GLOBAL
OBSERVATORY
OF CLIMATE ACTION

GLOBAL SYNTHESIS REPORT ON CLIMATE ACTION

OVERVIEW OF THE PROGRESS MADE BY NON-STATE ACTORS SINCE THE PARIS AGREEMENT

IN PARTNERSHIP WITH
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CLIMATE CHANCE

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RONAN DANTEC

President of Climate Chance

This sixth edition of the Global Synthesis Report on Cliimate Action contributes to the first "Global Stocktake" of the Paris Agreement, the evaluation of collective progress made since 2015, which will be presented at COP28. This report is based on the work produced by the Observatory and associated researchers over the last five years, with the freedom of analysis of a fully independent association.

This report aims to be realistic about the situation. We will not achieve the objective of stabilising the climate below a 1.5 °C rise in temperature; the 2 °C objective, with its already more devastating consequences, is also getting more distant. But beyond these observations, Climate Chance is driven by the desire to mobilise and strengthen action. This Report shows the proliferation of initiatives, the success of ambitious actions, the real transformation of certain sectors and the key role played by local and regional authorities.

A number of global trends are keeping hopes alive that the climate will stabilise at levels below current trajectories. Firstly, the development of renewable energies, which now account for the majority of global energy investments. But the speed at which they are being deployed is still not enough to reduce the share of fossil fuels, while investment by the oil majors remains too low; oil money continues to go to oil. But European governments, local authorities, large companies and citizens' movements are showing that it is possible to speed things up.

The electrification of end-uses is a second reason for hope. From China to Europe, the impressive transformation of the automotive sector, with the prospect of the internal combustion engine being phased out in around fifteen years, shows that the synergy between government regulations and the proactive strategies of industrial groups can produce real results.

Thus, there are positive signs, even if this report does not ignore a very clear global trend: the convergence of lifestyles based on highly consumerist models. We can no longer see the world as being divided into a North that emits CO_2 and a South that suffers the consequences. We live on a planet where the rich and the urban middle classes emit unsustainable quantities of CO_2, be it in China or the United States, in Europe or even in large African cities. This trend stands in the way of a reduction in global emissions and of a just transition. The cultural battle for sufficiency is far from won.

An uncompromising report, major trends that cannot be masked, interesting dynamics, a flurry of initiatives... This sixth Global Synthesis Report on Climate Action is therefore intended to contribute to our knowledge of the reality of action. Without lucid analysis, it is impossible to define credible scenarios for stabilising the climate, which are necessary to mobilise and commit to the issues at stake.

PASCAL CHARRIAU

President of Enerdata

2023 marks the conclusion of the first "Global Stocktake" of the Paris Agreement, evaluating the progress accomplished since it was signed in 2015. This is an excellent opportunity to take a step back, to separate structural changes from cyclical factors and, ultimately, to assess our ability to achieve a satisfactory trajectory for the decarbonization of society.

What stands out when we compare the situation in 2022 with "where we should have been on a trajectory below 2 °C, as targeted at COP 21"?

- Global CO_2 emissions have continued to rise, when they should have started to fall.

- The global economy is the main factor driving up energy consumption and CO_2 emissions – but it has not grown as much as expected due to various crises.

- The decoupling of activity and energy consumption ("energy intensity") is very weak and far from the targeted trajectories; energy efficiency gains are therefore too limited.

- Energy consumption continues to grow and remains highly carbon-intensive. The "emissions factor" (CO_2 emissions per unit of energy) is barely falling. While the development of renewable energies is accelerating, fossil fuels are not yet on the decline.

- In short, we are not yet on the right trajectory (below 2 °C), or even on the trajectory that corresponds to the commitments made by countries (NDCs).

This report also shows that positive signals of a real transformation in specific sectors or geographical zones, such as:

- The electrification of end-uses, a major driver of efficiency gains and decarbonization potential, is continuing to develop (electric vehicles, buildings, industry, etc.),

- Electricity generation from renewable sources is increasing strongly throughout the world,

- Many countries and local governments are adopting increasingly ambitious targets and policies.

Beyond the facts and figures, there are other encouraging signs to be confirmed in the near future:

- Local and regional players are becoming leaders in transformation

- Companies are gradually incorporating climate objectives into their strategic priorities

- Reduced energy consumption and the development of energy sufficiency policies are (finally) taking on a significant role in public debate

- The collective awareness of the need for far-reaching change is helping to push for greater demands from decision-makers and confidence in their ability to mobilise the community. And prospecting studies show that the transformation that is about to take place can be a source of improvement in the quality of life, reduced inequalities, reasonable development...

The intuition underlying Climate Chance is becoming more important by the day: valuing and deploying the initiatives and successes of non-state actors is essential to accelerating change. This report is both a clear assessment of the current situation and a source of inspiration for action...

EMISSIONS

Nº 1 Despite the adoption of the Paris Agreement and the Covid-19 pandemic, global CO_2 emissions continue to grow

- Global CO_2 emissions hit a new record in 2022, despite the drop observed in 2020 during the Covid-19 pandemic.
- Emissions have plateaued in the OECD. The EU and the UK have embarked on a sustained reduction in their territorial emissions. The trend has been more erratic in the United States since 2000. Japan reached its peak in 2013, as did Australia in 2017 and South Korea in 2018, more as a result of weak GDP growth than a real shift in the energy mix.
- Emissions are growing mainly in non-OECD countries, which now account for 60% of global emissions. More than 70% of the growth in global emissions since 2000 has taken place in China, where per capita emissions even exceed those of the EU. Despite strong growth, per capita emissions in India and Indonesia remain well below those of the industrialised countries.
- Carbon inequalities are increasingly well measured, and can now be observed both between nations and between income levels within countries. For example, the carbon footprint of China's middle and upper classes is converging with that of industrialised countries, and increasing the gap with the lowest incomes.

KEY FIGURES

Global emissions have not dropped since the Paris Agreement

- **52.8 Gt** of greenhouse gases emissions (excluding land-use) in 2021, vs. 49.2 $GtCO_2e$ in 2016 (UNEP, 2022).
- **+7.2% CO_2 emitted** between 2015 (35.6 $GtCO_2$) and 2022 (38.2 $GtCO_2$), in cumulative annual growth. 88% of these emissions were from fossil fuel combustion (Enerdata, 2023).
- **48% of global CO_2 emissions** are linked to energy production, ahead of industry (23%), transport (20%), buildings (8%), and agriculture (1%) (*ibid.*).

The intersecting trajectories of territorial emissions in emerging and industrialised economies

- **84% of global emissions are from the G20**, a constant share since 2000. But 49% from BRICS in 2022, vs. 28% in 2000. China's, India's and Indonesia's emissions have grown fivefold (*ibid.*).
- **The European Union (-25,6%)**, the United Kingdom (-42.6%), Japan (-9.1%), the Unites States (-1,9%) have reduced their emissions from 1990 to 2022.
- **-0,13 tCO_2 per capita** between the peak in 2013 (4.4 tCO_2 per capita) and 2022 (4.27 tCO_2 per capita) at the global level (*ibid.*).

The carbon footprint of the middle and upper classes widens inequalities in emissions

- **The world's leading emitter**, China's carbon footprint (8.3 tCO_2 per capita) is still smaller than that of the EU (11 tCO_2 per capita) and the United States (21 tCO_2 per capita) (INSEE, 2023).
- **1/3 of the carbon footprint of the EU** stems from its imports, vs. 26% in case of the US and 14% in China (*ibid.*).
- **The richest 10% emit 48% of global emissions** (IEA, 2023). 2/3 of carbon footprint inequalities stem from within countries, rather than between them, as the upper-middle classes of emerging economies expand (Chancel, 2022).

FURTHER READING

- Global Synthesis Report on Climate Action by Sector – 2018, 2019, 2020, 2021, 2022
- Global Synthesis Report on Climate Finance – 2018, 2019, 2020, 2022
- Global Synthesis Report on Local Climate Action – 2018, 2019, 2021, 2022
- Global Energy Trends 2023 (Enerdata)

TRENDS
EMISSIONS

Since the Paris Agreement, emissions have reached a record high despite transitions underway in some sectors

ANTOINE GILLOD • Director of the Global Observatory of Climate Action, Climate Chance

Global CO_2 emissions reached a new record in 2022. At a time when most of the negotiation items under the Paris Agreement are stumbling over the issue of financing and North-South solidarity, the intersecting emission trajectories of the industrialised countries and the major emerging economies are redrawing the divisions between past, present and future responsibilities. Nevertheless, territorial emissions, fruit of the international division of economic activities, mask major inequalities in carbon footprints between nations, reflecting the general level of consumption of their inhabitants. Carbon footprint inequalities are now widening as much between income levels within countries as between countries: the middle and affluent classes in the major emerging economies, especially in China, are adopting lifestyles that are just as carbon-intensive as those in industrialised countries. Public support for coal-fired power stations in the countries of the South and the inability of the countries of the North to embark on in-depth decarbonisation of their end-uses (transport, buildings, etc.) have led to the trends of transition identified in some industrial sectors.

Record concentrations of greenhouse gases are accelerating the rise in temperatures

In 2022, global surface temperatures were 1.15 [1.02 to 1.28] °C higher than pre-industrial temperatures recorded between 1850 and 1900, according to observations by the World Meteorological Organisation (WMO).[1] This warming is the result of the increase in the concentration of greenhouse gases (GHGs) in the atmosphere from the pre-industrial period (1750) to the present day: +149% in carbon dioxide (CO_2), +262% in methane (CH_4) and +124% in nitrous oxide (N_2O). These levels of concentration had not been observed for hundreds of thousands of years. The concentration of CO_2, which had never exceeded 300 ppm for 800,000 years,[2] rose from 278.3 ppm in 1750 to 285.5 ppm in 1850, then to 400 ppm in 2015, peaking at 415.7 ppm in 2021, the last year for which consolidated figures are available.[3]

As early as 1896, the Swedish chemist and physicist Svante Arrehnius identified the link between CO_2 emissions linked to human activities and the possibility of global warming. Since it was set up in 1988, the Intergovernmental Panel on Climate Change (IPCC) has consistently confirmed the influence of human activities on the climate system in its publications, going so far as to state in its sixth assessment report that the human origin of global warming is now "unequivocal".[4] For the past six years, the Observatory has therefore been looking at anthropogenic emissions, in order to tell the complex story of on-the-ground action that underlies the changes in emissions.

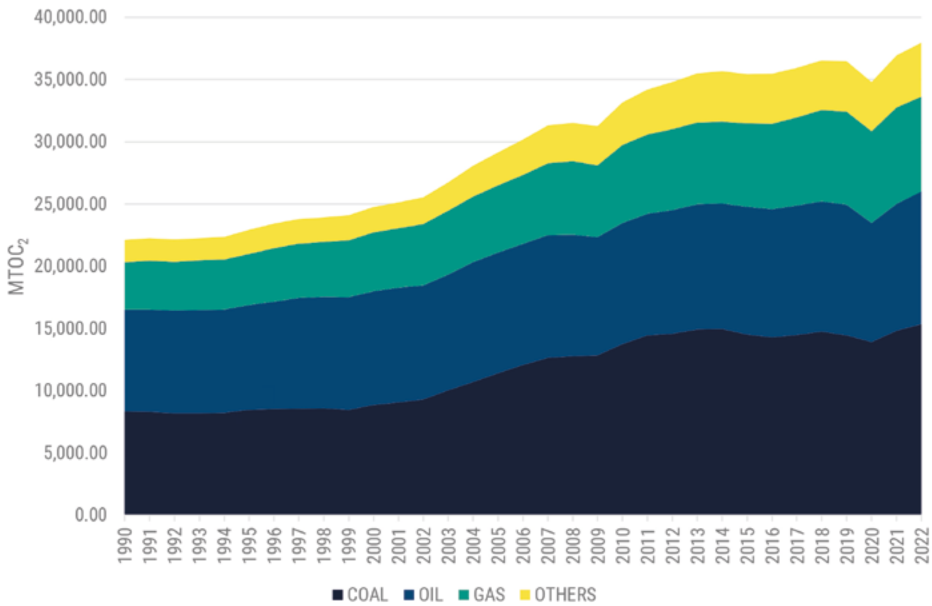
Since the Paris Agreement, global emissions continue to break records

Global greenhouse gas (GHG) emissions excluding land use, land-use change and forestry (LULUCF) amounted to 52.8 gigatonnes of CO_2-equivalent ($GtCO_2e$) in 2021, according to the 2022 edition of the United Nations Environment Programme's (UNEP) "Emissions Gap" report.[5] This is lower than the peak of 56.4 $GtCO_2e$ reached in 2019, due to the pandemic-driven fall in emissions in 2020, but already much higher than the 51 $GtCO_2e$ recorded in 2010 and the 42 $GtCO_2e$ measured in 2000. These figures include all greenhouse gases, the main ones being carbon dioxide (around 75%) and methane (around 16%), followed by other gases such as nitrous oxide, sulphur hexafluoride (SF_6) and fluorinated gases (F-gases).

FIGURE 1

GLOBAL CO_2 EMISSIONS BY FUEL, 1990-2022 ($MTCO_2$)

Source: Climate Chance, based on data from Enerdata



Global CO_2 emissions excluding LULUCF rose from 35.6 $GtCO_2$ in 2015 to 38.2 $GtCO_2$ in 2022, according to Enerdata figures, a growth of 7.2%. The annual growth rate of CO_2 emissions between 2010 and 2022 (1%) is lower than that observed during the decades 2000-2010 (2.7%) and 1990-2000 (1.1%). **88% (33.9 $GtCO_2$) of these CO_2 emissions were attributable to the combustion of fossil fuels** (**FIGURE 1**): coal (46%), oil (29%) and gas (24%). The remaining 12% came from industrial processes. Emissions associated with forests, agriculture and land use change are examined later in this report (**CF. "LAND USE" TRENDS**).

The global energy mix is still heavily dependent on fossil fuels (**CF. "ELECTRICITY" TRENDS**). Between 2015 and 2022, the annual consumption of petrol, gas and coal in absolute terms has increased by 4%, 16.5% and 8% respectively. **While the use of fossil fuels to generate electricity has fallen slightly since 2015, their share of the global energy mix has remained stable at around 80% for decades**.[6] Investment in renewable energies has only partially offset the structural decline in coal, which has also increased the share of gas, though this has been hindered by geopolitical events since 2020. The Observatory has analysed this duality in the transition of power generation away from coal in a number of countries that have recently fully or partially phased out coal, such as the United Kingdom,[7] the United States[8] or Spain.[9]

The sectoral breakdown of emissions has stayed stable

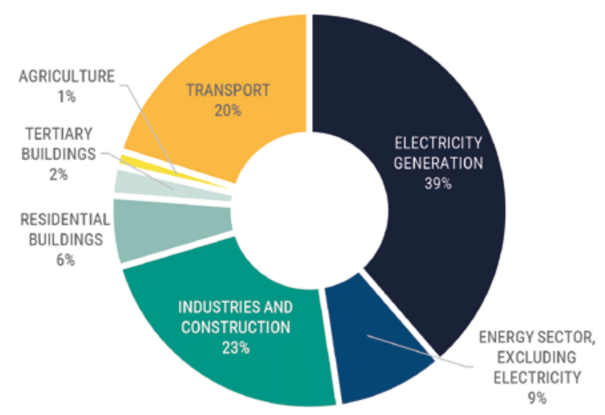
CO_2 emissions from combustion originate from the consumption of hydrocarbon-based and mineral solid fuels used in the various energy production and consumption activities (**FIGURE 2**). Energy industries, such as power generation and refining, were responsible for almost half (48%) of global CO_2 emissions in 2022. Manufacturing and construction industries, such as iron and steel and chemicals, accounted for 23% of emissions, followed by transport (20%), residential and tertiary buildings (8%) and agriculture (1%). This breakdown has not changed much since the signing of the Paris Agreement, or since 1990, except that emissions linked to energy production are taking up a little more space, mainly due to efficiency gains in other sectors.

On the other hand, the sectoral composition of emissions can vary more significantly from country to country. In France, for example, where electricity production is relatively low-carbon due to the country's nuclear fleet, the share of emissions linked to energy production is much lower (14%), and that of transport much higher (43%). Thus, each country is in a position to determine its priorities for action according to the origin of its emissions.

FIGURE 2

GLOBAL CO_2 EMISSIONS BY SECTOR, 2022 ($MTCO_2$)

Source: Climate Chance, based on data from Enerdata

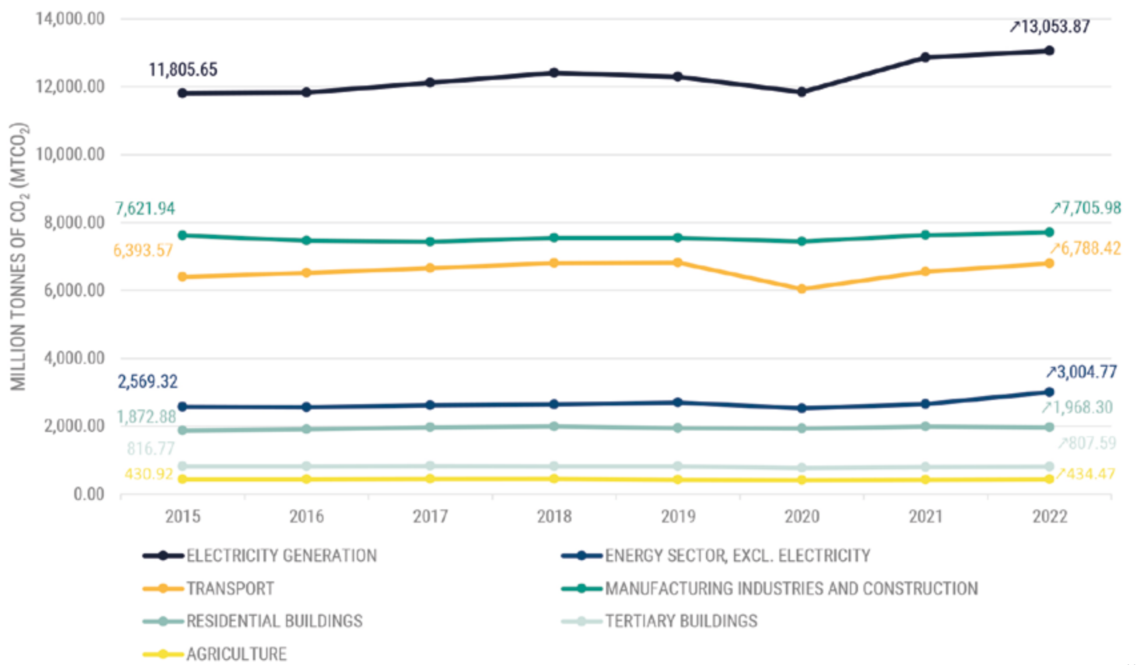


Since the Paris Agreement, not a single sector has escaped the general trend of increasing CO_2 emissions (**FIGURE 3**). The only blip in this trend has been the Covid-19 pandemic and the lockdown decisions by countries, which slowed the economy to the point of generating the biggest drop in emissions (-4.8%) since the 2009 economic crisis (-1.1%), particularly affecting the transport sector (-11.4%). However, after a spectacular rebound in 2021 under the effect of economic stimulus policies when the lockdowns were gradually lifted, emissions have very quickly returned to their growth rate and are already above their pre-pandemic levels (2019), except for transport and tertiary buildings. The various sectoral "Trends" in this report take a more in-depth look at the trajectories of each emissions sector (**CF. "TRANSPORT" AND "BUILDINGS" TRENDS**).

FIGURE 3

GLOBAL CO_2 EMISSIONS BY SECTOR, 2015-2022 ($MTCO_2$)

Source: Climate Chance, based on data from Enerdata



While stagnating in the OECD, emissions growth is concentrated in emerging countries

There are two approaches to measuring and tracking the greenhouse gas emissions of a country, city or region. The inventory approach accounts for emissions produced within the administrative and geographical boundaries of the jurisdiction studied, while the "footprint" approach, which incorporates emissions embodied in imports and exports, is more reflective of consumption behaviour in a globalized economy. **Going by the inventory approach, the emissions of G20 countries[a] accounted for 84% global CO_2 emissions. This ratio has remained virtually unchanged since 1990, but this group covers very different dynamics over the period.** The share of the BRICS (Brazil, Russia, India, China, South Africa) in global CO_2 emissions was only 28% in 2000, but rose to 49% in 2022. China, which increased its territorial emissions fivefold between 1990 and 2022, now accounts for over a third (34%) of global CO_2 emissions, as against 11% thirty years earlier. Even India, now the world's most populous country, still only emits 7% of emissions, compared to 3% in 1990 (**FIGURE 4**).

Conversely, the European Union (EU-27), whose territorial emissions fell by a quarter (-25.6%) over the period, now accounts for just 7% of global emissions, compared with 18% in 1990. The United States, which emitted 23% of CO_2 in 1990, accounts for just 13% by 2022, having reduced its emissions by only 1.9%. Downward trends can also be seen in Japan (-9.1%) and, above all, in the UK (-42.6%), which the Observatory's 2019 analysis showed to be almost entirely coal-free.[10] On the African continent, emissions rose by 122% between 1990 and 2022, but its share of global emissions only increased from 2.9% to 3.8%.

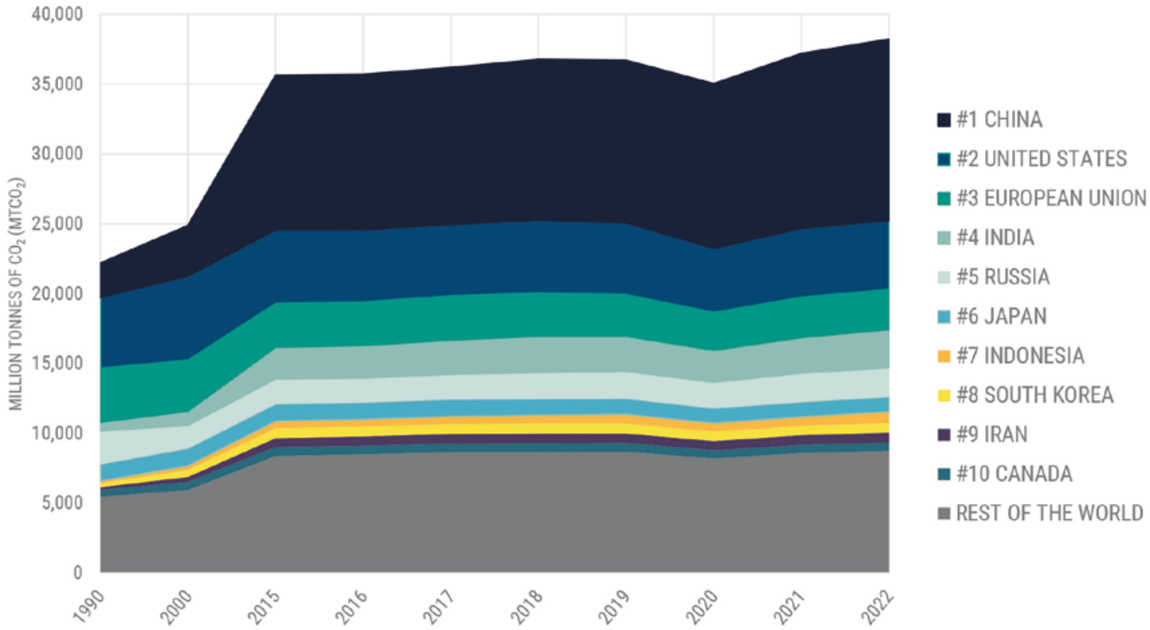
Since the Paris Agreement, territorial emissions from OECD countries have globally decreased by 6.5%, while they were rising by 15% in non-OECD countries. The European Union (-9.6%), Japan (-11.7%) recorded a much deeper drop than in North America (-5.3%) or Australia (-5.8%). Conversely CO_2 emissions rose by 17% in China, 23% in India and more than 56% in Indonesia. Emissions from the African continent grew by 8.7% over the period.

a G20 countries include Argentina, Australia, Brazil, Canada, China including Hong Kong, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, the United Kingdom, the United States and the European Union.

FIGURE 4

CO_2 EMISSIONS OF THE 10 HIGHEST EMITTERS AND OTHERS, 2015-2022 ($MTCO_2$)

Source: Climate Chance, based on data from Enerdata



The Covid-19 pandemic in early 2020, followed by the war in Ukraine in February 2022, were two exogenous factors that broke with the trends of the past two decades. All regions of the world were affected, to varying degrees, by the economic impact of travel and activity restrictions imposed by governments during the pandemic. All continents saw an exceptional drop in CO_2 emissions that year: North America (-10.3% CO_2 emissions), Europe (-7.8%), Africa (-7.3%), the Pacific nations (-4.8%), the Middle East (-3.4%)… Only China saw a steady rise in CO_2 emissions (+1.5%) in 2020, mitigating the effect perceived on the Asian continent (-1.3%).

The effect was short-lived, although the pandemic had major economic and political implications, as we analysed in our 2020 and 2021 Global Synthesis Reports. **By 2021, global CO_2 emissions had exceeded their pre-pandemic level (2019) by 1.3%, and by 4.1% in 2022.** But trajectories diverge according to the economic areas observed. OECD countries[b], where CO_2 emissions fell by 8.9% in 2020, saw a rebound in 2021 as elsewhere, but returned to the downward trajectory observed since 2005: emissions in 2022 remained 3.4% lower than in 2019. Only Mexico, Sweden and Turkey overshot their pre-pandemic emission levels – with Turkey already having returned to a trajectory of falling emissions.

Outside the OECD, emissions fell by a smaller proportion during the lock-downs (-2.3%). The rebound observed was all the more spectacular in 2021 (+6.3%), as it considerably accelerated the annual growth rate of emissions in 2022 (+4%) compared to the 2010-2019 decade (+2% on average each year). This trend is particularly striking in the BRICS. There, the effect of the pandemic was even weaker (-1.2%), and the rebound was even more pronounced in 2021 (+7%), although the preponderance of Chinese emissions should not be overlooked. A singular case, South Africa's emissions peaked in 2019, due to the difficulties encountered by Eskom, the state-owned company that supplies 90% of the country's electricity. Dilapidated infrastructure and corruption-ridden governance have led to a drop in national electricity production of almost 10% since 2018. While coal still

b OECD countries here include the USA, Canada, South Korea, Australia, New Zealand, Mexico and the following European countries: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Iceland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom. The most recent members from Latin America (Chile, Colombia, Costa Rica) are not included.

accounts for more than 85% of the electricity mix, this phenomenon has considerably reduced emissions from the sector, which is responsible for half of South Africa's CO_2 emissions.

Other major emerging countries are posting spectacular growth in emissions. Indonesia has become the world's sixth largest emitter, while its CO_2 emissions excluding LULUCF in 2022 (823 $MtCO_2$) were already more than a quarter higher than in 2019 (653 $MtCO_2$). The reason: coal and oil consumption growing by 33% and 12% respectively between 2021 and 2022, as analyzed by the Global Carbon Project.[11] Part of this record demand can be explained by efforts to restore post-pandemic industrial production, but it is not the only reason: the installed capacity of coal-fired power plants has risen from 25.4 GW in 2015 to 40.6 GW in 2022. The opening of new power plants is in line with Indonesian President Joko Widodo's plans to increase the country's capacity to extract and process nickel, a strategic metal that is crucial to the manufacture of lithium-ion batteries, which contribute to the electrification of road transport (**CF. "TRANSPORT" AND "INDUSTRY" TRENDS**). Numerous nickel smelters opened in Indonesia in 2019, which explains the jump in emissions from the industrial sector of almost 66% in just three years. In January 2023, Indonesia introduced a new mandatory emissions trading scheme for coal-fired power plants over 25 MW.[12]

The effects of the war in Ukraine on gas demand have been more concentrated on the European continent and have prolonged a trend that had already begun. In reality, the first tensions on the gas market appeared in the second half of 2021, due to a combination of economic and climatic effects. Against the backdrop of a cold winter in 2021 in the northern hemisphere and a global economic recovery, strong demand from Asian markets for liquefied natural gas (LNG) competed with European its demand, combined with a fall in European gas production and low gas stocks. A drought in Brazil during the summer also increased demand for LNG to make up for shortfalls in hydroelectric power generation. At the end of 2021, tankers loaded with LNG initially destined for Asia were finally rerouted to Europe, where the shortage of gas had led to an explosion in the price of FFT-future contracts and where suppliers were prepared to pay a higher price. Throughout the year, the Chinese, Japanese and Korean markets outbid European demand, generating spectacular inflation from early spring 2021.[13]

Russia's invasion of Ukraine in February 2022 has prolonged and accentuated this tension on the European continent. Russia's share in EU gas imports fell from 39% in the second quarter of 2021 to 13% in 2023.[14] To make up for this, the European Union has resorted to other trading partners, with whom it has contracted long-term LNG imports (Qatar, the United States, etc.). The RePowerEU strategy adopted in May 2022 has strengthened the objectives set by the European Green Deal and the Fit-for-55 strategy, with the aim of reinforcing energy independence by focusing on electrification and the deployment of renewable energies. Energy sufficiency has also entered the public debate in France, Spain, Italy and many other European countries, in the form of calls for individual and collective responsibility to reduce energy consumption against a backdrop of tensions over gas supplies. While an effective drop in electricity consumption has been observed energy-intensive industries in France in 2022 for example, there are many explanatory factors, which will require in-depth monitoring over time.[15] As a result, gas consumption in the European Union fell by 16.5% between 2021 and 2022: while it had rebounded in 2021 above its pre-pandemic level, emissions linked to gas combustion fell by almost 13%, falling below their 2015 levels.

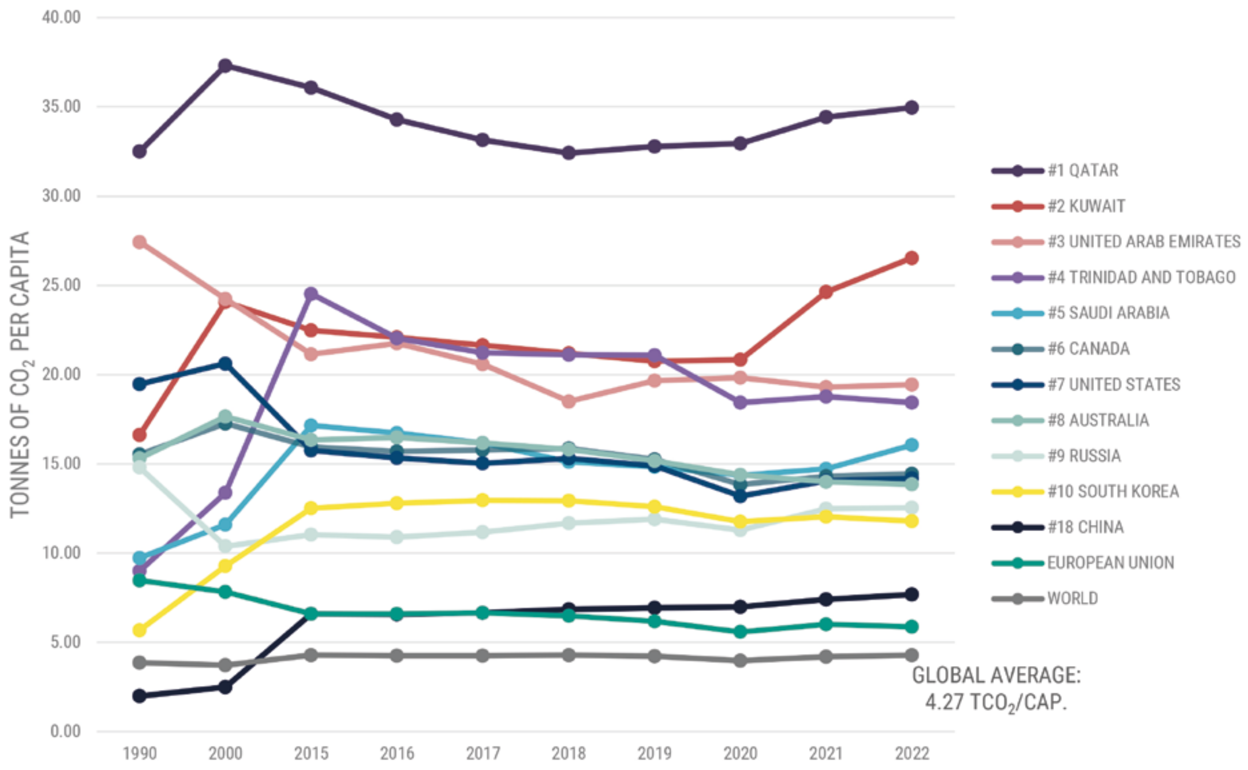
The carbon footprint, a marker of international as well as domestic inequalities

Global per capita emissions in 2022 (4.27 tCO_2 per capita) are down from 2015 levels (4.29 tCO_2/cap), and especially below the peak reached in 2013 (4.4 tCO_2/cap). On a per capita basis, territorial emissions remain more than twice as high in the OECD (8.17 tCO_2/cap) as in other countries (3.45). They are high as 34.4 tCO_2 per capita in Qatar, 14.1 tCO_2/cap in the United States, 8 tCO_2/cap in Japan, 7.7 $MtCO_2$/cap in China and 5.88 tCO_2/cap in the European Union. Territorial per capita emissions are also following intersecting trajectories; they peaked in 2000 in OECD countries (10.71 tCO_2/cap), while they tripled in China over the same period, overtaking the European Union. Despite the impressive growth in its national emissions over the last two years, Indonesia's per capita emissions (2.8 tCO_2/cap) remain well below those of most industrialised economies (**FIGURE 5**).

FIGURE 5

PER CAPITA CO_2 EMISSIONS OF THE TEN HIGHEST EMITTERS, 2015-2022

Source: Climate Chance, based on data from Enerdata



While territorial accounting of national emissions does reflect the political choices and orientations of governments, it is biased against countries that host natural resources or industrial activities that benefit the global economy as a whole. This is true of oil-exporting countries: the Gulf States, of course, but also Trinidad and Tobago, which has the world's fourth-largest per capita territorial footprint due to its status as the world's fifth-largest oil producer and the largest supplier of liquefied natural gas (LNG) to the United States. This is also the case for the new industrial and manufacturing powers that have emerged since the early 2000s, such as China, where industries account for 40% of GDP – against about 20% in the US and the EU. China's trade surplus has increased 28-fold between 2000 and 2021.

The carbon footprint, which takes into account the emissions embodied in the goods and services consumed by a country's inhabitants, offers a more refined indicator for measuring the economic distribution of emissions. The French National Institute for Statistics recently published a comparative study on this subject, using the example of the European Union, the United States and China.[16] The EU appears first and foremost as a 'net importer' of emissions: its per capita carbon footprint (11 tCO_2e) exceeds the per capita emissions calculated using the territorial approach (9.2 tCO_2e). In the United States, an even greater gap separates the per capita carbon footprint (21.3 tCO_2e) from per capita emissions measured by inventory (17.5 tCO_2e). Conversely, in China, per capita GHG emissions calculated using the territorial inventory approach (8.5 tCO_2e in 2018) are slightly higher than the carbon footprint per inhabitant (8.3 tCO_2e). In absolute terms, these carbon footprint levels reflect differences in purchasing power, demographic dynamics and economic growth. But breaking down these footprints also reveals uneven progress in local efforts to decarbonise. In each of these three economic zones, 85% of final demand for goods and services is met by domestic production, and 15% by imports. Yet imports account for 33% of the carbon footprint in the EU, 26% in the US and 14% in China. This difference results from EU and US domestic production being both more tertiarised and more advanced in its decarbonisation. The opposite is true in China, where domestic production, which is more industrial, is also highly carbon-intensive due to an electricity mix that is 62% coal-based.

It can be argued that the global distribution of industrial activities, and therefore emissions, has shifted in recent decades towards more carbon-intensive

countries, as value chains have become more international. China's entry into the World Trade Organisation (WTO) in 2001 seems to have marked a real turning point in this respect. The average annual growth rate in global CO_2 emissions from industry rose from 0.6% between 1990 and 2000 to 4.5% over the following decade. However, 80% of this increase in industrial emissions between 2000 and 2010 took place in China, while they fell by 15% in the European Union and 22% in the United States over the same period. As a result, while China accounts for a larger share of global industrial emissions – going from around 20% between 1990 and 2000 to 40.3% in 2018 – it is also driving absolute growth in global production, driven by the growing purchasing power of its middle classes.

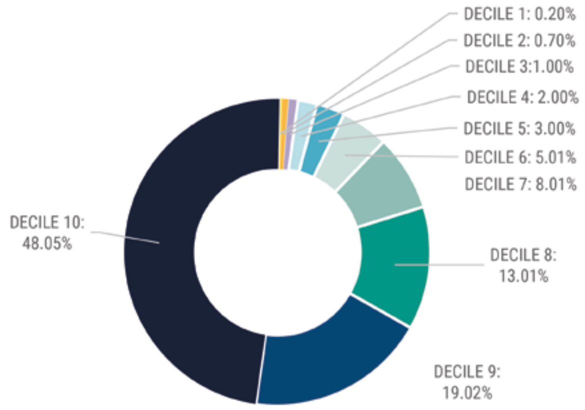
The transformation in the geographical distribution of global emissions also reflects the internal development trajectories of the major emerging countries, and not just the relocation of polluting activities away from industrialised countries, and cannot be summed up by the demographic growth of emerging countries alone. China's GDP per capita, measured in purchasing power parity, which was just $2.92 per capita in 2000 – compared with an OECD average of $24.6 per capita – increased sevenfold by 2022, and that of the BRICS as a whole by almost fivefold. This economic development is also reflected in infrastructure investment and the population's consumption. For example, while China is a net exporter of crude steel, accounting for 54% of global production, it is also by far the world's second largest consumer of finished steel, behind South Korea.[17] It has also become the world's leading car market, with the car ownership rate rising from 93 vehicles per 1,000 inhabitants in 2015[18] to 221 per 1,000 in 2022[19] (compared to 651 in Europe and 831 in the United States). Studies have shown that changes in consumption patterns by the middle and high-income classes are increasing the carbon footprint and emissions of Chinese households, as well as inequalities between urban and rural populations.[20,21]

Another change indicates that the differences in carbon footprints between income levels within countries are as important as the differences between countries. In a study published in Nature Sustainability at the end of 2022, the economist Lucas Chancel identifies two forces driving the increase in individual carbon footprint inequalities around the world: changes in average emission levels between countries, and changes in emission inequalities within countries. In 1990, 62% of carbon footprint inequalities were explained by differences in wealth between countries: the average citizen of a rich country almost invariably emitted more than the rest of the world. The situation has been completely reversed: it is now inequalities within countries themselves, between rich and poor, that explain almost two-thirds of global inequalities in emissions.[22]

FIGURE 6

ENERGY-RELATED CO_2 EMISSIONS BY INCOME DECILE, 2021

Source: International Energy Agency, 2023

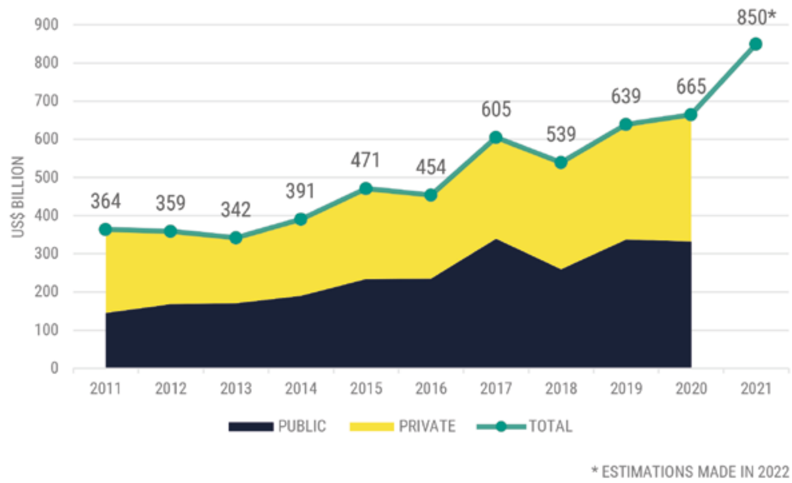


On a global scale, the International Energy Agency estimates that the richest 10% are responsible for almost half of the world's CO_2 emissions, while the poorest 10% emit just 0.2% (FIGURE 6).[23] These disparities can now be seen in both developed and emerging economies. In the United States and Europe, the top deciles emit three to five times more than the median level; in China and India, the ratio is five to eight. Inequalities persist between countries at all levels. In the United States, the 33 million people belonging to the richest 10% emit up to 55 tCO_2 per person per year, compared with just 7 tCO_2 per capita for the richest 10% in India. Similarly, says the IEA, the lowest deciles in the United States, Canada, Japan and South Korea always emit more than the global median. For example, the poorest 10% in the United States emit 3.5 tCO_2 per capita, compared with 0.2 tCO_2 per capita for the poorest 149 million in India. The gaps between the middle classes are narrower, particularly between the European Union and China.

FIGURE 7

GLOBAL CLIMATE FINANCE FLOWS, 2011-2020 ($ BILLION)

Source: Climate Policy Initiative, 2022



The ambition level of commitments remains too low to bring about a real reduction in global emissions

In 2015, the Parties to the Paris Agreement pledged to limit global warming to 2 °C or even 1.5 °C above pre-industrial averages. A veritable compass for climate action since the Paris Agreement and the publication of the IPCC's special report in 2019, the goal of "carbon neutrality" is now enshrined in many NDCs. According to the latest count by Net Zero Tracker, 151 countries covering 88% of emissions, 92% of GDP and 89% of the world's population have formulated a carbon neutrality objective.[24] **However, while global emissions need to fall by 43% between 2019 and 2030 to stay below the 1.5 °C threshold, according to the IPCC [25] the current plans of the 193 Parties to the Paris Agreement only commit to reducing emissions by 2% over the period,** according to a UNFCCC study.[26] UNEP, in its 2022 "Emissions Gap" report, concludes that full implementation of these so-called Nationally Determined Contributions (NDCs) would, at best, only limit global warming to 2.4~2.6 °C above pre-industrial averages. According to analyses by the Climate Action Tracker, out of 39 countries + the European Union covering 85% of global emissions,[c] no government action is compatible with a trajectory of limiting global warming to 1.5 °C. Only a handful of countries – Ethiopia, Kenya, Morocco, Nepal, Nigeria, Norway, Bhutan, Costa Rica and the Gambia – are considered "almost sufficient".

Climate finance is making progress, but flows are still insufficient to meet the needs of the transition. According to the latest findings of the Climate Policy Initiative (CPI), published in 2022, an average of $653 billion in climate finance flows was mobilised in 2019-20, 15% more than in the previous two years. Initial estimates put the figure at $850-940bn in 2021, an increase of 28-43%, which would be a new record (**FIGURE 7**). Renewable energies, which are seven times more profitable than fossil fuels, account for more than half of these flows. However, public subsidies for fossil fuels exceeded all the climate finance mobilised between 2011 and 2020 by 40%. CPI estimates that the annual growth in flows is not in line with a 1.5 °C trajectory, which would require $4,300 billion a year by 2030. CPI points in particular to the weakness of the mobilisation of private finance.[27] **To maintain a 50% chance of keeping global warming below 1.5 °C, the world cannot emit more than 380 $GtCO_2$ between 2022 and 2030; in the light of all the above analyses, the 1.5 °C objective now seems more doomed than ever[28].**

Eight years after the signing of the Paris Agreement, Climate Chance intends to contribute to the debates leading up to the first Global Stocktake of collective progress by governments, by offering an extensive analysis of trends in climate action around the world. The aim of this sixth edition of the Global Synthesis Report on Climate Action is to identify and analyse the public policies, private initiatives and civil society movements that, against this gloomy global backdrop, are showing signs of transition.

c Climate Action Tracker assesses government climate action in terms of the impact of policies implemented, commitments, NDCs and the fair share of each in the global effort to reduce emissions.

EMISSIONS CO_2

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RETOUR PAGE PRÉCÉDENTE

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ELECTRICITY

Nº 2 Renewable electricity generation continues to rise... but carbon-intense generation is not falling

- Emissions from electricity generation have followed a constant upward trend since 2015, except for the fall triggered by the pandemic in 2020.
- Since 2015, renewable capacity additions have outstripped fossil capacity additions (respectively accounting for three quarters and one quarter of the capacity added between 2019 and 2022). But on average, three times as much renewable capacity is needed to replace one unit of fossil capacity.
- The average carbon intensity of electricity generation has therefore fallen overall since 2015, but the rise in global demand is outstripping the decarbonization of the mix. Where it is taking place, the transition away from coal is benefiting renewables as much as gas.
- Government subsidies are keeping coal alive in China, India and Indonesia, while oil companies are still investing far too little in renewables to begin a genuine transition away from oil.

KEY FIGURES

Increase in emissions, decrease in carbon intensity

- **+10.91% emissions from electricity generation** from 2015 to 2022 – 15.95 $GtCO_2$ (Enerdata, 2023).
- **+10.11% primary energy consumed** from 2015 to 2022 – 14,951 Mtoe (*ibid.*).
- **+21.7% final electricity consumption** from 2015 to 2022 – 24,598 TWh (*ibid.*).
- **-8.08% average carbon intensity of global electricity generation** from 2015 to 2022 – 439.78 gCO_2/kWh (*ibid.*).
- **20.5% share of electricity** in final energy consumption, vs. 18% in 2015 (*ibid.*).

