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The Role of the World's Forests in the Fight Against Climate Change

Sustainability Industry Report

The Al-Attiyah Foundation

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Deforestation accounts for 15% - 20% of global greenhouse gas (GHG) emissions, while regrowth is an essential carbon sink. Forests store about 660 gigatonnes (Gt) of carbon, equivalent to almost 80 years of global emissions. They are also an essential store of biodiversity, a home for many peoples and a crucial part of the hydrological cycle.

What is the environmental role of forests? What are the drivers of deforestation? And what policies are being implemented at the national and international level?

SUSTAINABILITY REPORT

This research paper is part of a 12-month series published by the Al-Attiyah Foundation every year. Each in-depth research paper focuses on a current sustainability topic that is of interest to the Foundation's members and partners. The 12 technical papers are distributed to members, partners, and universities, as well as made available on the Foundation's website.

03 EXECUTIVE SUMMARY

The Role of Forests in Climate Change:

- Forests moderate climate change by absorbing ~15 billion tonnes / year of CO_2, whilst deforestation, fires, and other disturbances released an average of 8.1 billion metric tonnes / year.
- The impact of forest growth or deforestation on atmospheric CO_2 and climate change is the difference between CO_2 absorbed by forest growth (i.e. carbon sink) and the CO_2 emitted from deforestation and degradation (i.e. carbon source).
- Global forest stock currently stands at 557 billion m3, with the highest forest stock areas being the tropics mostly found in South America. Brazil has the largest forest growing stock with 120 billion m3, which accounts for 22% of the world's total forest growing stock.
- Deforestation contributes to global warming or cooling by changing the amount of sunlight that is reflected by the forest plantation, reducing evapotranspiration (which cools the air), affecting the release of aerosols and biogenic volatile organic compounds (which can affect cloud formation), and changing the roughness of Earth's surface (that can affect wind speed).
- Conversely, climate change also affects the health and functioning of forests and their ecosystems by increasing the frequency and the intensity of natural disturbances, mainly by exceeding forest ecological resilience and resulting in permanently altered forests, and / or shifts to non-forest ecosystems.

The Economic and Environmental Drivers of Deforestation:

- Direct causes of deforestation are human activities or immediate actions that directly affect forest cover and loss of carbon stock. Whereas, indirect causes are a complex interplay of demographic, social, economic, political, cultural, and technological processes that are often distant from their area of impact.
- Agriculture production, timber extraction, selective logging, and infrastructure expansion are the main direct drivers of deforestation. Macroeconomic growth, weak governance systems, cultural, demographic, and technological factors are the primary indirect causes of deforestation.

National Policies to Tackle Deforestation:

- The effectiveness of government regulatory policies to reduce or reverse deforestation is dependent on the ability to limit the profitability incentive to convert forest covers for agricultural production and improve land use regulation and institutional capacity, taking into account other direct and indirect extra-sectoral drivers of deforestation.
- Regulatory policies aimed at promoting afforestation and reforestation, improving forest management, and increasing the substitution of forest-derived biofuels for fossil fuels could also be effective in discouraging deforestation.

- Regulatory policies should also recognise the role of Indigenous people, knowledge and practices, which are an important component of climate resilience, and can be utilised to ensure tenure security against outside actors seeking to appropriate their land and resources.

International Policies to Tackle Deforestation:

- Climate finance is one of the fundamental causes of complexity on the issue of forest conservation, deforestation, and climate risk management. Tropical forests conservation can produce ~1.8 GtCO2e / year of investible carbon credits that could yield a return on investment (ROI) worth ~US$ 46 bn / year.
- Through the United Nations-backed programme for "Reducing Emissions from Deforestation and forest Degradation" (REDD+), many developing countries have enhanced their forest monitoring, protection and sustainable management capacities. Numerous developed countries in North America and Europe, and international financing institutions have provided technical and financial support to developing countries for REDD+ readiness.
- At the November 2021 26th Annual United Nations Climate Change Conference (COP26) in Glasgow, United Kingdom, more than 100 countries have pledged to halt and reverse deforestation by 2030.

The term "forest" is used to describe areas of land that have a high concentration of trees. The Earth's forest cover currently stands at 4.06 million ha, with forest areas covering ~30% of the earth's land surface area, accounting for 50% of plant productivity, and storing 45% of the biological carbon on land. Almost half of the world's forests are found in five countries: the United States, Canada, Russia, China, and Brazil.

There are three general types of forests: temperate, tropical, and boreal. Temperate forests are found mostly in eastern North America and Eurasia, and experience four distinct seasons. Abundant precipitation results in fertile soil and a diverse flora such as maples, oak, and birch. Deer, squirrels, and bears are some of the native faunas.

Tropical forests are equatorial, mainly located across Southeast Asia, sub-Saharan Africa, and Central and northerly South America. Temperatures are quite stable, ranging between 20°C – 31°C, and precipitation is high, typically with distinct wet and dry seasons. Tropical rainforests are central to earth's biodiversity, containing various endangered animals.

Boreal forests are the most common land biomes, mainly found across Russia, Northern Europe, Canada and Alaska. Temperatures in boreal forests are below freezing point for lengthy parts of the year, which has resulted in flora such as conifers, spruce, fir, and pine trees. Moose and deer are examples of herbivorous fauna across this environment.

A forest ecosystem consists of a community of plants, animals, microbes, and all other living organisms that interact with the chemical and physical features of their environment. These living organisms are interdependent on one another for survival and can be broadly classified according to their ecological role as producers, consumers, and decomposers.

The producer-level consists of living organisms that manufacture their own energy from the sun. Green plants photosynthesise as producers of a forest ecosystem, and typically arrange themselves across four layers. The emergent layer consists of trees that are spaced apart. The understory consists of a few plants since it receives very little sunlight. And almost nothing grows on the forest floor as it is devoid of sunlight.

The consumer-level consists of primary, secondary, and tertiary consumers. Primary consumers can't produce their own energy and obtain it by eating green plants. Secondary consumers feed on primary consumers (or herbivores) in order the energy originally produced by green plants, and tertiary consumers feed on other secondary consumers.

