information on real GDP growth, and for these energy intensity declines 2.8 per cent per year from 2020 to 2050. This decline is substantially higher than the annual average reduction in the past 30 years of 1.7 per cent, and only one scenario has an energy intensity growth below that average.

The paper *Plausible Energy Demand Patterns in a Growing Global Economy with Climate Policy* makes clear that large improvements in energy intensity are a key characteristic of the IPCC scenarios. The paper asserts that combining energy demand reductions with robust income growth for the 6.4 billion people in middle- and low-income countries is something that has no clear precedent. The only period in which the world achieved a reduction in energy intensity similar to those of the IPCC scenarios was during the oil crisis of the 1970s.

As a result of the large improvement in energy intensity, the selected IPCC scenarios see low growth of primary energy compared to the growth of the last 30 years. From 1989 to 2019 primary energy grew 1.8 per cent per year (around 8 EJ per year on average) while the average of the IPCC scenarios is zero.

The low growth of primary energy is an indication that to achieve net zero carbon emissions by 2050, according to the IPCC scenarios at least, the world needs to change the way it consumes energy and break the link between energy and economic growth.

Interestingly, in 2050–2100, the same IPCC scenarios have significantly lower energy intensity improvements. Over these 50 years, energy intensity reduces only 0.9 per cent per year, well below the historical average. Why does energy intensity improve slowly once the decarbonization of the energy system has been achieved? A potential explanation could be that the current energy system is inefficient, and improving energy efficiency in the next three decades is relatively easy and becomes progressively harder and more expensive from then on. Another explanation could be that energy efficiency after 2050 becomes less relevant in terms of climate change because the energy mix is mostly decarbonized, and it is cheaper and more efficient to increase the amount of zero-carbon energy than to implement tighter energy-efficiency measures.

Second lesson: renewables growth displaces natural gas and coal, but the direct link between renewables and oil is less clear.

The article *Energy Transitions or Additions: Why a Transition from Fossil Fuels Requires More than the Growth of Renewable Energy* explores energy transitions between 1800 and 2017. The paper concludes that evidence from contemporary trends suggests that renewable energy is not replacing fossil fuels but rather expanding the overall amount of energy that is produced. In our sample of IPCC scenarios, we do not see this trend. These scenarios all have low primary energy growth, and so as clean energy sources grow, they displace fossil fuels. For example, energy from renewable sources increases 9.6 EJ per year on average, while fossil fuels consumption declines 9.6 EJ. It seems that renewable energy is directly displacing fossil fuel consumption.

Looking at each fuel individually, the average decline per year for the selected scenarios is 3.7, 1.9, and 4.1 EJ for oil, natural gas, and coal, respectively. A potential takeaway is that natural gas seems to be the more resilient fossil fuel, declining around half as much as oil or coal.

What is driving the changes in these three fossil fuels? The table below shows the statistical correlation between the growth of oil, natural gas, coal, and renewables. A possible interpretation of the results shown in the table is the following: On the one hand, renewable energy competes with gas and coal in the power sector and direct use of (renewable) electricity competes with gas and coal in the industry and buildings sectors. On the other hand, oil and renewable energy seem to have different drivers. A possible explanation for this finding is that decarbonizing transport outside of passenger cars (heavy-duty trucks, long-distance shipping, and aviation) is more difficult and expensive than decarbonizing other sectors (power, buildings, and parts of industry). This means that in these ambitious climate scenarios, fast renewable growth provides space for the use of oil in the transport sector, where oil's energy density and portability provide comparative advantage over other energy carriers.

Correlation among the rate of growth of energy intensity, renewables, and fossil fuels

	Renewables	Oil	Natural gas	Coal
Renewables	1	0.48	−0.50	−0.61
Oil		1	−0.25	−0.55
Natural gas			1	0.72
Coal				1

Third lesson: natural gas acts as a bridge in the energy transition, particularly over the next decade.

Natural gas is considered by many as a bridge for the energy transition because of its lower carbon content than coal or oil. In our sample of scenarios, coal decreases on average 7.3 EJ per year over the next decade. This compares to a 1.2 EJ decline in natural gas over the same period. In these deep and early decarbonization scenarios, natural gas demand is supported by a fast reduction in carbon emissions when renewables are primarily displacing coal. In 2030–2050, gas declines more quickly than in the 2020s, around 2.2 EJ per year, but still more slowly than coal, which declines 2.5 EJ per year. As a result of these changes, in these scenarios in 2050, the world consumes four times more natural gas than coal.

However, in our selection of scenarios there is a positive and significant correlation between coal and natural gas. As renewables increase, demand for both fuels declines, although the speed of decline of natural gas is slower than coal, becoming a key backup for intermittent renewable energy in the power system.

We should highlight that the emergence of new technologies or sharp changes in costs have an impact on these models. A different set of technology assumptions leads to a different decarbonization path. Hydrogen is a good example of this. The rapid decline in electrolyser costs and a different approach to the challenges associated with the hard-to-abate sectors have changed the role of hydrogen in the energy transition. Our sample has 41 net-zero scenarios that report information on hydrogen. The share of hydrogen in final energy consumed is around 5 per cent, ranging between 0.2 per cent and 17 per cent. Recent scenarios, like bp Net Zero (2020) or the International Energy Agency's Net Zero by 2050 (2021), offer a different view. Hydrogen plays a larger role, and its share of final energy consumed is 16 per cent and 13 per cent, respectively.

The growing relevance of hydrogen in net-zero scenarios will have an impact on the demand for wind and solar energy and natural gas, as the need for green and blue hydrogen increases. In the case of natural gas, the emergence of hydrogen as an essential energy carrier could significantly change the demand for this fuel.

Fourth lesson: carbon capture and storage is a key technology to achieve net zero emissions.

All the scenarios in our sample use carbon capture and storage (CCS) as an important technology to reach net zero carbon emission. On average the level of CCS for these scenarios is 12 $GtCO_2$ in 2050, with a minimum of 2 $GtCO_2$ and a maximum of 18 $GtCO_2$. The scenarios have a positive and significant relationship between CCS and coal consumption and CCS and natural gas consumption. In the same sense, the article *Negative Emissions Technologies and Carbon Capture and Storage to Achieve the Paris Agreement Commitments* considers that 'no CCS means no 2°C.'

We highlight that CCS is not a strictly necessary technology to achieve net zero before 2060. In theory it is possible to design scenarios with no CCS, no fossil fuel consumption, and net zero emissions. However, these types of scenarios tend to be far more costly. The study *Carbon Capture and Storage (CCS): the Way Forward* explains that the

> IPCC Fifth Assessment Report describes how leaving out CCS would result in far higher costs for an aggressive decarbonization strategy than would be the case if similar limitations were imposed on other

low-carbon technologies (e.g., costs would be on average 138% higher under a 450 ppm scenario if CCS were unavailable, compared to 7% higher if omitting nuclear power, 8% for limited penetration of solar/wind and 64% for bioenergy).

Although these studies have CCS as part of a least-cost solution, currently CCS has little policy support in comparison with other technologies. This lack of support creates the perception that scenarios with high levels of CCS are unrealistic. It is interesting to remember that renewables faced similar problems decades ago. The article *Bright Future—or Brief Flare—for Renewable Energy?,* published in 1999, said, 'Congress is now negotiating a final budget, as well as considering a pivotal tax credit for wind companies and bills that would mandate nationwide electricity deregulation. Some experts contend such federal handouts are the only way renewable energies can compete with fossil fuels.'

Alternative decarbonization strategies to achieve net zero

These four lessons or common trends among the scenarios could suggest that there is a clear and unique path to achieve net zero before 2060. However, the idea that all scenarios follow similar decarbonization strategies to achieve net zero emissions is not correct.

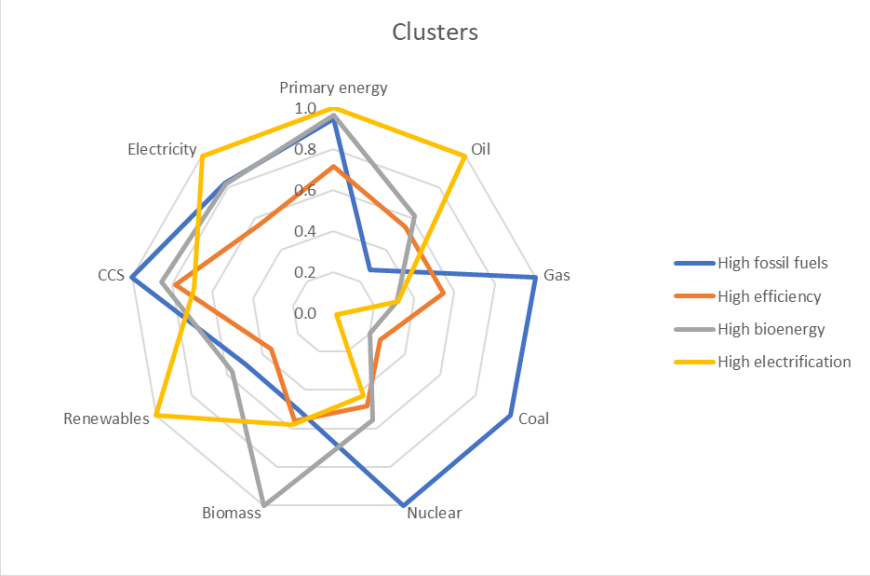
Based on a standard cluster analysis using nine key energy variables—primary energy, oil, natural gas, coal, nuclear, renewables excluding biomass, biomass, CCS, and electricity—we identify four distinct strategies. We call these four strategies high fossil fuel consumption, high energy efficiency, high bioenergy consumption, and high electrification.

There are two dominant strategies to achieve net zero, corresponding to the high-energy-efficiency and high-electrification clusters, with 18 and 19 scenarios, respectively. Scenarios for high energy efficiency tend to be characterized by large improvements in energy intensity and therefore sharp declines in primary energy. They have relatively small increases in electricity and modern renewables. Scenarios for high electrification follow an opposite strategy. These scenarios are characterized by large increases in primary energy and very large increases in electricity demand and renewable energy. For high electrification, the decline in oil is relatively small compared to the other clusters.

Scenarios in the cluster for high fossil fuel consumption have a strategy with relatively high fossil fuels and nuclear demand. These scenarios tend to see an increase in natural gas consumption, a slow reduction in coal consumption, and a large increase in nuclear energy. CCS is larger than in the other clusters to offset the higher carbon emissions from combusted fuels. Finally, high bioenergy is characterized by a large increase in biomass. These scenarios are also characterized by the lowest consumption of natural gas and coal. This suggests that biomass is displacing these two fuels.

The chart below shows the average variable in each cluster in 2050 normalized. If a variable is equal to 1 this means that this cluster has the maximum value for that variable. For example, the high-electrification cluster is the one with the highest electricity, primary energy, renewables, and oil. But this cluster consumes only 30 per cent as much natural gas as the high-fossil-fuel-consumption cluster.

Visual analysis of the four clusters



Conclusion

COP 26 is going to take place in a very different environment to COP 25 for two reasons. First, the COVID-19 pandemic, a human tragedy, has had a deep and asymmetrical impact on the global economy. On the other hand, around 70 per cent of the world carbon emissions are now covered by net-zero targets. It seems that the world is moving towards a deep decarbonization, despite the economic turbulence. In this context, the IPCC scenarios can provide a useful indication of the technical and economic constraints to reach net zero emissions in the next three decades. The analysis of these scenarios suggests that there is more than one plausible strategy to reach this goal, although all these scenarios share the common characteristics described in this article. Given this, it is not possible to summarize these strategies to decarbonize in a single metric like the decline in oil consumption per year or the reduction in carbon intensity. Potentially, two countries can equally decarbonize the energy system following two very different approaches. When a government or an international institution sets multiple intermediate energy targets in addition to a carbon emissions target, it is, in fact, choosing a particular decarbonization path.

NET ZERO RISKS MASKING DISASTROUS CLIMATE POLICY FAILURES

James G. Dyke, Wolfgang Knorr, and Robert Watson

Later this year, the highly anticipated 26th United Nations Climate Change Conference, COP 26, will attempt to make vital progress on climate change mitigation, adaptation, and finance. This third meeting of the parties to the Paris Agreement will be a key stage in the 'ratchet mechanism' where nations enhance their climate change ambitions. Consequently, COP 26 is being touted as the last chance we have to keep 1.5 alive. Net zero has emerged as a crucial component of the Paris Agreement. This will require potentially large-scale carbon dioxide removal from the atmosphere.

There are many suggestions as to how to actually do this, from mass tree planting to high-tech direct air capture devices that suck out carbon dioxide from the atmosphere. The current consensus is that if we deploy these at the same time as reducing our burning of fossil fuels, we can more rapidly halt global warming. Hopefully around the middle of this century we will achieve net zero in which all anthropogenic emissions are matched with anthropogenic removals. Given the assumed continued operation of natural carbon sinks, once net zero has been achieved, global temperatures will stabilize. This is not a new idea. In 2008, when the G8 were discussing a target of 50 per cent carbon dioxide emissions reduction by 2050, one of us [Knorr] co-authored a paper which pointed out that in order to stabilize the climate, net zero will be a necessity in the long term, and remaining emissions would have to be balanced out by a residual 'artificial sink'. What has happened since is that this 'artificial sink' has grown out of all proportions, creating a fantasy world of planetary-scale carbon removal.

We three authors have arrived at the painful realization that the idea of net zero has licensed a recklessly cavalier 'burn now, pay later' approach which has seen carbon emissions continue to soar. It has also hastened the destruction of the natural world by increasing deforestation today, and greatly increases the risk of further devastation in the future.

The rise of net zero

Carbon dioxide capture technologies are established. Compressed carbon dioxide has been separated from fossil gas and then injected underground in a number of projects since the 1970s. These enhanced-oil-recovery schemes were designed to force compressed carbon dioxide into oil wells in order to push oil towards drilling rigs and so allow more to be recovered—oil that would later be burnt, releasing even more carbon dioxide into the atmosphere. This is an example of carbon capture and utilization.

Carbon capture and storage offered the twist that instead of using the carbon dioxide to extract more oil, the gas would be left underground and removed from the atmosphere. This promised breakthrough technology would allow climate-friendly coal and so the continued use of this fossil fuel. But beyond a single demonstrator, there has never been any capture of carbon dioxide from a coal-fired power station chimney with that captured carbon then being stored underground. However, capture and storage has become baked into climate-economic models. In the end, the mere prospect of carbon capture and storage gave policymakers a way out of making the much-needed immediate cuts to greenhouse gas emissions.

Given how small the available carbon budget for 1.5°C has become, a technology is needed not only to slow down the increasing concentrations of carbon dioxide in the atmosphere, but to actually reverse it. In response, the climate-economic modelling community—already able to include plant-based carbon sinks and geological carbon storage in their models—increasingly adopted the 'solution' of combining the two.

Consequently bioenergy carbon capture and storage, or BECCS, has rapidly emerged as the new climate saviour technology. By burning 'replaceable' biomass such as wood, crops, and agricultural waste instead of coal in power stations, and then capturing the carbon dioxide from the power station chimney and storing it underground, BECCS could produce electricity at the same time as removing carbon dioxide from the atmosphere. That is because as trees and other biomass grow, they suck in carbon dioxide from the atmosphere. By planting trees and other bioenergy crops and storing carbon dioxide released when they are burnt, more carbon could be removed from the atmosphere.

A Parisian false dawn

On 13 December in Paris, against all expectations and after decades of false starts and failures, the international community finally agreed to do what it took to limit global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels. But dig a little deeper and you could find another emotion lurking within delegates on 13 December: doubt. We struggle to name any climate scientist who at that time thought the Paris Agreement was feasible. We have since been told personally by some scientists that the Paris Agreement was 'of course important for climate justice but unworkable' and 'a complete shock, no one thought limiting to 1.5°C was possible'. Rather than being able to limit warming to 1.5°C, a senior academic involved in the Intergovernmental Panel on Climate Change (IPCC) concluded, we were heading beyond 3°C by the end of this century.

Relying on untested carbon dioxide removal mechanisms to achieve the Paris targets when we have the technologies to transition away from fossil fuels today is plain wrong and foolhardy. Instead of confronting our doubts, we scientists decided to construct ever more elaborate fantasy worlds in which we would be safe. The price to pay for our cowardice: having to keep our mouths shut about the ever-growing absurdity of the required planetary-scale carbon dioxide removal.

Taking centre stage was BECCS because at the time this was the only way climate-economic models could find scenarios that would be consistent with the Paris Agreement. Alas, BECCS, just like all the previous solutions, was too good to be true. Across the scenarios produced by the IPCC with a 50 per cent or better chance of limiting temperature increase to 1.5°C, BECCS would need to remove a billion tonnes of carbon dioxide each year. BECCS at this scale would require massive planting schemes for trees and bioenergy crops.

The Earth certainly needs more trees. Humanity has cut down some three trillion since we first started farming some 13,000 years ago. But rather than allow ecosystems to recover from human impacts and forests to regrow, BECCS generally refers to dedicated industrial-scale monoculture plantations regularly harvested for bioenergy, rather than carbon stored away in forest trunks, roots, and soils. Currently, the two most efficient biofuels are sugar cane for bioethanol and palm oil for biodiesel—both grown in the tropics. Endless rows of such fast-growing monoculture trees or other bioenergy crops harvested at frequent intervals devastate biodiversity.

It has been estimated that BECCS could demand an area of land approaching twice the size of India. How will that be achieved at the same time as feeding 8–10 billion people around the middle of the century or without destroying native vegetation and biodiversity? Large-scale monoculture tree plantations can adversely impact water availability for agriculture as well as drinking. Increasing forest cover in higher latitudes can have an overall warming effect, because replacing grassland or fields with forests means the land surface becomes darker. This darker land absorbs more energy from the Sun and so temperatures rise. Focusing on developing vast plantations in poorer tropical nations comes with real risks of people being driven off their lands. The massive amount of offsetting needed for most net-zero scenarios with the aim of staying within safe climate limits cannot be met by leaving nature alone. It demands fast-growing, mostly alien species that are cut down often and regularly, thereby releasing carbon. We are already seeing the beginning of this in European forests. The consequences of net zero can look almost as scary as those of climate warming. As these impacts are becoming better understood, the sense of optimism around BECCS has diminished.

Pipe dreams

Given the dawning realization of how difficult Paris would be in the light of ever-rising emissions and the limited potential of BECCS, a new buzzword emerged in policy circles: the 'overshoot scenario'. Temperatures would be allowed to go beyond 1.5°C in the near term, but then be brought down with a range of carbon dioxide removal technologies by the end of the century. This means that net zero actually means 'carbon negative'. Within a few decades, we will need to transform the global economy from one that currently pumps out 40 billion tons of carbon dioxide into the atmosphere each year, to one that produces a net removal of tens of billions.

This is why the idea of direct air capture, now being touted by some as the most promising technology out there, has taken hold. It is generally more benign to ecosystems because it requires significantly less land to operate than BECCS, including the land needed to power the carbon capture machinery with wind turbines or solar panels. Unfortunately, it is widely believed that because of its exorbitant costs and energy demand, direct air capture—if it ever becomes feasible to be deployed at scale—will not be able to compete with BECCS with its voracious appetite for prime agricultural land.

Once we realise net zero will not happen in time or even at all, geoengineering—the deliberate and large-scale intervention in the Earth's climate system—will probably be invoked as the solution to limit temperature increases. One of the most researched geoengineering ideas is solar radiation management—the injection of millions of tons of sulphuric acid into the stratosphere that will reflect some of the Sun's energy away from the Earth. It is a wild idea, but some academics and politicians are deadly serious about it, despite its significant risks. The US National Academy of Sciences, for example, has recommended allocating up to US$200 million over the next five years to explore how geoengineering could be deployed and regulated. Funding and research in this area is sure to significantly increase.

It is astonishing how the continued absence of any credible carbon removal technology never seems to affect net-zero policies. Whatever is thrown at it, net zero carries on without a dent in the fender. The argument appears to be that net-zero technologies will work because they have to work. But beyond fine words and glossy brochures there is nothing there. The emperor has no clothes.

Difficult truths

In principle there is nothing wrong or dangerous about carbon dioxide removal proposals. In fact, developing ways of reducing concentrations of carbon dioxide can feel tremendously exciting. The problems come when it is assumed that these can be deployed at a vast scale. This effectively serves as a blank cheque for the continued burning of fossil fuels and the acceleration of habitat destruction.

Carbon-reduction technologies and geoengineering should be seen as a sort of ejector seat that could propel humanity away from rapid and catastrophic environmental change. Just like an ejector seat in a jet aircraft, it should only be used as the very last resort. But policymakers and businesses appear to be entirely serious about deploying highly speculative technologies as a way to land our civilization at a sustainable destination when these are no more than fairy tales. The only sure way to keep humanity safe is by immediate and sustained radical cuts to greenhouse gas emissions in a socially and economically just way.

Academics typically see themselves as serving society. Those that championed net zero as a way of breaking through the barriers holding back effective action on the climate work with the very best of intentions. This was certainly the motivation of a key group of international academics and activists that can be seen as one of the important centres for the emergence of the net-zero concept. This important work was designed around ways to accelerate actual mitigation that would be required in order to limit warming to well below 2°C. The tragedy is that their collective efforts were never able to mount an effective challenge to a climate policy process that would only allow a narrow range of scenarios to be explored.

Most scientists feel distinctly uncomfortable stepping over the invisible line that separates their day job from wider social and political concerns. There are genuine fears that being seen as advocates for or against particular issues could threaten their perceived independence. Science is one of the most trusted professions. Trust is very hard to build and easy to destroy.

But there is another invisible line, the one that separates maintaining academic integrity from self-censorship. As scientists, we are taught to be sceptical, to subject hypotheses to rigorous tests and interrogation. But when it comes to perhaps the greatest challenge humanity faces, we often show a dangerous lack of critical analysis. In private, scientists express significant scepticism about the Paris Agreement, BECCS, offsetting, geoengineering, and net zero. Apart from some notable exceptions, in public we quietly go about our work, apply for funding, publish papers, and teach (Anderson 2015). The path to disastrous climate change is paved with feasibility studies and impact assessments. Rather than acknowledge the seriousness of our situation, we instead continue to participate in the fantasy of net zero. What will we do when reality bites? What will we say to our friends and loved ones about our failure to speak out now?

The youth of today and future generations will look back in horror that our generation gambled with catastrophic changes in climate and biodiversity for the sake of cheap fossil fuel energy when cost-effective and socially acceptable alternatives were available. We have the knowledge needed to act. The most recent IPCC and IPBES assessments clearly show we are failing to meet any of the agreed targets for limiting climate change or loss of biodiversity.

The time has come to voice our fears and be honest with wider society. Current net-zero policies will not keep warming to within 1.5°C because they were never intended to. They were and still are driven by a need to protect business as usual for as long as possible, not the climate. If we want to keep people safe, then large and sustained cuts to carbon emissions need to happen now. That is the very simple acid test that must be applied to all climate policies, and it needs to be solidly on the negotiating table at COP 26. The time for wishful thinking is over.

THE IMPORTANCE OF A JUST ENERGY TRANSITION FOR COP 26 AND THE NET-ZERO CHALLENGE

Raphael J. Heffron

The importance of the UN COP 26 conference this year cannot be overstated. It is worth recalling that COP 26 was postponed from 2020, when all countries were to submit revised plans on how they would achieve their energy and climate plans for 2030 in accordance with the 2015 Paris Agreement. This has given many countries an extra year to devise their strategies, so despite the pandemic they should still have complete and ambitious plans.

The world needs to keep the global temperature rise within 1.5–2 degrees, as failing that there will be runaway climate change. The latter will involve a higher frequency of extreme events and a situation whereby human interventions will no longer slow the effects of climate change. In this context, climate change has already been in the news in June and July this year (2021) as the world has been witness to numerous events that have been attributed to climate change, such as the German, Chinese, and UK floods and the fires on the west coast of the US.

Hence, a global discussion and call for more action on climate change is timely, and this is what COP 26 will deliver. A key part of that discussion has, however, to be around justice. Given the ongoing pandemic and economic crisis (resulting from the pandemic), it is more important than ever to ensure that no one is left behind in this climate action. This short article analyses and advances the need for a just energy transition. The energy sector is the cause of the majority of carbon dioxide (CO_2) emissions, and as a result, ensuring that justice is permeated and diffused throughout this sector will bring justice to wider society also.

What is good and just energy decision-making today?

This is a key question in energy policymaking today. In a simplistic way, all good energy decision-making should be contributing to ensuring that the global temperature rise remains within 1.5–2 degrees. Just energy decision-making should ensure that no stakeholder within the energy sector is left behind. To interpret this further, and alongside the forms of justice society needs to achieve, this can be detailed below:

- the benefits of the energy sector more evenly distributed and environmental impacts limited—*distributive justice*
- barriers to new clean energy investment reduced —*procedural justice*
- all stakeholders recognized alongside their duties and rights—*recognition justice*
- existing energy victims restored to their original position—*restorative justice*
- national and international obligations achieved—*cosmopolitan justice*.

Just energy decision-making has to deliver just societal outcomes. Just outcomes have to be at the core of achieving 2030 energy and climate goals, and this is even more so for 2050 and beyond net-zero targets. Since the global financial crisis of 2007–2009 there has been an increased focus on societal inequality with a plethora of leading international economists—Joseph Stiglitz, Thomas Piketty, and Jean Tirole, to name just a few—all focusing their work on the issue. The energy sector has to play its role in addressing this issue, and energy decision-making needs to demonstrate how it will achieve just outcomes.