Growth in renewables, fossils persist

- **+82% renewable capacities** from 2015 (1,853 GW) to 2022 (**3,372 GW**) (IRENA, 2023).
- **40.2% of global generation capacity** was renewable in 2022, vs. 29.5% in 2015 (*ibid.*).
- **63.2% of fossils** in the electricity mix in 2022, vs. 68% in 2015. From 2015-22, solar went from 1% to 4.5%, and wind from 3.4% to 7.3% (Enerdata, 2023).

Investments and transition plans are insufficient

- **1,241 mergers and acquisitions** in 2022 in the energy sector, **+117%** compared to 2015 (White & Case, 2023).
- **13/100**, average ACT score of oil companies' transition plans. **37/100** for electric utilities (WBA, 2023).
- **+680% power purchase agreements (PPAs)** from 2015 (4.7 GW) to 2022 (**36.7 GW**) (BNEF, 2023).
- **1.3%** of the investments of 9 Oil Majors are "low-carbon" (Energy Monitor, 2023).

FURTHER READING

TRENDS

- The growth of renewables is still not enough to feed the insatiable energy appetite of the economic recovery (2022)
- From Big Oil to Big Power? At the heart of the renewable energy boom, oil producers are dreaming of a low-carbon future (2021)
- With PPAs, businesses and cities are securing the production and supply of low-carbon electricity (2021)

CASE STUDIES

MALI • Access to "clean" energy thanks to decentralised solar-mini-grids (2022)

GEORGIA • Gender-sensitive energy cooperatives in rural areas (2022)

VIETNAM • A boom in solar energy (2021)

MELBOURNE • En route to 100% renewables thanks to Power Purchase Agreements (2021)

CADIZ • At the forefront of the municipalisation of energy (2021)

SPAIN • Spain's upswing in renewables defeats years of headwinds (2021)

UNITED KINGDOM • A decarbonization model involving all stakeholders (2019)

KENYA • Innovation at the service of low-carbon electrification (2018)

TRENDS
ELECTRICITY

In a market under pressure, soaring consumption is eclipsing the energy transition

TANIA MARTHA THOMAS • Research Officer, Global Observatory of Climate Action, Climate Chance

The energy sector has been in a state of constant transformation since 2015. Subject to fluctuating prices and market concentration around dominant players, the sector has been hit hard by the pandemic and the war in Ukraine. Decarbonization and the penetration of renewables in the electricity mix, which were initially driven by the energy industry, now integrate the supply strategies of companies and local governments. Despite the increasing share of renewables in the mix, fossil fuels are still required to feed the global economy's voracious appetite for energy, creating a trend of accumulation rather than transition.

In the global energy landscape, consumption is moving faster than the transition

Decarbonization of the mix is too slow to compensate rising demand

In 2022, global CO_2 emissions (excluding land use) amounted to 38.1 $GtCO_2$ – a record, and a 7.02% rise compared to 2015, despite a historical drop in 2020 following the pandemic, which was rapidly wiped out by the economic recovery of 2021.[a, 1] The leading growth factor in emissions, global consumption of primary energy rose by 10.11% from 2015 to 2022. According to Enerdata's analyses, this increase is driven by the growth of the global population and per capita GDP, despite a weak reduction in the carbon intensity of the global energy mix.[2] Global emissions related to electricity production – which represented 20.4% of the final energy consumed in the world – amounted to 15.95 $GtCO_2$ in 2022, a rise of 10.91% since 2015 (**FIGURE 1**).

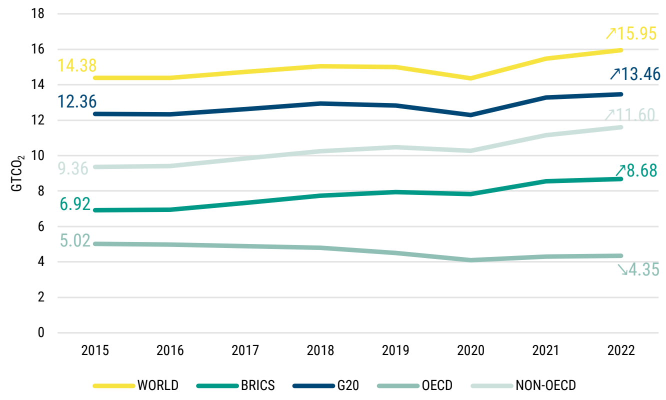
Two exogenous events bucked the trend one after the other. First, the Covid-19 pandemic provoked a drop in global energy demand (-3.88%), although at different levels depending on the country (**FIGURE 2**). The 2021 recovery saw consumption rise by 4.88% compared to its 2020 level, exceeding its 2019 level. Specifically, energy consumption is stagnating in industrialized countries (OECD), but has returned to rapid growth in non-OECD countries.[3] In 2022, this growth was driven by India (+7.36%), Indonesia (+9.24%), Saudi Arabia (+8.42%) and, to a smaller extent, China (+3.04%).

a The energy and emissions figures used in this analysis come from the Enerdata Global Energy and CO_2 Emissions database, unless otherwise indicated.

FIGURE 1

CO$_2$ EMISSIONS FROM ELECTRICITY GENERATION, 2015-2022

Source: Climate Chance, based on data from Enerdata

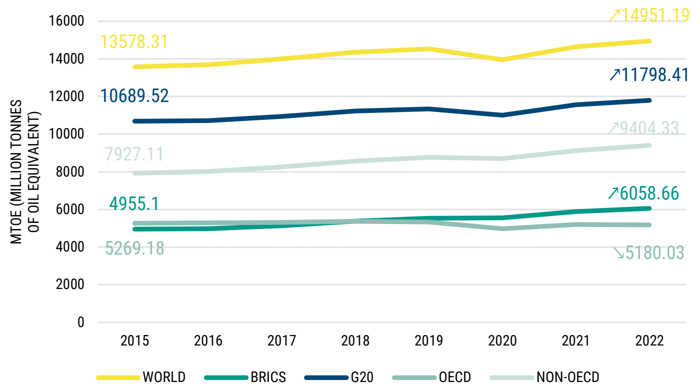


OECD countries, which have seen a constant drop in their emissions related to electricity reductions since 2015, and a more marked reduction in 2020, are the exception to the rule (**FIGURE 1**). The post-pandemic economic recovery led to a rise in emissions, but without exceeding 2019 levels. In contrast, emissions from non-OECD countries have pursued constant growth, with a less pronounced dip in 2020, and a very strong pickup in 2021, outstripping pre-pandemic figures.

FIGURE 2

GLOBAL CONSUMPTION OF PRIMARY ENERGY, 2015-2022

Source: Climate Chance, based on data from Enerdata



The war in Ukraine then accelerated the inflationary spiral triggered by the post-pandemic economic recovery, with a particularly strong impact in Europe. The combination of a warm winter and lower demand from industry saw energy consumption in Europe contract by 4% in 2022, well below its pre-Covid level.[4] Paradoxically, in 2022 the war and inflation generated a growth in emissions from the energy sector (+3.77%) in the European Union, due to the use of coal and oil to substitute Russian gas in the electricity mix.

Boom in renewable energies

The growth in global electricity production since the Paris Agreement also features a paradox. Although the volumes of CO$_2$ emitted by electricity production are increasing in absolute terms, its carbon intensity[b] has progressively decreased over the years: a

b The carbon intensity of electricity production is measured in grammes CO$_2$-equivalent emitted per kilowatt-hour of electricity produced.

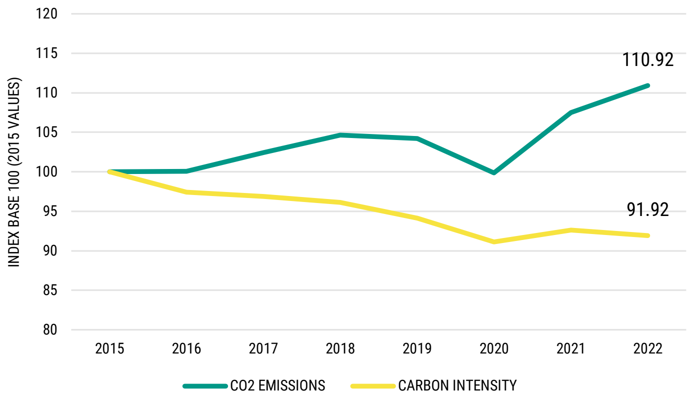
sign that electricity consumption, pushed by rising demand from end-uses is rising faster than the decarbonization of production (**FIGURE 3**). Even in end-uses with rising electricity demand, the rate of electrification remains low (**CF. "TRANSPORT" TRENDS**).

The trend therefore reveals an accumulation of low- and high-carbon sources of electricity generation rather than a genuine transition, which would involve substituting high-carbon sources with renewables.

FIGURE 3

EVOLUTION OF CARBON INTENSITY AND CO_2 EMISSIONS FROM ELECTRICITY GENERATION

Source: Climate Chance, based on data from Enerdata

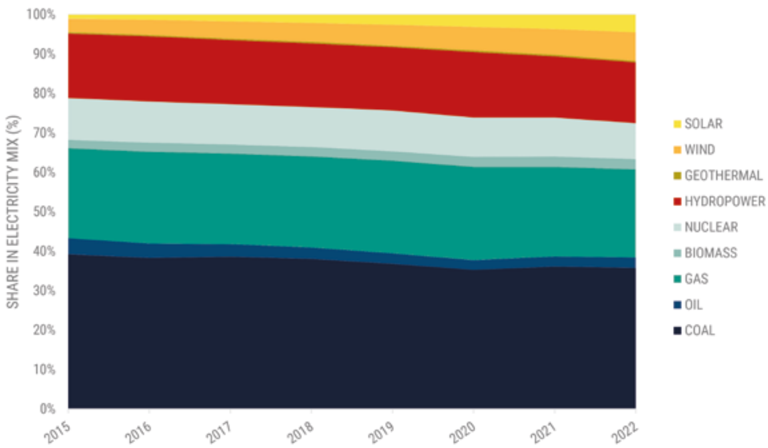


The place of renewable energy in the electricity mix is growing: the share of wind power more than doubled from 2015 (3.43%) to 2022 (7.27%) and the share of solar quadrupled (from 1.04% to 4.48%). Despite the strong growth of renewable energy compared to their initial share, the share of thermal fuel in the electricity mix only went down from 68.15% in 2015 to 63.8% in 2020, since when it has remained relatively stable (**FIGURE 4**).

FIGURE 4

EVOLUTION OF THE GLOBAL ELECTRICITY MIX, 2015-2022

Source: Climate Chance, based on data from Enerdata

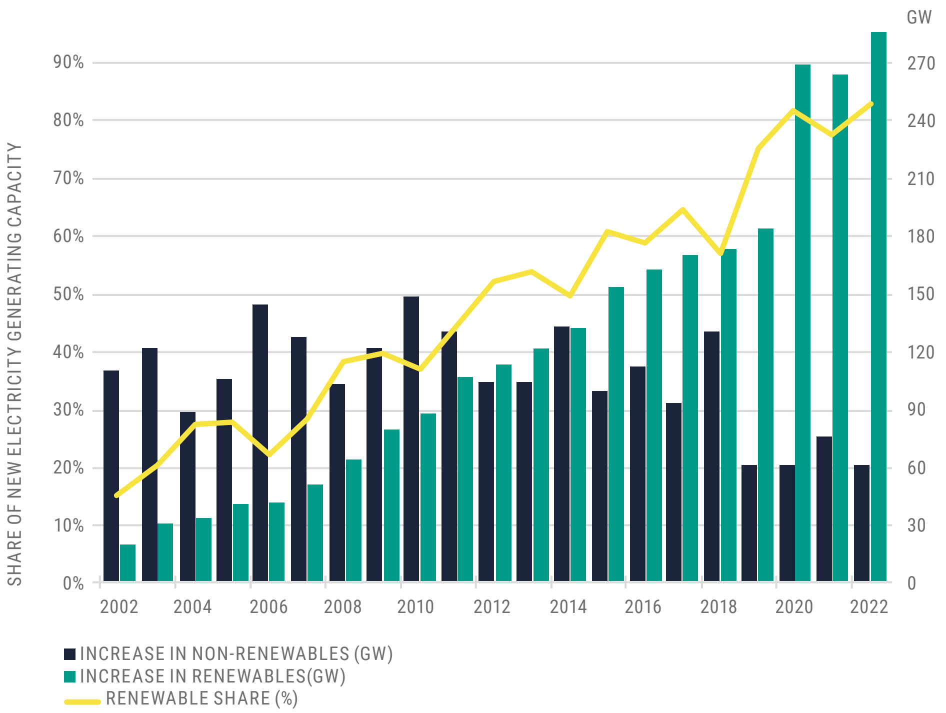


Annual additions of new electricity generation capacities from fossil and renewable sources follow crossed trajectories: renewable capacity additions have been at least three times higher than fossil capacity additions since 2019 (**FIGURE 5**). The total stock of renewable capacities installed rose by 82% from 2015 (1,853 GW) to 2022 (3,372 GW).[5] Nevertheless, the real impact of renewable capacity installations on production needs to take capacity factors into account[c] – a recent study observed that, based on data for 2000-2017, to replace 1 W of fossil production capacity on average requires about 4 W of photovoltaic solar capacity or 2 W of wind capacity.[6]

FIGURE 5

ELECTRICITY GENERATION CAPACITY ADDITIONS, AND THE RELATIVE SHARE OF RENEWABLE CAPACITIES

Source: IRENA, 2023



Solar photovoltaic capacities have grown the most, rising from 224 GW in 2015 to 1,047 GW in 2022 (+367%). In 2021, solar installations overtook wind in terms of capacity.[7] Asia is the main driver of the solar sector, led by China followed by India. The pace of expansion of wind capacities has in fact slowed down since 2020. The share of offshore wind remains low, representing just 7% of total installed wind capacity in 2022, most of it in China, ahead of the United States.[8]

Hydropower is the biggest provider of renewable energy in the global electricity mix (15.44% in 2022, **FIGURE 4**), although hydro capacity additions have followed a much slower pace than other energies (2% per year). China is the leader in installed capacity, while hydropower makes up over two-thirds of the electricity mix in Brazil, Colombia, Canada, New Zealand, Sweden and Norway. This partly explains why the latter two countries have some of the highest rates of electrification of end-uses in the world, particularly mobility.[9]

Following a year of decline in 2018, investments in renewable energy picked up again to reach a new record of $495.4 billion in 2022[d] (**FIGURE 6**). The particularly rapid acceleration of investments in renewable energy observed since 2020 was initially driven by post-Covid recovery policies and public investments, strengthened by energy sovereignty strategies in reaction to the war in Ukraine, like the Inflation Reduction Act in the United States, the RePowerEU strategy in Europe, and the GX Green Transformation

c The capacity factor of an electric power plant is a measure of actual production compared to the plant's maximum production capacity. While it is about 50% for fossil fuel plants and almost 80% for nuclear power plants, for renewable energies it is much more variable and depends on the location, ranging from about 12% to 25% for solar, and almost 30% for wind.

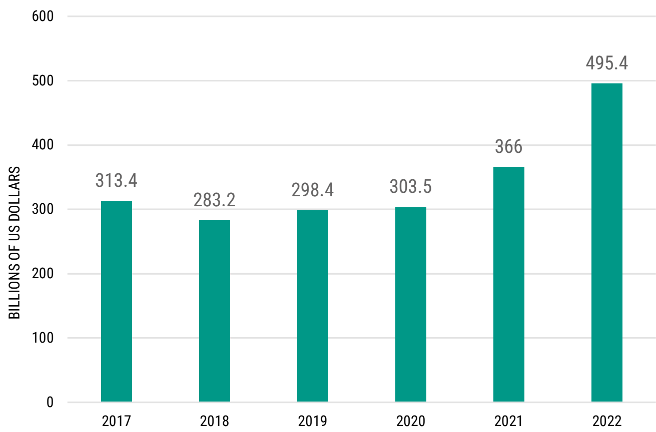
d Although these figures are higher partly due to inflation, the impact of inflation only presents a fraction of the total increase in investments.

Programme in Japan. China is the biggest investor in renewable energies. Brazil and India have also increased their investments since 2020, while Europe and the United States have followed a downward trend since 2020 due to uncertainties on the market despite public support.[10, 11]

FIGURE 6

GLOBAL INVESTMENTS IN RENEWABLE ENERGY (2017-2022)

Source: Climate Chance, based on REN21, 2023



Fossil fuels prove tenacious

Although the use of fossil energy to produce electricity has dropped slightly since 2015, its share in the global energy mix has remained stable at around 80% for decades.[12] Renewable energy only partly compensates the structural decline of coal, which also works to the benefit of gas, despite the negative impact of geopolitical events since 2020.

Oil demand shot up following the eruption of American shale oil on the market in 2016,[13] until the historical break caused by Covid-19 in 2020 (-9.2%). The pickup in demand in 2021 and 2022 was mainly driven by the recovery of the transport sector, and by the gas-to-oil shift in electricity generation, in a period of global economic downturn and gas price inflation.[14]

Touted as a bridge fuel for the transition, gas benefited from the coal-to-gas shift in the 2010s, but its place in global electricity generation plateaued at an average 23% between 2015 and 2022. Regional trends vary: gas represents a relatively high share of the mix in OECD countries (30% in 2022, a rise since 2015) – in particular when they are planning to phase out coal. The United Kingdom is a good example here: the share of gas went up from 29% to 38% of the electricity mix from 2015 to 2022, while coal – the primary source of electricity in the early 2010s – plummeted from 23% to under 2% over the same period. A similar trend can be observed in Spain, and in the United States during the shale oil boom.[15] In comparison, the major emerging BRICS economies use five times less gas – 6.6% in 2022, in constant decline since 2015. The majority of the 615 GW of gas power stations being developed in the world in 2022 are located in East Asia, the Middle East and North Africa.[16]

Although gas-fired electricity generation infrastructure can also be used for biogas or even renewable, less-emitting biomethane, the IEA estimated that in 2018 only 18 GW of the world's installed electricity generation capacity was biogas-fired.[17]

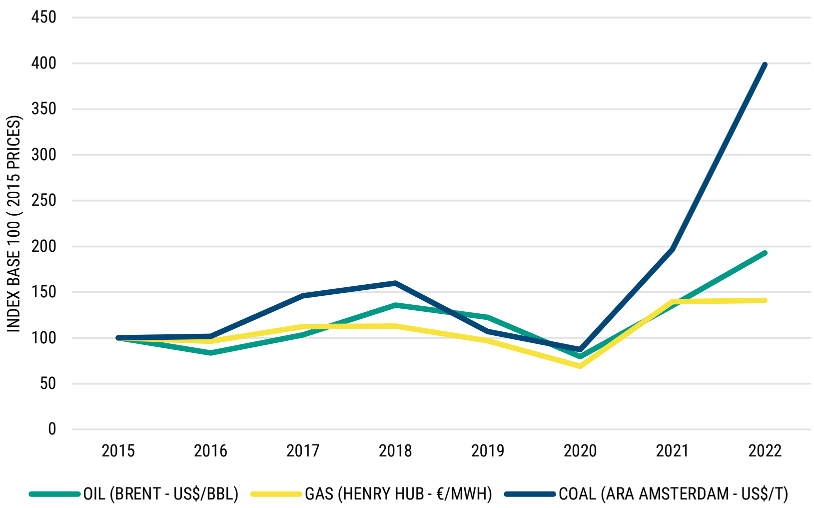
Electricity generation from coal has evolved erratically since 2015. Following two years of successive decreases in 2019 (-2.08 %) and 2020 (-4.91 %), the share of coal shot back by 8.1% in 2021. Coal power stations constituted half of the increase in global demand for electricity in 2021, a trend intensified by a rise in gas prices; this trend continued in 2022 with EU efforts to avoid using Russian gas.[18] Asia, in particular China, India and Indonesia, is the chief driver of coal growth, at the cost of huge public subsidies that keep the black mineral afloat in a market where renewable energies are nevertheless increasingly profitable and competitive.[19]

Faced with increasingly affordable renewable technologies, the relative and absolute cost of producing fossil fuels has tended to rise structurally (more expensive exploration and drilling), especially as the instability of oil and gas prices (**FIGURE 7**) does not guarantee their profitability. However, the voluntary cuts in oil production decided by OPEC+ and the war in Ukraine have boosted producers' revenues in recent years. The trend for investments is mixed: according to IEA figures,[20] following a relatively stable period from 2016 to 2018, investments in fossil fuels decreased from 2019 to 2020, then picked up again, recently strengthened by the super profits made by oil and gas giants (**CF. BELOW**).

FIGURE 7

SPOT PRICE INDEX FOR COAL, OIL AND GAS (2015 INDEX)

Source: Climate Chance, based on data from Enerdata



Nuclear energy in slight decline over recent years

The share of nuclear power in the global electricity mix went down from 2015-2022, from 10.56% in 2015 to 9.1% in 2022. Installed capacity, spread over 32 countries, grew from 387 GW in 2015 to 405 GW in 2018, and then dropped to 398 GW in 2022. According to the IEA,[21] an average $40 billion were invested annually in nuclear energy from 2016 to 2022, an increase compared to the period 2011-2015. Investments in nuclear power went up in G7 countries and emerging economies, driven by national governments, but dropped in China. Since the Paris Agreement, only Belarus and the United Arab Emirates have joined the list of countries equipped with nuclear power stations.

In a concentrated market, security of supply is a plus point for renewables

Energy market concentrated around major energy operators

According to an analysis by the World Benchmarking Alliance (WBA),[22] most of the 100 biggest oil and gas companies did not have a credible transition plan in 2023. Their average ACT[e] score is 15/100 for their low-carbon and just transition plans. Of the fifty "net zero" targets stated, 32 in reality only cover operational emissions (Scopes 1 & 2), while emissions upstream and downstream in the value chain (Scope 3) represent close to 80% of the sector's emissions. State-run oil companies, which are responsible for two-thirds of the world's oil reserves, come out even worse: they are likely to exceed their carbon budget even faster, and their ACT scores are about three times lower than those of their competitors (**FIGURE 8**).

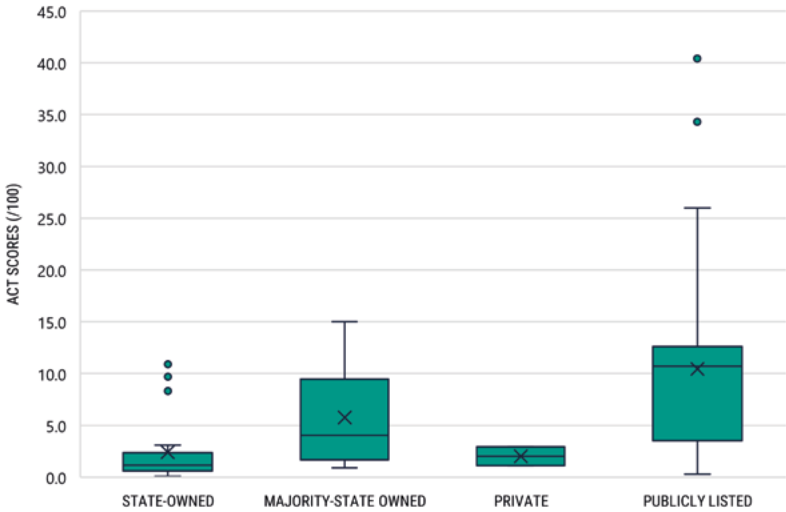
e The Assessing Low Carbon Transition (ACT) method, developed by Ademe and the CDP, evaluates the low-carbon transition plans of companies in a given sector, based on qualitative and quantitative indicators specific to that sector (**cf. "Companies" trends**)

ELECTRICITY

FIGURE 8

2023 ACT SCORES OF 100 BIGGEST OIL & GAS COMPANIES

Source: WBA, 2023



Following a difficult financial period in 2020, the tide began to turn from late 2021 and the start of the war in Ukraine. In 2022, Saudi Aramco recorded profits of over $161 billion, a historical high,[23] similar to Shell,[24] Exxon,[25] and Chevron.[26] TotalEnergies[27] and BP[28] also doubled their profits.

This historic profitability of oil only marginally seeps into low-carbon activities. The lion's share of profits is primarily used to remunerate shareholders and finance the repurchase of shares. In 2022, the oil sector devoted $20 billion, or over 4% of its investments, to low-carbon industries, compared to barely 1% in 2020.[29] These investments are mainly a response to the clear ambition of several oil companies, most of them European, to diversify and become integrated energy companies. This translates into higher investments in the production of renewable energies and biofuels, along with storage batteries, green and blue hydrogen, carbon capture and storage (CCS) **(CF. "INDUSTRY" TRENDS)** and even charging stations for electric vehicles.

The volume of low-carbon investments is far removed from the sums devoted to fossil energies. According to Reclaim Finance, TotalEnergies invests three times more in fossil fuels than in low-carbon energies; this ratio is six for Shell, fourteen for BP and thirty-two for Equinor. The US oil & gas majors do not communicate any investments in renewable energy.[30] In 2023, Shell[31] and BP[32] even partially backtracked on their commitments by announcing new increases in their oil production.

In addition, these investments mainly take the form of mergers and acquisitions (M&A), pointing to another trend: the growing concentration of the energy market. M&As in the energy sector reached a record 1,186 operations in 2021, for $228 billion in transactions. This figure dropped by 15% in 2022, but the tendency remains strong, with 1,241 operations recorded.[33]

In parallel, the electricity market has been reshaped, involving a concentration to the detriment of the smallest actors, hit hardest by the pandemic and inflation, especially in Europe. In the United Kingdom, from 2021 to 2022, 31 energy companies stopped their activities due to rocketing gas prices. Many of them were bought out by existing giants like British Gas, Scottish Power and EDF.[34] In France, the number of electricity and gas suppliers dropped from 39 in summer 2021 to 14 in the final quarter of 2022.[35] In Germany, municipal electricity companies were hit hard by inflation,[36] while bigger companies like Uniper,[37] and EDF in France[38] were nationalized. Although electricity companies started decarbonization before other industries, 66% of the generation capacity of the 50 biggest utilities evaluated by the WBA were still supplied by fossil fuels, and 98% of these utilities are expected to exceed their carbon budget by 2035. Forty-seven of these 50 utilities did not have an emissions reduction target aligned with a 1.5 °C scenario.[39]

Power Purchase Agreements, a lever for low-carbon electricity supply

Since the late 2000s, renewable energy certificate[f] markets have played a key role in companies' energy sourcing – in Europe, the number of "guarantees of origin" almost doubled from 2014 to 2018.[40] While certificates represented over a quarter of the renewable energy supplied to companies in 2018, direct contracts involving the signature of a PPA (Power Purchase Agreement)[g] have become increasingly popular.

In 2021, 49% of electricity consumption reported by companies committing to increase their renewable energy consumption under the RE100 initiative – 367 TWh of electricity, or more than the consumption of the United Kingdom – was of renewable origin, compared to 32% in 2016. Thirty-five per cent of renewable energy supplies took the form of a PPA, not far behind renewable energy certificates (39%). Direct purchase agreements have gradually eaten away the share of contracts made with suppliers, which halved between 2016 (41%) and 2021 (19%), while self-generation remains marginal (2%).[41]

These figures illustrate a growing tendency for direct supply contracts for renewable electricity among major firms. Global volumes of corporate PPAs went from 4.7 GW in 2015 to 36.7 GW in 2022. Two-thirds of them are located in the Americas, led by the USA, ahead of Europe (22%) and the Asia-Pacific region (12.5%), in particular in India and Australia.[42] Although relatively more recent on the African continent, legislation is evolving to allow the conclusion of green PPAs.[43]

PPAs are particularly popular with the biggest companies, especially digital ones. In 2023, Amazon took first place, with cumulated purchases of 24.8 GW, following on from the previous two years. Meta and Microsoft came second and third.[44] Although most PPAs are drawn up off-site (geographically disconnected from the purchasers), on-site PPAs and production for self-consumption are also popular with retail chains like Ikea, Target and Decathlon, which own vast built areas.

PPAs also increasingly attract public actors[45] even though volumes remain low compared to the private sector. In the United States, the volume of off-site PPAs concluded by US cities more than tripled, from 1,085 MW in 2015 to 3,974 MW in 2021, while on-site and virtual PPAs are also increasing.[46] This trend can also be found in Europe, where several cities, public services, universities and transport companies have signed PPAs.[47] In South Africa, Johannesburg recently entered into 92 MW of short-term PPAs with independent suppliers in order to make up for the difficulties encountered by Eksom, the national company.[48]

In the face of inflation, the resilience of decentralized energy systems is put to the test

In 2021, around 1,500 cities had established renewable energy targets or policies, covering almost 1.3 billion people, compared to 1,300 cities in the previous year, and over 1,000 cities in 2019.[49] Municipal policies are much more likely to go beyond the electricity sector and include renewable energy in building codes, heating and cooling, and transport – domains where local governments often have the most power to act (**CF. "LOCAL GOVERNMENTS" TRENDS**).

Cities play a role in the diversification of renewable electricity production models: by municipalizing all or part of production and electricity supply activities, as shown by the Observatory in the case of Cadiz,[50] they can direct these activities towards renewables. The European Commission listed about 9,000 active energy communities in Europe in late 2022,[51] including municipal enterprises and energy cooperatives, which are autonomous groups of citizens that get together to collectively consume and/or produce renewable energy. Cooperatives promote democracy, tackle the issue of energy poverty, and group local governments or consumers, making them increasingly popular in Europe. REScoop.eu, the European federation of citizen energy cooperatives, lists 1,900 cooperatives, representing 1,250,000 citizens.[52] The trend was nevertheless weakened by the pandemic, and especially by the 2022 energy crisis. Yet in a few exceptional cases, some cooperatives emerged from these crises even more resilient, as identified in Georgia.[53]

In parallel, there has been a growth of collective self-consumption – which in France refers to consumers located in the same geographic area and consuming renewable energy produced on-site[54] 187 collective self-consumption operations were

f These electronic documents are produced by renewable energy producers, certified by the applicable mandatory or voluntary market authority, then purchased by suppliers that want to certify the origin of their electricity.

g PPAs are long-term electricity purchase contracts at a fixed or variable price, negotiated directly between producers and consumers (purchasers) of renewable electricity, without involving an intermediate supplier.

observed in early 2023, over 100 of them driven by local authorities, compared to six in 2018, totalling 11 MW of power.[55]

Citizen involvement has had a positive effect on the local energy transition – a study of eleven countries in the Nordic and Baltic regions showed a strong correlation between citizen engagement and the share of renewable energy in the electricity mix.[56] This trend is also confirmed outside Europe: the Pan African Alliance for Climate Justice, for example, works with civil society organizations in Botswana, Cameroon, Kenya, Morocco and Nigeria to strengthen the implementation of renewable energy policies.[57]

Demonstrations by civil society have had a significant impact on the energy transition over recent years by holding back fossil or renewable energy projects (**CF. "CIVIL SOCIETY" TRENDS**), influencing commercial policy and strategies, defending and driving action for a just transition, and even organizing communities to be more resilient.

Conversely, the development of renewable energies can also come up against local resistance. In the USA, for example, in May 2023, 228 local restrictions in 35 states aimed to block or restrain renewable energy installations, along with nine restrictions at federal state level. In total, 293 renewable energy projects came up against significant opposition. This is an increase compared to 2021, when 100 local restrictions of this type existed, and 152 renewable installations were contested. Oppositions are most frequent in the states that have seen the biggest developments in terms of renewable energy (like Kansas, New York and Texas).[58, 59] A study of 649 cases of movements resisting fossil and renewable energy projects spanning 1997 to 2019 showed that over a quarter of projects coming up against resistance were cancelled, suspended or postponed. Among the renewable energy projects, hydropower was the most perturbed, while wind and solar projects were the least conflictual.[60]

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TRANSPORT

N° 3 The transition from fossil-fuelled to electric engines is overtaken by growing demand for transport

- Since the Paris Agreement, global CO_2 emissions from transport have been rising, except in the OECD countries, where it is slightly contracting. Demand for mobility is growing in the Global South, while efforts to reduce demand are still in their early days.
- The success of electric car sales in Europe and China has not yet dented the hegemony of oil, which has been eroded by biofuels only in a handful of countries (Norway, Sweden, Brazil...).
- Carmakers, whose sales have been falling for the past five years, have resolutely embarked on their transition, but the "SUVization" of the market is wiping out efficiency gains made possible by electrification.
- The mitigation roadmaps for international air and sea transport promote alternative fuels which remain marginal and do not address the growth in demand.
- The supply and demand for high-speed rail is expanding, particularly in China. Europe is gradually rehabilitating night trains and short-distance rail, while India has electrified its lines on a massive scale.

KEY FIGURES

Demand for mobility and emissions still rising in the transport sector

- **+6%** CO_2 emissions related to transport from 2015 (6.39 $GtCO_2$) to 2022 (6.78 $GtCO_2$) (Enerdata, 2023).
- **Road: +6.1%** from 2015 (5.75 $GtCO_2$) to 2022 (6.14 $GtCO_2$), with a slight drop observed in the OECD (-1.5%) and a strong increase elsewhere (+14.9%) (*ibid.*).
- **Rail: +4.2%** from 2015 (91.37 $MtCO_2$) to 2022 (95.24 $MtCO_2$) (*ibid.*).
- **Air: -9.1%** from 2015 (882.81 $MtCO_2$) to 2022 (789 $MtCO_2$) (*ibid.*).
- **Sea: +6.5%** from 2015 (663 $MtCO_2$) to 2022 (734 $MtCO_2$). +150% CH_4 from 2012 to 2018 (UNCTAD, 2022).
- **Road: +7%** energy consumption from 2015 and 2022 (Enerdata).
- **Rail: 4,100 billion passenger-kilometres** in 2019: record unequalled since the pandemic (UIC, 2023).
- **Air: 94.2%** of air traffic had picked up since the pandemic by June 2023. -8% air freight in 2022, dropping below its 2019 level (IATA, 2023).
- **Sea: +14%** transport of containerized cargo, +11.7% bulk cargo (UNCTAD, 2022).

Dependence on oil not yet contested

- **95% of road transport runs on petroleum** vs. 4.7% on biofuels and 0.3% on electricity (Enerdata).
- **42% of new vehicle sales are SUVs**, of which 84% have internal combustion engines (IEA, 2023).
- **98.2%** of ships in operation and 73.8% of ships on order run on conventional fuels (DNV, 2023).

Transition signals

- **23 countries and 17 sub-national jurisdictions** plan to phase out combustion vehicles (REN21, 2023).
- **14% of new vehicles sold were electric** in 2022, *i.e.* 20x more than in 2015. But EVs still only make up 2.1% of the global automobile fleet (IEA, 2023).
- **115 gCO_2/km average emissions for car manufacturers in Europe**, compared to 131 g/km in 2020 (12%) – the biggest drop observed since records began in 2010 (ICCT, 2022).

FURTHER READING

TRENDS

- Recycling Lithium-ion batteries, the new frontier in the electrification of mobility (2021)
- Metals, the precious fuel for the automotive market in the race to electrification (2022)

CASE STUDIES

ZIMBABWE • Mobility for Africa. Promoting access to sustainable electric mobility in rural areas to empower women (2022)

BARCELONA • Sant Antoni, the green street inspiring the city (2022)

COLOMBIA • Sustainable urban mobility, rural accessibility and interurban connectivity (2021)

JAPAN • At the cutting edge of technology and of the modal shift (2019)

NORWAY • The progressive electrification of land and maritime transport (2019)

SWEDEN • The automotive sector's transformation is taking shape (2018)

TRENDS
TRANSPORTS

The energy transition in the transport sector is struggling to keep up with the growing mobility demand

ANTOINE GILLOD • Director of the Global Observatory of Climate Action, Climate Chance

Responsible for one-fifth of global emissions, transport was hit hard by the immobility imposed by lockdowns during the Covid-19 pandemic. Since then, passenger and freight transportation has gradually got back to normal, rekindling demand, with certain trends accelerating the transition. In Europe and in China, sales of electric automobiles are driven by a mix of public infrastructure investments, purchase subsidies, and regulations on internal combustion engines. Nevertheless, low-carbon technologies for local and international mobility remain marginal in the global energy system. Strategies to bring down demand and shorten value chains still rarely feature on the agenda.

Strongly impacted by the pandemic, global transport emissions are on the rise again

Global CO_2 emissions from fossil fuel combustion in transport rose by 6% from 2015 (6.39 $GtCO_2$) to 2022 (6.78 $GtCO_2$). This figure covers emissions from road transport (6,214 $MtCO_2$ in 2022, +6.2% compared to 2015), rail (95 $MtCO_2$, +4.2%), domestic flights (363 $MtCO_2$, +1.6%) and domestic shipping (180 $MtCO_2$, +10.7%) (**FIGURE 1**). The growth of emissions in each of these sectors plummeted in 2020 during the pandemic. Only road transport has since returned to and exceeded its pre-pandemic emissions level.[a] About 58% of emissions from transport are related to passenger transportation activities, and 42% to freight.[1]

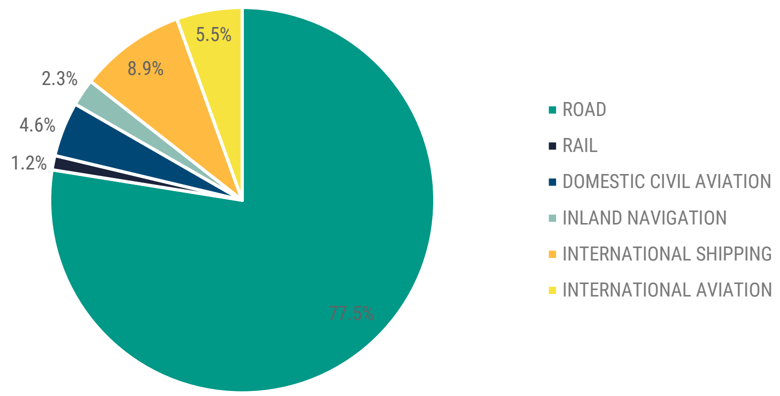
International air and maritme transport are subject to specific measures. Emissions from international shipping broke their upward trend in 2019 (-2.2% in one year), slumped further in 2020 following the major upheaval in trade (-8.5%), then recovered in 2022 (734 $MtCO_2$) surpassing the 2018 peak (708 $MtCO_2$). Emissions from international aviation rose the fastest from 2015 (525 $MtCO_2$) to 2019 (619 $MtCO_2$, +18%), but also shrank the most during the pandemic (-52.2%). Although emissions finally started to pick up again as air traffic increased, in 2022 they remained well below pre-pandemic levels (420.6 $MtCO_2$).

a Unless indicated otherwise, all data in this document come from the Enerdata "Global CO_2 and Energy" database.

FIGURE 1

BREAKDOWN OF GLOBAL CO_2 EMISSIONS FROM FUEL COMBUSTION IN THE TRANSPORT SECTOR, 2022

Source: Climate Chance, based on data from Enerdata



The transport sector has not really broken its dependence on fossil fuels. Petroleum still made up 93.1% of final energy consumption for transport in 2022, compared to 94.3% in 2015. At the same time, the electrification of transport is moving slowly: electricity accounted for only 1.2% of the final energy consumption of transport in 2022, compared to 0.91% in 2015. Over this period, energy demand for transport increased by 1.3%, despite a significant fall in 2020 during the confinements (-13.78%). Demand is particularly strong in India (+4.9%) and China (+3.39%), and generally stronger outside the OECD (+2.44%) than in the OECD (+0.48%). However, scattered signals show that new models are gradually being put in place, with support from non-state actors.

Electrification of the automobile fleet, driven by public policies, has not dented petroleum's domination

Slight drop in emissions from road transport in the OECD

Global emissions from the road transport sector, which represent 77.5% of total transport emissions, rose 6.1% from 2015 (5.75 $GtCO_2$) to 2022 (6.14 $GtCO_2$). Developing and developed countries are following crossed trajectories, with a slight drop in emissions in OECD countries (-1.5%), continuing an erratic trend that began in 2008, and a clear increase in non-OECD countries (+14.9%), over half of it concentrated in the BRICS.

Biofuel breakthrough restricted to a handful of countries

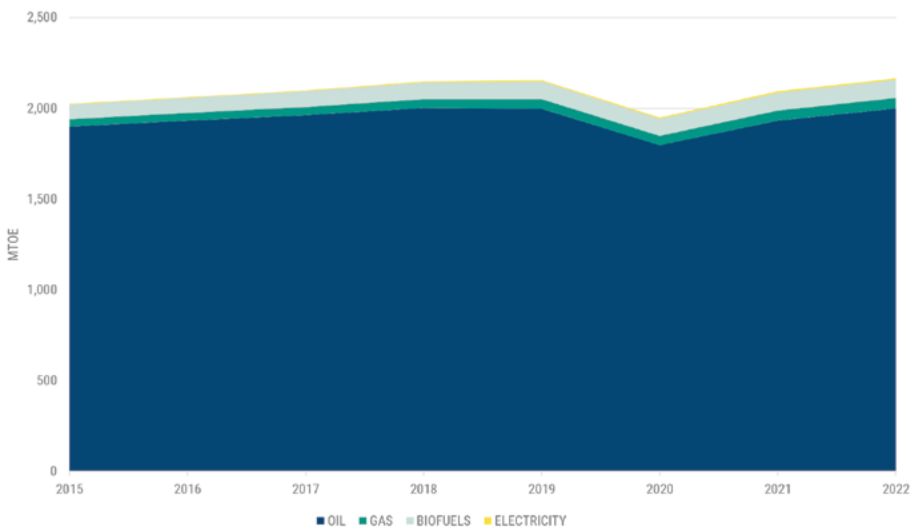
Global final energy consumption by road transport, which has grown 7% since 2015, was still made up of 95% fossil fuels (petrol, diesel, LPG and gas) in 2022. In comparison, the share of biofuels (ethanol and biodiesel) was only 4.7% and, despite the strong growth of electric vehicles, the electrification of road vehicles remains marginal (0.3%). The division of this balance has remained almost unchanged since the Paris Agreement (**FIGURE 2**). The efficiency gains made from 2005 to 2016 (+1.8% per year) slowed down from 2016 to 2017 (-0.7%) and remain far from the 2030 goals set by the Global Fuel Economy Initiative (-3.7% per year from 2017 to 2030).[2]

In the few countries that have succeeded in reducing their petroleum share, it has been to the benefit of biofuels. The final consumption of biofuels in road transport increased by one quarter from 2015 (80 Mtoe) to 2022 (101.3 Mtoe). These fuels are made up of 60% bioethanol (+10.3%) – manufactured through the fermentation of sugar from starch and sugar crops – and 40% biodiesel (+63%) – obtained from vegetable oils or animal fat. In Sweden, the share of petroleum used for transportation dropped from 83.3% to 68.6% thanks to a policy that saw the percentage of biofuels double (26.6% in 2022) over the period.[3] Brazilian transportation also has one of the lowest petroleum dependencies in the world (75.3%), thanks to the 22.3% share of biofuels, mainly in the form of ethanol.[4] In Indonesia, generous programmes subsidizing palm-oil-based biofuel took the share of biomass in transport's final energy consumption from 1.16% in 2015 to 14% in 2022. In Norway, the share of petroleum in the final energy consumption of transport fell from 93.6% in 2015 to 85.9% in 2022, thanks to a combined target to increase electrification and develop biofuels.[5] Other European countries have substantially developed biofuels since 2015, like Albania (15.6% in 2021) and Belgium (9.8%).

FIGURE 2

GLOBAL FINAL ENERGY CONSUMPTION OF ROAD TRANSPORT, 2015-2022

Source: Climate Chance, based on data from Enerdata



In 2022, 56 countries and 30 sub-national jurisdictions had a mandate and targets to incorporate biofuels; the number amounted to 65 in 2021, before some countries suspended their targets due to food price inflation.[6] The reason is that biofuels involve a change in land use that competes with agricultural production for food.[7] In Europe, the agricultural surface area devoted to biofuel could be used to feed 120 million people and absorb twice as much CO_2 if it were returned to its natural state, according to Transport & Environment.[8]

Generally, **the transition to biofuel or electric engines in some countries is not automatically accompanied by a fall in road transport emissions** (FIGURE 3). This is a sign that the growing demand for transport is wiping out some of the gains made by changes in engine technology.

Automobile market split between electrification and "SUVization"

Although a clear shift is not yet visible in emissions figures, recent years have seen a clear rising trend in sales of new electric vehicles on the main markets. From almost zero at the time of the Paris Agreement, **the final electricity consumption of road transport remains very marginal on a global scale (0.3%). However, demand has shot up in most industrial economies**: +240% in the OECD, +729% in the European Union, +172% in the United States, and +56% in China. In Norway, electricity demand from transport multiplied by sixteen from 2015 to 2022, and currently represents 5% of the national consumption of road transport.