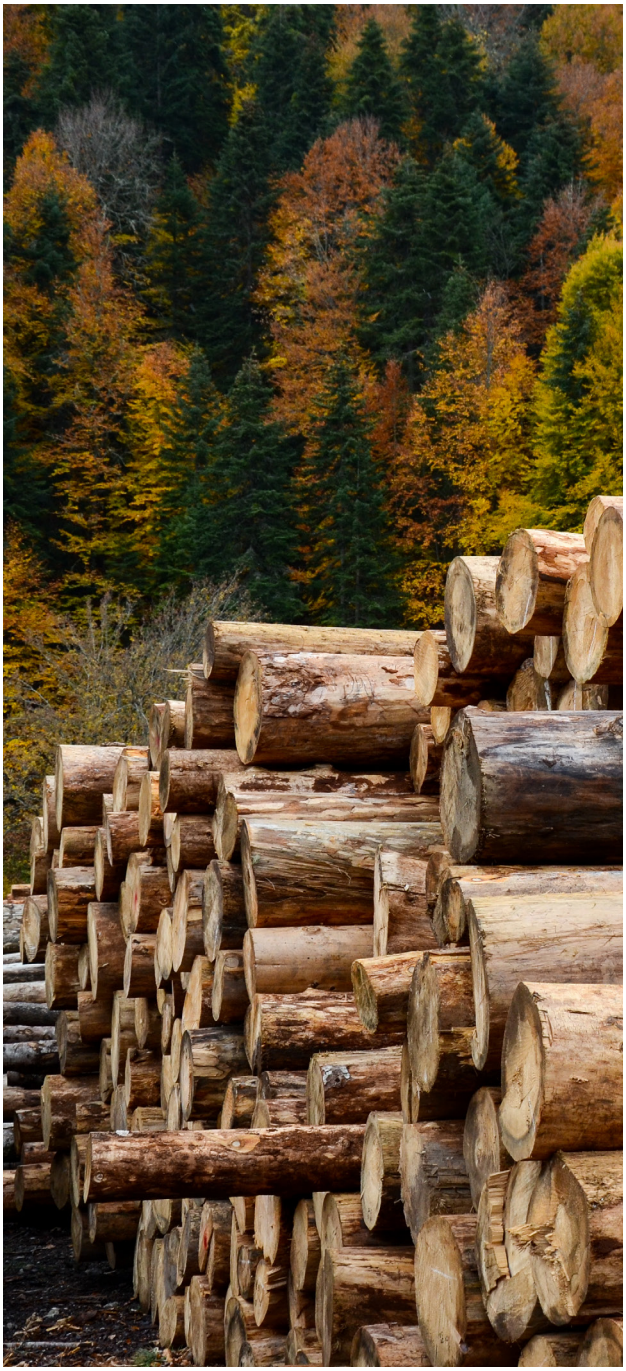
Forests play an important role in the fight against climate change. Well managed conservation efforts can help forests restore or increase their carbon stocks while simultaneously providing a sustainable supply of products that are renewable, sustainable, recyclable, and have a smaller carbon footprint than other substitutes. In addition to carbon stocks, forests are essential elements in maintaining a healthy ecosystem interaction and biodiversity.

The global forest area continues to shrink by ~5 million hectares (ha) / year[i]. Globally, the rate of net forest loss continues to decline since the early 1990s, but the pace of this decline has slowed over the last decade, mainly due to the slow expansion of forest areas in Southeast Asia and Europe.

Halting deforestation remains one of the main challenges of tackling climate change, despite continuing to increase at a lower rate than in the past. Africa is the new deforestation hotspot globally, where ~90% of the deforestation is taking place in the tropics[ii]. Africa lost the largest area to deforestation between 2010 – 2020, surpassing South America. The continuation of a high rate of deforestation across the continent largely reflects the combined impact of indirect drivers of deforestation such as high population growth, and direct effects such as the need to sustain food production through large-scale commercial agriculture.

Deforestation has more than halved across Asia and South America since the early 1990s. In Asia, this is mainly because of a reduction in deforestation in South Asia and Southeast Asia. In South America, the key factor is a reduction in deforestation across the Brazilian Amazon forest, particularly between 2010 -2015.

With forest management increasingly encouraging sustainable practices, production of forest commodities continues to be an important forest management objective. Since the early 1990s, ~30% of all the world's forests are managed primarily for the production of wood and non-wood products[ixvii].



Nonetheless, urgent action is needed to promote the positive trend of declining deforestation; and to incentivise afforestation, forest restoration and conservation, particularly across tropical developing countries such as Bangladesh, Lao PDR, and Nicaragua.

As part of Bangladesh's Pilot Program for Climate Resilience, the World Bank has financed mangrove afforestation in the Sundarbans in order to protect low-lying, reclaimed land[iv]. The afforestation efforts will also increase forest covers, reduce vulnerability against natural disasters such as floods and cyclones, expand the carbon sink, improve livelihoods, and provide habitat for wildlife.

Lao PDR is addressing deforestation and fighting climate change by shifting the way land is used at a large-scale. Through various national programmes, the country is tackling drivers of deforestation such as uncontrolled logging, commercial agriculture, and new infrastructure. Lao PDR efforts is also looking at how land tenure issues impact forest loss.

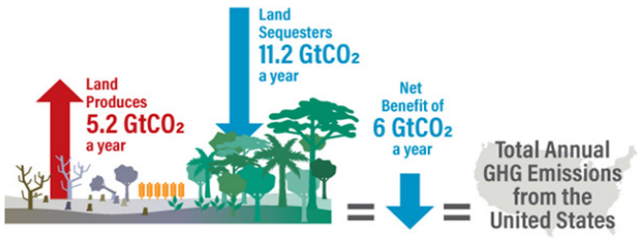
Nicaragua's proposed emission reduction program covers more than 7 million ha, of which ~50% is forestland, 90% of the country's forest cover. Through a programme supported by the World Bank, it aims to reduce deforestation, help communities adapt to extreme climate events, support rural development, and help build on legally recognised Indigenous territories.

THE ROLE OF FORESTS IN CLIMATE CHANGE

Forests are an important component of the earth's carbon cycle, which involves the movement of carbon from land and water, through the atmosphere, and into living organisms.

The land areas maintain the earth's carbon balance by storing and releasing carbon, which is a key element of the dynamic process of growth, decay, disturbance, and renewal, and an important constituent of the earth's carbon cycle.

