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HOW TO ACHIEVE THE ENERGY TRANSITION IN A GLOBALIZED, CAPITALIST AND GROWTH DRIVEN WORLD? A CRITICAL REVIEW OF THE COP 26 DECISIONS REGARDING THE ENERGY SECTOR TO PRESERVE THE ENVIRONMENT IN AN INCLUSIVE AND SUSTAINABLE WAY.

Research paper

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Acknowledgment

I certify that I am the sole author of this thesis. Its construction and the ideas put forward are of my own making and do not in any way involve my professors or the university in which I study.

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Abstract

This thesis aims to analyze the commitments of nations in the Glasgow Pact concerning the energy sector. The study takes a critical look at the limits of this type of international governance, whose negotiations are long, subject to power struggles and ideological biases, thus weakening its real impact. We distinguish two levers of action that were plebiscited at the 26th Conference of the Parties to reduce the carbon footprint of energy consumption: technology and "green" finance. These commitments are largely influenced by neoliberal, capitalist, and techno-solutionist ideologies. The objective of these two levers would be to limit the damage of a society at the service of the growth of capital without questioning our development choices. The regulation of markets or measures of sobriety are absent, alternative levers that we will rehabilitate in this article. In order to fuel a debate that was absent at the 26th Conference of the Parties, this work proposes to take a critical look at the proposed levers and their theoretical and practical limits.

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List of Acronyms

IEA: International Energy Alliance

CCS: Carbon Capture and Sequestration

CO2: Carbon dioxide

COP: Conference of the parties

CSR: Corporate Social Responsibility

DFIs: Development finance agencies

ECAs: Export credit agencies

GDP: Gross Domestic product

GFANZ: Glasgow Financial Alliance for Net Zero

GHG: Greenhouse gas

GTP: Global temperature-change potential

GWP: Global warming potential

ICTs: Information and communication technologies

IPCC: Intergovernmental panel on climate change

MDBs: Multinational development banks

MBI: Market Based Instrument

NDCs: Nationally determined contributions

PFIs: Public finance institutions

UN: United Nations

UNFCCC: United Nations Framework Convention on Climate Change

USD: United States Dollars

Introduction

« Alors que l'idéologie du Progrès de l'âge industriel prétendait, de Saint-Simon à Lénine, édifier une société radieuse en faisant table rase de la tradition, notre avenir ne semble aujourd'hui jamais avoir autant dépendu du passé. »

Christophe Bonneuil, 2017, historien des sciences.

« Il n'existe pas de technologies ni d'objets durables en soi : seuls les modes de vie peuvent l'être. »

Niko Paech, 2016, économiste allemand.

Each international climate summit is an opportunity for scientific experts from all around the world as well as organizations such as the Intergovernmental Panel on Climate Change (IPCC), the World Resource Institute or Climate Watch to remind us that we need to rapidly reduce global greenhouse gas emissions to prevent or at least mitigate a severe climate change. However, the proposals that emerged from the two weeks of international negotiations at the Conference of the Parties 26 (COP 26) seem insufficient to many. Climate ambitions are held back by the reality of production, consumption and capitalist approaches. Multinationals and investors are still seeking to maximize their individual profits with little or no integration of negative externalities, public actors are subordinated to lobbies that drain the substance of laws and binding proposals for the benefit of private interests and civil society is calling for a more ecological and egalitarian society without reaching agreement on a deep questioning of the frenetic consumerism that has taken hold of it.

Since the signing of the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, the UN has met every year at the Conference of the Parties (COP) to define objectives to reduce anthropogenic impacts on the planet, in particular those affecting the climate. December 12, 2015, the Conference of Parties resulted in the signing of the Paris Agreement[1], the primary goal of which is to limit global warming above 2°C and ideally above 1.5°C compared to the pre-industrial era's average temperature. To do so, the Parties seek to achieve carbon neutrality by 2050. To meet these objectives, nations and their industries must imperatively and drastically reduce their greenhouse gas emissions (GHG). Nations are required to individually establish, communicate, and follow an emissions reduction plan called

[1] The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris on December 12, 2015 and entered into force on November 4, 2016.

"Intended Nationally Determined Contribution" (INDC) and are supposed to reinforce these contributions every 5 years. According to the UNFCCC, the implementation of all the revisions of these contributions, when it has taken place at 30 July 2021, leads to a 16% drop of emissions in 2030 relative to 2010th levels[2]. At the same time, the IPCC[3], an organization of governments that are members of the United Nations or the World Meteorological Organization and which synthesizes the work of many scientists reporting on the impacts of human beings, or rather human activities on the planet, estimates that this decrease must be -45% compared to its levels in 2010 to achieve the 1.5°C goal. This is without taking into account the forest fires that the Amazon and Australia suffered in 2020, which contribute to GHG emissions and the degradation of biodiversity, as well as many emissions that slip through the cracks of the calculations. It is urgent that governments and companies consider the negative impacts their mode of operation has on the climate and nature, and act accordingly to prevent them.

The COP26 which was held in Glasgow from October 31 to November 12, 2021 reaffirmed the ambition to keep the climate objective of the Paris Agreements achievable. To do so, countries are invited to redouble their efforts to abandon fossil fuels, reduce deforestation, decarbonize their production, consumption, travel and more generally their lifestyle. The Parties are encouraged to stimulate investments in these transitions and in adaptation to climate change.

The capacity of humankind and its activities to transform the planet is nowadays commonly admitted. And rather for the worse. The choice of vocabulary used to designate human impacts on the planet and possible futures is important because it implicitly imposes a more or less direct and integral responsibility on humanity as well as a more or less radical conception of the necessary changes and challenges to the dominant system. In 1995, the Nobel Prize in Chemistry Paul Crutzen popularized the concept of the Anthropocene to informally designate a geological epoch succeeding the Holocene[4]. The Greek roots of this term refer to the central role of Man, the *anthropos*, in the climatic and environmental upheavals affecting the entire planet and accompanying the development of humanity (Hamilton, 2016). Earth-system scientists adept at this theory consensually position the beginning of this period from which

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[2] Data from the UNFCCC NDC Synthesis Report 2021 [Online].

[3] The IPCC reports, in particular the third part of the Sixth Assessment Report, *Climate Change 2022: Mitigation of Climate Change, the Working Group III contribution* finalized on 4 April, are regularly cited in this essay. Indeed, the IPCC provides the most complete and current state of the art of climate change and its implications on the earth and on societies. The last report constitutes a robust literature review concerning the global assessment of climate change mitigation progress and pledges, the sources of global emissions, and the impact of national climate pledges in relation to long-term emissions goals.

[4] We are still officially in the geological period of the Holocene which began about 11,700 years ago following the Würm Ice Age.

humanity became a major geological force, although difficult to identify, around the first industrial revolution 250 years ago (Dubois, 2016). Debates about the beginning of this era emerge, depending on the field of study, the objective pursued, or the conception of the contemporary environmental crisis. This period can thus begin with the appearance of Homo Sapiens as well as at the end of World War II, but we will not linger on it because, as Hamilton suggests, these discussions "*disorts and dilutes the message and the implications of the Anthropocene*" (2016, p.251).

More than an impact on its environment, something that human beings have been producing for millennia, the Anthropocene as perceived by socio-economists and part of the earth-system scientists wants to establish a break with previous geological periods by identifying human forces as competing with the forces of nature themselves and influencing them. Whereas in their seminal paper, Crutzen and Stoemer symbolically began the Anthropocene in 1784 - the year of the invention of the steam engine - to emphasize the role of the industrial revolution in bringing about the end of the Holocene ; the semantics of the term "Anthropocene" suggest that humanity, an abstract and timeless form comprising all of the earth's inhabitants, is producing changes in the environment to ensure its development. The beginning of the period and its causes, diverging from one discipline to another, can lead to the interpretation of the Anthropocene as a long process of environmental transformations and degradations linked to human nature. The focus is on individual behavior and each individual is invited to question his or her way of life, obscuring the climate impact of multinationals and the wealthy, as well as the unequal national and regional contributions to environmental degradation (see Annexe 1). This interpretation runs the risk of ignoring the role of the economic system in which human activities are anchored and the systemic nature of these degradations.

McNaill, in his attempt to provide a global inventory of the relationships between society and their environments (2010), admits that environmental damage has occurred over a very long period of time, but insists on the radical break that took place in the 20th century. The conversion to a system based on fossil fuels, coupled with strong demographic growth and the pre-existing desire for strong economic growth, caused a *great acceleration* of environmental degradation. In order to focus more precisely on the implications of contemporary human activities on the planet, i.e. pressure on natural resources, unprecedented levels of pollution, deforestation, biodiversidy’s erosion, disruption of ecosystems and many others, we prefer the concept of Capitalocene.

Capitalocene is a neologism of the Anthropocene inspired by Marxian and heterodox thinking, used by Jason W. Moore in 2015 to shift the responsibility for the global ecological crisis and global warming, and thus viewed through the prism of humanity as a whole, to the capitalist system and the advent of Western "modernity". Indeed, the concentration of CO_2 in the atmosphere (measured in parts per million: ppm) has been increasing since 1800 when it was at 285 ppm to reach 412.3 ppm by January 1, 2020. It had never exceeded 285 ppm before 1800. According to the projections based on the 8.5 "business as usual" scenario of the IPCC, i.e inertia of the political, technological, economic and demographic choices, it would rise to 720 ppm by the end of the century[5]. By assimilating the degradation of the environment to capitalism, the focus gets clearer. It is no longer a question of concentrating on the contemporary period and its excesses but of understanding the historical roots of the exploitation of nature, and moreover also of mankind, leading after five centuries of economic, social and technological transformation to an unreasonable exploitation of planetary resources with the consequences that we know.

Beyond the geological aspect related to the name of the period we are in, the semantics used reveals the way of conceiving the origin, or origins, of environmental degradations and thus the possible levers to prevent, mitigate and restore them. By highlighting the capitalist origin of global warming, it becomes clearer that such an economic system is not sustainable, and that a paradigm shift is needed to design truly effective solutions. It illustrates the incompatibility of respecting the objectives of the Paris Agreements with the persistence of productivism, mass consumption, exploitation of resources, and the monopolization of profit by certain fractions of the population. Although the concept of Capitalocene has its semantic weaknesses, such as the fact that it masks pre-capitalist forms of resource exploitation or those stemming from other ideologies, it seems to me to be the most relevant concept for questioning the dominant system and for taking a critical look at the responses given to current social and environmental issues.

The recognition in recent decades of the urgency of climate change and the impact of human activities on the degradation of our planet has given rise to a variety of responses from governments, businesses and civil society. International initiatives are multiplying to set targets to limit or compensate for greenhouse gas emissions, global warming and the destruction of biodiversity. The environmental COPs on climate change are by far the most anticipated and

[5] Projections established by *notre-planete.info* [En ligne], "Concentrations en CO2 dans l'atmosphère : statistiques", viewed on 21/04/2020.

mediatized international meetings on the subject as public concern grows. Indeed, the consensus of the IPCC scientists is increasingly known by the general public: Humanity is at a critical point for its future, and it is up to us to ensure that it is viable, sustainable and inclusive.

The aim of this work is to analyze from a heterodox point of view the decisions adopted (and the missed opportunities) during the COP26. The subject is dense if one wants to address all aspects of international governance coupled with the ecological transition since it raises many interconnected issues such as climate and ecological justice, lobbying, new technologies and digitalization, the transition to renewable energies, development models and business models among others. I will therefore focus on policies and objectives concerning the energy sector. I also wish to place my vision in line with those for whom the decisions taken at these intergovernmental meetings too often avoid questioning the capitalist, neo-liberal and financialized system, by pursuing instead an ill-considered and inequitable development which is showing its limits. In the words of Alexandre Monnin (2022), we need to move towards a general economy of sobriety because we cannot grow indefinitely in a finite world. However, these scenarios remain marginalized and are not explicitly discussed in the public sphere, as was the case at COP26.

This essay will therefore attempt to explain the decisions of the Glasgow Pact, adopted at COP 26 by the nations, which aim to reduce the climate impact of the energy sector and to analyze its justifications and repercussions.
First, we will present and critically examine the Glasgow Pact and the framework it provides for taking into account the impacts of human activities, since it influences the commitments that result from it, the proposed levers of action and the resulting outcomes (I-A). In the same spirit, we will then look at the energy transition’s engagements in the Glasgow Pact (I-B).
On reading these commitments and the related Agreements, two pillars appear to me as fundamental in the eyes of the international community to allow the transition from our globalized capitalist economic system dependent on energy that emit large amounts of GHG to a system compatible with the commitments of the Paris Climate Agreements: technological progress and the redirection of finances towards low-carbon energy sources. However, each of these pillars raises questions concerning the planetary and human limits of the advent of tomorrow's capitalist society, which one would like to see as ethical, innovative, decarbonized and fair. This is why we will try to raise these questions in order to analyze the beliefs and the coherence of the commitments made in order to reduce the environmental impact of our energy

consumption with the calendar established by the IPCC. I will then explore their theoretical origins, their expected effects and the underlying ones.

Through a comparison of the organizations' commitments at COP26, their scope, and their implementation, we will analyze the limits of the first pillar of action concerning the financial lever of the energy transition. It will be subdivided into an analysis of the commitments of private financial actors and a critique of neo-liberal "laissez faire" (II-A) and a presentation of public financial support for fossil fuels that limits the scope and coherence of the commitments made by the Parties (II-B).

We will then take a critical look at the second pillar which is the technical lever through a review of neo-classical and heterodox theories and the reflections that follow (III-A). Finally, we will present its practical implementation through the example of the electric car, which has been praised by the industrialized countries during the COP26 as a way to decouple the transport sector of its induced emissions (III-B).

I. The energy transition in the Glasgow pact

First of all, it is important to remember that while anthropogenic emissions and their consequences on climate are at the heart of the debate, ocean acidification, water scarcity, desertification of regions of the world or the extinction of biodiversity appear as subaltern problems. National governments and the international community are concerned about the threats that climate change poses to ecosystems across the spectrum of its consequences on socio-economic systems. Article 2 of the UNFCCC particularly highlights this view by emphasizing that the ultimate objective of the Convention and all related legal instruments is to stabilize the concentration of GHGs in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, and that this level should ensure that food production is not threatened and enable economic development to proceed in a sustainable manner (UN, 1992).

A focus on greenhouse gas emissions and their direct consequences for economic and social development reveals the fragmented and utilitarian view of the environment by humans. Many scientists and ecological economists have highlighted the interconnections and interdependencies between ecosystems and elements within ecosystems that do not allow us to remedy the climate crisis without including the fight against pollution and ocean acidification, against deforestation, soil degradation or the protection of biodiversity. We know in particular that ocean water and photosynthesis of terrestrial plants contribute greatly to the dissolution of

CO2 in the atmosphere. Taking into account the consequences of human activities on the planet is reductive because it is anthropocentric. However, we note that the importance of protecting and conserving all ecosystems in order to achieve the objectives of the Paris Agreement and, more generally, the links between climate and biodiversity are finally clarified in the Glasgow Pact (paragraph 21). This inclusion is the largest to date in a final UNFCCC COP decision, which suggests a growth in the policy corpus' consideration of ecosystem and climate interconnections, particularly through the work of scientists (IDDRI, 2021).

However, the primary objective, hammered out by the Presidency and many participants at COP26, remains focused on mitigating global warming through the prism of GHG emissions. To do so, Alok Sharma, the president-designate of the COP26, designates the exit from fossil fuel and the phasing out of polluting vehicles as the biggest policy decisions, followed by the development of a more sustainable agriculture, the tackle of deforestation to reach "net zero" emissions, and financial support among developing countries (COP26 outcomes, 2021).

A. Overview of the Glasgow Climate Pact and its limitations in reducing anthropogenic emissions

The objective explained throughout the COP 26 is to keep the long-term objective of limiting global warming to 1.5°C compared to the pre-industrial period and to adapt to the consequences of climate disruption that are already present or will be in the coming years. The two-week meeting of the 197 signatories of the UNFCCC in Glasgow resulted in the drafting and adoption of the Glasgow Pact by them (see Annex 2). This agreement is limited to a list of the Parties' recognition of a certain number of environmental and social issues and the responses to be provided. First, it recognizes the impact of human activities on the planet, in particular concerning GHG emissions, the destruction of biodiversity and the global warming of 1.1°C that they have caused to date. It also highlights the human development goals outlined in the 17 Sustainable Development Goals (SDGs)[6]. The need for coordinated and multi-scalar actions, based on local knowledge, and the urgent need to develop financial support for developing countries are also mentioned in these agreements. Finally, it emphasizes the efforts to be made

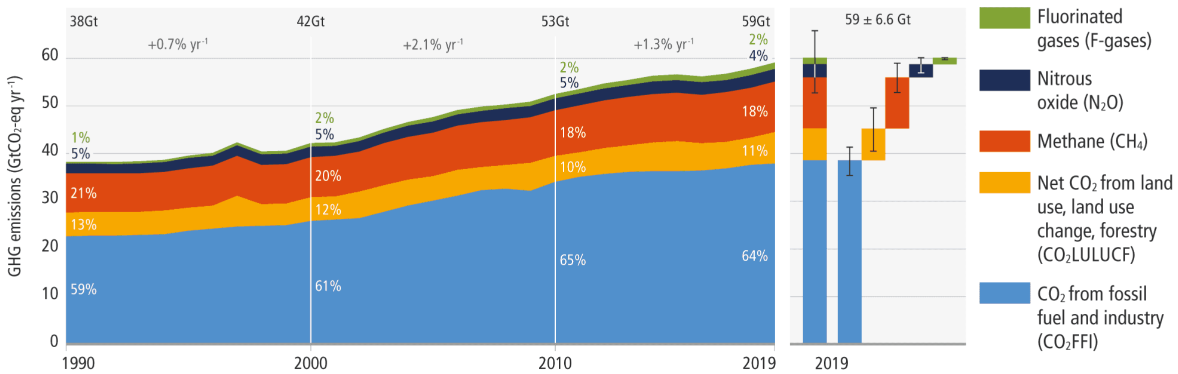
[6] The Sustainable development Goals are seventeen goals established by the member states of the United Nations and which are gathered in the 2030 Agenda adopted by the UN in September 2015. They bring together 169 targeted objectives common to all countries on topics such as hunger, health, education, justice, gender equality, access to water, decent work, clean energy, the development of local and sustainable industries, sustainable cities, and the protection of biodiversity.

in the development and dissemination of technologies to mitigate GHG emissions and above all to adapt to climate change, as well as the efforts to be made to finance them.

1. CO2 emissions, the only quantified target of the Glasgow Pact

The reduction of GHG emissions, through the CO2 emissions channel, remains the only quantified and dated objective of the pact. More precisely, it is to decrease "*45% of global carbon dioxide emissions by 2030 relative to the 2010 level and to net zero around mid-century*" (Glasgow Climate Pact, 2021, p.3). This figure appears in line with the last IPCC working group report which establishes in the scenario C1 that limiting global warming below 1.5°C in 2100 with a greater than 50% probability would require a reduction of 34% to 60% of the GHG emissions by 2030 followed by a deeper reduction by 2050 to reach net zero CO2 emissions (see Annex 3). However, we can notice that a difference persists between the scientific recommendations concerning all GHGs and what appears in the Glasgow pact focused on CO2. Indeed, according to the last IPCC report, all the groups of greenhouse gasses have grown during the last century, as we can see on the figure below. These include carbon (CO2), methane (CH4), nitrous oxide (N2O) and fluorinated gasses (F-gas).

Figure 1: Global net anthropogenic GHG emissions, 1990-2019



Source: IPCC AR6 WGIII

The impacts of each group of gasses on the greenhouse effect and their lifetimes in the atmosphere vary. CO2, which has an atmospheric lifetime of about 100 years, is the most emitted by humans, accounting for 75% of total anthropogenic GHG emissions according to the latest IPCC estimates. This quantity may be at the origin of the international community's focus on carbon dioxide reduction; its origin essentially from the combustion of fossil fuels and, to a lesser extent, from agriculture and deforestation, justifies the transition from fossil fuels to renewable energies as the main line of action to reduce its emissions. However, it is not the most dangerous gas for the environment, as demonstrated among others by the study of Gasser *and al*. (2017). The table in Annex 4 shows that the Global Warming Potential (GWP) - including feedback effects of emissions - is 96 times higher than the GWP of CO2 for methane, and up to 17700 times higher for sulfur hexafluoride, a fluorinated gas[7]. It is therefore imperative that the international community takes an equal interest in these issues and that the recognition of their destructive effects as well as actions to reduce GHG emissions concern all emitting sectors.

We can notice that the latter are briefly mentioned in the Glasgow Pact to *invite* the parties to *consider* actions to reduce GHGs other than CO2 by 2030, without any quantified objective being mentioned (paragraph 19). A turn of phrase that does not bode well for immediate action when the global warming potential, global temperature-change potentials (GTP) and lifetimes of the emissions other than CO2 are worrying to keep possible the goals of the Paris agreement without considering their drastic reduction.