The market for electric light-duty vehicles is rocketing. Ten million electric cars were sold in 2022: a record. **Sales have shot up 55% since 2021, and multiplied by twenty since 2015. Electric cars account for 14% of sales of new vehicles, compared to 4% in 2020, and 0.6% in 2015.** Battery electric vehicles (BEVs) are responsible for 70% of growth, ahead of plug-in hybrid electric vehicles (PHEVs). China, responsible for 60% of global sales, is by far the biggest world market, followed by Europe and the United States. Electric vehicles represent 29% of sales in China, and as much as 88% in Norway.[9]

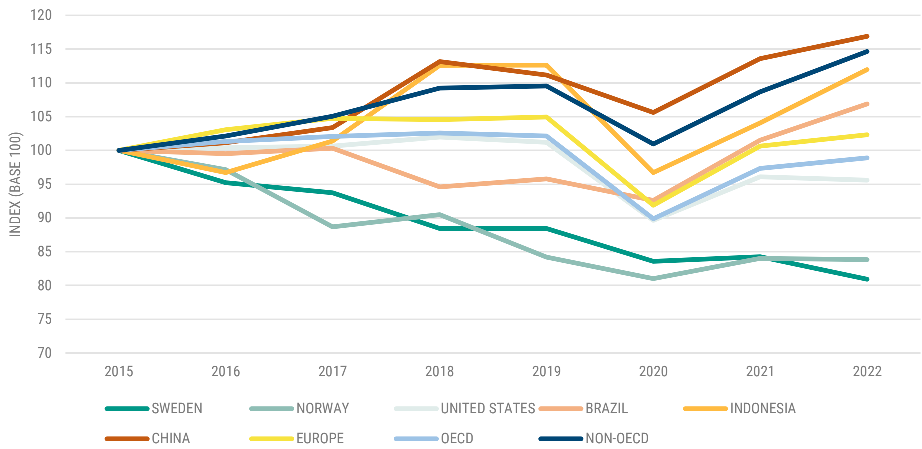
Sales of electric buses and lorries are much lower, and mostly concentrated in China, which also controls most of production. According to IEA figures, 66,000 electric buses and 52,000 trucks were sold in 2022, respectively 80% and 85% of them in China. Sales of electric buses and lorries have not really taken off since 2015, but the market has become more geographically diverse. In India, two-wheelers are undergoing an "electric revolution": sales of electric two-wheel vehicles went from 0.2% to 6% of the market from 2020 to 2023, and the Indian government is aiming at 80% by 2030.[10]

The share of electric light-duty vehicles is all the more significant given that global sales of new vehicles have been decreasing for several years. Following a post-lockdown pickup in 2021, sales of new vehicles in the world resumed the downward trend that began following the peak observed in 2017: 81,628,533 vehicles were sold in 2022, which is -1.4% in a year, and -15% compared to 2017 (**FIGURE 4**).[11] This trend can partly be put down to manufacturers' difficulties getting hold of spare and electronic parts during the semi-conductor shortage and lockdowns. Nevertheless, this trend is not visible in manufacturers' financial results, where the drop in volume is compensated by the growth of a very profitable market: sales of SUVs (sport utility vehicles).

FIGURE 3

ROAD TRANSPORT CO_2 EMISSIONS EVOLUTION INDICES FOR SELECTED COUNTRIES AND ECONOMIC ZONES, 2015-2022

Source: Climate Chance, based on data from Enerdata



SUVs, which are heavier and consume more fuel than average, totalled 46% of sales of new vehicles in 2022, compared to 27.4% in 2015. Currently, more than three out of ten vehicles operating in the world are SUVs. These more expensive cars generate more profitable financial margins for manufacturers.[12] Yet on average, an SUV consumes 20% more fuel than a standard-size vehicle, and according to the International Energy Agency, the 330 million SUVs on the roads generate 1 $GtCO_2$/year, which is 2.6% of global emissions. This "SUVization" of the market also includes electric vehicles: currently, more than one electric vehicle in two sold in the world is an SUV, with some models heavier than 4,000 kg, way above the average weight of new vehicles in France (1,240 kg),[13] and even in the USA (1,857 kg).[14] In fact, the average efficiency of vehicles, even electric ones, tends to decrease as the size of the vehicles increases, reports the IPCC.[15]

Planned phase-out of combustion-engine vehicles sees manufacturers adjust their strategies

The penetration of electric vehicles is mainly boosted by a legislative and political impetus to phase out combustion vehicles. To date, 39 countries, 60 local and regional governments, and 13 carmakers have signed the COP26 Declaration on accelerating the transition to 100% zero-emission cars and vans by 2040. **In late 2022, REN21 listed 23 countries and 17 sub-national jurisdictions that had totally banned vehicles with internal combustion engines.** The European Union has prohibited the sale of vehicles running on petrol and diesel by 2035, while the United Kingdom has set a target of 2030. In Norway, where electric vehicles total nearly 90% of new sales, it will be illegal to drive a combustion-engine vehicle starting from 2025. In the United States, some cities prohibit the construction of new petrol stations.[16]

In urban areas, attempts to improve air quality also contribute to a modal shift towards soft mobilities and the exclusion of combustion vehicles from cities and towns. In 2022, 320 low emission zones (LEZs) existed in Europe, compared to 228 in 2019 (+40%).[17] These urban zones either restrict or prohibit access for vehicles that do not respect certain emissions standards, with the aim of improving urban air quality. However, they can increase the risk of social exclusion for inhabitants that are the most dependent on combustion engine vehicles.

FIGURE 4

THE RECENT BREAKTHROUGH IN SALES OF ELECTRIC VEHICLES HAS NOT YET CHALLENGED THE HEGEMONY OF COMBUSTION-ENGINE VEHICLES

Source: Climate Chance, based on data from the International Energy Agency, 2023

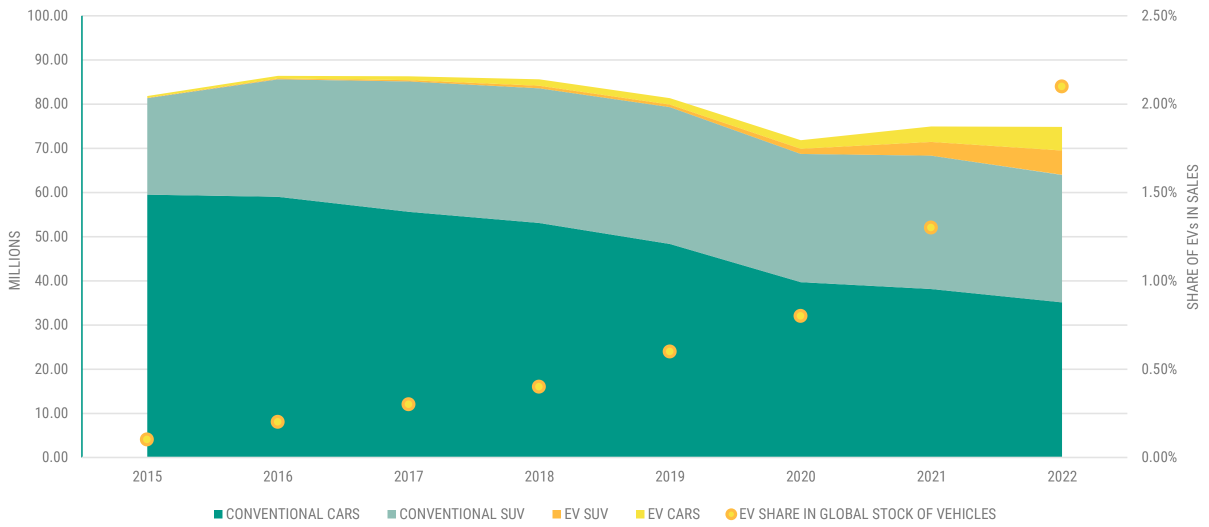
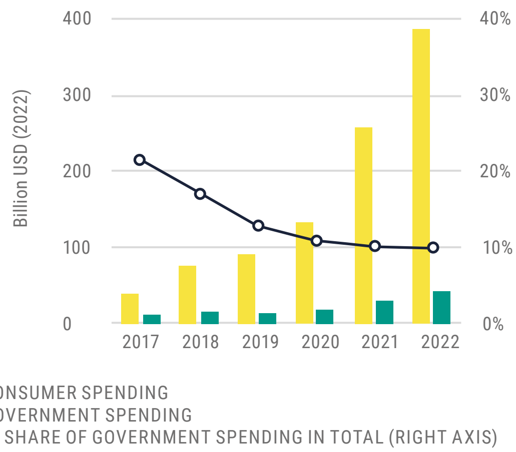


FIGURE 5

GLOBAL EXPENDITURES ON ELECTRIC VEHICLES, 2017-2022

Source: International Energy Agency, 2023



To encourage this transition, 90% of the market for sales of electric light-duty vehicles is covered by national incentive policies, taking the form of a bonus, purchase premium, or tax exemption. From 2017 to 2022, the ratio of public expenditure/private expenditure for electric vehicles went from 20% to 10% (**FIGURE 5**), proof of the lever effect of public expenditure, combined with the decreasing cost of batteries, which has been divided by three since 2015. Recycling of lithium-ion batteries, which takes a backseat in the regionalization strategies of industrial sectors, is gaining ground in North America: the province of Quebec, which strongly supports innovation and the emergence of a recycling channel, is a pioneer in this area.[18]

This legislative context, and growing competition from Chinese manufacturers, such as BYD, the world's leading EV manufacturer ahead of Tesla, obliges European carmakers to accelerate their transition. **In 2021, the average emissions of automobile manufacturers amounted to 115 g/km in Europe, compared to 131 g/km in 2020 (-12%) – the biggest drop observed since records began in 2010**. Eighty-four of the 88 manufacturers subject to EU regulation, taken individually or in groups authorized to align with legislation, reached or surpassed their targets, with variable margins: from 1 gCO_2/km for Renault-Nissan-Mitsubishi (109 g/km, against a target of 110) to 96 gCO_2/km for Tesla-Honda-Jaguar Land Rover, which obtained a result of 33 gCO_2/km against a target of 129.[19]

Chinese manufacturers were the first to stop building combustion engine vehicles: BYD has only sold electric vehicles since March 2022, while Chongqing Changan was the first to announce in 2017 that it would stop producing combustion vehicles by 2025. Jaguar-Land Rover, Mini and Rolls Royce, Lancia, Volkswagen and Mitsubishi have all announced that they will be totally converting to electric with different deadlines. Among the biggest carmakers, BMW anticipates 50% of EV sales in 2030, and Renault 90%. Toyota, the biggest global automobile manufacturer and the pioneer of hybrid vehicles, was slow to move into BEVs but has set ambitious sales targets for 2025 to compete with Tesla and BYD.[20]

The pace of installing charging stations is crucial for the market's development. At the end of 2022, 2.7 million public charging points were installed in the world, including 900,000 set up in 2022 and 500,000 in 2021, with an average annual growth rate of 50% observed since 2015, according to the IEA. On the main markets, BEV sales are growing faster than charging stations; the EV-to-public charging station ratio is on a rising trend. The European Union, which in 2014, in its AFID (Alternative Fuel Infrastructure Directive), established the goal of one charging station for ten electric vehicles by 2020, has not met its target (13:1 in 2022). South Korea (2 vehicles for 1 station) and the Netherlands (4:1) boast the lowest ratios, while the figure is 8:1 in China, 24:1 in the United States, and 34:1 in Norway. However, the latter two countries feature high numbers of houses with a garage; the ratio is therefore higher than average and following an upward trend, due to a predominance of charging points in the home.

Slow electrification of company fleets

In 2022, EV100, Climate Group's initiative to electrify the automobile fleet, included 127 member companies, compared to 16 at its launch in 2017.[21] Members commit to converting their company fleet to electric and installing charging stations. The initiative now covers 102 markets in the world, and a total of 5.75 million electric vehicles promised by 2030, either in company fleets or leased.

The number of EVs deployed in 2022 in individual company fleets grew 49% in a year; 79,615 company cars were in service (two-thirds are BEVs, the rest are PHEVs), out of a total of 724,310 units according to commitments. EDF operates the biggest EV fleet (8,732 units) among EV100 members, and recorded the biggest growth, ahead of Swiss Post and Siemens. In addition, ten companies have committed to deploying 5 million leased EVs for their clients, of which 325,000 have already been put on the market (zero in 2017). The Netherlands company LeasePlan has already deployed almost 150,000 vehicles, ahead of Lloyds Banking Group and Lyft. The United Kingdom is by far the leading market in this segment. Other companies, such as Iberdrola and the Japanese electric power company TEPCO have equipped all of their numerous offices with charging stations. TESCO, which is a member of EV 100, recently reached the target it set in 2019 in partnership with Volkswagen and Pod Point to equip 600 stores with an electric charging station.[22]

The ride-hailing sector is moving more slowly towards electric. The key market players – Uber, Lyft, Didi Chuxing – and subnational governments like California, have made commitments to make 100% of their fleets electric by 2030. But the electrification of ride-hailing fleets in Europe, the USA and Canada is slower than the rest of the market, according to a study by the World Resource Institute (WRI).[23] Some cities are exceptions. In Amsterdam, where over 6.5% of Uber vehicles are electric, the installation of charging stations following user requests has led to a network covering the territory in line with drivers' needs. In London, where Uber works closely with the municipality, the firm maintains that almost 90% of new drivers operate a 100% electric vehicle. In India, Delhi has become the first state in the country to make electric vehicles mandatory for some new app-based taxis (especially two- and three-wheelers).[24]

In urban areas, bikes have shifted up a gear

Along with changes in fuel and improved energy efficiency, a modal shift to soft mobility is the main policy lever to reduce emissions from transport. Urban mobility in particular has undergone several major changes since 2015. Since Covid-19, the number of bike lanes in place in the world has risen considerably.[25] Forty-three of the biggest 94 cities in the European Union announced that they were setting up bike-friendly measures in reaction to the pandemic, according to the European Cyclists' Federation (ECF). Europe now boasts 458,934 km of cycling infrastructures in 37 countries. In the Netherlands, the length of the cycling network is the equivalent of 70% of the road network, compared to 31.4% in Belgium, 9.2% in Germany, and 3.2% in France.[26] **In mid-2022, 1,914 bike-sharing systems were active around the world, in 1,590 towns in 92 countries, of which 47% in Europe and 38% in Asia**. China is by far the country with the most bike-share systems in place, ahead of the United States, Italy, Germany, Poland and France.[27] Even in Cairo (Egypt), a metropolis of 22 million inhabitants and one of the most congested in the world, a bike-share system was set up in 2022 close to city subway stations.[28]

The market is growing very fast in Europe: **14.7 million bicycles were manufactured in the EU in 2022, which is 10% more than in 2021 and 29% more than the average from 2012 to 2022.**[29] With 14.7 million units sold, regular bicycle sales dropped by 9.1% in 2022 following a record year in 2021, while electric bicycles followed an opposite trend (+8.6%, 5.5 million units).[30] Underlying this trend, the ECF lists 300 tax incentives and purchase premium schemes established in Europe by national, regional or local authorities, a figure that has "increased significantly" since 2019.[31] Cycling is now an integral part of the urban mobility policy in Bogota,[32] while in Jakarta, cycle lanes are devised to interconnect with the bus rapid transport network, with the result that four times more people can reach the city centre than the population within a 15-minute walk.[33]

Rail transport: in Asia and Europe, electrification of high-speed trains is on the right track

Rising emissions since 2015 do not give the whole rail picture

Global emissions from rail transport rose 4.2% from 2015 (91.37 MtCO_2) to 2022 (95.24 MtCO_2), with a peak in 2019 (103.25 MtCO_2) and a sharp drop in emissions in 2020 due to the pandemic (-16.7%). The train is one of the means of passenger transport that emits the least greenhouse gases (GHG): on average, its lifecycle carbon intensity is around 22.35 gCO_2e per passenger-kilometre, which is ten times less than for large cars and five times less than for planes.[34] Depending on the situation, the increase in emissions associated with rail can therefore translate into a positive global modal shift, and net emissions savings.

Despite a drop in passengers, rail infrastructure expansion is going full speed ahead

While passenger train travel grew to reach a new record in 2019 (over 4,100 billion passenger-kilometres), the volume of passengers transported dropped sharply by 34% from 2019 to 2020, due to the pandemic. Train passenger numbers then continued to drop in 2021 and 2022, with only half as many users as in 2019.[35, 36] Traffic picked up differently depending on the region and the country, as reported by the International Union of Railways (UIC).[37] In some countries in Europe – like France, Poland and Turkey – traffic has already exceeded its 2019 level, while recovery has been slower in Germany and Italy, and also in Asia, where passenger transport even dropped by 31% in China from 2021 to 2022, because of prolonged anti-Covid restrictions. The volume of rail freight, which was generally less impacted by the pandemic (-3.8%), surged back to its pre-level crisis, despite a drop in activity due to the war in Ukraine, especially in the Baltic countries.

Nevertheless, long-distance and urban rail infrastructures are burgeoning. In 2021, 58,839 km of high-speed lines were operating in twenty countries, compared to 38,828 km in 2015 (+51.5%). More than two-thirds (68%) of the global high-speed rail network is located in China (40,474 km), way ahead of Europe (11,990 km) and Japan (3,081 km). In relation to land area, South Korea has the highest density of high-speed railways, just ahead of Japan, Spain and Belgium. North America, where trains are used for freight but rarely to transport passengers, only counts 735 km of high-speed rails, with 274 km under construction. In Africa, the first and only high-speed railway was inaugurated in Morocco in 2018; the 186 km of tracks connect Tangiers with Kenitra. Other lines are planned, such as in Egypt.[38] Recent years have seen global railway growth driven by Chinese investments as part of the Belt and Road Initiative, and European investments through the Global Gateway initiative.[39]

Apart from high-speed trainlines, investments in rail transportation are more mixed. From 1995 to 2018, European countries devoted €1,500 billion to road infrastructures, compared to €930 billion for railways, according to Greenpeace. The road network in these 30 countries (EU27 + Norway, Switzerland and the United Kingdom) expanded by 60% over the period, while the rail network shrank by 6.5%. Since 1995, 13,700 km of passenger lines and 2,500 stations have closed. The only exceptions are Belgium, Austria and the United Kingdom, which invest more in rail than in roads.[40]

In late December 2021, the UITP listed 193 cities equipped with an underground railway system in the world, clocking up 17,221 km and over 58 million passengers transported in 2019 (before the pandemic). From 2014 to 2019, the number of passengers rose by 44% in Asia-Pacific, 21% in the Middle East/Africa, 16% in Latin America, 9% in Europe and 2% in North America. Covid-19 had a huge impact, bringing down subway usage by 34% in Tokyo, 42% in Beijing, 62% in New York and as much as 90% in Delhi in 2020.[41]

Electrification of rail transport steams ahead

From 2015 to 2019, final energy consumption (except electricity) of rail transport in the world rose by 14.6%, amounting to 60.01 Mtoe – a record, after thirty years of erratic evolution. Following the drop in 2020, consumption picked up in 2021, then decreased again in 2022 (55.07 Mtoe) to reach a level close to that of 1990 (55.92 Mtoe). The rail sector's energy mix comprises 36.8% petroleum, 34.7% diesel and 28.5% electricity. The use of coal has almost completely disappeared (0.02 Mtoe). However, trains cover about 9% of global passenger transport and 7% of global freight;[42] rail only represents 2.2% of energy demand from the transport sector, and 1.3% of its direct CO_2 emissions.

Eighty-five percent of passenger rail transportation now operates on electricity, compared to 55% for freight, according to the IEA. Yet this overview disguises regional disparities. In the United States, where trains are seldom used by passengers and more commonly for freight, less than 1% of the rail network is electrified.[43] In contrast, Asia has made great steps in electrification. India, which aims to make its entire network electric by the end of 2023, has already reached 90% electrification overall, and 100% in fourteen states.[44] In Europe, almost 60% of lines were electrified in 2021, with rates varying from 2.6% in the Republic of Ireland to 99.8% in Switzerland.[45] In any case, the final impact of electrification is highly dependent on the structure of the national electricity mix; for example, India still produces 72% of its electricity from coal (**CF. "ELECTRICITY" TRENDS**), and its very attractive passenger transport model is based on subsidies for transporting coal by rail.[46]

The electrification of trainlines is supported by a mix of national and/or regional investments, and a commitment from the key commercial and managing network operators. Deutsche Bahn (Germany) for example in 2021 announced that it was aiming to be climate-neutral by 2040, which is ten years earlier than its initial target. The company also aims to run its factories, offices and stations with 100% renewable energy by 2025. In 2021, it signed renewable energy purchase agreements with Statkraft and RWE.[47] To phase out the use of diesel for its "small lines" with low traffic, SNCF (France) is implementing a so-called "frugal electrification" strategy, based on developing battery-run trains on parts of the tracks that are difficult to electrify. A pilot project for the strategy has begun operating battery-powered trains on the Aix-Marseille section.[48] East Japan Railway, the biggest railway company in the country, has invested in solar energy since 2013, and in early 2021 announced new investments to reach its aim of "zero carbon" by 2050.[49]

In Germany, in summer 2022, the state of Lower Saxony launched the operation of fourteen *Coradia iLint* built by Alstom, the very first hydrogen-powered trains in the world,[50] while awaiting delivery of 27 more for the metropolitan region of Frankfurt Rhine-Main. Italy has also announced that it is earmarking €300 million of its post-Covid recovery funds to deploy hydrogen-powered trains to replace diesel trains in six regions.[51] Quebec is testing out a *Cordia iLint* on the Quebec-Charlevoix line, a first in the Americas.[52] Indian Railways is also setting its sights on hydrogen to electrify heritage lines.[53] However, one year after putting hydrogen trains into operation, the Lower Saxony rail company, LNVG, decided to opt for cheaper battery-electric and catenary-connected trains to phase out the remainder of its diesel lines.[54]

As well as action on power sources of trains, several governments have acted to boost demand for transport using trains. The return to night trains in Europe is part of this move. In February 2023, the European Commission announced a support programme for ten transboundary railway lines, three of them new night lines.[55] Starting from 2024, the private French operator Midnight Train hopes to connect Paris with a dozen European cities using upmarket night trains; the Belgian-Dutch cooperative European Sleeper is already running from Brussels and even links London to Berlin.[56] The Austrian company ÖBB, which operates the biggest night train fleet in Europe and covers 25 cities in fourteen countries, has ordered 33 new trains from Seimens worth €720 million.[57] Night trains, which are 28 times less polluting than aeroplane flights, have the potential to reduce emissions by 3% in Europe.[58]

Some countries have created fixed-price travel cards covering the entire transport network. In October 2021, following two years of negotiations between the government and regional authorities, Austria introduced the "KlimaTicket", which costs €3 per day (€1,095/year for an adult) and allows card holders to travel as much as they want on the country's transport system. 170,000 travel cards have been sold, and 85% of users state that they now travel by public transport instead of by car.[59] Germany has set up a similar initiative, with "D-Tickets" that allow travellers to take journeys on the entire urban and regional transport network for a cost of €49. The initiative was an immediate success, with 250,000 D-Tickets sold within three days of launching. This project follows the experiment of a 9-euro fixed-price ticket during the summer of 2022, which avoided an estimated 1.8 $MtCO_2$ of emissions.[60]

Air transport: decarbonization struggles to take off

After plummeting during the pandemic, emissions have gone sky high

Emissions from the entire international and domestic civil aviation sector in 2022 (789.2 $MtCO_2$) were 10.5% lower than in 2015 (882.5 $MtCO_2$). Yet the sector still represents over 10% of global emissions from transport. International aviation emissions grew the fastest from 2015 (525.9 $MtCO_2$) to 2019 (619.1 $MtCO_2$, +18.2%), and shrank the most during the during the 2020 pandemic (-52.2%). They then shot up again as air traffic took off, reaching 68% of their pre-pandemic levels in 2022 (420.6 $MtCO_2$), according to data from Enerdata. Emissions from domestic civil aviation (362.88 $MtCO_2$), which were relatively less impacted by lockdowns (-31%), have also returned to near 2019 levels (85.5%), and have already overtaken the volumes emitted during the year of the Paris Agreement.

Air transport activity almost back up to 2019 levels

Airline passenger traffic was almost back to 80% of its pre-pandemic level by December 2022, and up to 94.2% in June 2023.[61] From 2000 to 2020, commercial flights grew by an annual average of 5%, pushing up CO_2 emissions by 2% a year. However, the Covid-19 pandemic brought the trend to an abrupt halt, with planes all over the world left sitting on the tarmac for months.[62] China's reopening to international flights accelerated the recovery of global traffic. International flights going to or from Europe alone account for a quarter of global traffic. Domestic flights, which represent 42% of aviation activity – almost half of it in the United States – already exceed by 5.9% the volume of activity recorded in 2019.

Air freight, which had surpassed its 2018 peak after an exceptional recovery in 2021 (+18.7%), ultimately ended the year on a downward trend (-8%), below its pre-pandemic level.[63] European transporters (22% of the market) are impacted by the war in Ukraine, while the Asia-Pacific region (32.4% of the market) is still suffering from the industrial aftermath of Covid-19 and new waves announced in China. Inflation and the high rate of the dollar have slowed down international trade.

In the run-up to CORSIA, alternatives to conventional engines take a backseat

Only domestic flights are covered by the Paris Agreement's scope of application. Nevertheless, in 2021, just 6% of nationally determined contributions (NDCs) mentioning transport made a reference to mitigating aviation emissions.[64] In order to "*achieve carbon neutral growth from 2020 and to reduce its carbon emissions by 50 per cent by 2050 compared to 2005 levels*"[b] since 2016 the international civil aviation sector has organized itself around CORSIA, a carbon offsetting and reduction scheme set up by the International Civil Aviation Organization (ICAO). In autumn 2022, the triennial ICAO general assembly agreed to set a net-zero target for the sector by 2050.[65]

But CORSIA has not really taken off yet. Initially, the programme planned total offsetting of emissions generated above the average emissions recorded in 2019-2020. Only flights between countries opting to take place in the pilot phase (2021-2023) were concerned: these totalled 107 at the end of 2022, out of 193 ICAO members, representing 76% of international activity. But the Covid-19 pandemic brought the programme to a halt before it had the chance to get started. In June 2020, the ICAO Council decided to reduce the programme's reference threshold to 2019 emissions only, instead of average emissions from the sector from 2019-2020.[66] This decision delayed the programme's kick-off date by three years: because emissions are still below 2019 levels, volunteer companies theoretically still have not had to offset any additional emissions since the start of the pilot phase. The programme will not become mandatory until 2027.

In Europe, several countries have recently set up regulatory and taxation levers to spur a drop in domestic aviation. Austria, for example, has banned domestic flights when the same journey can be made by train in under three hours, and in 2020 established a tax of €30 per passenger on flights of less than 350 km, except for transfer flights.[67] France has prohibited domestic flights when an alternative of under 2.5 hours is available, but the application decree features so many exemptions that only three lines are concerned.[68] Spain and Germany are planning similar measures.[69]

Despite being on the table since 2019, the EU has still not reached an agreement to bring to an end exemptions on carbon taxes.[70] According to Transport & Environment, these various tax exemptions cost the European Union over €34 billion in 2022, and 35 $MtCO_2$ of emissions savings.[71] In the absence of standardized taxation of fuel, several European countries have followed Austria's example and implemented a tax on flight tickets (France, Belgium, Germany, Italy, Norway, Sweden and the United Kingdom).

Policies aimed at encouraging biofuels as a substitute for kerosene are rare: in late 2021, three countries (Finland, Indonesia and Sweden) put forward biofuel targets for the aviation sector.[72] Aligned with the EU roadmap featuring in the "Fit for 55" regulation, France for example has required since 1 January

b As declared by the ICAO in the resolution adopted at its 39th session in October 2016 which launched the CORSIA programme.

2022 that planes refuelling on French territory must use at least 1% sustainable aviation fuel (SAF) (then 2% in 2025, 5% in 2030, and 50% in 2050). The EU agreed in June 2023 on a target of 2% SAF in 2025 and up to 70% in 2050, in the ReFuelEU regulation.[73] Since 2011, when KLM operated the first such flight, 516,453 commercial flights have been run on SAF (342,256 flights in 2021) but none have used 100% SAF to date. Only six airports are currently regularly supplied with biofuels.[74] Electrification of international civil aviation, although sometimes evoked, is still a long way off; the German airline Lufthansa estimates that converting its entire fleet to SAF and e-kerosene would consume half of Germany's electricity production.[75]

Maritime transport: the pickup in international trade dwarfs decarbonization efforts

Closely correlated to international trade, emissions from maritime transport are on the rise

In 2022, emissions from international maritime transport (734 $MtCO_2$) were 10.8% higher than in 2015 (663 $MtCO_2$), according to Enerdata figures.[76] Emissions had dipped slightly in 2019 (-2.2%) compared to 2018, due to a slowdown in international trade, before slumping in 2020 (-8.5 %). The progressive recovery of international maritime trade took emissions to a new record level in 2022. According to data from Enerdata, emissions from domestic transport (river, cabotage, ferries, etc.) rose by 12.3% from 2015 (162.5 $MtCO_2$) to 2022 (182.6 $MtCO_2$). The peak was reached in 2019 (184.03 $MtCO_2$) before the pandemic saw figures plummet in 2020 (-10.9%).

According to the fourth study on greenhouse gases (GHG) by the International Maritime Organization (IMO), carbon dioxide (CO_2) constituted 98% of GHG emissions from the sector. However, over the 2012-2018 period, the IMO observes a particularly steep increase (150%) in emissions of methane (CH_4), which has a global warming potential (GWP) 86 times that of CO_2 over 20 years.[77]

Slowdown in growth of international maritime trade

Strongly correlated to the state of the global economy, international maritime trade has seen a slowdown in recent years. After shrinking by 3.8% in 2020 due to the pandemic, international shipping increased by 3.2% in 2021. Already in 2019, the growth of volumes transported had seen its second consecutive year of slump, dropping from 2.7% in 2018 to 0.5% in 2019: figures way below the average recorded from 1970 to 2017 (+3% per year).[78] Global traffic of container ships, which is a key indicator of the state of international trade, followed the same downward trend, with the growth rate dropping from 6.7% in 2017 to 2% in 2019 according to UNCTAD annual reports.

Transportation of containerized cargo, which represents 43% of international maritime trade, has nevertheless remained the main driver of international commerce since 2015 (+14%, in volume), and has already exceeded pre-pandemic levels. Bulk commodity trade (iron ore, grain, coal, bauxite, phosphate, making up 30% of international maritime trade) rose by 11.7% from 2015 to 2021, back to 2019 levels. Lastly, after an increase from 2015 to 2018 (+9.2%), transport of petroleum and chemicals by tanker (27% of commerce), slowed down slightly from 2019 before plummeting in 2020 (-7.7%), and has still not returned to pre-pandemic levels. Among the hydrocarbons, liquified natural gas (LNG) continues to grow strongly (+5.6% from 2020 to 2021), while the traffic of petroleum products has gone down (-0.9%), remaining below pre-pandemic levels (-8.6%). The tonnage of the international fleet carried on growing from 2021 to 2022 (+3%), although the growth rate was its second lowest since 2005.

Decarbonization remains a distant technological and political goal

In April 2018, over one hundred states gathered at the IMO headquarters in London adopted a sectoral strategy to reduce emissions by 2050. This strategy was revised in July 2023, and now sets its sights on zero emissions by 2050 for companies in the sector, with intermediate targets to reduce emissions by 20-30% in 2030 and 70-80% in 2040. The agreement also establishes a minimum incorporation rate for low-carbon energy, fuels and technologies of 5% to 10% of the sector's energy mix by 2030.[79] In addition, since January 2020, the IMO 2020 regulation mandates a reduction in the sulphur content of heavy fuel oil (HFO) used in ships from 3.5% m/m (mass by mass) to 0.5% m/m for all ships circulating outside Emissions Control Areas (ECAs).

To deal with this dual requirement to reduce pollution and carbon levels, the sector has several potential levers, some of which are contradictory.[80] The carbon intensity of the international container ship fleet dropped from 21% between 2012 and 2022, while that of bulk commodities and goods transporters fell by 18%, according to UNCTAD statistics. Yet at the same time, gross emissions increased (**SEE ABOVE**), a sign that the general growth of the international trade fleet is wiping out increased efficiency.

In terms of reducing carbon levels, some efforts focus on developing alternatives to the high-carbon fuels employed to power ships. In late 2022, 21 green shipping corridor initiatives were listed in the world, of which twelve are short-distance and seven are on the high seas. Nineteen of the corridors are run by non-state actors: ports (9), industries (4), and public-private partnerships (9); and the remainder by states (3).[81] The aim of these green shipping corridors is to develop low-carbon commercial shipping routes between major ports, by promoting the development of ships emitting low levels of CO_2, installing charging facilities, and creating an incentivizing legislative environment. To date, the targets set by these projects span from 2027 to 2030. For example, in January 2022, the ports of Los Angeles and Shanghai, joined in June by Long Beach Port, and in partnership with the global city network C40 Cities, A.P. Moller – Maersk, CMA CGM and other industrial and research players, announced the launch of a project to create the first green shipping corridor across the Pacific between China and the United States.[82]

Currently, according to figures from the risk management and assurance provider, DNV, 98.2% of ships operating in the world (93.5% in tonnage), and 73.8% of ships on order (48.7% in tonnage) use conventional fuel (**FIGURE 6**). Among the alternative operating fuels (6.5% in tonnage), liquified natural gas (LNG) largely dominates orders for long-distance ships (78% of tonnage on order and 91% of tonnage in operation), while the other options (batteries/hybrid, methanol, liquified petroleum gas) are more oriented towards short-distance ships.[83]

However, although LNG emits 25% less CO_2 than traditional ship fuels and contains almost no sulphur, it is responsible for the increase in CH_4 emissions observed by the IMO in recent years.[84] Methane leaks from ships running on LNG[85] could account for 0.2% to 3% of the combustion process.[86] In 100 years' time, provided more efficient technology is adopted, emissions savings thanks to LNG could reach 15% compared to marine gas oil (MGO); in twenty years, much closer to the urgent need for climate action, the use of LNG is likely to generate 4% more emissions.[87]

The use of ammonia as an alternative low-carbon shipping fuel comes up against the limitations of hydrogen production, of which it is a derivative. Since the energy density of ammonia is lower than that of petroleum, converting the entire international shipping fleet would mean tripling ammonia production to 440 million tonnes, requiring no less than 750 GW of renewable electricity.[88] Yet today, only 0.3% of the hydrogen produced in the world comes from renewable electricity (**CF. "INDUSTRY" TRENDS**). In February 2022, the Greek shipowner Avin International inaugurated Kriti Future, a "Suezmax" tanker announced as the first ship in the world running on ammonia. At the moment, the ship still operates using conventional fuel, but it is equipped with the necessary conversion technology.[89]

Methanol, which features in the strategies of the major shipping companies as a means to diversify their energy sources, has a high carbon content: almost all of the 98 million tonnes of methanol produced annually come from fossil energy (gas and coal). Only 0.2 million tonnes of "renewable" methanol are produced every year, mostly from biomass.[90] Here too, the production of "e-methanol" depends on the hydrogen market. A.P. Moller – Maersk, which has committed to only order low-carbon ships in the future, is expecting delivery of six methanol-powered ships in 2025,[91] and has signed a series of strategic partnerships with industrial companies (including Orsted, Proman and European Energy) to develop production of bio- and e-methanol.[92]

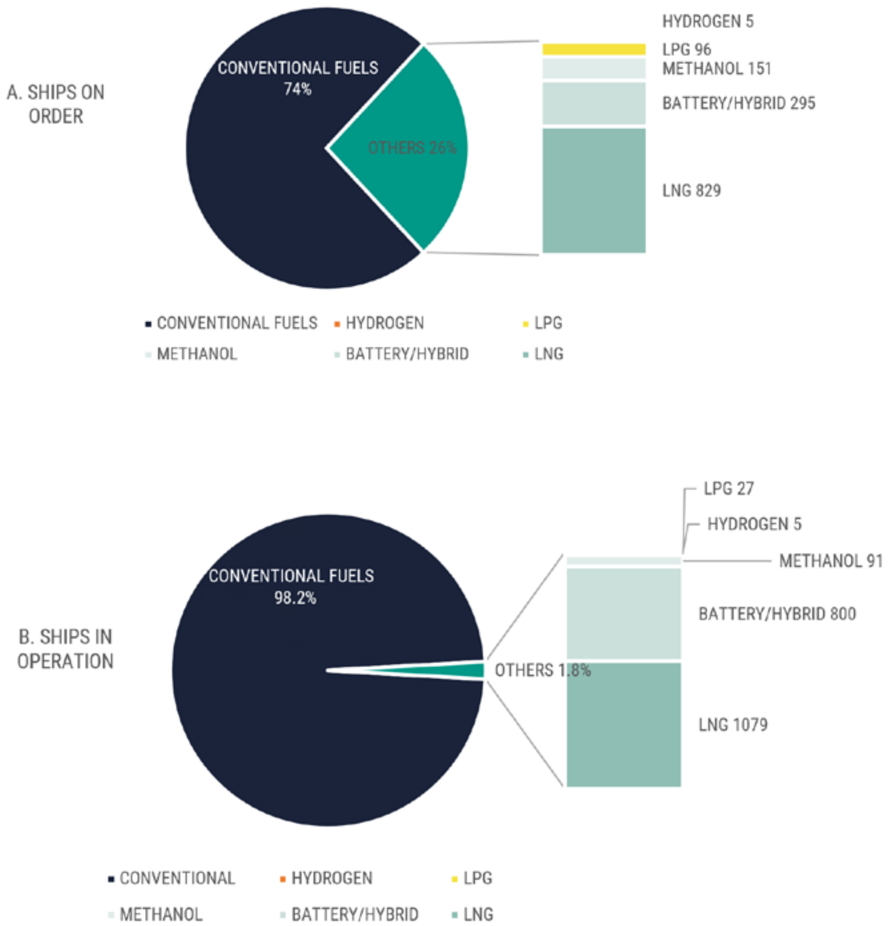
Currently, 800 ships operate with an electric battery or hybrid system, which only represents 0.26% of global tonnage, according to DNV. These are mostly short-distance ships. For example, in 2019 the Norwegian parliament voted to ban GHG emissions in the country's fjords, and since 2015, ferries and cruise liners must be equipped with zero- or low-emissions technology.[93] The Swedish company Stena Line, which already operates hybrid (diesel-electric) ferries, announced in September 2021 the launch of a 100% electric ferry... but not until 2030.[94] The *Yara Birkeland*, announced in 2017 as the first autonomous container ship powered by an electric battery, was baptized this year in Norway and is currently in a two-year testing phase to obtain certification.[95]

Reduced demand for transport and shorter value chains are not even on the table. Demand for transport of goods in tonne-kilometres is set to triple by 2050 if no action is taken.[96] This demand is the result of both more intense international trade (tonnes) and an organization of logistic trains that involves very long geographic distances (km). This reorganization involves a transition from a production-consumption system towards more circularity, proximity, and resilience to simplify and shorten value chains.[97] A recent UNCTAD study for example identified four key trajectories for logistics chains (reshoring, diversification, regionalization, and replication), three of which involve shorter, sometimes less fragmented chains.[98]

FIGURE 6

LIQUEFIED NATURAL GAS DOMINATES ALTERNATIVE FUELS FOR SHIPS IN OPERATION AND ON ORDER

Source: DNV, 2023



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BUILDINGS

Nº 4 Decarbonization policies fall behind construction and renovation needs

- The global built-up area has been growing faster than energy efficiency gains in buildings. As a result, emissions from the sector have been on the rise since 2015.
- Energy consumption from buildings in non-OECD countries, pushed by new constructions and demographic growth, is growing faster than in the OECD, where renovation isn't at the needed level.
- In the North, despite gradual electrification, the slow decarbonization of the electricity mix is holding back the sector's decline in emissions. In Germany and the United States, social movements are contesting the phase-out of gas in new buildings by states and municipalities.
- In light of its energy vulnerability revealed by the war in Ukraine, "energy sufficiency" is making a concrete entry into European policies; its impact remains to be seen over time.
- In the South, the need for air-conditioning is rapidly increasing. Isolated initiatives are seeking to scale-up, based on traditional materials and know-how.

KEY FIGURES

Property construction is outpacing energy savings

- **+8.5% emissions** and +12.8% energy consumption from 2015 to 2022. **30%** – share of the building sector in total final energy consumption (Enerdata, 2023).
- **+16.2% built-up area** from 2015 to 2022, compared to -5.5% energy intensity over the same period (IEA, 2023a).

Heating cools down while cooling heats up

- **54.5% of fossil energy** in building consumption in 2022 (mostly for heating), compared to 60.5% in 2015 (IEA, 2023b.)
- **+11% heat pumps** sold from 2021 to 2022, +40% in Europe. (IEA, 2023c).
- **+4%/year energy demand** for space cooling since 2000. Emissions generated by air conditioning systems increased by 16% from 2015 to 2022 (IEA, 2023d).

Sourcing, bans, certification – three popular action levers

- **920 municipal renewable energy targets** for 2022 – of which 793 concern supply, generation or consumption of electricity; 170 concern heating or cooling (REN21, 2022).
- **125+ local governments and 11 states in the United States, representing 36 million people,** have banned gas or encourage electrification of new buildings (RMI, 2023).
- **4.2 billion m² of built-up area certified** in 2021, compared to 1.05 in 2016 (WorldGBC, 2022).

FURTHER READING

TRENDS

- Real estate players are re-examining their foundations to adapt to climate change (2022)
- From efficiency to renewable energy generation: Commercial spaces in search of renewal favouring the low-carbon transition (2022)
- In the face of global warming, air-conditioning is locked in a market model that is costly for the climate (2021)
- US Cities embark on an anti-gas battle to electrify buildings (2021)

CASE STUDIES

ANGERS • EnergieSprong, an industrialized zero energy renovation project, a lever for mass uptake (2022)

INDONESIA • Betting on reflective roofs to avoid air condition (2022)

THE NETHERLANDS • Long-term strategies of local authorities to phase out fossil fuels in heating (2021)

BRAZIL • Buildings: Local authorities and businesses, pioneers in a still weak national set-up (2019)

CANADA • The energy intensity of the residential sector becomes more efficient (2018)

TRENDS
BUILDINGS

Renovate the old, adapt the new, go all-electric: the three pillars of the building sector's climate strategy

TANIA MARTHA THOMAS • Research Officer, Global Observatory on Climate Action, Climate Chance

The world's building sector is facing a double challenge: renovate existing stock to make it more energy efficient, and build new, less energy-intense buildings that are more resistant to future climate risks. With the global built-up area growing faster than gains in energy efficiency, and with the concept of "sufficiency" only making a limited appearance at the European level, emissions from the sector are on the rise. The decarbonization of buildings depends on their electrification, and on the transition of the electricity mix, which is progressing slowly. Local governments are adopting building codes and fossil energy bans that are often stricter than those implemented by national governments. At the same time, the accent is increasingly on certification for ecological buildings and a move towards circularity.

There lies the rub: reducing emissions from buildings depends on the electricity mix

In 2022, the building sector represented about 30% of total final energy consumption in the world (up to 40% in Europe), a relatively stable figure since 2015.[1,a] Nevertheless, the energy consumption of buildings grew, in absolute terms, by 2% to 3% per year from 2015 to 2018, before slowing down in 2019 then plummeting in 2020 due to the pandemic. Since the start of recovery in 2021, building energy consumption has hit a new record (**FIGURE 1**).

The energy consumption of buildings in non-OECD countries is higher, and pushed by a rising population, growing faster than in OECD countries. Nevertheless, the trend varies depending on the type of building – the energy consumption of residential buildings in the more populated non-OECD countries, is greater than in OECD countries, where commercial buildings constitute a bigger share than in emerging economies (**FIGURE 1**).[2]

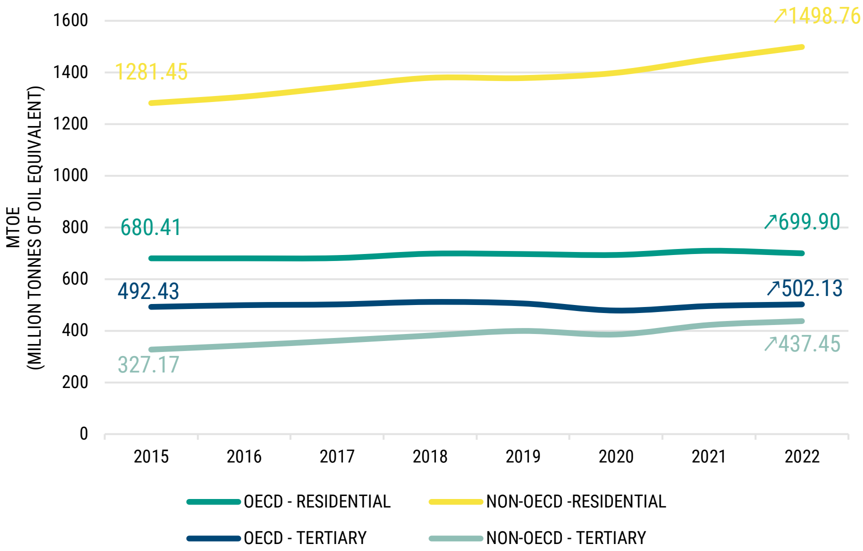
a The data on energy and emissions featuring in this analysis are taken from the Enerdata Global Energy and CO_2 Database, unless otherwise indicated.