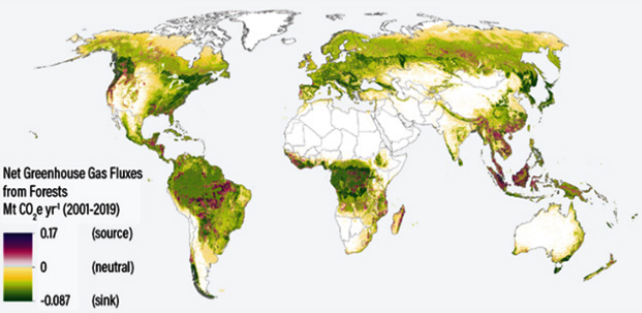
Figure 1: Forest Carbon Cycle[v]



Forests moderate climate change by absorbing ~15 billion tonnes/year of CO_2, whilst deforestation, fires, and other disturbances released an average of 8.1 billion metric tonnes/year of CO_2 between 2001 – 2019 (see Figure 2). This not only reduces the rate at which carbon accumulates in the atmosphere but also the rate of climate change.

The earth's carbon balance is the difference between the carbon emissions from human activities and the carbon absorbed and released by natural processes, including forestlands. The net carbon balance is driven by two roles that forests play, as carbon sinks or carbon sources.

Figure 2: Global Carbon Sinks and Sources[vi]



A forest is a carbon sink if it absorbs more carbon through the photosynthesis process from the atmosphere than it emits. The carbon is sequestered in forest biomasses such as trunks, branches, roots leaves, dead organic matter (i.e. litter and dead wood), and across different layers of soil.

Conversely, forests that are categorised as carbon sources release more carbon than they absorb. Forest carbon is released through degradation, when the vegetation burns or decays because of end-of-life, old age, natural disaster, fire, insect attack, and / or other natural disturbances, or human clearance.

The rate at which the carbon is sequestered by a forest (carbon stock) and then returned to the atmosphere as CO_2 depends on a complex interaction between soil minerals, plants and soil organisms, organic components, and local climatic conditions, which is determined by the forest growing stock[1], stock composition, and biomass stock.

Global forest stock currently stands at 557 billion m3, with the highest forest stock areas being the tropics mostly found in South America[vii]. Brazil has the largest forest growing stock with 120 billion m3, which accounts for 22% of the world's total forest growing stock.[viii] Over the last two decades, East Asian countries have experienced the largest increase in forest growing stock as a result of major reforestation programmes.

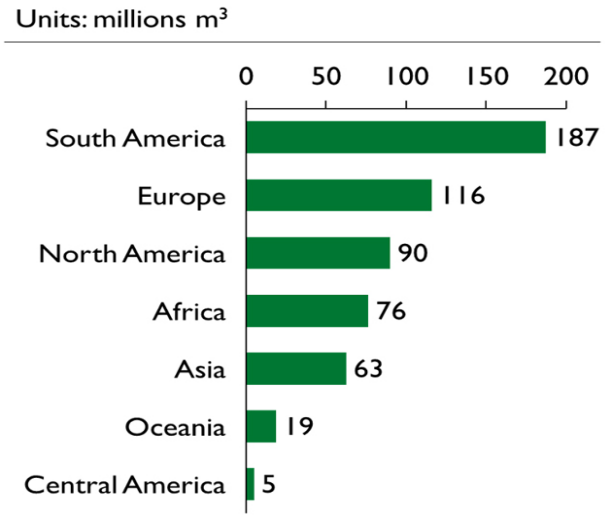
Most of the growing stock is found in naturally regenerating forests rather than artificially planted forests or plantations. This has led to almost all of the forest growing stock consisting of native species, with a small proportion of artificially planted tree species.

1-Forest stock is the volume of all living trees in a given area of forest or wooded land and is measured in cubic metres (m3).

As of 2020, 3.7 billion ha of the world's forestland area consists of natural regenerating forests, whereas 290 million ha consist of artificially planted forests.

An increase in global naturally regenerating forest stock will lead to an increase in biomass stock. The world's forests are estimated to contain 606 gigatonnes (Gt) of living biomass and 59 Gt of dead wood[xi]. In 2020, total carbon stock held by forested areas stood at 662 Gt, which has decreased slightly from 668 Gt in 1990[xii].

Figure 3: Forest Growing Stock by Region[ix]

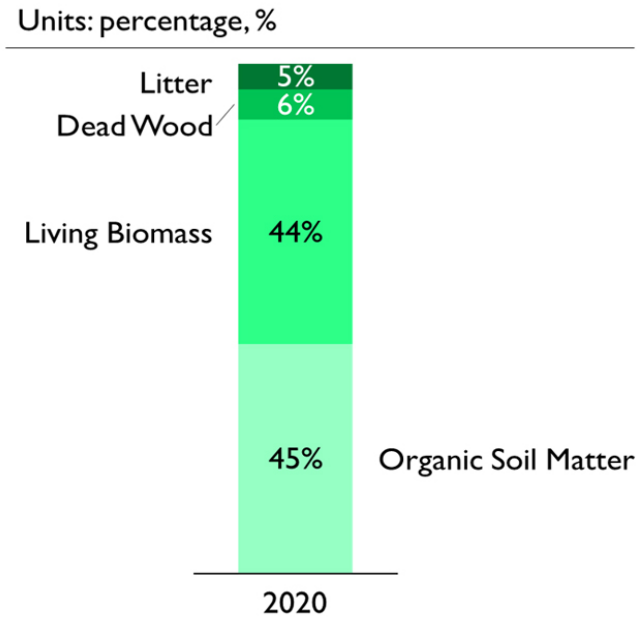


However, forest biomass carbon density[2] increased from 159 tonnes / ha in 1990 to 163 tonnes / ha in 2020 because of improvements in technology and practices relating to agriculture and forestry harvesting systems across tropical forests in South America and Southeast Asia, which minimised loss of dead organic matter, soil carbon erosion, and slash burning, hence resulting in an increasing maintenance of a large share of living biomass and soil organic matter.

2-Forest biomass carbon density is the amount of biomass carbon stock per unit of forestland.

The impact of forest growth or deforestation on atmospheric CO_2 and climate change is the difference between CO_2 absorbed by forest growth (i.e., carbon sink) and the CO_2 emitted from deforestation and degradation (i.e., carbon source).