However, it is notable that methane is for the first time the subject of multilateral agreements at COP 26, as 111 countries have joined the Global Methane Pledge and committed to reduce global methane emissions by 30% by 2030 compared to 2020. Methane is the second most emitted type of GHG by human activities and accounts for 18% of GHGs. It comes in particular from the oil and gas industries, waste and agriculture. But although its lifetime in the atmosphere is 10 years, which is much less than CO2, we have seen that its warming potential is almost 100 times higher. Its effects on temperature change is also 65 times higher than that of CO2 (Gasser and al., 2017), making it responsible for about half of the net rise in global average temperature since the pre-industrial era according to the 2021 IPCC report. Six of the world's top ten methane emitters - the United States, Brazil, the EU, Indonesia, Pakistan and Argentina - are signatories to the Global Methane Pledge. Depending on their local characteristics, these countries should reduce methane leaks linked to the exploitation of fossil fuels (coal, oil and natural gas), regulate open-air landfills by covering them, for example, and reduce final waste by relying on more circular industrial processes or on a reduction in the

[7] Actions have already been taken to limit the emission of F-gases into the atmosphere, which have very high GTP and GWP. The amendment to the Montreal Protocol added during the meeting of the Parties in Kigali in 2016 and aiming to eliminate by 2050 hydrofluorocarbons (HFCs), of the F-gas family, has been ratified by 114 countries and is legally binding. It then imposes progressive reductions in the consumption and production of HFCs, with differentiated timelines for each country, including banning or restricting trade in controlled substances between countries that have ratified the protocol or its amendments and states that have not yet ratified it, and an agreement by rich countries to help finance poor countries' transition to safer alternatives (UNEP, 2016).

production that leads to waste. A last axis should be devoted to the implementation of industrial and public policies in order to switch back to grass-fed and free-range feeding of livestock, to reduce the breeding of ruminants and consequently the consumption of meat[8]. However, this axis only appears marginally because it challenges the "modern" lifestyle of consumer societies initiated by the West and threatens the interests of the industries in the sector. Experts agree that many solutions already exist and that technological knowledge is sufficient to implement immediate actions and regulations to strongly reduce methane emissions in the coming decade, which will be necessary to limit global warming to 1.5°C (Lauvaux and al., 2022; RAC, 2017; UN News, 2021). However, this agreement is based on voluntary initiatives by the signatories, it is not legally binding and some of the most methane-emitting countries, notably China and India, are not part of it.

The COP 26 has provided the official recognition by the international community of the need to reduce GHG emissions based on scientific data. However, it ignores some of these and focuses more specifically on CO2 for which the targets are quantified and accompanied by an agenda. Alok Sharma stated that the translation of the commitments formulated in the Glasgow pact into rapid action would weakly keep the climate objective of limiting warming to 1.5° alive. A statement that the head of the UN does not share, however. The doubts about the implementation of these objectives are echoed by the scientific community, the latest IPCC report having recently pointed out the insufficiency of the current national pledges taken under the Paris Agreements to limit warning to 1.5°C with no or limited overshoot. Part of those limits reside in the incompleteness of policies regarding GHG emissions. Indeed, the report notes that there is a lack of coverage of gasses other than CO2, that even for the latter it is necessary to diversify the sectors concerned, currently focused on the industrial process, and that the levers of action - via the establishment of a price for CO2 emissions on carbon markets and the focus on the energy sector - are insufficient. We will explore further the limitations in the energy sector

[8] Total methane emissions from global livestock production account for about 6.4% of all anthropogenic GHG emissions. In terms of activities, feed production and processing (which includes land use change) and enteric fermentation of ruminants are the two main sources of emissions. According to the Food and Agriculture Organization of the United Nations - https://www.fao.org/news/story/fr/item/197623/icode/

2. Limitations of international COP governance methods

As the Glasgow Protocol is not legally binding, it does only rely on voluntary initiatives from the Parties to set up the actions needed to cut off their emissions. Even if it was indeed “legally binding” as the Paris Agreements before him, the compliance would have only relied on peer pressure[9]. An international treaty and a COP decision do not have the same legal consequences. International law obliges Parties to respect the commitments made in an international treaty and generally subjects it to a monitoring regime. It is binding in the sense that a set of measures are designed to constrain the recipient of the binding treaty norm (Laville, Thiébault and Euzen, 2015) whereas no verification or sanction measures accompany COP decisions. The COP's "pledge and review" approach relies on voluntary and revisable pledges over time, and while these provide incentives to guide and program actors' behaviors, the magnitude of reductions pledged so far will not meet the 2°C goal (IPCC, 2022). Since the birth of GHG emissions negotiations more than 20 years ago, we have not seen a decline in emissions. Amy Dahan (2014) argues that the top-down model of climate governance does not lead to effective greenhouse gas reductions because it focuses on the global management of emissions, subject to political influences and national interests. This conception of the climate governance obscures the social and local characteristics of GHG that require a multiscalar treatment. Moreover, by focusing on emissions alone, it marginalizes the questioning of the foundations of our contemporary industrial economies, the activities of production, consumption, transport and leisure that are dependent on fossil fuels and at the origin of emissions. It would be necessary to go even further than the questioning of these daily activities and to question the entire contemporary economic system - capitalist, financialized and globalized - including a reflection on monetary issues, the conception of debt and their respective roles, the financial system, its purpose and implications, remuneration systems, territorial planning, national and international governance, etc.

While the actual scope of COPs is questionable, this does not preclude them from being major international gatherings on environmental and climate issues and arenas for the exchange of

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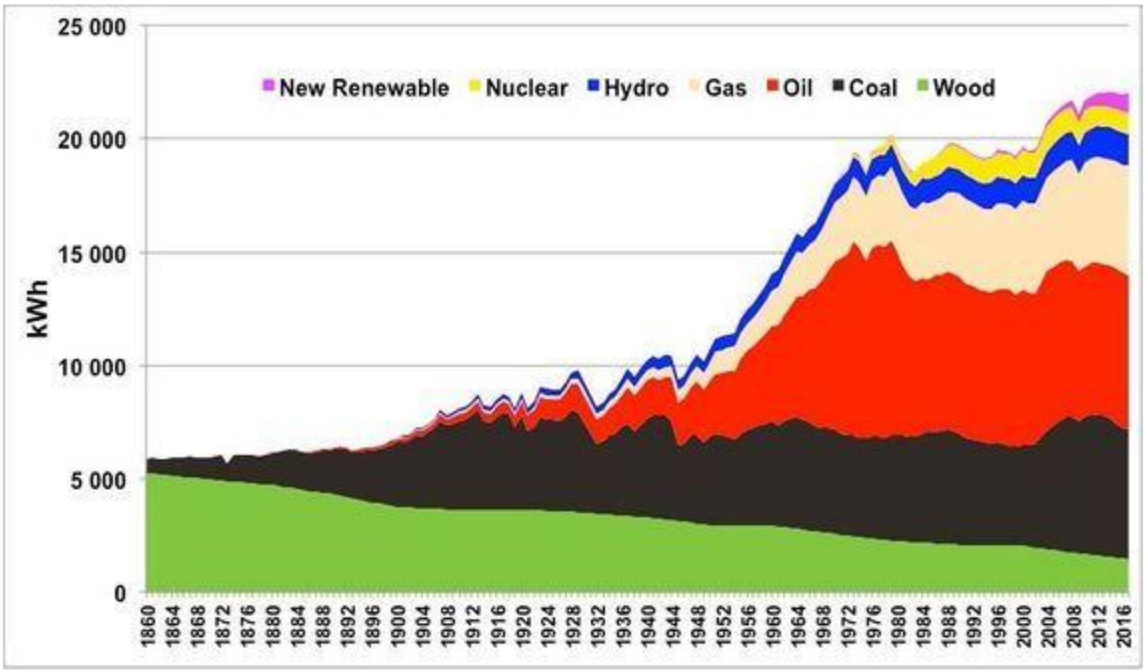
[9] According to some experts on the subject, the degree of liability of the Paris Agreements is limited since “*the treaty itself has few legal teeth. It does not impose penalties, such as fees or embargos, for parties that violate its terms, and there is no international court or governing body ready to enforce compliance*”. It appears that “*Countries are only expected to create increasingly ambitious goals for cutting emissions; technically, however, they can revise their NDCs in any direction without being tossed out of this global project.*” In *World Economic Forum* [Online] « Is the Paris Climate Agreement Legally Binding? Experts Explain ». Published the 22/11/2022, Consulted the 13/04/2022

scientific and economic knowledge, expertise, and local experiences to guide global decisions toward a sustainable future. They allow for the coordination of loss, damage, and risk calculations, and facilitate regional and international dialogues to coordinate responses (Warner, 2013). These faculties also have their weaknesses, including making it more difficult for alternative scenarios to emerge and for critics of previously employed methods to be accepted. As a result, we will see that the outcomes of COP 26 concerning the energy sector are not particularly significant as dependence on fossil fuels is high and a decrease in its use appears compromised.

B. Energy, a key factor in the fight against CO2 emissions.

While the climate crisis is the main environmental issue for political decision-makers, the ecological transition of the energy sector is rapidly becoming a frontline topic. And for good reason, between the beginning of the Capitalocene era and the year 2000, energy consumption (biomass, coal, hydrocarbons, uranium) has increased by a factor of 40 and has never stopped increasing since. If humanity has always consumed energy, especially biomass and coal since the eleventh century in China and Europe to ensure its survival and development (Bonneuil and Fressoz, 2015), the industrial revolutions mark a shift in the increase of its consumption but also in the nature of energy consumed and the impacts it generates. Indeed, we can see on the figure below that the last two centuries are marked by a strong growth in the use of coal, then oil and gas.

Figure 2: Change in energy consumption per capita, global average, 1860-2016.



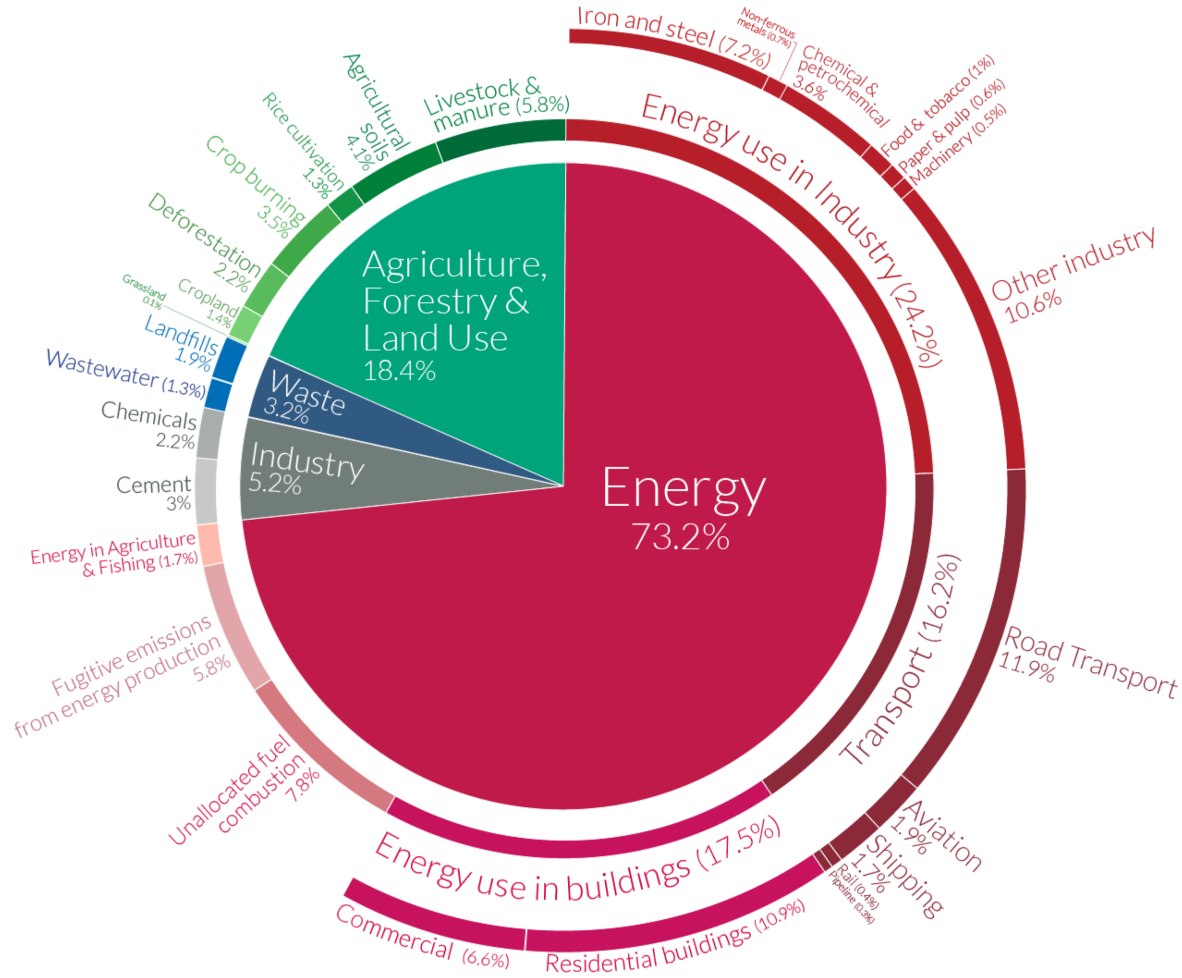
Note : All these energy sources have been stacked on top of each other: at no time have we committed large-scale substitution by replacing just one with another.

Source: Jancovici, 2015.

The IPCC, counts an increase of more than 30% of CO2 in the atmosphere since 1850, significantly intensifying the greenhouse effect and their latest report presents industrialization as the link between the humanity development path in recent history and the rise of GHG emissions. It seems clear that the massive industrialization of Western countries was the starting point of the Capitalocene era. In order to achieve the goal announced in the Glasgow Pact, the historically industrialized countries, but nowadays the vast majority of the countries in the world through their inclusion in the global value chain, have to question the production processes of many sectors and the consumption of certain resources as well as the lifestyles resulting from a development path that industrialization and the capitalist socio-economic system have generalized.

The diagram below shows the sectors with the highest GHG emissions. We can see that almost three-quarters of emissions come from energy use; almost one-fifth from agriculture and land-use; and the remaining 8% from industry and waste. Given a close look at energy use, we find that 24% of the energy’s émissions come from the industrial sector, the rest of it being shared between the powering of transport activities and the energy used in private and commercial buildings (Ritchie & Roser, 2020).

Figure 3: Global greenhouse gas emissions by sector in 2016



Note: Global GHG emissions in 2016 were 49,4 billion tons CO2eq.

Source: OurworldinData.org

Reducing these emissions has become a heavy political issue since it asks for an international coordination that adapts both consumption and production to a more sustainable way of life that takes into account the limited resources of the planet.

Given the size of the contribution from the energy sector to global GHG emissions, many solutions are needed on both the supply and demand sides. Moreover, the entire economies depend on the energy systems and its demand is expected to grow as 3 billion people still lack access to essential modern energy services (WBGU, 2011) and that the world continues to follow a capitalist growth path based on fossil fuels consumption. The transformation of the energy domain and the redefinition of energy needs in all sectors and at various scales is crucial. Yet the Glasgow Pact only briefly mentions the energy sector, which appears in paragraph 20, calling on the Parties to accelerate the energy transition to low-carbon systems. This paragraph refers to the attention that countries must give to technologies and policies to support the transition, as well as to the progressive reduction of the use of energy from coal and the progressive elimination of inefficient subsidies for fossil fuels. Finally, the paragraph discusses transition-integrated justice, which must be accompanied by support for the most vulnerable.

We will look in more detail at the implications of the parallel initiatives that countries have engaged in to support the statements in this paragraph. We will focus our attention on the two pillars, technological and financial, mentioned in the introduction and which are revealed in this paragraph of the Glasgow Pact in order to confront them with the appropriate theories supporting, or on the contrary criticizing, the choices made.

II. The limits of the financialization of the energy transition: profits and dependence on fossil fuels

Energy is omnipresent in our lives: to light, to eat, to provide care to all, to produce goods and services, to move, to dress, to communicate, etc. The materialistic and hedonistic Western lifestyle initiated by the historically industrialized and capitalist countries has spread across the globe, constantly pushing for increased energy consumption. Figures 1 and 2 previously presented illustrate this uninterrupted growth, driven in particular by the use of fossil fuels, and the additionality of energy sources. Socio-historical studies have highlighted cycles of socio-energy systems which, as sources change, are accompanied by technological, economic, political and societal evolutions (Dictionnaire critique de l'anthropocène, 2020). The current stage of Capitalocene era corresponds to the contemporary socio-energetic system that relies on the massive use of fossil fuels (coal, oil, gas) and fissile fuels (uranium, plutonium) made possible by the technical developments of the industrial era and an increasingly liberal and globalized market economy. The impact of capitalist ideology on the perception of energy resources and their use by societies can be found both in the modes of production (economic profitability of machines compared to salaried labor, then globalization of value chains for the needs of the development of capitalism) and consumption (dematerialized perception of resources and their ecological and social impacts, material accumulation, overconsumption, inequalities of access and waste), as well as in the social structure of economies (social relations of production and investment) and international relations (balance of power between countries, conflicts over energy resources, geopolitical interests) (Osmer, 2015).

The duration of this cycle is threatened by the finiteness of fossil energy sources, induced by the quantity and speed of energy consumption, but it is especially threatened by their impact on the environment and the continuity of life on Earth as we know it. These two issues make the future of energy consumption worrying as long as we do not reduce its ecological footprint, nor our demand. These questions are at the very origin of the reflection on the Capitalocene era. The progressive awareness of the impacts of capitalist growth by the scientific community and then by political decision-makers and civil society is creating pressure to change the world's energy mix, which is still largely dependent on fossil fuels, in order to counter the scenario of an unprecedented ecological and human crisis. On a global scale, two concordant solutions are emerging to limit GHG emissions from energy. One concerns the supply side, which is what we call the energy transition, and the other concerns the demand side, implying a change in lifestyle and development paths (production, consumption, travel, leisure, etc.). Whatever the scenarios envisaged, both should involve technical and social levers. In international dialogues, in parallel to the issues of energy efficiency and carbon capture (technical levers), and in the absence of a sober or even decreasing paradigm (societal levers), the very origin of energy is presented as an indispensable line of action. Indeed, the IPCC experts underline the insufficiency of measures to mitigate the carbon footprint of fossil fuels in order to respond to the climate emergency and the need to stop using them, or at least to drastically reduce them, in favor of renewable energies.

Renewable energies, in the sense that they are renewable on a human time scale, find their sources in a derivative of natural processes in perpetual renewal. They are diverse and vary according to the classifications chosen, the International Energy Agency (IAE) classifies them into three groups:

- Renewable technologies and sources, electricity alone: hydroelectric, wind, tidal, wave and marine, solar and photovoltaic.
- Renewable sources without stock variation: geothermal and solar thermal.
- Renewable sources with stock variations: industrial waste, urban and similar waste, solid biomass, biogas and liquid biofuels.

Although the primary motivation for switching to renewables is their low GHG emissions, especially carbon, an energy mix that includes 100% renewables will not be free of an ecological footprint. It is necessary to account for emissions over the entire life cycle (from the construction of infrastructures and the necessary materials to their recycling at the end of their use) which, in view of the growing demand for energy, does not allow them to be the only answer. We will see in the third part that at the current rate, the decoupling of material and monetary growth from GHG emissions on a global scale - if at all possible - would not allow us to limit global warming to 2°C (Schröder and Storm, 2018). Moreover, their various accessibility (technological advances, prices, geography), stage of development (public support, R&D, comparative advantages, fossil fuel dependence, lobbying) and relative weight in the economies reveal important contrasts in their consumption and energy mixes at the regional, national and local levels (see Annex 5) .

If we do not know what the future will be made of and what technical solutions it will be able to deliver, we can nevertheless influence it through the financial sector, whose investment choices are decisive for the exit from fossil fuels. The contribution of the financial sector to climate change mitigation, in particular through investments in sectors that are conducive to the ecological transition, was further explored after the 2015 Paris Agreements in order to achieve the stated climate objectives and is still relevant at COP 26. The main objective is to shift capital from fossil fuels to renewable energies to finance their infrastructure, research in this field and their large-scale deployment. This raises the issue of *moralisation du capitalisme* (Lacroix and Marchildon, 2014), which proposes to integrate ethical and ecological principles on which to base economic thinking and decision-making. This gives rise to the development of a branch of sustainable finance based on self-regulation and voluntary disclosures without questioning the functioning of the financial system as a whole (COP 21 Ripple Consortium, 2019). This is to forget that the hypothesis of market efficiency is mixed (as theorized by many economists such as Marshall, Keynes, Robinson, Chamberlain, Stiglitz or Spence) and that expectations take little or no account of climate externalities, giving priority to private economic interests. This last point is clearly demonstrated by the level of financing of the fossil fuel industries by the major banks, which has increased since the signing of the Paris Agreements (Annex 6).

In parallel, the NGO Reclaim Finance highlights the lack of coherence between the policies and timetables announced by financial organizations and the deadlines of the Paris Agreements. The Production Gab report 2021 makes the same observation regarding government announcements and actions. As an example, Fatih Birol, Executive Director of the IEA, and David Malpass, President of the World Bank Group, warn that 300 new coal-fired power plants will be commissioned over the next five years, fueled by the banking and financial sectors and subsidies to meet the economic and social needs of many countries dependent on this energy source (Le Monde, 2021). This is in complete contradiction with what is needed to keep the 1.5°C sustainable, i.e. the cessation of new coal-fired power plants and the decommissioning of existing coal-fired power plants by 2030 in the advanced economies and by 2040 for the rest of the world.

The official mention of a reduction in the use of fossil fuels and the regulation of their financing, at least by the public sector, came very late because of the economic stakes involved. The so-called developing and emerging economies are very dependent on fossil fuels, especially coal, which implies a particular financial support from the States of the North to those of the South to make their energy transitions possible. But apart from these commitments, which are focused on renewable energy development projects in a few regions of the world and which remain subject to the goodwill of States and other donors, national subsidies and financial and banking systems already appear to be powerful levers of action. In particular, they can help to structurally disengage from fossil fuel projects and to tackle the supply and demand of the latter.

The following paragraphs will attempt to explain the place and methods proposed for the energy transition in the Glasgow Pact as well as in the agreements emerging from COP26 from the point of view of the financial flows that support the fossil industries. The aim is to analyze the public and private financial incentives and to reveal the positive and negative points of the COP26 commitments. In particular, we highlight the need to move away from a moralization of capitalism based on the voluntariness of public and private actors and to establish a formal regulation of financial flows and markets.