BUILDINGS

FIGURE 1

FINAL ENERGY CONSUMPTION IN RESIDENTIAL AND TERTIARY BUILDINGS, OECD VS. NON-OECD, 2015-2022

Source: Climate Chance, based on data from Enerdata

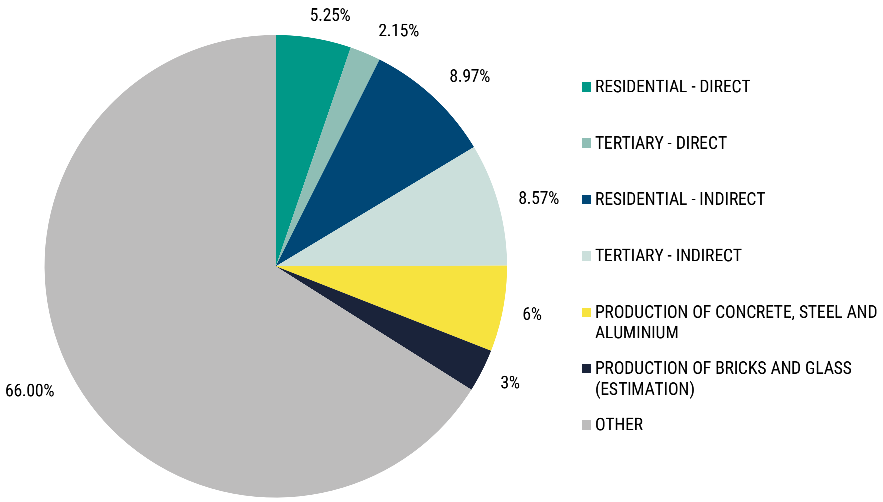


In 2022, building operations (energy uses like heating, cooling, cooking, lighting and other end-uses) were responsible for 9.5 $GtCO_2$, or a quarter of global energy-related emissions, an increase on its 2015 level of 8.8 $GtCO_2$ (+8.52%). The production of building materials (cement, concrete, bricks, aluminium, glass, etc.) represents an additional 9%, according to GlobalABC[3] (**FIGURE 2**).

FIGURE 2

SHARE OF EMISSIONS FROM THE CONSTRUCTION AND OPERATION OF BUILDINGS IN TOTAL ENERGY-RELATED EMISSIONS

Source: Climate Chance, based on Enerdata and GlobalABC, 2022



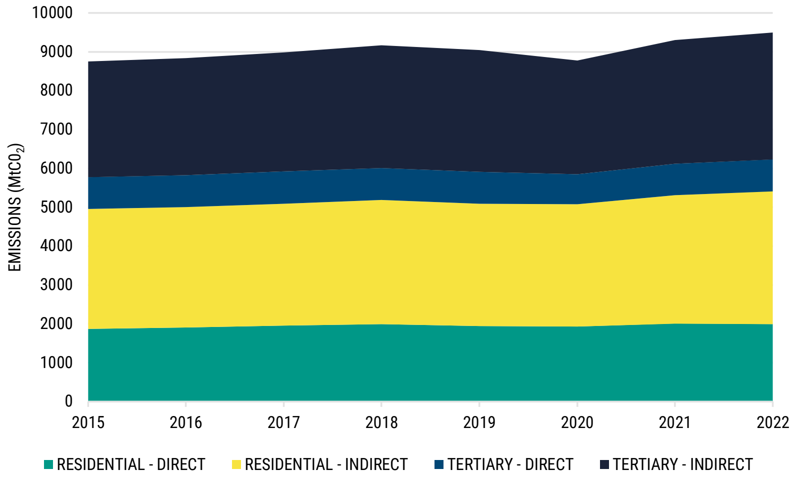
Direct emissions: heating makes its first steps to decarbonization

Direct emissions (2.8 $GtCO_2$ in 2022) from fuel combustion in buildings[b] are lower than indirect emissions (6.7 $GtCO_2$). The evolution is contrasted: after an initial peak in 2018, emissions from residential buildings dropped until the 2021 economic recovery. They then went on to exceed their 2018 level. In commercial buildings, direct emissions have maintained a general upward trend, although with a more marked drop in 2020 (-6.3%) and a stronger recovery since, but still remain below their peak of 2017 (**FIGURE 3**).

FIGURE 3

EVOLUTION OF DIRECT AND INDIRECT EMISSIONS FROM BUILDINGS

Source: Climate Chance, based on data from Enerdata



The biggest share of direct emissions from buildings comes from heating. According to the IEA, in 2022 more than 63% of energy demand for heating was met by fossil fuels (of which 42.12% natural gas), 14.34% by electricity (therefore depending on the country's electricity mix – **CF. "ELECTRICITY" TRENDS),** 11.04% by renewable energy,[c] and 11.27% by urban district heating (where the source of heat varies by country).[4] Electrification, and to a smaller extent renewable energy, have nevertheless surged, with the result that the share of fossil energy directly consumed in buildings went from 60.5% in 2015 to 54.5% in 2022.[5] The IEA analysis also shows that the carbon intensity of heated residential buildings dropped by more than one-third over the last two decades.

The heating transition is mainly driven by heat pumps, which have seen escalating growth: global sales rose by 11% in 2022, and 40% in Europe (mainly in France, Germany, and Italy, with a doubling of sales in Poland). China is the biggest producer, exporter and market for heat pumps.[6] The global share of electric heat pumps for heating needs went from 6% in 2015 to 11% in 2021, according to IEA data. Over the same period, the share of coal, oil and gas-fired equipment dropped from 57% to 48%.[7]

Despite rising rates of electrification, heating remains a major obstacle to building sector decarbonization in countries in the Global North. While the relative share of coal in energy consumption of buildings dropped by 23% from 2015 to 2022, the share of gas increased by 13.91%, and absolute consumption of fossil energy rose by 3.5% (**FIGURE 4**).

b Direct emissions from buildings result from the on-site combustion of fuel by equipment like boilers, furnaces and water heaters that use fossil fuels. Indirect emissions result from the off-site production of electricity employed in buildings for various appliances, lighting, and cooling, etc.

c Electricity here means heating supplied by the electric grid, whereas renewable energy designates the use of equipment like heat pumps and solar water heaters, which directly convert renewable energy into heat.

Indirect emissions are rising – an inevitable result of increasing electrification

Outside OECD countries, the share of direct emissions in the total of all emissions from the sector went from 29% in 2015 to 26% in 2022, while the share of indirect emissions increased. The global trend also indicates a faster increase in indirect emissions than direct emissions, partly due to the growing use of electricity for air conditioning units and other domestic appliances. The share of electricity in buildings' energy consumption rose by 16.75% from 2015 to 2022. At a time when the drive for widespread electrification (known as "electrify everything" in the USA)[8] continues to spread round the world, Europe boasts the highest rate of electrification of buildings (48%), ahead of Asia (33%) and the Americas (28%). Only 8.4% of buildings are electrified in Africa.[9]

FIGURE 4

EVOLUTION OF ENERGY CONSUMPTION IN BUILDINGS BY FUEL

Source: International Energy Agency, 2022

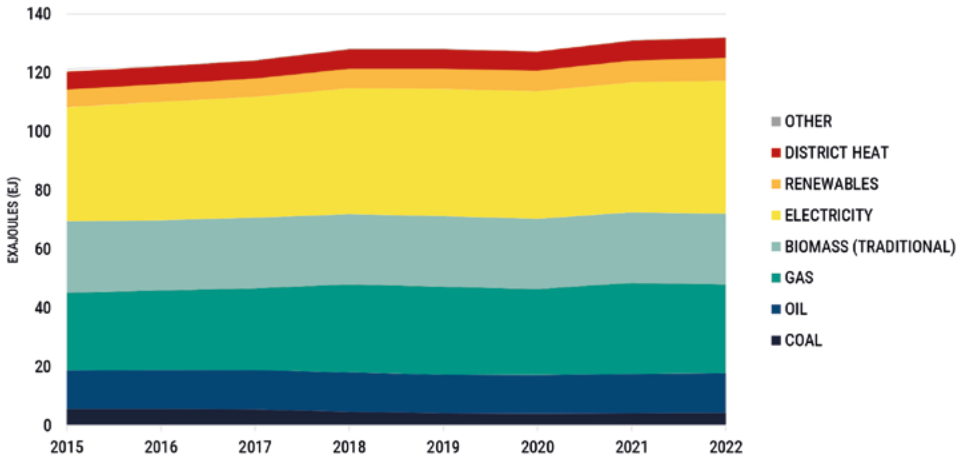
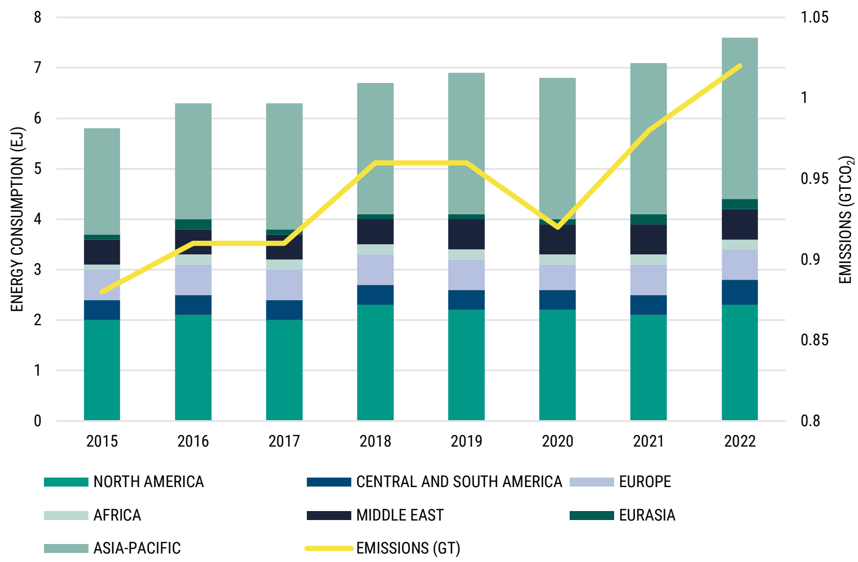


FIGURE 5

ENERGY CONSUMPTION AND EMISSIONS FROM SPACE COOLING

Source: International Energy Agency, 2023



The biggest growth in the final energy consumption of buildings comes from space cooling, which has grown by an average 4% since 2000. Emissions from air conditioning units went from 0.88 Gt in 2015 to 1.02 Gt in 2022 (+16%, **FIGURE 5**), and the number of air conditioning units operating in the world rose from 1.76 billion in 2015 to 2.27 billion in 2021 (+29%).[10] At the same time, rising global temperatures also call for wider access to cooling – in 2022, 1.2 billion disadvantaged rural and urban inhabitants of countries and areas subject to high temperatures were in danger of a lack of access to cooling, 28 million more than in 2021.[11] In Europe, from 1980 to 2020, 91% of deaths caused by meteorological incidents were due to heatwaves, which shows the rising need for access to air conditioning, even in countries in the North.[12]

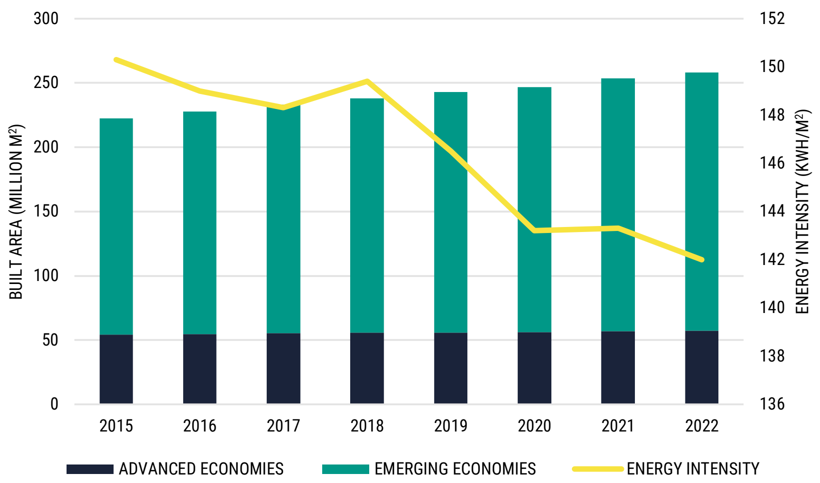
The never-ending quest for energy efficiency

Another key issue is the energy efficiency of buildings and their envelopes, and of end-use equipment. 90% of end-uses like heating and cooling, and 80% of lighting, are covered by mandatory minimum energy performance standards.[13] Yet, according to the IEA, the expansion of the built-up surface in the world (+16% in 2015-2022), which is particularly fast in emerging economies, wipes out the drop in global energy intensity of buildings (**FIGURE 6**).

FIGURE 6

EVOLUTION OF BUILT AREA AND ENERGY INTENSITY OF BUILDINGS

Source: International Energy Agency, 2022



At global level, the annual renovation rate is about 1%.[14] This figure disguises contrasting realities, because the challenge of renovating existing buildings is higher in industrialized countries where most of the building stock has already been constructed. Thus, in Europe, the energy renovation rate of buildings is 1%, while the rate of "deep" renovation, which improves the energy performance of buildings by 60% or more, levels out at 0.2%.[15] Annual investments in renovation in the EU went up by 13.2% from 2015 to 2019, but remain below the amounts required to reach climate neutrality in 2050.[16] Global investments in energy efficiency and the electrification of buildings have risen since 2018 and reached a record $285 billion in 2022, mostly in Europe, the United States and China (**FIGURE 7**).

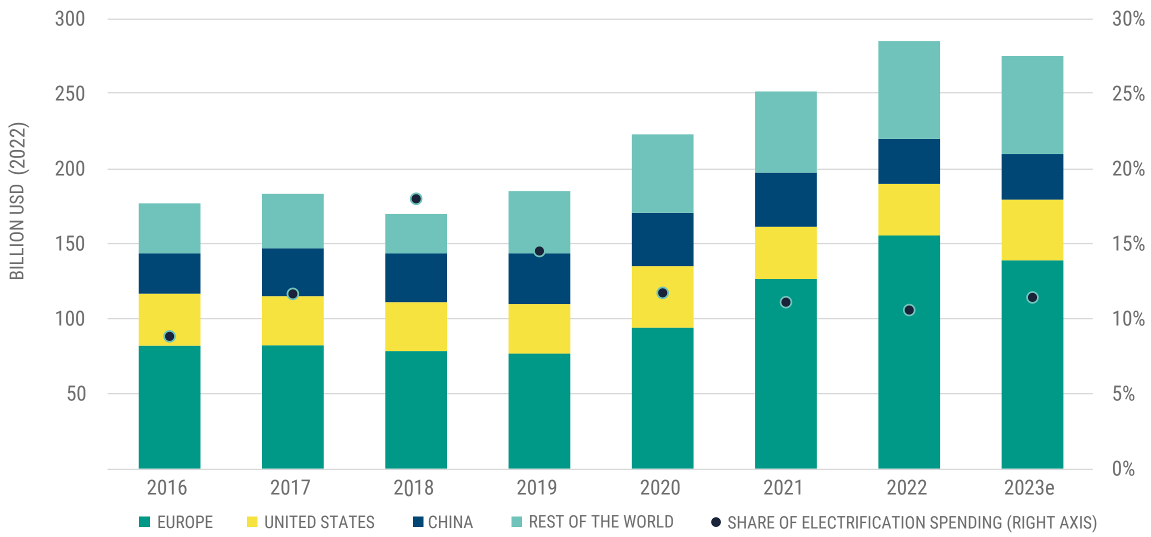
An Enerdata analysis[17] on the evolution of energy consumption in European residential buildings highlights a slowdown in progress on energy efficiency after 2014. While recent, more energy-efficient constructions have diminished, deep renovation rates have remained low, and behaviours have been more energy-intensive. In the light of the energy vulnerability revealed by the war in Ukraine, sufficiency is making a timid but concrete entry into national and local policies in Europe – France, for example, implemented an energy sufficiency plan in the last quarter of 2022 which, during a mild winter, enabled a 15% reduction in emissions from the building sector.[18] Behavioural factors contributed to reducing gas consumption in buildings in Europe in 2022, combined with a mild winter, and fuel poverty which forced some households to consume less.[19]

In emerging economies, where the built surface area is expanding rapidly, the challenge is more to guarantee the energy performance of new buildings, and adapt them to forthcoming climate changes. The number of countries with energy regulations applying to at least one type of building (residential or commercial) rose from 62 in 2015 to 79 in 2021, of which 51 apply to all buildings.[20] More recently, the EU and countries like the United Kingdom, Turkey, Japan, China, India and Australia have strengthened standards relating to the energy performance of buildings,[21] but not without some obstacles:[22] in the United Kingdom, a lack of awareness or funding, and the ageing state of a large proportion of buildings, makes them harder to renovate; in the United States, renovation is held back by conflicting municipal, state and federal targets, combined with overlapping jurisdictions for the codes on fire prevention, energy and construction, which compound bureaucracy and create problems when training workers.

FIGURE 7

INVESTMENTS IN ENERGY EFFICIENCY ANF ELECTRIFICATION BY REGION, 2015-2022

Source: International Energy Agency, 2022



Certification, circularity… consideration of climate change in the building sector is moving forwards

Local public policies catalyse action

Often, public policies for the decarbonization of buildings start at the national level – with a rising wave of legislation, such as the revision of the EU Energy Performance of Buildings Directive, and the "Renovation Wave" strategy that is part of the Green Deal in Europe; and in the United States, the "Build Back Better Act" and the "Inflation Reduction Act". In parallel, building and energy codes exist, as well as minimum performance requirements (which for example take the form of energy performance certificates; **CF. ABOVE**).

When it comes to implementation, local governments tend to take the initiative, drawing on building codes to increase the share of renewable energy on their territory. **In 2022, over 920 cities in 73 countries had set targets for integrating renewable energy sources into at least one sector – such as electricity supply, production or consumption (793), heating and cooling (170).**[23]

Since 2015, numerous European towns have successfully demonstrated their capacity to accelerate energy renovation on their territories, from municipal buildings – as the Observatory highlighted in its case study on Alba Iulia[24] – to the mass energy renovation of buildings, through programmes like EnergieSprong (the city of Angers being an example).[25] European cities have also taken initiatives to progressively eliminate the use of fossil fuels for heating thanks to the promotion of new technologies, as in Vienna,[26] or to develop and improve district heating and cooling systems, as in the Netherlands with the adoption of regional strategies to decarbonize heating and their application in cities like Heerlen.[27]

Civil society also plays a key role at national and local levels, working both to promote the transition through advocacy actions against energy poverty and for stricter energy efficiency requirements in Europe,[28] or against the transition. This is the case of demonstrations against laws on heating in Germany, when the ambitions of public policies are limited by local protests,[29] or the prohibition of gas cookers in the United States, which incited considerable debate.[30]

Apart from municipal and residential buildings, land occupied by commercial and tertiary buildings is increasingly used to produce on-site electricity, for example by installing solar panels on the roof, and promoting other low-carbon end-uses, such as mandatory charging stations for electric vehicles or bicycle parks, as the Observatory shows in its analysis of commercial buildings.[31] Most on-site production initiatives currently comprise photovoltaic solar panels. The introduction of municipal feed-in tariffs has also boosted the production of on-site electricity in industrial, commercial and residential buildings.[32]

In the United States, cities and states are engaged in a tug of war to prohibit the use of fossil energies in buildings and electrify end-uses.[33] According to the Rocky Mountain Institute,[34] in the USA, 125 local governments, 10 state governments and Washington, DC, covering 36 million inhabitants, have a policy to encourage or impose the electrification of buildings. The State of New York was one of the latest to vote to ban gas-fired cookers and heaters in new buildings by 2029.[35]

Another emerging move is the adaptation of buildings and the built environment in cities. This takes the form of green roofs in urban areas,[36] more reflective surfaces to mitigate increased heat,[37] the construction of waterproof infrastructures to tackle flooding (like "sponge cities" in China), and the use of local, bio-sourced materials.

Certified sustainable buildings: still in the minority, but growing fast

According to an analysis by the World Benchmarking Alliance (WBA) of 50 of the largest construction, property development and management companies,[38] 54% (27 companies) did not have a transition plan. Only 11 companies had "net zero" objectives covering all emission scopes, and only three of them had SBTi-approved targets – even though most emissions from the sector come under Scope 3. Four out of 50 companies had targets for embodied emissions, which result from the production of materials employed in construction work. However, 32 of the 50 companies owned or managed buildings certified as "green".

The certified built surface area has quadrupled, going from 1.05 to 4.2 billion square metres from 2016 to 2021,[39,40] but still represents less than 2% of the global built-up area. This figure is based on data reported by different green building councils in the world, and covers programmes for energy efficiency, such as LEED certification by the US Green Building Council and the French HQE certification. In addition, the surface area covered by passive house certification – buildings with very low energy consumption and high insulation requiring very little heating or cooling – went from a little more than 1.5 million m^2 in 2015 to about 3.5 million m^2 in 2022, most of it in Europe (~2.8 million m^2, or 80% of the total), far ahead of Asia, followed by the Americas which together represent about 800,000 m^2.[41]

The Net Zero Carbon Buildings Commitment gathers 175 signatories representing an annual turnover of $400 billion, including 29 cities, six states and sub-national regions, and 140 companies, possessing about 98 million m^2 of land surface. The signatories have declared an average annual drop of 12% in emissions intensity, according to the latest individual figures communicated.[42]

Back to the drawing board: reflections on design and circularity

The growing focus on the impacts of climate change, which take the form of extreme weather events and latent transformations, has forced building stakeholders to take a fresh look at their resilience. **According to SwissRE, since 2017, annual insured losses caused by climate events amount to at least $110 billion, and are going up by 5-7% per year.**[43] The real value of losses is in fact much higher: in Europe,[44] only a quarter of the financial losses related to hydrometeorological phenomena from 1980 to 2020 were insured. Integrating climate statistics in building codes has already begun, but the rapid pace of change in weather patterns and the use of historical data means that codes can lag behind actual events by up to a decade.[45] The biggest opportunity for change has been identified as designing new buildings to integrate sustainable design principles, such as energy efficiency, improved ventilation, and insulation based on traditional knowledge (with several examples from Asia and Africa).[46]

Traditional methods are increasingly popular with architects, as shown by the use of passive ventilation in the work of Diébédo Francis Kéré, by Middle Eastern and North African architecture featuring traditional interior courtyards and strategically placed windows,[47] and by cool roofs covered in "ultra-white" paint, inspired by whitewashed Mediterranean towns.[48] This movement is accompanied by a return to local materials, like typha, rammed earth (*pisé*), wood and stone. Inspired by nature, the principles of biomimetics have also had an impact on new constructions, although still in its early stages[49].

As more and more countries take the complete lifecycle of buildings into account (nine countries in Europe in 2021),[50] the circularity of materials used in buildings is also gaining ground, through initiatives like materials passports like in Chile, "materials banks" of existing buildings in Europe,[51] and extended producer responsibility programmes in the sector, like in France.[52]

BUILDINGS

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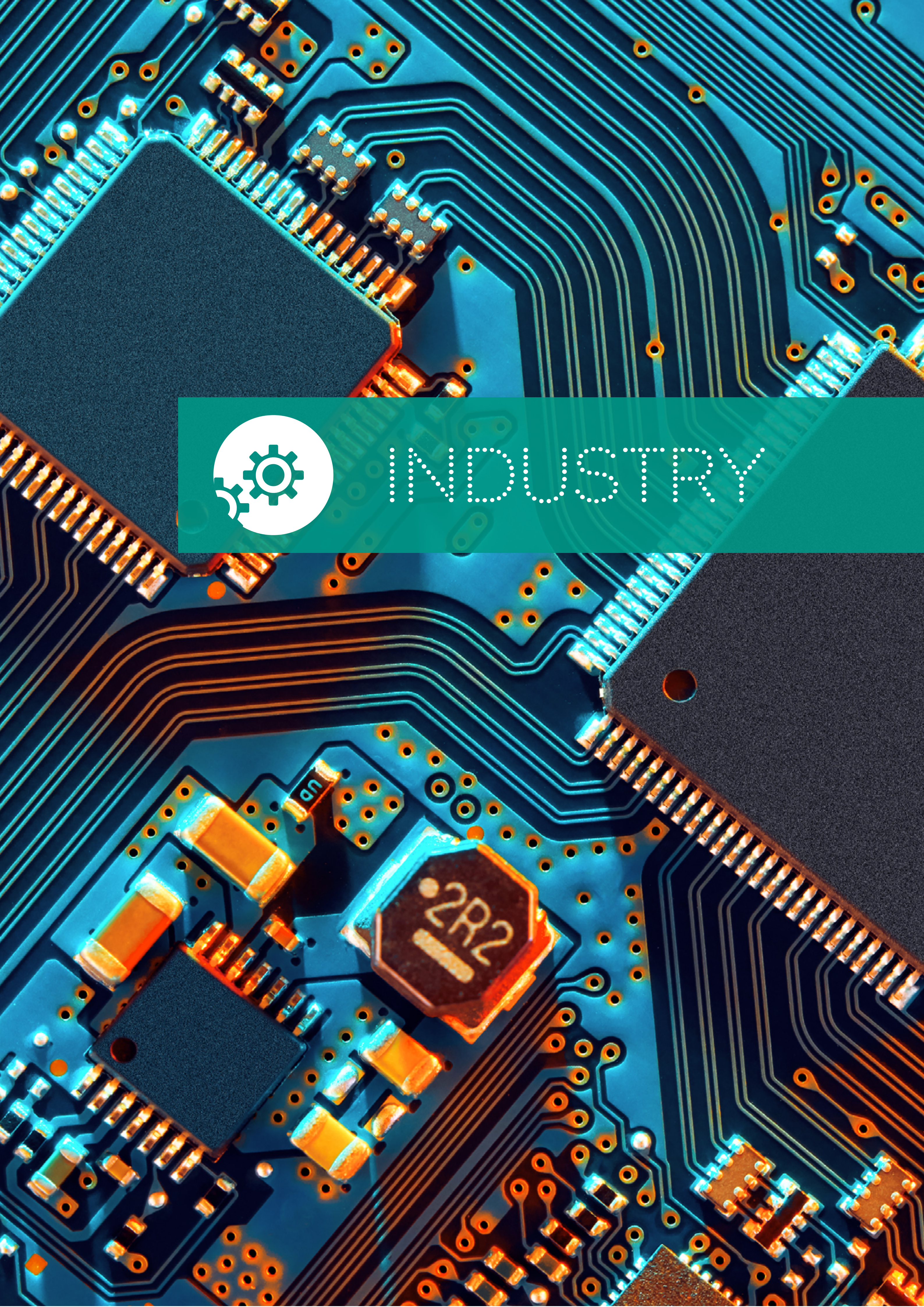
INDUSTRY



Nº 5 Hydrogen, CCS... disruptive technologies remain marginal and dependent on fossil fuels

- Global CO_2 emissions from industry rose slightly between 2015 and 2022, driven mainly by energy combustion.
- Long ignored, CO_2 capture and storage is once again mobilizing investors – especially oil companies, who are extending the life of depleting wells. Installed and developing capture potential remains very low.
- Despite growing political and financial investment since the post-pandemic recovery plans, "green" hydrogen production processes and its decarbonized uses are still limited, and depend on the availability of a decarbonized electricity mix.
- The quest for industrial sovereignty over metals strategic to the transition is defining the contours of a new geopolitical map of raw materials between industrialized countries, China who dominates the value chains, and emerging countries rich in natural resources (Indonesia, DRC, Bolivia...).

KEY FIGURES

Industrial emissions concentrated in a few heavy industries

- **+1% direct emissions from industry** from 2015-2022; steel (+5%), chemicals (+1%) and cement (+11%) represent 71% of the sector's emissions (IEA, 2023a).

Green hydrogen still a long way from its own decarbonization

- **95 Mt hydrogen (H_2) produced** in 2022; <1% of low-carbon origin, and 0.04% from renewable electricity (IEA, 2022).
- **40.8%** of production is employed in oil refining; the remainder is used to produce methanol, ammonia and direct reduced iron ore. 0.04% is devoted to low-carbon uses (transport, storage, decarbonization of industry, etc.) (*ibid.*).
- **25 States** had adopted a hydrogen strategy in 2021, compared to 3 in 2019: the pandemic marked a turning point in investments (*ibid.*).

Carbon capture and storage driven by the petroleum sector

- **42.6 million tonnes per annum (Mtpa)** was the capacity for carbon capture in 2022 (+44% since 2015), *i.e.* the equivalent of Sweden's emissions, and 0.1% of global emissions (Global CCS Institute, 2022).
- **20/30 CCS sites** financed by enhanced oil recovery (*ibid.*).
- **1 single industrial site** equipped with CCS: a cement plant in the United Arab Emirates (*ibid.*).

Metals strategic to the transition become increasingly critical

- Lithium (+539%), cobalt (+124%), nickel (+118%), rare earths (+160%), copper (+60%)... **inflation** is impacting all transition metals (IMF, 2023).
- 74% of cobalt is extracted in the DRC, 68% of rare earths in China, 49% of nickel in Indonesia, 47% of lithium in Australia; 24% of copper in Chile. China controls 57% of refining for these metals (IEA, 2023b).
- **14% of energy needs** of the mining industry covered by renewable energy (REN21, 2023).

FURTHER READING

TRENDS

- CCUS reaches a turning point (2021)
- Boosted by the recovery, the "hydrogen economy" gains credibility (2021)
- "Yes, in my backyard!" Under pressure, international competition for strategic minerals required for the energy transition intensifies (2021)
- Carbon-free steel: a miracle solution and massive investment alloy (2020)

CASE STUDIES

ALSACE • Towards a Made-in-Europe production of low-carbon lithium with the EuGeLi project (2022)

NORWAY • The Longship Project: CCS to decarbonise heavy industries (2021)

TOKYO • Hydrogen fuels the flame of the Tokyo Olympics (2021)

CHILE • An emerging key actor in the renewable energy arena (2019)

TRENDS
INDUSTRIES

The promise of disruptive technologies for decarbonizing industry

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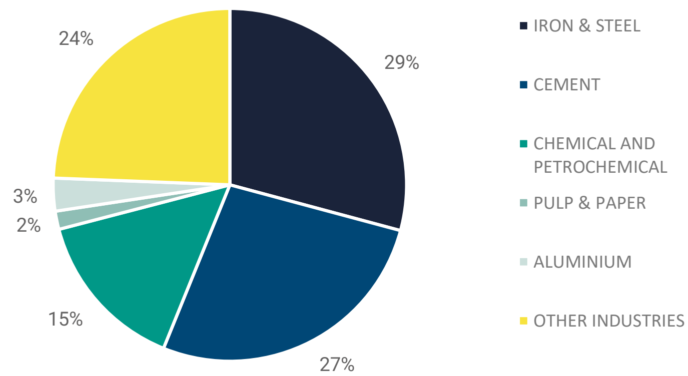
ANTOINE GILLOD • Director of the Global Observatory of Climate Action, Climate Chance

For industries, attaining carbon neutrality involves deep decarbonization of production processes sometimes already at their thermodynamic limit – a tall order for some heavy industries, like cement, steel and chemicals, whose core activity involves unavoidable high-emitting industrial processes. After years of teething troubles, two technologies have found new impetus from governments and investors to respond to the challenge: hydrogen, and carbon capture and storage. At the same time, increased competition between States to access strategic minerals for the transition of industries puts mining companies at the centre of the geopolitical arena.

FIGURE 1

GLOBAL CO_2 EMISSIONS FROM COMBUSTION IN INDUSTRY, 2022

Source: International Energy Agency, 2023



From 2015 to 2022, direct emissions from industry (**FIGURE 1**), which make up 25% of global emissions, rose by 1%, with variable trajectories depending on the country (**FIGURE 2**).[a] **Seventy-one percent of industrial emissions come from just three sectors: steel (+5% from 2015 to 2022), chemicals-petrochemicals (+1%), and cement (+11%).**[1] These processes emit high quantities of CO_2 and the quantity of heat required means electrification is difficult, making emissions

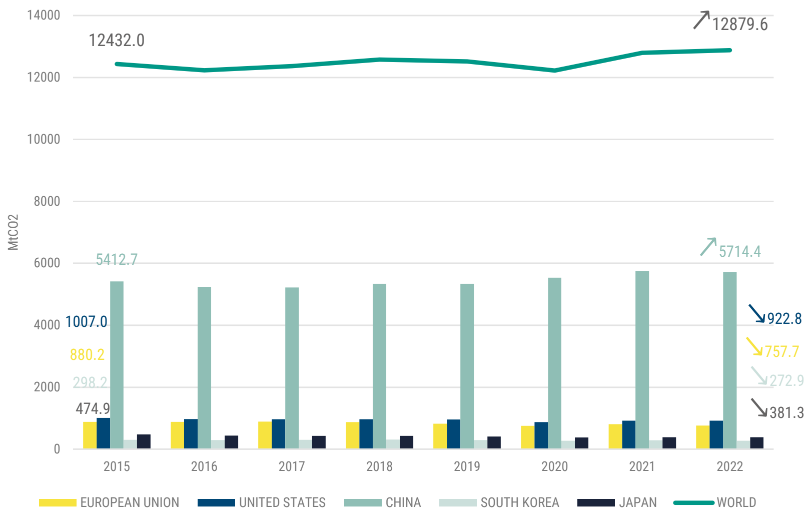
a Unless indicated otherwise, the data used come from the Enerdata "Global CO_2 and Energy" database.

from these heavy industries particularly hard to abate.[2] Since 2015, two "disruptive technologies" have boosted the hopes of states and industrials of getting closer to decarbonizing these sectors: "green hydrogen" and carbon capture and storage (CCS). Although still in their early stages, these two new technology fronts, which are industries in themselves, have received increasing political and financial support since 2015. In parallel, the affirmation of new industrial ambitions for sectors in transition (electric vehicles, renewable technologies, storage batteries, etc.) is reshuffling the cards of mining geopolitics. In this new game, the stakes are shifting for the decarbonization of the mining industry.

FIGURE 2

EVOLUTION OF CO_2 EMISSIONS FROM INDUSTRIES IN MAJOR ECONOMIES SINCE THE PARIS AGREEMENT (2015-2022)

Source: Climate Chance, based on data from Enerdata



Before it can contribute to decarbonization, hydrogen needs to undergo its own transition

Low capacities strongly dependent on carbon-intensive production processes and end-uses

In 2021, the global production of hydrogen amounted to 94 million tonnes (MtH_2), which is a 5% increase compared to 2019, as reported by the International Energy Agency (IEA).[3] Hydrogen production processes are high emitters, generating 900 $MtCO_2$ per year.[4] **99% of hydrogen is qualified as "grey", which means it results from steam-methane reforming of fossil fuels or from coal gasification. Less than 1% of hydrogen production is currently "low carbon" (FIGURE 3)**, mostly resulting from the same fossil processes, but at sites equipped with carbon capture and storage (CCS) technology: otherwise known as "blue" hydrogen. Hydrogen produced by the electrolysis of water only makes up 0.04% of production, despite a 200% rise from 2015 to 2021. With a production capacity of 0.09 Mtpa, "green" hydrogen produced by electrolysis using renewable energy was still anecdotal in 2022.[5] North America is home to the vast majority of operating capacities for producing low-carbon hydrogen (90%), while China has the biggest installed electrolysis capacities (300 MW), ahead of Europe (190 MW), out of a total 700 MW. To reach carbon neutrality in 2050 will require 200 GW of electrolysis before 2030.[6]

Today's hydrogen applications also rely heavily on carbon, with 40.8% of current hydrogen production (40 MtH_2) employed in oil refining. Among its industrial uses (54 MtH_2), 65% of hydrogen is employed to produce ammonia, used in fertilizers (+4% from 2018 to 2021), 25% for methanol to produce solvents and acetic acid (+17% from 2018 to 2021), and 10% to produce direct reduced iron ore for the steel industry (+11% from 2018 to 2021) (**FIGURE 4**). To date, low-carbon applications like decarbonizing transport, producing "zero-carbon" steel, heating buildings, and storing electricity produced from intermittent renewable energy sources remain very rare (0.04%, according to the IEA).

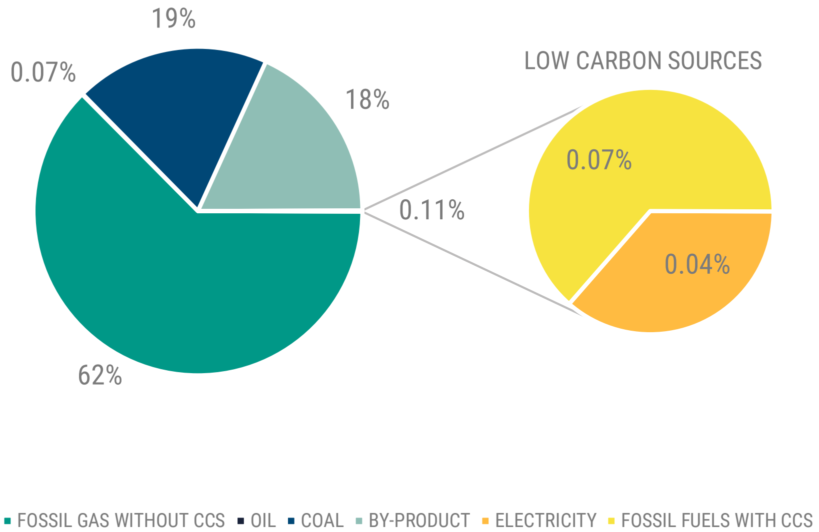
Accelerated, but fledgling investments

The latest review produced by the Hydrogen Council lists 1,040 hydrogen-related projects announced in the world, for a total investment of $320 billion by 2030. Two-thirds of these projects aim to increase production capacities, including 38 Mtpa of low-carbon (green and blue) hydrogen, 60% of it located in Europe and the United States – the remainder target infrastructure and prospection projects. To date, only 2.1 Mtpa of low-carbon hydrogen has received a final investment decision, of which 1 Mtpa comes from renewable energies. Seventy percent of these low-carbon projects are located in the United States, driven by the demand for ammonia and refining. 230 GW of electrolysis capacities have been announced, of which 40% in Europe, but only 9 GW have so far received a final investment decision. Production of "green" hydrogen is therefore in its very early stages.

FIGURE 3

GLOBAL HYDROGEN PRODUCTION BY TECHNOLOGY, 2021

Source: International Energy Agency, 2022



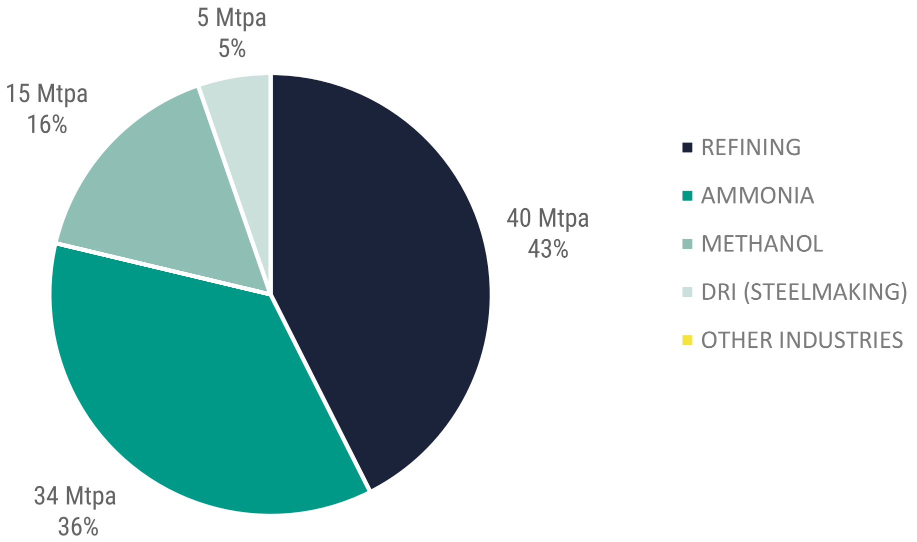
2020 marked a real turning point for the industry: low-carbon hydrogen took centre stage in post-lockdown announcements for public and private investments. In 2019, only three states had adopted strategies to develop hydrogen production with an aim of decarbonization. By 2021, the number had risen to 25, plus the EU, following the adoption of post-pandemic recovery plans, according to the IEA in its *Global Hydrogen Review*. The EU adopted a strategy in 2020, and is investing €10 billion in hydrogen through its *Important Project of Common European Interest* (IPCEI) plan, with a reference level of 3.38 $kgCO_2e/kgH_2$ for so-called "renewable" hydrogen. In the United States, the Biden-Harris administration has earmarked $9.5 billion for hydrogen in the Infrastructure Investment and Jobs Act, targeting carbon intensity of 4 $kgCO_2e/kgH_2$, along with tax credits in the Inflation Reduction Act. Japan, which was the first country to adopt a national hydrogen strategy in 2017, set new production targets in 2023, and intends to invest $107 billion in the sector over fifteen years.[7] In May 2022, six African countries – Egypt, Kenya, Mauritania, Morocco, Namibia, and South Africa – launched the African Green Hydrogen Alliance with the goal of making the continent a key player in green hydrogen production.[8]

These public investments are accompanied by strong mobilization from industrials. In Saudi Arabia, the biggest hydrogen production site in the world, scheduled for 2026, attracted $8.6 billion of multi-party investments in 2023.[9] Oil and gas companies play a major investment role by acting to reconvert existing structures. For example, the European Hydrogen Backbone initiative, launched in 2022 by twelve European gas supply network operators, aims to create an immense network to transport hydrogen throughout Europe, two-thirds of it based on converting the existing gas network. In the United Kingdom, the Zero Carbon Humber project led by Equinor, British Steel and a dozen other partners, intends to convert the gas network in the Humber Estuary to transport hydrogen, while capturing CO_2 from the hydrogen production and storing it in the North Sea.

FIGURE 4

HYDROGEN END-USES REMAIN CARBON-INTENSIVE

Source: International Energy Agency, 2022



Low-carbon applications still marginal

Several low-carbon hydrogen applications compete with each other and attract different investors depending on the local situation. While Japan and Germany are focusing on reducing emissions from transport, the EU's priority is heavy industry.[10] In China, the world's biggest producer of both solar energy and steel, green hydrogen opens opportunities for storing intermittent energy and reducing carbon emissions from heavy industry.

In 2020, 80% of the hydrogen required to produce 185 Mt of ammonia came from natural gas, and the rest from coal.[11] Large fertilizer manufacturers, like Fertiberia and Yara, are now investing in producing ammonia from green hydrogen, in partnership with energy providers like Iberdrola and Engie.[12,13] For methanol, the Dalian Institute of Chemical Physics in China is working on a project to combine green hydrogen production with CCS.[14]

In the steelmaking industry, green hydrogen provides a low-carbon solution for producing heat and in the transformation phase of iron ore ("reduction"), which mostly employs coke. However, 71.5% of the global production of primary steel is still carried out in coal-fired blast furnaces,[15] as well as in 57% of steelworks planned in 2023.[16] Yet in blast-furnaces, total substitution of carbon monoxide with hydrogen is not feasible.[17] In 2016, the energy supplier Vattenfall got together with the steelmakers Swedish Steel (SSAB), and the mining company Luossavaara-Kiirunavaara Aktiebolag (LKAB) to launch the Hydrogen Breakthrough Initiative (*Hybrit*). The project's aim is to manufacture steel by replacing coal with hydrogen and pig iron with direct reduced iron (DRI), produced from green hydrogen.[18] The "Carbon2Value" initiative led by ArcelorMittal combines DRI production via hydrogen with CCS in order to reduce site emissions. In Dunkerque, France, in partnership with the French Agency for Ecological Transition (ADEME) and the French Institute of Petroleum (IFPen), the group is setting up a pilot project based on these methods.[19]

Despite growing investments, the development of carbon capture remains uncertain

Unprecedented investment boom

Carbon capture and storage (CCS) technology has also attracted increased interest since 2017. The term covers different technology families that aim to capture CO_2 from industrial emissions or from electric power stations operating on fossil fuels, and either transport it to a storage point for permanent sequestration in a deep geological layer, or reuse it.

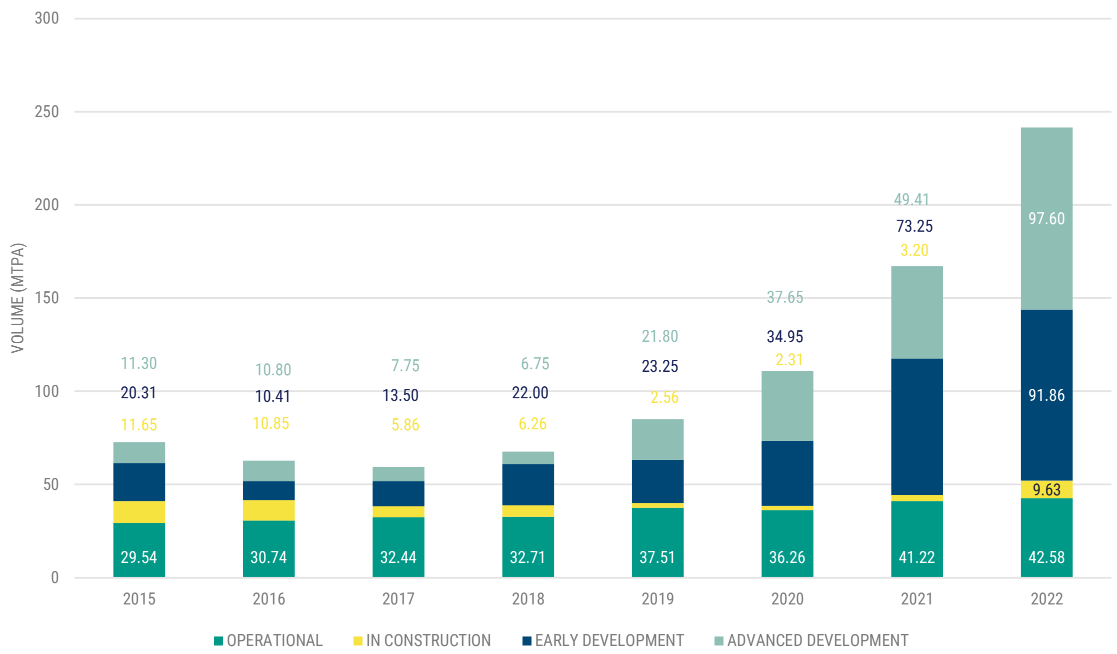
Global investments in CCS amounted to $6.4 billion in 2022 – 45% in the United States – which is almost six times more than in 2019.[20] In September 2022, 30 sites were operating in the world, with a total capture capacity of 42.6 million tonnes of CO_2 per year (Mtpa), compared to 29.54 Mtpa in 2015. This represents an average capture capacity of 1.4 Mtpa.