Increase policy flexibility and avoid energy technology lock-in

A key part of energy decision-making today is to avoid energy technology lock-in. Policy flexibility has to be a strategy in order for a country to avail itself of lower-cost and more commercially viable clean energy technology. Year on year, low-carbon technology is reducing in cost; for example, in the United Kingdom, witness the dramatic fall in cost of offshore wind by nearly

66 per cent over the last decade.[19] This is so significant and sends a huge signal to the market about what represents a good energy investment. This is perhaps why BP, a traditional oil and gas company, was prompted to invest £879 million in the UK offshore wind sector in 2021.[20]

For countries at different stages of development there may be calls for different types of energy investment; but today, serious research has to be completed by policymakers if they plan investment in fossil fuels (FFs). To invest in FF is a long-term commitment of 20-plus years. It is very likely that, with the advent of more technological advances in wind, solar, battery, and artificial intelligence software to manage these resources, costs of these energy sources will plummet in comparison with FFs. To make that energy decision to lock-in to FFs runs the risk that the FF energy plants will be turned off as low-carbon energy sources alongside battery storage and artificial intelligence become widespread in society.

There is also the additional issue of cost. FF may seem attractive today in some countries in terms of cost, but the reality is there are cost increases on the horizon. FFs have always been under-costed globally; however, now subsidies are being reduced, carbon taxes are becoming more widespread, and FFs are having to pay to restore the environment[21] after the damage they cause. Consider for example, in Australia, where an energy company adopted the well-known practice of going bankrupt to avoid its post-operation clean-up obligations. No longer could the Australian government continue to pay such clean-up costs—particularly when it is trying to respond to the challenge of COVID-19—and it did not. The solution was to charge all operating companies in the oil sector and make them all contribute to the costs of cleaning up (decommissioning) this abandoned energy infrastructure.[22]

A further looming cost issue centres on insurance. It will be increasingly difficult to get insurance for FF projects if it is not clear that they will run for their expected operational lifetime. Further, with the onset of more freak weather events that are attributed to climate change, the sentiment on the development of FFs will change and their risk profile will increase. Sentiment on developing coal projects has already changed. New proposed coal projects failed to go ahead in Australia and Kenya in 2019,[23] and it was noted that in particular, the socio-economic benefits of coal were misleading, and the data provided inaccurate. Significantly too, more recently, China has pulled out of a major investment in Africa,[24] while it has also stated that it does not envisage building additional coal infrastructure in terms of its Belt and Road initiative.

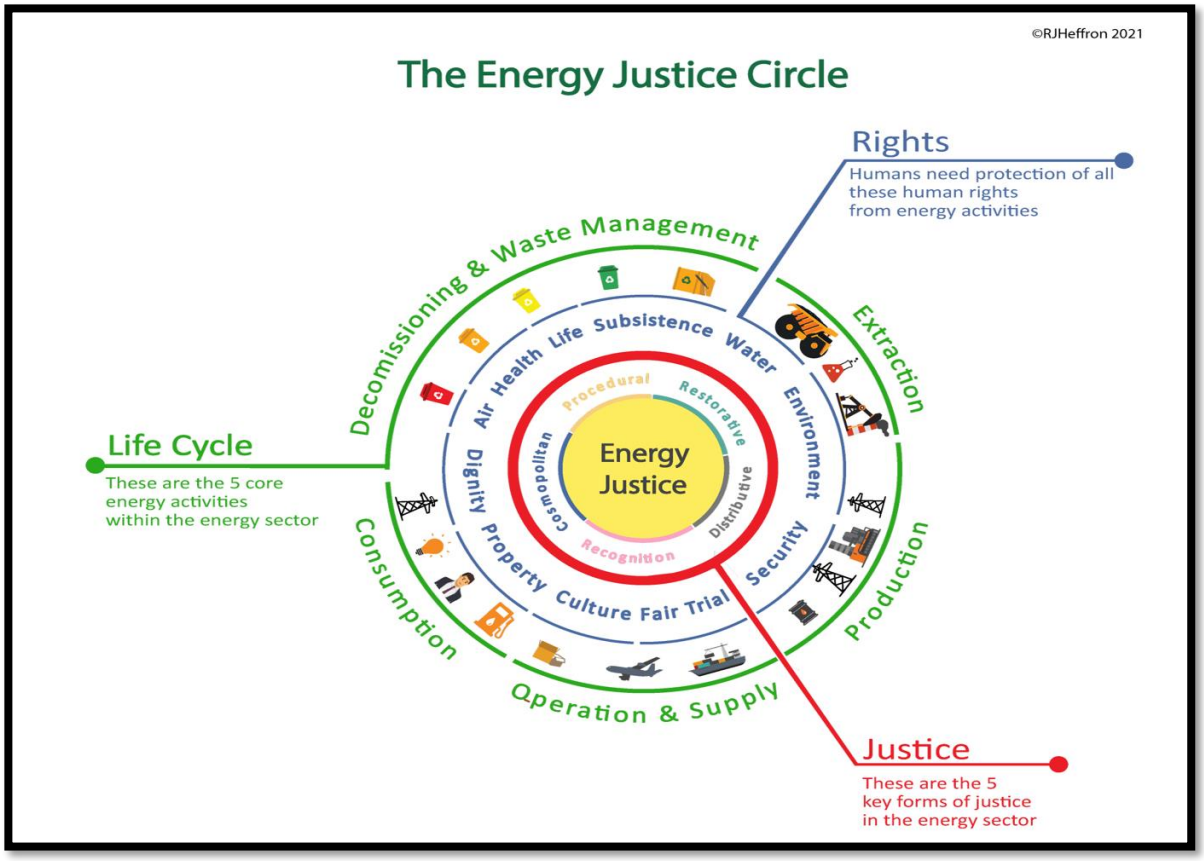
Justice in the energy sector post COP 26

The spread of energy justice, and the call for more justice at COP 26 and beyond, will see a rise in research into and practice of ways to deliver justice. In many ways the aforementioned Kenyan and Australian examples show to a point that socio-economic rights were important and these were not demonstrated by project developers. After COP 26 it should be expected that there will more concerted efforts to ensure delivery of justice into the energy sector in society.

The elements of justice will be targeted as potential avenues for ensuring different types of justice such as distributive, procedural, recognition, restorative, and cosmopolitan; for example, socio-economic rights would fit under distributive justice. The major question will be how this is achieved, and it is here the role of national courts will come into play. Rights can be protected in national courtrooms, and as evidence becomes easier to collect, it will be easier to demonstrate how different energy activities impinge upon human rights. The range of rights that can be protected across the core energy activities of the energy life cycle are demonstrated in the figure below in the energy justice circle which highlights energy activities, human rights, and the forms of justice.

[19] (Jansen, M. et al. 2020. Offshore wind competitiveness in mature markets without subsidy. Nature Energy, 5, 614–622. Available at: https://www.nature.com/articles/s41560-020-0661-2)
[20] Reuters. 2021. RWE, Total, BP among winners in UK offshore wind farm auction. Available at: https://www.reuters.com/article/us-britain-windpower-auction-idUSKBN2A80RN
[21] Hazrati, M. and Heffron, R. J. 2021. Conceptualising restorative justice in the energy transition: changing the perspectives of fossil fuels. Energy Research and Social Science, 78, 102115.
[22] Reuters. 2021. Australia hits oil producers with levy to decommission abandoned Timor Sea field. Available at: https://www.reuters.com/business/energy/australia-hits-oil-producers-with-levy-decommission-abandoned-timor-sea-field-2021-05-12
[23] B. Nogrady. 2019. Landmark Australian ruling rejects coal mine over global warming. Nature, (11 February 2019). Available at: https://www.nature.com/articles/d41586-019-00545-8. and D. Herbling. 2019. Kenya cancels environment license of $2 billion coal-power plant. Bloomberg, (26 June 2019) Available at: https://www.bloomberg.com/news/articles/2019-06-26/kenya-cancels-environment-license-of-2-billion-coal-power-plant
[24] Bloomberg (Ndlovu, R. and Sguazzin, A.). 2021. Biggest China Bank Abandons $3 Billion Zimbabwe Coal Plan. (30 June 2021). Available at: https://www.bloomberg.com/news/articles/2021-06-30/biggest-china-bank-walks-away-from-3-billion-zimbabwe-coal-plan?cmpid=BBD063021_GREENDAILY&utm_medium=email&utm_source=newsletter&utm_term=210630&utm_campaign=greendaily

Human rights and energy justice



Source: Heffron, R.J. 2021. *The Challenge for Energy Justice: Correcting Human Rights Abuses.* Springer Nature: Heidelberg, Germany.

The protection of these rights through courtrooms will add a more systematic approach to ensuring a just energy transition for 2030 under the 2015 Paris Agreement and also in terms of net-zero targets. Policymakers will be accountable for how they meet their commitments under the 2015 Paris Agreement. They will have to account for how they have adjusted, revised, or added to their plans for COP 26 and then later again when it is required for 2025 at COP 30. Both these time periods increase the likelihood of a wave of legal action, as different stakeholders take action on governments or other key stakeholders and seek out more demanding energy and climate goals for COP 26 and then subsequently for COP 30. And at the heart of this legal action will be how the policymakers aimed to ensure the entire list of human rights were protected within these energy transition and climate plans.

Already two major legal cases have been taken successfully in the Netherlands against the Dutch government (the Urgenda case in 2019) and the large multinational and traditional FF company Shell (in 2021).[25] In both cases the issue of their inadequate response to 2030 Paris Agreement energy and climate targets was raised and was in essence the reason they lost the legal case and were forced to change their behaviour. Continuing to invest in FF when it provides just short-term gain for energy supply is really an unjust energy decision in today's world where there is, according to the UN secretary general, a climate emergency in every country.[26]

The evidence to support the continuation of FF investments is becoming harder to obtain and also harder to demonstrate successfully. Already savvy investors must be looking at the proposed bans on coal and FF-based cars and planning exit strategies for the next FF activities that are under threat as they would be valued at a peak price at the moment.

[25] See: Heffron, R.J. 2021. Energy multinationals challenged by the growth of human rights. Nature Energy (2021). https://doi.org/10.1038/s41560-021-00906-6

[26] United Nations. 2020 (12 Dec). Secretary-General's remarks at the Climate Ambition Summit. Available at: https://www.un.org/sg/en/content/sg/statement/2020-12-12/secretary-generals-remarks-the-climate-ambition-summit-bilingual-delivered-scroll-down-for-all-english-version

Final thoughts: data to drive the just energy transition

Today, society is characterized by data. It is no surprise, therefore, that data on the energy sector is on rise. The availability of this data, the transferability of this data, and the accuracy of this data are informing energy decision-making. In policy analysis, in legal courtrooms, and in company boardrooms, there is a need to accurately assess the data, as it is becoming easier to demonstrate the socio-economic, environmental and climate change, and general societal (including health) impacts of an energy project. Accountability in decision-making will increase as it will be harder to avoid doing more comprehensive data analysis.

A just energy transition will need all stakeholders to work together, and that includes those who are overly reliant on FF today. For the research community, there is an opportunity and need to work collaboratively like never before. To deliver just outcomes post this pandemic and given the climate change emergency, more innovative and interdisciplinary methods of ensuring society meets its energy and climate targets of 2030 are necessary. Data will form the cornerstone of much of the interdisciplinary and collaborative research, and strategically it can be utilized to deliver a just energy transition.

INTRODUCING EQUITY IN THE NET-ZERO DEBATE—A VIEW FROM INDIA AHEAD OF COP 26

Arunabha Ghosh and Vaibhav Chaturvedi

The 26th Conference of Parties (COP 26) is being held in interesting times. Three big forces are shaping the larger backdrop of this COP. The first is the COVID-19 pandemic, which has ravaged humanity, not just taking lives but also pushing millions into poverty across the world, especially in the developing economies. The second is increasing impacts of climate change, felt more by the vulnerable communities. The response to the former includes significant efforts by governments around the world to minimize the impact of economic shock through investments and easier access to credit. The response to the latter includes enhancing ambition through either nationally determined contributions or long-term targets. The third force looming large in the backdrop of COP 26 is increasing attention to the call for net-zero targets. A theme that is common among all the forces is equity.

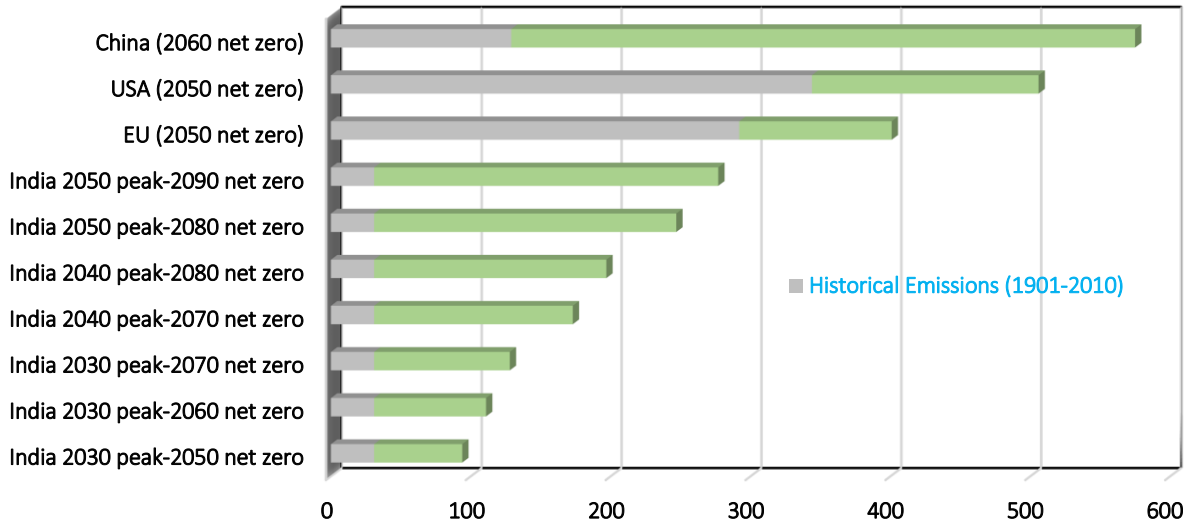
Principles

While the need to ensure equity in response to the pandemic and impacts of climate change is fairly well understood, the need to ensure equity in the net-zero debate needs to be emphasized and made explicit. Reflecting on some aspects is critical to ensure that equity is embedded in the net-zero debate. First, country-specific targets should be dependent on what countries have done in the past in terms of cornering the global carbon space; that is, historical responsibility matters. Climate negotiations cannot, and should not, delete the past from our collective memories. Latest analysis from Council on Energy, Environment and Water (CEEW), a first-of-its-kind assessment, shows that, as a whole, developed countries have emitted an extra 25 $GtCO_2eq$ during 2008–2020, or nearly half the world's greenhouse gas (GHG) emissions in 2019. This overconsumption of the global carbon budget by a few countries, if not accounted for, would impose an unjustified and iniquitous burden on other countries for the post-2020 period.

Secondly, the earlier point implies that developed countries have to be much more aggressive in their mitigation actions to ensure that they minimize the carbon space that they consume in the future. This simply implies that they 'have' to advance their net-zero years. The EU and US should achieve net-zero much before 2050 and achieve net-negative by 2050. Any discussion on the future consumption of carbon space cannot happen without the mention of China, probably the biggest elephant in the room. As the graph below shows, China's future emissions, even after accounting for its net-zero target, will far surpass the cumulative emissions of any other major emitter by a wide margin. It is critical that China also advance its net-zero year. The first and second point together imply that it is the aggregate historical and future emissions that matter now to the global climate debate and the call for a net-zero future.

Thirdly, the key principle of equity implies that all countries should not be expected to achieve net zero at the same time. Countries and regions, like the US and EU, that are high-income should achieve net-zero at the earliest possible time, followed by China, followed by other emerging economies depending on their national circumstances.

Cumulative (historical and projected) CO_2 emissions, $GtCO_2$



Source: Reproduced from Vaibhav Chaturvedi, 2021, Peaking and Net-Zero for India's Energy Sector CO2 Emissions: An Analytical Exposition. Council on Energy, Environment and Water, Issue Brief, March 2021.

National circumstances should determine the choice of net-zero years. A key indicator of the development stage of an economy is its per capita income. The World Bank classifies a high-income economy as one with gross national per capita income of USD 12,536 or more in 2019 prices. Any country that crosses this mark should attempt to achieve net-zero in 15–20 years from when it achieves the high-income status. The US and EU have long surpassed this income level; they should attempt achieving net-zero by 2035. China will enter this category between 2025 and 2030, and it should achieve net-zero by 2045. India should cross this income level around 2055, and should think about achieving net-zero by 2075.

Fourthly, a principle of progressive differentiation can be introduced. This would mean that countries that are looking to attain high-income status should also benefit from advances in technologies that increase the feasibility of low-carbon development. Contingent on having access to finance (not just grants but institutional investment at far lower costs of capital), these countries can progressively have shorter periods of transition between their peaking and net-zero years. If the suite of mitigation technologies is available globally at an affordable and competitive price to all, then all countries should harness that opportunity and advance their net-zero years to the extent possible.

Finally, while long-term actions are critical, these are not alternatives to short-term actions. At the COP-26 negotiations, all parties should enhance their Nationally Determined Contributions (NDC), as markers on the path to more equitably determined net-zero years. There should be transparent and measurable near-term actions that increase the credibility of the long-term commitments. The global stocktake process, scheduled for 2023, should ensure transparency in monitoring near-term actions of all countries and facilitate the move towards ambitious and equitable net-zero targets.

Lessons

Just as the conversation about net-zero would be contingent on the actions and inactions of the past, the roads to peaking emissions and net zero must also be informed by the lessons of international cooperation in the past. Two elements are central to learning the lessons of history and applying them to future pathways: technology and finance.

Lesson 1: Technology platforms have seldom been inclusive or designed for genuine technology co-development. Most climate and clean energy technology platforms that had been created until 2015 were limited to organizing workshops with only a subset promoting joint R&D. Almost none had demonstration projects or commercialization at scale. Even since the Paris Agreement, the Mission Innovation platform has focused on each country raising its clean energy R&D rather than promoting joint activities. A recent analysis of cooperation on green hydrogen finds that there are more than a dozen bilateral partnerships and at least 10 multi-country or multi-firm platforms focused on hydrogen. But they seldom involve developing countries, are not oriented towards joint technology development, and do not focus on deploying technologies in countries that will have the greatest demand for cleaner fuels for industrial development.

Lesson 2: Instead of cooperating on technologies, countries have tended to follow a principle of techno-mercantilism. Between the failed Copenhagen COP 15 and the successful Paris COP 21, 11 per cent of new disputes at the World Trade Organization related to clean energy and related technologies. This, despite the fact that clean energy certainly does not account for such a large share of global trade. The largest emitters have been busy planting mercantilist trade protectionist barriers against each other, while also excluding developing countries from any real conversation on more dispersed supply chains. More recently, out of 15 emerging markets analysed for their net import dependence for renewable energy equipment, only four were net exporters.

Lesson 3: Capital flows to developing countries for the clean-energy transition remain limited. Excluding large hydropower, of the total global investment in renewables of USD 2.6 trillion during 2010–2019, only China, India, Brazil, Mexico, and South Africa (along with developed countries) managed to secure investments exceeding USD 20 billion. Yet, emerging markets have vast renewable energy resources, 140 times greater than their energy demand.

Lesson 4: Investing in emerging markets is risky, but the perceived risks often exceed real ones. Either the investors are unwilling to look favourably at clean energy opportunities in developing countries, or they demand very high returns, which makes the cost of capital prohibitive in many instances. The cost of capital accounts for the highest share of the levelized cost of clean electricity in developing countries.

Lesson 5: There have been very few efforts made to effectively de-risk investments in sustainable infrastructure in developing countries. Out of 26 initiatives on clean energy finance started between 2011 and 2021, 17 initiatives seek to unlock private capital, but only six are trying to tackle investment risks. This is odd because without de-risked investments it is unlikely that large volumes of private capital will flow.

Opportunities

The post-pandemic recovery will be informed by the limited financial resources that individual governments will be able to muster and the access or lack thereof to sustainable technologies. Pooling resources and pooling risks would make sense for poor and rich countries alike, but only if the appropriate governance platforms are designed.

Technology collaborations have been most effective when they have clearly defined objectives, focus on price reductions to make them more accessible to poorer countries, allow for contributions in cash and in kind (technical personnel, laboratories, test sandboxes, etc.) so that developing countries can also participate, enable jointly held intellectual property, have clear rules of responsibility and liability, and give participating countries equal voice in the governance of technology platforms.

Similarly, an inclusive and equitable approach to climate and clean energy finance must not remain trapped between a negotiated maximum (of USD 100 billion) and a delivered minimum. The objective must be to reach USD 3.5 trillion, which developing countries need until 2030 alone. For this, four shifts are necessary: a sense of the scale of investment required, the regulatory changes that developing countries must undertake at home to be able to welcome more sustainable investments, greater balance between adaptation and mitigation finance, and leveraging public capital to attract a larger pool of private investment by using innovative de-risking instruments.

A third way in which the net-zero conversation can introduce equity in actions is by bringing the energy transition closer to people. Well over a hundred million people have fallen back into poverty thanks to the pandemic. Rural areas in India and elsewhere are struggling with the influx of migrant labour and depressed incomes. Short-term income support measures, without investment in productive assets, could further compound the problem by triggering inflationary pressures. Under such circumstances, it is hard to see how the poor and vulnerable would lend support to long-term targets for net-zero GHG emissions.

Productive uses of distributed renewable energy (DRE) increase livelihood opportunities and incomes and thereby also the ability and willingness to pay for clean electricity solutions. They unlock incomes in hitherto energy-starved areas and help communities in climate-vulnerable areas to continue their livelihood activities. At scale, DRE systems offer a new investment category and a market opportunity for direct selling vendors and indirect enterprises in the supply chain. This investment opportunity runs into tens of billions of dollars in India and sub-Saharan Africa.

Finally, no net-zero target will be credible if countries do not have an insurance cushion against climate shocks. Globally, weather-related insurance losses have increased to USD 55 billion annually (five times higher than in the 1980s) with estimates of uninsured losses being twice as much. Lower-middle-income and low-income countries lost 1.14 per cent and 1.77 per cent

of GDP, respectively, from climate-related disasters during 1998–2017, compared to 0.41 per cent loss for high-income countries. As the COVID-19 pandemic demonstrates, even the wealthiest countries can find their financial resources stretched and administrative capacities exhausted for shocks of a certain magnitude. There is a need for a mechanism by which countries at different levels of vulnerability can spread and hedge the climate risks they face.

Actions

There is a road to COP 26 and a road through COP 26. The former focuses on trying to get all countries to sign up to long-term net-zero targets. The latter, less-travelled road, would create the platforms wherein the lessons of the past and the opportunities of the future converge to make the low-carbon transition a more just, inclusive, and equitable journey for the bulk of the world's population.

COP 26 could announce international partnerships on technology, finance, livelihoods, and resilience to put such an equitable vision into action and create opportunities on the road to net zero.

- **Global Green Hydrogen Alliance** to pool resources and make India a party to the development of advanced technologies, access to intellectual property (IP), setting of standards, and periodic assessments.
- **Common Risk Mitigation Mechanism** to pool non-project risks (currency, off-taker, policy) across projects and countries, improve credit ratings, lower cost of capital, and create a tradeable secondary market for clean energy and clean mobility investments.
- **Powering Livelihoods Globally** to develop a multi-stakeholder platform to take energy transition to the masses to enable their livelihoods by scaling innovations and enterprises.
- **Global Resilience Reserve Fund** to create an insurance cushion against climate shocks by pooling various kinds of risks, capitalized with an allocation of special drawing rights.

Such international partnerships would be critical for the world to expedite progress towards the global net-zero goal.

Reassessing political coalitions is imperative

India has been a part of various political coalitions to further its geopolitical interests. For instance, it is a part of the BASIC (Brazil, South Africa, India, and China) group and the LMDC (Like-Minded Developing Countries) coalition. In light of the changing global climate negotiation space, India must reassess if pushing the equity agenda in the net-zero discourse through these groupings is still the best strategic approach. As highlighted, equity in the net-zero debate would mean that China has to achieve net-zero much earlier than its stated target of 2060, as it has cornered the largest share of the carbon space. Highlighting the implications of China's unambitious policies for the global carbon space left for others should be an essential element in India's approach at COP 26. However, this implies that both BASIC and LMDC groups would not push for this specific formulation of equity due to an assertive China in these groups. Similarly, while creating a coalition with African nations might appear to be a good bet for India, this approach might not be successful given the close political ties of these nations with the US and EU due to dependence on aid and trade with the west. Given these realities, it becomes imperative for India to reassess political coalitions. It might be a better, though unconventional, idea for India to directly engage with the US and EU on the issue of equity in the net-zero discourse and bring them on board with this idea. Otherwise, it has to carefully think through and select partners that would not be swayed by the influence of powerful developed nations and China and would be dependable partners of India in the mission of introducing equity in the net-zero debate.

Net-zero is not just a technical equation for climate modellers. As a concept it is a tool for economic transformation. As necessary as that transformation is, it will have neither ethical legitimacy nor political salience if the pathways continue to widen inequalities. Equity and climate justice can no longer be treated as rhetorical phrases in the preambles of climate agreements. They must become the tools for developing new principles, evaluating past action, identifying new opportunities, and enabling just and ambitious climate action.

THEORIES OF CHANGE FOR GLOBAL COOPERATIVE CLIMATE ACTION

Grzegorz Peszko[27]

In the absence of top-down enforcement mechanisms, the effective and stable Paris Agreement needs to be glued by aligning the self-interests of the participants, hence self-enforcing (Barrett 1994). Contributions to the Paris Agreement can only be determined nationally; hence, the parties must be willing to achieve common goals acting in their individual self-interest. This was the price paid for achieving universal participation, something the Kyoto Protocol could not achieve with top-down assignment of national targets.