A. The absence of a questioning of private actors' role and of a regulation of financial markets

Ecosystems were long considered almost independent of the dominant economic system based on deregulated and globalized finance. The development of the dominant neoclassical economic thinking based on the hypotheses of the inexhaustibility of resources (Jean Baptiste Say, 1928) and the substitutability of capital - productive and human, natural capital was not originally included at all and was popularized by Solow in 1992, but still struggles to be integrated into the models - is found at the heart of the major current models and has conditioned for a very long time the general perception of the economy as independent of the environment. From then on, the consideration of natural resources, the environment and their limits did not appear in the "rational" expectations of agents. The neo-classical paradigm based on abstract theoretical concepts that are not correlated to the reality of the world and whose goal is almost exclusively capitalist, i.e., turned towards the accumulation of capital by a fraction of the population, is therefore not sustainable (Keller, 2021).

Financial markets are no exception to the rule. Their existence serves to mobilize the capital in order to make it available to agents who need it. Since that agent with surplus will receive interest and agent in need will be able to finance its consumption, their objectives will be to produce and speculate on intangible financial assets in order to maximize individual wealth accumulation. Environmental and social impacts do not appear in the profit maximization equation, a point made by Milton Friedman (1970) when he defined the sole social responsibility of an organization as increasing its profit. Its operation serves the interests of a minority, to the detriment of the well-being of present and future society. According to Ann Pettifor (2019), deregulated financial markets and the required rates of return have therefore stimulated the extraction of fossil fuels through industrialization, urbanization, motorization and the growth of mass material consumption, driving the growth of GHG emissions. Many continue to look away from the consequences of the financial sector's activities. Therefore, keeping global warming below 1.5°C or even 2°C while meeting the SDGs cannot be done without a commitment from the private sectors to divert investment from polluting sectors to industries that are consistent with these goals.

In line with mainstream economic thinking, the most common solutions are based on self-regulation of financial agents through transparency of activities, their ecological impacts and the financial risks inherent in investing in environmentally harmful activities, and through the integration of a price for negative environmental externalities (taxes, permits, etc.). Other solutions to be explored include the implementation of reglementations and norms requiring the shift away from fossil fuel energy and ensuring that private finance is accountable to green standards, preparing their portfolios for the transition to a net-zero economy and channeling money to developing economies.

Oil, natural gas and coal are so-called fossil fuels, they are not renewable because they require several million years to form, if the problem stopped at their mere decrease in time, given the quantities that we know are present on Earth[10], we would still have decades ahead of us to deploy the many alternatives that already exist or to reduce our energy consumption as the reserves dwindle. But the problem does not stop at their non-renewability. Their extraction from

[10] According to estimates by BP and the World Nuclear Association, the world's fossil fuel reserves in 2020 are 1,014 billion tons of oil equivalent (toe), or 84 years of production at current rates. This ranges from 140 years for coal to about 50 years for oil and natural gas.

the ground, transport and combustion emit large quantities of greenhouse gases, in particular carbon. Indeed, between 400 and 1300 kg CO2e are emitted for the production of one Megawatt hour using fossil energies while this carbon footprint is on average less than 200 for renewable energies (Annex 7). Although non-state actors are facing increasing pressure to demonstrate the integrity of their carbon neutrality commitments, private investment in fossil fuels is doing well. Annex 6 shows a 16% increase in fossil fuel financing by the 60 largest banks between 2016 and 2019. The Five years lost report (2021) reveals that financial institutions have provided $1.6 trillion in loans and underwriting since January 2016 until August 2020 and, as of August 2020, invested $1.1 trillion in bonds and shares in 133 companies driving fossil fuel expansion projects. Since the investments in low-carbon businesses by oil and gas companies (coal is not part of these figures) has been less than 1% of total expenditure (see Annex 8) and that their results as measured by the CO2 intensity of invested capital varies from 10% since 2015 (BP, Shell, Equinor) to a worsening (IEA, 2020), we can consider that the large majority of investments towards fossil fuel companies are not align with the Paris Agreements.
Continued investment in fossil fuel industries is inconsistent with the need to halt the expansion of oil, gas and coal as outlined in the International Energy Agency's net-zero scenario in order to limit global warming to 1.5°C. However, the private financial sector is only marginally addressed in the Glasgow Pact, and at no point is the question of divestment from fossil fuels put on the table, since the rare appearances of the private financial sector are directed towards increasing investments for adaptation to climate change.

A private financial sector initiative was presented at COP 26 called the Glasgow Financial Alliance for Net Zero (GFANZ). It is a coalition of over 450 financial institutions - banks, asset owners, insurers, asset managers, investment consultants, exchanges, rating agencies, audit firms, and other key financial service providers - controlling over 130$ trillion assets, that is more than a third of the world’s investable capital. This coalition announces a "net zero" objective by 2050 for the financial sector, i.e. that the GHGs emitted by companies in their portfolios be balanced by a removal out of the atmosphere of at least the same amount. However, this alliance has many weaknesses regarding the effective reduction of GHGs within the timeframe set by the IPCC.[11] In particular, there is an absence of significant actions towards

[11] These weaknesses are listed by Patrick McCully (2021) and concern many aspects of the alliances, such as the time available for action by the institutions, the criteria used (in particular the absence of criteria concerning fossil fuels and the lack of incentives for offsetting mechanisms), the type of emissions considered, which do not include scope 3, which accounts for the majority of GHG emissions (although this is recommended when the data is available), and the absence of significant sanctions.

the energy sector, while the 6 alliances composing GFANZ do not mention any criteria for stopping or divesting from fossil fuels (see figure 4). At best, the Asset Owner Alliance calls, but does not require, an end to investments in new coal mines and power plants (McCully, 2021).

Figure 4: GFANZ criteria regarding the emissions linked to the portfolios and to the fossil fuel industries

	Asset Owner Alliance	Asset Managers Initiative	Insurance Alliance	Banking Alliance	Investment Consultants Initiative	Financial Service Providers Alliance
Emission reduction targets						
Requires 2025 targets?	Yes	No	No	No	No	No
Requires 2030 targets?	Yes	Yes	Yes	Yes	Yes	Yes
Requires absolute emissions targets?	No	No	No	No	No	No
Requires targets include Scope 3 emissions?	No	No	No	No	No	No
Numerical restriction on use of offsets?	No	No	No	No	No	No
Fossil fuels						
Requires coal phase out?	No	No	No	No	No	No
Requires halt to fossil fuel expansion?	No	No	No	No	No	No

Source: Reclaim Finance

Thus, the Net Zero Alliance of private financial institutions lacks credibility because its members are committed to emissions neutrality while avoiding the necessary end of support for fossil fuels, thereby sending positive signals that fossil fuels will continue to explore and develop new deposits and continue to increase production as long as the resulting emissions are reduced, notably through CCS technologies. Yet, investors would do well to consider the sustainability issues that arise from their operations, as several research studies find that this leads to better future performance than those that do not or do so less (Scanlan, 2021).

Many economists consider that a social and economic accountability of financial actors on a voluntary basis can only be achieved in the presence of economic incentives since, as revealed through Friedman's point of view, in a deregulated and liberalized market, the search for profit prevails. For economic agents to disinvest from fossil fuels, they would have to take into account the environmental costs. In the absence of formal regulation imposed by public authorities or established internally, this information can be transmitted through the establishment of a price on emissions, generalized to all sectors, global and growing, for example in the form of a carbon tax or a cap-and-trade system. This growing trend must be guaranteed over the long term so that investors can anticipate future losses. However, as long as countries or regions do not impose a high carbon price (Annex 9) or even reduce or cancel out its real cost by directly or indirectly subsidizing fossil fuels, they will remain profitable enough to attract investors. In the absence of such a universal framework to incentivize and coordinate, investors offer only voluntarism.

This framework of market self-regulation is a continuation of laissez-faire and free-market economic liberalism. To restrict market freedom and protect themselves from the dangers of deregulation, societies have already established legal and social institutions and codes, such as trade unions, public health, social insurance and public services, through state intervention. This is at least the interpretation of Polanyi, whose theory also highlights "*the need for regulatory intervention in the market to compensate for the socially problematic effects of the market system*" (Polanyi, 1983, p. 37) (Maucourant and Plociniczak, 2011). However, private regulation is nowadays very insufficient when it comes to fossil fuels and the harmful effects of their combustion. It is in this sense that it must be coupled with normative, legislative and institutional constraints to regulate the commercial activities of fossil fuels and the investments made in companies that pursue activities contrary to the objectives of the Paris Agreements.

While the private sector is not about to drastically cut back their investments in the fossil fuel industries, it would be the duty of public institutions representing the Parties to pave the way by starting to stop their public support to fossil fuels as well. The GFANZ report (2021) calls on governments to set targets for phasing out fossil fuel subsidies by 2050 or earlier, highlighting the inconsistency between the rhetoric and the actions of the governments that signed the Paris Agreement and the Glasgow Pact.

B. The need to urgently end public support for the fossil fuel sector.

Fossil energies are the "elephant in the room", the expression was re-popularized at COP26, since they are known to be responsible for three quarters of greenhouse gas emissions, without any international commitments being made to drastically reduce their use. For example, there is no explicit mention of fossil fuels in the Paris Agreements, nor in any final COP decision text before COP 26.

It was therefore with relief and enthusiasm that the first mention in a commitment pact of a call to phase out coal use and inefficient fossil fuel subsidies was welcomed. We can mention that this is a minor step compared to what needs to be done in these areas. The latest IPCC report recommends a reduction of nearly 80% of coal without CCS devices, and to a lesser extent of gas and oil use by 2030, and furthermore takes care to specify that new investments in coal-fired electricity without CCS are inconsistent with limiting warming to 2°C or 1.5°C. Indeed, coal is responsible for nearly 40% of global C02 emissions from energy combustion, oil for 30% and natural gas for 19% (Annex 10). At first glance, the commitments announced in the Glasgow Pact seem to indicate a withdrawal from fossil fuels consistent with the alarming scientific forecasts. However, the lack of quantified targets for actual coal use reduction - leaving it open to interpretation by economies and incorporation into their NDCs as they see fit - the lack of mention of declining use of other fossil fuels or clear targets for them, the question of "effective financing" for fossil fuels, and the dependence of much of the world's population and industry on these fuels[12], leave one skeptical.

There is no universal definition of a "subsidy," and even less of what an "effective subsidy" would be. Nevertheless, a subsidy is generally understood as a government decision to protect a domestic industry through financial leverage. It should therefore be considered efficient if it benefits the whole economy (competitiveness on world markets, lowering the price to the consumer, balancing the trade balance, etc.). In the case of subsidies to fossil fuels and their value chains, it seems inconceivable to consider some of them as efficient if we take into account their negative externalities. Indeed, the reduction or even the total cessation of fossil fuel subsidies would bring environmental benefits, but also public health benefits thanks to the reduction in pollution, public expenditure, the balance of trade and would encourage the

[12] In 2020, fossil fuels account for 83.1% of the world's energy mix, a very slight decrease (-1.2%) compared to 2019. Oil is still in first place among the energies consumed in the world (31.2% of world primary energy consumption) followed by coal (27.2%). (BP Statistical Review of World energy, 2021).

development of energy efficiency and renewable energies, which would become more competitive (Gollier, 2015).

The multi-stakeholder agreements that emerged during COP26 still need to be looked at to hope to find more clarity, if not on the means to achieve them, at least on the targets.

1. COP 26 Alliances to phase-out fossil fuel

For example, the Powering Past Coal Alliance (PPCA), launched by Canada and the United Kingdom at the 2017 Bonn conference, has added new members and now includes 48 countries, 48 subnational governments and 70 organizations; and the less popular Beyond Oil and Gas (BOGA), launched by Costa Rica and Denmark during COP26, now includes 8 member countries plus 3 associate members. These international communities are committed to moving away from coal (PPCA) or planning an exit from oil and gas (BOGA), to align with the goals of the Paris Agreements. However, these coalitions remain symbolic and their commitments are non-binding.

Indeed, although the objective of the BOGA is to launch the theme of the exit from oil and gas production, it includes only a tiny fraction of the world's oil producers (the 10 largest producers representing 72% of world production[13] are notably absent). Moreover, the governments in this alliance commit themselves to setting a date for the abandonment of oil and gas exploration and extraction on national territories, which leaves aside refining activities and consumption, does not commit the countries to invest in exploration on other territories and postpones the real date of exit from fossil fuels. These various reasons make the BOGA coalition lack credibility, and countries' commitments may even amount to political greenwashing[14], as in the case of France, which, in complete inconsistency with its new commitments, has not yet given up on issuing an operating permit to the French energy company Française de l'Énergie to install up to 400 drilling wells in Moselle for the exploitation of unconventional gas (Les Amis de la Terre, 2021). Although the BOGA coalition is one of the few supply-side initiatives to cut hydrocarbon production and hopes to draw more and more countries into following its lead, the

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[13] The 10 largest producers are the United States, Saudi Arabia, Russia, Canada, China, Iraq, the United Emirates, Brazil, Iran and Kuwait in 202 according to the EIA. https://www.eia.gov/tools/faqs/faq.php?id=709&t=6

[14] We retain the definition of greenwashing provided by Greenwashing Economy [En ligne] , which is: "*Any innovation, action or private or state initiative presented as sustainable, decarbonized, sustainable, ecological, green or clean, but dependent on the techno-industrial system for its deployment and long-term viability.*"

project is highly incomplete in terms of the sectors involved (exploration, domestic), the weight of the countries involved, and its voluntary and non-binding basis in light of the urgent situation.

Regarding the exit from coal, while the mention in the Glasgow Pact is more explicit, it was highly controversial that India and China lobbied to diminish the final scope of the commitment by replacing the "phase out" of coal with its "phase down". The international coalition of PPCAs then pledged to bring the original scope of the pact back to the table by renouncing the use of coal in the production of electricity by 2030 or 2040 depending on the country. On the other hand, its scope is again limited from a global emissions point of view because if some coal users such as Poland, Viet Nam (2.5% of the world consumption[15]) commit themselves to renounce to this fossil fuel to produce electricity, the biggest consumers such as China (which alone represents 54.3% of the world consumption), the United States (11.6%), and India (6.1%) are absent. Furthermore, the declaration does not require the end of new coal projects since they are still accepted if coupled with abatement measures, and these measures are not themselves monitored. Australia, one of the largest producers (about 8%[16], but far behind China which has 50% of the market), for example, has announced that it wishes to continue producing coal and selling it for decades to protect its market share and its nearly 200,000 jobs in the sector. The lack of action on coal production greatly weakens the coalition's reach.

While a growing number of countries and organizations are committing to such multilateral alliances to limit their support or use of fossil fuels, their actions rarely align with their commitments. In fact, Reclaim Finance notes that :

"*21 out of 23 financial institutions that signed the PPCA declaration are not on track to exit coal and 15 did not take any credible step in that direction. According to the latest financial data available, as of January 2021, these 23 financial institutions had collectively invested more than $38 billion in the 935 coal companies on the Global Coal Exit List"* (Schreiber and Reclaim Finance, 2021, p.4).

Similarly, most PPCA signatory governments, including its co-chairs Canada and the United Kingdom, have not planned an exit from coal, and 140 of the 266 coal power units in the

[15] Figures from the BP statistical review of World energy (2021)
[16] *Ibid*.

PPCA do not plan to close within the Paris Agreement timeframe[17]. Worse, some countries, starting with Canada, continue to develop mining projects.

The lack of contribution from both public and private members of the PPCA to the coal phase-out and the weak reach of the BOGA do not allow these alliances to be taken seriously in the fight against fossil fuel use. Once again, voluntary commitments, similar to the declarations contained in the Glasgow Pact, appear incoherent and unattainable as long as we do not question our energy demands and do not truly regulate the fossil fuel sectors. As long as the demand for energy is high and growing, it will be too profitable for private and public actors to turn away from fossil fuels.

2. The end of the Parties' support for the fossil industries is not at hand

This production of fossil fuels would not be possible without the sponsorship provided by governments, investors and banks to operate and develop extractive and productive infrastructures. The financial support given to renewable energies is essential to develop our energy sources, but it is also necessary to take into account the support given to fossil energies to measure their respective competitiveness. The public support we observe for the latters highlights the inconsistency of the international community with regard to its commitments made in the Paris Agreements and the Glasgow Pact, and, in general, reveals the weakness of the ambitions to move away from fossil fuels. While the International Energy Agency (IEA) and IPCC scientists are urging against any new fossil fuel extraction projects right now in order to meet the 1.5°C target, the Production gap report (2021) states that governments' plans are dangerously far from the limits of the Paris Agreements, and are not in line with the Glasgow Pact either since:

"*The world's governments still plan to produce more than double the amount of fossil fuels in 2030 than would be consistent with limiting global warming to 1.5°C, and 45% more than consistent with limiting warming to 2°C. Collectively, although many governments have pledged to lower their emissions and even set net-zero targets, they have not yet made plans to wind down production of the fossil fuels that, once burned, generate most of those emissions.*" (p.3).

[17] Data from Global Energy Monitor's Global Coal Plant Tracker, March 20th 2021, concerning the 34 countries members of the PPCA. Consulted on 19/03/2022.

The latter focus particularly on emission reductions, rather than on stopping or at least decreasing the use of fossil fuels, which are their source. The paradigm of technological innovation obscures any other alternative solution, and delays in the first place the reduction of extractive activities and the cessation or reduction of support for this sector.

Several organizations (such as WBGU, ICCP and UNEP) maintain that the completion of a decarbonization of the energy sector by mid-century must be accompanied by the abolition of countervailing incentives such as subsidies and political and financial support for fossil industries. These direct and indirect public incentives include tax breaks, financing from governments but also from public finance institutions (PFIs) such as national export credit agencies (ECAs), development finance agencies (DFIs), and multinational development banks (MDBs), direct investment in infrastructure, and exemptions from environmental requirements. A first step was taken at COP 26, which issued the Statement on international public support for the clean energy transition[18], signed by 34 countries and five public finance institutions committing to end direct public support for foreign fossil fuel power projects without mitigation by the end of 2022. This announcement is expected to free up approximately $24 billion per year for renewable energy deployment to lower the cost of renewable energy and to encourage the private sector and non-signatory countries to follow suit. Once again, the details of the pledges provide a measure of their ambition. The number of signatory countries and financial institutions remains very low on an international scale, moreover it is only a question of stopping direct public support (which does not engage the private sector or indirect public support, the definition of which can be rather vague) and projects abroad (which does not prevent fossil energy projects on national territories) and finally, it will still be possible to extract and exploit fossil energy in the presence of CCS. This last point reveals the absence of questioning the use of fossil energies by legitimizing their "clean" use.

However, there have been slight efforts by G20 countries and MDBs to reduce new public financing for fossil fuel production since 2017. Their financial support remains strong, but an increasing number are implementing policies to exclude future investments in these activities (Production gap report, 2021) (see Annex 11). On the other hand, to recover from the COVID-19 crisis, these same countries have committed more public funding to unconditional fossil fuel

[18] Ukcop26 [Online], “Statement on international public support for the clean energy transition”, released on 04/11/2021, consulted on 24/04/2022.

industries[19] (USD 281.47 billion) than to unconditional clean energy[20] (USD 81.72 billion) (Energy Policy Tracker, 2022). This trend is not confined to the period of the COVID-19 pandemic since the organization Ideas for development (iD4D, 2021) reveals that between 2015 and 2019, following the signing of the Paris Agreements, G20 countries' ECAs have in majority granted their support (insurance covers, guarantees...) to fuel-related value chains to support the competitiveness of their national companies on the markets. In France, over this period, the government has raised 9.3 billion euros of public financing for oil and gas projects through its investment bank Bpifrance[21]. It is important to consider the support provided by the ECAs, which are the "*largest source of public financing for fossil fuel projects abroad*" (Five Years Lost Report, 2020, p.19). Their environmental regulations are still too lenient or non-existent in the context of export financing allowing their involvement in fossil fuel projects and contributing significantly to a global carbon lock-in. Using the pretext of supporting the competitiveness of national companies and protecting jobs, one can only tend to weaken regulations. While by strengthening them, gains may be lost initially, but the boom in renewable energy projects and the sectors concerned should take over, while public support would be directed towards low-carbon energies, which are more labor intensive and whose investments can support more jobs than the oil and gas industries as shown by the UK's case (Vivid Economics, 2020). On the other hand, there has been an increase in subsidies for renewable energy. Moreover, these subsidies and investments have allowed the costs, performance and adoption of renewable energies, notably wind and PV solar energies, to improve dramatically over the past few years, enhancing the feasibility of rapid energy transitions. According to the IPCC, the costs of some renewables are even competitive with fossil fuels on the market, a situation that is nevertheless hindered by subsidies to fossil fuels.

[19] "*Policies are classified as "fossil unconditional" if they support production and consumption of fossil fuels (oil, gas, coal, "grey" hydrogen or fossil fuel-based electricity) without any climate targets or additional pollution reduction requirements*." *Energy policy trackers* [En ligne] "Methodology", consulté le 04/05/2022

[20] *"Policies are marked as "clean unconditional" if they support production or consumption of energy that is both low-carbon and has negligible impacts on the environment if implemented with appropriate safeguards. These policies support energy efficiency and renewable energy coming from naturally replenished resources such as sunlight, wind, small hydropower, rain, tides, and geothermal heat. "Green" hydrogen, active transport (cycling, walking) are also included." Ibid.*

[21] D'après les chiffres du ministère de l'Économie et des Finances, *Propositions de pistes de modulation des garanties publiques pour le commerce extérieur,* 5 novembre 2019.

It is high time for governments to create a level playing field for sustainable compliance with the Paris Agreements. The easiest way to do this would be to define the activities whose value chains undermine the commitments made in the Paris Agreements and the Glasgow Pact and to remove any public financial support for them. Lobbies can be expected to try to undermine the scope of such a taxonomy, so it will be necessary to guard against any interference in its development by actors with financial interests.