Current capture capacities are therefore currently more or less equal to Sweden's emissions, or 0.1% of global emissions. Currently, 164 projects are being developed, of which 11 are under construction, and 78 are at an advanced stage of development, representing a capture potential of 244 Mtpa (0.65% of global emissions). From 2015 to 2022, the number of projects in the early development phase multiplied by 3.5, and advanced phase projects by 7.6 (**FIGURE 5**). Another 61 new projects were announced in 2022.[21]

FIGURE 5

PIPELINES OF COMMERCIAL FACILITIES SINCE 2010 BY CAPTURE CAPACITY (MTPA)

Source: Global CCS Institute, 2022



CCS driven by the oil and gas sector

The CCS sector also turns out to be highly dependent on fossil industries. **Historically, most CCS projects have been funded by Enhanced Oil Recovery (EOR): 20 of the 30 sites in operation store their carbon in oil wells to extend their lifecycle**, thus reducing CCS's real contribution to global mitigation efforts. Fourteen of these sites are natural gas processing facilities, five produce ethanol and methanol, one is a refinery, and one is a petrochemical site operated by Sinopec, the Chinese national petroleum company. Operational projects are concentrated in the United States and Canada (18), which are big oil producers. In Europe, 73 projects are currently being developed, mostly in countries possessing hydrocarbon resources and a strong industrial fabric: the United Kingdom, the Netherlands and Norway.

Thus, 85% of CCS project partners are companies from the fossil energy sector.[22] In 2020, CCS was the third "low-carbon" expenditure item for big oil companies,[23] which are equipped with the infrastructure required to transport carbon by pipeline and are interested in extending the lifecycle of wells. In the United Kingdom, the "Net-Zero Teesside" project, which aims to capture and store 2 $MtCO_2$/year emitted by a gas plant in saltmarshes in the North Sea, is funded by the Oil and gas Climate Investment consortium (30% of the world's petroleum) and supported by the British government. In Canada, the "Alberta Carbon Trunk Line" (ACTL) project will reinject part of the CO_2 captured from a fertilizer factory and an oil sand refinery into oil wells in order to extend their operational duration.[24]

Capturing emissions from heavy industry still a long way off

To date, only one CCS installation is in place at the exit of an industrial site: Abu Dhabi CCS captures 90% (0.8 Mtpa) of CO_2 from a steelworks in Mussafah in the United Arab Emirates and injects it into oil fields 43 km away.[25] The deployment of CCS is however attractive for the cement industry, where the concentration of CO_2 emissions makes them easier to capture.[26] In Norway, the Longship project aims to capture 44% of the 900,000 tCO_2 emitted annually by the Norcem Brevik cement plant and then store it in a permanent reservoir via Northern Lights infrastructures, a storage and transportation project with an annual capacity of 1.5 $MtCO_2$ in its first phase, financed to the tune of €680 million by Equinor, Shell and TotalEnergies.[27] In France, the scattered locations of cement plants and their distance from storage sites hinder the wide-scale adoption of this technique.[28]

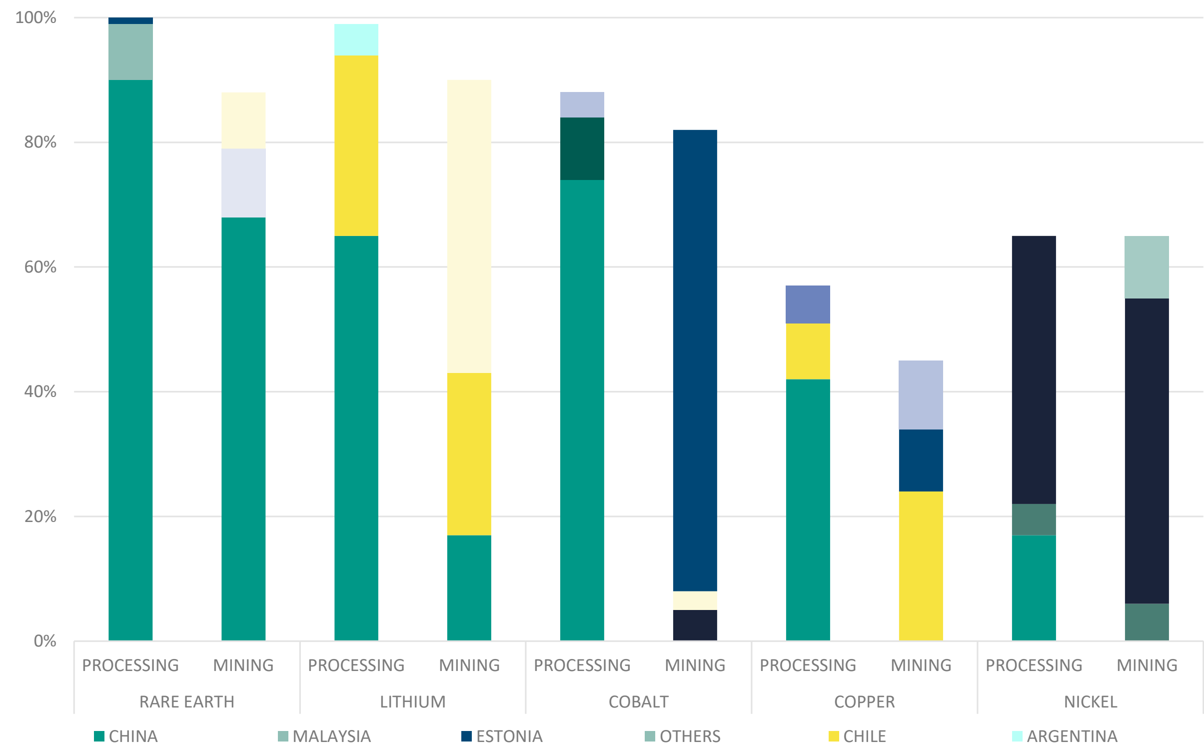
Other applications are still in demonstration or development phases. Today, only one direct air capture (DAC) site exists, called ORCA, located in Iceland. Opened in 2021 by the Swiss company Climeworks, the installation has the lowest capacity of all CCS technologies (0.004 Mtpa). The site takes advantage of a geothermal source for its electricity supply, and the CO_2 is stored in a special reservoir. Climeworks raised $650 million in April 2022 to develop new installations.[29] In addition, no bioenergy with carbon capture and storage (BECCS) sites are in operation in the world; however, the former Drax coal-fired power station (United Kingdom), which has converted to biomass, is due to inaugurate the largest BECCS project (8 Mtpa) in the world in 2027. Lastly, despite the complementary nature of the two technologies, only two blue hydrogen production (with CCS) sites are in place in the world, operated by Shell in Canada since 2015 (geological storage) and Air Products & Chemicals Inc. in Texas since 2013 (EOR).

Despite a gradual shift towards CO_2 storage in deep saline formations in the United States and in the North Sea, storage in oil wells is set to expand in Australia, Southeast Asia and the United Kingdom. For example, the British government has announced that, as well as granting new licences to exploit oil and gas fields, it will be supporting two new CCS projects. These include the Viking project (transport and storage), owned 40% by BP, which will reuse pipelines to carry captured CO_2 to depleting fields in the North Sea.[30]

FIGURE 6

SHARE OF TOP THREE COUNTRIES IN TERMS OF EXTRACTION AND PROCESSING OF SELECTED MINERALS, 2022

Source: International Energy Agency, 2022



Sectors undergoing a transition put pressure on strategic mineral resources

The electrification of end-uses is intensifying the global economy's demand for mineral ores

The global final consumption of electricity, one of the main drivers of decarbonization, rose by 38% from 2010 to 2022. The electrification of end-uses, combined with a greater share of renewable energy in the electricity mix, means the transition depends on global issues of strategic metal supplies.[31] In the last decade, the metal intensity of new electricity production capacities rose by 50%. For the same level of power, a wind turbine requires nine times more metal than a gas power station, and an electric car six times more than a thermal combustion vehicle. The IEA estimates that metal production will need to be multiplied by six by 2040 in a scenario of carbon neutrality by 2050.[32]

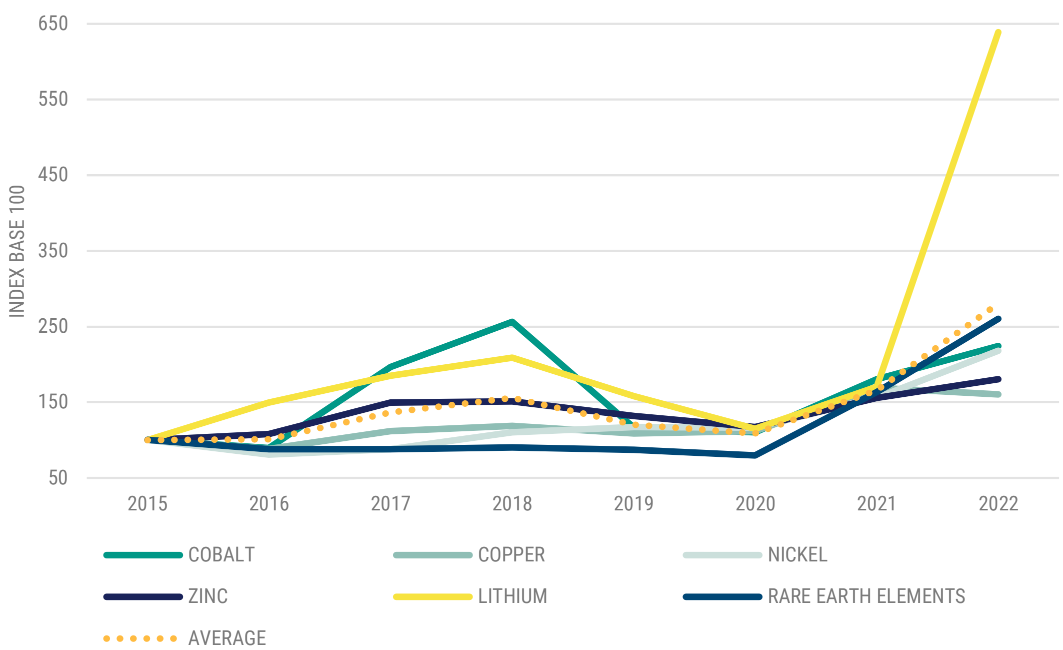
Although they are abundant in the earth's crust, many of these metals are considered to be "critical" by states due to the risks associated with their supply (geographic availability, concentration of extraction and production, political stability in producer countries, etc.), and the importance of metal for economies. Cobalt, copper, nickel, lithium and rare earths, which are the key components of the major transition technologies (batteries, wind turbines, etc.), are the focus of particular attention.[33]

Concentration is an issue for extraction, and in particular refining (**FIGURE 6**). Currently, the Democratic Republic of the Congo (DRC) extracts 74% of cobalt, Indonesia 49% of nickel, Australia 47% of lithium, Chile 24% of copper, and China 68% of rare earths. China is almost unavoidable in refining steps, of which it controls 90% for rare earths, 65% for lithium, 74% for cobalt, and 42% for copper; Indonesia operates 42% of nickel refining.[34] Given this concentration, the growth in demand observed in several sectors in transition (**CF. "ELECTRICITY" AND "TRANSPORT" TRENDS**) has generated high price inflation. From 2015 to 2022, the price of lithium increased by 539%. Over the same period, cobalt (+124%), nickel (118%), rare earths (160%) and copper (60%) also saw rocketing inflation (**FIGURE 7**). The phenomenon impacts industrial industries strategic to the transition, especially electric batteries, whose price is strongly dependent on the price of these metals.

FIGURE 7

EVOLUTION OF PRICE INDEX OF SELECTED MINERALS, 2015-2022

Source: Climate Chance based on data from IMF Primary Commodity Price System



From mines to factories, states seek to gain control and sovereignty

The acceleration of some transition sectors coupled with increasing geopolitical tensions has seen access to strategic metals revive economic nationalism. On the one side, industrialized states dependent on imports are attempting to secure their supplies, via joint ventures, free trade agreements, supply contracts, and by opening mines on their own territories.[35] The EU Critical Raw Materials Act and the US Executive Order 14017 on America's Supply Chains are responses to this objective.[36,37] On the other side, emerging countries with abundant mineral resources are setting up industrialization strategies to substitute exportation, and tightening the global supply of minerals in order take advantage of their raw materials resources to integrate value chains and increase added value. The Chilean president Gabriel Boric has announced his intention to increase state control of national lithium. In April 2022, Mexico had already created Litio para México, a state-run company to nationalize its resources.[38] In 2021, the leading Korean battery company, LG Energy Solution (LGES), signed a memorandum of agreement with four public Indonesian companies to form the Indonesian Battery Corporation, and create a national nickel industry.[39]

The opening of new mines comes up against opposition from civil society in countries that sometimes turned the page on their mining history years ago, or due to environmental concerns. In Serbia, strong popular opposition forced the government to cancel the biggest lithium mining project in Europe in the Jadar Valley.[40] In Portugal, against a backdrop of natural heritage protection, local movements frequently gather and demonstrate against the government's ambition to open mining concessions to exploit lithium in the region.[41] In Indonesia, increasing numbers of activists have been arrested since the revision of the mining law in 2020: in 2021, 53 people were pursued on criminal charges after opposing mining projects.[42]

In response to environmental concerns, companies are innovating to reduce the environmental disturbances caused by mining activities. The "Zero Carbon Lithium" project deployed in Germany by the Australian company Vulcan with support from the automobile maker Stellantis, and the project "European Geothermal Lithium Brine" (EuGeLi) driven by the French mining company Eramet in partnership with Electricité de Strasbourg, both aim at extracting lithium from geothermal brine to reduce carbon emissions, water consumption, and the cost of open-air mines or evaporation tanks generally used in the sector.[43]

For the most part, companies in the mining sector are aware of their strategic role in supplying the raw materials needed for the low-carbon technology transition. Their transition plans tend to follow three strategic axes. The first involves totally or progressively disinvesting carbon-intensive energy: AngloAmerican has exited from the coal mining business in South Africa,[44] while the petroleum branch of BHP has merged with Woodside Petroleum.[45] The second is to reduce the carbon intensity of their extraction activities and the entire supply chain: only 14% of the energy needs of the mining industry were covered by renewable sources in 2021, despite being the most electrified heavy industry (44%).[46] Lastly, companies are trying to focus their efforts on exploiting metal mines that supply low-carbon markets and thus contribute downstream to the energy and technology transition in the transformation of raw materials into finished or semi-finished products. This positioning takes the form of numerous mergers and acquisitions,[47] along with joint ventures aimed at innovation in hard-to-abate industries. In this last area, Rio Tinto and Alcoa for example formed a joint venture in 2018, Elysis, to develop a process to produce aluminium without emitting CO_2 – BMW has already placed an order to supply its production lines from 2024.[48]

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WASTE

Nº 6 The already small share of recycled materials is shrinking, but new circular industrial channels are developing

- Since 2018, the share of circular processes (recycling, composting, etc.) in global consumption of raw materials has continued to shrink: the growth in demand for virgin raw materials has overtaken the progress made by global circularity.
- Monitoring of the evolution of global waste production suffers from a lack of aggregated data, making it hard to precisely follow its destination: numerous waste items drop off the grid, move into informal circuits, or disappear in landfills.
- The closure of Chinese and other Asian borders to imports of recyclable waste in 2018, followed by the amendment of the Basel Convention on hazardous waste, have slowed and redirected international waste trade towards new countries. Landfilling and incineration, emitting CH_4 and CO_2, have gained ground.
- In Europe, and increasingly in North America, Extended Producer Responsibility (EPR) and deposit-return schemes are demonstrating their ability to organize and finance collection and recycling channels.

KEY FIGURES

Consumption of materials overrides the progress of circularity

- **2.01 billion tonnes solid municipal waste produced in 2016**, according to latest available global figures (World Bank, 2018).
- **7.2% in 2022**: the rate of global circularity, which has been continuously dropping since 2018 (9.1%) (Circle Economy, 2023).
- **48.3% of waste recycled or composted in the EU** in 2021, compared to 44.9% in 2015 (Eurostat, 2023) and 32.1% in the United States in 2018 (EPA, n.d.), while Japan reduced its waste production by 7% from 2015 to 2021 (MOE, 2022).

China has shifted the status quo on international waste trade

- **0 tonnes of plastic waste** imported into China in 2022, compared to 8.8 million tonnes in 2017; -98% imports of paper and cardboard waste... the National Sword Policy has slashed international waste processing (UN Comtrade, 2023).
- **72% of the 300 biggest global companies** have a target to reduce plastic pollution (Diana et al., 2022).

Multifaceted reorganization of local processing capacities

- 352.9 million people in 50 jurisdictions around the world lived an area with a container deposit return system. **The average rate of return is 74.2%** in the world, 90% in Europe (Reloop, 2023).
- 180,000t of battery recycling capacities per year in the world. <1% of lithium used is currently recycled (IEA, 2021).
- **+11% biogas production** in the European Union from 2015-2022, *i.e.* 8% of its gas consumption, as much as +114% in France, where the move to methanation is strongest (Enerdata, 2023).

FURTHER READING

TRENDS

- In Europe, the circular economy in textiles is being reinvented (2022)
- Recycling Lithium-ion batteries, the new frontier in the electrification of mobility (2021)

CASE STUDIES

KAMIKATSU • A social project beyond the zero waste objective (2022)

MENDOZA • Promoting a socially inclusive model of comprehensive waste management (2021)

BRITISH COLUMBIA • Operation EPR at the heart of "Zero Waste" and the Circular Economy (2021)

FLANDERS • The development of a comprehensive strategy for the bioeconomy (2021)

MOROCCO • Moroccan society's uneven response to the proliferation of waste (2020)

TRENDS
WASTE

The relocation of waste treatment: still linear, but different circularity strategies emerge

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ANTOINE GILLOD • Director of the Global Observatory of Climate Action, Climate Chance

After more than thirty years of exporting western waste to Asia, the international waste treatment system is changing shape. The closure of Chinese, then other Asian borders to imports has highlighted the weaknesses and shortfalls of local recycling capacities in high-income economies. Confronted with a backflow of waste accentuated by the Covid-19 crisis, companies and local authorities are finding themselves on the front line of the global reorganization of waste treatment.

Global circularity eclipsed by extraction of raw materials

Circularity index on a constant downward trend since 2018

The World Bank estimates that 2.01 billion (bn) tonnes of solid municipal waste[a] were produced in the world in 2016. Global waste is made up of 44% green and food waste, followed by paper and cardboard (17%), plastic (12%), glass (5%), metal (4%) and other sources (wood, rubber, etc.). The economic origin of this waste is fairly equally divided between high (34%), upper-middle (32%), and lower-middle income (29%) countries. Low-income countries generate much less waste (5%) (**FIGURE 1**).

The management of this solid municipal waste generates about 1.6 $GtCO_2e$, most of it emitted in the form of methane (CH_4) during decomposition. More than half of the waste produced in the world is buried or discharged in open dumps. Up to 75% of waste is sent to dumps in South Asia, while in Latin America, 68% of waste is buried. Only 13.5% of solid municipal waste is recycled.[1]

The global circular economy index even appears to have dropped over the last few years, according to Circle Economy.[b] Of the 100 billion tonnes of material that entered the economy in

a Solid municipal waste is only one component of total waste, which also includes building waste and wastewater, for example. Solid municipal waste represents 27% of the waste generated in the European Union (source: European Parliament)

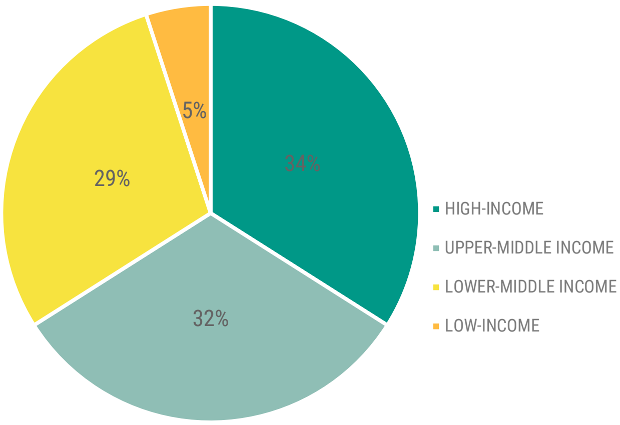
b Created by Circle Economy, the circular economy index is a ratio that measures the mass of secondary material incorporated into the economy compared to the total quantity of material consumed over a year. Published for the first time at the Davos Forum in 2018, the Circularity Gap Report measures the evolution of the index annually. The authors recognize the limits of the measure, which does not take into account the composition, value or quality of the secondary material, and does not capture slower processes, such as the extended life of products, or limited use of material.

2022, only 7.2 billion were the result of circular processes. This rate was 8.6% in 2020 and 9.1% in 2018. The reason is that the extraction of virgin materials is rising faster than the progress made by circularity: raw material extraction has tripled since 1970, and doubled since 2000.[2]

FIGURE 1

GLOBAL WASTE PRODUCTION ACCORDING TO INCOME LEVEL

Source: World Bank, 2018



Production of material constantly rising

The global production of the main plant crops (cereals, sugar cane, vegetables, oilseed, fruit, tubers and roots) amounted to 9.3 billion tonnes in 2020, a 52% rise since 2000 (6.1 bn tonnes). Over the same period, the volume of meat production increased by 45%, reaching 377 million tonnes (Mt) in 2020.[3] 14% of global food production is lost during industrial and logistical processes.[4] In 2019, food waste taking place during sales or distribution amounted to 931 million tonnes, which is 17% of food production.[5] This type of waste, which is rich in methane, represents almost 40% of the potential emissions of methane from landfills in the United States.[6]

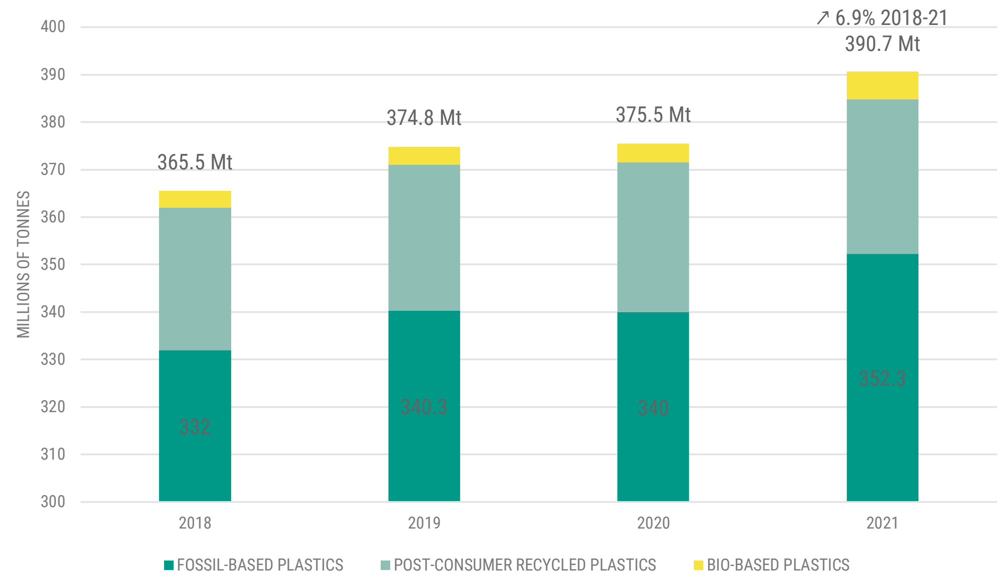
Global paper and cardboard production went from 402.8 Mt in 2013 to 412.7 Mt in 2018, over half of which incorporated recovered fibres (50.24%). The production of recovered fibres is contingent on the trade of industrial waste, for which the volumes traded amounted to 56 Mt in 2018. Asia concentrates 61.8% of imports of recovered fibres and 72% of processes for incorporating recycled material.[7]

From 2018 to 2021, global plastic production rose by 7%, and the vast majority of it was produced from fossil energies (FIGURE 2).[8] In particular, the production of single-use plastics from fossil energy rose by 6 Mt from 2019 to 2021 (137 Mt), with only 2% resulting from recycling. In total, 230 Mt of polymers were produced in the world in 2021. Although a little slower than during the previous two decades, demand could push up the production of single-use plastics by 17 million tonnes by 2027.[9] Once used, where do these plastics end up? From 1950 to 2015, only 9% of the plastic produced in the world annually was recycled, 12% was incinerated, while 79% accumulated in landfills or the natural environment.[10] The natural environment has already accumulated 710 million tonnes of plastic, including 11 million tonnes discharged into the sea.[11] Recent studies estimate the level of greenhouse gases emitted by the plastic industry as between 1.7 and 2 $GtCO_2e$ throughout the lifecycle.[12, 13, 14]

FIGURE 2

EVOLUTION OF GLOBAL PLASTIC PRODUCTION

Source: Plastics Europe, 2022

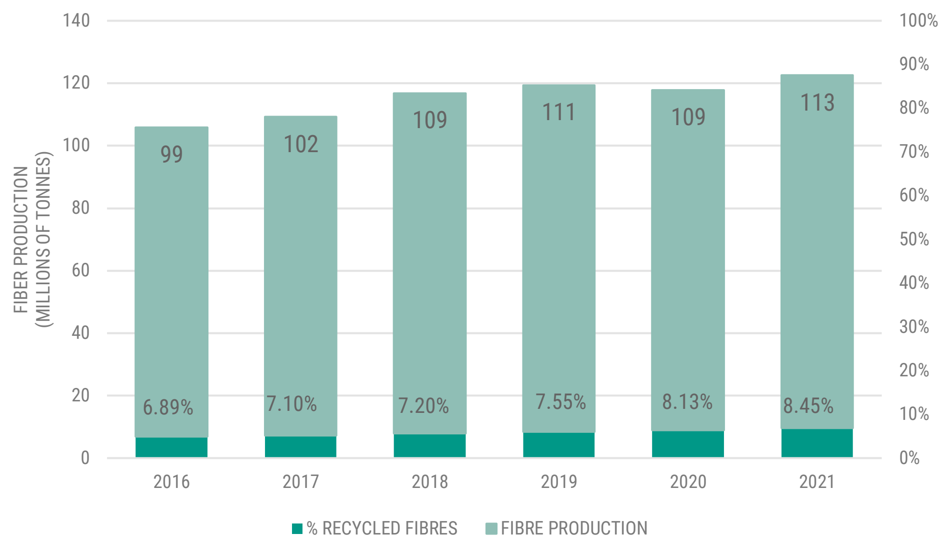


The production of textile fibres amounted to 113 million tonnes in 2021 – a figure that has doubled in the space of twenty years and could reach 149 Mt in 2030. According to Textile Exchange – a body that brings together the textile industry to target a 45% reduction in greenhouse gas (GHG) emissions by 2030 – growth is driven by the production of virgin raw materials, which went from 100 to 103 Mt from 2020 to 2021. In particular, the production of virgin fibre from fossil material increased by 3.4 Mt in a year. Synthetic fibres now make up 64% of production – led by polyester (54%), followed by cotton (24%) and manmade cellulosic fibres (MMCF – 6.4%). The recycling rate of all fibres was estimated at 8.45% in 2021, a slight increase since 2016 (6.89%) (**FIGURE 3**).[15]

FIGURE 3

GLOBAL PRODUCTION OF TEXTILE FIBRES (MT), INCLUDING THE SHARE INCORPORATING RECYCLED MATERIAL

Source: Textile Exchange, 2022



Globalized processing of domestic waste is losing steam

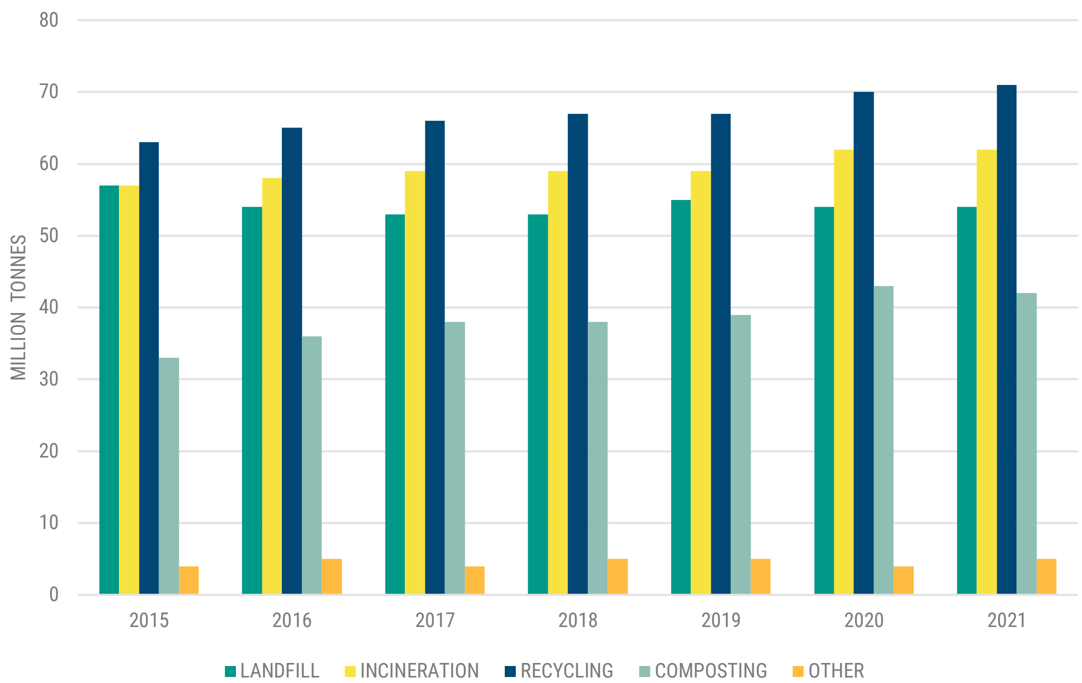
High-income countries are choosing to recycle... but also to incinerate

Very few statistics are available to precisely follow the progress made in waste treatment since 2015. In the European Union (EU), where waste production increased by 9% from 2015 to 2021, volumes of solid municipal waste put in landfills dropped 5% between 2015 (for a share of 26.6% in the means of treatment) and 2021 (23%), while incineration went up 9% (26.5%). Over that period, the rate of recycled and composted waste rose from 44.9% to 48.3% (**FIGURE 4**).[16] In the United States, the data published by the Environmental Protection Agency (EPA) stops at 2018; the rate of recycling and composting of solid municipal waste was 32.1% for that year, compared to 25.7% in 2015, while more than 50% still went to landfill.[17] In Japan, a comparison of annual reports by the Ministry of the Environment indicates a 7% decrease in waste production from 2015 to 2021. The landfill rate dropped by 18%, while the recycling rate stagnated at around 20%.[18] However, none of these countries provide figures that differentiate waste recycled in the country from exported waste, whose trace is lost once abroad.

FIGURE 4

EVOLUTION OF MEANS OF WASTE TREATMENT IN EUROPE (EU-27), 2015-2021

Source: Eurostat, 2023



Globalized treatment of paper, plastic, metal, and textile waste

According to the World Customs Organization (WCO), the volume of globally traded waste increased almost fivefold between 1992 (45.6 Mt) and 2012 (222.6 Mt),[19] triggering large, very lucrative illicit flows in its wake, worth more than $10 billion a year.[20]

Thus, in 2019, 73.3% of exports of recovered paper and cardboard fibres came from the European Union and the United States, and Asia represented almost two-thirds of imports. During the 2010-2020 decade, China received 60% of plastic imports in the world. Germany, the United States and Japan made up the three leading plastic waste exporters, while six of the ten main importers were Asian countries. For exporting countries, competitive treatment costs encouraged this outsourcing of plastic treatment rather than local recycling.[21] For Chinese companies, the trade was a way of accessing better-quality plastics than those present in domestic waste. However, in 2010, an estimated 76% of Chinese plastic waste was not managed correctly and ended up in landfill.[22]

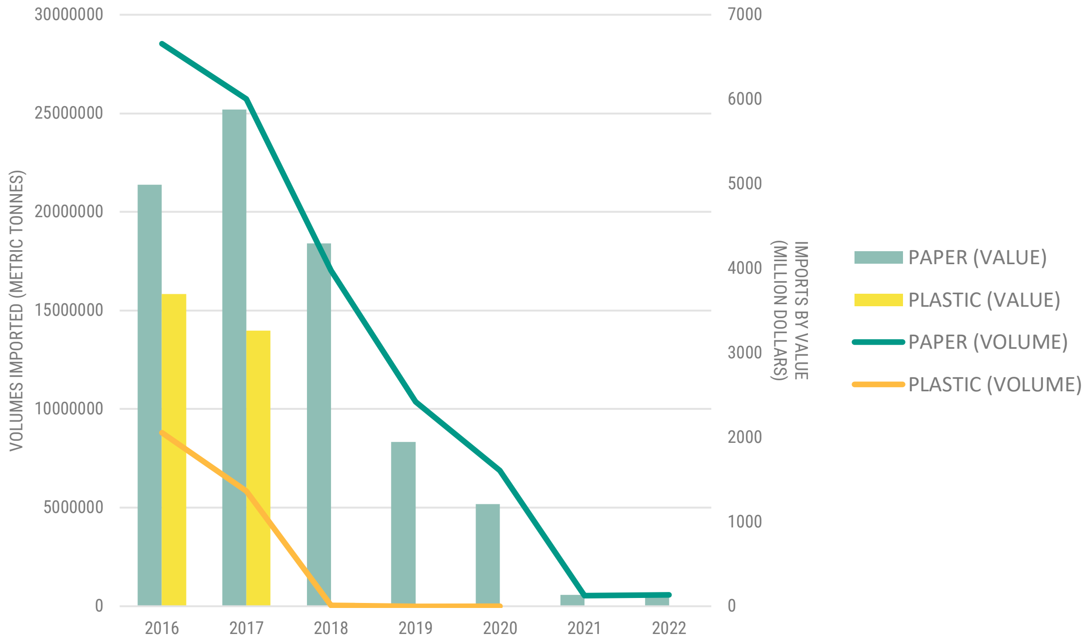
Restrictions on transborder trade have reshaped the world waste market

In February 2017, China took repressive action against uncontrolled transborder waste trade by adopting its National Sword Policy, which banned imports of 24 types of waste, including several forms of non-industrial plastic, mixed papers, textiles, and even vanadium slag, a rare metal.[23] The prohibition took the form of a standard aimed at limiting the "contamination" rate of recyclable materials, in other words the rate of mix with other non-recyclable waste, to between 0.3% and 1% – a rate that is almost unreachable, immediately disqualifying numerous cargoes destined for China.[24] The impact was immediate: imports of plastic waste (-99%) and recovered paper (-33.8%) plummeted starting from 2018.[25] The Chinese government then extended the list, before prohibiting all imports of solid waste in January 2021. **According to data from UN Comtrade, Chinese imports of plastic waste are almost down to zero, dropping from nearly $3.7 billion and 8.8 Mt in 2017 to only $180,000 and 310 tonnes in 2020; imports of paper and cardboard waste have been slashed by almost 98% in volume** (FIGURE 5).

FIGURE 5

CHINA SUDDENLY CLOSED ITS BORDERS TO A WASTE MARKET WORTH BILLIONS OF DOLLARS

Source: Climate Chance, based on data from UN Comtrade



Starting in 2018, Malaysia, the Philippines, Vietnam and Thailand became the new outlets for plastic waste from the United States, Japan and the EU.[26] Exports of recovered paper were immediately redirected towards India (+15%), Indonesia (+8.33%), Vietnam (+14.28%), and Thailand (+40%).[27] Exports of plastic waste to the region also increased by 171% from 2016 to 2018.[28] However, these new destinations went on to adopt their own legislation to limit the entry of waste into their territories, and rapidly started to refuse whole containers of waste that did not comply with contamination rules.[29]

These sovereign decisions accelerated the strengthening of international legislation on waste control. In May 2019, 187 countries adopted a series of amendments to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. The Convention, which applies to all OECD countries, now requires previous agreement from the importing state to receive cargoes of plastic waste, some of which have been requalified as "hazardous".[30]

The impact of these measures is indisputable: volumes of plastic exported by OECD member countries, which generate 89% of the world's plastic waste exports, halved between 2017 and the end of 2021. China's share of imports, which still amounted to 7% in 2018, fell to 1.2% in 2021. In particular, flows of plastic waste from OECD to non-OECD countries have taken a nosedive: transfers and treatment are now much more regionalized.[31]

The trend is visible in the European Union's export figures.[c] The EU still exported 33 Mt of waste in 2021, which is 77% more than in 2004. While cargoes travelling to China plummeted from 10.1 to 0.4 Mt between 2009 and 2021 (including a more recent drop for plastic and paper), Turkey has become the leading destination for European waste: 14.7 Mt have been transferred to the country (45% of exports), far ahead of India (1.9 Mt), Egypt (1.2 Mt), Switzerland (1.7 Mt) and the United Kingdom (1.5 Mt). Ferrous metals are the most exported waste by far (19.5 Mt), followed by paper and cardboard (4.4 Mt).[32]

Nevertheless, treatment capacities of receiving countries are not necessarily more virtuous, and statistics have had to be revised to take into account dependence on exports. In the United States, for example, plastic waste exports plunged from 2.3 Mt in 2015 to 1.2 Mt in 2018, then 0.6 Mt in 2021.[33] Yet since the Chinese ban, 23.2% more plastic ends up in landfills, according to one study,[34] while recycling rates remain steady at 5% to 6%.[35] In Europe, the recycling rate of plastic packaging was re-evaluated from 41% in 2019 to 38% in 2020 after accounting rules were made stricter.[36] Japan, which announced a figure of 84% reuse of plastic waste in 2018, in fact only recycles 23%, most of it being recovered in the form of energy, notably through incineration.[37] According to Interpol, these restrictions have also boosted the trafficking of plastic waste: transfers of illicit waste cargoes to other destinations, unauthorized dumping, illegal incineration, and administrative fraud are among the alternatives pursued in the absence of domestic recycling capacities in countries formerly dependent on China.[38]

Lastly, importing countries have also been hit by the measures. Since the volumes of waste imported to China dropped by 30% from 2015 to 2019,[39] local industries have lost important sources of "secondary raw materials". In 2020, the Chinese cardboard packaging leader, Nine Dragons, opened new factories producing virgin and recycled paper in Maine, Western Virginia and Wisconsin; these new factories have the dual advantage of maintaining local employment in the United States and bringing Nine Dragons closer to its recycled paper supply sources.[40] Shanying International began investing in an old paper factory in Kentucky in 2018, then in 2019 announced that it was investing another $200 million in developing an on-site recycling facility.[41]

Local actors spearheading action against waste

Top-down regulation: single-use plastics targeted by prevention policies

The waste crisis has revealed the structural weakness of collection and sorting capacities, obsolete recycling infrastructures, and a lack of awareness that prevents exporting countries from efficiently managing their waste domestically. In the hierarchy of waste treatment methods, as recommended by Zero Waste and adopted by the European Union, prevention is the primary lever to reduce waste production at source, and can include varied approaches, ranging from banning single-use products to taxation and recycling regulations.

Plastics, especially single-use, are the main target. An emblematic symbol of the linear economy, their degradation into microplastics generates considerable damage to biodiversity. Microplastics range in size from 1 μm to 5 mm and result from the degradation of bigger items abandoned in the natural environment. Their accumulation in ecosystems, in proportion with the exponential production of virgin plastics over decades, is increasingly documented. While in 2014, researchers evaluated the number of pieces of plastic floating in the ocean at 5 trillion,[42] a study based on withdrawals using finer nets in the Gulf of Maine (USA) and the English Channel estimated that the total is probably closer to 125 trillion.[43] Concerning the climate, reusable food packaging (beverage containers, sushi boxes, burger boxes, etc.) almost systematically has a much lower carbon footprint than disposable plastic alternatives.[44]

In March 2022, 175 countries agreed to negotiate a legally binding UN treaty on plastic, due for adoption at the end of 2024.[45] The legal scope and level of legal constraint of this treaty remain uncertain: a High Ambition Coalition to End Plastic Pollution, comprising 58 countries, is calling for binding targets to reduce plastic production, while other countries, led by the Gulf States, would like to restrict discussions to waste treatment.[46] Within the C40, 21 cities

c The latest federal data for the United States, published by the Environmental Protection Agency (EPA), stops at 2018 and does not give a precise idea of the evolution of flows. It is worth noting that the United States is not a signatory of the Basel Convention; yet as a member of the OECD, it must nevertheless comply with its standards.

have already committed to reduce their per capita household waste production by at least 15% by 2030 compared to 2015.[47]

The latest global review on anti-plastic regulations and legislation dates from 2019. A report by the UN Environment Programme and the World Resources Institute at the time estimated that in July 2018, 127 countries out of the 192 examined had adopted some type of regulation on plastic bags.[48] Africa was at that point the continent with the highest percentage of countries with legislation on single-use plastic, with 34 countries out of 54.[49] When the report was published, 27 countries had established a total or partial ban of some products (plates, cups, cutlery, etc.) and single-use plastic materials. Since 2021, the European Union has prohibited the sale of a dozen single-use products (cutlery, straws, cotton buds, etc.),[50] followed by Canada[51] and New Zealand in 2022, then the United Kingdom in October 2023.[52] A 2022 study deplores the limited success of plastic bag bans, due to states' incapacity to control and ensure respect of prohibitions, while the black market is booming and the industry has found ways of getting round restrictions.[53]

The unreliability of the data gathered makes it difficult to draw clear conclusions in most of the countries analysed by research. A recent study by the University of Portsmouth reports that over 50% of the 100 plastic-related policies evaluated by the authors presented little or no proof of their effectiveness.[54] The authors nevertheless identify conclusive results of policies prohibiting plastic bags in Antigua and Barbuda, Kenya, and the city of San Francisco. Several success factors are highlighted: strong political backing, clearly identified objectives spread over time, strict sanctions, stakeholder commitment, public awareness-raising, and the existence of industrial alternatives to the products targeted.

According to the UNEP report, in 2018, 27 countries taxed the production and manufacture of plastic bags, and 30 had set up a consumer tax. Since the report, the EU definitively adopted a tax on non-recycled plastic waste in 2021. Every kilo of non-recycled plastic packaging waste costs 80 cents of a euro to the country concerned, or €800 per metric tonne. States can pay the cost of the tax directly through their national budget, or finance it by taxing the private sector. To date, France, Germany, Ireland, Luxembourg and Slovakia have chosen the former option, but intend to shift the cost to companies in the long term.[55] In 2019, a study review estimated that the tax measures applied to plastic bags had led to a 66% reduction in their usage in Denmark, 90% in Ireland, 74% to 90% in South Africa, Hong Kong and the United Kingdom, and 50% in Botswana and China.[56]

Strongly established in Europe, Extended Producer Responsibility is being taken up in North America

In 2022, a study estimated that 72% of 300 of the biggest global firms in terms of income (Global 500 index) analysed from 2015 to 2020 had established plastic pollution reduction targets. Companies committed to voluntary environmental initiatives (67%) are four times more likely to establish targets that are measurable and have a clear timeline, and tend to effectively focus on recycling more than other stages in the plastic lifecycle.[57] **Recycling is in fact a lucrative industry: the Bureau of International Recycling (BIR) evaluates the recycling market at 200 billion dollars**.[58]

In 2022, for the fifth consecutive year, Coca-Cola was identified as the worst polluting brand, ahead of Pepsico and Nestlé, according to a list established by the Break Free From Plastic movement. Since 2018, BFFP, which gathers 2,700 organizations around the world, makes an annual analysis of plastic waste to identify the companies that generate the most plastic pollution. In five years, almost 207,000 volunteers have analysed over 2,125,000 plastic items in 87 countries.[59]

Paradoxically, Coco-Cola also comes out top in the ranking established by the US shareholder advocacy organization, As You Sow. The scorecard focuses on the plastic pollution prevention and management practices of companies in the beverage, fast food, consumer packaging and large retailer sectors. The report published in 2021 ranks 50 companies applying grades from A to F through 44 metrics on 6 pillars: 1) packaging design, 2) reusable packaging, 3) recycled content, 4) public data transparency, 5) supporting recycling, and 6) extended producer responsibility (EPR). No company received the highest score, and only Coca-Cola was awarded a B-, compared to 17 Cs, 18 Ds, and 14 Fs.[60]

Extended producer responsibility (EPR) programmes precisely shift the financial or operational responsibility of collecting and treating waste onto the companies responsible for putting it onto the market. According to a UNEP report, in 2018, 43 countries had included elements on extending producer respobsibility. Already very common in Europe, EPRs are now being implemented in the United States. Maine was the first State to vote in favour of an EPR in July 2021, followed by Oregon, Colorado, New Jersey, Washington and California.[61] The latter state requires that by

2032 some types of packaging must be recyclable or compostable, along with an absolute reduction of plastic packaging by 25%, and recycling of 65% of single-use packaging. The law establishes the participation of producers in a common fund to cover waste management costs.