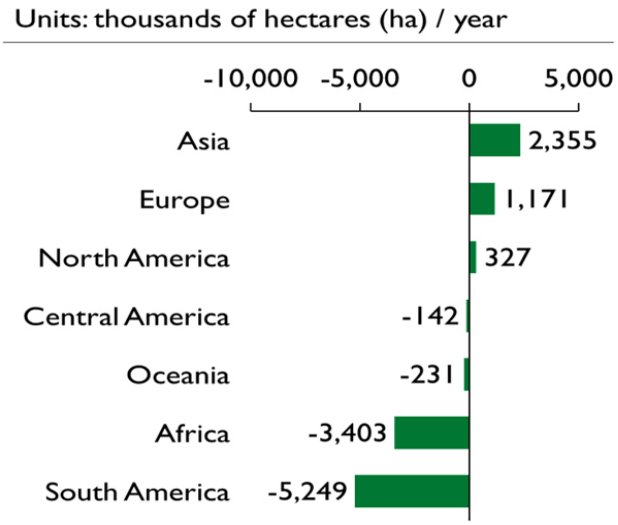
Figure 4: Global Balance of Carbon Stock in Forest Carbon Pools, 2020[xiii]



Since 1990, the world has lost a net area of 178 million ha of forestland, which is almost equivalent to the total land size of Libya[xiv]. Over the same period, a total of 420 million ha of forestland (not accounting for regeneration or new plantation) has been lost due to deforestation[xv]. The rate of deforestation over the last two decades has declined somewhat, such that 10 million ha / year of forestland was lost because of deforestation between 2015 – 2020, in comparison to 12 million ha / year between 2010 – 2015[xvi].

Deforestation is one of the main contributors of climate change. When forests are burned or cleared, usually for agriculture production or infrastructure development, the net flow of carbon (i.e. carbon cycle) from the atmosphere into the forest is permanently stopped.

Figure 5: Average Annual Net Change in Forest Area per Year by Region, 2010 – 2020[xvii]



Deforestation releases carbon stock that has been accumulated in forests' biomass. The rate at which the carbon is released is dependent on how the forest is cleared and for what the wood is used. The removal of forest biomass by

burning for bioenergy causes an immediate release of carbon, whereas harvesting for wood products such as timber will trap some of the carbon in the final product for its lifetime.

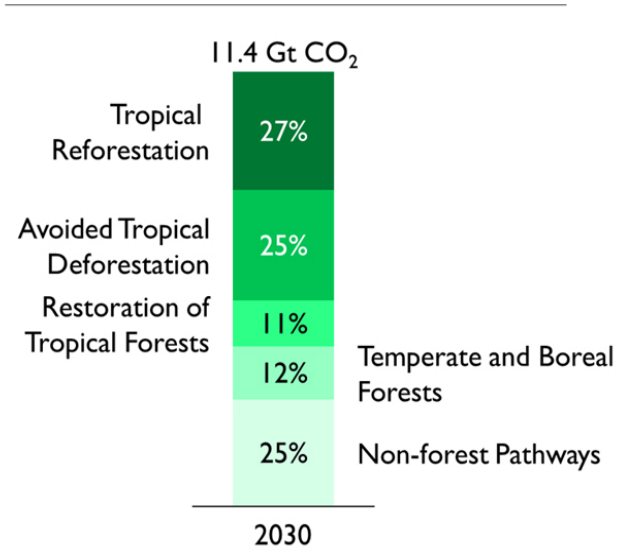
Biomass left in the forest such as twigs, branches, or leaves will decay and eventually release its stored carbon into the atmosphere over decades, depending on the type of residue and the local climate conditions.

The net impact on the atmospheric climate from deforestation also depends on how the cleared forest is replaced. If the forest is selectively harvested, then the forestland area can regenerate naturally and trees can also be re-planted through active forest management. However, across the tropics, forest has been cleared completely in recent decades, especially for cultivating agricultural commodities for domestic consumption and export; and also for mining, infrastructure development, and urban expansion.

Moreover, forest degradation also affects the climate. Forests that are left standing are exposed to logging, wood fuel extraction, fires, and grazing, which also reduces carbon stocks faster than they can naturally recover. Apart from causing climate change, forest degradation provides an opening to outright deforestation.

The Intergovernmental Panel on Climate Change (IPCC) estimates that deforestation and degradation contribute to most of the 13% of total human-caused CO_2 emissions[xviii]. And reducing deforestation and degradation rates is one of the most effective and robust ways to mitigate climate change. For example, tropical forests alone can deliver 63% of the land sector's cost-effective climate change mitigation potential by 2030 (see figure 6).

Figure 6: Climate Change Mitigation Potential of Forests by 2030[xix]



Deforestation can contribute to global warming or cooling by changing the albedo (the amount of sunlight that is reflected); reducing evapotranspiration (which cools the air); affecting the release of aerosols and biogenic volatile organic compounds (which can affect cloud formation); and changing the roughness of Earth's surface (that can affect wind speed).

The combination of these factors and their interactions is complicated. However, the end result depends on the scale of the forest disturbance, latitude and seasonality, and environmental conditions such as temperature, available moisture and snow cover.

Conversely, climate change also affects the health and functioning of forests and their ecosystems by increasing the frequency and the intensity of natural disturbances, mainly by exceeding forest ecological resilience and resulting in permanently altered forests, and / or shifts to non-forest ecosystems[xx].

Natural disturbances to forests are extreme weather events such as forest fires, heat waves, droughts, and floods. Forests are also vulnerable to new pests and diseases whose ranges are expanding in warmer temperatures.

Fires are the most common natural disturbance that have adversely affected forests' health and vitality, and reduced their ability to provide a full range of goods and ecosystem services. In 2018, there was a sharp increase in forest fires across various temperate and boreal forests in the United States, Russia, and Australia. In the same year, forest fires destroyed 98 million ha of forestland area mainly in the tropics, which led to a 4% decline in total in forestland[xxi]. In the same year, insects, diseases, and severe natural disasters also damaged 40 million ha of temperate and boreal forests[xxii].