Theory of change #1: beauty contest for the rich, finance for the poor

The Paris Agreement relies on the theory of change providing that the five-year review and pledge cycles will gradually increase the level of ambition of the nationally determined contributions (NDCs) so that eventually all parties will reach global peaking of greenhouse gas emissions as soon as possible and achieve climate neutrality in the second half of the century. Incentives depend on mutual peer pressure and goodwill informed by climate science. Countries' reports and plans are publicly compared against one other and against various non-binding benchmarks and ranked on how ambitious they are. Willingness to increase ambition is to be propelled by the market and non-market mechanisms under Article 6 and financial and technology transfers from developed to developing countries.

Key to the mainstream theory of change for the Paris Agreement is the assumption inherited from the Kyoto Protocol that the willingness to decarbonize is inversely related to income. Developed (high-income) countries are expected to lead climate action, lower technology costs and support developing countries, which are assumed to follow. Therefore, the standard policy recipe proposed by economists is a minimum price on carbon emissions implemented by all, with high-income countries/large emitters applying higher prices and providing financial transfer to low-income nations (Weitzman 2014; Gollier and Tirole 2015; IMF 2021). Such policies would provide fairness to the Paris Agreement, but we argue that they would not be sufficient to ensure its full effectiveness, because of incentive incompatibility.

Income level or volume of emissions do not explain countries' willingness to act and cooperate on climate. Several high-income countries and regions, such as the European Union, California and a few other US states, and British Columbia and Quebec in Canada, are indeed primary movers. But the hesitancy of the US, Australia, and other Canadian provinces shows that high-income countries and regions do not have common incentives to form a stable climate club soon enough to prevent the worst climate warming scenarios. Gulf Cooperation Council (GCC) countries have very high income per capita but are not leading global decarbonization. On the other hand, several middle-income economies, like Korea, China, India, Chile, Costa Rica, Morocco, Georgia, and the Alliance of Small Island States behave like climate leaders. What the primary movers have in common is that they are almost without exceptions net importers of fossil fuels. Conversely, the most reluctant countries to cooperate on climate action are not the poor ones, but those who depend on fossil fuel revenues, regardless of income.

Theory of change #2: climate OPEC

One alternative theory of change for the Paris Agreement was proposed by the literature on supply-side climate policies. It suggests that fuel-producing countries have a rationale to be the first-movers of climate action and to form a super-cartel to scale down fossil fuel production to ensure market stability and higher rents (Asheim et al., 2019; Green & Denniss, 2018; Newell & Simms, 2019). Such a 'climate OPEC' could maximize producers' revenue by restricting supply and increasing prices above the marginal costs, as per the popular saying that 'monopolists are environmentalists' best friends.'

This concept also can be incentive-incompatible, although for different reasons. To make production cuts aligned with the goals of the Paris Agreement, all producers would have to believe that some external drivers will depress future demand for fuels faster than they would choose in order to maximize the present value of their future revenue. But if the members of such a "climate OPEC" believed in rapidly declining demand, the competition for the disappearing oil, gas, and coal rents would put pressure on the stability of a large, heterogenous climate cartel. Low-income, high-cost producers would try to accelerate extraction before they are priced out of the market. High-income, low-cost producers with market power will be tempted to increase production, accelerating bankruptcy of more costly, vulnerable, and financially leveraged competitors, and grab their

[27] This note is supported by Peszko, et al. 2020, Peszko, van der Mensbrugghe and Golub, 2019 and 2020 and the forthcoming 2021 edition of the World Bank's Changing Wealth of Nations, but the views expressed here are of the author alone and should not be attributed to the World Bank.

market shares before creating supply crunches and hiking prices again. Therefore, this theory of change may also not be robust enough to trigger climate action on the needed scale and timeline.

Theory of change #3: strategic games for diversification and cooperation

The third theory of change for the Paris Agreement focuses much more on the countries' incentives to act and cooperate on climate mitigation. It is based on the observation that net importers of fossil fuels (regardless of income) have self-interest to lead on climate action. They have already demonstrated leadership in green technologies and revealed their comparative advantage in green products. They have accumulated assets, skills and capabilities to leapfrog to the low-carbon economy and harness primary mover advantages. Fossil-fuel-dependent countries (FFDCs), on the other hand, share the concern that deep decarbonization would disrupt their (often narrow) income sources and antiquate their revealed comparative advantage in extractive and heavy manufacturing products. Therefore, they are usually reluctant to implement domestic climate policies and distrust climate cooperation.

FFDCs are indeed vulnerable to the policy choices made by fuel importers. By implementing demand-side climate policies, the fuel-importing nations reduce the welfare of fuel exporters. Their energy and carbon taxes capture part of exporters' hydrocarbon resource rents and transfer them to importers' government coffers as fiscal revenue. Technology policies, significant shifts in investors' and global consumers' sentiment towards low-emissions products and trade barriers implemented by fossil fuel importers raise risks to the outlook for fuel commodities and carbon-intensive products, which are the mainstay of much of the FFDCs' economies.

According to this theory of change, the key to success of the Paris Agreement lies in credible and decisive policy action by fossil fuel importers with a critical mass of market power (declarations and targets are not enough). The open, bottom-up architecture of the Paris Agreement allows a group of major fuel importers to form a 'climate club' and pursue voluntary cooperation to increase the ambition of their climate action (Nordhaus 2015). They need to collectively agree on their individual commitments and exclusive privileges available to members and establish an enforcement mechanism based on reciprocity ('I will if you will' as suggested by Ostrom 2009), to build mutual trust and keep the club stable (Gollier and Tirole 2015; MacKay 2015; Cramton et al 2017). Such a club can play a multi-stage strategic game with non-participants, using a combination of financial and technology transfers, trade agreements, carbon markets and border adjustment taxes, and other 'carrots' and 'sticks', to entice their cooperative behaviour. An effective climate club is yet to be established, but first signs are emerging, such as the Carbon Border Adjustment Mechanism proposed jointly by 27 EU countries, although the market power of EU is too small.

FFDCs would have no means to stop demand-side action by fuel importers, but can creatively and anticipatorily adapt to it and harness emerging opportunities to make growth of their economies more diversified and hence resilient to external shocks and sustainable. Such a theory of change for the Paris Agreement was first explored in Peszko et al. 2020.

The incentive-compatibility of this theory of change has been stress-tested with the global CGE model GTAP-ENVISAGE (van der Mensbrugghe 2019, Aguiar et al. 2019; Chepeliev 2020) integrated with an endogenous dynamic oil, gas, and coal extraction module. This module cuts supply by high-cost producers when demand and prices drop, leaving some proven reserves stranded, and does the reverse when market conditions become favourable. The countries were aggregated into two stylized climate policy 'clubs'. First is the club of climate policy leaders (CPLs), comprising net fossil fuel importers subdivided into high-income CPLs and middle- and low-income CPLs. The second club represents FFDCs, further subdivided into several groups depending on their pattern of fossil fuel dependency.

Scenarios

The model simulated incentives for different country groups to engage in multiple alternative cooperative and non-cooperative policy scenarios. Here, we only present results for a sub-set of policy instruments, namely economywide carbon taxes and border carbon adjustment taxes (BCAT):

The reference scenario assumes that countries will implement their unconditional NDCs.

- In unilateral policy scenarios, CPLs implement carbon taxes, reaching US$ 400/tCO_2 in 2025–2050. FFDCs do nothing beyond their NDC pledges.
- In some unilateral policy scenarios, CPLs apply a BCAT on the carbon content of imports from noncooperating FFDCs, with the same rates as domestic carbon taxes.

- In the cooperative scenarios, all countries, including FFDCs, implement domestic carbon prices with the same rates, reaching US$ 130/tCO_2 by 2050, much less than CPL prices in the cooperative scenario with the same cumulative CO_2 emissions.

In all policy scenarios—unilateral and cooperative—the cumulative gross CO_2 emissions calculated by the model (862 GtCO_2 in the 2018–2050 period) are in line with the carbon budget in the 2°C-consistent IPCC mitigation pathways. In the research underpinning this note, we simulated more scenarios with additional 'carrots', such as financial and technology transfers, preferential trade agreements with green conditionalities, and 'sticks' such as stricter trade sanctions proposed by Nordhaus (2015).

Results

Simulations confirm that net fuel importers have economic incentives and capabilities to lead climate policies. High-income CPLs face the lowest risk of slower growth, especially in cooperative scenarios, and the largest opportunities for potential upsides.[28]

Middle- and low-income CPLs, such as China, India, Ukraine, Cambodia, Serbia, Morocco, or Turkey, face larger GDP loss against the Business-as-Usual scenario, even relative to FFDCs, especially in unilateral scenarios. They are net fuel importers with a large share of coal in their domestic energy mix. Potentially stranded coal assets in these countries are large in value and pose a transition challenge in the electricity sector and social/political risks of potentially 'stranded labour' in coal mining and coal-burning industry. They are not a source of systemic macro-fiscal risk, however, due to the unequivocally small share in the total output and export. China and India benefit from climate cooperation, however, because lower domestic carbon taxes in the cooperative scenarios prevent industrial leakage to FFDCs and delay early retirement of some of the most efficient coal power and industrial plants.

All net fuel importers (CPLs) have both incentives and market power to use BCATs to discourage free riding by fuel exporters. But, unsurprisingly, BCAT it is not a very attractive policy for CPLs. They have incentive to apply BCAT mainly to induce cooperative behaviour by FFDCs—ideally as a credible threat rather than implemented tariff, especially if FFDCs threatened to retaliate.

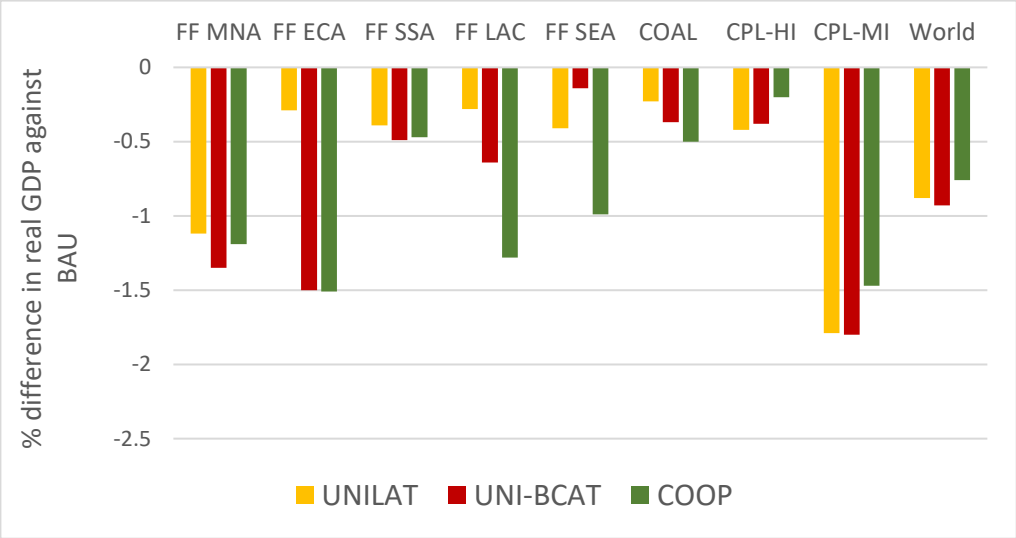
Among the FFDCs, the most negative impact on economic output can be found in the Middle East and North Africa and in Europe and Central Asia. Coal exporters (including Australia, Colombia, Indonesia, Mongolia, and South Africa) would forego the least in GDP terms, especially in non-cooperative scenarios, because coal extraction is a small share of their economies.

Simulations suggest that free-riding incentives differ significantly among FFDCs. Low-cost oil producers can be relatively easily incentivized to cooperate with CPLs. BCAT can be an effective incentive for FFDCs in the Middle East and North Africa, Europe and Central Asia, and sub-Saharan Africa to engage in cooperative climate policy. Their growth and exports are heavily dependent on oil revenues. Lower CPL carbon taxes in the cooperative scenarios prolong the transition away from oil in transport in the major oil importers and keep global oil prices higher than in unilateral scenarios. Unilateral climate action of CPLs, especially with BCAT, is particularly harmful for the growth of GCC countries, which have very low production costs and would have higher market share and export revenue in cooperative scenarios.

Ambitious unilateral climate policies implemented by CPLs increase fuel prices for their consumers, suppressing fuel demand and imports, reducing exporters' prices. This can trigger a chain of macroeconomic pressures on gas and coal exporters to domesticate emission-intensive heavy industries and increase the carbon footprint of domestic production. Exchange rates of their currencies fall more in unilateral scenarios, reversing the Dutch disease and boosting the export competitiveness of their already competitive heavy industry, while foreign competitors in CPLs exit the market, squeezed out by high domestic carbon prices. Lower export prices decrease exporters' opportunity costs of using fuels at home. Fuel exporters with already developed and competitive industrial base and value chains, such as Russia, Mexico, or the GCC countries, may be particularly tempted to give their heavy industries a 'free ride' on the global effort to mitigate climate change and expand their market shares in the globally declining carbon-intensive manufacturing sectors, at the expense of the CPLs.

[28] Macroeconomic models tend to underestimate the benefits of low-carbon transition because they are not very good at simulating growth of new green technologies and sectors that are very small in the base year. Avoided damages of climate change are not included in these simulations. Adding these action triggers would provide a fuller picture of incentives.

Differences in real GDP against the NDC scenario



Source: Peszko et al, 2021.

MNA = Middle East and North Africa; ECA = Europe and Central Asia; SSA = sub-Saharan Africa; LAC = Latin America and Caribbean; SEA = South-East Asia; COAL = coal exporters; CPL-HI = high-income CPLs; CPL-MI = middle- and low-income CPLs; UNILAT = unilateral policy scenarios; UNI-BCAT = unilateral policy scenarios in which CPLs apply a BCAT; COOP = cooperative scenarios.

Such traditional diversification, which reduces reliance on fuel exports and increases reliance on downstream, fuel-intensive tradeable manufacturing products is widely considered by almost all macro-economists as a standard recipe for the success of resource-rich countries. But it leads to accumulation of carbon-intensive produced capital, and hence increased macro-fiscal exposure to external shocks of the low-carbon transition. A credible possibility of a BCAT imposed by importers with large market power would erase the benefits of free-riding for gas and coal producers who have invested in emission-intensive downstream industries.

Lower-income, fragile, and conflict-torn FFDCs, such as many African oil and gas exporters, Iraq, Libya, or Venezuela, pose a special development challenge. These countries have limited ability to redirect fossil fuels from exports to domestic use by increasing the output of energy- and emission-intensive industries. They have few alternative sources of short-term revenue that could be reinvested in a diversified portfolio of national wealth to create a more resilient and greener asset base for long-term resilient, sustainable, and equitable prosperity. Reversing Dutch disease may not help them in the absence of well-developed internationally competitive manufacturing sectors. They will need international assistance to leapfrog to a green economy.

AN EU PERSPECTIVE ON THE CHALLENGES OF COP26 AND ACHIEVING NET ZERO TARGETS

Klaus-Dieter Borchardt

Key challenges to be addressed by COP 26

The challenges of COP 26 are threefold. First, all countries have to disclose their long-term climate goals. A total of 120 countries, including recently the USA under the Biden administration, have committed to achieve the net-zero emission target by 2050. China has joined by setting its net-zero target for 2060, and Russia has announced its Low Carbon Development Strategy with a target date of 2050. However, there are still important polluting countries out there, notably India and Brazil, which still need to deliver their ambitions.

Second, the long-term target settings must be complemented by intermediate targets for 2030 accompanied by concrete measures and actions for their achievement. This is mainly a question of the credibility of the whole implementation process of the Paris Climate Agreement, which cannot continue to treat simple target setting as the silver bullet without developing clear actions for an immediate and fast implementation. Recently, this has also become a legal issue. The German Constitutional Court in its ruling of 24 March 2021 obliged the legislature to develop a forward-looking plan to deal carefully with residual emissions after 2030 based on the freedom of fundamental rights and the state objective of environmental protection. On 26

May 2021, the court of The Hague in the Netherlands rendered a judgment in which for the first time ever a company was ordered to change its policies in order to bring them in line with 'universally accepted' CO_2 emission-reduction targets. The court found that based on the unwritten standard of care, notably the companies' responsibility to respect human rights and the UN Guiding Principles, the company has a CO_2 reduction obligation.

Third, unfinished work from COP 25 needs to be settled, notably rules for a carbon market between countries.

The role of the European Union

The EU considers itself as the leader in the fight against climate change and the achievement of the 2030 and 2050 targets. Indeed, the EU is the only party which not only has set ambitious targets for 2030 and 2050 but has also adopted a first of its kind climate law raising the greenhouse gas (GHG) emission reduction from 40 per cent to 55 per cent by 2030. On 14 July the European Commission put forward 13 concrete legislative proposals which, once adopted by the EU legislature, will form a comprehensive legal framework for the achievement of the 2030 and 2050 climate targets.

Two questions, however, arise from this legislative package. The first is whether it is indeed suitable for the practical achievement of the targets, taking into account the three overarching primary objectives, which are sustainability, affordability/competitiveness, and security of supply. The second is whether the EU with this package can lead the global transformation process by example.

Legal framework for the achievement of the climate targets

Without any doubts, the Fit for 55 package contains a number of measures and actions which will positively drive the fulfilment of the sustainability objective and the transformation process towards the 2030 and 2050 targets.

The **energy-efficiency-first principle** becomes a legal principle obliging member states to ensure that energy-efficiency solutions are taken into account in planning, policy, and major investment decisions related to energy systems and non-energy sectors.

The overall **EU-level target for the share of renewable energy sources** (RES) in final energy consumption to be reached by 2030 shall be increased to 40 per cent (instead of the previous 32 per cent). In parallel a number of sub-targets for specific sectors of the economy are also increased, notably for buildings, industries, heating and cooling, and transport. These new and increased renewable energy (sub-)targets are supported by a number of new (largely 'soft law') measures and obligations laid down on member states, of which the following are noteworthy: adapting the National Energy and Climate Plans (NECPs) to the new climate targets, limiting support to biomass-based energy production, improving the regulatory framework for renewable power purchasing agreements, improving transparency and guarantees of origin, expanding the 'additionality' framework, promoting energy system integration, and incentivizing district heating.

The EU's **Emission Trading System** (ETS) remains one of the cornerstones of EU policy to combat climate change. In essence, it works by establishing a market of GHG emissions permits, called allowances, by creating through regulations the (capped) supply and demand for such allowances, as well as their tradability. The systems of free allocation of allowances shall be restricted in multiple ways: free allocation is phased out in the aviation sector; free allocation in industrial sectors is made conditional on companies demonstrating decarbonization efforts; and since a Carbon Border Adjustment Mechanism (CBAM) is introduced as an alternative measure to mitigate carbon leakage risks, the industrial sectors and subsectors will no longer receive free allocations after a transitional period involving a 10 per cent reduction in free allocation per year from 2026 to 2035.

The Commission is also proposing to establish a new and **separate ETS for the road transport and buildings sectors** as of 2025. The emissions cap and linear reduction factor for the new ETS will be set in such a way as to set the ambition level at 43 per cent of GHG emissions reduction in 2030. Of the revenues from the new system, 25 per cent are to be put in a dedicated Social Climate Fund that will be used to help vulnerable households, micro-enterprises, and transport users to address the possible social impact of this new system.

The obligation on member states to now spend 100 per cent of their ETS revenues (instead of 50 per cent under current law) for climate-related purposes, combined with the likely increase of the price of ETS allowances, will make more funds available at the national level, where the funding of low-carbon technologies may be considered more favourably.

The Commission also proposes to establish a **CBAM**, which is a system pursuant to which the importers of a limited number of goods in certain sectors will need to surrender annually sufficient 'CBAM certificates'—the price of which will largely mirror the

ETS price—to cover the imported goods' 'embedded emissions'. The goods covered by the CBAM are cement, iron and steel, aluminium, fertilizers (including ammonia), and electricity. The CBAM provides for the virtual connection of the EU trading partners to the EU emissions trading system—and is accordingly assessed critically by them, because the CBAM will make their products more expensive when they are imported by pricing in the CO_2 costs. The Commission tries to ensure conformity with World Trade Organization rules, notably the principle of non-discrimination, by putting the obligation to cover the emissions embedded in imported goods by the appropriate number of CBAM certificates on the importers and replacing the carbon leakage protection for EU industry by the CBAM, although only after a relatively long transition period (until 2035). The CBAM shall also act as a climate policy lever. The more states cooperate with the EU on climate policy, the less need there is to use the instrument. If it is successful, the CBAM becomes superfluous. The EU and member states have to hold intensive talks with their trading partners in which they explain their approach and negotiate details of their application and exceptions.

The reform of the **Energy Tax Directive** introduces a new tax structure, determining a minimum tax level and tax ranking based on the energy content and environmental performance of fuels and electricity. The aim is to ensure that lower taxes are paid by energy sources or vectors that are considered to support the energy transition, in proportion to their contribution. Furthermore, the scope of the Directive is broadened by covering kerosene for aviation and heavy oil used in maritime transport, and by removing the possibilities for member states to provide general and specific exemptions in particular for fossil fuels. This taxation regime is highly favourable to electricity and represents a strong push towards electrification.

On the other side, the package also raises some concerns with regard to the affordability and security of supply objectives.

Potential issues with the EU plans

The new ETS for building heating will put a price on polluting fuels, encouraging producers to innovate and invest in clean energy and offer it to end-users. Despite the good intentions of the Commission, which views carbon pricing as the most effective way to lower emissions, the creation of a second ETS might become the most controversial part of the whole package, because if the balance between the introduction of a price on polluting fuels and the financial support for poor and vulnerable consumers is not achieved, the extra cost will be borne by poor and vulnerable households, which might lead to a European movement of the Yellow Jackets.

There is also a very strong push towards electrification of road vehicles. In particular, the '−100 per cent' target for direct emissions by 2035 entails, in effect, the prohibition of combustion engines, which might stir very controversial discussions with some member states because of the lack of technological neutrality by ruling out the use of synthetic fuels in combustion engines.

Other measures where the principle of technology neutrality is clearly breached concern the use of renewable hydrogen. In particular in the proposed FuelEU Aviation Regulation and the Energy Tax Directive, renewable hydrogen is clearly favoured for reasons unrelated to its GHG content, creating artificial demand for this type of hydrogen while stifling the potential for low-carbon hydrogen.

Some of the proposed measures seem also to be driven by political aspirations rather than by hard facts. This is particularly true for the skyrocketing need for renewable electricity: The new 40 per cent RES target for renewable energy in the final consumption means—based on the Commission estimate—a target for renewable electricity of 68.3 per cent. For illustration, according to Wind Europe, this 40 per cent RES target requires the installation of 27 GW of new wind power capacity per year until 2030, while the current expectations based on the NECPs are that 18 GW will be built per year. Filling that gap may be viewed as unrealistic, and it can be expected that there will not be enough renewable electricity for electrification, transport, and industries.

Indeed, there is an increasing amount of evidence that, due to the required speed of the decarbonization process, there will simply not be enough renewable electricity under current national plans to green the power sector in parallel with the other sectors of the economy. One particularly poignant example in this respect is the necessary coal phase-out. It seems most unlikely that, regardless of political efforts, renewable electricity alone will be able to simultaneously phase out coal, decarbonize the other sectors of the economy, and meet any potential incremental power demand. As an alternative to both low-carbon and bio-gases, one could in theory rely on nuclear power to complement the scarce renewable electricity. Even if one puts aside the question of the dangers of nuclear power and its undesirable side effects (such as nuclear waste), considering that the climate crisis outweighs these issues in terms of urgency, the political reality of the energy landscape at the EU level would in any case not permit widespread reliance on nuclear energy as a low-carbon solution to the scarcity of renewable electricity. Indeed,

member states still maintain total sovereignty over their energy mix, and it is very clear that many member states will never be willing to start relying on nuclear power, while many others have in fact decided to phase out their nuclear power plants, precisely the opposite of increased reliance.

Since a Paris-compliant pathway requires the use of the least carbon-intensive form of power possible, and having exhausted renewable electricity, low-carbon and bio-gases, and nuclear power, the next option to consider is natural-gas-based power as the least carbon-intensive technology available. It may seem counter-intuitive to consider the use of natural gas as part of the Paris-compatible decarbonization path. However, once again, this is the logical consequence of (1) the need to find the quickest decarbonization path possible, (2) the scarcity of renewable electricity, and (3) the political or physical supply constraints on the other energy sources.

Given the urgency of the coal phase-out, there are good arguments to support the view that the only realistic Paris-compliant path is the use of natural gas together with the most carbon-efficient technologies. This means that combined-heat-and-power technologies and/or carbon capture and storage and use technologies as well as pyrolysis are economic and practical options (for example in terms of cost, availability of infrastructure, storage, and heat demand) that any natural-gas-fired turbines should use. An often-used argument against the use of carbon-efficient technologies linked to natural gas is the lock-in of carbon-intensive assets. To avoid this, one should incentivize natural gas operators to invest in new gas-fired turbines that can use low-carbon gases, in particular hydrogen, blended with natural gas at first then in its pure form, and/or to ensure that any new investment in natural gas turbines is made according to a business plan that would see the amortization of the investment in a time frame appropriate to ensure that they could be decommissioned (for example by a governmental decision) without any economic loss. In other words, the use of natural gas will be necessary, in practice, to successfully achieve the Paris Agreement within the EU. Used intelligently, it can enable the EU to best allocate its scarce renewable electricity to decarbonize a wide cross-section of the economy and to decrease the EU's greenhouse gas emissions faster than without it.