The means of implementing EPRs differ widely from one country to the next. Most often, companies make a financial contribution which is collected by a third party, and then paid via a government agency to municipalities to refund all or part of their collection and recycling costs. During 2020, the Quebec government announced the transformation of its financial EPR – which is based on a financial contribution paid to an ecological body responsible for waste prevention and management – into an operational EPR. In this system, from 2025, companies will be responsible for residual matter throughout the lifecycle of waste, from the market launch of the product up to its treatment, in order to oblige them to develop a circular economy on the Quebecois territory to reach the new mandatory recycling targets.[62]

In a report on five EPR programmes set up close to coastal areas in Australia, Canada (British Colombia), the European Union, South Korea and Tunisia, GIZ concluded that EPR programmes are effective in avoiding marine pollution, provided that they are precisely designed, truly implemented, and continuously monitored and developed.[63]

Multifaceted reinforcement of local collection and treatment capacities has environmental and social stakes

According to the World Bank's "What a Waste 2.0" report, about 70% of waste management services come under local jurisdictions; in low-income countries, the task can take up to 20% of the municipal budget. On a larger scale, the world's 27 biggest megacities (with over 10 million inhabitants) represented 13% of waste flows in 2015.[64] Local and regional governments therefore play a key role in organizing waste collection and treatment, while dealing with their own particular problems.

In late 2022, over 352.9 million people in 50 countries, states and provinces in the world had a deposit return system (DRS) for single-use beverage containers (bottles, cans, etc.). Taking together the different DRS bills identified, 745 million people in 70 jurisdictions could be concerned in 2026, according to Reloop, a European thinktank that analyses these systems.[65] The average return rate of bottles around the world is 74.2%; the figure is 90% in the 13 European countries that have set up a deposit system, and as much as 98% in Germany (**FIGURE 5**). Malta and Latvia are the latest countries to have adopted a DRS in 2022, while the Swedish system dates back to 1984, and even 1971 in Oregon. Cities in the United Kingdom and Portugal have recently tested digital deposits: consumers scan a code printed on the container before throwing it into a recycling bin. Once it arrives at the recycling centre, an operator scans the code again; the person then receives a deposit refund on a digital account.[66]

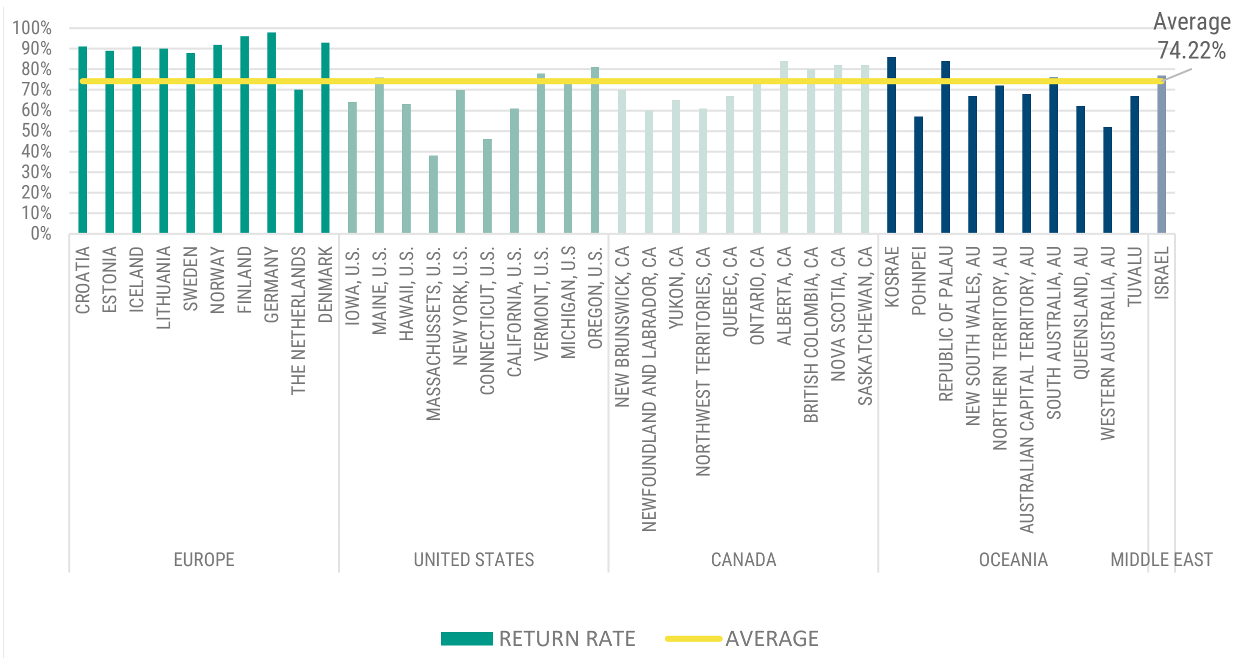
Other models exist that encourage recycling through incentive mechanisms. The cities of Curitiba in Brazil and Istanbul in Turkey for example propose reductions on school text books, transport tickets, and food.[67] In India, the city of Ambikapur has set up a café in which people can receive a meal in exchange for plastic waste[68] as part of a plan to modernize the city's collection through mobilization, including recognized employment for women's self-help groups.[69]

In numerous developing countries, improved collection conditions and the diversion of waste sent to landfill play a crucial social role in integrating informal collectors. **Around 15 million informal waste pickers around the world collect 15% to 20% of waste, including in landfills, often enduring very precarious social, economic and health conditions**.[70] In Latin America and the Caribbean, one-third of waste ends up in fly-tips or in the natural environment.[71] Some cities have made great progress in integrating these informal waste pickers. For example, in 2019 the provincial government of Mendoza (Argentina), studied by the Climate Chance Observatory in 2021, launched the "integrated urban solid waste management project" (PGIRS), attaining a treatment rate of 100% in the metropolitan area of Mendoza and the Uco Valley, with two outcomes: protection of the environment, and social inclusion of informal workers in the sector. The civil association of urban waste pickers of the province of Mendoza (ACRUM), which gathers six waste picker cooperatives, was granted a subsidy of $1.8 million in early 2020 from a Mendoza trust fund to improve its equipment, technical capacities and work infrastructure.[72] In Ghana, from 2016 to 2018, the inclusion of workers from the informal sector led to an increase in collection rates from 58% to 90%.[73]

FIGURE 6

LATEST KNOWN RETURN RATES OF SINGLE-USE BEVERAGE CONTAINERS IN DEPOSIT RETURN SYSTEMS (%)

Source: Reloop, 2023. Reporting years ranging from 2017 to 2022.



The treatment of organic waste generated by food loss and waste raises specific treatment challenges. Humidity makes food waste difficult to handle with technical equipment, notably producing high quantities of leachate that can drown machines. This is a great problem in developing countries, where organic matter makes up a very high proportion of waste volumes. Seoul has been pioneering in this area: the South Korean capital has succeeded in reaching 95% recycling of food waste, mainly thanks to the availability of compost bins and urban gardens.[74] In Brazil, Sao Paulo has adopted strategies to divert the 100,000 tonnes of organic waste produced annually, such as towards decentralized compost parks, and integrate them into the city's circular agriculture programme.[75] In Morocco, analysed by the Observatory in 2020, the organic waste rate is 70%, and two options are being tested: combining methanation units with treatment plants, and transforming waste into solid recovered fuel. After being shredded then dried, non-recycled waste is simply used to produce energy by incineration.[76] According to one study, European cities equipped with a "door-to-door" collection system for biodegradable waste also facilitate the best recycling rates of other, dry waste (glass, metal, paper, plastic, etc.).[77] Ljubljana (Slovenia), which has an ambitious intermediate sorting target of 75% by 2025, collects biodegradable waste in this way, mostly for composting.

In Europe, the production of biomethane from anaerobic digestion of organic waste has accelerated in recent years. The REPowerEU plan has set a target to produce 30 bcm in 2030, compared to 3 bcm currently. According to Enerdata statistics, biogas production amounted to 15.2 Mtoe in the European Union in 2022, against 13.7 Mtoe in 2015. Germany produces almost 50% of European biogas, principally to supply its electricity production. With 7.62 Mtoe produced in 2022, the country is even the world leader, ahead of China (7.42 Mtoe), the United States (3.55 Mtoe) and the United Kingdom (2.92 Mtoe). Although far behind, Italy (2.13 Mteo in 2022) has increased its production by 11% since 2015, mainly for use in transport. The strongest momentum is undoubtedly in France, which more than doubled its annual production from 2015 to 2022, from 0.69 to 1.48 Mtoe, opting to transform this biogas into biomethane for injection into the natural gas grid. However, the installation of biogas plants is also the subject of debate: in France, where 80% of the 1,300 methanation units installed are agricultural, methanation offers farmers a unique economic opportunity, at the risk of converting food farming activities to produce gas, which is more profitable. It can also lead to an intensification of animal farming and crops to optimize unit yields.[78, 79]

Batteries, textiles: the new industrial frontiers of recycling

The recycling of lithium-ion batteries used for electric mobility and the electrification of numerous uses turns out to be the poor relation of transition value chains. According to the International Energy Agency (IEA), the global recycling capacity was 180,000 t/ year in 2021, half of which is identified in China. According to the World Bank, the recycling rate of minerals rarely exceeds 70%; in the case of lithium, it is even less than 1%.[80] In addition, the most common method for recycling batteries, using pyrometallurgy, gives low returns on investment, generates polluting residual matter, and relies on complex processes. The province of Quebec (Canada) is at the avant-garde of lithium-ion battery recycling thanks to considerable public support for research and development of the sector. The start-up Recyclage Lithion opened its first pilot factories in the province to test recycling of lithium-ion batteries using hydrometallurgy, a patented process that is able to recuperate and process up to 95% of battery components, according to the company.[81]

In the textile industry, the new frontier is called chemical recycling. Highly popular with industrials, this technique involves dissolving fibres made up of natural polymers (linen, latex, cotton, etc.) or synthetic ones (PET, acrylic, etc.), and then separating the monomers of the fibre. This process can be used to create a new recycled polymer with the same properties as a virgin polymer. Most fibres contained in clothes are cotton, polyester or elastane mixes; polyester and elastane are polluting agents that make recycling or reuse almost impossible, in particular due to their complex chemical compositions.[82] One example is the CE-PET project, coordinated by the company Carbios and co-funded by the French state from 2018 to 2023, which has validated a pilot process for the enzymatic recycling of PET to produce white textile fibres from coloured plastic.

WASTE

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LAND USE

Nº 7 Deforestation is slowing... but is not stopping the decline of the carbon sink

- Annual global tree cover loss has slowed since peaking in 2016, but remains above the 2000-2015 average. The carbon stocking capacity of forests therefore continues to weaken.
- Indonesia has significantly slowed its rate of deforestation, which is accelerating in the Democratic Republic of Congo and Brazil.
- International targets for combating deforestation (New York Declaration), accelerating reforestation (Bonn Challenge) and promoting biodiversity (Aichi Targets) have generally not been met.
- Financing for biodiversity and forests is growing. "Nature-based" carbon credits are driving the development of voluntary carbon markets.

KEY FIGURES

Deforestation slowing down but still high

- **25 million hectares (Mha) of forest cover** lost on average each year since the 2016 peak of 29.6 Mha. Noteworthy slowdown in Indonesia from the 2016 peak (2.2 Mha) to 2022 (0.8 Mha) (GFW, 2023).
- **4 Mha** humid primary forests lost on average each year since the 2016 peak of 6 Mha (*ibid.*).
- **2/3 of the loss of primary forests** between 2013 and 2019 was due to conversion for commercial agriculture, and 3/4 of that conversion was illegal (Forest Trends, 2021).

The forest carbon sink continues to shrink

- **-7.72 $GtCO_2e$/year**: net sink for the period from 2001 to 2022, resulting from 8.84 $GtCO_2e$/year of emissions from forests and -16.6 $GtCO_2e$/year absorbed (GFW, 2023).
- **-5.8 GtC sequestration capacity** in tropical forests from the 1990s to the 2010s – the carbon equivalent of a decade of fossil energy emissions from the United Kingdom, Germany, France and Canada combined (CIRAD, 2020).
- **0.22 $GtCO_2e$/year** of net emissions from the Brazilian Amazon between 2001 and 2019, now a net source of emissions (Harris et al, 2021).

Despite increased commitments and funding

- **69% of companies with the highest forest risk** had a policy against deforestation in 2023 (41% in 2015), and 39% of financial institutions (0 in 2015) (Forest500, 2015; 2023).
- **$130 billion funding** to support biodiversity in 2020, compared to $52 billion in 2012 (Global Canopy, 2012; The Nature Conservancy, 2020)
- **$263 million/year**: average multilateral funding of REDD+ projects between 2015 and 2021 (CFU, 2022).
- **+321%** value of nature-based carbon credits sold on the voluntary market from 2020 to 2021 (Ecosystem Marketplace, 2022).

FURTHER READING

TRENDS

- Strengthening ecological connectivity to adapt ecosystems to climate change (2022)
- Rights of nature as a bastion against the destruction of natural ecosystems (2022)
- Community Forestry in Central Africa: Still a fragile sustainable forest mangement model (2021)
- A matter of trust: How palm oil supply chain actors respond to the evolving sustainability standards (2021)

CASE STUDIES

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TRENDS
LAND USE

The tree that hides the forest: increasing commitments and a slowdown in deforestation mask the shrinking carbon sink

TANIA MARTHA THOMAS • Research Officer, Global Observatory of Climate Action, Climate Chance

Changing land use practices over recent decades have intensified the interrelated crises of climate change, biodiversity loss, and desertification. After reaching a peak in 2016, the loss of global tree cover began to slow down, although erratically. The loss of primary forests is mainly due to deforestation for commercial agriculture, which has seen a rise in resulting emissions, and a reduction in the net carbon sink of forests. The impacts of increased state and private commitments to combat deforestation and bigger financial flows towards forests and biodiversity still await confirmation. Regional exceptions persist, and conservation works best when local communities are involved.

Evolution of forest cover and emissions

2015 – 2022: Loss and degradation of forest cover remains high

Following a historic peak in 2016, annual tree cover loss[a] has remained above its 2015 level, at a rate of 25 million hectares a year (Mha)[1] – an annual loss equivalent to the total surface area of Ecuador. About one quarter of total loss is permanent, in areas where deforestation is mainly commodity-driven or for urbanization (FIGURE 1).[2,b] Overall, despite different trends between regions, the commodity-driven deforestation rate has not diminished since 2001,[3] maintaining an average pace of 5 Mha/year since 2017.

Most of the permanent loss concerns humid primary forests in tropical zones – from 2015 to 2020, primary forest loss remained higher than during the five preceding years[4] (FIGURE 2). These forests

a "Tree cover loss" here refers to the total loss as presented on Global Forest Watch, including "*humid primary forests, dry and non-tropical primary forests, secondary forests and tree plantations*", measured using Landsat satellite images. This loss comprises deforestation – due to human activity – and loss due to fire, disease, storms, etc.

b Here, "commodity-driven" deforestation designates the permanent conversion of forest land for non-forestry purposes such as commercial agriculture, mining, or energy infrastructures; "shifting cultivation" designates small- or medium-scale conversion of forests for agriculture that is later abandoned; "forestry" designates large-scale operations within managed forests and tree plantations.

store about half of the world's carbon,[5] harbour the greatest biodiversity, and provide numerous ecosystem services.[6] A study by Forest Trends revealed that nearly two-thirds of tropical forest lost from 2013 to 2019 was due to commercial agriculture (in particular soy, palm oil, beef products, plus smaller-scale products like cocoa, rubber, coffee and corn).[7] Three-quarters of this agricultural conversion took place illegally.

FIGURE 1

TREE COVER LOSS AND SHARE OF MAIN DRIVERS, 2015 – 2022

Source: Climate Chance, based on Global Forest Watch data

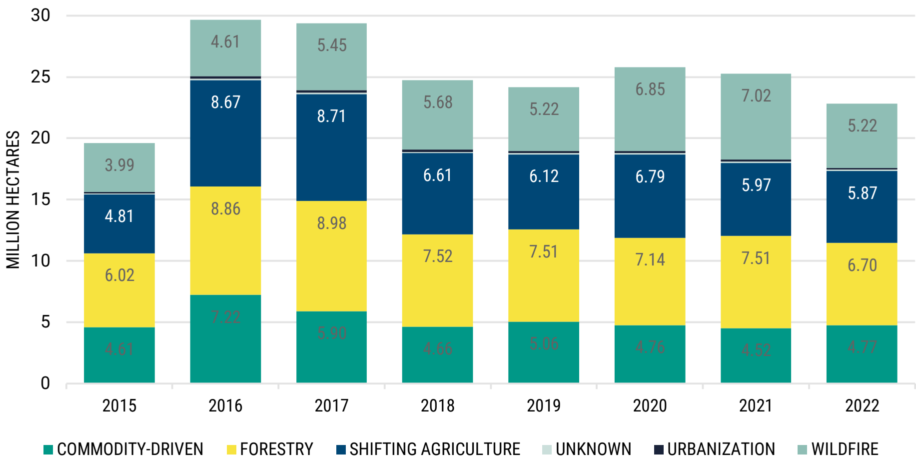
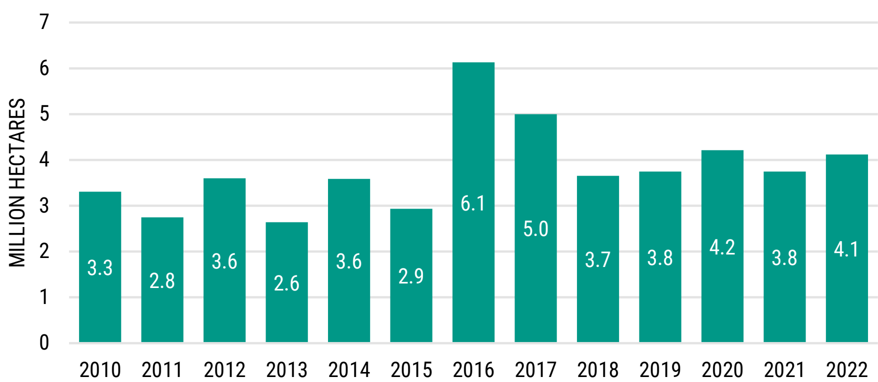


FIGURE 2

LOSS OF HUMID PRIMARY FORESTS, 2010-2022

Source: Global Forest Watch, 2023



The remainder of the loss can be put down to so-called "temporary" factors (forestry, forest fires, and shifting cultivation in some cases), since these forests can sometimes grow back: but the process is generally slower and much harder to measure. In addition to this loss of forest area, several scientific studies published in 2020 and 2021 highlight a second key mechanism:[8, 9, 10, 11] forest degradation, a term that covers occasional perturbations to extract wood, small-scale fires and storms. In January 2020, of the 1,071 million hectares of remaining humid tropical forest, about 10% were degraded. **Degradation is reportedly responsible for about 73% of biomass loss and 44% of carbon emissions related to land use, compared to 27% and 56% for deforestation respectively**. In addition to considerable emissions, these areas are at greater risk of deforestation. Researchers estimate that 7.5 years after perturbation, almost 50% of degraded forests have been deforested.

This loss and degradation of forests coupled with global changes in land use patterns generate several interconnected impacts, in particular biodiversity loss and desertification. Despite an increase in the number of protected areas, the collapse of biodiversity continues.[12]

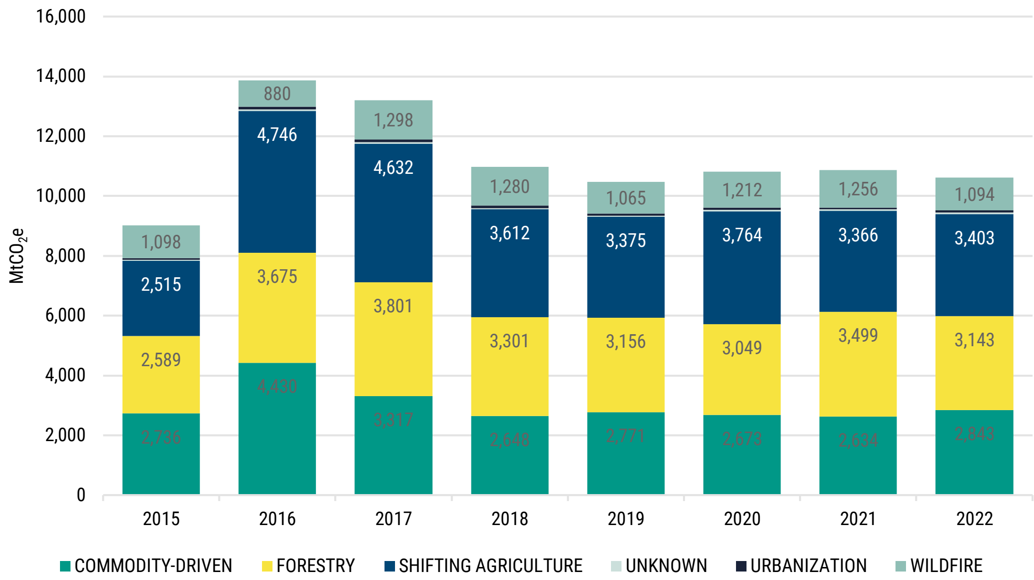
Emissions continue to rise while the carbon sink is declining

According to the IPCC, between 2006 and 2017, activities related to agriculture, forestry and land use represented about 13% of anthropogenic CO_2 emissions, 44% of methane emissions, and 81% of nitrous oxide, amounting to an estimated 12±2.9 $GtCO_2e$ per year. In a natural response to these increased emissions, the land carbon sink has absorbed 11.2 $GtCO_2$ per year, but the persistence of the sink is uncertain, given the impacts of climate change.[13] Emissions related to the use of land are harder to assess than those resulting from energy combustion, with current estimates varying depending on the definition of forests or cultivated land, and the data source (national bookkeeping models, digital models or satellite imagery). According to Harris et al., the differences between national and global estimates can be as much as 4.3 $GtCO_2$ a year – the equivalent of the annual emissions of India.[14]

FIGURE 3

EMISSIONS DUE TO TREE COVER LOSS, BY DEFORESTATION DRIVER

Source: Climate Chance, based on Global Forest Watch data



Emissions coming from all of these forest modifications (whether anthropogenic or otherwise, measured by satellite imagery),[c] were estimated at 8.1±2.5 $GtCO_2e$ per year from 2001 to 2019 by the same authors. During the same period, forests absorbed about 15.6±49 $GtCO_2e$ per year, representing a net annual sink of -7.6±49 $GtCO_2e$. According to the same study, tropical and sub-tropical forests contribute the most to global carbon fluxes in terms of emissions and absorptions, but only represent 30% of the planet's net carbon sink, the remainder being attributed to temperate and boreal forests. The Brazilian Amazon was therefore a net carbon source of 0.22 $GtCO_2e$/year from 2001 to 2019, mainly due to commodity-driven deforestation. Globally, deforestation for commodities, shifting cultivation, and forestry represents more than three-quarters of emissions due to tree cover loss (**FIGURE 3**).

Taken overall, the global food system represents up to one-third of all global anthropogenic emissions.[15] The CO_2 emissions generated by the conversion of forests into agricultural land are the main source, followed by CH_4 produced by enteric fermentation

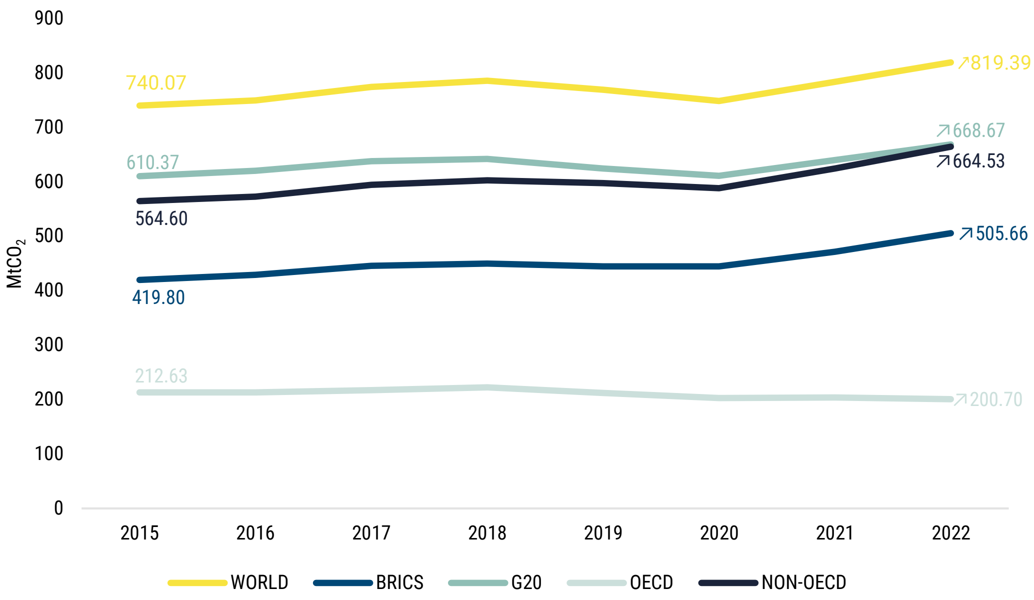
c Whereas the emissions featuring in IPCC reports and the Global Carbon Budget are calculated using bookkeeping models or a dynamic model of global vegetation, the figures given here were calculated based on forest cover data obtained from satellite imagery.

of livestock and the use of manure. Except for OECD countries, emissions related to energy usage in the agriculture, forestry and fisheries sector (energy combustion for crops, support activities, and post-harvest activities on production sites) have been increasing since 2015, in particular in the BRICS (+20% in 2022 compared to 2015)[16] (**FIGURE 4**).

FIGURE 4

EMISSIONS RELATED TO ENERGY USAGE IN THE AGRICULTURE SECTOR

Source: Climate Chance, based on data from Enerdata



Increasing regional differences

Regional trends reveal different trajectories and emerging positive signals. Of the three large nations with humid tropical forests, Brazil and the Democratic Republic of the Congo (DRC) have undergone increased forest loss since 2015, while Indonesia has, on the contrary, seen a sharp drop in deforestation (**FIGURE 5**).

In the case of Brazil (which represented 43% of total primary forest loss in 2022), most of the loss was due to clear-cut deforestation, and recent increases in forest loss coincided with the weakening of environmental protection policies and enforcement agencies by the Bolsonaro government, and with the reduced rights of indigenous peoples.[17] In the Congo, losses are rather due to smaller-scale clearance for short-term cultivation in response to increasing food demand, and the production of charcoal.[18] In 2021, the government also announced the end of a moratorium on forest exploitation, but the impact of this policy is not necessarily apparent in the figures.[19] The relative success of Indonesia in its continued slowdown of deforestation since 2016 can be explained by a progressive reinforcement of standards in the palm oil sector – as analysed by the Observatory in 2021[20] – coupled with more government policies aimed at reducing peatland fires.

Forest carbon sinks also appear to have regional differences: one study showed that the carbon absorption peak was reached in 1990 in the Amazon. In African forests, the peak was reached ten years later.[21]

The paradox of forest fires

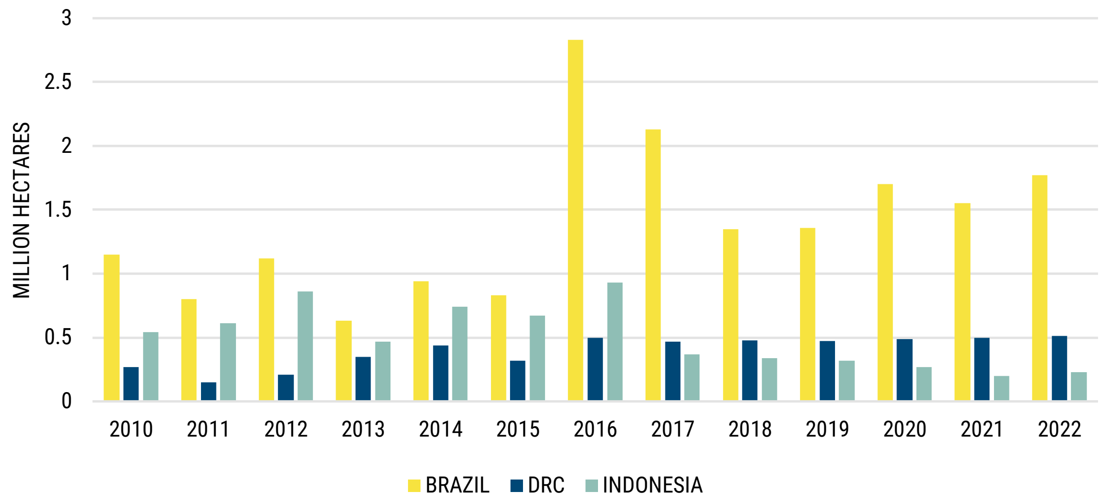
Apart from tree cover loss caused by human activities, forest fires play an increasingly large role – rising from 3.9 million hectares in 2015 to a peak of 7 million in 2021 (**FIGURE 1**) – due to increased temperatures and drier conditions in the tropical, sub-tropical and temperate regions of Australia and Boreal Eurasia.[22] Nevertheless, in absolute terms, the total burned surface area is decreasing (-25% from 1998 to 2015), partly thanks to a slowdown in prairie and savanna fires, due to increasing conversion of these lands into cropland, pastureland or urban areas.[23] Consequently, CO_2 emissions related to fires have followed a global downward trend since the 2000s (**FIGURE 6**).

These apparent paradoxes can be explained by interactions between fire regime control mechanisms: quantity of combustible matter, humidity, ignition (outbreak of fire) and suppression (fire extinction). These changes in fire regime also coincide with the appearance of a new type of fire, more complex and harder to control, described by Aude Valade, researcher at Cirad, in the 2021 Global Synthesis Report on Climate Action, *i.e.* megafires. These massive fires have exceptionally intense fire lines, propagation speeds, and unpredictable behaviour, as observed in recent years in California, Australia and Siberia,[24] and even more recently in Canada.[25]

FIGURE 5

TREE COVER LOSS IN BRAZIL, DRC AND INDONESIA

Source: Global Forest Watch, 2023



International commitments out of sync with local conservation

Steep rise in funding, but monitoring of impacts remains unresolved

Funding for biodiversity more than doubled from 2012 to 2020, going from $52 billion dollars annually[26] to about $130 billion.[27] The same goes for financial flows aimed at protecting forests: multilateral financing of REDD+ projects (reducing emissions from deforestation and forest degradation in developing countries) supported by the United Nations amounted to an average $263 million a year from 2015 to 2021.[28] Studied by the Observatory in 2022,[29] voluntary carbon markets, whose value went from $278 million in 2015 to over $2 billion in 2021, increasingly channel the action of companies looking to offset their emissions.[30] Credits related to forestry and land use are among the most in demand and have the highest values, in particular when they generate benefits for biodiversity, the sign of a greater focus on the interconnection of multiple planetary crises. However, most of these "nature-based solution" credits, including REDD+ projects, support emissions-avoidance schemes; not only do they make no contribution to increasing the natural capture of carbon by reforestation or afforestation – "only" preserving it – but the methodologies they use to evaluate their impacts have been accused of underestimating the emissions avoided, protecting land that is not under threat, and implementing debateable forest management practices.[31, 32] Even REDD+ credits do not clearly pass close examination[33] (**CF. "COMPANIES" TRENDS**).

Concrete commitments from companies, but insufficient progress

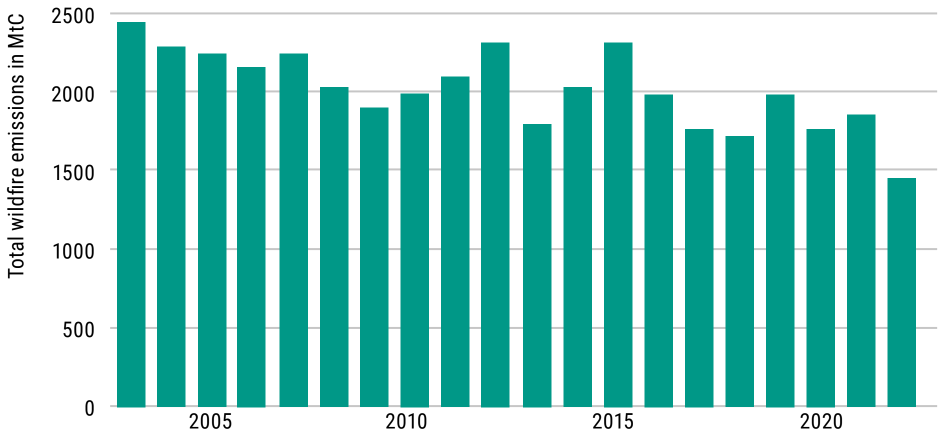
Following growing pressure from civil society in the early 2000s to eliminate deforestation from supply chains, corporate commitments began to take shape and develop, starting with the Consumer Goods Forum created in 2010, which aimed at net-zero deforestation by 2020.[34] Multi-stakeholder initiatives have seen the day, like the New York Declaration on Forests in 2014, by which 190 different organizations committed to bring deforestation to an end in 2020, and the Bonn Challenge, which aims to reforest 350 million hectares by 2030. Following COP26 in 2021, the "Glasgow Declaration" reaffirmed the objective to "halt and reverse forest loss and land degradation by 2030".[35] A first review produced in 2020 by the Climate Chance Observatory showed that most of the targets set for that year had not been reached;[36] in fact, the pandemic had diminished surveillance, and deforestation was continuing relentlessly.[37] Current progress towards 2030 targets is also proving insufficient.[38, 39]

A study by the World Benchmarking Alliance of the 350 biggest food and agriculture companies found that only 2% of them communicated their environmental impacts, while none of them "holistically address their dependencies on nature".[40]

FIGURE 6

GLOBAL EMISSIONS DUE TO FOREST FIRES

Source: CAMS, 2022



Since 2014, the Forest 500 initiative has been identifying companies and financial institutions that represent the greatest risk of deforestation due to their participation in, exposure to or financing of supply chains for soy, beef, leather, palm oil, wood, paper pulp and paper. In 2015,[41] 59% of the 250 companies evaluated had no deforestation policy, either concerning a specific product or general deforestation targets. None of the 150 financial institutions studied had a policy on deforestation. In 2023,[42] 31% of the 350 firms evaluated still had no policy, while 61% of the financial institutions most exposed to the risk of deforestation had no policy on the matter for their loans and investments. **Only 2% of Forest 500 companies that had made net-zero commitments and aligned themselves on a 1.5 °C objective attained a sufficiently high score to put them on track to respect those commitments**. Commitments also vary according to the sector: palm oil and timber are the commodities with the highest commitment levels, whereas leather, beef and soy come in at under 50%.

Forthcoming policies and legislation could encourage companies at risk for forests to act more, such as the EU Deforestation Regulation, which requires that goods produced after 29 June 2023 to be commercialized on EU markets in 2025 must not have contributed to deforestation or forest degradation after 2020.[43, 44] The regulation applies to coffee, cocoa, rubber, palm oil, soy, beef and wood, and all derived products including leather, charcoal and printed paper. Although it triggered strong reactions from the EU's commercial partners,[45] institutional investors like Aviva, the Norwegian sovereign wealth fund NBIM, and others, are already planning to withdraw from supply chains at risk.[46]

Local communities at the heart of conservation and resilience

Since the 2000s, research has shown that community forest management contributes to reducing deforestation and illegal forest exploitation,[47, 48, 49, 50] while generating substantial socio-economic advantages thanks to a fairer share of income from forest exploitation. It is now recognized that local communities and indigenous peoples have been sustainably managing forest resources for centuries through community management approaches. In Brazil, the deforestation of indigenous community forests would have been 22 times greater without their legal recognition. In the Mexican Yucatan, the figures are even more striking: the rate of deforestation within community forests was 350 times lower than in other areas.[51, 52] In Mexico, a highly decentralized country, 80% of forest areas are managed by communities.[53] In the Asia-Pacific region, 15 million hectares are managed by communities, which is equivalent to the size of Cambodia, and this management enabled local inhabitants to better resist the pandemic.[54] However, in practice, community forestry comes up against obstacles. In Central African forests – analysed for the Observatory in 2021 by Marie-Ange Kalenga, from the NGO Fern – legal frameworks, land rights issues and access to financing hinder potential progress.[55]

Civil society has played an increasingly large role recently when it comes to land rights issues and even the rights of nature,[56] involving more frequent legal action. This is the case in Ecuador, where oil fields and mining projects have been cancelled following legal decisions or popular referendums (**CF. "CIVIL SOCIETY" TRENDS**). Forest exploitation, mining, and widescale industrial agriculture have been identified as the main sources of conflict with civil society activists, and more than three-quarters of fatal attacks in 2021 took place in the Amazon.[57]

Cooperation with the local population has turned out to be more effective for conservation – through protected areas managed by the community or multi-use conservation areas – with advantages for biodiversity and forest carbon stocks.[58] Examples include the Cardamom Mountains in Cambodia,[59] and Madre de Dios in Peru,[60] two cases studied by the Observatory in recent years. Often coordinated by NGOs on the field, local cooperatives have boosted the socio-economic and ecological resilience of women and families in particular, like on plantations growing coffee in Uganda and Rwanda,[61] cocoa, bananas and plantains in Costa Rica,[62] and the restoration of mangroves in the Sundarbans Delta in India.[63]

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COMPANIES

N° 8 Distant and hard to measure, net zero commitments of companies lack credible transition plans and progress monitoring

- Since the Paris Agreement, "net zero emissions" has become the compass of corporate climate action and a driver for their growth strategies.
- Often unclear and limited to "operational" emissions (Scopes 1 & 2), these targets overlook value chain emissions (Scope 3), which represent 75% of companies' carbon footprint.
- Corporate transition plans, which should specify the means to reach carbon neutrality, are lacking precision on the required investments and changes in business models.
- Carbon offsets via voluntary markets, gaining popularity among companies, requires greater methodological credibility and transparency, at a time when "carbon neutrality" claims are beginning to be regulated in Europe.

KEY FIGURES

Measuring emissions, a prerequisite to commitments but not yet universal

- **8,307 companies have committed to the Race to Zero**. 929 of the 2,000 biggest companies have set net-zero targets, 4% of them aligned with RtZ requirements (Net Zero Tracker, 2023).
- **71% of companies disclose their operational emissions** (Scopes 1 & 2) out of the 4,000 biggest global firms, vs. 54% in 2015 (FTSE Russell).
- **22% disclose their Scope 3 emissions**, which represent 75% of their total emissions (CDP, 2023).

Transition plans lack precision

- **3,960 companies supported the TCFD in 2022**, seven times more than in 2018 (571) (TCFD, 2022).
- **2,079 "science-based" emissions reduction targets validated** by the STBi in 2022 (28 in 2015), out of 4,230 committed companies. 136 "net-zero" strategies validated (SBTi, 2023).
- **0.4% transition plans judged credible**. Financial planning, science-based targets, and net-zero strategies were lacking (CDP, 2023).
- **27.6/100** is the average score of company transition plans evaluated using the methodologies of the Assessing low-Carbon Transition® initiative set up by Ademe and the CDP (WBA).

Booming carbon markets shifting towards nature-based solutions

- **475 MtCO_2e of carbon credits put on the market in 2022**, the equivalent of Brazil's CO_2 emissions. 55% financed renewable energy projects, and 17.6% financed the elimination of CO_2 in 2022 (World Bank, 2022).
- **$1.3 billion "nature-based" carbon credits exchanged in 2021**, 20 times more than in 2016, way ahead of renewable energy credits. This success comes up against questions concerning the integrity of emissions avoidance credits (Ecosystem Marketplace, 2022).

FURTHER READING

TRENDS

- The Net Zero Target: The Voluntary Carbon Market enters a new dimensions (2022)
- As it surges ahead, the ESG market seeks to standardise transparency norms (2022)
- Regulation: From China, to Europe, taxonomies are increasing the transparency of financial markets (2022)
- From Big Oil to Big Power? At the heart of the renewable energy boom, oil producers are dreaming of a low-carbon future (2021)
- With PPAs, businesses and cities are securing the production and supply of low-carbon electricity (2021)

CASE STUDIES

ALSACE • Towards a Made-in-Europe production of low-carbon lithium with the EuGeLi project (2022)

ANGERS • EnergieSprong, an industrialized zero energy renovation project, a lever for mass uptake (2022)

THE OBSERVATORY'S BLOG

- Non-financial reporting standards: What impact on corporate climate accountability? (2023)
- UNFCCC Secretariat Recognition and Accountability Framework for non-party stakeholder climate action: What's to be expected? (2023)

TRENDS
COMPANIES

On the road to net zero, businesses have found the compass but not the map

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In the space of a few years, carbon neutrality has become the polestar of corporate climate action. The spate of commitments that followed the signature of the Paris Agreement was succeeded by a phase to reinforce reporting frameworks, progress measurement, and credibility assessments of low-carbon transition plans. Over and above accusations of greenwashing, companies aim to demonstrate a genuine capacity to reduce the carbon footprint of their business model, in line with the most ambitious scenarios. But a close look at their transition plans and real-life performances reveals that they still have a long way to go.

"Net Zero", the new buzzword of business commitment

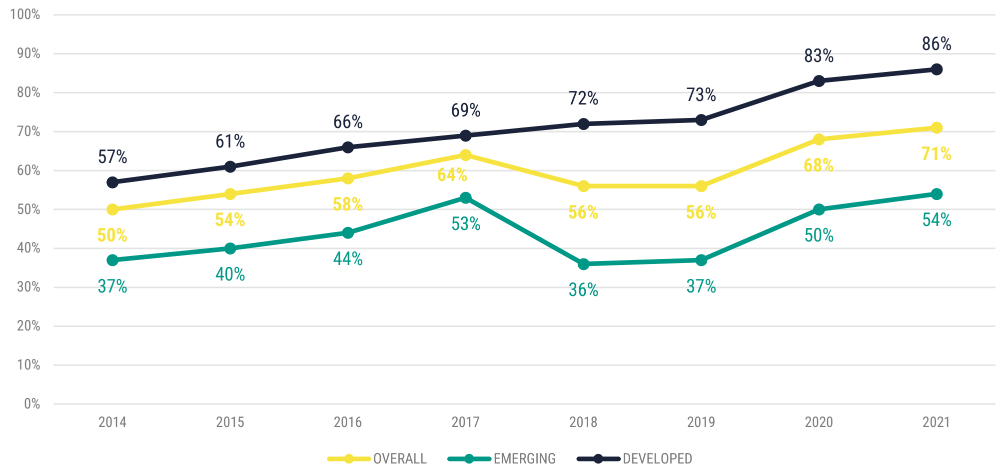
8,307 businesses have joined the Race to Zero campaign since it was launched in 2021 by the High-level Champions of COP25 and COP26. More than other actors, financial and non-financial corporations have gradually taken on the principle of "carbon neutrality", both as the ultimate target of their emissions reduction strategies, and as the narrative framework of their transition, which often forms the foundation of their growth strategy. Reaching carbon neutrality (or climate neutrality) means bringing net CO_2 emissions down to zero – in other words the quantity of emissions released must be equal to the quantity removed from the Earth's atmosphere. To achieve this, actors need to activate three levers: avoid emissions; reduce the flux of greenhouse gases (GHGs) sent into the atmosphere; and remove carbon from the atmosphere with natural carbon sinks (forests, oceans) or technological sinks (direct carbon capture from the air, carbon capture and storage at the point of production, etc.).

Companies have applied this target of stabilizing global emissions to the scale of their businesses, under the label "net zero", usually coupled with the pathway of limiting global warming to 1.5 °C above pre-industrial levels. **Of the 2,000 biggest listed companies in the world, 929 had established a net zero objective in June 2023, compared to 417 in December 2020, according to the annual report published by Net Zero Tracker.**[1] The movement has even been picked up in some of the highest-emitting sectors, like mining[2] and European oil majors, which by positioning themselves as energy service companies, have made carbon neutrality part of their growth and diversification strategies (**CF. "ELECTRICITY" TRENDS**).[3] Yet only 4% of the 929 companies with a net zero target fulfil Race to Zero basic requirements, according to Net Zero Tracker. This raises the question of the quality of the targets and transition plans behind business commitments. Although no standard system exists to measure, monitor and assess companies' progress, a detailed analysis of numerous reports and studies makes it possible to identify the trends underway since the signature of the Paris Agreement.

FIGURE 1

RECENT PROGRESS IN CLOSING THE DISCLOSURE GAP

Source: Climate Chance based on data from FTSE Russell



Beyond commitments, monitoring remains unclear and actual performance is mixed

The principle of measuring emissions is understood but not yet widespread

Measuring and publishing corporate emissions is the cornerstone for building any decarbonization strategy. Since 2015, clear progress has been made in the area of "operational" emissions (Scopes 1 & 2), but measurements of emissions related to the value chain (Scope 3) are still very patchy.