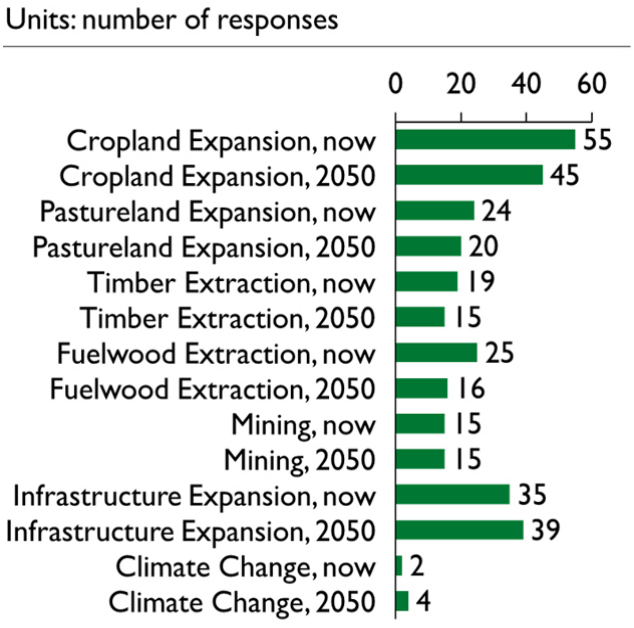
Forest fires are important not only because of their impact on forestland area and future regeneration, but also because of large quantities of greenhouse gases (GHG) emissions. These GHGs not only include CO_2, but also methane (CH4) and nitrous oxide (N2O) emissions, which per tonne have a much greater impact on global climate than CO_2. In 2021, forest fires emitted 1.8 billion tonnes of carbon into the atmosphere[xxiii].

THE ECONOMIC AND ENVIRONMENTAL DRIVERS OF DEFORESTATION

The causes of deforestation vary regionally and change over time, but they generally fall in two categories: direct and indirect. Direct causes are human activities or immediate actions that directly affect forest cover and loss of carbon stock. Whereas, indirect causes are a complex interplay of demographic, social, economic, political, cultural, and technological processes that are often distant from their area of impact.

Most causes of deforestation do not originate from activities within the forestry sector (i.e. intra-sectoral causes), but instead from inter-related or external sectors (i.e. extra-sectoral causes) such as the materials and industrial sector. For example, an increase in urban incomes, national socio-economic prosperity, or improvements in standards of living can boost demand for materials, and industrial commodities, in turn triggering the expansion of agricultural commodities and / or forest harvest for timber, wood fuel and paper.

Figure 7: Largest Drivers of Forest Loss Now and in 2050 (based on a survey conducted by FAO)[xxiv]

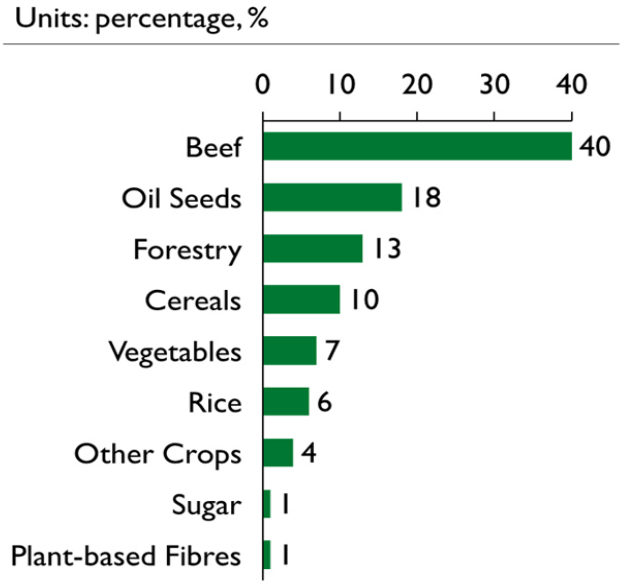


Agriculture production, timber extraction, selective logging, and infrastructure expansion are the main direct drivers of deforestation.

Agricultural expansion is the main direct cause of deforestation. The direct causes that encourage the conversion of forestland for agricultural production are:

- changes in population growth, higher rural population, increasing urbanisation etc. (i.e. demographic changes)
- expansion of infrastructure (e.g. roads) that makes forested areas more accessible and the extraction of timber and agricultural commodities easier
- higher market prices of agricultural commodities, which results in more profitable production
- and, favourable environmental conditions for agricultural expansion (i.e. forests with good arability, soil fertility, and water access)

Figure 8: Breakdown of Agricultural Production as a Global Driver of Tropical Deforestation[xxv]



Globally, the use of pastureland for beef production and cattle raising accounts for 41% of tropical deforestation[xxvi]. Most of the forestland is converted in Brazil, where beef production drives 24% of the tropical deforestation[xxvii].

Palm oil, soybean, and oil seed cultivation accounts for 18% of global deforestation[xxviii]. The palm oil industry in Indonesia and Malaysia is a big driver of tropical deforestation across Southeast Asia. Biofuels and palm oil production not only competes with a growing demand for food that is driven by an increasing population, but also contribute to deforestation, with crops used to produce biofuels requiring vast areas of land, leading to forests being cut down to make way for agricultural expansion. Both, biofuels and palm oil account for 18% of tropical deforestation[xxix].

Uncontrolled or under-regulated wood extraction and logging to produce forestry commodities such as timber, pulpwood, fuelwood, and charcoal is the third largest driver of deforestation. Poor wood extraction and logging practices lead to large volumes of combustible waste, making forests vulnerable to escaped fires that are usually set to clear the forestland for commercial or subsistence agriculture. This has been a major cause of tropical deforestation in Southeast Asia and drier forests in sub-Saharan Africa.

Both wood extraction and logging are also related to infrastructure expansion, which facilitates deforestation by opening new access to forestland, and promotes migration and land colonisation. Infrastructure expansion typically involves clearing the forest to construct roads, settlements, public projects, pipelines, open-pit mines, hydropower projects, and/or other infrastructure projects.

Macroeconomic growth, weak governance systems, cultural, demographic, and technological factors are the primary indirect causes of deforestation.

Macroeconomic growth is the main economic factor that drives the conversion of forestland for other uses. Macroeconomic growth may increase deforestation at an early stage (i.e. industrialisation phase), when forests are cleared for agricultural commodity production; whereas at later stages of economic development (i.e. post industrialisation phase), pressures on forests decrease as agricultural production becomes more intensive, the service sector's share of economic contribution increases, environmental protection regulations are tightened, and demand for forest commodities and services (such as tourism) grows, making timberland or forestland more valuable.

Some of the macroeconomic factors that encourage deforestation are:

- foreign exchange rate policies that facilitate currency devaluation, turning foreign direct investment in the agricultural sector more profitable
- contractionary fiscal policies (i.e. austerity programmes) that curtail urban economic growth and encourage counter-urbanisation into rural areas
- international trade policies that protect forestry sectors from imported substitutes, by increasing pressure on forests to meet local demand
- and, fuel and transport subsidies that reduce the cost of wood extraction and logging

A macroeconomic recession can also stimulate deforestation. For example, in 1997, the Indonesian economy collapsed, and people who had lost their jobs in the industrial sector moved to the forestry sector to supplement their incomes. Their activities included clearing forests for cultivation and illegal logging on idle timber concessions. However, the recessions also paused the development of large-scale infrastructure projects that would have otherwise had a significant impact on deforestation.