According to the IEA, these activities include, at a minimum, the development of new fossil fuel deposits, including coal, oil and natural gas, and associated value chains such as exports of equipment, technologies or services related to the exploration, extraction, refining and combustion of fossil fuel products. Given the inertia of private financial actors, public financing institutions, whose shareholders and constituents represent governments that are signatories to the COP agreements, must lead the transformation that the financial sector needs to contribute to a fair and sustainable recovery, even if this means that short-term economic gains would benefit other governments or private actors for some time.

III. Technological innovations, the pillar of decoupling between economic growth based on energy consumption and its CO2 emissions.

To begin with, it should be noted that "technology" is mentioned 17 times in the Glasgow Pact, including 7 times to refer to advisory committees or their reports on this sector and 6 times to mention technology transfer. Technology transfer refers to the collaboration of knowledge and actors to translate inventions protected by intellectual property rights into products that industries can market to public and private users. This approach involves the infiltration of commercial thinking as "economic usefulness" and "profits generation" into Academia and thus risks supporting private interests at the expense of public interests (WIPO, 2012). These transfers should theoretically allow for the deployment of technologies on a global scale, especially to the most vulnerable economies to enable them to adapt to climate change in the first place.

Paragraph 20 of the Glasgow Pact refers to the development and deployment of technological solutions to support the energy transition to low-carbon systems, in particular by accelerating the use of clean energy (it is understood that this does not necessarily mean moving away from fossil fuels, which are implicitly accepted if their carbon footprint is reduced) and by improving the energy efficiency of systems. In general terms, energy efficiency refers to the ratio of output of performance, service, goods or energy that can be produced with a given input of energy (European Parliament, 2015). In addition, paragraphs 36 and 53 of the Glasgow Pact, without referring directly to energy, provide a more explicit understanding of the extent to which the international community relies on technological solutions and innovations "*across all actors of society, sectors and regions, in contributing to progress towards the objective of the Convention and the goals of the Paris Agreement"* (Pacte de Glasgow, 2021, p.6).

In parallel, following the COP26 session dedicated to innovation and deployment of *greentechs*, i.e. the application of new technologies to environmental protection, the leaders of 40 countries representing more than 70% of the world economy signed a multilateral agreement to develop and deploy *greentechs* by 2030. These should enable the production of clean energy (low or net zero emissions), electrify vehicles, produce low-emission steel, support green hydrogen and create climate-resilient agriculture. COP26 also saw the launch of the Green Grids Initiative (One Sun One World One Grid) supported by more than 80 countries, which aims to connect continents, countries and communities to the world's best renewable energy sources. As part of these plans, the innovation sector has been promised increased public[22] and private[23] investment, and actors are encouraged to follow suit, particularly to make renewable energy more affordable than fossil fuels.

There is a widespread belief that technological solutions can separate activities from the consequences of these activities. Such claim are easily founded in national and international policies (Fagerberg, 2019; Hickel and Kallis, 2019). That includes innovation in decarbonization of industrial process, conversion towards renewable energy sources, increasing energy and material use efficiency throughout the system and implementing carbon capture and sequestration technologies (CCS) to reach low or net zero emissions[24].

The separation of the activities from the current ressource-using and waste-producing path is assimilable to the decoupling framework required by the *Green growth* and sustainable

[22] Global Energy Alliance for People&Planet seeks to catalyze big investments, technical support and regulatory change to provide green energy technology in low and middle-income countries. Initial funding of $10 billion is expected from patrons and development banks.

[23] The private sector is getting involved in the plan's agenda through a coalition of 25 global pioneers including Big Tech companies like Bill Gates' Breakthrough Energy, Apple and Google. These U.S. players are committed to investing in decarbonization technologies and making operations and supply chains more sustainable, according to a *Forbes* article [Online], "La technologie climatique accessible à tous", published 12/12/2021 and accessed 04/14/2022.

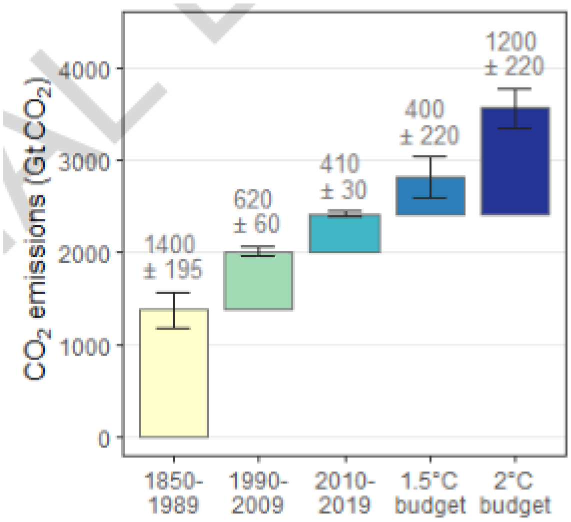
[24] In this essay, zero net CO2 emissions refers to the notion of carbon neutrality, i.e. achieving a balance between anthropogenic emissions and anthropogenic CO2 absorptions.

development paradigm[25], which assumes the possibility of delinking GDP growth and development current path from resource use and environmental impact. The notion of *Green Growth* is the dominant paradigm under which the policy responses to climate and environment issues are made. It assumes the compatibility between the economic growth as measured by the GDP and the sustainability of the planet. It therefore refers to an economy that would be able to grow without corresponding increases of environmental pressure. This theory requires technological change and substitution (Hickel and Kallis, 2019) and highly depends on the technological innovations to be able to permanently decouple GDP growth from resource use and carbon emissions on a global scale, as well as innovations in economic structure, governance and lifestyle (Faberger, 2019). According to the definitions given by the OECD, decoupling should permit "*fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies*" (2011, p. 18). The World Bank (2012) defines decoupling as "*economic growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters*". These definitions remain very vague as to the actual reduction of the impacts of the activities necessary for economic growth, and none of them use the term "diminish"; at best, the World Bank proposes to "minimize" the impacts on the environment. These definitions rather assume the maintenance of the consumption of natural resources necessary at best for human well-being, if not at least for economic growth. Since the Paris Agreements, the pursuit of a *Green growth* also requires a global decoupling at a rate rapid enough to prevent us from exceeding the carbon budget that would allow us to stay below an increase of 1.5°C or 2°C. Indeed, respecting the carbon budget necessary for these objectives does not only require reducing the flow of GHG emissions but also staying within the budget, which corresponds to a limited stock of GHG that

[25] Sustainable development refers to the idea of improving and modernizing economic and social structures to promote economic growth while preserving the planet's resources. The term development refers to the idealistic Western vision of progress and the liberal market economy which, to be sustainable, ecologically viable, must impose a global regulation of relations to the Earth and to resources based on data considered as objective. In short, "*Sustainable development defends an economic, political, and societal ideal favorable to capitalism and Western actors*." (Critical Dictionary of the Antrhopocene, 2020, p.254)
In the same way, green growth does not question the principles of capital accumulation since this term presupposes the conciliation of objectives that appear to be contradictory, namely the growth of population, consumption and profit in parallel with a reduction of environmental impacts. Its apologists hope for a form of moralization of capitalism through certain state regulations to correct market failures concerning energy and resources, and by taking into account "natural assets" in the calculation of economic costs. (Critical Dictionary of the Anthropocene, 2020, p. 220-222)

humanity can still afford to emit without exceeding the stage where climate disruption will become particularly harmful. The carbon budget estimated by the IPCC in their last report to limit warming to 1.5°C with a 67% probability is about 400 [± 220] GtCO2. As we can see on Figure 5, this corresponds to what we emitted between 2010 and 2019. This differentiation between stock and flow induces reductions, and therefore changes in production and consumption patterns, that are necessarily more radical as we get closer to the pivotal dates.

Figure 5: Historic emissions vs. future carbon budget



Source: IPCC AR6 WGIII

Several sectors are concerned by technological innovations aimed at reducing emissions or capturing them. In line with their respective CO2 emission rates, energy use in the industry, building and transport sectors are the main ones concerned (see Figure 3). At COP 26, the transport sector, on which international trade relies due to globalization and the fragmentation of production chains, was the subject of discussion and increased media coverage, particularly due to the development of electric cars.

This part will therefore take a critical look at solutions based on technical and technological innovations before proposing a concrete example with the case of the electric car.

A. Technologies linked to production and consumption or the continuity of the capitalist economic model

Most CO2 emissions from industry result from the combustion of fossil fuels, in particular to produce electricity. A first line of study should naturally focus on the transition to renewable energies to reduce emissions from the production of electricity needed for industrial processes. But today, although wind and solar power are on the rise, they only accounted for

5.9% and 3.2% of the world's electricity mix in 2020, making them the third and fourth largest sources of low-carbon electricity after hydroelectricity (16%) and nuclear power (10.1%)[26]. The current global energy mix does not allow us to perpetuate our lifestyles sustainably, especially the lifestyles of rich countries whose consumption habits lead to greater pressures on the environment (Phillippe, 2011). In the absence of questioning the lifestyle allowed by the capitalist, globalized and dematerialized society, and while the exit of fossil energies seems distant, the solutions envisaged are more about reducing the carbon footprint of production and consumption, primarily through technical and technological innovations.

1. Limit or nullify emissions from production processes through the use of technology

Within industrial activities, different solutions, independent of the energy used, are being proposed and are spreading in order to limit the emissions inherent in production methods. Two axes are being developed: energy efficiency, which concerns the modification of processes to optimize input consumption ; and carbon capture and storage (CCS), which aims to reduce or even cancel emissions at the end of the pipe and avoid their accumulation in the atmosphere. Regarding the energy efficiency of processes, it may be a question of making progress through the use of new materials or power electronics, which is what the food, textile and paper industries are trying to do, for example. Other industries such as steel, glass and cement, whose production processes consume a lot of energy, are looking for innovations that would modify the process itself or, more widely because it is simpler, to recycle waste if they want to hope to increase their energy efficiency (Laville et al. 2015). Energy efficiency is not confined to industrial processes, all production sectors are concerned as for consumer products which themselves require energy to function.

It should be noted, however, that improvements in energy efficiency in recent years have resulted in lower than expected energy savings, and may even lead to an increase in energy consumption, which is referred to as the Jevons paradox or more commonly, the rebound effect. The English economist Stanley Jevons (1835-1882) had already noticed in his time that the technical progress brought to the steam engine led to a stimulation of the coal consumption leading him to establish a paradox: the more efficient the machine becomes, the more it is used, and the more the energy consumption increases (Lacroix, 2016). This can be explained by the fact that consumers do not simply replace an old product with a more efficient product with the same specifications, but may switch to a larger product that ultimately consumes more energy,

[26] According to the BP Statistical Review of World energy 2021

energy savings free up money to consume other goods and services (which require energy to be produced and/or consumed), and technical improvements may make the product cheaper which makes a previously uncommon use more widespread. An analysis of EU data shows that 11 member states experienced rebound effects greater than 50 percent, with six exceeding 100 percent (European Parliament, 2015).

CCS techniques represent alternatives to avoid questioning the production process by acting after the fact, i.e. by capturing CO2 in order to limit its emission into the atmosphere and burying it in underground storage and/or by compensating for the CO2 emitted, for example through reforestation. It is by relying on these processes that the international community intends to achieve the objective of net zero carbon emissions, since it is a question of producing goods and services without emitting more CO2 into the atmosphere than we can technically and naturally extract. CCS processes have all their advantages and risks. Regarding the latter, carbon capture through the creation of natural carbon sinks, such as reforestation, would lead to competition for land use and their use risks degrading biodiversity by favouring monocultures (Doumergue & Kabbej, 2021), the capture of carbon from industry is itself a consumer of energy (pushing up demand) and of the materials necessary for their elaboration. Moreover, the cost of installation, transport and storage is still too high compared to the price of a ton of CO2 emitted for the system to become widespread. François Moisan estimated at 100 €/t of CO2 to create a price signal sufficient to make it cost-effective to introduce carbon-saving technologies where possible[27]. An estimate consistent with the decarbonization scenarios estimated for OECD and G20 countries (responsible for 80% of emissions) establishing a benchmark of 60 euros in 2030 for a low decarbonization scenario around 2060 and 120 euros in 2030 for a more robust decarbonization scenario if the carbon price system is considered as the main mechanism to do so (OECD, 2021). Meanwhile, CCS solutions are in general not used enough to allow the same rate of production and consumption of fossil fuels while limiting global warming and maintaining biodiversity. This has been highlighted in the latest IPCC report regarding the electricity sector, where CCS technology installations have not lived up to the expectations of the stabilization scenarios. If the international community wants

[27] In “Les techniques de réduction des émissions industrielles de gaz à effet de serre” (pp.171-178), in Laville Bettina, Thiébaut Stéphanie et Euzen Agathe (2015). *Quelles solutions face au changement climatique ?* CNRS Editions, Paris.

to limit warming below 2°C or 1.5°C, nearly all electricity should come from low or no-carbon technologies, including fossil fuels energy in combination with CCS.
Apart from their compensatory role, carbon-seeking methods, whether technological or natural, will necessarily have to be developed because the latest IPCC scenarios for keeping global warming below 1.5°C estimate overshoot periods of varying magnitude and, in order to bring the temperature down, include negative emissions anyway, i.e. the removal of greenhouse gasses from the atmosphere.

Short of drastically reducing energy consumption and regulating its sources, and short of making these mechanisms mandatory at least for the essential high-emission sectors, public authorities must consider sending a sufficient price signal to make it more profitable to implement CCS technologies than to use carbon-based energies without mitigation mechanisms. We have just seen that François Moisan estimated this price at 100 €/t of CO2. Around the world, the integration of pollution, which is a negative externality, into the price of production or consumption is beginning to spread on the basis of the polluter-pays principle. It is a matter of explicitly or implicitly putting a price on carbon, notably by taxing the polluter or via a Market Based Instrument (MBI) like a carbon emissions trading scheme. None of the instruments that exist to date are applicable on a global scale. Carbon taxes remain mostly national or even sub-national while the European Emission Trading System (EU ETS) is the largest carbon trading systems deployed so far, and the only supranational one. Beside this one, the International Carbon Action Partnership Status Report (2020) reveals that 21 carbon markets exist over four continents and that 24 others are planned. On the EU ETS, the price of the ton of Carbon remained too low, most of the time under 20 €/t, even if from October 2020 they skyrocketed to around 80 euros (see Figure 5).
According to the French Ministry of Ecological Transition, 31 carbon taxes and 30 tradable allowance markets were in operation worldwide as of May 1, 2020 (Annex 4) and among them, only Sweden imposes a carbon price above 100 €/t[28]. Therefore, prices of carbon emissions are globally too low compared to what is needed and a stable growth of the latter as well as an application to all sectors is not guaranteed enough to create an incentive that generalizes the implementation of CCS technologies.

[28] 100 € being equivalent to 108,07 USD on April 14, 2022, the carbon tax in Switzerland amounts to 118,42 €.

Figure 6: EU ETS Carbon price from 2007 to 2022

Source: tradingeconomics.com

2. Energy, material and theoretical limits to technology-based solutions

As human beings always hope to solve their problems with technical solutions, information and communication technologies (ICTs) are becoming increasingly important in the solutions proposed to reduce energy consumption. Technological solutions are not exempt from the ecological footprint because the materials, the production process, the shipping, the way supply chains are organized or the end of life of products are not decarbonized. A lot of the technological solutions are based on digitalization and on the belief that the dematerialization of services, manufacturing, and the rise of telecommunications reduce energy consumption. The concept of intelligent systems is also gaining momentum, with the development of ultra-connected networks, the *Smart Grid*, which should make it possible to rapidly process complex information to improve energy management and gain in energy efficiency. But these beliefs are largely overestimated, with many specialists warning about the carbon and environmental footprint induced by ICTs themselves and the rebound effects that these innovations can generate. The study by Lange, Pohlc, and Santariusa (2020) on the effects of ICTs on energy demand finds that the direct effects and economic growth have been greater than the energy reducing effects (energy efficiency and sectoral change). Berthoud and al. (2015) also point out that "*new technologies never completely replace previous technologies, but complement them and, therefore, their impacts are additive*" (p.234). In addition, the promises of gains in energy efficiency, reductions in energy consumption and emissions in many sectors thanks to digitalization and dematerialization are based on extraction activities to find the rare metals and limited resources necessary for the production of digital and technical tools and are therefore to be put into perspective. More worryingly, some of these so-called solutions are still only science fiction projects. Finally, the research paper *Rebooting the IT Revolution: A call to action* (2015) warns of the problem that the growth of computing will pose to energy consumption in the near future[29] and concerns arise about the ecological footprint of digital technology. To date, digital technology accounts for between 3 and 4% of total GHG[30] emissions and these will increase significantly if nothing is done to reduce its footprint, which is all the more reason to deepen and mitigate thinking about solutions based on technical substitutions of innovation and on the digitalization of the economy.

A gap persists in the existing institutions and methodologies that do not raise this issue, whether in research centers, universities and consequently in international debates.

Nevertheless, the last IPCC report observes a decarbonisation of most industrial processes using technologies that include electricity and hydrogen for energy and feedstocks, carbon capture and utilization technologies, and innovation in circular material flows. In contrast, industrial emissions have continued to grow at the same time, driven by strong global demand. The rapid development of low-emission innovations must be accompanied by a reduction in demand growth if GHG emissions from the industrial sector are to be sufficiently reduced in the coming decades. If we are serious about mitigating the climate crisis and the destruction of biodiversity, then the solutions, in parallel with technical and technological innovation, must include a change of business model, that many sectors be radically transformed and that we question our lifestyle and consumer society. It would be a matter of collectively redefining the energy needs of the population and industries to reduce energy demand; energy efficiency and CCS techniques should only be supports or solutions of last resort when the carbon footprint of essential activities cannot be quickly reduced. Indeed, if the technical and technological solutions to bring about deep-decarbonization have already shown positive results on small scales, concerning specific sectors or industries or in the laboratory, we have seen that the

[29] "*In current mainstream systems, the lower-edge system-level energy per one bit transition is ~10^{-14} J, which is referred as the "benchmark" in Figure A8. For this benchmark energy per bit, computing will not be sustainable by 2040, when the energy required for computing will exceed the estimated world's energy production. Thus, radical improvement in the energy efficiency of computing is needed.*" (SIA, 2015, p.27)

[30] According to the estimates of Shiftproject, Lean ICT : Pour une sobriété numérique, octobre 2018 ; and of L'étude Green IT, Empreinte environnementale du numérique mondiale, septembre 2019

growing demand for energy would not allow these to be the only pillars on which to base the energy sector strategy. Yet this logic overrides potential sectoral environmental regulations, drastic reductions in fossil fuel use, and is part of the dominant socioeconomic system based on carbon- and resource-hungry economic growth (Schroder and Storm, 2018; Anderson and Peter, 2016).

Several empirical studies, however, put into perspective the success of a decoupling for the whole world economy based on the current knowledge and the technologies we master. Hickle and Kallis studies (2019) suggest that absolute decoupling of GDP (2 to 3% of growth rate) from resource use may be possible in the short run in some rich countries, but just to achieve this result would require highly optimistic conditions such as strong policy of reduction as well as sufficient efficiency gains. However, on a global scale and in the long-term, such decoupling is not feasible. By estimating the growth rate of global per capita income for the period 2014-2050, consistent with the Paris Agreements commitments and based on the IEA and OECD assumptions of future energy efficiency and carbon changes, Shroder and Storm (2018) find it impossible to realize the emissions cut needed without compromising economic growth.

Game-changing innovation and revolutionary social change could change the results, but are surrounded by great uncertainty. Marginal improvements in energy efficiency and carbon capture will not be enough. For the decoupling path to works in the given time, "*a concerted (global) policy shift to deep de-carbonization , a rapid transition to renewable energy sources (Peters et al. 2017), structural change in production, consumption and transportation (Steffen et al.2018), and a transformation of finance (Malm 2016; Mazzucato and Semieniuk 2018*)" would be necessary (Schroder and Strom, 2018, p.6).

Finally, there is an astonishing form of denial on the part of those who believe in progress, even though science explains the material limits of digitalization, the quantitative limits of the energy transition, the difficulty of doing without hydrocarbons to perpetuate our lifestyles, etc. Science explains to us that we cannot rely on it alone, but that developments in our societies must be added to it. The importance of the topic is unquestionable given the urgency of responding to climate change and, beyond that, to the socio-ecological crisis of modern capitalism. The idea that decoupling would solve the problem has failed and, as Kothari et al. (2014) argue, will continue to fail. Therefore, the international community needs to develop responses that challenge the direction of economic growth, and build an alternative path to ecologically and socially conscious well-being.

B. Technology to decarbonise human mobility: the case of the electric car

The challenges of "sustainable mobility" are considerable, given the dependence of the so-called developed countries on cars, the growing dependence of developing and emerging economies, and the environmental impacts that their use generates.

Since the transport revolution of the 20th century, the internal combustion engine car has rapidly become the main means of transporting people and goods, contributing to the growth of the automobile, oil and road industries, urban spread, the disappearance of the neighborhood economy, air pollution, and causing millions of premature deaths every year (Lacroix, 2016). The number of motor vehicles in circulation (4 wheels or more, private and commercial) has been growing steadily since then and is estimated at nearly 1.4 billion worldwide in 2016[31], or one for every 5.6 inhabitants, and is expected to continue to grow to double by 2050 due to the demand from so-called developing and emerging economies. This figure is very unevenly distributed around the world and is mostly shared between the United States, Europe, and Asia-Pacific since their recent car boom. At the same time, the transport sector is responsible for more than 16% of global GHG emissions, of which road transport is the main contributor with nearly 12% (see figure 3). This contribution to air pollution is due to the massive use of thermal engines responsible for the consumption of a little more than half of the world's oil and emitting between 12 and 17kg of CO2 per 100km[32]. According to the COP 26 report, "*decarbonization of road transport could lead to a reduction of 2.6 gigatonnes of carbon dioxide per year by 2030*" (2021, p.13). We are only considering direct CO2 emissions here. Some of the emissions from industry, for example, are also induced by our use of transportation increasing its carbon bill to almost a third of CO2 emissions. Nor should we overlook other types of pollution such as fine particles, ecosystem degradation and human health impacts induced by vehicles and their industries.