Leading the global transformation by example

The EU wants to take this role on and develop concrete strategies for this kind of energy diplomacy. The European Parliament is proposing to designate a Special Climate Envoy who could bundle all different aspects of the transformation and make the EU speak with one voice on these matters at the global level. However, it is very doubtful whether this idea will fly in the Council and the Commission.

In substance, other countries could indeed learn from the positive and negative experiences within the EU. They could take over what has worked well and is adaptable to their situation—notably those measures creating new value chains, jobs, and growth or green technologies. They should avoid what did not work because it was technologically not implementable or too expensive or put the security of supply in jeopardy. The continuous use of natural gas, notably in the context of the coal phase-out, serves as an example here.

To be successful as a global leader for combatting climate change, the EU also needs to support poor and developing countries and to share with them its know-how, technologies, and markets. First examples are, at the EU level, the public climate finance provided to developing countries by the EU, its member states, and the European Investment Bank; together they provided €21.9 billion in 2019, by far the highest support awarded to developing countries in the world. At the member states level, the German H2Global foundation can serve as an example by which the development of green hydrogen production in developing countries and the opening of the German and European markets for those productions is supported. However, assistance for countries in need cannot only consist of opening new business opportunities in terms of exports of renewable energy. It should also directly contribute to the transformation of the economy and the energy system in those countries, helping them to decarbonize; otherwise, the business opportunities could work against domestic decarbonization efforts, because the domestic use of renewable energy solutions would be kept low in order to increase the available volumes for the money-making exports. In this respect international standards should be set introducing, for example, a rule that a certificate for renewable energy is only issued if a minimum percentage of renewable energy use is reached domestically.

Conclusion

If the process of the implementation of the Paris Climate Agreement shall not lose its credibility, COP 26 must deliver, not only in terms of target- and ambition-setting but notably in terms of concrete measures and actions with clear milestones with a precise timeline. The EU proposals for a comprehensive legal framework for achieving the 2030 and 2050 targets can be very useful for this exercise, but it must be clear that the EU framework is not a blueprint for other countries. It should be used as a

kind of laboratory for the analysis of how best to organize the transformation of the economy and deliver at the same time on the overarching objectives of sustainability, affordability, and security of supply. The message from the EU in this regard will most probably be that the EU will demonstrate that the decarbonization of the economy is possible by creating at the same time growth, jobs, and new value chains. At COP26 the EU will aim to take Europe's climate policies global and invite other countries, China and the US specifically, to join the EU in this endeavour, looking for close cooperation at the global level. The CBAM will serve in this context as a reminder that if the international community is not ready or willing to bring its share to the table, notably by supporting global carbon markets, there is no other way for the EU to unilaterally put its companies on more equal footing with competitors in countries with weaker carbon policies.

In terms of practical organization, the EU aims to provide a space for both physical and digital side events seeking to stimulate the debate on its messages and actions, which are all covered in its Fit for 55 package, such as transition to net-zero emissions, adaptation and resilience, climate finance, just transition, and involving citizens in the transition. By this the EU intends to facilitate the dialogue with party delegates and other participants, as well as launching new initiatives and partnerships and showcasing inspiring and successful projects or policies. All events will be accessible through an online platform to reach out to broader audiences around the globe and allow enhanced virtual participation.

With its world-first climate package, the EU will clearly demonstrate its global climate leadership intention. However, it is unclear if that will be enough to trigger similarly ambitious actions from other major economies at COP 26 in November in Glasgow.

THE EUROPEAN UNION'S PROPOSAL FOR A CARBON BORDER TAX – A CATALYST FOR GLOBAL CARBON PRICING OR A PROTECTIONIST TRADING MEASURE?

Alex Barnes

COP 26[29] is the next meeting of the world's nations to try and address the climate change emergency. The urgency of the task has been emphasized by the recent Intergovernmental Panel on Climate Change (IPCC)[30] report which made clear how much global warming was already 'baked in' and that the world was unlikely to meet the Paris Agreement's[31] ambition of limiting warming to 1.5°C by the end of the century unless 'there are immediate, rapid and large scale reductions in greenhouse gas emissions.'[32] Given that existing government policies (as opposed to declarations of intent to reduce emissions) fall well short of the reductions needed to meet even a 2°C global warming target,[33] the need for action is both clear and more urgent.

Greenhouse gas (GHG) emissions are a classic externality in economic terms, meaning that global agreement is needed to ensure that global emissions actually decrease. As the IPCC report shows, reaching *impactful* global agreement to reduce emissions has so far proved elusive. Hopefully COP 26 will be more successful. Into this complicated mix the European Union Commission has introduced a proposal for a Carbon Border Adjustment Mechanism (CBAM),[34] a form of carbon border tax, to ensure that importers of certain goods into the EU face the same carbon costs as EU producers of those goods. Effective global carbon pricing coupled with emissions trading will be an important tool in reducing global emissions. The EU CBAM could be a catalyst for reaching agreement on such international mechanisms at COP 26, such as the detailed rules for Article 6 of the Paris Agreement, which remain to be adopted. This article will look at why this could be the case, and what the obstacles are facing the adoption of the EU CBAM.

[29] https://ukcop26.org
[30] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.
[31] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
[32] IPCC Press Release. "Climate change widespread, rapid and intensifying - IPCC." 9 August 2021.
[33] See for example the International Energy Agency's Stated Policies Scenarios (STEPS). IEA (2020), World Energy Model, IEA, Paris https://www.iea.org/reports/world-energy-model.
[34] European Commission. Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a carbon border adjustment mechanism. 14 July 2021.

Why has the European Commission proposed the CBAM?

The European Union is legally committed to reaching net zero GHG emissions by 2050, and as a stepping stone to this target, reducing emissions by 55 per cent by 2030.[35] These targets are designed to meet the EU's commitments under the Paris Agreement. On 14 July 2021 the Commission introduced the Fit for 55 package[36] of legislative measures to meet the 2030 target. Two key elements for this were proposals to reform the current EU Emissions Trading System (ETS), and the introduction of the CBAM. Reform of the ETS includes reducing the number of allowances which will be available overall and phasing out the quantity of free allowances granted to emitters.[37] This will increase the carbon price for EU industry and hence their costs compared to non-EU competitors. The CBAM is therefore introduced to address the risk of 'carbon leakage', the risk that EU producers will lose out to imports of goods from countries with lower carbon costs, with no effective reduction in global GHG emissions but an adverse impact on EU companies and employment.

Currently carbon leakage is addressed by issuing free allowances to producers deemed at risk.[38] However, this has the effect of reducing incentives for those sectors to reduce their emissions. The EU notes that the power generation sector, which must buy all its allowances, has reduced its emissions much more than industry. In its impact assessment accompanying the proposal, the EU also notes that whilst studies have not shown much evidence of carbon leakage to date because of the use of free allowances, the risk of carbon leakage increases as the carbon price increases and if free allowances are withdrawn.

There has been much discussion about what form the EU CBAM should take, both to address the carbon leak threat, and to ensure it complies with the EU's obligations under World Trade Organization (WTO) rules.[39] The EU Commission's proposals are limited in terms of the sectors they cover and the time scale for the introduction of the CBAM and the consequent reduction of free allowances given to those sectors. This can be seen as a means of testing the water and minimizing the amount of opposition that the proposals may face, both within the EU and by the EU's trading partners. The Commission has focussed on sectors which are easy to define and which have a significant impact. Initially the CBAM will be restricted to the following sectors: cement, steel, electricity, aluminium, and fertilizers. These non-electricity sectors account for 13 per cent of EU 27 GHG emissions in 2020, and 55 per cent of total industrial emissions. Iron and steel account for 27 per cent of industry emissions, cement for 21 per cent, fertilizer for 6 per cent, and aluminium for 1 per cent.[40] Power generation accounts for 27 per cent of EU emissions,[41] but electricity imports only account for 1 to 2 per cent of EU consumption. However, imports of electricity increased from 3 TWh in 2017 to 20 TWh in 2020 as connections with neighbouring countries have improved.[42] This helps explain why electricity is also included in the CBAM. The Commission can add sectors in the future.

Companies which import these goods into the EU will have to buy CBAM certificates equivalent to the quantity of emissions associated with these products, at a price based on the weekly price of the EU ETS allowances which EU companies must buy to cover their own emissions. Importers' emissions calculations will be based on independently verified installation-level data where available. Where reliable installation information is not available, default values based on the host country's emissions data for the sector will be used. If country-level data is not available, default values will be based on the 10 per cent worst performing EU installations in the sector.

However, there is a long transition period for the phase-out of the free allowances that EU companies currently receive to protect them from carbon leakage. In the first two years of the scheme, 2023 to 2025, importers will only be required to report their emissions, but not buy allowances. EU companies will continue to receive 100 per cent free allowances during this period, but between 2025 and 2035 the quantity of free allowances will be reduced to zero. Importers will have to buy CBAM certificates for the same share of emissions for which EU companies have to buy allowances. Ensuring that importers are effectively treated

[35] The European Climate Law. Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law').
[36] European Commission Press Release. European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions. 14 July 2021.
[37] For an overview of how the EU ETS works see Barnes, A. (2021). "The Challenges and Prospects for Carbon Pricing in Europe." Oxford Institute for Energy Studies. Page 4.
[38] Ibid. Page 5.
[39] For further discussion of this see Ibid. Page 10.
[40] European Commission. COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT REPORT Accompanying the document Proposal for a regulation of the European Parliament and of the Council establishing a carbon border adjustment mechanism. Figure 7. Direct CO_2 equivalent emissions in the CBAM sectors – EU 27 in 2020. Page 44.
[41] Ibid.
[42] Ibid. Page 36 to 37.

the same as EU companies is essential if the CBAM is not to fall foul of WTO rules. This does not mean that the WTO compliance of the CBAM is universally acknowledged by the EU's main trading partners. Issuing of CBAM certificates and collection of revenues will be done by EU member states with supervision by the Commission. The use of the revenue is not specified, but it would need to be used to reduce emissions to avoid WTO-related complaints of protectionism.

Could the CBAM be a catalyst for global carbon pricing?

The CBAM will take into account any carbon taxation that importers have already had to pay in their home country.[43] The EU Commission will also have the ability to exclude from the CBAM importers based in countries which apply the EU ETS, or have an agreement linking the EU ETS to that country's own ETS, and the importers pay an equivalent carbon price to EU companies.[44] Currently the EU ETS applies to Norway, Iceland, and Liechtenstein, which are not EU member states but are part of the European Economic Area. Switzerland has an agreement linking its own ETS to the EU ETS, the first country to do so. The EU has ambitions to link its ETS with other countries as a means of addressing climate change more effectively.[45] The imposition of a CBAM would be a significant incentive for many countries to introduce carbon-taxation or emissions-trading policies to avoid the CBAM itself. For example, Russia is the largest exporter of fertilizer, aluminium, steel, electricity, and cement to the EU, followed by China and Turkey, and none of these countries have a national carbon price,[46] although China has recently introduced its own ETS. China is the world's largest GHG emitter, whilst Russia is the fourth.

As well as incentivizing the more widespread introduction of carbon pricing, the CBAM could also encourage adoption of carbon pricing at a level high enough to incentivize emissions reductions. Estimates of the carbon price necessary to achieve this vary, but the International Energy Agency (IEA) assumes a carbon price of \$63/tCO_2 in 2025 and \$140/tCO_2 in 2040 for advanced economies, and \$43/tCO_2 in 2025 and \$125/tCO_2 in 2040 for developing economies in its Sustainable Development Scenario.[47] To avoid the CBAM, countries would need ETS prices similar to the EU ETS; the lower the differential between a country's carbon price and the CBAM price, the less money importers would need to pay to the EU, and the more revenue importers' own governments would gain. This represents a 'double win' for importers: they retain access to the EU market, and they would be able to choose how to spend carbon taxation revenues rather than paying them to the EU.

Moreover, there are considerable efficiency gains to be realized by more international cooperation on carbon pricing. The IEA estimates the global GHG abatement cost range for industrial energy efficiency at between negative \$132.17/tCO_2e and positive \$153.07/tCO_2e with a global average of negative \$24.00/tCO_2e.[48] It may be a lot cheaper to reduce emissions in non-EU countries with less energy-efficient industries than in the EU itself. Whilst ultimately global industry will need to decarbonize almost totally if the Paris Agreement objectives are to be achieved, quick and cheaper wins outside the EU could help achieve the 'immediate, rapid and large scale' emissions reductions called for by the IPCC.

This is where Article 6[49] and the COP 26 negotiations become relevant. Article 6 aims to foster international cooperation and emissions trading. It will be on one of the key negotiating areas at COP 26 as countries have so far failed to agree on detailed rules to implement it. Article 6.2 allows for bilateral trading of emissions credits between countries, whilst Article 6.4 provides for the establishment of a global carbon-trading mechanism. If such mechanisms can be realized, they could be a way for importers to reduce their effective carbon footprint, and hence exposure to the CBAM, whilst at the same time ensuring that global emissions are reduced in aggregate.

Even if this does not happen, the CBAM can contribute to better carbon accounting, an essential prerequisite for Article 6 mechanisms. Importers will have to use default values for the emissions declarations unless they have independently verified

[43] European Commission. Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a carbon border adjustment mechanism. 14th July 2021. Article 8.
[44] Ibid. Article 2.
[45] For further discussion of this see Barnes, A. (2021). "The Challenges and Prospects for Carbon Pricing in Europe." Oxford Institute for Energy Studies. Page 22.
[46] Wolf, M. (2021) "Giving green a chance. Climate change mitigation will alter global trade." Deloitte Insights. Figure 1.
[47] Figures in \$2019. International Energy Agency. World Energy Model. Macro Drivers. CO_2 Prices. October 2020. The Sustainable Development Scenario is designed to be compatible with the Paris Agreement. However, it may need to be revised in light of the recent IPCC report. (IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.)
[48] International Energy Agency. GHG abatement costs for selected measures of the Sustainable Recovery Plan.
[49] https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

installation emissions data. If the default values are high relative to actual emissions, there is an obvious incentive to verify actual emissions, which will build up emissions verification capability, as well as help develop a globally trusted approach, similar to international accounting rules.

Hurdles to be overcome by the CBAM

There is a long way to go before the CBAM will have an impact. First it needs to be agreed by both EU member states and the EU Parliament before it becomes law. Although many in the EU have been pushing for a CBAM because of fears of carbon leakage, many companies are unhappy with the Commission's proposals. This is likely to lead to intense negotiations on the final form of the CBAM as member states protect their own companies' interests. For example, many companies do not want free allowances to be phased out, arguing that whilst the CBAM may even the playing field within the EU, they will still face higher carbon costs than their foreign competitors when selling into non-EU markets.[50] Thus, they would like free allowances as export credits to compensate. This causes two problems. It reduces the incentive to cut emissions, as it shields EU exporters from the EU ETS carbon price. Secondly it opens the EU to accusations that the CBAM is a protectionist, rather than a climate change, measure, and increases the chances of a successful challenge under WTO rules.

The risks of a WTO challenge should not be underestimated. The EU's trading partners, such as Russia,[51] India, Brazil, China,[52] and the United States[53] have all criticized the CBAM as a restraint on trade. At a recent meeting of the WTO Market Access Committee, members expressed concerns that the CBAM was 'not aimed at climate protection but rather at economic objectives, including fiscal and protectionist ones' because of the intention to use it as a source of revenue.[54] Trade rules and negotiations are notoriously complex and fraught, but it is entirely plausible that the legality of the CBAM will not be settled for some time to come. The use of default values for carbon emissions, for example based on the 10 per cent worst-performing EU installations, provides further ground for dispute. Trade lawyers could be busy for years to come.

There are also practical hurdles to be overcome such as the verification of emissions by importers, recognition of carbon prices already paid in their home countries by importers, and the authorization of importers under the CBAM. All of this is necessary but provides considerable scope for mistakes or fraud. For example, the proposed CBAM requires that 'verifiers shall carry out verifications with an attitude of professional scepticism.'[55] Financial accounting rules and procedures have been established over many decades, but this has not stopped a series of scandals where 'professional scepticism' has been noticeably lacking. It is not hard to imagine similar problems in the less established field of carbon accounting.

Conclusion

The EU Commission's proposed CBAM is a bold step, the first of its kind. Like any pioneer it faces previously unencountered challenges. As a result, it may not come to pass in its current form or may fall by the wayside because of international objections. Reconciling the conflicting forces of EU member states and international industrial self-interest with the requirement of effective carbon pricing resembles a game of three-dimensional chess, and a successful outcome is far from guaranteed. However, at the very least it has focussed further attention on the need to have international cooperation on emissions reduction because of global trade. Although the EU Commission has introduced its formal proposals for a CBAM, it is conceivable that a deal at COP 26 could include expectations that the CBAM proposals would be modified, for example by amendments proposed by EU member states, in return for an agreement on Article 6.

[50] Euractiv. "EU industry shuns carbon border levy, calls for export rebates." 27 July 2021.
[51] Financial Times. "EU plan for world's first carbon border tax provokes trading partners. Russia sharply critical of policy of limiting climate change by imposing cost on imports linked to emissions." 16 July 2021.
[52] Euractiv. "Emerging economies share 'grave concern' over EU plans for a carbon border levy." 12th April 2021.
[53] "John Kerry warns EU against carbon border tax US climate envoy 'concerned' about trade implications of Brussels' plans." Financial Times 12th March 2021.
[54] World Trade Organisation. "Brexit, EU's carbon border adjustment mechanism take centre stage at Market Access Committee." 16th November 2020.
[55] European Commission. Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a carbon border adjustment mechanism. 14th July 2021. Annex V. 1(a).

COP26 COULD BE A DEFINING MOMENT FOR TACKLING CLIMATE CHANGE – BUT ONLY IF WE CAN ACHIEVE GLOBAL SOLIDARITY ON DECARBONISATION

Antony Green

COP 26 is a huge opportunity to bring voices together from across the world. The event will continue to be an accelerator for change in the coming months and beyond the summit, with more global leaders looking to be bold on decarbonization. The focus for now, and for COP 26, must be the rate of decline of carbon emissions in the next decade—global consensus on actions that will accelerate decarbonization is needed. Failure to do so risks stalling progress and reducing our chances of tackling climate change.

Critical decisions and changes to the world's energy infrastructure need to be made, which will be much easier said than done. For example, turning off coal in India and China would hit 2030 climate targets; however, its complete removal would create major issues particularly for employment.

The challenge at COP26 will be about how much of the heavy lifting can be done by the residual coal-using countries, and how much will be made up of marginal gains from, for example, shifting to gas in the US and big reductions in oil as cars electrify. Reaching global agreement and solidarity on the way forward for the next 10 years will be key for longer-term success.

Crucially, it needs to be collectively acknowledged that there isn't a one-size-fits-all answer to tackling the climate crisis and that it will take a combination of solutions to reach net zero. This includes finding energy-efficient options so that overall, energy consumption is reduced—from improving building standards and increasing levels of insulation to looking at how business is conducted and where we buy from, all of which needs global, local, and individual action.

Achieving this will require pulling out all the stops and shifting from debate and discussion to concrete action—working with the knowledge and technology we have now and raising awareness of the range of options we can leverage to reach our climate goals.

Going harder and faster ahead of COP26

Reflecting on the last six to 12 months, there have been significant moves towards net zero globally, with new commitments from China and strong actions from the Biden administration. Eighteen months ago, many commentators would have hoped for this calibre of announcements at COP 26. As global ambitions continue to grow, the question now should be, can the world go even harder and faster ahead of November?

Based on announcements from Prime Minister Boris Johnson and President Joe Biden, the answer is yes, it can. A new steeper climate target in the UK reflects how seriously the government is taking the issue, with ambitions to inspire other countries to follow suit. Committing to cut carbon emissions by 78 per cent by 2035 has set the UK on a challenging yet exciting path to 2035. The plans go a critical step further to encompass emissions from international aviation and shipping, representing a real shift in understanding what needs to be done. Meanwhile in the US, climate change is firmly on the political agenda, with President Biden ramping up plans for tackling the climate crisis with bold action to slash US emissions in half by 2030.

More recently, the International Energy Agency presented a potential pathway to net zero by 2050 which included no new coal, oil, or gas developments from now on. This has since been closely followed by G7 environment ministers agreeing to stop direct funding of coal-fired power stations in poorer nations by the end of 2021. Whether this translates into action will depend on the ability of nations to put in place the policies needed to back up these intentions—but ultimately, the signs are positive.

Looking beyond COP26, global consensus on actions that will crank up decarbonization in the next 10 years will be critical for maintaining momentum in the months and years after the summit. There also needs to be confidence that energy markets and policies are able to deliver on climate goals. For National Grid, this requires the right regulatory, planning, and policy framework to drive investment in infrastructure. This will enable the development of energy networks fit for the shift to clean energy and the long-term, and in a way which minimizes the impact on the communities which often house our infrastructure.

All businesses have a role to play

Ambitious emissions targets can help focus minds across industries, sectors, and businesses of all shapes and sizes. But it can't just be a number on a piece of paper. Companies need to take stock of what these targets mean in practice and think about the role they can play in achieving them.

On the ground in each country, there's real momentum building among businesses with over 2,100 companies around the world, including National Grid, joining the global Race to Zero campaign, with a commitment to halve emissions by 2030 and achieve net zero by 2050 at the very latest.

There is a huge opportunity for businesses across different sectors and industries to ramp up their efforts and drive the green economic recovery. But this will involve each and every organization making climate change a top priority on their agendas. From creating green jobs, driving green innovation, and reducing greenhouse gas emissions to working with supply chains to achieve decarbonization, there are a number of ways companies can drive the long-term change needed.

Importantly, this requires collaboration between businesses and government to ensure corporate action and keeping consumers at the heart of the net-zero journey go hand in hand. Inputting to inform government policy, sharing ideas and best practice to ministerial support for corporate initiatives and net zero projects—there's huge opportunity to collaborate on this agenda and in doing so accelerate progress.

Zooming in on UK policy

To leverage the full potential of businesses, clear policy and frameworks are needed across all countries. In the UK, the *Energy White Paper* published at the end of 2020 envisions the clean energy transition as a green industrial revolution where the UK energy system is transformed in a way that delivers net zero emissions by 2050, creates and promotes green jobs, and provides resilient economic growth.

The strategies and roadmaps that have and will be published to provide clarity and direction are absolutely critical to guiding industries and sectors on how they can best play their role in the net-zero journey. They represent government commitments to different areas that can tackle climate change while in many cases providing consumer, commercial, and investor confidence in different solutions that have a viable role in net-zero scenarios.

For the energy sector, the possibility for government policy to support and speed up the rollout of different solutions is huge; including unlocking the potential of hydrogen, facilitating the shift to electric vehicles, increasing zero-carbon electricity generation through offshore wind, and capitalizing on carbon capture and storage technology to remove carbon from the atmosphere—to name a few.

Whether it's giving investors more confidence, providing details on funding models to encourage investment through to achieving a transition that brings everyone on the journey, or shedding light on a coordinated approach to achieving a greener future—government policy can provide the foundation that can bring together different groups and ensure that no one is left behind.

For example, the government's hydrogen strategy published in August signals the UK's commitment to hydrogen and provides the certainty needed to boost consumer and investor confidence and support commercial solutions. Importantly, unlocking the potential of hydrogen as a clean energy solution requires significant pace and innovation to scale up production, and the guidance from government in the strategy will be key to triggering the investment and buy-in needed to achieve this.

As more hydrogen projects come online, National Grid is confident it can get the infrastructure in place that can transport this hydrogen to help decarbonize buildings. The gas networks are already looking at the technical challenge of repurposing existing networks to carry hydrogen, and results to date are looking very positive with importantly no showstoppers.

Achieving a clean energy transition

We know the opportunity—but we also know the risks if we fail. There would be negative fallout on economic prosperity and environmental protection. Clean energy can provide sustainable solutions, while also protecting the planet from climate change, and it is a growth sector with opportunities in areas including generation, infrastructure, and storage. Stalling on the energy transition will prevent us from creating reliable and secure power supplies, ensuring there is enough to meet demand and enable the world to reduce dependence on imported fuels.

This is a truly global challenge and one which has serious implications for all countries. No nation will be exempt from the consequences if we fail—and that in itself should power action and change.

International collaboration

As renewable energy develops, there is more and more scope for international collaboration and sharing supply. For the UK, strengthening global relationships could help the country become an energy-exporting powerhouse, while leveraging our domestic hydrogen and Carbon Capture & Storage projects to support new, green jobs.

As an example, the UK can leverage connections to mainland Europe and Ireland through gas interconnectors and the world gas markets via our LNG terminals. Creating a close collaboration between the UK and other countries will be essential to retaining resilience in our energy supply during the journey to net zero, and will help identify wider import and export opportunities.

We're already seeing benefits from sharing information and learnings through the UK hydrogen backbone and the European backbone projects—this can no doubt be amplified with more formal commitments to international partnerships. Our interconnector projects are also a great example of international collaboration. For example, BritNed, which connects the UK with the Netherlands, has capacity to share enough energy to power 1 million homes.

The next decade and beyond

The clock is ticking. There's a lot of work to be done in the next 10 years and beyond, and we can't afford to stall. There's a risk that we'll get caught up in discussing pros and cons or locked in debate between different solutions—for example, when it comes to electrification or hydrogen, the reality is that both have an important role to play and we need to move forward in both areas quickly. We can't wait for a perfect answer to solving the net-zero challenge and so need to explore a mix of low- and zero-carbon options in our efforts to achieve a greener future.

As global leaders and governments rally around the climate change agenda, leaders need to emerge from COP 26 with global solidarity on decarbonization through a combination of stretching targets, game-changing policy, and concrete action which leverages a range of solutions across the world—all tied together with mechanisms that will hold each nation to account.