Governance factors that cause deforestation include poorly defined property rights, non-transparent legal provisions, corruption by economic and political elites, and weak law enforcement capacity.

The conversion of forestland because of forest tenure[3] results from poorly defined property rights that reward deforestation with tenure establishment. Yet in countries where property rights are well-defined but clear regulatory framework and institutional responsibility is absent; deforestation can still occur.

Another significant governance factor that causes deforestation is non-transparent legal provisions relating to the allocation and conversion of forestland and its resources. Ambiguous or overlapping legal provisions

3-Forest tenure is the agreement between a company, a community, an individual, and the government regulatory body that grant the rights and outlines the conditions, through licences and permits, under which timber is harvested from national land.

and regulations in the forestry sector provide opportunities for commercial enterprise to exploit demi-legal (i.e. grey areas) to bypass forest protection and conservation policies.

In addition to this, the weak law enforcement capacity in some countries, allows corrupt elites to leverage their economic and/or political authority to acquire economic control of forestlands, which ultimately contributes to unsustainable forestry practices. The prevalence of economic and political corruption in countries with vast forestlands allows powerful political and corporate enterprises to operate with minimal levels of public accountability. Wood extraction and timber producers with close government ties are able to acquire preferential access to valuable forestland concessions and capture a significant portion of their economic rent.

Beyond macroeconomic and governance factors, cultural, demographic, and technological factors are also known to contribute to deforestation. For example in South America, pressures to preserve religiously and culturally sacred sites have led to selected forests being protected from conversion and deforestation.

An increasing rural population and migration increases the labour supply that is available for deforestation. Conversely, similar trends in urban areas also results in an increase in demand for agricultural and forest commodities, which leads to an increase in demand for forestland.

The role of technological improvements in deforestation is ambiguous. The adoption of land-extensive technologies may result in higher agricultural profitability, which in effect makes forestland conversion more economically attractive. However, the resulting increase in supply of agriculture commodities from forestland conversion could change prices in medium-term in a way that dampens (or reverse) the profitability trend.

In addition to technological improvements, changes in consumer lifestyle patterns and diet also have an indirect impact on deforestation. Some researchers have found that if everyone went vegan, global farmland use could be reduced by 75%, which can significantly reduce forestland conversion[xxx]. And global deforestation could decrease by 94% if global demand for protein were met through artificial methods[xxxi].

The effectiveness of government regulatory policies to reduce or reverse deforestation is dependent on the ability to limit the profitability incentive to convert forest covers for agricultural production and improve land use regulation and institutional capacity, taking into account other direct and indirect extra-sectoral drivers of deforestation.

The option to maintain forest covers on private land across developing countries is generally more limited, as governments have less regulatory control over them compared to public lands. An exception to this is the private land areas in the Amazon forest in Brazil, where the government requires landowners to maintain 80% of their property under forest cover[xxxii].

Despite the limited effectiveness of the regulation, the recent introduction of a licensing and monitoring system in the state of Mato Grosso has shown that enforcement can significantly reduce deforestation rates.

Another approach for governments is to provide environmental service payments to private forestland owners in developing countries, which consists of a direct financial incentive to reward the retention of forest covers. High transaction costs, insecure land, and resource tenures have reduced the effectiveness of this approach in many countries. Yet, there is some potential to introduce a payment scheme that is in-line with international efforts, for the restoration and retention of forest covers (see REDD+ programme in section COP26 Deforestation Pledge).

Asian countries such as China, Thailand, Philippines, and Malaysia have significantly reduced deforestation rates in response to mitigating the environmental and public health consequences of forest cover loss. In India, the government's Joint Forest Management Programme has been effective in partnering with communities to reduce forest degradation[xxxiii].

Regulatory policies aimed at promoting afforestation and reforestation, improving forest management, and increasing the substitution of forest-derived biofuels for fossil fuels could be effective in discouraging deforestation.

Incentives for re-plantation or new plantations through grants, investments in transportation and roads, energy subsidies, tax exemptions for forestry investments, and tariffs or trade restrictions against competing forestry imports have been very successful in the creation of new forest plantations in developed and developing countries. However, the creation of new plantations is heavily dependent on government support, particularly in the initial stages mainly due to the illiquidity of the investment required, the high cost of capital, and long payback period for financial returns.

Regulatory policies to improve forestland also include incentives to maintain forest covers or to improve their management. These incentives include tax credits, government subsidies, technical assistance, and environmental service payments. For example, in the United States, government programmes such the Conservation Reserve Program, Forestry Incentive Program, and Partners for Wildlife continue to promote the establishment, retention, and improved

management of forest covers on private lands. In contrast to developed countries, the limited or weak regulatory and institutional capacity, trained personnel, and secure land tenure have constrained the effectiveness of forest management across various developing countries. Perhaps, voluntary certifications that reward sustainable forest management standards could improve forest management in developing countries by providing incentives such as increased market access or price premiums to certified producers that meet these standards.

Some regulatory policies enforce the use of bioenergy to promote demand for greener fuel sources and/or promote rural development. For example, Brazil has a history of encouraging plantations for the production of ethanol by offering a combination of tax exemption for purchasing plantation lands and income originating from plantation companies[xxxiv]. The United States also provides a range of incentives for ethanol production such as exclusion from excise taxes, and accelerated depreciation schedules for electricity generating equipment that burn biomass[xxxv].

Regulatory policies should also recognise the role of Indigenous people as forest protectors. Indigenous knowledge and practices are an important component of climate resilience, and must be encouraged through regulatory policies that strengthen Indigenous communities' tenure security, which can lead to better forest management, especially by empowering them to exclude outside actors seeking to appropriate their land and resources.

Climate finance is one of the fundamental causes of complexity on the issue of forest conservation, deforestation, and climate risk management. Tropical forests conservation can produce ~1.8 GtCO2e / year of investible carbon credits that could yield a return on investment (ROI) worth ~US$ 46 bn / year[xxxvi].

In the past, various pacts and institutions such as the Kyoto Protocol, the United Nations Forum on Forests and the International Tropical Timber Organisation, the Forest Law Enforcement and Governance introduced by the World Bank and G-8 countries, the Food and Agricultural Organisation's (FAO) Forestry Programme, and the Paris Climate Agreement, introduced regulatory mechanisms to support developing countries financially and technically in managing forests conservation and climate risks.