The main statement of COP26 regarding transportation revealed a timetable for the large-scale deployment of electric and hydrogen vehicles, which are referred to as "zero-emission" (ZE). The official COP 26 report states the inevitability of "*a transition to zero-emission road*

[31] According to Wards intelligence [Online], "*World Vehicle Population Rose 4.6% in 2016",* published on Octber 17, 2017 and consulted on April, 15, 2021.

[32] The differences are due to the type of engine and the year of construction of the engine, with gasoline emitting the most carbon and vehicles running on bioethanol (E85) emitting the least. In addition, depending on the engine, fine particles and carbon monoxide may also be emitted to a greater or lesser extent. The figures are taken from various ADEME reports.

transport technology" to meet the climate goals of the Paris Agreements, and the generation of "*a mass market*" (2021, p.13) for them. These statements are a perfect illustration of the industrial and capitalist technocentrism that we have previously noted for decoupling the transport sector from its heavy reliance on fossil fuels and their emissions.

As a result, a coalition of 35 countries (1/5th of the global automotive market), six major automakers (30% of the global market), 43 cities, states, and regions, 28 fleet owners, and 15 financial institutions is committed to working together to ensure that all passenger and commercial vehicle sales are ZE vehicles by 2040 globally and by 2035 in key markets (Europe, the U.S., and Asia-Pacific).

The objectives of the personal and business' mobility decarbonization focuses on presenting the ZE car as the " right " way to behave at the individual level to have a lesser impact on the planet. The COP 26 outcomes avoids questions about their effectiveness, legitimacy, and purpose, which we will try to reveal in this section. We will focus on electric cars with external recharging (which we will call hereafter electric cars), which are more competitive than those using a hydrogen fuel cell. Fuel cells are expensive to produce, their energy efficiency is low, and hydrogen is 96% manufactured by chemical transformation of fossil fuels, so they do not project a market that supplants combustion engine vehicles on the medium-long term (Miotti, Hofer and Bauer, 2017). As for electric vehicles (battery and plug-in), they represent 1.5 to 11% of the vehicle market depending on the region (see Annex 12).

1. The myth of the "zero emission" car

First, let us analyze the effectiveness of the democratization of the use of electric cars to reduce our GHG emissions. Studies on the primacy of their advantages or disadvantages are legion, and the main environmental limitations that emerge concern the production of electricity and the resources needed to produce them (Nordelöf, Messagie, Tillman and al., 2014). We will touch only minimally on the topic of materials, their availability, and the environmental and geopolitical implications of these[33] to focus on the energy issue.

[33] Here are some resources for more information on these topics:
A UNCTAD report (2020), Commodities at a glance : Special issue on strategic battery raw materials, provides an overview of the metals needed for batteries, their value chains and the economic, social and environmental implications
Emmanuel Hache's webinar on Wednesday, May 27, 2020, "Les matériaux de la transition énergétique : remplacer un problème par un autre ?" analyzes the criticality of natural resources and materials in energy transition technologies.

The electric car requires a considerable amount of energy over its entire life cycle. The manufacturing of the electric car requires more energy than the thermal car, especially for the production of the lithium-ion battery, which weighs several hundred kilograms and includes several types of critical metals. The emissions related to the production are at least 30% higher than for gasoline-powered cars with the world's average electricity mix (Knobloch, Hanssen, Lam et al., 2020)[34], and probably largely underestimated[35]. Indeed, life cycle pollution also includes the extraction of metals needed to manufacture the battery (63kg of critical metals in the battery of a Renault Zoe) such as lithium from Chile, cobalt from the Democratic Republic of Congo, or nickel from Indonesia, sometimes in environmental conditions with few or no standards. It also includes refining, which requires astronomical amounts of water and highly corrosive acids that can be the source of discharges into the environment. Other metals such as copper and aluminum, although not rare, must be extracted from the earth and transported in much larger quantities than in a typical thermal car, which also requires a lot of energy. And finally, all the direct and indirect inputs and outputs from waste, recycling and transportation. It is only during its use that the electric vehicle can hope to limit its environmental impact compared to the thermal car. But to increase the GHG emission gains of electric vehicles, electricity production must first be decarbonized. On a global scale, electricity is still largely produced from fossil fuels. In 2020, more than 60% of electricity was generated from fossil fuels, including 35% from coal, which is by far the largest emitter of CO2 (BP statistical review of world energy, 2021). Although renewable electricity sources (wind and solar) have developed strongly, they still only represent 11% of the world's electricity mix. Nuclear and hydroelectric power, although the source of various controversies (impact on ecosystems, radioactive waste and risk of accidents), also enable the production of low-carbon electricity and represent 26%[36] of the global electricity mix. The global electricity mix does not therefore

A book by Guillaume Pitron, *La guerre des métaux rares. La face cachée de la transition énergétique et numérique*, Les Liens qui Libèrent, 2018, p.296 that studies the geopolitical, social and environmental stakes of the needs of the energy transition.

[34] The authors state that their calculations of emissions related to the production of the car include the electricity required for the production process - of the car, parts, and materials - as well as non-electric emissions - transportation, mining, etc. For the production of the battery, the non-electric emissions were estimated to be 3,200 kgCO2e (21.3 gCO2e km-1), and the electricity requirement of the battery cells was estimated to be 5,000 kWh (0.034 kWh km-1).

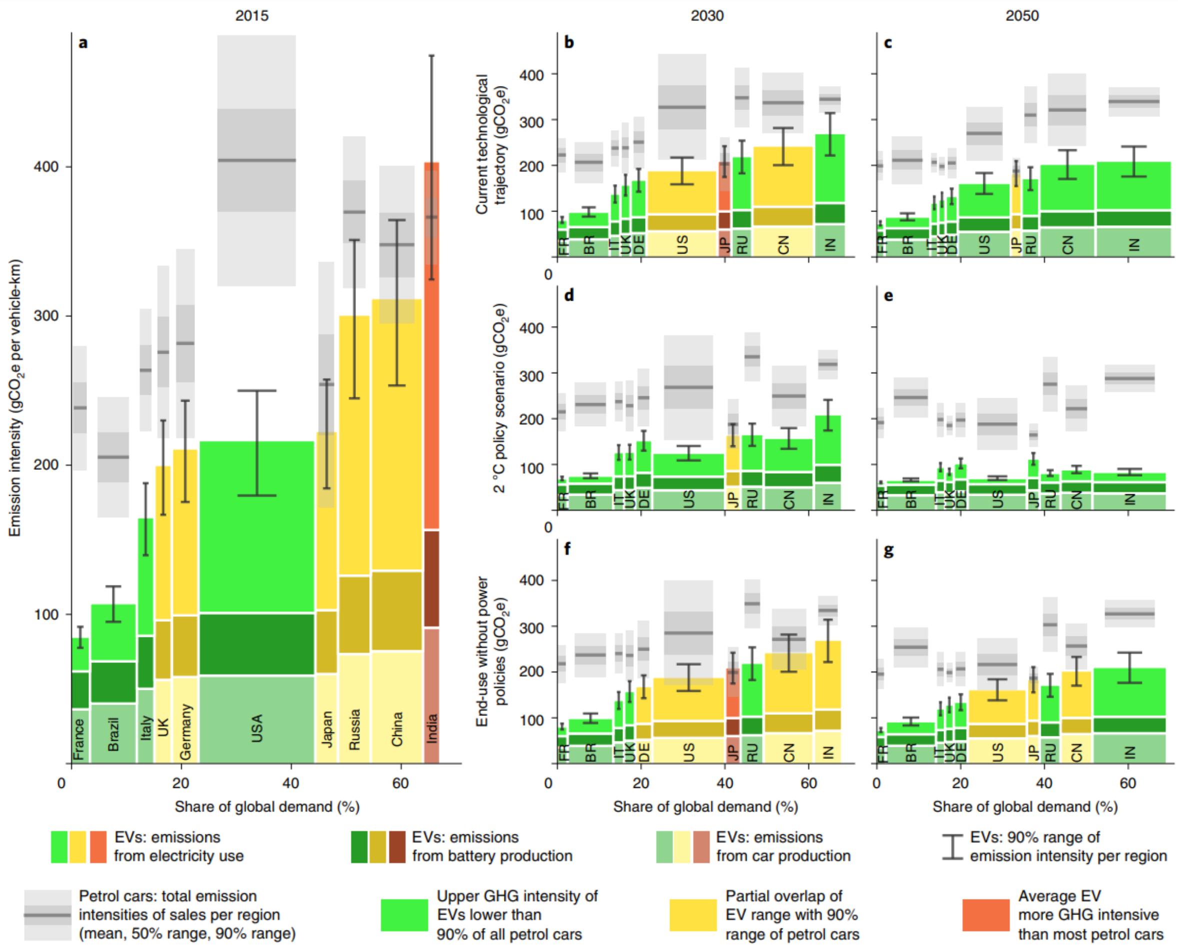
[35] Indeed, a study by ICCT (2018) established in its literature reviews a range from 40 to 250 kgCO2/kWh for battery production alone. Analyses are not yet thorough enough to accurately determine the ecological footprint of the electric car, which can lead to a wide range of results and to an over- or underestimation of the emissions it induces.

[36] The figures are from the BP statistical review of world energy (2021).

allow us to say that electric vehicles represent a "zero emission" alternative to our current modes of transport. All the more so as there are strong disparities in the energy mix between regions (see Annex 13). Moreover, if we consider the whole life cycle, no means of electricity production has a null environmental footprint.

Of the 3 main markets we mentioned earlier, Europe has the most decarbonized electricity mix (nearly 65% of total electricity), followed by North America (44%) and Asia Pacific (only 30%). And this still hides interregional disparities. At present, the electricity mix of most of the major automotive markets still provides CO2 emission gains, a situation that could be expected to improve as the share of renewable, nuclear or hydroelectric power increases and CCS technologies develop (Figure 6).

Figure 7: GHG emission intensities of passenger cars

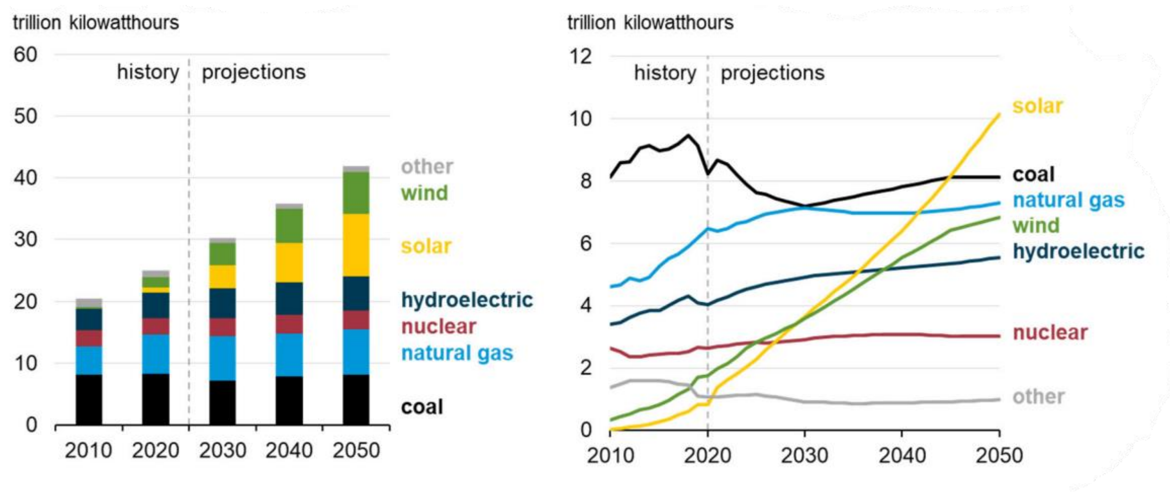


Note: Current(a) and projected (b–g) GHG emission intensities from driving EVs, for the ten countries with the highest passenger car transport demand in 2015. Projections under the current technological trajectory (b,c), the 2 °C policy scenario (d,e) and the end-use without power policies scenario (f,g) are shown. The heights of the vertical bars show an average EV's estimated GHG emission intensity, given the power sector's emission intensity in each country. The range of the GHG emission intensities reflects higher and lower use-phase energy requirements of different available EV models and sizes. For comparison, the grey box plots show the distributions of GHG emission intensities of newly sold fossil fuel cars in each country (mean, 50% and 90% ranges).

Source : Knobloch, Hanssen, Lam et al. , 2020

However, we have seen in the previous sections that public and private support for fossil fuel industries is still very much present. A situation that is expected to perdure since the commitments made at COP 26 by institutions and governments to reduce this support do not make the development of renewable energies sufficiently competitive on a global scale to supplant fossil fuels. Taking into account the decarbonized electricity projects under development and in the absence of strong economic incentives, commitments by all governments to stop the use of fossil fuels and technological breakthroughs, the U.S. EIA projections (2021) estimate a global electricity mix still dependent on 37% fossil fuels in 2050 (Figure 7). Although these projections show strong growth in low-carbon electricity generation, the CO2 emissions from it remain relatively similar to those of today, offset by strong demand growth that maintains or even increases the amount of fossil fuels consumed.

Figure 8: Evolution of the world net electricity generation by source



Source: U.S Energy Information Administration, International Energy outlook 2021.

The increase in electric vehicles is weighing on the increase in demand for electricity while fossil fuels are the cheapest means of producing it, particularly in Pacific Asian countries where coal reserves are substantial (nearly 43% of world reserves according to BP statistical review of World energy 2021). In addition to relying heavily on this fuel in their energy mix, China and India lobbied at COP26 for the elimination of its use not to appear in the Glasgow Climate Pact and Australia announced the opening of new mines.

CCS devices could still be relied upon to limit the carbon footprint of power generation, and would also have the advantage of capturing concentrated emissions at the factory gate, which is more complicated to achieve with diffuse tailpipe emissions. But we have already seen that these devices have their own limitations and that they are not sufficiently established to make electricity production including fossil fuel energy consistent with the climate objectives of the Paris Agreements. While their development promises to increase, more diverse solutions are needed to achieve a real reduction in overall net CO2 emissions from transportation energy by 2050.

Thus, replacing thermal cars with electric ones does not appear to be a solution at the global level, while we do not have the technical means to ensure that its demand for energy does not lead to rebound effects. Market adoption of electric vehicles may still be hampered by limited production capacity, limited product diffusion and costly infrastructure adjustments. Although current and future life-cycle emissions are on average lower than those of gasoline-powered cars, the electrification of the thermal vehicle fleet can only lead to a marginal reduction in environmental degradation and reduce the user's sense of guilt through its lack of direct local pollution emissions. As we noted in the first part, the Parties focus their attention on the reduction of GHG emissions, and even of CO2 alone, neglecting the other environmental (water consumption, soil and water pollution) and social (working conditions, inequalities of access to technologies, health impacts of pollution) limits of electric vehicles. We still have to rely on optimistic assumptions of economic and technical improvements to produce decarbonized electricity, to put an end to pollution, to limit the consumption of energy and water during the process, to allow the recycling of batteries, or to make these vehicles accessible and used by the greatest number of people. Faced with these uncertainties about the future, we must increase the number of alternatives to carbon-based modes of transport and redefine our mobility needs.

2. The levers of sobriety, from car models to lifestyle.

The strategy presented at COP26 relies mainly on technological levers and shows little ambition towards sobriety levers. The stated ambition to proceed with the rapid electrification of vehicles that would retain the same characteristics of number, mass and power, continuing to increase mobility and the global demand for cars while reducing CO2 emissions is illusory. Promoting electric vehicles means first of all continuing to promote the existing dominant model of mobility, i.e. the individual, heavy and powerful car, to the detriment of alternative forms of mobility or a revision of our transport habits. In particular, it is a question of questioning our needs in terms of daily mobility (access to services, travel to work) and goods transport (globalised value chains, commercial freight).

Regarding the mobility of people, individual cars are parked 95% of their lifetime and the rest of the time carry on average only 1.22 passengers. According to Nicolas Meilhan, the market for electric cars today is concentrated on large cars (between 1 and 2 tonnes) with heavy batteries to allow high engine power (Greenletter club, 2021). These models dominate the market, yet they require more metals to produce the battery and more energy to drive the vehicles, which has a strong impact on emissions gains. Given their use, current electric passenger vehicles do not appear to be an environmentally efficient means of transport. This opinion is shared by Lacroix (2016), who advocates a reduction in the mass and power of vehicle engines in order to gain in energy efficiency. However, electric vehicles are initially aimed at a wealthy clientele for whom there are few incentives to increase the occupancy rate of vehicles or to favor smaller and less powerful models. These solutions are marginalized by car marketing and ostentatious consumer behavior which associates car power with a symbol of wealth. They are part of the continuity of consumerism by the wealthy fringes of the population for the benefit of industrial elites. The latter, directly interested in maintaining the individual car and in the high prices justified by premium models such as heavy and powerful SUVs, have a desire to develop the 'green car', imbued with ecological morality. These criticisms echo those of Alfred Sauvy and Ivan Illich against the automobile lobbies in the 1970s, denouncing the massive development of the automobile by the capitalist consumer society in the service of capital accumulation.

There are other inconsistencies in the planning of this market. Firstly, the focus in public debates is on the private car. However, their immobility rate in relation to the number of kilometers they need to cover in order to 'repay' the carbon debt resulting from their production[37] does not make this segment of the market the most relevant for electric vehicles. Laurent Castaignède regrets in particular the lack of emphasis on the electrification of two-

[37] The range depends largely on national car models and electric mixes. Studies in Europe estimate between 28% and 72% less greenhouse gases over the life cycle (estimated at 150,000 kilometers of driving), depending on local electricity generation (ICCT, 2018). Studies estimate a very wide range of 13,000 to 80,000 km for electric cars to make up for the emissions emitted during their production (Transport & Environment, 2020; Pipitone, Caltabellotta, Occhipinti; 2021, Agora Verkehrswende, 2019). As for the rest of the world, we saw in Figure 6 that 6 of the top 10 markets may currently never reach this cleavage point.

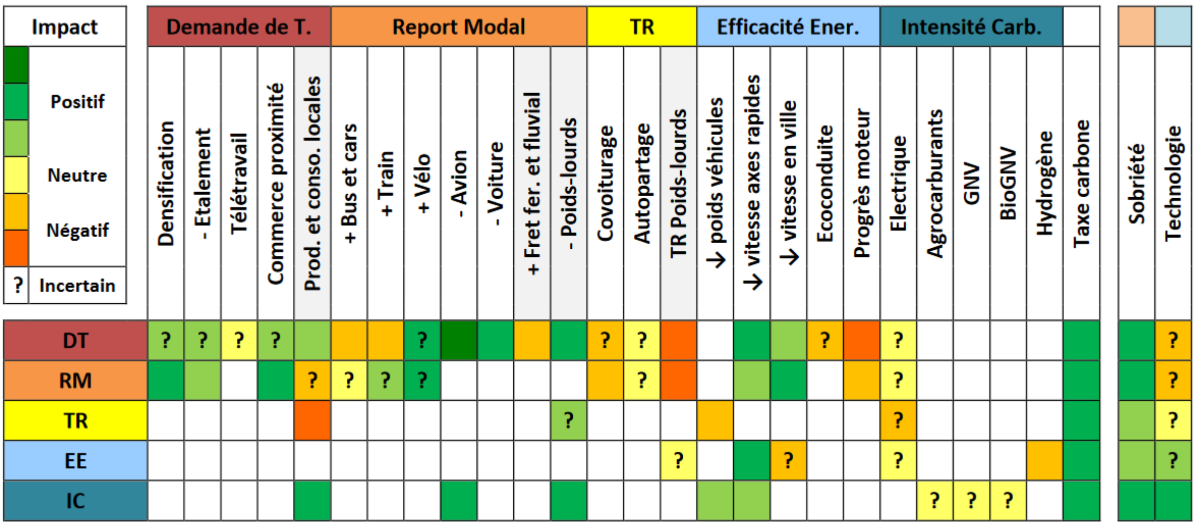
wheeled vehicles whose weight and power require less material and energy, and questions the use of electric cars. In practice, individual electric cars rarely replace thermal cars, but rather contribute to reducing emissions due to the expansion of the global car fleet (Greenletter club, 2022). It is therefore on the demand side that we need to act, asking ourselves why it is growing, what mobility alternatives exist or what levers can be used to reduce it.

Aurélien Bigo (2020) questions the weakness of the sobriety scenarios, while the most ambitious ones in France estimate a -40% reduction for passenger transport and -50% for freight by acting on demand, transport modes and fill rates. In addition to being able to reduce transport-related emissions by almost half, Bigo's research shows that :

> "*sobriety measures [...] present more co-benefits on other externalities and other environmental impacts, and make it possible to limit the cost of the transition, unlike technological developments that are often more expensive, with indirect impacts and sometimes limited resources*" (p.222).

This can be seen in the following table (Figure 8), which presents the positive and negative externalities according to the policy lever applied to the transport sector. Five of them are shown: transport demand, modal shift, occupancy rate (TR), energy efficiency and carbon intensity.

Figure 9: Main interactions between the evolutions cited by the scenarios and the 5 decarbonization levers



Reading: Densification reduces daily travel distances (but potentially increases long-distance travel distances, hence the "?"), while having a positive interaction with modal shift, by encouraging the use

of walking, cycling or the development of public transport; on the contrary, the development of carpooling may be to the detriment of rail and encourage new transport demand, as observed for long-distance travel, hence the negative interactions for emissions.
Note : Shaded cells are specific to freight transport.

Source: Aurelien Bigo, 2020

In France, electric vehicles have neutral or negative externalities in most of these areas. At the global level, their accessibility and the energy mix on which their load depends may further penalize their effects on the other levers. On the contrary, sobriety measures acting directly on the power and weight of car models or on territorial planning to reduce the need for personal mobility may result in more positive externalities on the other levers.