ENERGY AND CLIMATE POLICY CHALLENGES FOR JAPAN TOWARD CARBON NEUTRALITY IN 2050

Ken Koyama

The discussion to revise the Strategic Energy Plan (SEP) of Japan is underway, and now is in Its final stage. The SEP is the most basic and fundamental energy policy document for Japan's long-term energy policy to address the so-called '3E challenges' (energy security, environment protection, and economic efficiency) for Japan simultaneously. The first SEP was officially authorized by the Cabinet in 2003 and since then has been revised every three to four years. The fifth and latest SEP was approved by the Cabinet in 2018, and the discussion to conclude the sixth SEP to meet newly emerging domestic and international conditions has been made at a special advisory council at the Ministry of Economy, Trade, and Industry (METI), for which the final draft of the SEP is expected to be officially approved sometime this autumn. The revised SEP will become the official policy basis of Japan's stance towards international discussion on climate change prevention, including the forthcoming COP 26 in Glasgow, UK (https://ukcop26.org).

The discussion to finalize the sixth SEP is required to fully take into account changing global energy market conditions, such as the unprecedented impacts of the COVID-19 pandemic on the world energy market. The possibility of a post-pandemic world transformation into an increasingly geopolitically complicated and security-prioritized world will have an important implication for Japan's energy security for the future. However, the single most important factor to influence the discussion on the sixth SEP is no doubt the necessity to meet its extremely ambitious greenhouse gas (GHG) reduction target for Japan in both 2030 and 2050.

Interestingly, the target for 2050 was announced first. Prime Minister Suga declared his intention to achieve Japan's carbon neutrality status in 2050 in a Diet speech in October 2020. Before his declaration, Japan's GHG reduction target for 2050 was an 'aspirational target' to reduce GHG by 80 per cent. But in the wake of the 'global wave of carbon neutrality declaration' during the course of the year 2020, Prime Minister Suga made a strategic decision for Japan to head for carbon neutrality in 2050 while recognizing the enormous challenges for Japan to realize this goal.

The global decarbonization trend was further accelerated with the inauguration of the Biden administration in the US, after which Prime Minister Suga once again made a strategic decision to announce a significant increase in GHG reduction for 2030 at the climate summit hosted by the Biden administration in April 2021. The revised GHG reduction target was to reduce GHG by 46 per cent from the level in 2013. As the previous official target for 2030 was a 26 per cent reduction, the new target means a very ambitious upward revision of 20 percentage points reduction just for the next nine years up to 2030. And the significance is that the revised new 2030 GHG reduction target will be positioned as Japan's national commitment for the world discussions on climate change prevention, including those at the forthcoming COP 26 and other important international fora.

As a result, the discussion of the sixth SEP is focusing on the energy mix or scenarios of energy supply/demand structures in the future to realize a 46 per cent GHG reduction in 2030 as well as carbon neutrality in 2050.

Japan's energy mix for 2030

The previous 26 per cent GHG reduction target for 2030 was supported by the energy mix target decided in the previous SEP. The gist of the target was to realize a power generation mix in 2030 with the share of nuclear power at 20–22 per cent, renewable energy at 22–24 per cent, LNG at 27 per cent, coal at 26 per cent, and oil at 3 per cent. With the above energy mix plus the targeted impact of energy saving of 43 Mtoe in 2030 (in comparison to energy demand in the Business As Usual case), the previous SEP aimed at achieving the 3E targets of a 26 per cent decline in GHG, a reduction in total power generation cost, and an improvement in energy self-sufficiency up to 25 per cent in 2030 simultaneously.

However, the new 46 per cent GHG reduction target announced this spring made the surrounding landscape for SEP discussion completely different. The deeper reduction in GHG emissions itself for the same target year of 2030 is important, as only nine years are left to implement GHG reduction. But the fact that the new target was given in a 'top-down approach' was also a very important difference from the traditional 'bottom-up approach' adopted in the past SEP discussions, in which the GHG reduction target was given from the result of the discussion by the advisory council at METI. The latest experience actually means that the discussion by the advisory council is required to take fully into account the 46 per cent reduction target for 2030 (and carbon neutrality in 2050) as 'a given condition' declared by the prime minister himself to formulate the energy mix target for 2030 and 2050.

With these new and difficult conditions, the advisory council has continued the discussion on SEP. In the course of the discussion, the draft SEP report was published on 21 July. Major points of the draft SEP include the following: (1) Japan's total final energy consumption will be reduced from around 312 Mtoe in 2013 to around 241 Mtoe in 2030, with the targeted effect of energy savings of 53 Mtoe; (2) total power generation in 2030 will be 930–940 terawatt-hours; and (3) the targeted power generation shares will be nuclear at 20–22 per cent, renewable energy at 36–38 per cent, LNG at 20 per cent, coal at 19 per cent, oil at 2 per cent, and hydrogen/ammonia at 1 per cent.

With this revised energy mix, Japan seeks to achieve its GHG reduction target (46 per cent) while aiming at increasing its energy self-sufficiency up to 30 per cent and capping the electricity cost run-up. Therefore, the new energy mix target for 2030 can be viewed as Japan's increasingly ambitious energy policy goal to achieve the enhanced 3E objectives, responding to the newest energy and climate policy conditions surrounding Japan.

But the problem is that it is a very ambitious target to achieve, given the fact that there are only nine years left for policy implementation. It is a kind of fight against time. For example, to achieve the 20–22 per cent target for nuclear, it is necessary to have 27 nuclear plants in normal operation in 2030, while only 10 plants have restarted operation. Given the social sensitivity on nuclear issues, it is hard to project at what speed the nuclear restart can progress in Japan. In addition, to restart 27 plants, it is necessary for some plants to get approval for their life-time extension of up to 60 years from the Nuclear Regulatory Agency, which again makes a nuclear restart uncertain and complicated.

As for the increased share of renewable energy, solar photovoltaic (PV) is expected to contribute a major part of the total incremental power supply, simply because solar PV is the most immediate option to increase supply substantially for the next nine years, as other renewable energy (such as wind power) in Japan will require a much longer lead time to be constructed and operational. In the new energy mix target for 2030, the expected growth in solar PV supply accounts for more than two-thirds of total growth in all renewable energy generation. The high dependence on solar PV growth to achieve the renewables target (36–38 per cent share) will imply several important challenges for Japan, such as finding and securing appropriate sites for new and large-scale solar PV construction; the possibility of higher construction costs due to site/land limitation; and the additional cost increase for Japan's electricity bill on top of the existing heavy burden of the Feed-In-Tariff surcharge.

As the new energy mix target has the first-ever numerical target for hydrogen/ammonia (1 per cent in total power generation), how to secure a hydrogen/ammonia supply to the Japanese market will be an important agenda item from now on. With the combined effects of the expected contributions from zero-emission power generation, including nuclear, renewable energy, and hydrogen/ammonia, fossil fuel power will account for 41 per cent of total power generation in 2030, which is a 15 per cent downward revision from the previous energy mix target. But it is also a fact that Japan continues to use LNG and coal-fired power generation in pursuit of achieving its 3E policy goals. It is important for Japan to continue to address LNG security of supply and cleaner coal utilization while phasing out small/medium-scale and inefficient coal-fired power plants, surrounded by a very difficult environment with opposition to fossil fuels, in particular to coal.

Energy scenarios for carbon neutrality in 2050

While the issue for the 2030 energy mix target can be explained as a fight against time, the challenges for the 2050 energy mix target will be quite different in nature. We have three decades to go to pursue and achieve carbon neutrality status, but the magnitude of the required change is simply enormous. In other words, energy transition towards carbon neutrality requires Japan (and any country) to undergo a fundamental transformation or a revolutionary change in Its energy supply/demand system from the current one, which is heavily dependent of fossil fuels with a well-developed international and domestic energy supply chain, related infrastructure, and appliances for final consumption, all of which tend to be long-life and legacy assets.

The basic prescription for carbon neutrality can be summarized as maximum introduction of energy-efficiency improvements and energy savings, together with maximum use of non-fossil fuels such as renewable energy and nuclear power; and maximum promotion of electrification while realizing zero-emission power generation. In addition to the basic prescription, innovative technologies/options such as CO_2-free hydrogen/ammonia and negative-emission technology (Bio Energy Carbon Capture and Storage and Direct Air Capture) need to play a significant role to achieve carbon neutrality.

The problem is that the level of uncertainty is too high with regard to all the technologies and options required to achieve carbon neutrality in terms of technological development, market diffusion, cost reduction, public acceptance, and other important conditions. In short, it is too uncertain to be sure of the pathway towards carbon neutrality. We can draw a map for a carbon neutrality pathway, but it may be risky if we depend on only one pathway or scenario for the future.

At the time of writing this paper, the discussion on the sixth SEP had no clear proposal for an energy mix target for 2050. Instead, the advisory council had discussions on the reference concept of the energy mix in 2050 to achieve carbon neutrality as proposed by METI. The proposed concept includes the following: the electrification rate (electricity demand in final energy consumption) will be increased from around 20 per cent now to around 45 per cent in 2050; total power generation will reach 1,350 terawatt-hours in 2050; renewable energy will account for 50–60 per cent of total power generation in 2050; nuclear plus fossil fuel power generation with Carbon Capture Utilization and Storage (CCUS) for 30–40 per cent and CO_2-free hydrogen/ammonia for 10 per cent. Based on this proposed concept as a reference, the result of a study on electricity cost for various energy scenarios for power generation mix, which was conducted by RITE (Research Institute of Technology Innovation for the Earth), was discussed by the advisory council. The gist of the study results was that the estimated marginal cost of electricity supply in the above-mentioned proposed concept—with the assumption of nuclear share at 10 per cent and fossil fuel power generation with CCUS at 23 per cent—will increase from 13 JPY/kWh now to 25 JPY/kWh in 2050; other scenarios with a different power generation mix all indicate higher electricity costs ranging from 20 JPY/kWh to 53 JPY/kWh; the highest-cost scenario is 100 per cent renewable power generation at 53 JPY/kWh, while the lowest-cost scenario is 20 per cent nuclear share at 20 JPY/kWh.

In any case, the study pointed out that Japan will face higher (almost doubled) electricity supply cost if we pursue and achieve carbon neutrality. Again, it is important to note that there is a very high level of uncertainty with regard to development and diffusion of technologies/options for achieving carbon neutrality and that we need to overcome a number of economic, technological, social, and political challenges of great significance to achieve carbon neutrality.

Closing notes

It is expected that the discussion on the sixth SEP will come to an end soon with conclusion of the energy mix target for 2030 and 2050 to meet Japan’s 3E objectives simultaneously. The GHG reduction target, 46 per cent reduction for 2030 and carbon neutrality for 2050, will be the key component of the energy mix consideration. The revised SEP will become an official policy basis of Japan’s stance towards international discussion on climate change prevention, including the forthcoming COP 26, where it is expected that Japan will highlight the significance of its ambitious GHG reduction goal, supported by national energy

policy, while emphasizing Japan's continued national efforts to meet its 3E target simultaneously in a balanced manner. But there are numerous great challenges and difficulties to be overcome to achieve Japan's energy and climate policy goals, and Japanese society will be required to embark on a fully-fledged, comprehensive, and committed effort to realize successful energy transition towards carbon neutrality, which will likely be a voyage through uncharted waters.

KEEPING THE NUCLEAR ENERGY OPTION OPEN

Adnan Shihab-Eldin, H-Holger Rogner, Robert J. Budnitz, Charles McCombie, Noura Y. Mansouri, and Robert N. Schock[56]

Governments face the challenge of limiting global temperature rise above pre-industrial levels to below 1.5°C, as set out in the Paris Agreement and within the United Nations' *2030 Agenda for Sustainable Development*. To meet that goal, cost-effective measures are required to transition toward carbon neutrality and net-zero greenhouse gas (GHG) emissions, as early as practically feasible, preferably before 2050 or soon thereafter. These measures inevitably include electrifying energy end-uses and decarbonizing electricity generation. Urgently needed are evidence-informed policies and the implementation of cost-effective measures.

Achieving climate neutrality by mid-century or soon after while ensuring energy security is a major challenge that will be much more difficult to meet if some near-zero-carbon electricity-generating technologies are excluded a priori for ideological reasons. Doing so would also compromise the reliability of the electricity supply, especially because low-carbon electricity is increasingly being required in other sectors such as transport and industry.

In the 2018 special report of the Intergovernmental Panel on Climate Change (IPCC 2018), all pathways to a stable global average temperature rise of less than 1.5°C assume that renewables provide the bulk of electricity by 2050. The 1.5°C target also depends on large-scale utilization of carbon-dioxide removal (CDR) technologies and on utilizing carbon capture and storage (CCS) to accompany the continued use of fossil fuels.

In a special report, prepared by the International Energy Agency (IEA) for COP 26, detailed analysis was provided for a pathway to achieve the desired target of net zero emissions (NZE) for the global energy system by 2050 (IEA, 2021). The NZE scenario is asserted to be critically necessary to limit the global temperature rise to less than 1.5°C. As a matter of preference, the IEA's NZE pathway, described as 'narrow' and calling for urgent actions now and for the following 30 years, is heavily reliant on maximum expansion of renewables and lesser shares of nuclear, fossil fuels (with CCS), and CDR. The IEA's report stressed that the pathway will be extremely challenging, requiring all stakeholders to take action this year and every year to meet the target. It raised many questions and triggered a few controversies. The NZE scenario would be very costly, requiring rapidly increasing global investment to $5 trillion annually by 2030, almost twice current levels, to be borne by taxpayers and rate payers. The scenario would also involve huge transfers of funds from advanced economies to those of emerging and developing economies to assist them in meeting their obligations.

IEA's NZE scenario, most IPCC scenarios, as well as a few others from academic and research institutions all assume, to varying degrees, increasing contributions from nuclear energy. However, all heavily favour renewables—some assume scenarios using exclusively renewables—as their first choice, thus resulting in a lower-than-optimum share for other low-emission sources, including nuclear and decarbonized fossil fuels, such as blue hydrogen or fossil fuels with CCS. In this article, we review the reasons why nuclear energy should play a more prominent role in the energy transition.

Nuclear energy is a mature, safe, and highly reliable energy supply technology, with a proven track record and extremely low life-cycle GHG emissions per unit of electricity generated. It can provide baseload as well as load-following electricity needed to ensure 24-hour stability in electric grids that have an increasing contribution from renewable sources.

Nevertheless, expansion of nuclear energy faces several challenges. These involve socio-political, economic, and strategic issues often dominated by public perceptions—most notably over safety, security, and the safe disposal of spent nuclear fuel.

[56] This article is based in part on a paper by Budnitz et al. (2018), on a policy brief to the 2020 G20 summit by Shihab-Eldin et al. (2020), and on an expanded paper by Rogner et al. (2021).

Logically, all low-emission energy technologies and pathways should be considered and assessed on merit as part of any net-zero-GHG global strategy. Decisions on the most appropriate electricity generation pathways and technology choices should consider a multitude of criteria, the most important of which are

1. generating capacity to be implemented
2. grid compatibility
3. safety
4. human health
5. environmental impacts including emissions
6. economics on a full life-cycle basis
7. resilience against natural and anthropogenic hazards
8. sustainability of the energy resource.

The fact that nuclear power compares very well with alternative low-emission technologies for all of these criteria, if externalities are internalized, is the multifaceted reason why this article argues for a larger role for nuclear power over the next several decades than is envisioned in most of the publicized proposals for the desirable zero-emission path forward to 2050**,** and why it should be given due consideration in the negotiations at the forthcoming COP 26 in November this year.

Nuclear power's current and future role

Without the expansion of nuclear electricity from currently 393 GWe to 800 GWe,[57] an additional 5.5 Gt of CO_2 emissions per year would result by 2050 if nuclear power were replaced exclusively by state-of-the-art coal generation (with no CCS) or 2.9 Gt per year if replaced by natural gas. Even though CDR is today unproven at commercial scales, it would be required at rates of 2 Gt CO_2 per year or more. Expanding *proven* nuclear energy can readily provide all of the CO_2 reductions in case CDR's technical implementation is less successful than projected or its costs are too high.

By the end of 2020, 33 countries operated one or more nuclear power plants (NPPs). The combined electric generation of 442 NPPs contributed 10.1 per cent or 2,553 TWh to global electricity supply and provided 28 per cent of the world's low-carbon electricity.

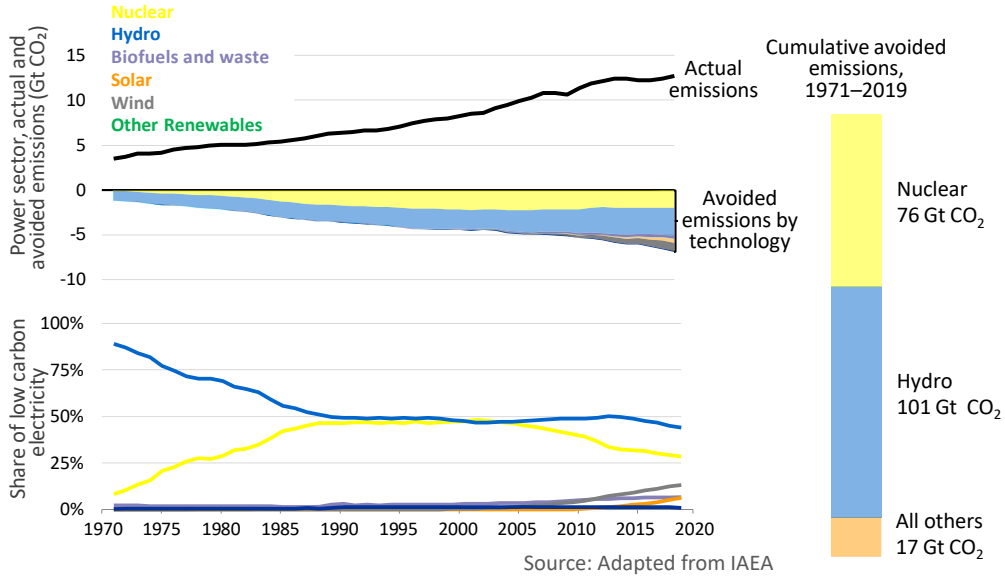
More than two dozen countries, developed and developing, are considering, planning, or actively working to include nuclear power in their energy mix. The number of countries expanding their nuclear generating capacities or preparing for the introduction of NPPs by far exceeds the number of countries rejecting nuclear power, implying that global support for nuclear power might outweigh the opposition to its use.

Over the past 50 years, nuclear power has avoided the emission of some 76 Gt of CO_2 (second only to hydropower), assuming electricity from NPPs would otherwise have been generated using the average fossil fuel mix in a given year. All other low-carbon-emitting, non-hydro renewables began to make a noticeable contribution from around 1990, and these renewables by 2020 are estimated to have historically avoided 17 Gt CO_2. Over the past 20 years, wind and solar have been the fastest-growing low-carbon electricity generators, a growth trend that is generally projected to continue for the next decades. After years of policy support and subsidies, along with major cost reductions due to technological advances, these technologies now provide competitive electricity in many places, but only intermittently as the time of day and weather allows. As these sources increase their market shares, other zero-GHG electricity technologies will be needed to balance their variability and ensure flexibility and resilience of the grid, adding significantly to the costs.

Nuclear power in combination with various electricity storage options (pumped hydro, batteries, compressed air energy storage, etc.) can complement renewable sources and provide reliable 24/7 supplies. Furthermore, although a carbon-neutral energy system appears to disfavour fossil fuels, CCS and CDR must not be discounted a priori.

[57] Median nuclear contribution across 89 available 1.5°C pathways by 2050.

Global CO_2 emissions from electricity generation: estimated emissions avoided by low-carbon technologies (upper panel) and share of low-carbon electricity (lower panel), 1971–2019



Safety

One of the key arguments presented by opponents of nuclear power, which receives wide coverage by the media and is accepted by a good segment of the public in developed countries, is the claim that nuclear power plants, and associated nuclear fuel cycle facilities, pose high risk to the public and the environment, in particular from catastrophic accidents, such as the 1986 Chernobyl and the 2011 Fukushima accidents. Technically, the risks of any accident can be quantified by assessing its probability and consequences; there is no 'zero risk' in any endeavour. Historically, many members of the public have been concerned with a nuclear-plant accident independent of its probability. Nuclear power-plant accidents with significant consequences are understood to have a likelihood today in the range of 1 in 10,000 or lower per year per reactor for a well-run NPP, and are estimated to be lower still for modern advanced designs.

The Chernobyl and Fukushima accidents resulted in radioactivity being released widely, which produced major offsite contamination of both land and property. Very few direct radiation-caused fatalities resulted from Chernobyl and none from Fukushima. If there is no lower limit to their harmful effects, these releases might produce long-term impacts to public health, including cancers, but at un-attributable low incidence levels. Based on actual operating experience, the safety of NPPs has been steadily improving worldwide for decades.

These safety improvements, arising from both advances in engineering and learning from experience, have led to changes in designs, operations, and regulations, resulting now in a much lower likelihood of an accident and also much lower consequences, even though an accident with serious radioactivity release is not impossible.

A prerequisite to ensuring a strong safety record is a strong national regulatory agency that implements and enforces rules and regulations. Nuclear safety regulation is the responsibility of the national jurisdiction in which a nuclear reactor operates. Safety standards, regulation, enforcement, and safety culture vary between countries, and international cooperation in nuclear reactor safety is crucial, both to improve safety and to assure that these countries' programs are safe and do not pose a transboundary threat. Today, the International Atomic Energy Agency (IAEA) plays a major role internationally in enhancing safety by sponsoring best practices, standards, and conventions and providing a variety of technical assistance. However, the IAEA's role is strictly advisory and is exercised only if a country requests assistance. One proposal is to modify and broaden the IAEA's role, gradually enhancing its authority so that it would assume responsibility for certain aspects of nuclear regulation. This includes giving the IAEA authority for mandatory inspections, although enforcement would remain a national responsibility, similar to the role played by the International Civil Aviation Organization in ensuring the safety of international commercial air travel. This change would help decrease the global risk of a major accident. It would assure the early identification of weak performance or other safety concerns, would enhance the dissemination of best practices, and would bring a significant increase in global confidence that a major accident and its associated social and economic impacts will not occur.

Spent fuel management

Another key argument against nuclear power is the assertion that it is extremely difficult to safely dispose of the highly radioactive spent nuclear fuel, which remains radioactive for thousands of years.

The most common technical view is that the challenge is primarily societal because (a) the waste quantities have low volume in comparison with alternative energy sources, and (b) feasible and affordable engineering approaches to safe disposal have been developed and are being continually improved.

Over a 60-year plant life, a 1,000-MWe light-water reactor generates about 1,500 tonnes of spent nuclear fuel with a highly radiotoxic waste inventory of about 172 kg/TWh. This radioactive waste decays with time, although for some isotopes this happens very slowly**.**

The recognized solution for final disposal is emplacement in deep geological formations that have been stable for time scales far beyond the active lifetime of even very long-lived radionuclides. Deep geologic disposal is the official policy of virtually all countries operating or planning NPPs, although progress on actual site selection and development has been slow (or non-existent) almost everywhere. Note that the toxic waste inventories from some solar modules and from some wind-turbine technologies contain potentially dangerous materials that do not decay away.

Nuclear technology innovation and small modular reactors

Innovation is an ongoing phenomenon in all industries, and the nuclear industry is no exception. Future energy markets clearly indicate that commercially available nuclear reactor designs of 1,000 to 1,600 MWe unit sizes need to be supplemented by small modular reactors (SMRs), of 20 MWe to 300 MWe. This is because the current large reactors are too expensive to build in most developed countries today.

The rationale for SMRs is that they possess the potential to provide electricity, as well as a range of other energy services, more competitively than current designs. SMRs will be fabricated in factories and delivered to the site instead of requiring on-site construction, thus greatly reducing investment outlays, the risks of project delays, and cost overruns. Also, they feature lower up-front capital costs per unit and are much more scalable.

Most SMR designs offer demonstrably superior safety features. Their small size means less heat energy to manage, less radioactivity to manage or to be released, and fewer and smaller systems overall. These SMR designs also rely less on operator intervention, have simpler safety systems, and employ passive heat dissipation, a very important factor to improve reactor safety. These features should not only reduce the likelihood of an accidental radioactive release, but if an accident were to occur, the SMRs' much smaller inventory of radioactive materials means that offsite consequences of any release would be much smaller.

SMRs would have markets in electricity grids too small for conventional reactors and can be added incrementally to large grids to more closely match electricity demand growth or meet replacement needs. While NPPs are not naturally thought of in a load-balancing role compared with natural gas or electricity storage systems, many SMR designs have faster ramp rates and can function effectively in a load-balancing role. Rather than competing with renewables, SMRs could increase their market penetration by compensating for renewables' intrinsic variability. The first SMRs are being built today, and their full potential will likely be tested over the next 10–15 years.

Conclusions

Nuclear energy already plays a crucial role in reducing carbon emissions from generating electricity. It can have a stronger role than is currently envisioned in many national energy-transition strategies and in scenarios by most multilateral/international organizations and think tanks that aim to achieve NZE for global energy mid-century or soon after so as to limit the rise of average global temperature to less than 1.5°C.

Notwithstanding the clear climate benefits of nuclear energy, corroborated by most analyses on net-zero-GHG-emission futures, nuclear energy has not been acknowledged within the COP negotiations as an effective climate mitigation measure. Nor is it mentioned explicitly in the Paris Agreement or the UN Sustainable Development Goals (SDGs), in deference largely to the dominating influence of environmental groups who embrace and advocate an 'all renewable energy future'. This article presents compelling arguments why it should not be excluded from full consideration at climate-related conferences and negotiations, especially the forthcoming COP 26.