The Clean Development Mechanism (CDM) under the Kyoto Protocol provided US$ 304 bn for ~8,000 projects and programmes relating to climate change mitigation across 111 countries between 2001 – 2018[xxxvii]. Under the Paris Climate Agreement, developed countries committed to provide US$ 100 bn/year of climate finance to developing countries[xxxviii].

Geopolitical complexities between the developed and developing world and the global west and global east have affected the development, implementation, and outcomes of these international policy mechanisms. An example of such a complexity is the United States' withdrawal from the Paris Climate Agreement in 2017 due ostensibly to perceived economic disadvantages posed by the agreement, and in reality mostly to ideology, which challenged the effectiveness of the agreement.

The transaction cost of implementing various policies relating to forest conservation and climate risk management is uncertain, because of a lack of a consistent framework and methodology for costs assessments[xxxix]. And in case of international policies that are well-designed such as the United Nations' Reducing Emissions from Deforestation and Forest Degradation (REDD+), the difference in their implementation cost across various countries may affect the consistency and overall effectiveness of the international policy mechanism at national and international level.

In a complex web of geopolitics, international policy, and institutional structures, the success of policies for forest conservation and climate risk management are dependent on the extent to which they are implemented and monitored at the national level. Unfortunately, much of these interventions revolve around announcements and ratification of agreements, whereas tracking mechanisms to monitor their success are minimal.

The Paris Climate Agreement is the most widely ratified international protocol on mitigating climate change with 193 entities already declaring their emissions reduction targets through their Nationally Determined Contributions. The United Nations' REDD+ programme is the most widely endorsed policy mechanism on forest conservation, enhancing forest carbon stock, and the limiting the impact of deforestation on climate change.

The REDD+ programme is a collaborative effort between the Food and Agriculture Organisation (FAO), the United Nations Development Programme (UNDP), and the United Nations Environment Programme (UNEP). The programme helps 65 partner countries value the carbon and ecosystem services of their forests and create incentives to reduce deforestation and degradation[xl].

The support REDD+ offers can take the form of direct payments or can be in exchange for carbon credits, based on reductions in GHG emissions. The financial support for REDD+ comes from developed countries, multilateral financial institutions, and various private sector institutions.

Partner countries under the REDD+ programme must prepare a national strategy to combat deforestation, implement a national forest monitoring system, and measure the current level of carbon in their forests to gauge change over time. An example of a forest carbon tracking system is the Forest Carbon Monitoring Project, which has implemented a detailed platform to monitor forest carbon stock and carbon sink comprehensively[xli].

REDD+ has made significant efforts for its implementation, which include capacity-building, technical assistance, demonstration activities and results-based financing programmes. Through the REDD+ programme, many developing countries have enhanced their forest monitoring, protection, and sustainable management capacities. Numerous developed countries in North America and Europe, and international financing institutions have also provided technical and financial support for REDD+ readiness.

The REDD+ programme will continue to evolve in terms of policies, projects, and sectoral activities. REDD+ policies are likely to focus on generating credits by reforming land-use policies to reduce deforestation. Future policy-based initiatives will continue to provide credits that counteract agricultural subsidies in developing countries that incentivise forestland conversion.

REDD+ policies will also continue to ensure that the leakage risk is minimised. REDD+ credits could create market leakages by boosting the market prices of timber and agricultural commodities and so making deforestation profitable in another location. The size of the leakage risk depends on the design of the forest conservation project, the market forces driving deforestation, country-level regulatory policies and market pressures affecting the forestland, and the level of international participation in the REDD+ programme.

Under the UN's carbon offset scheme, the CDM, carbon credits are generated from REDD+ projects, as temporary certified emissions reductions (tCERs), which are valid for a five-year period. After the expiry of the tCERs, the buying country is responsible for finding a new source of emissions reductions. Hence, the buying country has two options, either to purchase new tCERs that will expire in five years, or purchase permanent credits.

At the November 2021 26th Annual United Nations Climate Change Conference (COP26) in Glasgow, United Kingdom, more than 100 countries pledged to halt and reverse deforestation by 2030[4]. The pledge emphasised the critical and interdependent roles of forests, biodiversity, and sustainable land use in enabling the world to achieve its sustainable development goals, adapt to climate change, and maintain other ecosystem services.

Member countries reaffirmed their collective and individual commitment to the United Nation's Framework Convention on Climate Change and the Paris Agreement, the Convention on Biological Diversity, the United Nation's Convention to Combat Desertification, the Sustainable Development Goals, and other relevant initiatives.

While the COP26 pledge is inspirational, its success will be dependent on how it is translated into regulatory action at the national level over the next two years; with transparency, accountability, and the involvement of Indigenous peoples and local communities. At the same time, the REDD+ framework and reporting mechanism will also need to be developed in order to ensure the promises are met at the national level.

In the past, global commitments such as the 2014 New York Declaration on Forests, which set a goal of no net deforestation by 2030, failed to meet its interim goal of a 50% reduction by 2020 with tropical deforestation alone increasing by 13% between 2019 and 2020[xlii].

However, the COP26 pledge could prove to be more effective than its predecessors, mainly due to its financial commitment of US$ 19 bn for public and private implementation projects relating to sustainable production and consumption, infrastructure development, trade, finance and investments, support for smallholders, Indigenous and local communities that depend on forestlands for their livelihoods and have an important role to play in their administration.

4–Some of the countries that pledged to halt or reverse deforestation by 2030 at COP26 include Brazil, Mexico, Indonesia, and Malaysia. However, a notable absentee from the list of countries is India.

A number of global private sector corporations such as IKEA, Walmart, JBS Brazil, and Starbucks are beginning to restructure their supply chains in order to eliminate deforestation as result of their business operations, while their respective governments have included plans to address deforestation as part of their Nationally Determined Contributions (NDCs) under the Paris Climate Agreement.

Despite sharing similar objectives, a closer collaboration and coordination between the private and public sector could provide valuable synergies in tackling deforestation. Private sector corporations need a regulatory and policy environment that supports their deforestation commitment, which governments can provide; and governments around the world will benefit tremendously from their private sector's participation in order to achieve deforestation and forest landscape restoration goals.