We will probably not succeed in quickly overcoming the dependence on the private car, and electric vehicles do allow for gains in emissions and pollution in regions where the electricity mix is mostly renewable and where extraction conditions are subject to strict ecological standards. Rather than betting on a total replacement of the car fleet by all-electric vehicles, which is in any case unlikely by 2050, we should start by questioning the models and sectors where they allow the most gains. The relevance of the electric car is not to individual use but rather to heavy-duty vehicles, such as cabs or freight transport. 28 fleet owners have committed in Glasgow, but if these are additional products and not substitutes, there will only be more pressure on the environment. Similarly, in cities, individual trips are the shortest and most easily replaced by alternatives (bicycle, public transport), whereas trips where car use is the most inelastic are more likely to occur in rural areas where services are far away and where the thermal car can often be the only mobility available. In this case, it would be possible to envisage a substitution to electric models, but this would have to be coupled with a decentralization of services and alternatives to distant trips to work, for example.

The electric vehicle then appears to be as good an idea as the context in which it takes place. That is to say, in areas where the supply of carbon-free transport is the lowest and complicated to plan in the short to medium term, with regulations limiting or even reducing the expansion of the car fleet, as well as for their weight and power, and powered by carbon-free, not too expensive, and controllable electricity. This is not the panacea advocated by the international community at COP 26.

The lack of debate and public policy proposals on the demand factor is problematic because it was the main factor in the evolution of GHG emissions in the past. Reducing energy and material demand for transport will have to combine technological developments with behavioral, organizational and societal changes. These include land use planning to promote local social infrastructures, shorten production chains, promote local consumption, reduce consumption and develop a circular economy.

Conclusion

Following the example of the fight against the ozone hole, the ongoing climate policies including the agreements taken during the COP26 have focused on the reduction of greenhouse gas emissions. In the energy domain, the outputs of our economic and productive system based on the combustion of fossil fuels are discussed first. The question of inputs, i.e. the fossil fuels themselves and the modes of production and consumption, is relegated to a secondary consideration. However, we cannot solve the problems caused by the combustion of fossil fuels afterwards, by regulating only the emissions, without raising the question of extraction, trade or the infrastructure we are building, which will put us on a very carbon-intensive trajectory that will make it very difficult and costly to reverse.

Few concrete and radical changes were initiated at COP 26. Many are skeptical about the fact that too many proposals were announced for their implementation to be credible, about the ambitions that do not match the actions under development, and about the scope of the Pact itself in terms of the Parties' commitment. Indeed, the Glasgow Pact, like the Agreements that have flourished during the two weeks of negotiations, are not binding and lack guarantees. The commitments concerning the energy sector are weak since they do not guarantee a drastic reduction in the use of fossil fuels or even the financing of its infrastructures. These shortcomings are deeply regretted by the scientific community and actors from all sides (politicians, associations, civil society), who, like Jennifer Morgan, head of Greenpeace International, Antonio Guterres, UN Secretary General, or Alok Sharma, COP president-designate, consider the Glasgow Pact as a progress but are disappointed by its scope, which is barely sufficient to keep the 1.5°C objective alive[38].

This is why I argue that we must first define the type of change we want and condition it to what is necessary to preserve the planet's resources and the environment. The point of view that

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[38] *Ouest-France.fr* [En ligne], AFP et Agnès, S., « Pacte de Glasgow sur le climat : une avancée pour certains, du « bla bla bla » pour Greta Thunberg ». Published 13 novembre 2021. Consulté le 07/04/2022.
Major-Prépa [En ligne]. « COP26 : le fiasco de Glasgow ? », 18 décembre 2021. Consulté le 07/04/2022.

I have documented throughout this dissertation is to challenge the dominant economic paradigm, the financialized, neo-liberal capitalist system. Most, if not all, government and corporate representatives maintain growth targets and the solutions proposed to achieve this decoupling of economic growth from environmental destruction, such as energy efficiency, renewable energy and carbon capture and sequestration, are based on the belief that technological development will limit environmental impacts (Rees, 2021; Tordjman, 2021). There is a real lack of questioning of production models, the global value chain, the business model, consumption habits or even the financial system on which the exercise of the right allocation of investments to support *green growth* is based.
At present, climate objectives must not contradict the Western perception of development and the growth imperative that countries give themselves or that organizations such as the IMF demand. This is reflected in the semantics used to determine the dominant vision of the paths that humanity must take, namely "green growth" or "sustainable development", both of which are rooted in the capitalist system and appear as oxymorons. An apparent moralization of capitalism based on the goodwill of economic actors and subordinated to its economic imperatives is taking place (Lacroix and Marchildon, 2014). The proposed development scenarios are based on a salutary technological progress to mitigate and then reverse the greenhouse gas emitting trend. The questioning of the economic system and the capitalist society of consumption, from which the quantity of energy consumed derives, do not appear in the international dialogues and the resulting pacts. A situation which will hopefully change as the contribution of the Working Group III to the IPCC's Sixth Assessment Report clearly states that development pathways are linked to climate change since it drives GHG emissions and that it shapes the mitigation policies. Moreover, the growth imperative, in particular as measured by Gross Domestic Product (GDP) is indicated as the strongest driver of CO2 emissions fossil fuel combustion, with population growth.
Therefore, the question of the quantity and source of energy, whether it is a fossil fuel, a biomass power or a renewable one is a central question. As well as the process of creating energy and its transport. The result is a dichotomy between the alarmist predictions of scientists, their recognition by the international community, and the commitments that flow from climate summits. The continued subsidization of fossil fuel projects by many nations is a striking example.

The lack of debate on sober development paths at COP 26 results in a Glasgow Pact whose *solutions* to climate change are based on the same set of beliefs, values and assumptions about capitalism and neo-liberal economics, which are at the root of environmental and climate degradation. They then pursue a goal of reducing emissions without impeding the economic growth that would be made possible by continued technological development. The examples we have highlighted, such as CCS technologies and electric cars, whose net beneficial effects are not yet proven, but also renewable energy technologies, imply massive capital investments and future profits, becoming the new gears of a devastating system destined to perdure.

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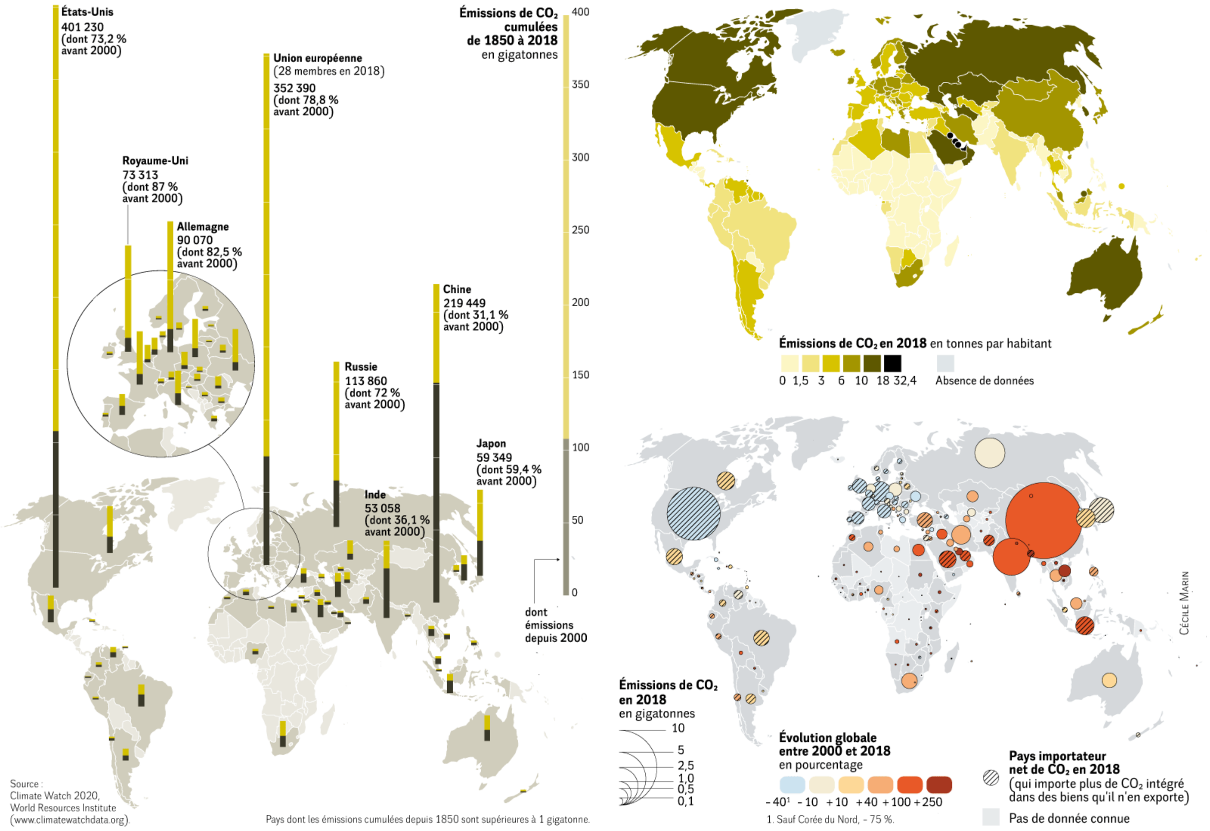
Appendixes

Annex 1: National or regional contribution to the CO2 cumulated emissions from 1850 to 2018



Notes: shows only countries with cumulative emissions greater than 1 Gigaton

Source: Climate Watch 2020, World Resources Institute

Advance unedited version

Decision -/CP.26

Glasgow Climate Pact

The Conference of the Parties,

Recalling decisions 1/CP.19, 1/CP.20, 1/CP.21, 1/CP.22, 1/CP.23, 1/CP.24 and 1/CP.25,

Noting decisions 1/CMP.16 and 1/CMA.3,

Recognizing the role of multilateralism and the Convention, including its processes and principles, and the importance of international cooperation in addressing climate change and its impacts, in the context of sustainable development and efforts to eradicate poverty,

Acknowledging the devastating impacts of the coronavirus disease 2019 pandemic and the importance of ensuring a sustainable, resilient and inclusive global recovery, showing solidarity particularly with developing country Parties,

Recognizing the important advances made through the UNFCCC multilateral process since 1994, including in the context of the Convention, the Kyoto Protocol and the Paris Agreement,

Acknowledging that climate change is a common concern of humankind, Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity,

Noting the importance of ensuring the integrity of all ecosystems, including in forests, the ocean and the cryosphere, and the protection of biodiversity, recognized by some cultures as Mother Earth, and *also noting* the importance for some of the concept of ‘climate justice’, when taking action to address climate change,

Expressing appreciation to the Heads of State and Government who participated in the World Leaders Summit in Glasgow and for the increased targets and actions announced and the commitments made to work together and with non-Party stakeholders to accelerate sectoral action by 2030,

Recognizing the important role of indigenous peoples, local communities and civil society, including youth and children, in addressing and responding to climate change, and *highlighting* the urgent need for multilevel and cooperative action,

Recognizing the interlinked global crises of climate change and biodiversity loss, and the critical role of protecting, conserving and restoring nature and ecosystems in delivering benefits for climate adaptation and mitigation, while ensuring social and environmental safeguards,

I. Science and urgency

1. *Recognizes* the importance of the best available science for effective climate action and policymaking;

2. *Welcomes* the contribution of Working Group I to the Intergovernmental Panel on Climate Change Sixth Assessment Report[1] and the recent global and regional reports on the state of the climate from the World Meteorological Organization, and *invites* the Intergovernmental Panel on Climate Change to present its forthcoming reports to the Subsidiary Body for Scientific and Technological Advice in 2022;

3. *Expresses alarm and utmost concern* that human activities have caused around 1.1 °C of global warming to date and that impacts are already being felt in every region;

4. *Stresses* the urgency of enhancing ambition and action in relation to mitigation adaptation and finance in this critical decade to address gaps between current efforts and pathways in pursuit of the ultimate objective of the Convention and its long-term global goal;

II. Adaptation

5. *Notes with serious concern* the findings from the contribution of Working Group I to the Intergovernmental Panel on Climate Change Sixth Assessment Report, including that climate and weather extremes and their adverse impacts on people and nature will continue to increase with every additional increment of rising temperatures;

6. *Emphasizes* the urgency of scaling up action and support, including finance, capacity-building and technology transfer, to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change in line with the best available science, taking into account the priorities and needs of developing country Parties;

7. *Welcomes* the national adaptation plans submitted to date, which enhance the understanding and implementation of adaptation actions and priorities;

8. *Urges* Parties to further integrate adaptation into local, national and regional planning;

9. *Invites* the Intergovernmental Panel on Climate Change to present to the Conference of the Parties at its twenty-seventh session (November 2022) the findings from the contribution of Working Group II to its Sixth Assessment Report, including those relevant to assessing adaptation needs, and *calls upon* the research community to further the understanding of global, regional and local impacts of climate change, response options and adaptation needs;

III. Adaptation finance

10. *Notes with concern* that the current provision of climate finance for adaptation remains insufficient to respond to worsening climate change impacts in developing country Parties;

11. *Urges* developed country Parties to urgently and significantly scale up their provision of climate finance, technology transfer and capacity-building for adaptation so as to respond to the needs of developing country Parties as part of a global effort, including for the formulation and implementation of national adaptation plans;

12. *Recognizes* the importance of the adequacy and predictability of adaptation finance, including the value of the Adaptation Fund in delivering dedicated support for adaptation;

13. *Welcomes* the recent pledges made by many developed country Parties to increase their provision of climate finance to support adaptation in developing country Parties in

[1] Intergovernmental Panel on Climate Change. 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*. V Masson-Delmotte, P Zhai, A Pirani, et al. (eds.). Cambridge: Cambridge University Press. Available at https://www.ipcc.ch/report/ar6/wg1/.

response to their growing needs, including contributions made to the Adaptation Fund and the Least Developed Countries Fund, which represent significant progress compared with previous efforts;

14. *Calls upon* multilateral development banks, other financial institutions and the private sector to enhance finance mobilization in order to deliver the scale of resources needed to achieve climate plans, particularly for adaptation, and *encourages* Parties to continue to explore innovative approaches and instruments for mobilizing finance for adaptation from private sources;

IV. Mitigation

15. *Reaffirms* the long-term global goal to hold 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, recognizing that this would significantly reduce the risks and impacts of climate change;

16. *Recognizes* that the impacts of climate change will be much lower at the temperature increase of 1.5 °C compared with 2 °C, and *resolves* to pursue efforts to limit the temperature increase to 1.5 °C;

17. *Also recognizes* that limiting global warming to 1.5 °C requires rapid, deep and sustained reductions in global greenhouse gas emissions, including reducing global carbon dioxide emissions by 45 per cent by 2030 relative to the 2010 level and to net zero around mid-century, as well as deep reductions in other greenhouse gases;

18. *Further recognizes* that this requires accelerated action in this critical decade, on the basis of the best available scientific knowledge and equity, reflecting common but differentiated responsibilities and respective capabilities and in the context of sustainable development and efforts to eradicate poverty;

19. *Invites* Parties to consider further actions to reduce by 2030 non-carbon dioxide greenhouse gas emissions, including methane;

20. *Calls upon* Parties to accelerate the development, deployment and dissemination of technologies, and the adoption of policies, to transition towards low-emission energy systems, including by rapidly scaling up the deployment of clean power generation and energy efficiency measures, including accelerating efforts towards the phasedown of unabated coal power and phase-out of inefficient fossil fuel subsidies, while providing targeted support to the poorest and most vulnerable in line with national circumstances and recognizing the need for support towards a just transition;

21. *Emphasizes* the importance of protecting, conserving and restoring nature and ecosystems, including forests and other terrestrial and marine ecosystems, to achieve the long-term global goal of the Convention by acting as sinks and reservoirs of greenhouse gases and protecting biodiversity, while ensuring social and environmental safeguards;

V. Finance, technology transfer and capacity-building for mitigation and adaptation

22. *Urges* developed country Parties to provide enhanced support, including through financial resources, technology transfer and capacity-building, to assist developing country Parties with respect to both mitigation and adaptation, in continuation of their existing obligations under the Convention, and *encourages* other Parties to provide or continue to provide such support voluntarily;

23. *Notes with concern* the growing needs of developing country Parties, in particular due to the increasing impacts of climate change and increased indebtedness as a consequence of the coronavirus disease 2019 pandemic;

24. *Welcomes* the first report on the determination of the needs of developing country Parties related to implementing the Convention and the Paris Agreement[2] and the fourth Biennial Assessment and Overview of Climate Finance Flows[3] by the Standing Committee on Finance;

25. *Emphasizes* the need to mobilize climate finance from all sources to reach the level needed to achieve the goals of the Paris Agreement, including significantly increasing support for developing country Parties, beyond USD 100 billion per year;

26. *Notes with deep regret* that the goal of developed country Parties to mobilize jointly USD 100 billion per year by 2020 in the context of meaningful mitigation actions and transparency on implementation has not yet been met, and *welcomes* the increased pledges made by many developed country Parties and the *Climate Finance Delivery Plan: Meeting the US$100 Billion Goal*[4] and the collective actions contained therein;

27. *Urges* developed country Parties to fully deliver on the USD 100 billion goal urgently and through to 2025, and *emphasizes* the importance of transparency in the implementation of their pledges;

28. *Urges* the operating entities of the Financial Mechanism, multilateral development banks and other financial institutions to further scale up investments in climate action, and *calls for* a continued increase in the scale and effectiveness of climate finance from all sources globally, including grants and other highly concessional forms of finance;

29. *Re-emphasizes* the need for scaled-up financial resources to take into account the needs of those countries particularly vulnerable to the adverse effects of climate change, and in this regard *encourages* relevant multilateral institutions to consider how climate vulnerabilities should be reflected in the provision and mobilization of concessional financial resources and other forms of support, including special drawing rights;

30. *Emphasizes* the challenges faced by many developing country Parties in accessing finance and *encourages* further efforts to enhance access to finance, including by the operating entities of the Financial Mechanism;

31. *Notes* the specific concerns raised with regard to eligibility and ability to access concessional forms of climate finance, and *re-emphasizes* the importance of the provision of scaled-up financial resources, taking into account the needs of developing country Parties that are particularly vulnerable to the adverse effects of climate change;

32. *Encourages* relevant providers of financial support to consider how vulnerability to the adverse effects of climate change could be reflected in the provision and mobilization of concessional financial resources and how they could simplify and enhance access to finance;

33. *Acknowledges* the progress made on capacity-building, particularly in relation to enhancing the coherence and coordination of capacity-building activities towards the implementation of the Convention and the Paris Agreement;

34. *Recognizes* the need to continue supporting developing country Parties in identifying and addressing both current and emerging capacity-building gaps and needs, and to catalyse climate action and solutions to respond;

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[2] See document FCCC/CP/2021/10/Add.2–FCCC/PA/CMA/2021/7/Add.2.

[3] See document FCCC/CP/2021/10/Add.1–FCCC/PA/CMA/2021/7/Add.1.

[4] Available at https://ukcop26.org/wp-content/uploads/2021/10/Climate-Finance-Delivery-Plan-1.pdf.

35. *Welcomes* the joint annual reports of the Technology Executive Committee and the Climate Technology Centre and Network for 2020 and 2021[5] and *invites* the two bodies to strengthen their collaboration;

36. *Emphasizes* the importance of strengthening cooperative action on technology development and transfer for the implementation of mitigation and adaptation action, including accelerating, encouraging and enabling innovation, and the importance of predictable, sustainable and adequate funding from diverse sources for the Technology Mechanism;

VI. Loss and damage

37. *Acknowledges* that climate change has already caused and will increasingly cause loss and damage and that, as temperatures rise, impacts from climate and weather extremes, as well as slow onset events, will pose an ever-greater social, economic and environmental threat;

38. *Also acknowledges* the important role of a broad range of stakeholders at the local, national and regional level, including indigenous peoples and local communities, in averting, minimizing and addressing loss and damage associated with the adverse effects of climate change;

39. *Reiterates* the urgency of scaling up action and support, as appropriate, including finance, technology transfer and capacity-building, for implementing approaches to averting, minimizing and addressing loss and damage associated with the adverse effects of climate change in developing country Parties that are particularly vulnerable to these effects;

40. *Urges* developed country Parties, the operating entities of the Financial Mechanism, United Nations entities and intergovernmental organizations and other bilateral and multilateral institutions, including non-governmental organizations and private sources, to provide enhanced and additional support for activities addressing loss and damage associated with the adverse effects of climate change;

41. *Recognizes* the importance of demand-driven technical assistance in building capacity to implement approaches to averting, minimizing and addressing loss and damage associated with the adverse effects of climate change;

42. *Welcomes* the further operationalization of the Santiago network for averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including the agreement on its functions and process for further developing its institutional arrangements;

43. *Endorses* paragraphs 67–70 and 73–74 of decision -/CMA.3;[6, 7]

44. *Acknowledges* the importance of coherent action to respond to the scale of needs caused by the adverse impacts of climate change;

45. *Resolves* to strengthen partnerships between developing and developed countries, funds, technical agencies, civil society and communities to enhance understanding of how approaches to averting, minimizing and addressing loss and damage can be improved;

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[5] FCCC/SB/2020/4 and FCCC/SB/2021/5.

[6] Draft decision entitled “Glasgow Climate Pact” proposed under agenda item 2(c) of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement at its third session.

[7] It is noted that discussions related to the governance of the Warsaw International Mechanism on Loss and Damage associated with Climate Change Impacts did not produce an outcome: this is without prejudice to further consideration of this matter.