Without expanding the role of nuclear energy and all other viable low-emission technologies, to their maximum potential on merit, it will be extremely difficult and highly costly to achieve the international goal of avoiding unacceptable changes in global climate. Moreover, in most countries, a large, stable zero-carbon electrical grid cannot be implemented effectively if nuclear energy is excluded.

The climate benefits of nuclear energy can be obtained without significant impacts on safety, security, or energy costs. Three prerequisites for its widespread expansion are that (1) it needs to be accepted politically and by large segments of the public; (2) its economic performance must become more consistently positive globally; and (3) its record of safe operations needs to be acknowledged, maintained, and continuously advanced, including through the strengthening of the international safety regime.

CHINA'S AMBIGUOUS CLIMATE POSITION

Michal Meidan

As the world's largest emitter of greenhouse gases, China's attitude toward and position in global climate negotiations are critical for its success. As such, in the run-up to COP 26, all eyes are on China. But while Beijing may estimate that its recently announced climate targets, namely to peak emissions before 2030 and reach carbon neutrality by 2060, are testament to the country's ambition and willingness to take a leading role in global climate negotiations, failure to issue a more specific road map to achieving these goals alongside Beijing's reluctance to commit to phasing out coal in the near term will weigh on global efforts and on China's position. Moreover, at COP 21 in Paris, China's emergence as a global leader was facilitated by a combination of a strong domestic agenda and international coordination. In Glasgow, despite China's bold domestic ambitions, limited coordination with the EU and the US, disagreements on carbon markets, and indeed competition for climate leadership could undermine the success of COP 26. In this article, we discuss the changes in China's position in global climate negotiations alongside the elements of continuity. While China's 2030–2060 pledges have injected considerable momentum into global efforts to tackle climate change—thereby making China a climate leader—implementing them will require flexibility, suggesting some ambiguity in Beijing's global commitments.

China's changing role in global climate negotiations: from zero to hero

China's position toward and involvement in climate negotiations has evolved dramatically over the past three decades, with China playing a peripheral role in climate talks following the ratification of the Kyoto Protocol in 1997, focused mainly on asserting and defending its rights to development. China emphasized the principle of common but differentiated responsibilities and stressed that it was ready to take some action to reduce emissions and adapt to climate change, albeit with financial support from developed countries. Domestically, even though China quadrupled its GDP between 1980 and 2000, it only doubled the amount of energy it consumed over that period, marking a dramatic achievement in energy-intensity gains. China was reluctant to commit to legally binding greenhouse gas (GHG) emission reduction targets, but pointed to its active involvement in the implementation of the Clean Development Mechanism set out in the Kyoto Protocol as a testament to its commitment to that process.

By the early 2000s, following China's accession to the World Trade Organization, the domestic trajectory had changed dramatically with energy growth surpassing economic growth, leading to a rapid rise in emissions. In 2007, China surpassed the US as the world's largest CO_2 emitter. Climate change policies sought to coordinate domestic action and improving international engagement as a number of domestic policy priorities converged in support of strong climate action:[58] Beijing sought to increase energy efficiency, raise the share of renewable sources in the energy mix, and develop clean-tech manufacturing capabilities as part of the country's efforts to increase its energy security, rise up the industrial value chain, and tackle deteriorating air quality. The majority of the policies and programs were not climate change policies per se, but to the extent that they were implemented throughout the economy, they would also mitigate GHG emissions. In June 2007, China released its first National Climate Change Program report, with the growing importance of climate change also reflected in changes to the domestic bureaucracy.[59]

[58] Joanna Lewis, "China's Strategic Priorities in International Climate Change Negotiations", The Washington Quarterly, Winter 2007-08; Pan Jiahua, "The evolution and transformation of China's climate change response strategy: From preventing 'black swan' events to reducing 'grey rhino' risks", in Ross Garnaut et al, *China's 40 Years of Reform and Development;* ANU Press: 2018

[59] In the 1990s, climate change was treated as a scientific question under the auspices of the China Metrological Administration, which was also the body charged with representing the Chinese government at the IPCC. With the conclusion of the Kyoto Protocol negotiations, climate change was moved to the NDRC, China's main macroeconomic planning body, highlighting that climate change also touched on development and economic expansion. In 2018, climate change negotiations were transferred to the Ministry of Ecology and Environment, before being

Yet despite China's changing attitude and efforts to reduce energy and carbon domestically, the international landscape had also shifted considerably. Copenhagen blurred the distinction between developed and developing countries, and while it fell far short of a legally binding global agreement, for the first time all the major economies pledged to take on specific individual responsibilities. Chinese negotiators in Copenhagen, however, were careful not to link domestic action on climate change to any presumptions of international obligation, in part because there were still disagreements within the government over climate change and because of limited US–China cooperation on climate.[60] Ultimately, Beijing was widely criticized for dragging out climate negotiations at Copenhagen in 2009 and playing a key role in its failure.

Yet six years later, China emerged as a positive participant at the Paris COP 21 and a key contributor to its success, agreeing, among other things, to commit to a cap on emissions subject to international measurement, reporting, and verification. This more constructive role in the global climate regime was due to a number of reasons: first, and perhaps most important, was China's shift to a 'New Normal' model of economic development whereby China's economic policy, starting in 2011, prioritized a transition from energy-intensive growth to a more balanced development path characterized by slower growth, an increasing role for services and domestic consumption, and a focus on innovation and low-carbon technologies. With the overall use of coal falling, China also launched an energy revolution in 2014, aimed at increasing the share of non-fossil energy sources. Indeed, the 13th Five Year Plan (2016–2020) included for the first time a binding goal to limit the share of coal in the energy mix to 58 per cent or less and increase the share of non-fossil fuels.

A range of external factors also supported the change, including French diplomacy in the run-up to COP 21 and the important shift to a bottom-up, voluntary approach to contributions rather than commitments. This concept of contribution was compatible with China and other developing nations' position as they rejected the proposition that developing countries should undertake legally binding commitments and sought to uphold the principle of common but differentiated responsibilities. Finally, mindful of the lessons of Copenhagen, Beijing also worked proactively with the US and the EU to align negotiating positions and pledge new emissions-reduction commitments. A 2014 bilateral climate agreement between the US and China helped catalyse the ambition of the Paris Agreement.

Following the Paris agreement, China's nationally determined contribution (NDC) included a pledge to peak CO_2 emissions by 2030, or earlier if possible. This pledge had been the subject of much debate in China, with estimates undertaken at the time suggesting China could peak emissions between 2025 and 2035. The government's choice of the time frame reflected an ambitious albeit achievable goal, especially given the domestic imperatives of restructuring the economy and tackling local air pollution. At the same time, China did not commit to an absolute level at which emissions would peak. Instead, it vowed to lower the carbon intensity of GDP by 60 to 65 per cent below 2005 levels by 2030. Beijing also pledged to increase the share of non-fossil energy sources in the total primary energy supply to around 20 per cent by 2030, and to increase the forest stock volume by around 4.5 billion cubic metres, compared to 2005 levels.

The Paris process also allowed China to establish itself as the leader of the developing world (or the G77) as it proposed a concrete road map to scale up the level of pre-2020 financial support by developed countries to achieve the goal of jointly providing US$100 billion annually by 2020 for mitigation and adaptation. The quid pro quo, as seen by Beijing, was to concede on the long-term ambition for mitigation: Beijing argued that it was unclear how the 1.5°C limit was going to be met given that there is a massive commitment gap between the 2°C target and the emissions-reductions pledges in the intended nationally determined contributions (INDCs), but China nonetheless agreed to mentioning the aspirational goal of 1.5°C in the Paris agreement. Beijing also agreed to periodic reviews of countries' pledges as well as to a higher level of ambition every five years.

An ambiguous position ahead of Glasgow

By 2019, China had reached or was on track to reaching its 2015 commitments, having also included them in the domestic policy cycle as part of its 13th Five Year Plan (2016–2020) targets. Its air pollution control plans and efforts to limit coal consumption were central in improving air quality in many cities through an accelerated coal-to-gas switch. Beijing also pushed

transferred back to the NDRC in 2021 as part of its efforts to coordinate both domestic and international action for China's 2030 and 2060 goals.

[60] In the Western media, China was widely blamed for the Copenhagen failure, although this was also in part related to frictions within the Chinese delegation. The climate negotiators headed by Xie Zhenhua were ultimately sidelined, during the last two days of negotiations, by the diplomatic team surrounding Premier Wen Jiabao, who sought to minimize reputational damage to the premier. See Björn Conrad, "China in Copenhagen: Reconciling the "Beijing Climate Revolution" and the "Copenhagen Climate Obstinacy", the China Quarterly, June 2012, No. 210, pp. 435-455; Gao Xiaosheng, "China's Evolving Image in International Climate Ne-gotiation: From Copenhagen to Paris", *China Quarterly of InternationalStrategic Studies*, July 2018.

for a national emissions trading system (ETS) as one of several policy tools for reducing GHG emissions. In late 2017, the national carbon market was announced starting with the power sector, the largest emitting sector. In September 2020, Chinese president Xi Jinping pledged that China would peak emissions before 2030—bringing the time frame forward slightly—and reach carbon neutrality by 2060.

Based on these pledges, China can claim a leading role in global climate efforts: Xi's 2060 net-zero commitment is the first pledge of its kind from the world's largest emitter, and it has prompted similar commitments from countries including Japan and South Korea. So, even though China's pledge is for 2060, rather than 2050, it laid the groundwork for greater global ambition. At the same time, China's pledge was unilateral: The EU had suggested that a net-zero announcement would be a credible benchmark for Chinese climate action during an EU–China summit the week prior to Xi's pledge, but there was no mention of Beijing's intention at the time. Xi's announcement was close enough to the EU–China leaders' meeting to give a hat-tip to European diplomacy but be firmly independent on a multilateral stage, setting China in a positive light in comparison to the Trump administration and getting ahead of a potential Biden administration, if he were to win the election. Unlike in 2014, where bilateral US–China action catalysed change, this time Beijing is signalling its intention to play a central role. Moreover, given the ongoing tensions in US–China relations and the competition over technological leadership, China may not want to coordinate with the US on climate change, to avoid being seen as kowtowing to the US. In short, China has now clearly accepted the urgency of the low-carbon transition and is assuming a key role in global climate efforts due to a combination of its more assertive diplomatic stance but also its ambitions as a leading producer and exporter of green technologies as well as a standard-setter on environmental questions.

At COP 26, China will also seek to challenge taxation of imports based on their carbon intensity. The launch of China's ETS in July 2021 was also likely strategically timed ahead of COP 26 and ahead of the legislative proposals of the EU's Carbon Border Adjustment Mechanism (CBAM), also issued in July. The CBAM could start as early as 2023 and would seek to ensure that imported industrial products face the same carbon price as those covered by the EU ETS, thereby weakening the competitiveness of Chinese goods in their largest export market. Beijing is therefore likely looking to steer the debate on carbon duties, especially since the US does not yet have a strategy to respond to the CBAM. With debates about Article 6 and the contours of a global carbon market set to figure prominently at COP 26, China is signalling that it is undertaking serious efforts to tax carbon emissions domestically and will likely seek to rally the G77 in arguing that the EU's CBAM could undermine the multilateral spirit of the Paris Agreement.

China will also seek to capitalize on its leadership of the developing world as it continues to argue for greater financing from developed countries to support the transition in the global South. Even though China has been investing and will find opportunities to invest overseas, it still places itself firmly in the developing country camp. This ambiguity allows China to point the finger at richer nations, recognizing the potential economic benefits for China because it dominates the supply and processing of most of the raw materials for clean technologies.

While China hopes to capitalize on these gains, its post-COVID-19 economic recovery has placed the country on an energy- and emissions-intensive development path, with coal use and emissions rising (even though the share of coal in the energy mix continues to fall). In 2021, accelerating energy demand on the back of a strong economic recovery has also led to the reopening of coal mines. Both the US and the UK have already highlighted the importance of curbing coal use both inside of China and overseas. While Beijing has now announced a ban on funding overseas coal projects, the Chinese leadership has already clarified that coal-fired plants in China are unlikely to be banned before 2025. This will likely be a sticking point in Glasgow.

China's global leadership position could also be challenged by the limited detail on how it intends to implement its 2060 targets. At the time of writing, China had missed the cut-off date of end-July 2021 to submit new or updated NDCs to the Paris Agreement. Beijing is unlikely to commit to reaching net zero by 2050, much as it is unlikely to produce a detailed road map on how it will achieve its net-zero aspirations. Despite pressure from the international community, China will continue to insist on charting its own course to net zero emissions. Indeed, China's climate envoy Xie Zhenhua has already offered some clarification, stating in July 2021 that the country aims to neutralize 'all GHGs' before 2060, including non-CO_2 GHGs, such as methane and hydrofluorocarbons. On peaking carbon emissions, Xie said China's objective is to reach its peak emissions of CO_2—not GHGs—by 2030. This is significant as it is the first official clarification of the scope of China's 2060 carbon-neutrality target to the public. But Xie also said in August 2021 that it was more important for countries to implement their commitments rather than to argue about whether it should be 1.5 or 2 degrees.

Much like in previous rounds, Chinese climate negotiations are driven by international considerations, but the level of ambition and commitment is dictated by domestic drivers. So even though Beijing is committed to its 2030–2060 targets, it needs flexibility to meet these aspirations as it sets out on the task of balancing various domestic policy priorities including economic growth, infrastructure development, employment, and sustainability.[61] As different provinces vary in their resource endowment, industrial structure, and speed of adaptation, the goals set out by the central government must be flexible enough to accommodate these differences. This could make any additional pledges sound rather vague. Historically, however, China has issued targets that it could meet and even exceed, so even though China could and will likely peak emissions well before 2030, its pledge will err on the conservative side. At COP 26 China may end up with an ambiguous position: a climate leader with ambitious pledges, a leading provider of technology, and a champion of the developing world, but equally, a laggard on coal and a potential disruptor of global carbon markets.

LEADER OR LAGGARD? A BRAZILIAN ENERGY PERSPECTIVE ON COP 26 AND NET ZERO

Clarissa Lins and Bruna Mascotte

In the run-up to COP 26, Brazil can be seen both as a leader and as a laggard in the transition to a low-carbon economy, depending on which lens is used. Considering its total emission profile, Brazil has been lagging on the deforestation front, resulting in record greenhouse gas (GHG) emissions due to land use and forest loss rates. At the same time, the country is already a leader in renewable energy and has vast natural resources and a robust institutional framework to lead the energy transition. In this context, COP 26 can be an opportunity to uniquely position Brazil in the climate and energy agenda, by strengthening private-sector support to fight illegal deforestation, promoting sound carbon markets, and consolidating Brazil´s orientation to the future of energy.

Over recent years, Brazil has been pictured worldwide as a laggard in the climate agenda. While global leaders have been announcing net zero and more ambitious targets and putting the climate agenda at the centre of COVID-19 recovery plans, Brazil ranked poorly in curbing its GHG emissions, as these increased 10 per cent in 2019 compared to 2018 levels, reaching 2.2 GtCO2e. Of the country's GHG emissions, 44 per cent came from forests and land use change—namely deforestation—followed by agribusiness with 28 per cent of GHG emissions, while the energy sector was responsible for only 19 per cent of emissions in Brazil. Therefore, the Brazilian climate challenge differs from the rest of the world—where energy production and use are at the roots of the climate crisis—as it is heavily connected to land use, more specifically to illegal deforestation and lack of respect for the rule of law.

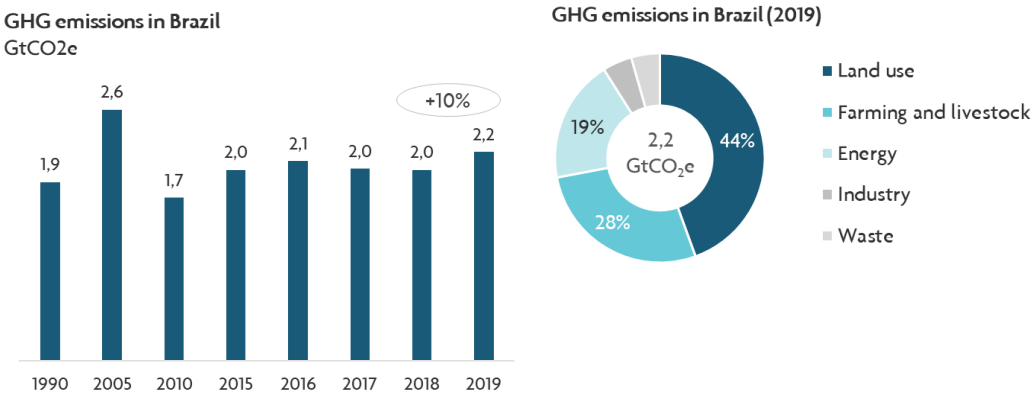
In the context of the Paris Agreement, the Brazilian nationally determined contribution (NDC) targets consist of an absolute 37 per cent reduction in GHG emissions by 2025 and 43 per cent reduction by 2030 (compared to 2005 levels). More recently, the government set a long-term goal of getting to net zero by 2050. The country also has targets for ending illegal deforestation by 2030 and recovering 12 million hectares by the same year.

Nonetheless, the deforestation rate kept rising in 2020 (+14 per cent compared to 2019), mounting to 13,853 km². This is equivalent to more than 12 times the London metropolitan area, or more than 10 per cent of the area of England. Of deforestation in Brazil, 99 per cent is illegal, mainly supported by lack of efficient law enforcement. As of April 2021, only 5 per cent of the area deforested between 2019 and 2020 had been subject to fines or embargoes by Ibama, the Brazilian environmental agency.

The Amazon biome is the most affected by deforestation, accounting for 61 per cent of the deforested area in 2020. Since 2012, deforestation has more than doubled in the so-called Legal Amazon. This has led not only to increased emissions, but also to loss of biodiversity and negative impacts on the ecosystem services provided by the rainforest. The Amazon basin is home to 20 per cent of global freshwater supply, 10 per cent of global biodiversity, and roughly 15 per cent of the world's total river discharge into the oceans. Its ecosystem regulates, for example, hydrological cycles throughout Brazil, with scientific evidence indicating that Amazon deforestation can increase the incidence of water shortage crises, with serious impacts on agribusiness and the power sector.

[61] For a discussion of the ambitions vs short-term realities, see Michal Meidan, "Unpacking China's 2060 carbon neutrality pledge, Oxford Energy Comment, December 2020, https://www.oxfordenergy.org/publications/unpacking-chinas-2060-carbon-neutrality-pledge/

Brazilian GHG emissions and profile



Source: SEEG, 2020.

Several experts point to a win-win opportunity in the fight against illegal deforestation in Brazil. The first priority should be to ensure strong law enforcement and the correct application of the Brazilian Forest Code. Land invasion, removal of vegetation, and illegal logging and mining should all be subject to increased levels of enforcement. Technology could also be applied, through satellite-based alerts, blockchain, and artificial intelligence, while legislation should guarantee adequate investigation and repression of illegal activity. A second priority would be to enforce better accountability, leveraging existing environmental records with transparent digital registries for rural properties that would enable suitable monitoring. This could help promote sustainable rural financing, which would only be granted if recipients could prove that their economic activities do not overlap with deforested areas. The third priority is to enable sustainable development while valuing standing forests.

Overall, Brazil must reconcile forest conservation and reforestation with the generation of positive socio-economic benefits to the local communities. An inclusive bioeconomy in regions such as the Amazon could leverage agroforestry systems and research and innovation initiatives focused on valuing its rich biodiversity. Several companies and governments are already targeting this opportunity. The Lowering Emissions by Accelerating Forest Finance Coalition aims to mobilize at least $1 billion in financing public–private efforts to protect tropical forests and promote sustainable development. It is led by the governments of UK, USA, and Norway, in partnership with Amazon, Nestlé, Unilever, Bayer, and others. Conserving and reforesting is a Brazilian opportunity that can not only provide socio-environmental services but also reposition the country in the global climate geopolitical agenda.

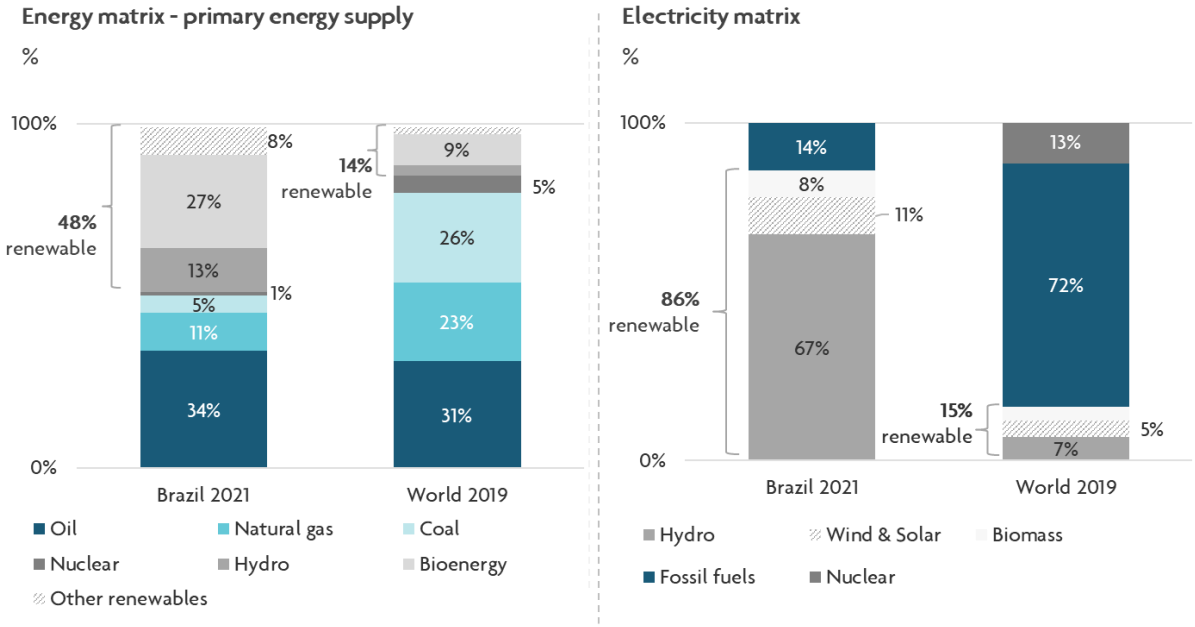
While deforestation turns Brazil into a climate laggard, the energy and power profiles position the country as a leader in this field. Considering that global energy demand is likely to increase even in a world of reduced carbon emissions, the Brazilian energy sector could become an energy superpower in the years to come, if it is underpinned by an open, diversified, and competitive business environment which adapts to the global transition to a low-carbon economy. Brazil has a diversified energy mix, leveraging vast natural and balanced resources. Renewable sources already account for almost 50 per cent of the country's energy matrix, compared to only 14 per cent globally.

One of the energy sources responsible for such a high renewable penetration in energy supply is bioenergy, used for both transportation and power generation. Brazil is currently the third largest biofuel producer globally, helping the country to reduce emissions from its transport sector, due to a high penetration of flex-fuel cars and the obligation to mix fossil fuels with ethanol and biodiesel at the pumps. The sector has potential for growth in a low-carbon transition, with Brazil expected to provide the second largest projected growth in biofuel production up to 2024, only behind China. In this context, projections point to a 14 per cent increase in Brazilian bioenergy demand up to 2030, reaching 88.3 Mtoe, from 77.7 Mtoe in 2021.

The second driver for Brazil's cleaner energy mix relates to the high share of renewables in the power supply. When considering the electricity sector, the difference between Brazil's profile and the rest of the world is massive—86 per cent of power in Brazil is renewable versus 15 per cent globally. Hydro currently accounts for more than two-thirds of power generation, while wind and solar have grown substantially in recent years, surpassing a 10 per cent share in 2021. The Brazilian Energy Planning Agency forecasts continued diversification towards renewables by 2030, potentially reaching 92 per cent of power generation. This is driven by declining solar and wind costs. Wind power costs fell 63 per cent between 2009 and 2019, reaching US$19/MWh and becoming the lowest-cost power source in Brazil. Brazil relies on strong and constant wind, with an average capacity factor for

onshore wind of almost 41 per cent in 2020, although it could reach 70 per cent in the northeast region, compared to 34 per cent globally. In this context, wind power capacity reached 18GW in 2021, a 19-times increase compared to 2010, putting Brazil in the top seven global markets for wind power, with ample room for future growth.

A diverse energy sector with large renewable penetration



Source: EPE, 2021; IEA, 2020.

Additionally, Brazil is already home to a world-class oil and gas industry, being a relevant and reliable supplier to the global market, especially to Asia. For the future, it has a window of opportunity for generating socio-economical development while responsibly exploring its resources. The country currently produces 3.8 MMboe/day of oil and gas, 73 per cent of that in the competitive pre-salt basin. It is a net supplier of crude oil to the world, exporting around 1,6 MMboe/day, mainly to China (54 per cent). Brazilian crude is recognized for having one of the lowest carbon contents globally. In this context, it is considered one of the most environmentally as well as economically resilient in a low-carbon transition scenario. At the same time, the recently approved New Gas Law provides the legal framework for the transition from a vertically integrated to a liberalized and competitive market structure, based on unbundling, third-party access, entry–exit transport system, and transparency. It lays the foundations for a gas market in Brazil that fosters competition among market participants and improves efficiency.

Even in a net-zero world, oil and gas will retain a share of the energy market, mainly for the heavy transport and petrochemical sectors. Even though the expected increase in the Brazilian production of oil and gas might lead to growing GHG emissions in the energy sector, it is compatible with the country's economy-wide NDC. This should be counterbalanced by a steep fall in land-use-related emissions through combating deforestation and developing low-carbon agriculture. The Brazilian oil and gas sector has the opportunity to support the transition towards a low-carbon economy through excellence in emission management, minimizing operational emissions, including through carbon capture, use, and storage (CCUS), as well as being prepared to respond to increased societal pressure on portfolio resilience, climate targets, and diversification to lower-carbon businesses. Additionally, it could also leverage nature-based solutions to address emissions coming from its value chain.