For example, Brazil through its NDCs, aims to reduce emissions by 37% below 2005 levels by 2025, and 43% below 2005 levels by 2030. Many companies with operations in Brazil have developed zero-deforestation commitments and are collaborating with the Brazilian government through multi-stakeholder initiatives such as the Produce, Conserve, and Include (PCI) programme. The PCI programme aims to reduce deforestation, increase reforestation, increase sustainable agricultural and livestock production; which is line with Brazil's NDCs.

Large Brazilian corporations such as Marfrig and Amaggi have signed on to this initiative and are contributing to the design, implementation, and mobilisation of finance to support the PCI programme. Another member of the programme is the Sustainable Trade Initiative (IDH) in Brazil, which has created a de-risking fund to increase the intensification of beef production and reforestation.

Through these interactions and partnerships, the Brazilian private sector is supporting its government in accelerating the implementation of the country's NDC goals, and revealing pathways through which these collaborations can be scaled up and amplified in other parts of the world.

In Indonesia, the government has enacted several policies that are focused on peatland and forest conservation and restoration, and has made an unconditional commitment through its NDC to reduce emissions 29% below business-as-usual estimated emissions by 2030, and a conditional commitment (depending on international support and climate finance) to further reduce emissions 41% below BAU by 2030.

In addition to the Indonesian government's efforts to tackle deforestation, the country's private sector corporations have committed to reducing deforestation across their supply chains. Local companies are collaborating with regional governments across different regions, through various multi-stakeholder initiatives aimed at achieving their shared goals of reducing deforestation.

An example of a multi-stakeholder initiative is the Central Kalimantan Jurisdictional Commitment to Sustainable Palm Oil, which is one of the most advanced public-private collaborations to address deforestation and emissions in Indonesia, and has brought together representatives from local governments, NGOs, Indigenous peoples, smallholder farmers, and palm oil producers

toward the goal of certifying palm oil production in the Kalimantan province by 2019. A prominent member of the initiative is the Unilever corporation.

Lessons from Brazil and Indonesia have shown that corporate zero deforestation commitments, combined with robust government initiatives have enhanced multi-stakeholder partnerships and can help countries reach their goals of reducing deforestation and enhancing forest landscape restoration.

Therefore, in order to tackle deforestation in their respective countries, governments should provide a platform for consultation on their NDCs relating to deforestation; identify ways through which private sector initiatives can support their NDCs; encourage private sector response through policies, incentives, and financial mechanisms; and remove barriers on extra-legal conservation efforts by private companies.

Conversely, private sector companies should leverage their economic contributions to discuss with their governments on how their NDCs and regulatory policies could support their commitment to tackle deforestation. Similar to public-private initiatives in Brazil and Indonesia, they can participate in new multi-stakeholder initiatives and/or help scale and replicate existing initiatives across other regions and countries.

25 CONCLUSIONS

Preventing dangerous climate change is critical for promoting global development and protecting the world's poorest people. Every year an area of tropical forests approximately the size of Austria is lost due to deforestation.

Protecting tropical forests is the quickest and most affordable pathway to decrease emissions, while also advancing sustainable economic development.

Ending tropical deforestation and letting damaged forests recover could reduce current annual GHG emissions by as much as 15 – 20%, and at low costs compared to most other abatement opportunities.

Standing tropical forests are fundamental to the achievement of Sustainable Development Goals relating to food, water, health, energy, human safety, and biological diversity.

In order to mitigate the effects of deforestation on climate change, government policies must address the direct and indirect causes of deforestation. Government regulatory policies at the national level must incentivise and promote the reduction or reversal of deforestation by limiting the profitability incentive to convert forestlands for agricultural production or infrastructure development. These policies could also promote afforestation and reforestation by improving forest management; and by recognising the role of Indigenous people, knowledge and practices, which can be utilised to ensure their tenure security.

At the same time, governments should also align their regulatory interventions with international policies such as the REDD+ programme, and international initiatives such as the Glasgow pledge to halt and reverse deforestation by 2030.

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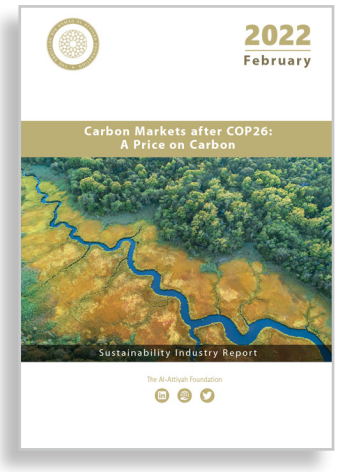

February – 2022

Carbon Markets after COP26:A Price on Carbon

The Paris Agreement's Article 6, on carbon markets, was a crucial part of the COP26 negotiations. A price on carbon is a key tool for reducing global emissions in anefficient and fair way. But there were serious challenges in reaching a workable text, that would allow carbon markets to function effectively while avoiding doublecounting or encouraging unsustainable activities.

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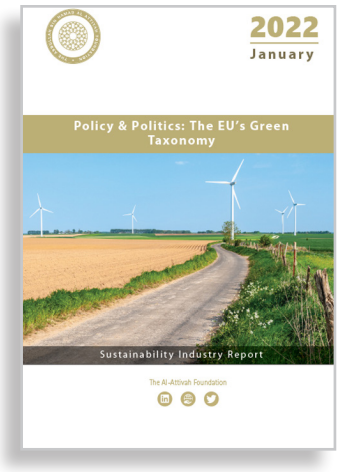

January– 2022

Policy & Politics: The EU's Green Taxonomy

The European Union's draft green taxonomy of sustainable investments was released in December 2021. The document is intended to outline which types of projects and technology can be claimed as 'sustainable' by companies, to avoid allegations of 'greenwashing'.

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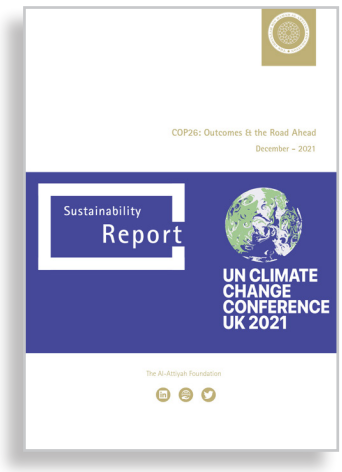

December – 2021

Consensus Forecasts on Long-Term Demand for Fossil Fuels

As the world begins to recover from the COVID-19 pandemic, a fundamental change is unfolding in the global energy system. Climate policy and advancing energy technologies are having an increasing impact alongside the short-term pandemic impacts and the usual long-term effects of economic growth and demographics.

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