VII. Implementation

46. *Recalls* that the round tables among Parties and non-Party stakeholders on pre-2020 implementation and ambition held in 2018, 2019 and 2020 helped to highlight and enhance understanding of the efforts of and challenges faced by Parties in relation to action and support in the pre-2020 period, as well as of the work of the constituted bodies in that period;

47. *Strongly urges* all Parties that have not yet done so to meet any outstanding pledges under the Convention as soon as possible;

48. *Welcomes* the action taken to unlock the potential for sectoral action to contribute to fulfilling and implementing national targets, particularly in emission-intensive sectors;

49. *Recognizes* the need to take into consideration the concerns of Parties with economies most affected by the impacts of response measures, particularly developing country Parties, in line with Article 4, paragraphs 8 and 10, of the Convention;

50. *Also recognizes* the importance of protecting, conserving and restoring ecosystems to deliver crucial services, including acting as sinks and reservoirs of greenhouse gases, reducing vulnerability to climate change impacts and supporting sustainable livelihoods, including for indigenous peoples and local communities;

51. *Encourages* Parties to take an integrated approach to addressing the issues referred to in paragraph 50 above in national and local policy and planning decisions;

52. *Recognizes* the need to ensure just transitions that promote sustainable development and eradication of poverty, and the creation of decent work and quality jobs, including through making financial flows consistent with a pathway towards low greenhouse gas emission and climate-resilient development, including through deployment and transfer of technology, and provision of support to developing country Parties;

VIII. Collaboration

53. *Recognizes* the importance of international collaboration on innovative climate action, including technological advancement, across all actors of society, sectors and regions, in contributing to progress towards the objective of the Convention and the goals of the Paris Agreement;

54. *Recalls* Article 3, paragraph 5, of the Convention and the importance of cooperation to address climate change and support sustainable economic growth and development;

55. *Recognizes* the important role of non-Party stakeholders, including civil society, indigenous peoples, local communities, youth, children, local and regional governments and other stakeholders, in contributing to progress towards the objective of the Convention and the goals of the Paris Agreement;

56. *Welcomes* the improvement of the Marrakech Partnership for Global Climate Action[8] for enhancing ambition, the leadership and actions of the high-level champions, and the work of the secretariat on the Non-state Actor Zone for Climate Action platform to support accountability and track progress of voluntary initiatives;

57. *Also welcomes* the high-level communiqué[9] on the regional climate weeks and *encourages* the continuation of regional climate weeks where Parties and non-Party

[8] Available at https://unfccc.int/sites/default/files/resource/Improved%20Marrakech%20Partnership%202021-2025.pdf.

[9] Available at https://unfccc.int/regional-climate-weeks/rcw-2021-cop26-communique.

stakeholders can strengthen their credible and durable response to climate change at the regional level;

58. *Further welcomes* the informal summary reports by the Chair of the Subsidiary Body for Scientific and Technological Advice on the ocean and climate change dialogue to consider how to strengthen adaptation and mitigation action and on the dialogue on the relationship between land and climate change adaptation related matters;

59. *Invites* Parties to submit views on how to enhance climate action on land under the existing UNFCCC programmes and activities in paragraph 75 of the report on the dialogue on the relationship between land and climate change adaptation related matters referred to in paragraph 58 above, and *requests* the Chair of the Subsidiary Body for Scientific and Technological Advice to prepare an informal summary report thereon and make it available to the Conference of the Parties at its twenty-seventh session;

60. *Invites* the relevant work programmes and constituted bodies under the UNFCCC to consider how to integrate and strengthen ocean-based action in their existing mandates and workplans and to report on these activities within the existing reporting processes, as appropriate;

61. *Also invites* the Chair of the Subsidiary Body for Scientific and Technological Advice to hold an annual dialogue, starting at the fifty-sixth session of the Subsidiary Body for Scientific and Technological Advice (June 2022), to strengthen ocean-based action and to prepare an informal summary report thereon and make it available to the Conference of the Parties at its subsequent session;

62. *Urges* Parties to swiftly begin implementing the Glasgow work programme on Action for Climate Empowerment, respecting, promoting and considering their respective obligations on human rights, as well as gender equality and empowerment of women;

63. *Expresses appreciation* for the outcomes of the sixteenth Conference of Youth, organized by the constituency of children and youth non-governmental organizations and held in Glasgow in October 2021, and the “Youth4Climate2021: Driving Ambition” event hosted by Italy in Milan, Italy, in September 2021;

64. *Urges* Parties and stakeholders to ensure meaningful youth participation and representation in multilateral, national and local decision-making processes, including under the Convention and the Paris Agreement;

65. *Invites* future Presidencies of the Conference of the Parties, with the support of the secretariat, to facilitate the organization of an annual youth-led climate forum for dialogue between Parties and youth in collaboration with the UNFCCC children and youth constituency and other youth organizations with a view to contributing to the implementation of the Glasgow work programme on Action for Climate Empowerment;

66. *Emphasizes* the important role of indigenous peoples’ and local communities’ culture and knowledge in effective action on climate change, and *urges* Parties to actively involve indigenous peoples and local communities in designing and implementing climate action and to engage with the second three-year workplan for implementing the functions of the Local Communities and Indigenous Peoples Platform, for 2022–2024;

67. *Expresses its recognition* for the important role the observer organizations play, including the nine non-governmental organization constituencies, in sharing their knowledge, and their calls to see ambitious action to meet the objectives of the Convention and collaborating with Parties to that end;

68. *Encourages* Parties to increase the full, meaningful and equal participation of women in climate action and to ensure gender-responsive implementation and means of implementation, which are vital for raising ambition and achieving climate goals;

69. *Calls upon* Parties to strengthen their implementation of the enhanced Lima work programme on gender and its gender action plan;[10]

70. *Takes note* of the estimated budgetary implications of the activities to be undertaken by the secretariat referred to in this decision;

71. *Requests* that the actions of the secretariat called for in this decision be undertaken subject to the availability of financial resources.

[10] Decision 3/CP.25.

Annex 3: GHG, CO2 emissions and warning characteristics of different mitigation pathways submitted to the ER6 scenarios database and as categorized in the climate assessment.

p50 (p5-p95) [0]	Global Mean Surface Air Temperature change		GHG emissions Gt CO_2-eq/yr			GHG emissions reductions from 2019 % [5]			Emissions milestones [6,7,8]			
Category [1, 2, 3, 4] [# pathways]	Category description	WG1 SSP & IPs alignment	2030	2040	2050	2030	2040	2050	Peak CO_2 emissions	Peak GHG emissions	net-zero CO_2 [% net-zero pathways]	net-zero GHGs [9] [% net-zero pathways]
C1 [97]	Below 1.5°C with no or limited overshoot	SP, LD Ren, SSP1-1.9	31 (21-36)	17 (6-23)	9 (1-15)	43 (34-60)	69 (58-90)	84 (73-98)	2020-2025 [100%] (2020-2025)	2020-2025 [100%] (2020-2025)	2050-2055 [100%] (2035-2070)	2095-2100 [52%] (2050-...)
C2 [133]	Below 1.5°C with high overshoot	Neg	42 (31-55)	25 (16-34)	14 (5-21)	23 (0-44)	55 (40-71)	75 (62-91)	2020-2025 [100%] (2020-2030)	2020-2025 [100%] (2020-2030)	2055-2060 [100%] (2045-2070)	2070-2075 [87%] (2055-...)
C3 [311]	Likely below 2°C	SSP2-2.6	44 (32-55)	29 (20-36)	20 (13-26)	21 (1-42)	46 (34-63)	64 (53-77)	2020-2025 [100%] (2020-2030)	2020-2025 [100%] (2020-2030)	2070-2075 [91%] (2060-...)	...-... [30%] (2075-...)
C3a [204]	Immediate action		40 (30-49)	29 (21-36)	20 (13-26)	27 (13-45)	47 (35-63)	63 (52-76)	2020-2025 [100%] (2020-2025)	2020-2025 [100%] (2020-2025)	2075-2080 [88%] (2060-...)	...-... [24%] (2080-..)
C3b [97]	NDCs	GS	52 (47-55)	29 (20-36)	18 (10-25)	5 (0-14)	46 (34-63)	68 (56-82)	2020-2025 [100%] (2020-2030)	2020-2025 [100%] (2020-2030)	2065-2070 [96%] (2060-2100)	...-... [42%] (2075-...)
C4 [159]	Below 2°C		50 (41-56)	38 (28-43)	28 (19-35)	10 (0-27)	31 (20-50)	49 (35-65)	2020-2025 [100%] (2020-2030)	2020-2025 [100%] (2020-2030)	2075-2080 [86%] (2065-...)	...-... [31%] (2075-...)
C5 [212]	Below 2.5°C		52 (46-56)	45 (36-52)	39 (30-49)	6 (-1-18)	18 (4-33)	29 (11-48)	2020-2025 [100%] (2020-2035)	2020-2025 [100%] (2020-2035)	...-... [40%] (2075-...)	...-... [11%] (2090-...)
C6 [97]	Below 3°C	SSP2-4.5 Mod-Act	54 (50-62)	53 (48-61)	52 (45-57)	2 (-10-11)	3 (-14-14)	5 (-2-18)	2030-2035 [96%] (2020-2085)	2030-2035 [96%] (2020-2085)	...-... [0%] (...-...)	...-... [0%] (...-...)
C7 [164]	Below 4°C	SSP3-7.0 Cur-Pol	62 (53-69)	67 (56-76)	70 (58-83)	-11 (-18-3)	-19 (-31-0)	-24 (-41--2)	2070-2075 [56%] (2025-2095)	2070-2075 [56%] (2025-2095)	...-... [0%] (...-...)	...-... [0%] (...-...)
C8 [29]	Above 4°C	SSP5-8.5	71 (68-80)	79 (77-96)	87 (82-112)	-20 (-34--17)	-35 (-66--29)	-46 (-92--36)	2080-2085 [89%] (2060-2095)	2080-2085 [89%] (2060-2095)	...-... [0%] (...-...)	...-... [0%] (...-...)

Category [1, 2, 3, 4] [# pathways]	Cumulative CO_2 emissions Gt CO_2 [10]		Cumulative net-negative CO_2 emissions Gt CO_2	Temperature change 50% probability [11] °C		Likelihood of staying below (%) [12]			Time when specific temeprature levels are reached (with a 50% probability)		
	2020 to netzero CO_2	2020-2100	year of net-zero CO_2 to 2100	at peak warming	2100	<1.5°C	<2.0°C	<3.0°C	1.5°C	2.0°C	3.0°C
C1 [97]	510 (330-710)	320 (-210-570)	-200 (-560-0)	1.6 (1.3-1.6)	1.3 (0.8-1.5)	38 (33-73)	90 (86-98)	100 (99-100)	2030-2035 [90%] (2030-...)	...-... [0%] (...-...)	...-... [0%] (...-...)
C2 [133]	720 (540-930)	400 (-90-620)	-330 (-620--30)	1.7 (1.4-1.8)	1.4 (0.8-1.5)	24 (15-58)	82 (71-95)	100 (99-100)	2030-2035 [100%] (2030-2035)	...-... [0%] (...-...)	...-... [0%] (...-...)
C3 [311]	890 (640-1160)	800 (500-1140)	-40 (-280-0)	1.7 (1.4-1.8)	1.6 (1.1-1.8)	20 (13-66)	76 (68-97)	99 (98-100)	2030-2035 [100%] (2030-2040)	...-... [0%] (...-...)	...-... [0%] (...-...)
C3a [204]	860 (640-1180)	790 (480-1150)	-10 (-280-0)	1.7 (1.4-1.8)	1.6 (1.1-1.8)	21 (14-70)	78 (69-97)	100 (98-100)	2030-2035 [100%] (2030-2040)	...-... [0%] (...-...)	...-... [0%] (...-...)
C3b [97]	910 (720-1150)	800 (560-1050)	-70 (-300-0)	1.8 (1.4-1.8)	1.6 (1.1-1.7)	17 (12-61)	73 (67-96)	99 (98-99)	2030-2035 [100%] (2030-2035)	...-... [0%] (...-...)	...-... [0%] (...-...)
C4 [159]	1210 (970-1500)	1160 (700-1490)	-30 (-390-0)	1.9 (1.5-2.0)	1.8 (1.2-2.0)	11 (7-50)	59 (50-93)	98 (95-99)	2030-2035 [100%] (2030-2035)	...-... [0%] (...-...)	...-... [0%] (...-...)
C5 [212]	1780 (1400-2360)	1780 (1260-2360)	0 (-140-0)	2.2 (1.6-2.5)	2.1 (1.5-2.5)	4 (0-28)	37 (18-84)	91 (83-99)	2030-2035 [100%] (2030-2035)	2060-2065 [99%] (2055-2095)	...-... [0%] (...-...)
C6 [97]	2790 (2440-3520)	2790 (2440-3520)	0 (0-0)	2.7 (2.0-2.9)	2.7 (2.0-2.9)	0 (0-2)	8 (2-45)	71 (53-96)	2030-2035 [100%] (2030-2035)	2050-2055 [100%] (2045-2060)	...-... [0%] (...-...)
C7 [164]	4220 (3160-5000)	4220 (3160-5000)	0 (0-0)	3.5 (2.5-3.9)	3.5 (2.5-3.9)	0 (0-0)	0 (0-5)	22 (7-80)	2030-2035 [100%] (2030-2035)	2045-2050 [100%] (2045-2055)	2080-2085 [100%] (2070-2100)
C8 [29]	5600 (4910-7450)	5600 (4910-7450)	0 (0-0)	4.2 (3.3-5.0)	4.2 (3.3-5.0)	0 (0-0)	0 (0-0)	4 (0-27)	2030-2035 [100%] (2025-2035)	2040-2045 [100%] (2040-2050)	2065-2070 [100%] (2060-2075)

Source: IPCC AR6 WGIII

Annex 4: Accounting for the climate–carbon feedback in emission metrics

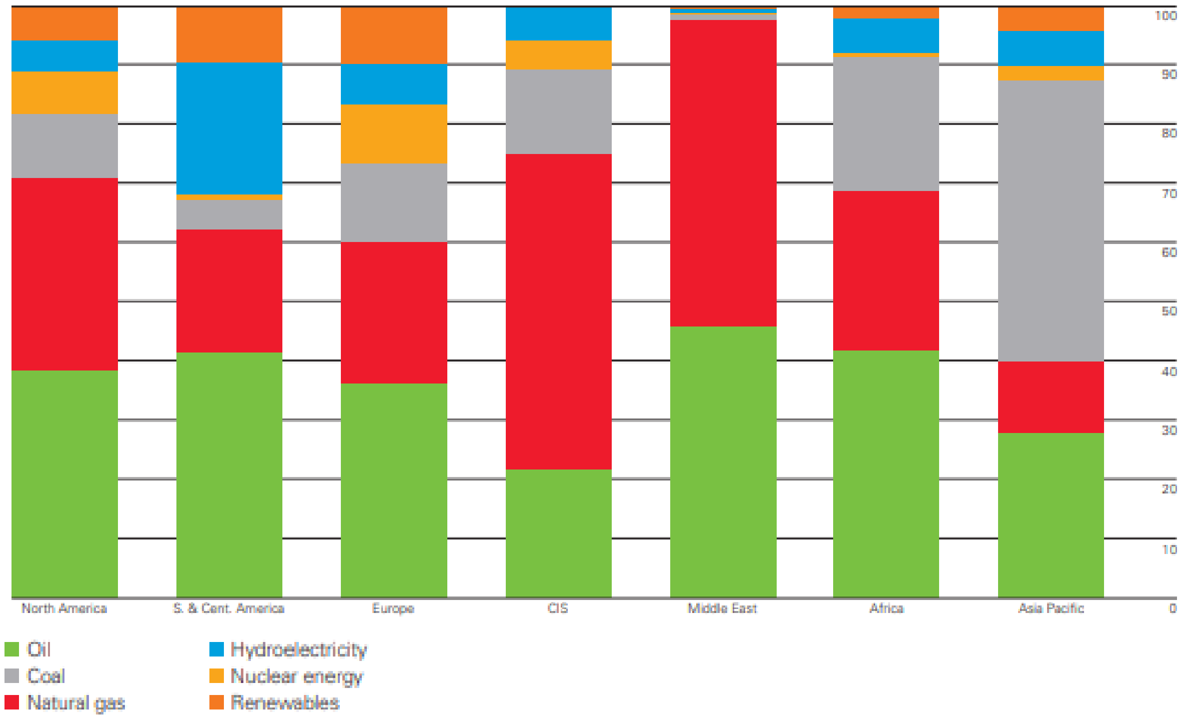
	GWP			GTP		
Time horizon (in years)	20	50	100	20	50	100
			CH_4^a			
AR5 (default)[b]	84	48	28	67	14	4
AR5 + Collins[b]	*85*	52	34	70	20	11
AR5 + OSCAR	86	52	31	70	18	5
AR5 + OSCAR + climate IRF update	86	51	31	60	14	7
AR5 + OSCAR + IRF and REs updates	96	57	34	67	16	7
All OSCAR	96	57	34	66	18	9
All OSCAR (no CC-fdbk)	96	57	34	65	16	8
			N_2O			
AR5 (default)[b]	*263*	275	*264*	*276*	*281*	234
AR5 + Collins[b]	*267*	290	*297*	*283*	311	297
AR5 + OSCAR	269	289	283	285	304	258
AR5 + OSCAR + climate IRF update	270	288	281	294	300	253
AR5 + OSCAR + IRF and REs updates	256	274	267	279	285	240
All OSCAR	255	273	267	279	283	241
All OSCAR (no CC-fdbk)	257	275	269	282	286	244
			SF_6			
AR5 (default)[b]	17 500	20 500	*23 600*	*19 000*	*23 900*	*28 300*
AR5 + Collins[b]	17 800	21 600	26 200	19 400	26 000	33 700
AR5 + OSCAR	17 900	21 500	25 200	19 500	25 500	30 800
AR5 + OSCAR + climate IRF update	18 000	21 500	25 000	20 500	25 900	30 400
AR5 + OSCAR + IRF and REs updates	17 600	21 100	24 500	20 100	25 400	29 800
All OSCAR	17 600	21 000	24 500	20 100	25 200	29 400
All OSCAR (no CC-fdbk)	17 700	21 200	24 800	20 400	25 600	30 200
			BC^c			
AR5 (default)[b]	1560	736	426	451	71	58
AR5 + Collins[b]	1620	818	519	528	172	165
AR5 + OSCAR	1630	794	465	525	110	69
AR5 + OSCAR + climate IRF update	1630	787	460	210	116	90
AR5 + OSCAR + IRF and REs updates	1600	772	451	206	114	88
All OSCAR	1590	769	450	213	147	105
All OSCAR (no CC-fdbk)	1570	760	448	165	128	101
			SO_2^c			
AR5 (default)[b]	−140	−66	−38	−40	−6	−5
AR5 + Collins[b]	−145	−73	−47	−47	−15	−15
AR5 + OSCAR	−146	−71	−42	−47	−10	−6
AR5 + OSCAR + climate IRF update	−146	−71	−41	−19	−10	−8
AR5 + OSCAR + IRF and REs updates	−143	−69	−41	−18	−10	−8
All OSCAR	−143	−69	−40	−19	−13	−9
All OSCAR (no CC-fdbk)	−141	−68	−40	−15	−11	−9

[a] Because we use a numerical resolution method while the IPCC used an analytical one, some values in these rows may differ from the IPCC values by 1 because of the rounding (by 100 in the case of SF6); these differing values are shown in italic font.
[b] This does not account for the oxidation of CH4 into CO2 (see e.g. Boucher et al., 2009).
[c] Metrics for BC and SO2 are not directly provided by the IPCC; rather, we use here the IPCC method with lifetimes and radiative efficiencies from Fuglestvedt et al. (2010).

Notes: The first row ("AR5 default") shows the base metrics as calculated by the IPCC AR5 (Myhre et al., 2013; Table 8.A.1). The second row ("AR5 + Collins") shows the metrics proposed in the IPCC AR5 as a first attempt to account for the climate–carbon feedback (their Table 8.7). The third row ("AR5 + OSCAR") shows the metrics when using our climate–carbon feedback IRF. The fourth row ("AR5 + OSCAR + climate IRF update") shows the same metrics as the third row, except that the climate IRF (λrT) is updated to one based on an ensemble of CMIP5 models (Geoffroy et al., 2013). The fifth row ("AR5 + OSCAR + IRF & REs updates") is the same as the fourth one, except that we also update the radiative efficiencies (REs) of CO2, CH4 and N2O (Etminan et al., 2016). The sixth row ("all OSCAR") shows the metrics obtained when all IRFs used are based on OSCAR and the radiative efficiencies are also updated, with inclusion of the climate–carbon feedback. The seventh and last row ("all OSCAR no CC-fdbk") shows the same as the sixth row, but this time without including the feedback: neither for CO2 nor for non-CO2 species.

Source : T. Gasser et al.