As far as new technologies are concerned, the country relies on its considerable potential to profit from a growing hydrogen economy. It is home to one of the world's largest renewable power sources, which can be used to produce green hydrogen, which could in turn be used both to decarbonize the national hard-to-abate sectors and to export to countries with an energy deficit and net-zero commitments. The nation's robust oil and gas sector could also play an important role through the development of blue hydrogen, exploring Brazilian reserves while relying on a growing expertise in CCUS, with Petrobras being one of the first global players to successfully inject CO_2 in its reservoirs at a large scale.

Brazil is uniquely positioned to benefit from the nexus between climate and energy on the road to COP 26 and to a net-zero economy. Brazil has historically been a leader in global climate diplomacy, hosting Rio 92 and acting as a key protagonist in COP 21 in Paris. For Glasgow, it could leverage its soft power, based on three guidelines.

Firstly, the country must rely on a strong commitment to the end of illegal deforestation and ensure law enforcement. Scientists argue that ending deforestation is one of the most relevant and cost-effective climate mitigation initiatives in Brazil. At the same time, the need to meet an economy-wide NDC target means that, if the country is unable to reduce its land-use emissions, these increased emissions will have to be compensated by diminished emissions from other sectors. This will need to be from energy, which would limit its efficient development and lead to a non-optimal emission reduction pathway in socio-economical terms.

Secondly, supporting the Paris Accord Article 6 implementation is critical as it allows for the establishment of an international carbon market, and therefore a business opportunity for Brazil. There are many uncertainties regarding the scope of the decarbonization challenge and the commercial maturity of low-carbon technologies. At the same time, science recognizes that residual emissions will have to be neutralized through removals, especially in hard-to-abate industries, for the world to reach net zero by 2050. Well-designed voluntary carbon credits can direct private financing to climate-action projects that would not otherwise be implemented. These projects can have additional benefits such as biodiversity protection, pollution prevention, income generation, and overall contribution to the Sustainable Development Goals.

Brazil's geography contains 20 per cent of the global potential for natural climate solutions, mainly through forest conservation and reforestation. However, this potential supply may not find buyers if Brazilian credits are not perceived as reliable and credible. A transparent carbon market may provide both a successful tool for a lower-cost transition to a zero-carbon economy and a business opportunity for those willing to sell carbon credits. The Brazilian private sector should, in this scenario, encourage robust rules and regulations, in accordance with international best practices.

Finally, the Brazilian energy sector should prioritize being part of the future of energy, while leveraging its competitive advantages and integrating global chains. Decentralization, electrification, decarbonization, and digitalization trends will continue to transform how the world uses and produces energy. Although the country has unique characteristics, such as a high bioenergy share in its transport mix, it cannot be immune to global paradigm shifts that are occurring, such as the electrification of transport. It is crucial that the Brazilian energy sector prepares itself to be a superpower in a low-carbon economy, responsibly using fossil fuel resources while prioritizing emission-reduction initiatives, adequately influencing the population to promote behaviour changes, and further developing its renewable potential in a competitive, stable pro-business environment.

THE RUSSIAN PERSPECTIVE ON COP 26 AND THE KEY CHALLENGES OF THE ROAD TO NET ZERO

Irina Gayda and Tatiana Mitrova

For the Russian Federation, the net-zero goal poses a great challenge—on the one hand, it means the need for a radical restructuring of all sectors of the economy in the domestic market; on the other, it poses great threats to the sustainability of export revenues.

Unlike in many other countries in the world, the issue of climate change until recently has been of little interest to the Russian government, society, businesses, and financial institutions. For a long time, Russia has been widely seen as one of the countries which were most behind in terms of the climate agenda. Despite being the fifth largest emitter of CO_2 in the world, it ranks as low as 52nd out of 61 countries in the 2021 Climate Change Performance Index. Russia signed the Paris Agreement in 2015 but did not adopt it until September 2019. For a long time, decarbonization was not among the priorities for the Russian authorities.

Emission targets declared by Russia in the framework of the Paris Agreement have long been met. They envision a 30 per cent reduction in its domestic emissions by 2030, compared to 1990 levels. However, current Russian emissions already amount to approximately 50 per cent compared to 1990 levels: due to a profound transformation of the economy, this obligation was met at the start of the 1990s. Clearly, the Russian regulators have had no serious reasons to introduce additional regulation of greenhouse gas emissions and promote the development of green technologies. Russia was able to meet its climate commitments without any particular effort, thanks to factors such as the absorption capacity of its forests and relatively low carbon intensity of the electricity mix (with its high share of natural gas, nuclear, and hydro).

The fight against climate change was not mentioned among the goals and priorities of the Russian government for the period to 2024. Neither was this task specified in any other strategic documents, including the new *Energy Strategy of the Russian*

Federation Up to 2035, adopted in 2020. The latter still envisions actively growing hydrocarbon exports and does not set any considerable targets for replacing fossil fuels with green energy sources in the domestic market. Despite Russia having the largest wind and solar power technical potential in the world, in 2020 the share of wind and solar power generation in the balance of the Unified Energy System (UES) of Russia was just 0.32 per cent. Calculations show that even if the most ambitious of the current power sector development plans were to be implemented, by 2035 the share of renewable energy (excluding hydro power) in electricity generation in Russia would only reach 2–2.5 per cent.

However, in 2020–2021 the situation started changing rapidly. As the move towards carbon neutrality gathered pace around the world (and in particular, commitments were announced by Russia's core export markets—EU, China, Japan, and Korea) and the prospects for the introduction of new regulations in the main export markets became imminent, Russian leaders were forced to take a much closer look at climate issues. The EU Green Deal and many regulations within the Fit for 55 framework have particularly influenced Russian decision-makers. The main export market for Russian hydrocarbons is now consistently creating comprehensive regulation that will push its participants and national governments towards meeting their climate targets. The Carbon Border Adjustment Mechanism project, proposals for which were published by the European Commission on 14 July, has prompted particularly intense discussion in Russia.

The Russian authorities are becoming increasingly serious concerning the climate agenda. Firstly, it provides Russia with an opportunity to improve its international image. An environmental policy report published in April by the Higher School of Economics states: 'Preservation and conservation of nature should become an important component of the Russian national idea, its mission for itself and the world, an important element of the Russian international identity.'

The Russian authorities are also influenced by economic considerations. On the one hand, global decarbonization poses serious long-term threats to Russia. If the Paris Agreement members meet their targets pledged for 2030, Russian energy exports will be 20 per cent below its baseline scenario, not taking into account the impact on other sectors of the economy.

On the other hand, Russian export-oriented business is aware of the threats to its niche in foreign markets and is extremely interested in the deployment of new green technologies, to remain competitive on a global scale. And, finally, the country's low economic growth over the past decade (just 1 per cent per year on average) justifies a change in focus from rapid GDP growth to sustainable development accompanied by slower economic growth but focused on resolving environmental and climate issues. The resource-based economic model failed to ensure Russia's GDP growth, and a change in the technological order prompted by the energy transition and the sustainable development agenda at least gives a chance to look for new economic growth models.

Thus, the combination of geopolitical considerations, awareness of long-term threats to the Russian economy, and pressure from Russian corporations operating in the global market forces the country's leadership to pay more attention to the climate issue.

In his April message to the Federal Assembly, Russian President Putin for the first time explicitly identified the environment and the climate agenda as one of the country's development priorities, thus sending a clear signal to government officials of all ranks. Many foreign observers were surprised by his subsequent speech at the Leaders Summit on Climate with Biden, where Putin called for broad international cooperation in the fight against climate change.

In May, Putin instructed the government to specify a reduction in the accumulated volume of greenhouse gas emissions to levels below those in the EU within the *Strategy for the Socio-economic Development of the Russian Federation to 2050*. He also instructed the Cabinet of Ministers to prepare a road map for the period to 2050, with the aim of reducing Russia's carbon intensity and ensuring the implementation of 'major innovative projects of national importance' in any way related to the green transition, giving a deadline of 1 October. These projects include the development and implementation of new approaches in the areas of renewable energy, nuclear power generation, hydrogen energy, and energy storage, as well establishing a national system for precise monitoring and utilization of climate-active gases.

At the St. Petersburg Forum in early June, Putin said it was 'nonsense' to claim that Russia was not concerned with climate change, and for the first time emphasized that Russia, like other countries, is affected by 'the risks and threats in this area, including desertification, soil erosion, permafrost melting'.

On 2 July 2021, the president signed the long-awaited Law on Limiting Emissions of Greenhouse Gases, which had undergone numerous discussions and approvals since November 2018. It implements 'soft' regulation minimizing additional burdens on

companies. It includes obligatory reporting of emissions for large emitting companies; however, quotes or payments for emissions in excess of certain limits, which were part of the initial version of the document, did not make it to the final version. The companies can execute 'climate projects' with emissions reduction or negative emissions and sell corresponding 'climate units' on a voluntary carbon market. The idea is that those units will be recognized by international counterparts and can help protect Russian exporters against EU carbon border adjustments. The legislative work on this topic continues, focusing on the mechanics of climate units verification, registration, and sales.

The final text still appears to be much of a compromise: the law does not specify a mechanism for capping emissions. For now, regulation is limited to reporting. (In addition to the oil and gas and electricity sectors, other carbon-intensive industries—metallurgy, transport, chemicals, and the pulp and paper industry—are subject to reporting requirements.) However, for the first time, the law introduces the necessary definitions of terms (greenhouse gases, carbon footprint, climate projects, carbon units, etc.) and a fairly vague concept of a 'target for reducing greenhouse gas emissions'. The exact mechanism for calculating this indicator is still unclear (the law mentions that it will be calculated taking into account the absorbing capacity of forests). The companies which file the necessary reports will be entered into a special federal emissions register. Those which fail to submit their statements or do so with violations will be subject to sanctions (these are also unclear).

RSPP (the Russian Union of Industrialists and Entrepreneurs) supported this document, which is not surprising given the large influence that coal and oil and gas players have in the organization—the RSPP Climate Committee is led by Andrey Melnichenko (the main beneficiary of the chemical company Eurochem and the coal mining company SUEK) and co-led by Leonid Fedun (a member of the board and major shareholder of the largest privately held company, LUKOIL). Representative of the Trade Industrial Chamber (an organization uniting a broader set of businesses and industries) Oleg Pluzhnikov expressed some criticism of the document, stating that the only achieved goal is 'minimization of the burden on business, obtaining reliable information on emissions and decarbonization are more a declaration, and are not addressed by the law'.

Another milestone of decarbonization could have been the Ministry of Economic Development's *Integrated Plan of Activities to Improve the Energy Efficiency of the Russian Economy*, which was published after almost a one-year delay in June 2021. Although the final document is a bit less ambitious than its draft version, it is an important milestone in promoting energy efficiency in various sectors as a means of decarbonization. It is still missing some key elements—such as ambitious sectoral targets on energy efficiency improvement and, for example, a requirement to use only the most energy-efficient technologies in state-funded procurement activities.

The Ministry of Industry and Trade together with the Ministry of Economic Development published the *Concept of Development of Production and Use of EVs till 2030*, which includes demand support initiatives for low-carbon vehicle sales, such as discounts on leasing and car loans. Producers will get grants to fund 30–40 per cent of research and development and pilot productions for fuel cells, electric engines, control units, power train electronics, and other relevant new technologies. KAMAZ, which is developing a hydrogen bus prototype, is already benefiting from this program. However, no ban on sales of internal combustion vehicles is planned.

Significant attention of the government is also dedicated to creating a Russian hydrogen program. Prime Minister Mishustin created a working group headed by Deputy Prime Minister Novak and incorporating the minister of industry and trade, minister of economic development, minister of energy, and several other prominent experts from the corporate world and academia. Hydrogen is believed to be the new export commodity, which is due to substitute declining exports of coal and hydrocarbons. The task of the group is to develop a specific road map on how to achieve that, including necessary state support measures.

The low-carbon economic development strategy of Russia will be updated following the order of President Putin in April 2021. The overall accumulated greenhouse gas emissions between 2021 and 2050 will have to be lower than those of the EU. The base scenario described in the previous version of the low-carbon strategy is now described as conservative, and two more aggressive scenarios, including apparently a net-zero option, are also considered. Multiple ministries and representatives of business and academia are part of this work. This strategy will have to be ready by October 2021, although there are some concerns whether this is feasible, given the lack of readily available analytical tools.

Additionally, an experiment to reduce CO_2 emissions in the Sakhalin Region is to be launched shortly. It is intended as a pilot project to test the concept of a national CO_2 trading system. There are plans to establish a carbon trading system, the first in Russia, and ensure that the region achieves carbon neutrality as early as 2025, as part of the approved road map for the implementation of the pilot.

Russian government officials are also actively working on a scheme for the development of green bonds to finance climate projects, discussing the so-called carbon farms.

We can expect that such a shift in Russia's approach will lead to increased government support for green technologies and projects. For example, ambitious goals for the development of a hydrogen economy are already being voiced at all levels. In June 2021, Deputy Prime Minister Alexander Novak noted that in future Russia plans to occupy 20 per cent of the world hydrogen energy market (comparable to Russia's current share of the hydrocarbon market). Having said that, there is not yet a single low-carbon hydrogen production project in Russia that has gone beyond the stage of memorandums of understanding.

Great ambitions are also pinned on the development of a new generation of nuclear power. Solar and wind energy have started to develop and localize, and the first energy storage projects have emerged. However, for now, Russia's position on green energy comes down to the statement 'we have great potential.' The most promising areas are in their infancy in terms of availability of their own technologies and qualified personnel, and also given regulation and a more than modest scale of projects being implemented. Ensuring sustainability of hydrocarbon and other resource exports by reducing their carbon footprint, as opposed to a fundamental green transformation of the economy, remains Russia's main task.

With such a background, Russia's perspective on the COP negotiations is really controversial. In theory, climate and green energy are the areas in which Russia, the US, the EU, China, and developing countries have a common interest. It is possible to speculate about potential joint projects, new investments, and the transfer of green technologies to Russia. However, a radical difference in goal setting and the regulatory framework makes a less optimistic scenario fairly probable. The current heated debate around European cross-border carbon regulations, the methodology for assessing the absorptive capacity of Russian forests, and the acceptability of various methods of hydrogen production ('grey', 'green', 'blue', and 'yellow') are the first examples of potential conflict points in this area. For now, despite a surge of interest in the green agenda in Russia, it is impossible to say with any certainty that Russia is ready to move from loud statements to real measures for combatting climate change, or that the climate agenda can make Russia's cooperation with other countries more constructive.

At COP 26, countries are expected to announce new increased nationally determined contributions to reduce emissions by 2030. In addition, it is expected that the countries will present more specific national plans to meet Paris Agreement targets and that the carbon markets issue relating to Article 6 of the Agreement will be resolved.

Particular attention will be focused on the United States, as Joe Biden's planned speech will mark the return of the United States to the Paris Agreement. The US is expected to announce a double increase in the annual volume of climate finance allocated to developing countries. From a geopolitical viewpoint, Russia, which regards itself as an equally important global player, needs to make a comparable appearance—not necessarily in financing, but potentially in any other area. It is expected that Russia will oppose discrimination in international climate regulation, in particular regarding Carbon Border Adjustment Mechanisms. Far less certain is its position on achieving the goal of net zero. Though there were some internal discussions on this topic leaking into the public space, so far no official statements have been made; and given the huge uncertainties related to the green transition for Russia, it is questionable whether Russia will make such a commitment at Glasgow.

A SAUDI PERSPECTIVE ON COP 26 AND CURRENT INITIATIVES

Noura Y. Mansouri and Aisha Al-Sarihi

Disclaimer: *The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of King Abdullah Petroleum Studies and Research Center (KAPSARC) or Saudi Arabia.*

Saudi Arabia's socio-economic development has strongly revolved around the wealth generated from oil and gas exports, accounting for about 70 per cent of total government export earnings and about 50 per cent of gross domestic product as of 2019 (OPEC, 2020). Hence, Saudi Arabia's vulnerability to climate change is not limited to its bio-physical impacts, given its arid environment and sensitive ecosystems, but also includes the potential impacts of so-called climate change response measures (RM), especially constraints on fossil fuel consumption, as it is highly dependent on a single source of income.

Despite the importance of hydrocarbons in its economy, Saudi Arabia has joined global forces to address climate change: it joined the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, ratified the Paris Agreement (PA) in 2016, and had submitted its intended nationally determined contribution (INDC), which became its NDC, ahead of the Conference of Parties (COP) in December 2015.

Having been involved in all the COP meetings, Saudi Arabia has been actively engaged with climate change negotiations and has been persistently working toward global acknowledgement of the special circumstances of fossil-fuel-rich countries, stressing the possibility for those countries to address climate change through co-benefits of economic diversification, amongst others.

Since the adoption of the PA in 2015, parties to the Agreement have continued the negotiations on the implementation guidelines of the so-called Paris Rulebook to execute the Agreement. While countries adopted the majority of the Paris Rulebook at the COP 24 in 2018, a few issues remain unresolved, partly due to the technical nature of the negotiated issues and/or countries' different positions on these issues. Expectations are heightened that the fifth COP since the PA, COP 26, will be a breakthrough for parties to reach an agreement on unresolved Paris Rulebook issues. This article explores Saudi Arabia's position towards outstanding issues under consideration at COP 26, including carbon markets, global stocktake (GST) and timeline to rachet up NDCs, and impacts of RM. It furthermore sheds light on Saudi Arabia's position on the rising ambitions to reach net zero emissions by 2050, and the Kingdom's current climate mitigation initiatives that could align with global forces aimed at keeping 1.5°C within reach.

COP 26 outstanding issues: Saudi Arabia's position

Expectations are heightened that the 26th United Nations climate summit, COP 26, will be the most important meeting on climate change since the PA, to reach agreement on key unresolved Paris Rulebook issues, including Article 6 on carbon markets, GST, common time frames, and impacts of RM. Given the high economic dependence of Saudi Arabia on oil revenues and its relatively lower contributions to global greenhouse gas (GHG) emissions, Saudi Arabia, for the Arab Group, takes a negotiation position that pushes for ensuring that addressing climate challenges comes in line with protecting economic growth, especially in developing nations.

Carbon markets

Article 6 of the PA sets out how countries can reduce emissions using international carbon markets and non-market approaches. Countries have tried and failed to agree on the rules governing this mechanism. It is the last section of the PA Rulebook which remains unresolved, and it has the potential to make or break efforts to curb emissions.

Saudi Arabia is persistent in ensuring that climate mitigation must focus on reducing emissions rather than banning or restricting specific energy sources, such as fossil fuels; take into consideration 'common but differentiated responsibilities' (CBDR) based on national circumstances and respective capabilities; and avoid a one-size-fits-all, top-down framework, but rather base it on each country's unique context. Saudi Arabia, for the Arab Group, agrees that developed economies should take the lead and that developing nations should not be overburdened, and that actions would be taken to address all economic sectors, not just the energy industry.

However, since the adoption of the PA, developing countries including Saudi Arabia have witnessed a sharp deviation from the provisions agreed in Paris. They argue that there is an undue emphasis on energy and particularly oil, with efforts to impose excessive and unrealistic taxes on hydrocarbon fuels; a transfer of the financial burden to developing countries, many of which still suffer from energy poverty; and reluctance to operationalize the agreed-upon provisions. That includes the mitigation co-benefits resulting from adaptation actions and economic and diversification plans, as well as RM. Such misguided efforts ignore the social and economic consequences of tackling environmental issues, which has led to social unrest, rising unemployment, violent protests, and slowing economic growth in both developed and developing nations around the globe.

To fully deliver on the PA, Saudi Arabia emphasizes that the shift to low-emission economies will take time, and therefore, making ample and reliable energy supplies available for the long term is necessary in order to ensure an orderly transition. The consequences of not doing so would make an already fragile situation worse. Saudi Arabia believes investments must also be channelled into improving the performance of conventional energy as well as accelerating the uptake of renewable energy as it becomes feasible. Saudi Arabia argues that, to meet both its environmental targets and its development goals, the world will require investment in all energy sources, and that means not discouraging or curtailing needed investments in proven energy sources.

Furthermore, Saudi Arabia believes no pragmatic and impartial discussion about climate change can take place without reference to clean energy technologies, including carbon capture, utilization, and storage (CCUS) technology. By lightening the environmental footprint of conventional fuels—which continue to drive global economic development and social prosperity—

CCUS represents a necessary component in meeting climate change objectives while making prudent use of the earth's hydrocarbons endowment and sustaining economic growth and prosperity.

For its part, Saudi Arabia is putting its resources behind these principles. Saudi Arabia fully supports investment in renewables and other alternatives and has embarked on the implementation process for generating a greater share of energy from gas, solar, wind, and nuclear sources. At the same time, Saudi Arabia is investing heavily in new energy and efficiency technologies, and is encouraging international collaboration to find both technological and policy solutions to the challenges of global warming.

This position builds on the Kingdom's nearly 40 years of global leadership in this vital area. The result of these efforts to date can be seen in Saudi Arabia's upstream carbon intensity of oil production and gas flaring, which is one of the lowest in the world amongst major producers.

Global stocktake and timeline to ratchet up NDCs

The GST, referred to in Article 14 of the PA, is a process for periodically taking stock of the implementation of the PA to assess collective progress towards achieving its purpose and its long-term goals. The collective progress is assessed in the thematic areas of mitigation, adaptation, and finance flows and means of implementation and support, the social and economic consequences of RM and averting, minimizing, and addressing loss and damage, in light of equity and the best available science. While the GST structure was largely finalized at COP 24 in 2018, there remain a handful of details that are yet to be agreed, including input for GST and timeline to rachet up NDCs. Saudi Arabia, for the Arab Group, has been consistent in ensuring that the inputs for GST should provide the following (UNFCCC, 2021, *Arab Group Statements for Informal GST Consultations*):

- **A balanced representation of all thematic areas** by making sufficient reference to all thematic areas in a balanced manner and taking into account important areas such as adaptation with mitigation co-benefits and economic diversification. Most specifically for Saudi Arabia, as an oil-producing country, the impact of the implementation of response measures should be an important source of input for the GST to ensure it is truly comprehensive and inclusive.
- **Inclusivity in terms of the sources of inputs** by having a wide and balanced variety of sources that are not biased towards specific perspectives or institutions, with a suggestion to have a level of standardization in the input phase.
- **Integrity of inputs** by having some sort of verification method to ensure that the methodology used to assess sources of inputs is subject to a set of objective requirements to make sure that all information used is scientifically valid, reliable, and credible.
- **A balanced picture of global aggregated efforts**, rather than acting as a measure of transparency of NDCs or infringing on any countries' sovereignty or specific level of ambition.

The NDCs as they stand now cover a range of time frames at the discretion of each party, but COP 24 in 2018 agreed that all NDCs should cover a common time frame from 2031, with the length of the time frame to be decided later. COP 25 in Madrid was unable to reach an agreement on what the common time frame should be, whether five years, 10 years, a choice of either, or a hybrid of the two. Countries such as EU member states and smaller developing countries argue it is imperative for countries to do a stocktake of the impact of their combined action every five years, and then ratchet up their targets as early as 2020. However, some developing countries believe they should be allowed to wait longer than developed ones to rachet up their targets. India, China, and several countries in Latin America and the Middle East, including Saudi Arabia, want to wait until up to 2030 to strengthen their targets. India insists that developed nations have a historic responsibility to do more.

Impacts of response measures

Article 4.15 of the PA acknowledges that some developing countries such as Saudi Arabia, with a single income source, will be adversely impacted by actions taken by the international community to address climate change. Article 4.15 therefore constitutes a continuation of provisions for addressing the issue of the impacts of RM on developing countries with economies that are most affected by policies and measures under the PA. The greatest significance is the obligatory language to consider RM issues under this Agreement, yet since the PA departs from the rigid binary distinction of Annex I and non-Annex I, towards a range of differentiation (e.g. least developed countries), it is not clear how would it affect the work on RM. This issue of the impacts attributed to negative shifts in trade and reduction in fossil fuel consumption is addressed in the UNFCCC, Article 3,

where oil-exporting non-Annex I countries are disproportionately affected by RM due to their dependence on oil revenues.

In pursuing their efforts to mitigate climate change, parties to the UNFCCC and its PA are implementing RM which are designed primarily to limit emissions of GHG into the atmosphere. Some of these climate change policies and measures, particularly by developed countries (UNFCCC, Article 4), especially those aimed at reducing dependence on hydrocarbons, are expected to undermine the efforts of Saudi Arabia to achieve its sustainable development objectives, since its economy is largely dependent on a single source of revenue. This is a rather common position for developing countries (G77), recognizing that the vast majority of them are single-income-source countries.

According to Saudi Arabia's First Biennial Update Report, submitted to the UNFCCC in March 2018 by the Designated National Authority, Saudi Arabia argues that the social and economic welfare losses arising from climate change RM could 'adversely affect its economic diversification and climate adaptation efforts,' since oil export revenues still play a significant role in financing these efforts. The social and economic welfare losses arising from climate change RM could also lead to eliminating the chances for addressing key requirements for achieving sustainable development such as poverty eradication and environmental sustainability over time. It further argues, therefore, that the UNFCCC must enhance its efforts, namely, to identify innovative and efficient adaptation technologies for addressing the impact of RM such as enhancing international cooperation in the development of tools for quantitative ex-ante and ex-post analysis of impacts of RM, and encourage developed countries to share information and expertise on carbon pricing and its negative impacts on the international pricing of raw materials, processed goods, and finished goods.