71% of the 4,000 member companies of the FTSE All-World index, which covers 98% of investable market capitalization, published their operational emissions in 2021, compared to 54% in 2015 (**FIGURE 1**).[4] The more capitalized a company is, the more frequent its disclosure practices (**FIGURE 2**). A high number of so-called "developed" businesses in Europe disclose their operational emissions (92%), far ahead of Chinese companies (42%), which release few statistics (**FIGURE 3**). The proportion of data disclosure is more uniform when it comes to sector of activity: the standard deviation is only 12 points between utilities (76%) – the same level as energy companies – and businesses in the technology sector (62%) (**FIGURE 4**).

In 2022, 99% of the 18,600 companies that disclosed to the reporting platform CDP communicated their Scope 2 emissions, 71% for Scope 1, and only 22% for Scope 3.[a] Yet on average Scope 3 emissions represent 75% of corporate emissions; up to 80% for oil and gas companies for example, and 99% for financial ones.[5] In addition, barely 14% had their emissions verified by a third party[6] (**FIGURE 5**).

Even in countries where accounting and reporting of emissions is now mandatory, companies sometimes fail to ensure regular, precise monitoring of their emissions. In France, for example, companies with more than 500 employees have been required to published their carbon footprint since 2012. Yet in 2021, only 43% of them had actually transmitted their carbon footprint to the French Agency for Ecological Transition (Ademe).[7]

a CDP does not verify the quality of data or their credibility, but instead refers to the responses to questions that companies answer on a voluntary basis.

FIGURE 2

SHARE OF COMPANIES DISCLOSING THEIR SCOPE 1 & 2 EMISSIONS IN 2021 IN THE FTSE ALL WORLD INDEX, BY SIZE

Source: Climate Chance based on data from FTSE Russell

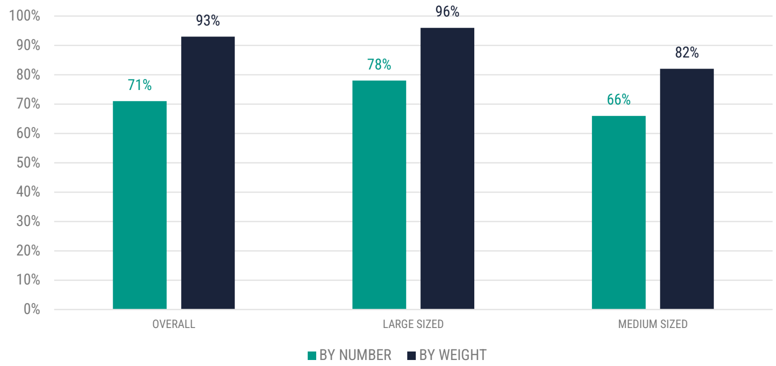
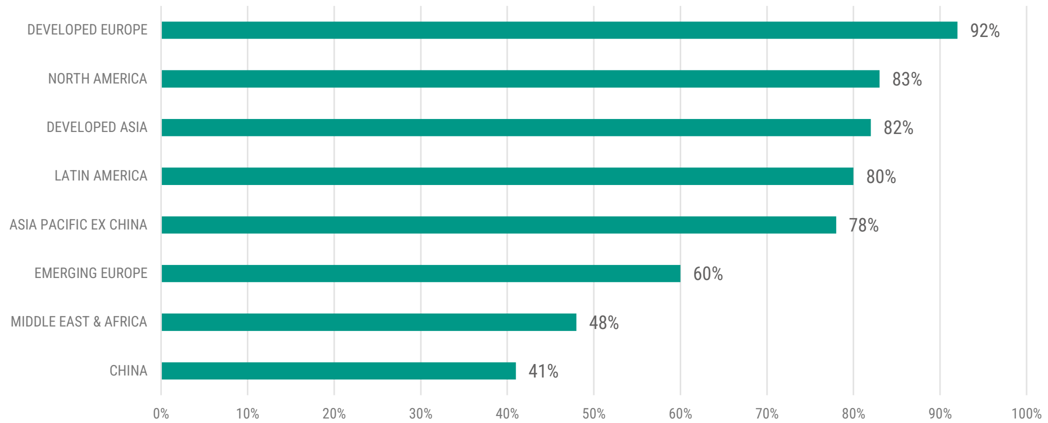


FIGURE 3

ONLY DEVELOPED EUROPE SHOWS A DISCLOSURE RATE ABOVE 90%

Source: Climate Chance based on data from FTSE Russell



COMPANIES

FIGURE 4

CARBON-INTENSIVE SECTORS SHOW A HIGH DISCLOSURE RATE

Source: Climate Chance based on data from FTSE Russell

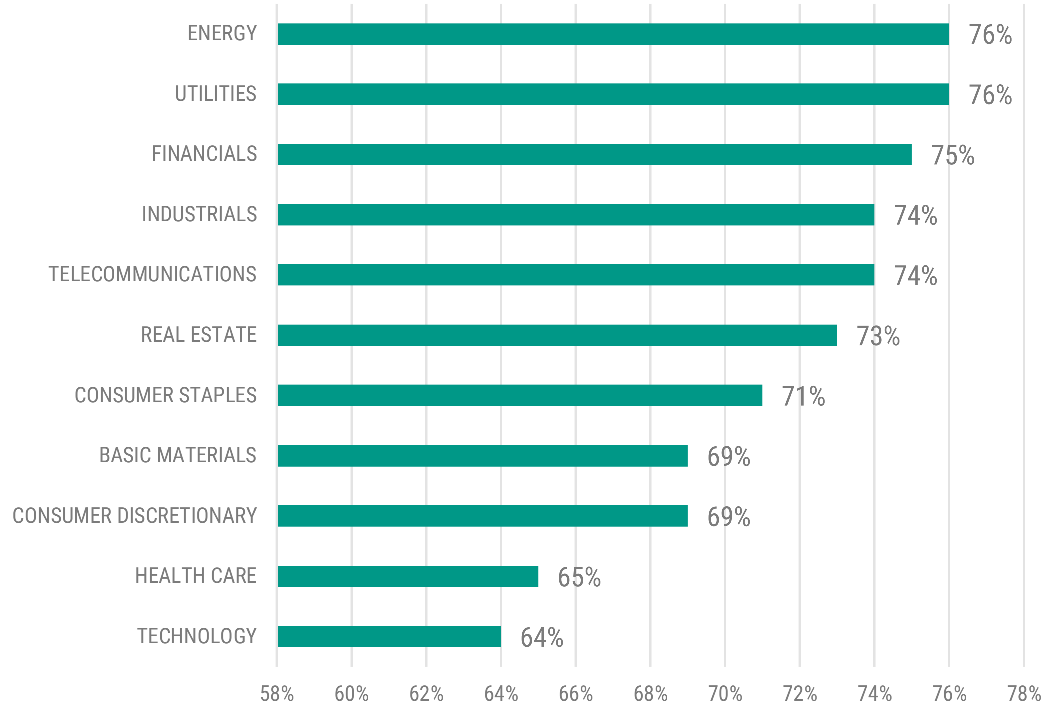


FIGURE 5

ACCOUNTING OF SCOPES 1, 2 AND 3, WITH VERIFICATION

Source: CDP, 2023

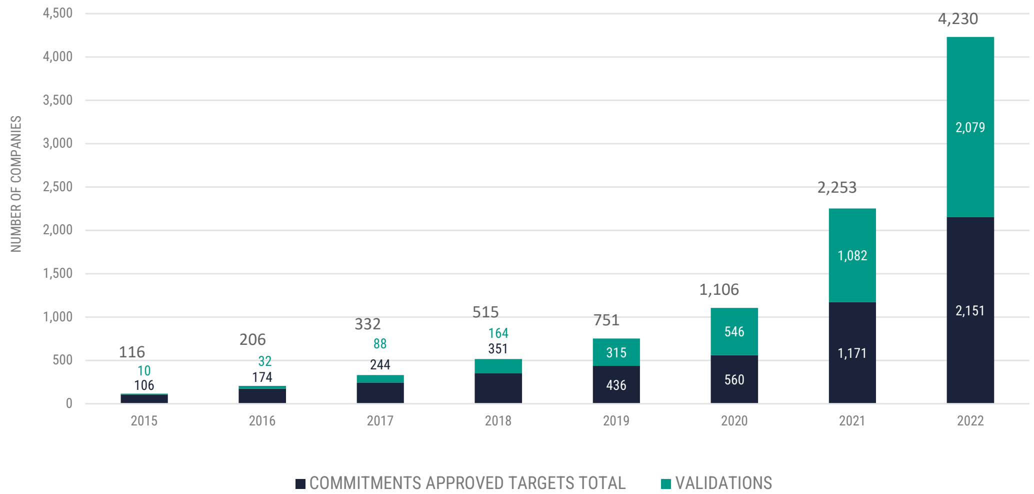
Credibility of targets on the rise

The number of companies requesting validation of their emissions reduction targets from the Science-Based Target initiative (SBTi)[b] has rocketed in recent years, from 28 in 2015 to 4,230 in December 2022 (**FIGURE 6**). Currently, 34% of the global economy, expressed in market value, has made a commitment to the SBTi. The targets set by 2,079 companies have received science-based validation, in other words aligned with the 1.5 °C or 2 °C objectives established in the Paris Agreement, based on SBTi methodology. Europe alone is home to 54% of the committed, validated companies. Service companies (1,320) make up the biggest share, far ahead of energy companies (85) which take last place. 53% of businesses with a validated SBT reported their progress on all of their targets in 2022, compared to 45% in 2020.[8]

FIGURE 6

CUMULATIVE ANNUAL NUMBER OF COMPANIES SETTING AND VALIDATING TARGETS, 2015 – 2022

Source: Science-based Target initiative, 2023



In October 2021, the SBTi launched the "Corporate Net-Zero Standard" (CNZS), which is the first standard in the world to help businesses set their own "net zero" targets aligned with the 1.5 °C and 2 °C objectives in the Paris Agreement. The standard is based on four principles: 1) prioritize rapid, deep emission reductions with near-term targets (-50% by 2030); 2) set long-term targets (-90% by 2050); 3) offset residual emissions; 4) finance carbon reduction beyond the value chain. A company is only considered to have reached net-zero when it has achieved its long-term science-based target and "neutralized" its residual emissions.[9]

In late December 2022, 136 organizations had fulfilled the first two criteria and received "science-based" certification for their net-zero targets, including 38% (52) small and medium-sized enterprises, for which the SBTi applies a specific methodology. Nevertheless, a report by the NewClimate Institute and Carbon Market Watch, focused on 22 multinationals from a range of sectors and validated by the SBTi, esteemed that in early 2023 the established targets only resulted in a median reduction of 15% between 2019 and 2030, and that only five companies presented a deep reduction target by 2050.[10] Yet according to the IPCC, limiting the temperature increase to 1.5 °C above pre-industrial levels will require a 43% reduction of emissions by 2030 compared to 2019, and 84% by 2050.[11]

b The SBTi is an organization that drives science-based greenhouse gas emission reduction targets and net-zero strategies by private actors (companies, financial institutions). With the backing of expert committees, it defines assessment criteria and provides technical support to committed companies.

COMPANIES

FIGURE 7

ACT AND JUST TRANSITION SCORES OF COMPANIES FROM DIFFERENT SECTORS - *Source: Data from WBA, 2023*

			SCORE								
SECTOR	NUMBER OF EVALUATED COMPANIES	YEAR OF EVALUATION	TOTAL (/100)			ACT (60% of the total score)			SOCIAL AND JUST TRANSITION (40% of the total score)		
			AVERAGE	MEDIAN	MAX	AVERAGE	MEDIAN	MAX	AVERAGE	MEDIAN	MAX
OIL & GAS	99	2023	15%	14%	56%	13%	8%	67%	19%	16%	65%
BUILDINGS	50	2023	20%	17%	50%	27%	21%	78%	10%	9%	28%
TRANSPORT	50	2022	21%	19%	48%	27%	24%	72%	11%	11%	31%
AUTOMAKERS	30	2021	-	-	-	34%	29%	71%	-	-	-
ELECTRIC UTILITIES	50	2021	-	-	-	37%	27%	96%	-	-	-

Long road ahead to make transition plans credible

At a global scale, less than 0.4% of businesses have put forward a credible transition plan. These are the results of the CDP assessment mentioned above, which were obtained from responses to a questionnaire answered by over 18,600 companies around the world. Of these, 4,100 stated that they had developed a transition plan corresponding to a 1.5 °C pathway. However, only 81 businesses were able to reply to the 21 key indicators that featured in the 2022 version of the questionnaire, which is fewer than in 2021 when 135 companies met with requirements, despite the fact that 40% more companies responded to the questionnaire in 2022. The companies that responded turned out to be particularly inefficient in terms of planning the financing of their transition plan (3%), setting science-based targets (4%), and establishing net-zero strategies (7%). Performances were better for identifying risks and opportunities (33%) and setting up governance for the transition (24%).

How does the CDP establish that a transition plan is credible? In its technical note, which describes the questionnaire method, the CDP states that its definition of a "climate transition plan" is 100% aligned with the ACT – Assessing low-Carbon Transition® methodology, an initiative jointly launched with Ademe in 2018. ACT evaluates the credibility of the transition plans presented by businesses in comparison with International Energy Agency scenarios. More than 407 companies have been evaluated by ACT and received scores across three dimensions:

- A Performance score, measuring alignment with the transition scenario (1 to 20)
- An Assessment score, reflecting the overall quality of the transition plan (E to A)
- A Trend score, measuring anticipation of future transformations (+, - or =).

The World Benchmarking Alliance (WBA) uses the ACT methodology to rate businesses with a score out of 100, weighted since 2022 based on the quality of low-carbon transition plans (60%), and just transition and social indicators (40%). Taken overall – notwithstanding the specific features of each sector, which are subject to a particular methodology, and changing methodologies over the years – the scores obtained by companies primarily highlight inadequate just transition and social policies (**FIGURE 7**). The climate transition plans evaluated using ACT are of a slightly higher quality, although still well below average (27.6%). No obvious correlation can be made between these two categories, meaning that the climate leaders are not necessarily the best placed when it comes to a just transition, and vice-versa.

The average scores are much higher than the median scores, indicating that a handful of companies pull up the average in each sector. This is the case for the electricity company Ørsted, which received a score of 96/100 for its low-carbon transition plan, mostly thanks to a deep decarbonization target for its operational emissions (-98 % by 2025), and its business model and investments centred on renewable energy.

A comparison of sectoral benchmarks identifies recurrent shortfalls in corporate climate transition plans, which coincides with the CDP analysis: targets to reduce operational emissions (Scopes 1 & 2) not aligned with the IEA's 1.5 °C scenario, few intermediate targets punctuating the trajectory, inadequate financial planning for the transition, very few analyses backed by scenarios, and a lack of vision to transform companies' economic models.

Monitoring and measuring impact over time: a mirage in a data desert

Since the Paris Agreement, followed by the launch of the Marrakesh Partnership for Global Climate Action, numerous researchers have attempted to evaluate *ex ante* the potential impact of mitigation by non-state actors. In 2019, one study for example estimated at 1.2-2 $GtCO_2e$/year the reduction potential of individual commitments put forward by non-state actors (businesses, cities and regions) in the ten biggest emitting economies.[12] But how much progress has really been made? *Ex post* research of *real* results obtained by actors on their targets is almost inexistant, due to low-quality data and disparate accounting and reporting practices.

In June 2023, a study published in the journal *Nature Communications* produced results on a small sample. In 2015-2019, the 102 high-revenue companies studied (listed on the Forbes 500 index), which were committed to the SBTi and the RE100 initiative, had reduced their Scope 1 and 2 emissions by 35.6% compared to their reference level of 808.7 $MtCO_2e$.[c] The 63 businesses that had set absolute reduction targets with the SBTi had reduced their emissions by 7.8%, exceeding their objectives of 34 $MtCO_2$. However, the authors point out that 75% of companies provide low-quality monitoring data (i.e. little verification by third parties, no indication about the supply of renewable energy, etc.). As a result, 86% of the total reduction observed can be attributed to only eight companies in the "electricity production" and "energy-intensive industry" sectors.[13]

Reporting frameworks designed for financial markets come up against conservative resistance

To offset the weak monitoring and evaluation practices of the companies observed above, several private organizations and public institutions have attempted to devise standards in order to encourage or oblige businesses to report credible, comparable environmental, social and governance (ESG) data. Given that companies would on average require four CEO mandates to reach "zero net emissions", according to a calculation made by the Financial Times and S&P Global,[14] the stability of reporting frameworks is crucial to guarantee long-term follow-up on progress made.

The search for financial stability drives non-financial reporting rules

Since 2015, financial authorities have mainly been behind the standards established for corporate ESG reporting. Created in 2015 at the initiative of the Financial Stability Board (FSB) of the G20, the Task Force on Climate-related Financial Disclosure (TCFD) makes recommendations to economic and financial actors on disclosure practices to measure their exposure to climate risks and opportunities. The task force also advises that they compare their current activities and future strategies with climate scenarios, including at least one low-carbon scenario. Applying these recommendations is voluntary: **in October 2022, the TCFD recorded 3,960 "supporters",[d] which is seven times more than in 2018 (571).**[15]

At the start of the 2020s, new non-financial reporting standards were released. The new IFRS Foundation standards, developed by the International Sustainability Standard Board (ISSB) since COP26, are private and voluntary, and a response to the request to standardize non-financial reporting frameworks[16] made by the G20 and the International Organization of Securities Commissions (IOSCO), which brings together the world's securities regulators. In terms of climate, the IFRS requires the publication of a transition plan, a resilience analysis, a set of metrics (Scope 1, 2 & 3 emissions, low-carbon investment expenditure, etc.), and targets with figures. Their scope of application depends on whether they are adopted by national financial regulators wanting to refer to them to establish regulations: this is the case, for example in Australia[17] and for the Hong Kong stock exchange.[18]

In the United States, it was also the financial market authority, the Securities and Exchange Commission (SEC), that proposed a regulation obliging listed companies to publish their greenhouse gas emission levels (Scopes 1 & 2), and have them audited by a third party. US and foreign firms registered with the SEC would also publish an annual emissions reduction plan. Currently, the regulations oblige companies to publish Scope 3 emissions only if they are considered to be "material" or are part of the company's mitigation targets. They are not necessarily subject to evaluation by a third party and protected from all legal responsibility. Companies would also establish a decarbonization plan and a calendar. The adoption of the text, which has been postponed several times,

c Which is a little less than emissions from Indonesia in 2022 (823.5 $MtCO_2$), the 6th global emitter, according to Enerdata statistics.

d TCFD "supporters" are organizations that have publicly expressed their support for the TCFD recommendations by filling in a form on the TCFD website.

is not expected before autumn 2023.[19] The State of California is in the process of adopting its own bill obliging all firms generating over $1 billion turnover to publish their Scope 1, 2 and 3 emissions.[20]

The European Commission is also reinforcing its standardized reporting framework on corporate ESG data. The Corporate Sustainability Reporting Directive (CSRD) came into force in January 2023, and extends the obligation for ESG reporting from 11,000 to 50,000 companies. This is the third pillar of the European Union's strategy for financing the transition to a sustainable economy which is part of the European Green Deal, along with the Sustainable Finance Disclosure Regulation (SFDR) on non-financial reporting by investors, and the Green Taxonomy, which precisely defines the list of activities judged to be "green" or "brown". The ESRS (European Sustainability Reporting Standards) adopted by the Commission in August 2023 comprise over 80 disclosure requirements, bringing together over 1,000 data points.

By clarifying the definitions of "green" and "brown" investments in the bond market, financial taxonomies are a way of identifying the share of corporate activities that are compatible and aligned with precise environmental targets. Fifteen taxonomies have been adopted around the world, 29 are being developed, and eight are under discussion, according to the Climate Bonds Initiative. In 2012, China began working on a green taxonomy, and in 2015 adopted a green bond catalogue, known as the "Chinese Green Bond Taxonomy". The Association of Southeast Asian Nations (ASEAN) adopted then updated its own taxonomy in 2021,[21] followed by Thailand in 2023.[22] In Europe, companies above a certain size are now obliged to evaluate and publish the alignment of their activities with the EU taxonomy.

"Materiality", the Gordian knot of corporate climate accountability

The TCFD recommendations, IFRS standards and SEC rules have another thing in common: they identify pertinent data based on "simple materiality", which is only financial. In accounting terms, "materiality" means relevant information to include in corporate reporting. Financial materiality consists in evaluating the risks and opportunities of the environment/climate change for a company's financial performance. In contrast, impact materiality evaluates the economic, environmental and social impacts of a company for all stakeholders.[23] Depending on the type of materiality, reporting has two different objectives: the stability of financial markets (financial materiality), and corporate accountability (impact materiality). "Double materiality" is when reporting frameworks apply both of these approaches. When aligned to financial materiality only, reporting standards are driven by shared confidence in market discipline and investors' capacity to make rational, self-determined decisions based on the information available.

Unlike the three frameworks mentioned above, the European Union's ESG (ESRS) disclosure rules are subject to legislative work by political institutions within the community. After making them dependent on the principle of "double materiality", the European Commission then backtracked and granted companies more freedom in assessing the materiality of some data, such as measuring Scope 3 emissions. Initially intended to be mandatory, transition plans on biodiversity are now voluntary.[24] This easier application has without doubt facilitated convergence with the other international standards, but has resulted in a scaled-down ambition and reduced consistency with the other EU standards, according to observers.[25]

This backtracking corresponds to an "anti-ESG" outcry, particularly in the USA since the early 2020s. In the West Virginia v. Environmental Protection Agency decision dating from June 2022, the US Supreme Court esteemed that state agencies, like the EPA and the SEC, must obtain approval from Congress to create environmental rules with major economic and political impacts.[26] In May 2023, the leader of the movement, governor of Florida Ron DeSantis, signed into law a bill aimed at preventing state officials from investigating the ESG impact of public expenditure, and prohibiting ESG bond sales.[27]

Booming carbon offsets in search of integrity

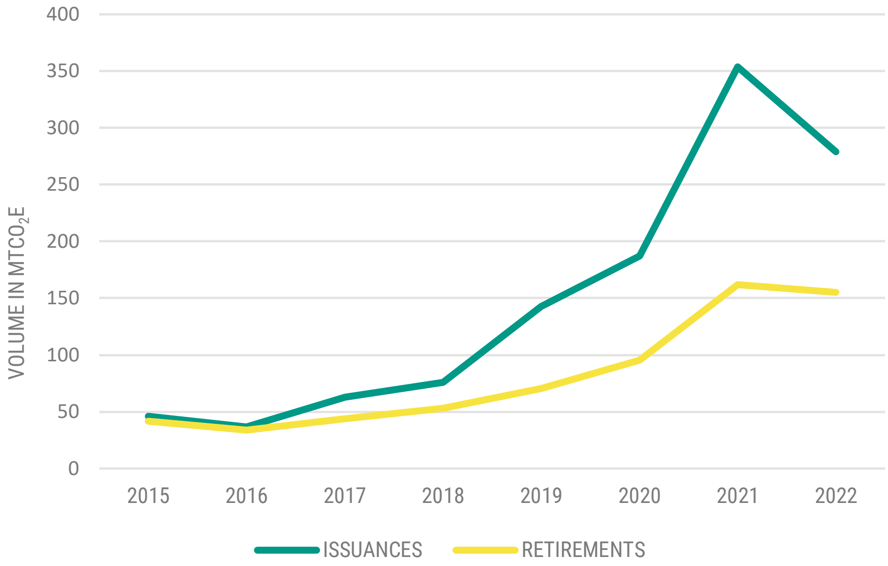
Although available studies show that companies have more or less integrated the issue of reducing their operational emissions (Scope 1 & 2) through decarbonizing their electricity supply (**CF. "ELECTRICITY" TRENDS**), converting their company car fleets (**CF. "TRANSPORT" TRENDS**) and carrying out energy renovations of offices and production sites (**CF. "BUILDINGS" TRENDS**), Scope 3 reduction and avoidance actions, which are generally not measured, are significantly rarer. Given this situation, emission offsets through the purchase of carbon credits on voluntary markets has boomed in recent years. The voluntary carbon market is designed to act as a new instrument to direct private funding towards action to avoid, reduce or remove carbon while giving firms the possibility of offsetting their carbon emissions: 90% of companies questioned in Europe and the USA said they planned to use the system to offset their unabated emissions.[28]

On the supply side, new carbon credits issued in 2022 amounted to an estimated 475 $MtCO_2e$[e] (-22% compared to 2021), according to the World Bank. They are mostly made up of credits certified by private organizations for "offsetting" purposes (58%) – *e.g.* Gold Standard, Verra and Plan Vivo – followed by credits issued under the Clean Development Mechanism (CDM) of the Kyoto Protocol (32%), and credits issued under domestic regulations (10%). 55% of new credits are issued to finance renewable energy installation projects. However, the steady drop in the cost of these technologies over more than a decade (CF. "ELECTRICITY" TRENDS) does not guarantee any real additional financing through carbon credits: the growth of the renewables market means that the projects would have seen the day with or without credits.[29]

FIGURE 8

ISSUANCES AND RETIREMENTS OF CARBON CREDITS, 2015-2022

Source: Climate Focus, 2023



Nature-based Solutions (NbS) constitute one-third of new credits certified by private organizations (93/279 $MtCO_2$), just behind renewable energy credits (35%), according to Climate Focus.[30] Two-thirds of these NbS credits are projects to *avoid* emissions, to prevent deforestation or land conversion. Credits aimed at financing the *elimination* of CO_2 via reforestation, afforestation, improved forestry practices, or the restoration of wetlands (27.6 $MtCO_2$) in reality only make up 30% of NbS credits, and therefore 17.6% of the total credits put on the market in 2022. Afforestation and reforestation activities nevertheless constituted half of new projects registered for certification in 2022, while the credibility of counterfactual scenarios employed to measure "avoided emissions" has been challenged by several critical studies in 2023.[31, 32] The Integrity Council for Voluntary Carbon Markets (IC-VCM), an initiative dating from COP26, has published a series of "Core Carbon Principles", a "meta standard" that should serve as a common denominator for certification methods in view of promoting high-quality, transparent carbon credits.[33]

On the demand side, 196 million credits were "retired" in 2022 – in other words, counted in the carbon footprint of a company, which can no longer put the credit on the market and sell it. This is a slight annual drop (-1.3%), but the figure remains much higher than in previous years. 52% of retired credits relate to renewable energy projects (44% in 2021), among the cheapest on the market. However, NbS credits are worth more: their transaction volume increased twenty-fold from 2016 ($0.067 billion) and 2021 ($1.328 billion), way ahead of renewable energy

e Which is the equivalent of the CO_2 emissions of Brazil in 2022 (475.3 $MtCO_2$), the world's 13th biggest emitter according to data published by Enerdata.

projects ($0.479 billion in 2021).[34] The average prices of different types of credit exchanged on the market, based on the cost of implementing the projects and consumer preferences, have followed a double downward and converging trend in recent years. Elimination credits and projects with joint social benefits or biodiversity benefits are particularly sought after.[35] The surplus that ultimately results from the gap between supply and demand for carbon credits is likely to drive down their value; but it also reflects a certain financialization of the voluntary carbon market, with the emergence of numerous intermediary players who buy credits without retiring them in order to increase their value on resale (**FIGURE 8**).

Carbon offsets are attractive to companies because they can ultimately claim that they or their activities are "carbon neutral". Yet the relevance of this notion applied at the scale of a product, event, organization, or even a state, is debateable.[36] before it extended the definition, for a long time the IPCC restricted carbon neutrality to a planetary scale. To counter unjustified, ill-founded claims, the European Union is preparing draft regulations prohibiting the use of "carbon-neutral", "green" and "eco-responsible" declarations for 2026.[37] In June 2022, the Voluntary Carbon Markets Integrity Initiative (VCMI) presented a "Claims Code of Practice", recommending certification of the SBTi's Net Zero standard, the purchase of mitigation credits beyond an organization's value chain, and the use of quality credits.[38]

COMPANIES

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LOCAL GOVERNMENTS

Nº 9 At the heart of innovation and climate action, local public policies seek to scale-up in order to reach 2030 targets

- Cities signatory to the Covenant of Mayors in Europe have, according to reported data, reduced emissions beyond their average targets for 2005 to 2020, in line with EU targets.
- The mobilisation of cities is growing significantly in Latin America and Sub-Saharan Africa. In Europe, adaptation planning is improving in quality.
- Around the world, the analysis of real progress by local governments is met with a lack of data that is credible and coherent over time. In Europe, the average gap between two municipal inventories equals the length of a mayor's mandate in France – six years.
- Several cities are rendering permanent the resilience measures that were taken during the pandemic, like the roll-out of cycling infrastructure. Subnational regions play a central role in ensuring the just transition of coal-dependent areas.

KEY FIGURES

Local governments committing for the climate

- **12,800+ signatories** of the Global Covenant of Mayors for Climate and Energy, representing 1.1 billion+ people (GCoM, 2023).
- **1,136 cities and 52 regions** among signatories of the Race to Zero initiative (UNFCCC, 2022).
- **2,336 jurisdictions** in the world have declared a "climate emergency" (Cedamia, 2023).
- **1.3 billion people** in 1,500 cities covered by renewable energy targets and policies (REN21, 2022).

Reporting and monitoring in need of standardization

- **862 distinct jurisdictions** have published emissions figures at least once through CDP (CDP, 2022).
- **58% (503 out of 862)** of them disclosed their emissions at least twice, permitting their monitoring (*ibid.*).
- **2-3 years** is the average gap between accounting and reporting years of cities reporting to CDP (*ibid.*).
- **6 years** is the average gap between two inventories of CoM-EU cities (JRC, 2022)

Europe: A general downtrend in emissions

- **41% of the 10,800+ current signatories** have renewed their targets for 2030 or 2050 (JRC, 2022).
- **-25.3% emissions** from 1,851 cities between 2005 and 2020, above the average target of -22.7% (*ibid.*).
- **320 low-emission zones (LEZ)** in Europe in 2022, vs. 228 in 2019 (Azdad, 2023)
- **1,500 cities (1.3 bn people)** have set targets policies in favour of renewables globally (REN21, 2022)

FURTHER READING

REPORTS

GLOBAL SYNTHESIS REPORT ON LOCAL CLIMATE ACTION – 2018, 2019, 2021, 2022

CASE STUDIES

BOBO-DIOULASSO • The development of a SEACAP after signing up to CoM SSA (2022)

ATHENS • A whole department of the municipality dedicated to developing resilience (2022)

SCOTLAND • Linking climate action and the SDGs (2022)

DANNIEH • Using the SEACAP as a climate finance instrument (2022)

MANCHESTER • A local carbon budget for the city (2021)

MEXICO CITY • MERCI-CO2, an example of atmospheric accounting of emissions (2021)

NOUAKCHOTT • The AREDDUN project for resilience and adaptation (2019)

Local governments: Commitment and action are advancing, but monitoring of progress lags behind

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The confluence of economic activities and greenhouse gas sources in urban areas, along with their vulnerability to climate change, has highlighted the key role played by local levels in climate action. Although cities and regions began strengthening their commitments even before the Paris Agreement, in particular through international cooperation networks and initiatives, monitoring the progress made thanks to these commitments remains complex. Reporting on common platforms like CDP has made considerable progress since 2015, and become increasingly standardized over time as more and more cities join the "transparency wave". Nevertheless, the wide range of accounting methods, the time it takes to prepare inventories, and the irregularity of available emissions data make it hard to follow the global impacts of action.

Increasing commitment through networks and initiatives

More than 50% of the world's population live in cities, generating 67% to 72% of global greenhouse gas (GHG) emissions in 2020, compared to 62% in 2015. These emissions are mainly the result of fossil energy combustion in buildings, transport and other urban infrastructures.[1,2,3] With their hubs of economic activity, built-up areas, and dense housing, cities concentrate intense climate change vulnerabilities.[4] Cities and regions are also on the front line of climate action, since they are where public policies are ultimately implemented.

Even before the signature of the Paris Agreement, cities around the world started to formulate commitments and set up mitigation and adaptation plans, either voluntarily or because required to do so by legislation. Sometimes, they are helped by international cooperation networks and initiatives that support the exchange of best practices between cities, pool resources and knowledge, and even provide technical or financial support to local decision-makers. **In 2016, over 200 national and international city networks already existed, 29% of which had an explicitly environmental vocation**.[5] Although local community networks have existed for 800 years, they have mushroomed since the 20th century. They include general city networks like United Cities and Local Governments (UCLG), and networks specializing in environmental issues like ICLEI and C40 Cities, and their common initiatives featuring thousands of signatories, like the Global Covenant of Mayors for Climate and Energy (GCoM). The same impetus can be found in other local and sub-national jurisdictions (federated states, regions, provinces, etc.), led by networks like Regions4 and initiatives like the Under2 coalition.[6]

The Global Covenant of Mayors for Climate and Energy and its regional branches currently count more than 12,800 signatory cities, representing over 1.1 billion inhabitants (or 13% of the global population).[7] Added together, their commitments could lead to a potential emissions reduction of 4.1 $GtCO_2e$ in 2050[8] and make their territories more resilient to climate change. 1,136 cities and 52 regions feature among the 11,309 signatories of the Race to Zero initiative led by UN Climate Change High-level Champions aiming to reach "net zero" by 2050. The Race to Resilience initiative, which aims to "*increase the resilience of four billion people living in vulnerable communities by 2030*", counts 1,762 members, including cities and regions encouraged by the Covenant of the Mayors and the RegionsAdapt initiative, which brings together 70 regional governments from around the world to adapt to climate change.[9] Since 2019, 2,336 jurisdictions in the world have declared that they are in a "climate emergency", including 40 states. In total, over one billion people were covered by this kind of declaration in September 2023. The biggest number of declarations come from the United Kingdom (592) and Quebec (525), far ahead of South Korea (228) and the United States (203).[10]

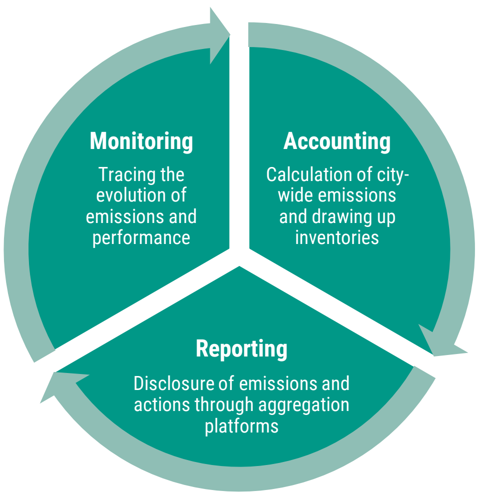
While regions featuring more recent networks and initiatives have seen a steep rise in commitment (especially the Covenant of Mayors in Latin America and the Mediterranean), regions where commitment was already high are now slowing down. According to the 2022 assessment by the European Covenant of Mayors carried out by the European Union Joint Research Centre (JRC),[11] 59% of the 10,800+ current signatories (44% of the population covered by the initiative) have committed to mitigation targets for 2020, and have still not renewed their mitigation and adaptation targets for 2030 or 2050.

A brief analysis by the Global Observatory of Climate Action of the data reported by over 1,500 cities from 2015 to 2022, publicly available on the CDP-ICLEI Track[a,b] platform, gives a more detailed overview of the increasing commitment and action of cities through evolving practices in the different phases of their "transparency cycle" (**FIGURE 1**).

FIGURE 1

THE TRANSPARENCY CYCLE OF CITIES' CLIMATE ACTION

Source: Climate Chance



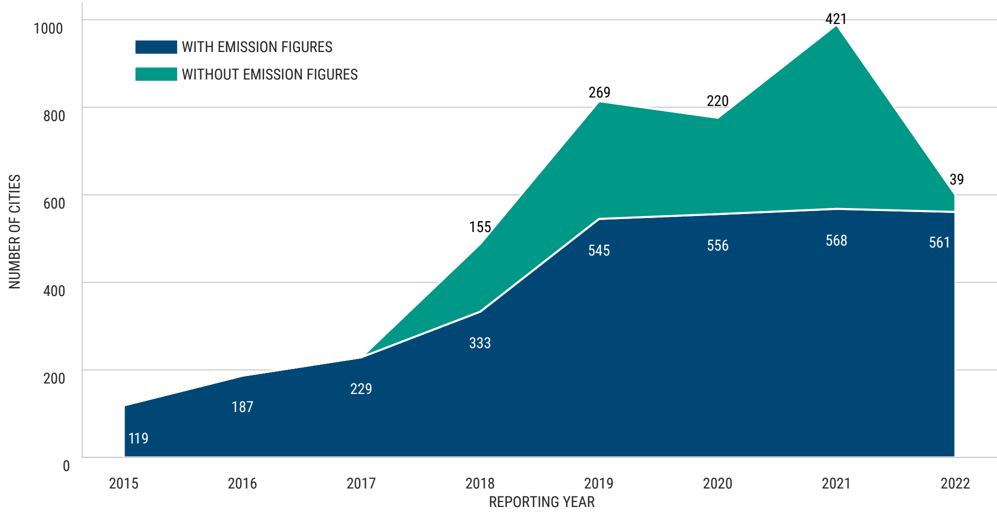
a Founded in 2003, CDP is a "*is a not-for-profit charity that runs the global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts*" (cf. Focus on CDP, Local Action Report 2022).

b These data were extracted from the "Citywide Emissions" database for the years 2015 to 2022, on the CDP "Open Data portal', in March and April 2023.

FIGURE 2

NUMBER OF CITIES RESPONDING TO THE QUESTIONNAIRE, WITH AND WITHOUT EMISSIONS FIGURES

Source: Climate Chance, based on data from CDP-ICLEI Track



The data challenge: lacking standardization, the monitoring of progress stands on shaky foundations

Reporting: cities join the "transparency" wave

In 2022, 600 distinct jurisdictions responded to the CDP[c] questionnaire, compared to 119 in 2015. The CDP Cities questionnaire is a reporting tool designed for the disclosure of data related to the risks and opportunities facing cities related to climate, water, and forests. The questionnaire brings together statistics reported by cities involved in different international cooperation networks and initiatives, including but not limited to:

- CDP, via the CDP-ICLEI Track platform, a common, shared reporting system run since 2019 with ICLEI, an international network of cities committed to sustainable development.
- C40, an international network of almost 100 cities representing one twelfth of the world's population and 20% of the global economy.
- The Global Covenant of Mayors (GCoM), the biggest alliance of cities and local governments in the world acting for the climate, based on the guidelines of the Common Reporting Framework (CRF).

Every year, CDP draws up an "A-List" of the most transparent cities – giving a score of a "A" to those that responded best to the questionnaire, totalling 122 cities in 2022[12] – but it does not publicly analyse the information behind the figures. The CDP in fact analyses the smallest common denominator of all the cities, *i.e.* their capacity to provide answers to the questionnaire, whatever the method employed or the quality of the data disclosed. A close examination of the data reveals some key facts.

From 2015 to 2022, 1,527 distinct jurisdictions replied to CDP's annual questionnaire at least once. Of those, a little more than half (862) published their emissions figures at least once on the CDP platform (FIGURE 2).[d] 58% (503 out of 862) of these cities reported their emissions at least twice, making it possible to follow the evolution of their emissions over at least two years; only 15% disclosed their data at least six times from 2015 to 2022. The situation is similar in Europe: out of a total 6,200 European and Mediterranean cities that have signed the Covenant of Mayors disclo-

c "Distinct jurisdiction" here designates each entity that responded to the Cities questionnaire. These, rarely, include two sets of responses for the same "city" – from the municipality, metropolitan council or a bigger agglomeration, a county, etc.

d The data featured here include cities that provided quantified items in their responses to questions on emissions – stating more than zero for at least one emissions category – and not cities that declared the existence of an inventory. A city that does not disclose quantified emissions does not necessarily have no inventory – it may simply not be publicly available, or the figures may not be declared due to a lack of reporting capacity.

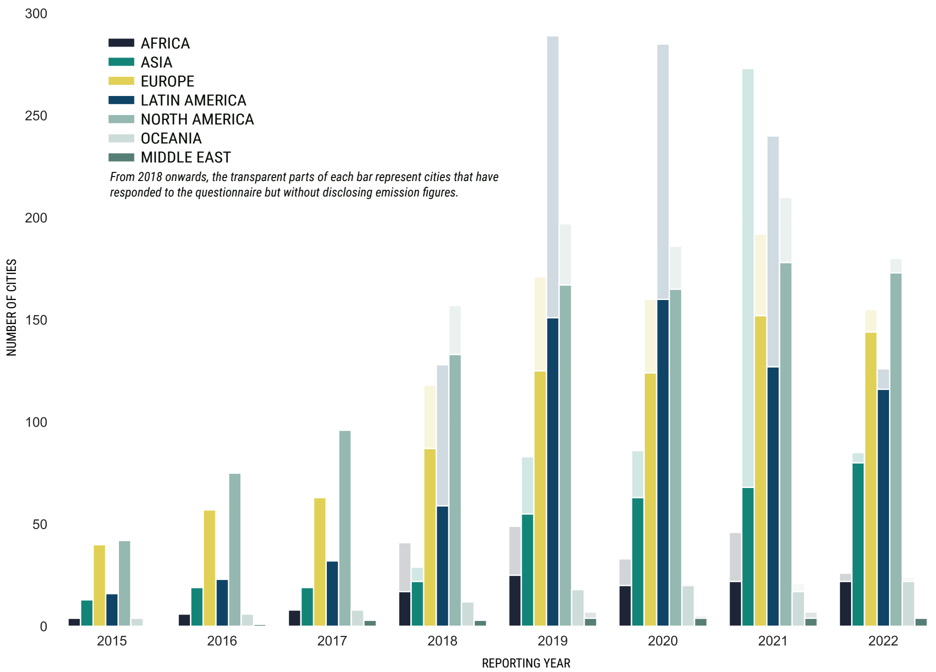
sing on the "My Covenant" platform of the European Covenant of Mayors, only 30% (1,845) had produced a baseline inventory and a monitoring inventory.[13]

North American cities rank first, with the highest number of disclosures each year, and most of them also publish their emissions figures (**FIGURE 3**). European cities also have high disclosure rates on the CDP platform – with general figures very close to the Americas. Nevertheless, the European Covenant of Mayors, which has been established the longest and has over 10,400 signatories (81% of 12,800+ signatories of the global covenant), has its own member disclosure platform – MyCovenant[14] – featuring the emissions inventories, climate-energy plans, policies and key actions established by cities.

FIGURE 3

REGIONAL DISTRIBUTION OF CITIES THAT DISCLOSE TO CDP

Source: Climate Chance, based on data from CDP-ICLEI Track



Latin American cities, which have been very active since 2019 – due to increasing local involvement and the international activity of national and regional city networks[15] – present high declaration levels, but relatively few emissions inventories. Asian cities have a relatively low disclosure rate, which can be explained by less involvement in international networks – which does not mean a lack of action. In Africa, Oceania and the Middle East, the number of cities that disclose remains very low, despite increasing involvement in regional covenants of mayors.[16] It is therefore worth stipulating that regional differences in disclosure practices do not necessarily mean a lack of commitment from some cities compared to others, but can also reflect different sizes, technical and financial means, or a different approach to participating in international cooperation spaces.

Emissions accounting: methodological convergence hides heterogeneous practices

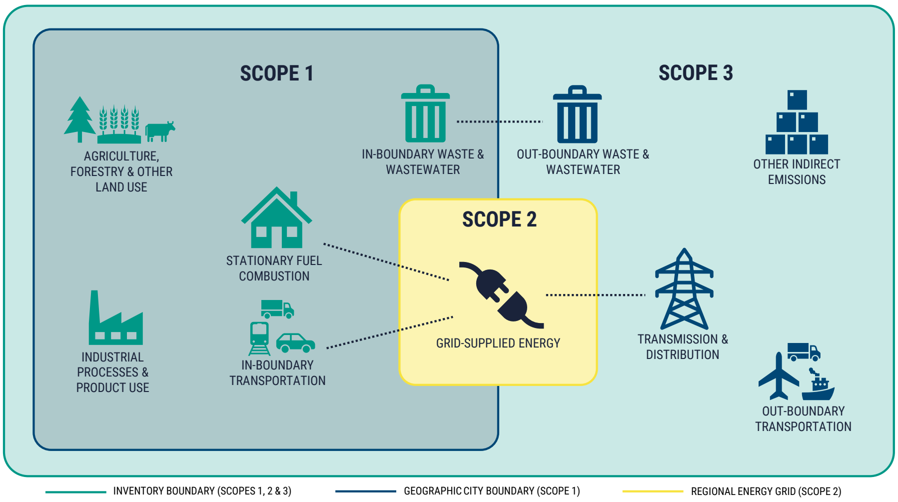
Calculating the greenhouse gas emissions of a territory, whether a state, region or city, provides authorities with strategic input to direct their short- and long-term mitigation efforts. Emissions accounting is both a tool to steer public policies based on solid data and a political instrument that provides greater transparency and accountability towards citizens and the international community. This makes it a cornerstone of international cooperation in the frame of the Paris Agreement.