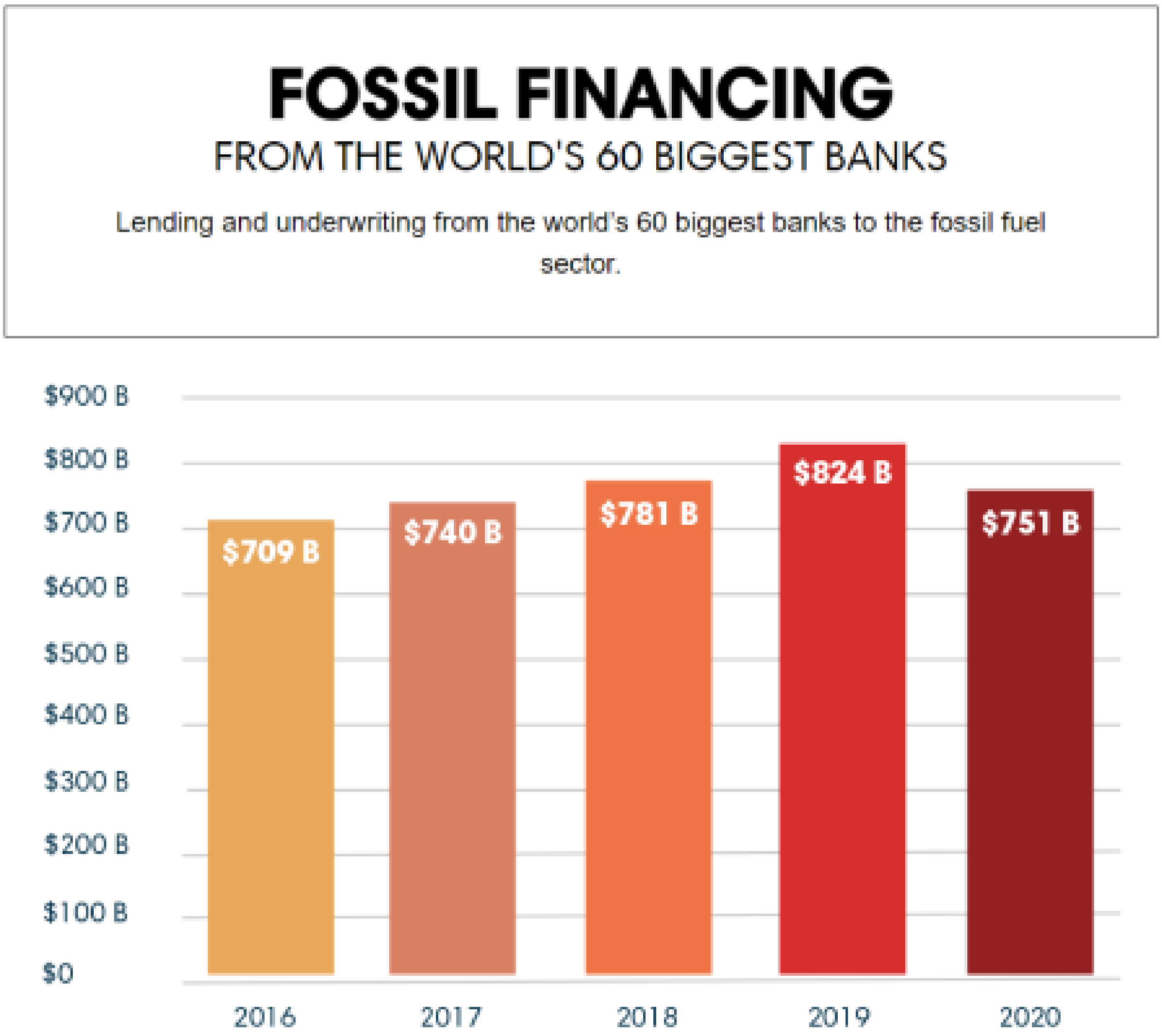
Annex 5: Regional energy consumption pattern 2019 (%)



Note: Oil remains the dominant fuel in Africa, Europe and the Americas, while natural gas dominates in CIS (Commonwealth of Independant States) and the Middle East, accounting for more than half of the energy mix in both regions. Coal is the dominant fuel in the Asia Pacific region. In 2019 coal's share of primary energy fell to its lowest level in our data series in North America and Europe

Source: BP Statistical Review of World energy, 2020, 69th edition

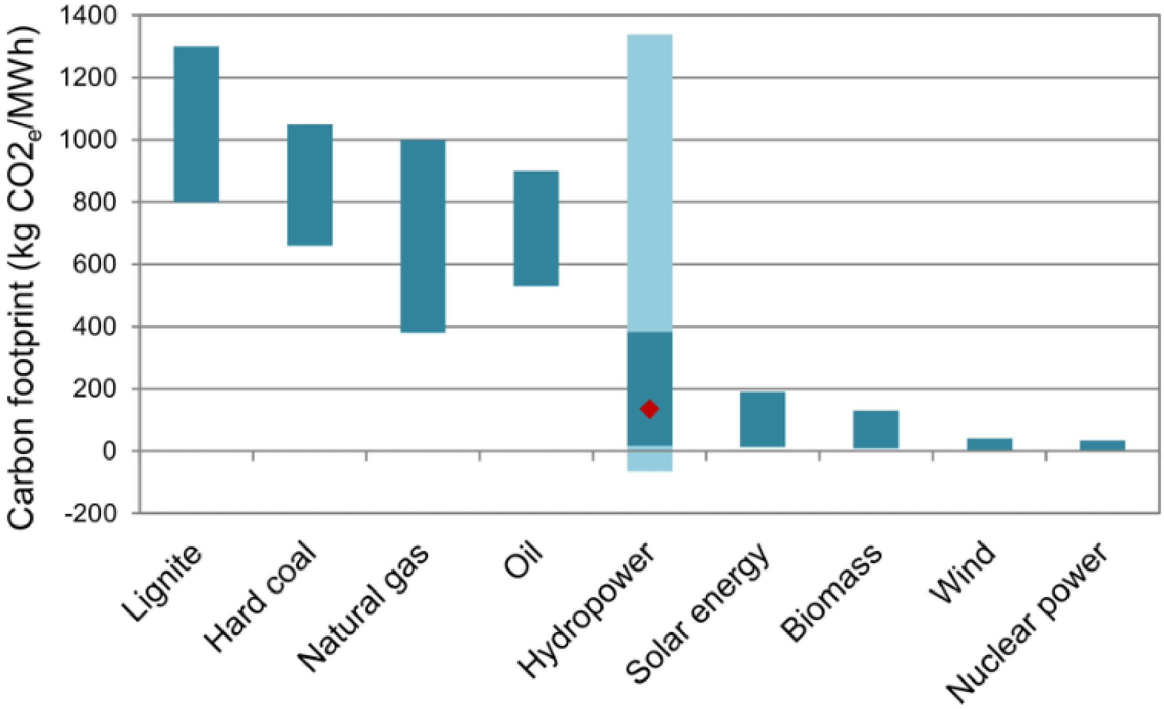
Annex 6: Fossil Financing from the world's 60 biggest banks



Note: The decline in 2020 does not indicate that the banking sector has taken environmental issues into account, since it must be considered in the light of the global pandemic of COVID-19, which has greatly slowed or even stopped trade and human travel.

Source: Bankingonclimatechaos.org

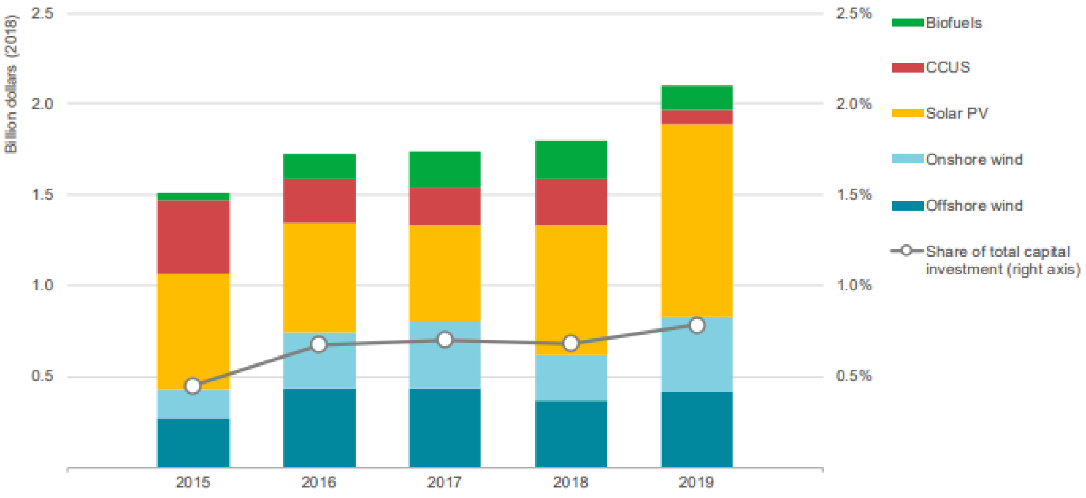
Annex 7: Carbon footprint of various sources of energy



Note: The lower and upper value of the dark bar for hydropower are the lower and upper quartiles for the corrected model average (Model AC). The light extensions represent the 10 and 90% quantiles and the red diamond marks the median.

Source: Scherer L, Pfister S (2016).

Annex 8: Capital investment by Major oil and gas industries in new project outside core areas in % of overall capital expenditure.

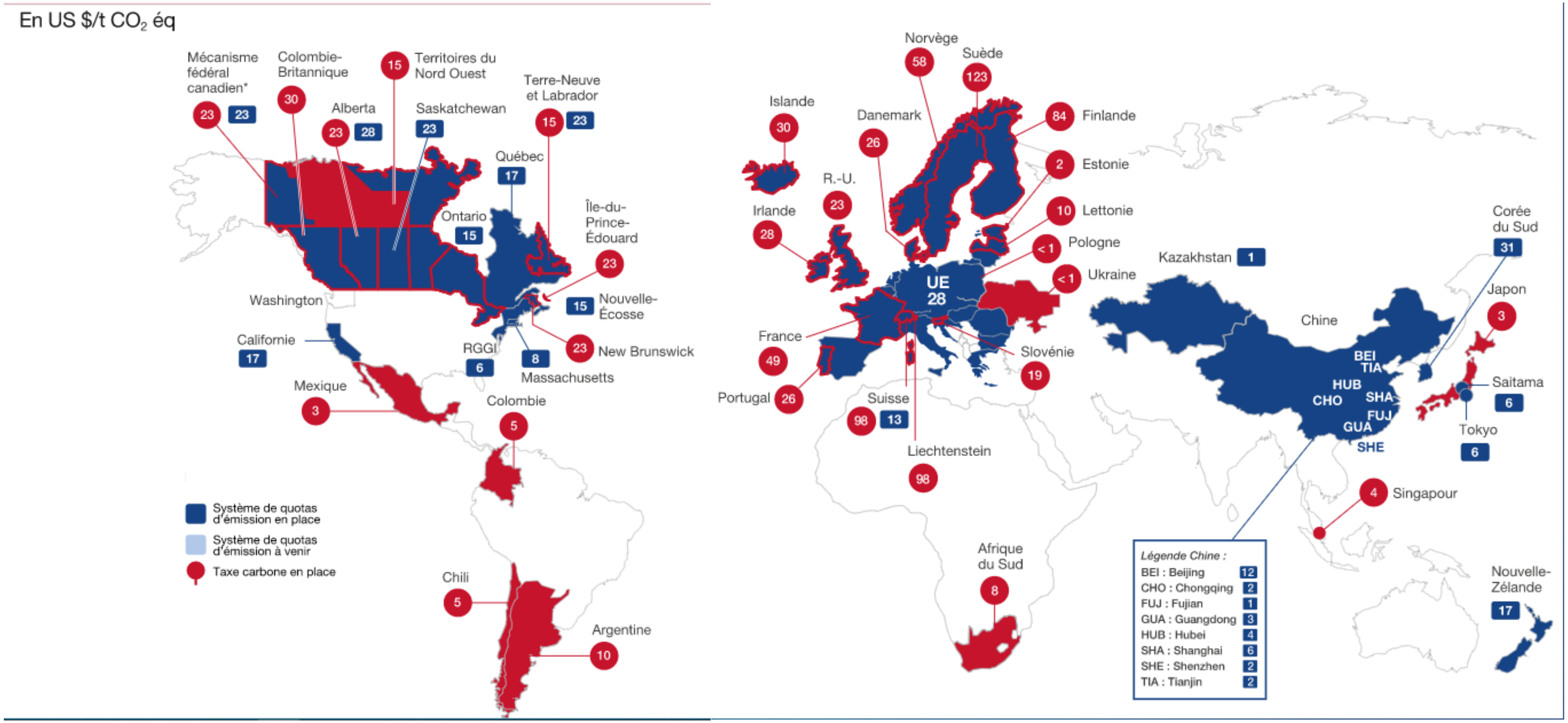


Note 1: Companies include the Majors (BP, Chevron, ExxonMobil, Shell, Total, ConocoPhillips and Eni) and selected others (ADNOC, CNPC, CNOOC, Equinor, Gazprom, Kuwait Petroleum Corporation, Lukoil, Petrobras, Repsol, Rosneft, Saudi Aramco, Sinopec, Sonatrach).

Note 2: Capital investment is measured as the ongoing capital spending in new capacity from when projects start construction and are based on the owner's share of the project. CCUS investment is in large-scale facilities; it includes developments by independent oil and gas companies in Canada and China and capital spend undertaken with government funds.

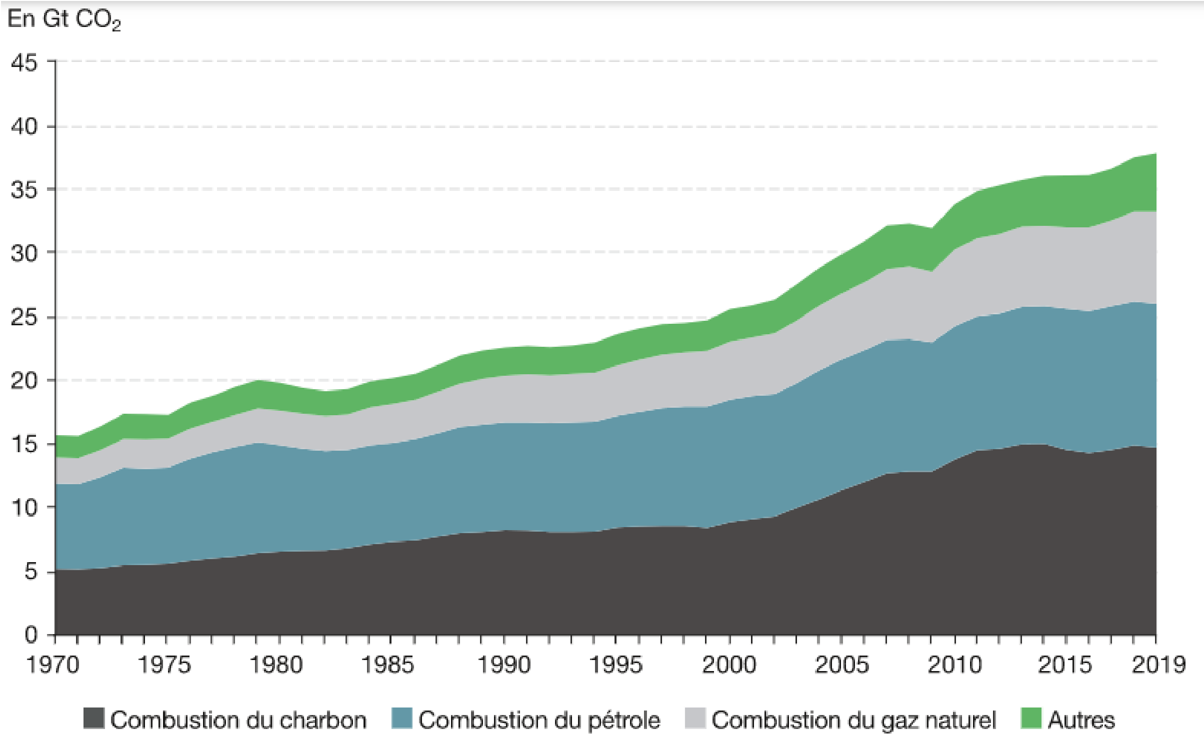
Source: IEA

Annex 9: Global overview of carbon prices as of May 1, 2020.



Source : Ministère de la Transition écologique

Annex 10: CO_2 emissions from fossil fuel combustion in the world.



Note: The "Autres" category is related to industrial processes (such as the transformation of limestone into lime to make cement).

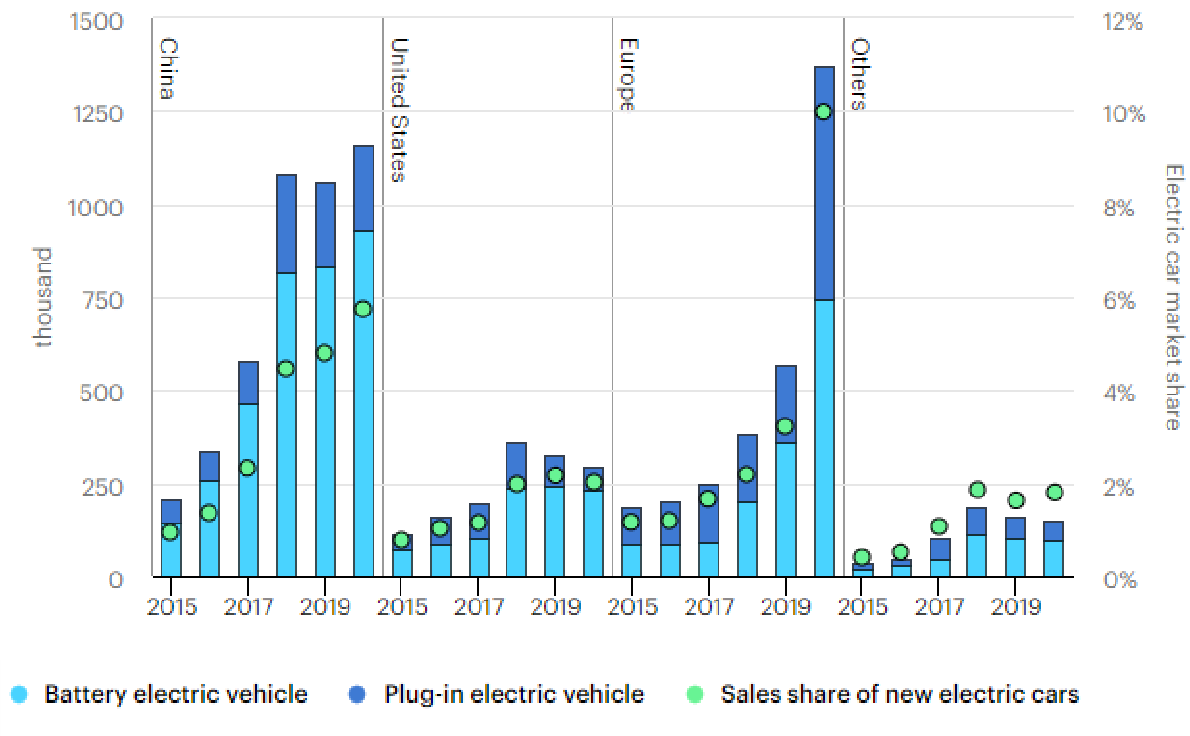
Source : Ministère de la transition écologique Français.

Annex 11: Exclusion policies for coal mining and processing and upstream oil and gas in major MDBs and G20 DFIs by asset size.

Notes: Upstream activities include all the steps involved from the preliminary exploration through the extraction of the resource. They do not cover power generation and transportation. Exclusion policies usually apply only to future investments, current assets are displayed as indicative information.

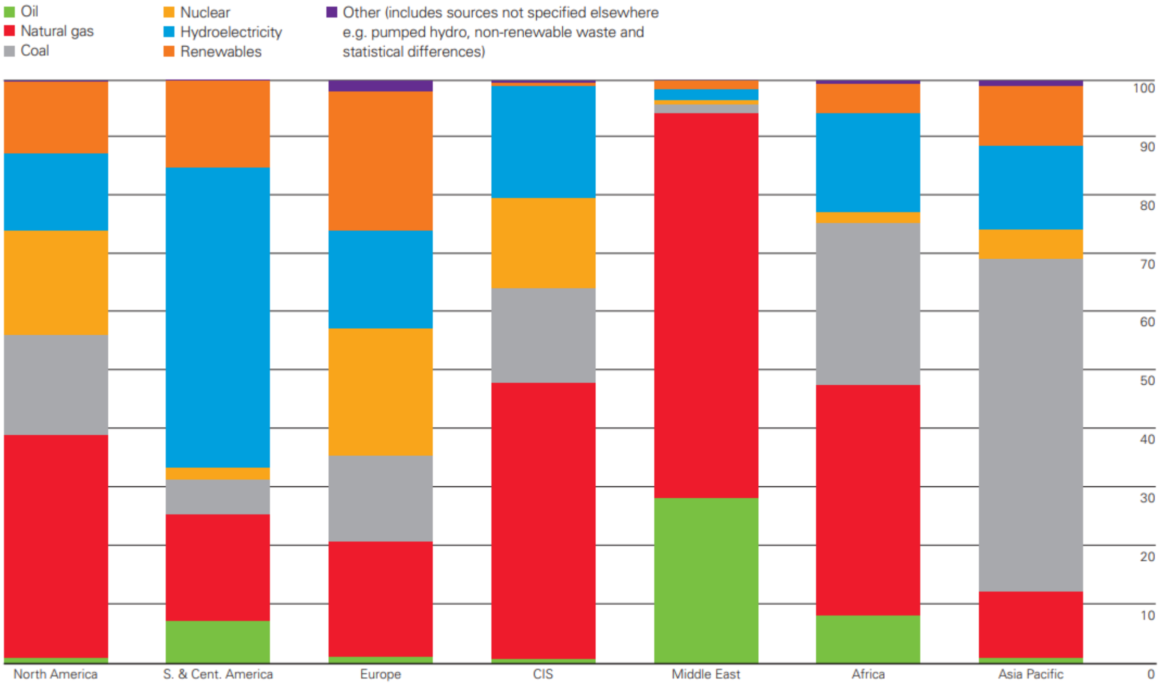
Source: The Production Gap: 2021 Report

Annex 12: Global electric car registrations and market share, 2015-2020.



Source: IAE

Annex 13: Regional electricity generation by fuel (%) 2020.



Natural gas is the dominant fuel used for power generation in North America, CIS, the Middle East and Africa. More than half of the power in South and Central America is hydroelectricity, while in Asia, coal comprises 57% of the generation mix – a far higher share than any other region. In Europe, renewables (including biopower) are the largest source of power generation with 23.8% for the first time, overtaking nuclear on 21.6%. Generation in Europe is spread fairly evenly between renewables, nuclear, gas (19.6%) and hydro (16.9%).

Source: BP statistical review of world energy 2021.