Against this backdrop, Saudi Arabia takes a position to explore ways and means of minimizing these adverse impacts within the broader context of sustainable development and economic diversification, conditional to the technical support needed in performing rigorous and comprehensive scientific studies to model, predict, and evaluate the impacts of various climate change mitigation measures on Saudi society, economy, and environment.

COP 26 and the road to net zero

The 2018 Intergovernmental Panel on Climate Change (IPCC) report on the 1.5°C target concluded that global emissions need to reach net zero around mid-century to give a reasonable chance of limiting warming to 1.5°C. The net-zero target refers to a point when all GHG emissions released by humans are counterbalanced by removing GHGs from the atmosphere in a process known as carbon removal.

The Race to Zero global campaign, established in 2019, co-led by Chile and UK (COP 25 and 26 presidencies), is gaining momentum ahead of COP 26. The UN chief reminds, 'The world urgently needs a clear and unambiguous commitment to the 1.5 degree goal of the Paris Agreement from all G20 nations'; António Guterres and others are lobbying for new language to be agreed at COP 26 to explicitly recognize 1.5°C as the temperature goal (e.g., IIED 2021, Norton 2021). The momentum is further heightened by the release of the new IPCC report (*Climate Change 2021: The Physical Science Basis*), which builds on findings of the IPCC special report *Global Warming of 1.5°C*, which Saudi Arabia, USA, Russia, and Kuwait opposed to at COP 24.

The UK COP presidency announced its key goal is keeping the critical 1.5°C temperature rise limit alive, namely, by driving down emissions with mid-century net zero commitments and ambitious 2030 emissions reduction targets. This is a more ambitious aspiration compared to what the parties to the PA agreed to, namely, in Article 2.1, 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursing efforts to limit the temperature increase to 1.5°C above pre-industrial levels'. This ambitious aspiration for the COP 26 outcome by the UK may impact the balance of the PA—between adaptation, mitigation, and means of implementation in the context of CBDR and equity.

Moreover, developing countries will uphold the rights enshrined in Article 2.2. on CBDR, taking into account national circumstances and equity. In addition, Article 4.1 states very clearly that developed countries will peak their emissions before developing countries as the latter will take time. Under Article 4.4, developed countries 'should' and developing countries 'are encouraged' to apply economy-wide emissions reduction targets, where developing countries will pursue mitigation efforts. The target of peaking by the second half of the century is stated in the PA, and not reduction by 2050. Therefore, many developing countries are insistent that they are not in a position to now renegotiate the PA. For example, China announced a net-zero target of 2060, whereas India refused to update its NDC based on the equity argument.

Moreover, the UK, as president of both G7 and COP 26, has a responsibility to showcase strong support for climate-vulnerable countries. The UK's recent aid budget cuts undermine its moral authority to showcase leadership and triumph a legacy. World

leaders must commit to stronger climate finance targets. Least developed countries have argued for what is termed a 'fair share accounting', which allocates emissions cuts based on historical responsibility and the capacity to act.

While Saudi Arabia has not set a net-zero target per se, it has joined global efforts to keep 1.5°C within reach by embarking on many climate mitigation initiatives and programs. These include the control of emissions sources as well as emissions offsetting. For instance, Saudi Arabia's INDC, which became its NDC, sets a target of reducing emissions by up to 130 $MtCO_2e$ by 2030 'through contributions to economic diversification and adaptation', as stated in its first NDC, submitted in 2015. Also, in April 2021, Saudi Arabia joined the Net Zero Producers Forum, alongside the US, Canada, Norway, and Qatar—together responsible for 40 per cent of global oil and gas production, who joined forces to come up with 'pragmatic net-zero emission strategies', including methane abatement, advancing the circular carbon economy (CCE) approach, development and deployment of clean-energy and carbon capture and storage technologies, diversification from reliance on hydrocarbon revenues, and other measures in line with each country's national circumstances. Most importantly, in 2020, under the Saudi G20 presidency, Saudi Arabia proposed the CCE—endorsed now by all G20 countries as a holistic, integrated, inclusive, and pragmatic approach to managing emissions.

The G20 and managing emissions—the circular carbon economy approach

By encompassing the broad range of pathways and options available, CCE considers different national circumstances, while striving to meet our shared global aspirations. CCE enables reducing GHGs, considering system efficiency and national circumstances, including its specific resources endowment and its political, economic, environmental, social, and risk-informed development contexts.

CCE is an energy strategy that advocates the 'three Rs': reduce, reuse and recycle (carbon). Crucially, however, it adds a fourth R, remove, in an effort to eliminate emissions from the atmosphere—making the 4Rs of CCE reduce, reuse, recycle, and remove (KAPSARC, 2020, CCE Guide Overview, KAPSARC: King Abdullah Petroleum Studies and Research Center)—reducing the carbon that must be managed in the first place (through energy efficiency, renewables, and nuclear), reusing carbon as an input to create feedstocks and fuels (including mobile carbon capture technology for transportation that captures and stores carbon onboard the vehicle using a redesigned exhaust system, and CO_2-enhanced oil recovery, which uses injected CO_2 to extract oil that is otherwise not recoverable), recycling carbon through the natural carbon cycle with bioenergy, and, unique to CCE (through natural sinks such as forests and oceans and the use of hydrogen-based synthetic fuels to recycle CO_2), removing excess carbon and storing it (through CCUS). For sustainable energy transitions, utilization of all energy sources and innovative technologies will offer opportunities to further advance cleaner energy transitions.

As the world's lowest-cost and second-lowest-carbon producer per barrel of oil (Masnadi et al., 2018, Global carbon intensity of crude oil production, Science; L. Jing et al., 2020, Carbon intensity of global crude oil refining and mitigation potential, Nature Climate Change), 'Saudi Arabia will produce every molecule of hydrocarbon and it will put it to good use, and it will be done in a most environmentally sound and more sustainable way,' according to Saudi Energy Minister Prince Abdulaziz bin Salman (Future Investment Initiative Institute, 2020). Saudi Arabia has a long history of environmental stewardship, embodied in the Kingdom's Master Gas System, and for over four decades has been capturing gas that was once flared and turning it into a valuable, clean fuel and feedstock and making it the foundation of an entirely new domestic industrial sector, avoiding 98 million tons CO_2 annually (~4.7 gigatons since 1970). The economic and environmental benefits have been enormous, and the Master Gas System continues to serve as proof-of-concept when it comes to integrating economic viability with environmental protection.

Saudi Arabia's pursuit of CCE includes over 100 initiatives by 45 stakeholders; to name a few:

- New energy mix—committed by 2030, the power sector will be powered by 50 per cent renewables and 50 per cent gas (substituting liquid fuels).
- The world's first shipment of blue ammonia—produced from natural gas with carbon capture utilisation and storage in the hydrogen plant in Jubail and shipped to Japan to be used in power stations to produce electricity without carbon emissions.
- The world's largest green hydrogen project in Neom—to produce 650 tons of green hydrogen daily.
- The world's largest CCUS plant in SABIC—to purify up to 500,000 metric tons of CO_2 from the production of ethylene glycol every year.

- Resource and energy efficiency in SABIC:
    - utilization of CO_2 as a feedstock increased to 3.3 million metric tons
    - reducing material loss intensity by 29 per cent since 2010
    - mitigating GHG emissions intensity, decreased by 7.8 per cent
    - reducing energy intensity by 8.1 per cent
    - reducing water intensity by 11 per cent.
- Energy efficiency program and energy price reforms.

Pursuant to the Saudi Vision 2030, launched in 2016, mandated as a long-term model of prosperity for the Kingdom, Saudi Arabia is embarking upon many gigaprojects—including Qiddiya Entertainment City, Neom Future City, the Red Sea Project, and Amaala resort—delivering co-benefits from economic diversification and mitigating GHG emissions.

Offsetting emissions

Saudi Arabia has been committed to the enablement of nature-based solutions, including afforestation—planting trees as well as advancing blue carbon in coastal ecosystems such as mangroves, seagrass meadows, and tidal marshes that provide support to many critical aspects of the ecosystem, as well as sequestering and safely storing large amounts of blue carbon. In March 2021, Saudi Arabia announced two nature-based solution initiatives: the Saudi Arabia Green Initiative and the Middle East Green Initiative—aimed at planting 10 billion trees within Saudi Arabia during the coming decades, using recycled water, equivalent to rehabilitating about 40 million hectares of degraded lands, with hopes to increase the area covered by the current trees by 12 times and reduce carbon emissions by more than 4 per cent of global contributions, in addition to planting 40 billion trees across the region—the world's largest reforestation program, which aims to reduce carbon emissions by 60 percent with the help of clean hydrocarbon technologies.

Conclusions

Saudi Arabia's heavy reliance on oil has not prevented it from pursuing environmental sustainability and actively engaging in addressing climate change. Saudi Arabia has proactively participated in shaping global climate governance, joined the UNFCCC in 1994, ratified the PA, and has been involved in all COP meetings. Despite its high economic dependence on oil revenues, Saudi Arabia has embarked on many domestic climate mitigation initiatives and projects that have potential co-benefits in diversifying the economy and mitigating GHG emissions. Essentially, with its proposed CCE approach, endorsed by all G20 countries, Saudi Arabia leads the way in reducing, reusing, recycling, and removing carbon in its over 100 local and global initiatives, as well as offsetting emissions through nature-based solutions commitments.

TRANSITIONING TO NET ZERO: CCUS AND THE ROLE OF OIL- AND GAS-PRODUCING COUNTRIES

Bassam Fattouh, Wolfgang Heidug, and Paul Zakkour

While the physical impacts of climate change pose a grave threat to many nations and regions, the economic impacts of mitigating climate change also pose a serious destabilising risk to many others. In this article, we focus on the impacts of the energy transition for those countries highly dependent on fossil fuel revenues for their way of life, and possible strategies through which to orderly manage such effects.

A key distinguishing feature of climate change is the unevenness of its impacts on countries and regions.[62] The physical impacts of climate change and the ability to adapt to its consequences are not the same across countries. Also, the adjustments needed to reduce emissions are not uniform. Some countries, for instance those that rely heavily on the hydrocarbon sector as the main source of their income and export revenues, will have to undergo much deeper adjustments and transformations to reduce their emissions when compared to more diversified economies. This unevenness also applies to capabilities and capacities, where even within the group of oil and gas exporters, some are in a better position to cope with the challenges of

[62] See Stiglitz, J. 2015. 'Overcoming the Copenhagen Failure with Flexible Commitments', Economics of Energy & Environmental Policy, International Association for Energy Economics, vol. 4 (Number 2).

reducing greenhouse gas (GHG) emissions and investing in low-carbon technologies. Climate policies can also induce substantial distributional effects and cause a significant reallocation of wealth. Oil- and gas-exporting countries are expected to experience a decline in their incomes and their wealth as the demand for their key export products is projected to fall.

There is recognition that carbon taxes and emissions trading systems (ETS) by themselves can't induce change at the scale and the speed needed to achieve the Paris Agreement targets. Thus, there have been some calls to develop complementary supply-side policies that focus on restricting the use of oil and gas and keeping hydrocarbon reserves underground. Such policies will further amplify the distributional impacts of climate change policies, making hydrocarbon exporters worse off even if one considers the benefits from reduced threats from climate change. They also ignore the political economy of oil and gas producers and the central role the hydrocarbon sector plays in their economies and the welfare of their people. Such proposals are also short or even absent in identifying concrete mechanisms that could help producers in their adaptation process. Also, to expect oil and gas exporters to keep their resources underground and/or fully diversify away from the oil and gas sector, which constitutes their core competitive advantage, and for this strategic sector to play a lesser role in the transition process is not only unrealistic; it is also sub-optimal, as these economies will limit their scope for risk reduction and adaptation strategies in the face of a potentially disruptive shock.

Policies focused on restricting the supply of hydrocarbons risk disincentivizing oil and gas exporters from playing a more constructive role in COP 26 negotiations and reducing their incentive to be part of the solution to climate change. Instead, COP 26 should build on the momentum that many oil and gas exporters recognize the climate change threat and are adopting a fundamentally different approach from the past and have shown willingness to employ technical and financial resources and to lead on initiatives on climate change mitigation.

Surprisingly, technologies such as Carbon Capture, Utilization and Storage (CCUS) do not feature heavily in such supply-side policies, as many remain sceptical about the role of CCUS as a climate mitigation technology, citing factors such as its high cost and fears around the safety and permanence of storage. Other sceptics argue that CCUS can also perpetuate the use of fossil fuels and discourage change in societal behaviour and reinforce existing dependencies and power structures. It is also argued that CCUS could discourage countries from pursuing clean technologies. However, as noted by Allen et al., 'worthwhile policies should be pursued in their own right. Solving climate change is too important to be held hostage to any other issue.'[63]

From oil and gas producers' perspective, enabling investment in CCUS and CO_2/carbon sink mitigation strategy can reinforce certain principles which are key for a smooth energy transition. These include:

- The recognition of national circumstances in climate change negotiations.
- The recognition that there will be various transition paths depending on the starting points, core competencies, and existing assets of each of the countries. Insisting on a single path and selecting winning technologies while excluding other technologies leads to an inefficient transition.
- The concept of a 'just transition' and the recognition that adjustment costs are not uniform across the globe and therefore the importance of offsetting some of the adverse impacts through the establishment of mechanisms under Article 6 of the Paris Agreement that allow for cost sharing and reducing the adjustment cost for the most affected countries.

The challenge of fiscal diversification

In the face of a shock that could disrupt a strategic sector such as oil and gas, an effective strategy is to diversify away from that sector. However, most oil- and gas-producing countries face real challenges in realizing meaningful diversification, particularly fiscal diversification that reduces reliance of their government budgets on hydrocarbon revenues. Diversification could be successful if the country can generate new uncorrelated income streams through creating new sectors and alternative sources of income through direct and indirect taxation of newly created sectors. Also, diversification into substantively different areas away from their core competitive advantage runs the risk of failure to establish viable non-resource export sectors.

Achieving diversification also requires building human capital and improving the education system and extensive structural reforms to improve the economic and business environment, enhance transparency and economic governance, and remove

[63] Allen, M.R., D.J. Frame, and C. F. Mason. 2009. 'The case for mandatory sequestration?' Nature Geoscience 2: 813-814.

barriers to private-sector participation. There is significant uncertainty regarding how fast or even whether such extensive economic and institutional reforms can be implemented in most oil and gas exporters.

Furthermore, the oil and gas sectors remain very profitable and still enjoy higher margins than any new industries or sectors that governments in oil- and gas-exporting countries aim to establish. Reduced investment flows into the oil and gas sector can cause supply to fall faster than demand, resulting in high margins at least for short periods of time. Governments can also leverage oil and gas revenues to ease the pain of structural reforms by developing compensation mechanisms to offset the adverse impacts on households and firms. Given that the speed of the transition is highly uncertain and its impacts are uneven across the globe, exiting too early from such an established strategic sector deprives the country of an important source of income. After all, countries are likely to pursue different transition strategies, and even importing countries don't constitute a homogeneous group. Several importing countries could continue using oil and gas if prices are lowered because of forced compression of demand in 'committed' countries.

Competing on reducing emissions and the role of CCUS

If diversifying fully from the oil and gas sector is sub-optimal, and in many hydrocarbon-rich countries it can't be achieved at a rapid pace, the issue then becomes how to enhance the competitiveness and increase the resilience of the hydrocarbon sector in a world that is transitioning towards net zero emissions.

One key aspect of competitive advantage is cost. Given the size and the nature of their hydrocarbon reserves, some oil and gas exporters, particularly those in the Gulf, can compete effectively on the cost of developments and extraction. Also, in the face of uncertainty about demand and in response to importing countries' oil-substitution policies, some exporters can adopt faster extraction and monetization strategies. However, lack of fiscal diversification and the high 'social cost of production' act as constraints on this strategy.[64] Also, in response, oil importers may decide to implement carbon taxes based on carbon content, creating a wedge between the revenues generated by oil exporters and revenues generated by importing countries, with the latter capturing a substantial part of the rent.[65] This is nothing new, as importing countries, especially in Europe and Japan, have always taxed fossil fuels heavily.

Another option for managing the transition is to diversify into products and sectors closely related to hydrocarbons where energy is an important component of competitiveness. But this strategy is not without risks. Industrialization into energy-intensive industries increases domestic emissions of GHG, and some importers, such as the European Union, are already developing policies to measure and verify the carbon content for final goods and have plans to implement carbon border adjustment measures[66] to address the problem of carbon leakage.

Thus, in addition to the cost dimension, hydrocarbon-rich countries could compete on reducing their CO_2 emissions. This involves reducing emissions from both the production process (Scope 1 and Scope 2 emissions, from the producers' perspective) and the consumption of gas and products derived from crude (Scope 3 emissions, from the producers' perspective). However, the real challenge lies in reducing emissions from the consumption of the gas/petroleum products. This is where CCUS can play an important role in oil and gas exporters' policies and strategies, for a number of reasons.

- Global deployment of CCUS is needed to help achieve the goal of net zero emissions, given that oil and gas are projected to remain part of the energy mix at least for the foreseeable future.
- CCUS could reduce the cost of meeting climate targets as other sectors have to pursue more expensive mitigation options and CCUS enables continuing access to lower-cost fossil fuels.[67] Also, in many models, CCUS plays an important role in achieving the 2°C scenario.
- IPCC scenarios rely on the availability of carbon sinks (either biological or geological) to achieve negative emissions and the 1.5°C goal.[68] CCUS offers long-lived storage solutions that can complement nature-based solutions which offer

[64] Dale, S. and Fattouh, B. (2018) 'Peak Oil Demand and Long Run Oil Prices', OIES Energy Insight 25, Oxford Institute for Energy Studies. https://www.oxfordenergy.org/publications/peak-oil-demand-long-run-oil-prices/.
[65] See Franks, Max and Edenhofer, Ottmar and Lessmann, Kai, Why Finance Ministers Favor Carbon Taxes, Even If They Do Not Take Climate Change into Account (March 9, 2015). Available at SSRN: https://ssrn.com/abstract=2599482 or http://dx.doi.org/10.2139/ssrn.2599482
[66] Peszko et al, 2020. 'Diversification and Cooperation in a Decarbonizing World', World Bank Publications, The World Bank, number 34011.
[67] See Element Energy & Vivid Economics. (2018). CCS market mechanisms: Policy mechanisms to support the large-scale deployment of Carbon Capture and Storage (CCS). OGCI.
[68] Rogelj, J., D. Shindell, K. Jiang, S. Fifita, P. Forster, V. Ginzburg, C. Handa, H. Kheshgi, S. Kobayashi, E. Kriegler, L. Mundaca, R. Séférian,

shorter-lived storage options.[69] Oil- and gas-producing countries are well endowed with geological sinks.

- For some energy-intensive hard-to-abate sectors such as steel and cement, technical options to reduce emissions without CCUS are currently limited. Given that energy-intensive industries are at the heart of the industrialization and development strategies of many hydrocarbon-rich countries, CCUS is an essential technology to decarbonize and maintain the competitiveness of these sectors in a world with carbon taxes.
- This is a sector where some exporters could establish a clear comparative advantage and contribute to emissions reduction given their geological storage capacities and access to depleted fields, existing infrastructure, and the expertise built over the years.
- Finally, as noted by Allen et al.,[70] policies aimed at controlling emissions, for instance by limiting consumption or extraction of hydrocarbons reserves, are economically intrusive and do not constitute a solution on their own. The authors also argue that 'policies focused on emission rates make tension between growth and climate protection seem inevitable,' especially in oil and gas exporters and developing countries that rely on hydrocarbons to fuel their economies.

Why investment in CCUS remains limited in oil- and gas-exporting countries

If CCUS is essential to reduce emissions, and if it needs to be an integral part of low-carbon strategies for exporters, a key question is why investment in CCUS remains limited, particularly in oil- and gas-exporting countries. According to the International Energy Agency, the world has 22 large commercial CCUS facilities with capacity to capture only 40 to 50 Mt CO_2 each year, with most of these projects located in developed economies.

Failure to lead on the CCUS front could risk undermining the position of oil and gas exporters. It is of strategic importance for large oil and gas reserve holders either individually or as a group to implement more projects to prove CCUS technology at scale, reduce its cost, and develop sustainable business models. This would help to decouple the growth of demand for oil from the growth of emissions. While such capital outlays reduce the return on existing projects compared to the current default strategy of exporting unabated oil and gas, such investments can de-risk the current source of revenue and trigger the development of new skills and capabilities. Alongside diversification, this could constitute an additional strategy to manage the low-carbon transition. In fact, given the poor record of diversification in most oil- and gas-exporting countries, such investments may prove to be more effective.

If the cost of CCUS projects is too high and if it is shifted to producers alone, the returns of such a strategy can be low, reducing the incentive to undertake CCUS projects. Thus, if CCUS is to emerge as a key mitigation strategy, costs need to be spread if oil- and gas-exporting countries are to play a role in contributing to its development. So far, many of the CCUS projects in oil- and gas-exporting countries have been implemented through national oil companies and state-owned enterprises.[71] But this model may not be sustainable given the competing needs for funding from other sectors and the need for scaling up CCUS. Also, not all oil and gas exporters have the technical capacity and expertise to build CCUS projects. Thus, the challenge is how to put in place frameworks and business models that allow for the large-scale deployment of geological CO_2 storage to become profitable.

Pricing GHG emissions through mechanisms such as carbon taxes and ETS are considered the economically most efficient way to correct for the externalities associated with climate change.[72] However, carbon taxes and ETS are not sufficient to induce investment in geological storage, given the relatively low and volatile carbon prices which do not compensate for the upfront costs and don't provide long-term certainty for investors. Most of the CCUS projects implemented have received government

and M.V.Vilariño, 2018: Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]

69 The Oxford Principles for Net Zero Aligned Carbon Offsetting, 2020. https://www.smithschool.ox.ac.uk/publications/reports/Oxford-Offsetting-Principles-2020.pdf

70 Allen, Myles R., David J. Frame, and Charles F. Mason. 2009. 'The case for mandatory sequestration?' Nature Geoscience 2: 813-814.

71 IEA, 2021. Financing Clean Energy Transitions in Emerging and Developing Economies, IEA: Paris.

72 See for instance, Edenhofer, O., and A. Ockenfels. 2015. 'Climate Policy at an Impasse'. In Global Carbon Pricing: The Path to Climate Cooperation, 2017, edited by P. Cramton, D. J. MacKay, A. Ockenfels, and S. Stoft. Cambridge, MA: MIT Press.

grants in the form of direct capital injection or tax credits, and/or have created value by using the sequestered CO_2 for enhanced oil recovery.

If CCUS is an integral part of meeting the Paris targets as well as an important strategy for increasing the resilience of the oil and gas sector and extending the life of oil and gas in the energy mix, then a multilateral system based on existing carbon pricing mechanisms alone limits the contribution of oil-and gas-exporting countries in climate mitigation and reduces the competitiveness of key sectors of their economies in a world transitioning to net-zero emissions. Thus, there is an increasing recognition that innovative mechanisms are needed to overcome this challenge.

Specifically, so far, there is no well-defined policy framework in place which recognizes that storage of carbon/CO_2 has a value. This disincentivizes investment in carbon sinks and creation of effective burden-sharing mechanisms. So far, most of the focus of the climate change policy discussion has been on demand-side policies which assign value to emission reduction. To incentivize investment in CCUS projects, such instruments should be complemented by policies that assign value to CO_2 storage which is separate from emissions reductions. Carbon storage units (CSUs) can play such a role.[73] Here the focus would not be on reduced emissions but rather on the CO_2 securely stored in geological sinks. For every ton of CO2 committed to storage, the companies/countries could obtain a storage certificate which could be used towards meeting climate change obligations or traded. The generation of CSUs and their trading could be integrated into a multilateral system taking advantage of the mechanisms under Article 6. An appealing option is that through generating CSUs, oil producers could offset the emissions of the oil they produce at the consumer's end (Scope 3 emissions).

Several proposals have been suggested to address the burden-sharing problem. Some elements of these proposals are worth highlighting.

First, not all countries have a strong incentive to support CCUS, and therefore there have been suggestions to create clubs of like-minded countries that have a strong interest in developing the technology (for instance, those countries that are highly dependent on hydrocarbons) and have the financial and technical expertise to enable CCUS as a mitigating technology. Article 6.2 of the Paris Agreement allows for such agreements.

Second, only a few countries have made explicit reference to CCUS as part of their nationally determined contributions (NDCs). To promote CCUS, the Clean Energy Ministerial recommends as one of its key financing principles for governments to consider 'CCUS as part of their Nationally Determined Contributions (NDC) under the Paris Agreement' and include CCUS under Article 6, as this 'will encourage novel CCUS financial and cost-sharing mechanisms that benefit both developed and developing countries, helping to meet their NDCs'.[74]

The challenges in creating value for CO_2 storage and integrating the concept into multilateral and regional mechanisms are various. But this should not preclude negotiators in COP 26 from proactively supporting and shaping an international mechanism to make large-scale storage in geological sinks financially viable. Oil and gas exporters will have to share part of the cost of reducing emissions, but the hope is that these costs will decline over time as the technology scales up. Innovative mechanisms are needed to enable oil and gas exporters to play a more decisive role in the global low-carbon transition.

[73] Zakkour, Paul, and Wolfgang Heidug. 2019. "A Mechanism for CCUS in the Post-Paris Era: Piloting Results-Based Finance and Supply Side Policy Under Article 6" KAPSARC Discussion Paper, April.
[74] See Clean Energy Ministerial's (CEM) 2020. 'Key Financing Principles for Carbon Capture, Utilization and Storage',

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