Currently, statistical accounting is the most widespread method used to measure emissions. In a territorial approach, this involves drawing up an inventory of direct emissions produced by activities within the administrative or geographical borders of a territory (Scope 1), which can be associated with indirect emissions related to electricity produced outside the territory used for its production activities (Scope 2). Cities taking a so-called "global" approach, can also measure emissions produced by or for the territory beyond its borders (Scope 3) (**FIGURE 4**).

FIGURE 4

DEFINITION OF SCOPES FOR CITY INVENTORIES

Source: Global GHG Protocol for Cities, 2021

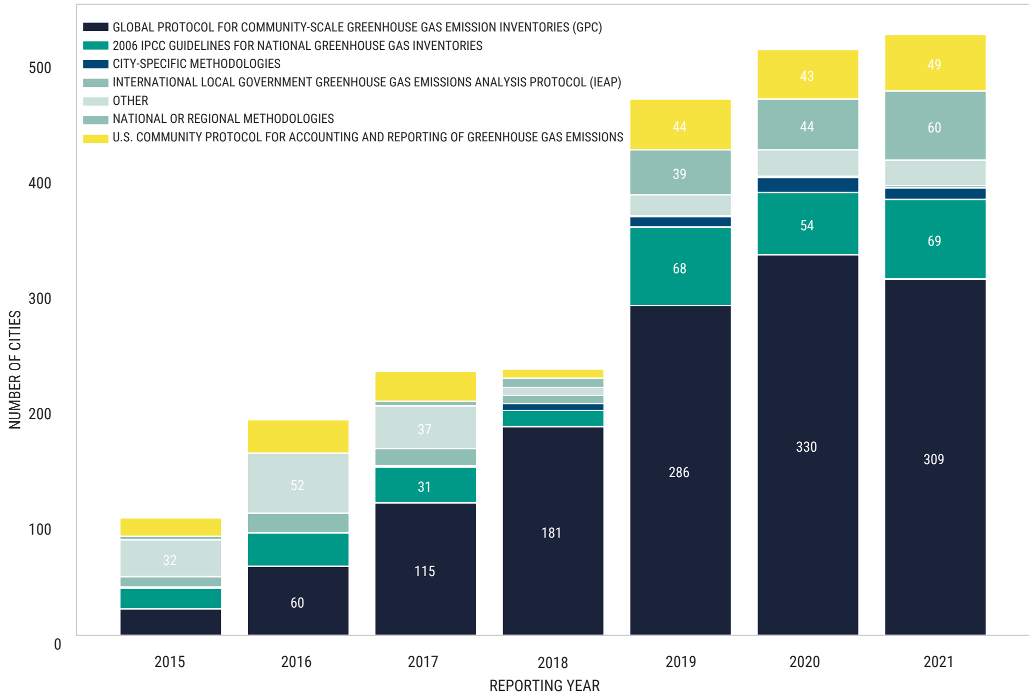


An analysis of CDP reporting reveals the very disparate methods employed by cities that have disclosed their inventories. In 2015, the breakdown was extremely heterogeneous, with no methodology used significantly more on a global scale. Over the years, the "Global Protocol for Community-scale Greenhouse Gas Emission Inventories" (GPC), produced by the World Resources Institute, C40 and ICLEI, has emerged as the most popular – GPC represented 22.5% of inventories in 2015, 78% in 2018, and 59% in 2021. Although its relative share has diminished since 2018 due to increased reporting using national methodologies, the absolute number of cities using GPC increased up to 2020 (**FIGURE 5**).

FIGURE 5

SHARE OF DIFFERENT ACCOUNTING METHODOLOGIES, 2015 -2021

Source: Climate Chance, based on data from CDP-ICLEI Track



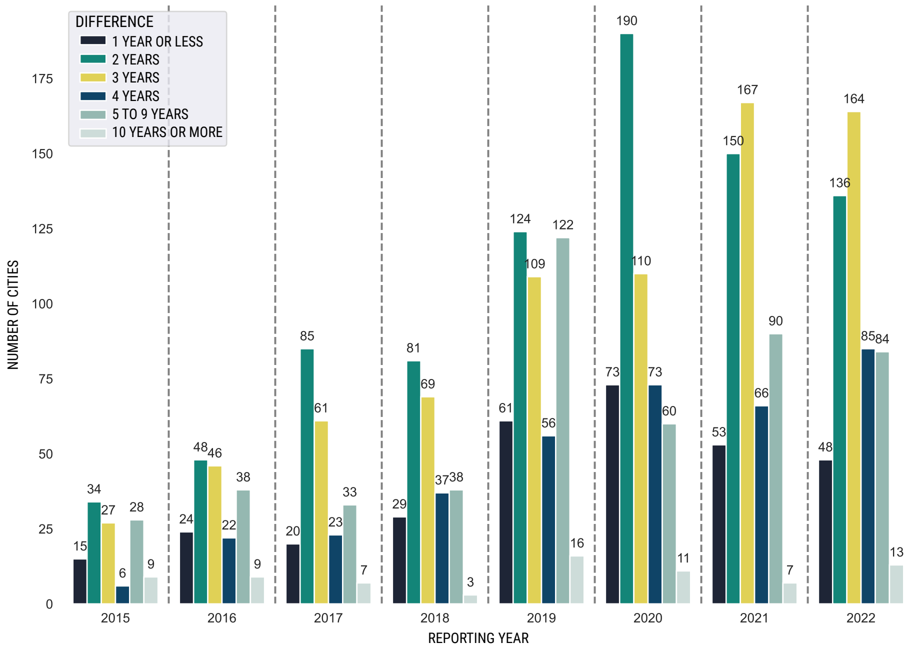
Apart from the existence of several methods, the practice of calculating emissions using inventories raises several challenges in itself. **The first difficulty that cities encounter is that of "under-reporting"**. Statistical accounting of emissions is based on the capacity of authorities to gather data on activities in their territory and on the existence of emission factors adapted to the local context. Consequently, the reliability of inventories can be highly variable. Studies using ground-based sensors and satellite observations of urban emissions have revealed differences with data declared by cities using statistical methods, in general involving an under-estimation by local governments. For example, the results of a recent study comparing the voluntary inventories of 48 of the 100 highest-emitting cities in the United States with national public databases revealed that the cities interrogated had under-estimated their CO_2 emissions related to fossil fuels by 18.3%.[17]

The second difficulty encountered by cities is the "border issue". "*Cities house 50% of the world's population but only represent about 3% of the land mass, which means that they have to externalize a high number of emissions beyond their borders*".[18] For this reason, a territorial approach to emissions (Scopes 1 & 2) does not sufficiently reflect the emissions embodied in imported goods and services. For example, in 2019, a C40 report estimated that the emissions based on the consumption of 94 of the biggest cities in the world already amounted to 10% of global GHG emissions (4.5 $GtCO_2e$), while their total emissions based on production in 2017 were 2.9 $GtCO_2e$. These emissions are mostly hidden in territorial inventories since 85% of emissions related to goods and services consumed in C40 cities are generated beyond city borders.[19]

FIGURE 6

TIME LAG BETWEEN INVENTORY YEAR AND REPORTING YEAR

Source: Climate Chance, based on data from CDP-ICLEI Track



Lastly, an examination of the inventories reveals a time lag between the publication of statistical inventories and the year of observation. Taking into account all cities that disclosed their emissions on the CDP platform, there is an average gap of about two years between the year of the inventory and that of reporting for the period from 2015 to 2019, and a three-year gap in 2021 and 2022 (**FIGURE 6**). According to a JRC study, on average, the last emissions inventory presented by cities committed to the 2020 targets of the European Covenant of Mayors dated from 2014, which is the length of a municipal term of office in France. This underlines the time lapse between declaration practices and the drawing-up of policies.[20]

This gap can still be observed in countries that have made emissions inventories mandatory for cities. In France, 20% of large cities, 66.6% of regions, and 51% of *départements*, which have been required to publish an emissions inventory since 2011, had not yet done so in 2022.[21] Since the monitoring process is therefore incomplete (or out of sync), it is difficult to compare the progress made in relation to the targets and to evaluate the costs and advantages of implementing climate plans – as observed in the case of cities that have signed the European Covenant of Mayors.[22]

Uneven data make monitoring difficult

From 2015 to 2022, several cities among those that produced two inventories or more used different reporting formats over the years, changed accounting methodologies, modified their accounting scopes, or incorporated or withdrew some data categories, etc. These fluctuations make it harder to monitor their individual progress, and even more difficult to aggregate the statistics in order to understand the real contribution to mitigation and adaptation efforts made by local and regional governments.

The few studies that have attempted to do so at regional level – mainly in Europe – provide encouraging results. **The 2022 assessment of the European Covenant by the JRC observes that the reduction of emissions obtained by 1,851 cities with commitments for 2020 accompanied by an action plan and at least two inventories, amounted to an average 25.3% between 2005 and 2020 – a higher result than the average reduction target of 22.7%**. However, an examination of more ambitious commitments for 2030, based on a set of data available for 415 cities, showed that, on the basis of progress made up to now, the reduction of emissions by 2030 is following a trajectory 13.7% below the average city target. In both cases, the results are highly contingent, given the lack of consistency of aggregated data. These figures are in fact compiled without considering the time boundaries of reference and monitoring inventories provided by cities: they therefore feature inventories documenting the evolution between 2005 and 2020 as well as results obtained from 2010 to 2016.

Action is making headway despite difficulties monitoring progress

Mitigation: municipal influence on all fronts

The 2022 assessmentof the European Covenant showed that, in EU-27 cities, 56% of emissions in reference inventories came from buildings, 30% from transport, and 15% from industry. In cities outside the EU, the share generated by industry and waste processing was sometimes higher. Regarding the mitigation measures indicated by cities, 49% concerned the building sector, 21% waste management, 16% transport, and 8% local electricity production. On a global scale, the data communicated by cities to the Global Covenant of Mayors in their annual reporting indicate a similar structure[23]: in all regions in the world, buildings represent the biggest share of measures taken in 2021, followed by waste and transport – with different priorities depending on the region. Cities in Eastern Europe reported a high share of action in industry (**FIGURE 7**).

Another study of 12,000 policies included in 315 monitoring inventories from European cities showed that the most common policies applied to municipal assets and structures.[24] Among the contextual factors that influence policies, population size is the most important: the least populated cities use "municipal self-management" tools (like public procurement, or energy management of public infrastructures and buildings), whereas the most populated ones tend to use more regulatory measures (urban planning, building codes, mobility plans) and financial tools. All cities employ awareness-raising tools.

More precisely, in the energy domain, REN21 identifies about 1,500 global cities that had set up policies or targets on renewable energy production or consumption in late 2021. Renewable sourcing increasingly involves Power Purchase Agreements (PPAs) between the producer and the city. Like in Melbourne (Australia)[25] or London (United Kingdom),[26] this tool initially adopted by companies is increasingly popular with cities (**CF. "ELECTRICITY" TRENDS**). This movement is part of the growing municipalization of electricity supply, also observed in the creation of municipal and participative electricity companies, such as in Cadiz (Spain).[27] Action to combat energy poverty is also a crucial issue for cities, as indicated by the creation of an energy access and poverty pillar in the Covenant of Mayors, with the objective of carrying out a just transition.[28]

This fight against energy poverty is closely linked to energy efficiency measures for buildings, which cities encourage and plan through building codes or renovation requirements (**CF. "BUILDINGS" TREND**), green or cool roof requirements,[29] or district heating and cooling systems.[30] Cities in the global North are focusing more on the energy and thermal efficiency of existing buildings and those under construction - Climate Chance has produced case studies of Vienna (Austria),[31] Rüsselsheim (Germany),[32] and Slavutych (Ukraine).[33] Meanwhile, cities in the Global South extend the issue to include energy access, as highlighted by the Observatory in the cases of Bobo-Dioulasso (Burkina Faso)[34] and Palembang (Indonesia).[35]

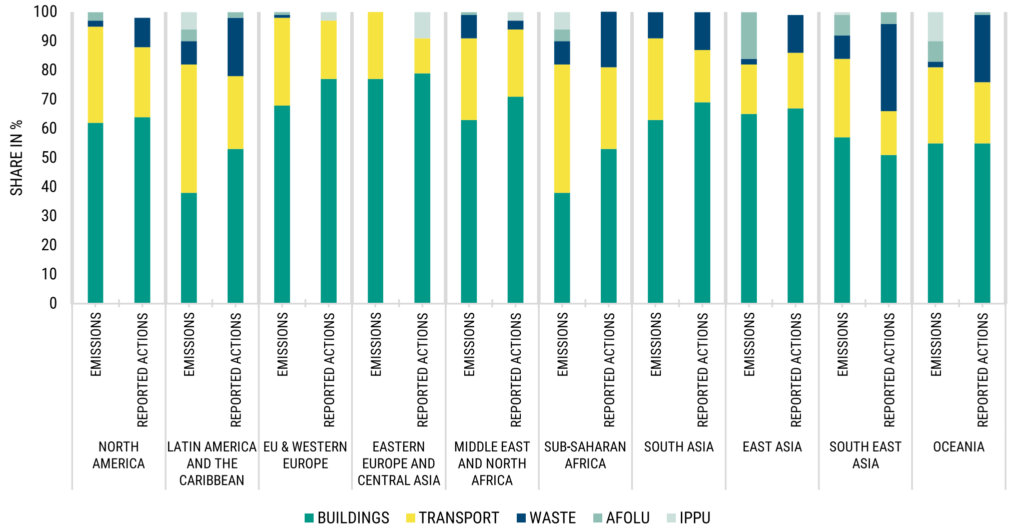
Cities are also rethinking then reorganizing the use of the public space, including in the mobility sector by giving more room to soft mobility,[36] and in land use by increasing green areas. The use of public markets is clear in the transport sector (**CF. "TRANSPORT" TRENDS**), involving cities ranging from Bogota (Colombia) to Mumbai (India), and several others, which are converting their public transport fleets into electric buses, already widespread in China.

Waste management takes different forms depending on the composition of municipal waste and socio-economic contexts. The Climate Chance Observatory has thus identified the policies that encourage composting in São Paulo (Brazil),[37] a general "zero waste" plan (Kamikatsu)[38], and the socio-economic integration of informal waste collectors in Mendoza (Argentina)[39].

FIGURE 7

AVERAGE BREAKDOWN BY SECTOR OF EMISSIONS AND ACTION IN 2021

Source: Adapted from GCoM, 2021



Local governments are better at identifying their weak spots, but still founder in their adaptation planning

While an increasing number of cities identify climate-related risks in their annual reporting (2,021 cities in the Global Covenant of Mayors indicated 14,153 risks in 2022), the proportion of adaptation measures compared to mitigation measures remains relatively low: 16,329 adaptation measures in 2022, compared to 191,055 mitigation measures.[40] Nevertheless, a large number of cross-cutting actions are indicated, which highlights the interconnection of local policies that very often combine adaption and mitigation targets – such as in Athens (Greece),[41] Kigali (Rwanda)[42] and Bariloche (Argentina).[43]

Adaptation measures are very often the starting point of integrating "nature-based solutions" into urban landscapes – with cities introducing elements ranging from parks to mangroves and even artificial reefs along the coastline – aimed at combining climate action with biodiversity.[44] Latin American and African cities have been identified as "*leading the way in redefining the relationship between people and nature in cities in an enduring way.*"[45]

The European Union Adaptation to Climate Change Mission, which aims to develop adaptation pathways at local and regional levels, includes 308 local and regional governments.[46] The regional level is also important when it involves sharing knowledge and resources on adaptation, gathering localities with similar geographic conditions.[47] For the 2021-2022 reporting cycle, 72% of regions reporting as part of the RegionsAdapt initiative had an adaptation plan.[48] The question of adaptation also implies more intersectoral and multi-actor approaches on territories, to plan and establish measures that are suited to the specific local context. This is the case in the United Kingdom, where "place-based" adaptation is gaining ground and concerns around twenty initiatives to date.[49]

The results of a study of 167 European cities shows that the overall quality of adaptation plans of cities in Europe, evaluated according to six criteria, has strongly improved in recent years.[50] The reason behind this increased quality is a combination of "*collective learning through parallel and sequential peer-to-peer transfer of knowledge and capacity building and transnational networks and other types of science-policy collaborations.*"

However, the study also identifies the lack of information on monitoring and evaluation as an obstacle to improving the quality of plans. Unlike for mitigation, it is even more difficult to standardize the definition of targets and monitoring of progress on adaptation without a common measurement unit, and given local contexts and histories that influence risks and resilience.[51] The question has generally received less attention and few attempts have been made to establish systematic monitoring.[52] Moreover, a study of 1,971 indicators taken from the adaptation plans of eleven cities that enumerate indicators and measures showed that precise targets, monitoring calendars, and data sources are rarely defined.[53]

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CIVIL SOCIETY

N° 10 The multifaceted conflicts of civil action on climate feature both legal successes and difficult applications

- Since 2015, civil society has diversified its repertoire of actions and radicalized its positions, multiplying conflicts and leading to contested major infrastructure projects being abandoned (Notre Dame des Landes, Yasuni...).
- Shareholder activism is on the increase, but shareholder-supported resolutions are less likely to win the confidence of general assembly meetings than those tabled by the company's board.
- Use of legal proceedings to challenge a government policy or a company strategy has a high success rate in the courts. On a case-by-case basis, the effectiveness of the implementation of decisions has yet to be assessed.
- The increasingly frequent use of law or legislation to confer rights on nature, ecosystems or animals is gaining in popularity.

KEY FIGURES

Double-edged conflicts for the most vulnerable

- **649 conflicts observed** from 1997 to 2019 on fossil energy projects (371) and low-carbon projects (278) (Temper et al, 2020).
- **15% of contested projects** have been cancelled, suspended, or seen investment withdrawn (*ibid.*).
- **10% of conflicts** have led to the assassination of an activist (*ibid.*), in particular among indigenous communities. 1,910 ecological activists were killed between 2012 and 2023 (Global Witness, 2023).

Shareholder activism pushes corporate ambitions

- **182 resolutions on climate** filed by shareholders at corporate AGMs in 2023 (Ademe, French SIF, 2023).
- **17.4% average approval** of shareholder resolutions at AGMs in 2023, compared to 90% average approval for "Say on climate" board resolutions (*ibid.*).
- **31% of shareholder resolutions** are withdrawn following an agreement with the company, with the formulation of an emissions or offset target, or a transition plan (*ibid.*).

Rise in legal action since 2015

- **2,341 climate litigation cases** observed from 1986 to 2023; 2/3 were filed 2015 onwards. 9 cases in 10 were pursued by NGOs last year, mostly in the Global North (LSE, 2023).
- **55% of decisions** made were favourable to the climate (*ibid.*).
- **457 "ecological jurisprudence" initiatives** listed in 44 countries in 2022 (since 1969); +130% compared to 2015 (198). 75% aim to grant rights of nature to an ecosystem or animals (Kauffman, 2023).
- **70% of ecological jurisprudence initiatives** are adopted; only 16% are rejected (*ibid.*).

FURTHER READING

TRENDS

- Rights of nature as a bastion against the destruction of natural ecosystems (2022)
- "Yes, in my backyard!" Under pressure, international competition for strategic minerals required for the energy transition intensifies (2021)
- Community forestry in Central Africa: Still a fragile sustainable forest management model (2021)

CASE STUDIES

GEORGIA • Gender-sensitive energy cooperatives in rural areas (2022)

ULAANBAATAR • An ecosystem for the thermal insulation of precarious housing (2021)

PARIS GOOD FASHION • Making Paris the capital of sustainable fashion (2021)

TRENDS
CIVIL SOCIETY

From legal action to civil disobedience: the multifaceted conflicts of climate governance are reshaping the action of civil society

ANTOINE GILLOD • Director of the Global Observatory of Climate Action, Climate Chance

The signature of the Paris Agreement in 2015 opened a new phase in climate governance, less centred on negotiations between the Parties and more focused on a call for action and performance from those responsible for its implementation. The proliferation of climate governance spaces outside institutional United Nations spheres, coupled with a new repertoire of civil society contention have led to a more "conflictual" relationship between activists and decision-makers. The trend is illustrated through three movements observed since 2015: the politicization of climate activism through civil disobedience, a growing demand for corporate accountability, and collective action through legal disputes.

Civil disobedience, an assertive politicization of the fight against climate change

The increasing attention paid to non-state action on climate since the signature of the Paris Agreement has "*opened new struggle fronts and shifted [climate movements] away from the UN process as the only avenue for mobilization*".[1] Climate activism has undergone two major changes due to this shift over the last seven years. On the one hand, the repertoire of contention has moved beyond "expert" science-based forms that tend to inspire and influence public action through institutional avenues (lobbying, advocacy, etc.). In adopting strategies of civil disobedience and mass mobilization, climate movements have reshaped environmental action, while remaining firmly rooted in the fertile breeding ground of political and social struggle. These new forms of action mark the second change: an increasing politicization of some militant environmentalist viewpoints, tying up with feminist, antiracist and anti-capitalist narratives or with grassroots struggles against infrastructure plans or power installations.

In late 2018, the emergence of the public figure Greta Thunberg saw the start of a wave of "climate strikes" initiated by youth organizations like Fridays for Future and Youth for Climate. These demonstrations proliferated throughout the world, with no local protest base, and with the aim of calling out public powers and inciting them to take action. The highpoint came in 2019, when up to 250,000 demonstrators gathered in New York, and 2,500 events were identified in 117 countries in September.[2] These mass mobilizations had an immediate negative impact on the stock prices of the biggest emitting companies in Europe,[3] and saw a spike in web searches on climate change.[4] These exceptionally large, fairly conventional mobilizations have become a matter of course at international meetings: 100,000 people descended into the streets of Glasgow in the lead up to COP26.[5]

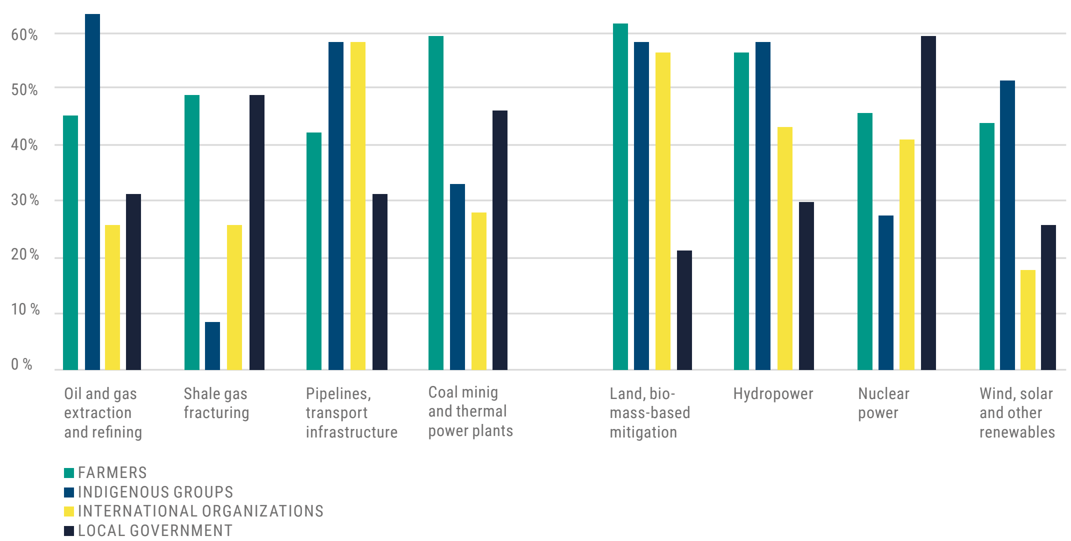
The increasing use of non-violent civil disobedience has opened up more conflictual forms of expression to put pressure on actors. The creation of Extinction Rebellion (XR) in October 2018 in the United Kingdom, which spread to 87 countries through 1,022 local groups, has drawn the biggest numbers and media attention, and inspired the creation of other movements.[6] In 2020, 1,000 scientists gathered under the banner of Scientist Rebellion to make a new call for civil disobedience.[7] Established tools of ecological and social struggles like destruction of property, blockades and sabotage, have gradually been mobilized *for the climate*, taking new spectacular forms or borrowed from former social movements: soup thrown on Van Gogh paintings by Just Stop Oil in October 2022, happenings at sports events (like Wimbledon and the Tour de France), blockades at the headquarters of companies attending their general assemblies, etc. These actions mainly target fossil energy companies. Every year since 2015, Ende Gelände for example organizes a blockade at coal mines in Germany, rallying militants throughout Europe; in October 2016, five members of the group Climate Direct Action, aka the "Valve turners", simultaneously shut five pipelines in the USA. After four years of existence, XR UK nevertheless decided to put "public disruption" into the background and instead "*prioritise attendance over arrest and relationships over roadblocks*".[8]

With what outcome? In July 2023, the *Global Atlas of Environmental Justice* platform listed 3,900 cases of past and present environmental conflicts since 1975. Out of **649 conflicts related to fossil energy infrastructures (371) and low-carbon installations (278) identified from 1997 to 2019 in 106 countries, 104 (16%) were either cancelled, suspended, or subject to an investment withdrawal**.[9] Projects for oil and gas infrastructures and mines are more resilient to opposition because they depend on fixed, localized resources. However, coal and nuclear power plant projects are more frequently cancelled and suspended because they can be moved elsewhere. Controversial solar and wind power projects are more likely to be suspended than cancelled. Rural inhabitants (involved in 71% of cases) and indigenous peoples (58%) are overrepresented in these conflicts, while only 5% of projects are considered to be urban (**FIGURE 1**).

FIGURE 1

MOST FREQUENTLY MOBILIZED ACTORS BY TYPE OF CONFLICT

Source: Temper et al., 2020

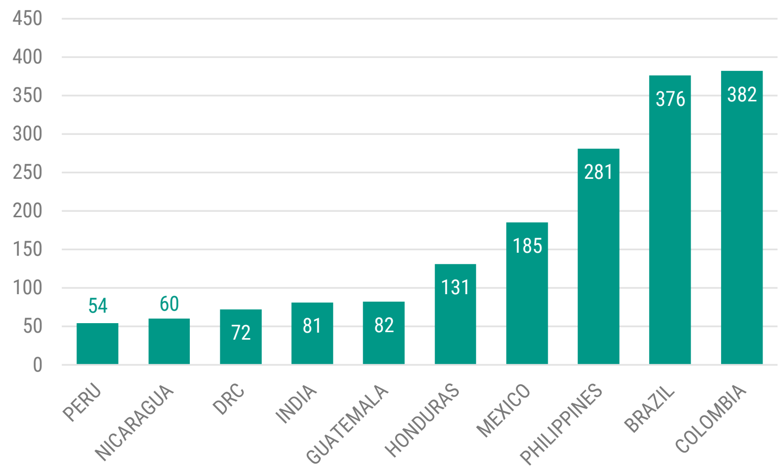


Since 2015, opponents to energy and mining projects have made significant victories. After a decade of opposition, Joe Biden blocked the permit granted to the Keystone XL pipeline in June 2021.[10] In January 2022, the Serbian government finally revoked Rio Tinto group's operating licence to open one of the world's biggest lithium mines in the Jadar River Valley.[11] Plans to develop lithium mines by Savannah Resources in Portugal, in a region classed as part of the World Agricultural Heritage,[12] or Thacker Pass in the United States,[13] have also met with local opposition, at a time when nations are looking for ways to reduce their dependence on imports of strategic metals for the transition (lithium, nickel, cobalt, rare earths, etc.). The trend clashes with the mineral sovereignty policies of economies implementing the energy transition (**CF. "INDSUTRY" TRENDS**). In France, the scrapping of the airport project at Notre-Dame-des-Landes in 2018, after more than 45 years of legal battles and ten years of occupation of the land by activists, marked a decisive turning point in the history of local struggles in the country, inspiring by new movements such as the *Soulèvements de la terre* (Earth uprisings).

One-third of the 649 energy conflicts mentioned above have led to a repressive response or a form of criminalization, and 10% of the cases studied ended up with the assassination of an activist. According to the authors, oppositions against fossil and renewable energy projects are similarly intense. According to the NGO Global Witness, **1,910 environmental activists were killed from 2012 to 2023**, with a peak in 2020 (227 deaths). The victims included journalists, park rangers, and members of indigenous communities, with the vast majority of the murders taking place in the Global South, and half in Latin America. Brazil, Colombia, the Philippines, Mexico and Honduras are the countries most at risk (**FIGURE 2**). Thirty-six percent of victims recorded in 2022 were from indigenous communities residing in low-income countries.[14]

FIGURE 2

ENVIRONMENTAL ACTIVISTS KILLED BETWEEN 2012 AND 2022 - *Source: Global Witness, 2023*



Companies are now the target of anti-corporate activism... and shareholder activism

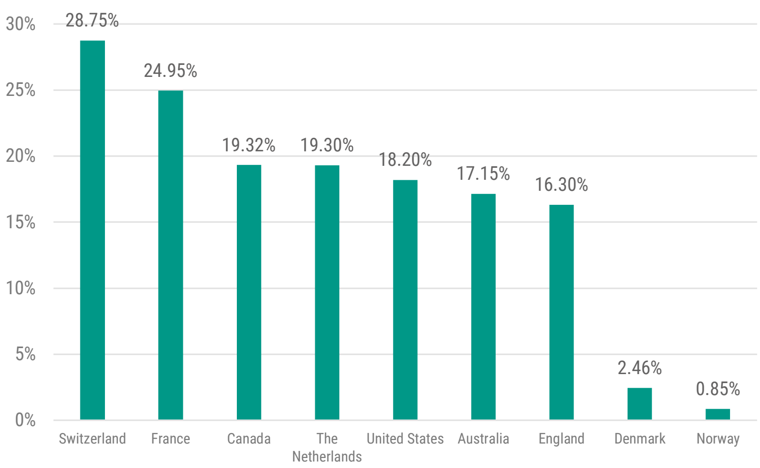
The Paris Agreement shifted the climate action regime towards a "pledge and review" style of governance: ambitious, global targets are set (pledge) to which the signatory Parties voluntarily contribute through regularly reviewed, flexible commitments (review). Consequently, the latitude given to actors to contribute to global targets has generated high expectations from the private sector.[15] This new pressure on corporate commitment comes from both outside and inside organizations.

The main objective pursued by "anti-corporate" activism, which comes from the outside, is to attack companies' value, by proposing alternative *valuations*, for example looking at environmental damage or the violation of human rights caused by economic activity.[16] "Name and shame" is a particularly widespread practice. The comic "Fossil of the Day" ceremonies organized by the Climate Action Network at the COP, or the ratings of banks connected to fossil fuel industries produced by Reclaim Finance participate, to different extents, in putting pressure on actors by exposing their poor or insufficient environmental performances to the general public. The expected impact is not necessarily to shift the company's strategy itself, but rather to create media attention and public awareness, and influence legislation, according to sociologist Sophie Dubuisson-Quellier. While some studies have analysed the impacts and motivations of name and shame against states,[17] few analyses provide proof of how efficient this strategy is against companies.

FIGURE 3

AVERAGE APPROVAL RATES OF SHAREHOLDER RESOLUTIONS FOR THE CLIMATE IN 2023, BY COUNTRY

Source: Ademe, French SIF, 2023



Unlike "name and shame" practices, shareholder advocacy aims to maintain a company's value by influencing its decisions from the inside, maintaining shareholder dialogue throughout the year and proposing resolutions at general assemblies. No known source has reported an aggregated analysis of global trends but in 2023, Ademe and the French Sustainable Investment Forum started to gather and analyse the statistics.[a] **Of the 182 shareholder resolutions related to the climate recorded in the world in 2023, the average approval rate was 17.4%**, with only one resolution adopted, by Coterra Energy. Approval rates vary from one country to another (**FIGURE 3**). In contrast, the number of "Say on Climate" resolutions made by corporate managements, which dropped from 48 in 2022 to 23 in 2023, obtained an average approval rate of 89.9% globally.[18] Most shareholder resolutions are filed in the United States and Japan. In 2023, 193 shareholder resolutions on the environment were put to the vote at the AGMs of the 3,000 biggest US companies (Russell 3000 index), an increase since 2022 (172). Of these resolutions, the vast majority (138) related to the company's climate policy: 80 concerned the reduction of GHG emissions, of which 23 called for Scope 3 reporting and/or objectives; 60 environmental resolutions were withdrawn following agreement with the company, and 89 were put to the vote; only 2 obtained a majority.[19]

A low level of favourable votes is not necessarily a sign that a resolution has failed; on the contrary, companies increasingly tend to seek prior agreement with shareholders to avoid a vote at the AGM. Of the 256 shareholder resolutions on climate identified by Ceres in 2023,[b] 79 were withdrawn after an agreement was reached with the company. In 55% of cases, these agreements related to the formulation of an emissions target or of a transition plan, offsets, or a combination of the above.[20]

Climate-related litigation sees success in court but limited application

Collective action by civil society began to make greater use of the law and climate litigation starting from 2015. Of the **2,341 climate lawsuits recorded in the Sabin Center Climate Change Litigation Database from 1986 to May 2023**, almost two-thirds (1,557) were opened after 2015. Undeniably, the signature of the Paris Agreement has had an accelerating effect (**FIGURE 4**).[21] The large majority of these lawsuits are filed in the Global North, increasingly by NGOs (90% in the twelve months leading up to June 2022). Historically, governments (national and sub-national) have been the main target. However, since 2021, lawsuits increasingly involve companies.

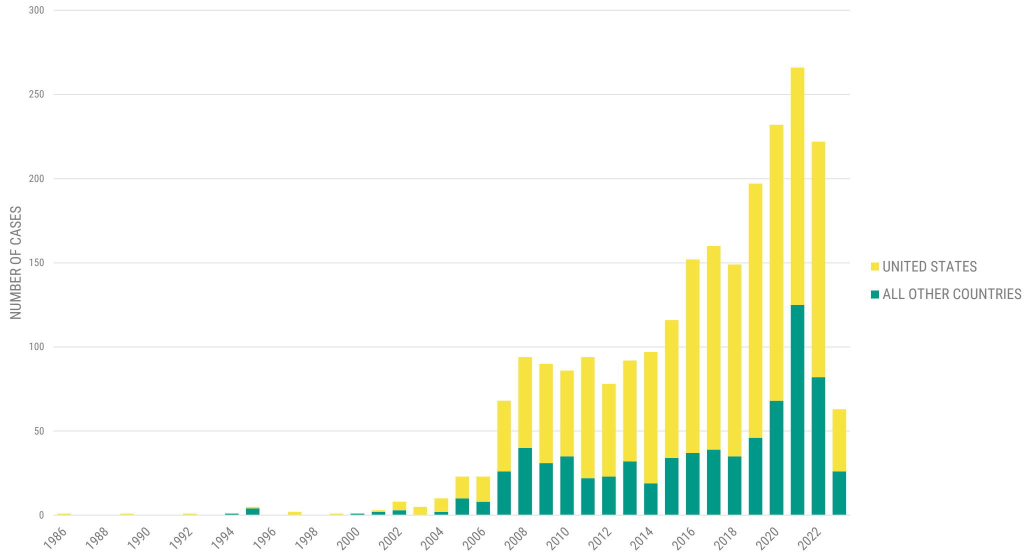
a Ademe, the French Sustainable Investment Forum and Freshfields work with data from the Shareholder Service (ISS).

b A network of businesses and investors founded in 1989 following the Exxon-Valdez oil spill in order to improve their practices.

FIGURE 4

TOTAL CLIMATE CHANGE CASES IN THE UNITED STATES AND OUTSIDE (1986-31 MAY, 2023)

Source: Grantham Research Institute, 2023



More and more of these lawsuits are "strategic" in nature, according to Grantham Institute authors. In other words, they are seen by the plaintiffs "*as a tool to influence policy outcomes and/or to change corporate and societal behaviour*", beyond the case of the defendant. They are therefore generally accompanied by large-scale advocacy campaigns by an NGO, individual, member of parliament, or political party, to bring out a key message: *e.g.* the accelerated phase-out of fossil fuels in a lawsuit against an oil company. This is the case for almost 80% of litigation brought against companies between 2015 and 2022. The last two years saw a diversification of sectors targeted by legal proceedings, due to the numerous lawsuits aimed at making companies accountable for their climate commitments. In Europe, the "duty of care"[c] was retained by the International Court of Justice in The Hague which, referred to by seven NGOs, judged Shell's GHG reduction strategy to be insufficient and ordered the company to reduce its emissions by 45% by 2030.[22]

Ultimately, **almost 55% of the 549 intermediate or final court decisions have ruled in favour of the climate** (**FIGURE 5**). Nevertheless, the symbolic and media scope of decisions is often greater than their actual legal scope. Among the emblematic cases of recent years, *State of the Netherlands vs. Urgenda Foundation* created a symbolic precedent when in December 2019 the Supreme Court of the Netherlands ruled illegal the Netherlands state's lack of ambition to reach its 2020 emissions reduction targets. Although it did not force the state to take measures to reach its target, the decision put genuine pressure on the government at the point of presenting its integrated national energy and climate plan for 2021-2030 to the European Commission.[23] In France, since October 2020, when the government was condemned for its climate inaction following an initiative by the town of Grande-Synthe, it is obliged by the Council of State, the highest civil jurisdiction, to regularly produce appropriate measures.[24]

Among the adverse rulings for plaintiffs, the Supreme Court of the United Kingdom overruled a tribunal decision judging the construction of a third runway at Heathrow airport (London) illegal because it did not respect the Paris Agreement, arguing that the ratification of the agreement did not bind the government in this case.[25] In the United States, the lawsuit filed by the State of New York against ExxonMobil alleging misstatements and omissions made to investors on its knowledge of climate change impacts led to a defeat for the prosecution.[26] In February and July 2023, two cases made against TotalEnergies for failing its duty of care were dismissed, since the

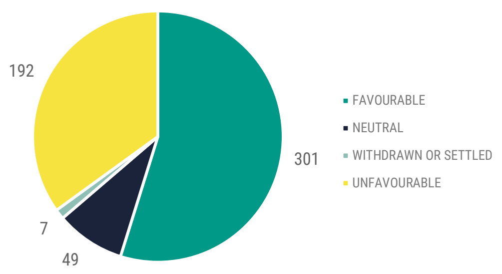
c This is the obligation of companies to prevent social, environmental and governance risks associated with their activities, sometimes throughout the value chain.

prosecuting NGO coalition had avoided the negotiation phase prior to legal action. In addition, only a small number of legal proceedings "non-aligned on climate" have been launched since 2015 (16) with a view to contesting the application scope of a law, obtaining compensation for stranded assets due to political decisions, or dissuading actors committed to the climate from pursuing their efforts. For example, in November 2022, the lawsuit by Uniper and RWE claiming compensation from the Dutch government for stranded assets due to the scheduled phase-out of coal-fired electricity power stations was finally dismissed.[27]

FIGURE 5

OUTCOMES IN GLOBAL CLIMATE LITIGATION

Source: Grantham Research Institute, 2023



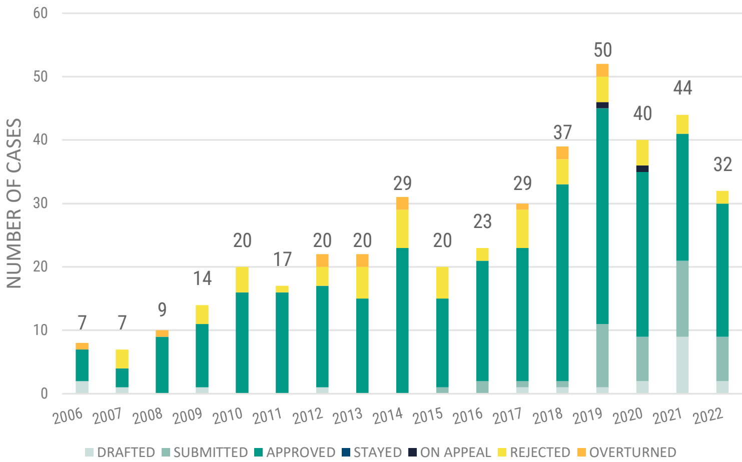
Another study by the Grantham Institute examined the impact of complaints or legal decisions against a company on its market value, by examining 108 cases related to the climate from 2005 to 2021. Although the companies' value had diminished in modest proportions (between 0.4 and 1.5%), the authors esteemed that it was a sign that the companies were just as exposed to the risk of litigation as to the risks of transition and physical risks.[28]

Some plaintiffs go so far as to seek legal recognition for a causal link between a company's activities and its impact on climate change. In 2022, fishermen on the island of Pulau Pari in Indonesia – which is threatened by rising sea levels – launched legal proceedings against the cement manufacturers Lafarge and Holcim. Considering that these companies were responsible for 0.42% of historical global emissions,[29] the accusers, supported by the NGO Swiss Church Aid HEKS/EPER, claimed compensation of about €3,500 each – the equivalent of 0.42% of the anticipated costs of redeveloping the damaged areas and adapting the island to higher sea levels – and new emissions reduction targets for the shorter term.[30] Similarly, for the first time in the history of climate litigation, in May 2022, German judges travelled abroad, to Peru, to evaluate the responsibility of RWE in the shrinking of the glacier lake Palcacocha, whose volume has been divided by 34 in 50 years. The instigator of the complaint was a mountain guide, who is claiming $20,000 to cover part of the costs of preventing damage from a potentially devastating outburst flood.[31]

FIGURE 6

HISTORICAL EVOLUTION AND STATUS OF ECOLOGICAL JURISPRUDENCE (2006-2022)

Source: Putzer et al., 2022



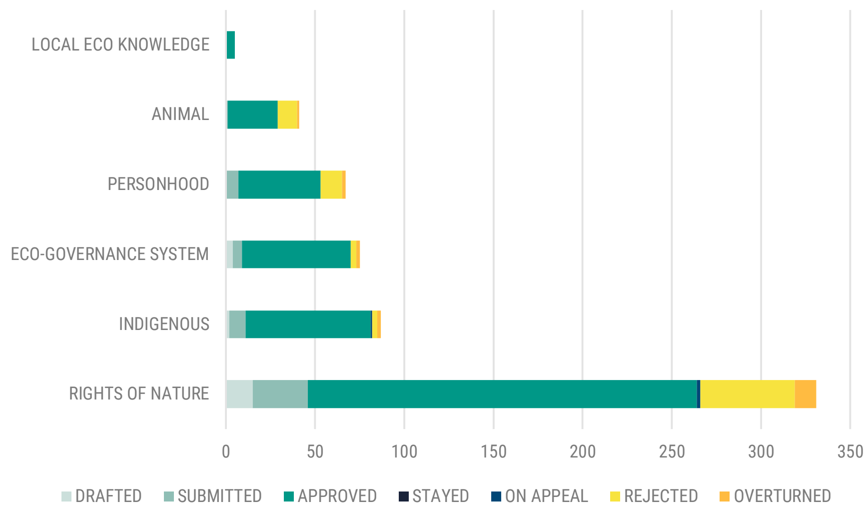
This increasing recourse to legal measures for climate action has also been fuelled by "ecological jurisprudence", a trend that attempts to use legal means to shield natural entities and ecosystems from anthropocentric utilitarianism, at the same time as recognizing the human right to a healthy environment. In January 2023, the Eco Jurisprudence Monitor platform listed **457 initiatives of this type engaged in 44 countries** around the world (**FIGURE 6**).[32] The movement has grown since the early 2000s and even more so since the Paris Agreement: only 198 initiatives were listed in 2015 (+130%). These initiatives are relatively successful, with an adoption rate of 70%, and only 16% rejections (the others are pending or quashed).

Ecological jurisprudence covers two major types of action: those based on rights (74%), and those based on responsibility (26%). Rights-based initiatives aim at recognition of legal personhood, human attributes (in particular for animal rights) or relational dependencies between natural entities that justify moral, legal protection. Responsibility-based approaches draw from indigenous knowledge to obtain recognition of a responsibility for care, or scientific knowledge to justify the maintenance of an ecosystem's ecological functions and preserve it from damage (*e.g.* via recognition of the crime of ecocide). Ecological jurisprudence is based on a wide range of legal provisions, dominated by court decisions (28%) and local legislation (25%) (**FIGURE 7**).

FIGURE 7

TYPES OF ECOLOGICAL JURISPRUDENCE INITIATIVES

Source: Climate Chance, based on data from Eco-Jurisprudence Monitor



Eighty percent of initiatives are concentrated on the American continent, with strong geographic polarisations: 82% of initiatives appealing to local law took place in the USA, while 69% of court decisions made in Latin America were in Ecuador. The inclusion of the rights of nature in the Ecuadorian constitution in 2008 has therefore had an impact. In March 2023, a regional court for example revoked the permits granted to two companies to open a sulphur mine in the Intag Valley in the heart of the Tropical Andes, the world's biggest biodiversity "hotspot", judging that they had violated constitutional law that requires consulting communities.[33] In August, 5.2 million Ecuadorian citizens taking part in a referendum launched by popular initiative rejected the exploitation of oil fields located in the Yasuni National Park, after ten years of legal battles led by environmental activists and indigenous peoples. The same day, a local referendum led to the cancellation of a mining project in the Chocó Andino de Pichincha Biosphere Reserve.[34]

Yet implementation often proves a sticking point once the legal decision is made. In Colombia, the legal personhood granted to the Colombian Amazon by the Supreme Court in 2019 resulting in an order to the state to take the necessary steps to reduce deforestation has not yet borne fruit.[35] In the United States, the application of local laws granting rights to natural entities is contingent on the two-party political system and its divisions.

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