Environmental and climate policy

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FOREWORD FROM THE PUBLISHER

There is little doubt today that environmental issues, notably climate change, are among the greatest challenges that mankind must face in the twenty-first century. Effectively addressing these problems requires action on many fronts, and many emphasise the need for individual lifestyle changes and voluntary action in the corporate sector. Nevertheless, because of its potential to bring about large-scale changes, public policymaking can arguably be the most effective in driving a shift toward sustainability.

This book offers an insight into some of the most important questions of environmental, and specifically, climate policy. It presents the fundamentals, including the basic tools and principles of environmental regulation and the drivers and effects of global warming, and also describes the current state of play, with a look at the evolution of international agreements and specific measures in the field of climate policy. For the latter, the book focuses on the policies of the European Union, which has perhaps the most highly developed system of regulatory instruments in the world in this field. While highlighting some promising developments that have occurred so far, the book makes a clear case that the current policy response to the climate change issue is altogether far from adequate, and points in the direction of further steps that could be taken to remedy this.

The volume is published as part of the series of the Institute for Geography, Geoeconomy and Sustainable Development (GEO Institute), entitled Corvinus Geographia, Geopolitica, Geooeconomia. Questions of long-term sustainable development – including environmental economics, environmental policy and corporate sustainability, long term competitiveness – are central themes of the research and education activities of our Institute. The other important aspect of our work is the geopolitical dimension – with a focus on international agreements and policy harmonisation at the EU level, this viewpoint is also represented in this book. We are therefore pleased to present it to students, professionals and all readers interested in deepening their knowledge about these important issues.

Géza Salamin
Director, CUB GEO Institute

1. INTRODUCTION

In the centuries since the industrial revolution, mankind has witnessed unprecedented economic development, which, alongside its enormous benefits, has also led to increasing problems in the environmental domain. Over the past decades, these problems have received increasing attention in public policymaking, gradually leading to the development of a sophisticated toolbox of measures designed to encourage companies and individuals (alongside the public actors themselves) to make decisions that are less detrimental to the environment. From outright bans and performance standards to economic incentives such as taxes and subsidies, and many other tools, various policy approaches can be adopted and different instruments work best in relation to different problem areas and target sectors. Moreover, while the theory of environmental economics offers valuable insights into the fundamental mechanisms and characteristics of these instruments (see Kerekes et al. 2018), in practice, a myriad of details must be worked out in order to develop policies which perform as intended.

Perhaps the most complex and salient environmental issue of our time, climate change, is an area where the policy tools applied by countries across the world today are as diverse as the sources responsible for the problem. From huge CO_2 emitters in industry and the power sector to the millions of cars on the road and boilers in homes, from burning forests in tropical areas to waste landfills and cows belching methane, all of us are involved in causing global warming and we will all be (or indeed already are) affected by its consequences. Achieving the necessary shift toward decarbonisation in all these sectors while making sure that the economic and social costs are kept to a minimum is indeed a great challenge for policymakers, requiring them to make wise use of the full toolkit at their disposal – and perhaps even to implement hitherto untested solutions.

A very important component of environmental policymaking today is the international dimension. The importance of this dimension is readily apparent with an issue such as climate change, which is global by nature and requires international cooperation to be addressed effectively. However, even with environmental issues where the problem itself is more local, the related policies often have important international implications because they impact the competitiveness of regulated sectors. Taking a harmonised approach to environmental protection can therefore help to bring into being more ambitious policies. Today, the European Union level represents the highest degree of the international harmonisation of environmental regulations – in some areas, targets are set at the Community level, while the measures for achieving them are left in the hands of Member States, but there are also areas where common rules dictate all the details. Multilateral environmental agreements, such as ones which address climate change, of course involve a much lower level of policy harmonisation, but they also point in this direction.

The aim of this book is twofold: first, it offers a general overview of the most important tools of environmental policy and the main features of and current trends in EU environmental policy. Second, it presents the issue of climate change, including drivers, impacts and the current standing of international efforts to address it. Finally, these two themes are combined in a detailed discussion of the climate policy of the EU. (While many – in fact, nearly all – policy areas have implications for climate change, this book only addresses those measures and strategies that are directly aimed at reducing greenhouse gas emissions and does not discuss topics such as economic, development or trade policy.)

2. INSTRUMENTS OF ENVIRONMENTAL POLICY

Environmental pollution is the addition of **substances or energy** to the environment at a rate **faster than it can accommodate** (Nathanson 2018). Some pollutants (such a CFCs) are entirely man-made, but many also occur naturally. Some substances are toxic and cause adverse effects even in very small amounts, while others only become a problem at much higher levels. CO_2, for example, is a natural component of the Earth's atmosphere and is only considered pollution since emissions due to human activity now exceed the capacity of natural 'sinks' (such as forests and oceans) and contribute to dangerous climate change. Examples of polluting forms of energy include noise, heat, and light pollution. Sources of environmental pollution can be classified as point sources or diffuse sources. The former refer to sources that emit large amounts of a certain pollutant in one place, such as power plants and factories. Diffuse pollution comes from sources that are scattered and individually small but together may cause significant problems, such as cars, households, and agricultural fields.

Environmental policy uses a wide range of instruments to address various forms and sources of pollution. From bans and emission standards to taxes, tradable pollution permits and simple awareness raising, policymakers can choose from a variety of tools to influence the behaviour of economic actors in the desired direction. When deciding which policy instrument to use in a given situation, there are several issues to consider (Richards 2000, Mickwitz 2003, Goulder-Parry 2008):

- **Effectiveness** refers to whether the given policy instrument is able to achieve the desired environmental outcome. This question arises because decision makers do not have access to perfect information when designing environmental policy, which gives rise to uncertainty when using certain types of instruments.
- **Efficiency** refers to the cost of achieving the desired environmental outcome, which should be as low as possible. Comparing the cost efficiency of various environmental policy tools is a central task in environmental economics. The theory shows that the total cost of reducing pollution by a defined amount is minimized if pollution is always minimized by the polluter who can do this in the cheapest way.[1] This can be ensured if a policy allows economic actors the flexibility to decide how much and by what means they can reduce their pollution. In the long term, the cost efficiency of environmental policy instruments also depends on the extent that they are able to foster innovation; i.e., to motivate companies to develop new, cheaper methods for reducing pollution. In practice, these

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[1] This means that the marginal abatement costs for all polluters should be equal (see Kerekes et al. 2018, Chapter 5).

factors should be complemented by considering the administrative costs associated with policy implementation.
- **'Fairness'** - in addition to the latter factors, it is clearly also necessary to take into account the social impact and political acceptability of environmental policy measures. The main question here is how the costs (and benefits) of a policy will be distributed among different groups (e.g. the polluters themselves versus the rest of society; high versus low income groups, etc). Acceptance of a policy may also be influenced by the characteristics of the adoption process itself (transparency, stakeholder consultations, etc.)

The instruments of environmental policy are usually classified into three main groups: direct instruments, indirect instruments, and soft measures. In the following, the characteristics of these groups and the specific measures that are applicable to each group will be discussed.

2.1. Direct instruments

Direct instruments (also known as regulatory instruments or 'command and control' approaches) introduce specific limits on environmentally harmful behaviour. Tools in this group include:
- **Bans** on substances or products which are considered environmentally harmful
- **Technology standards** which mandate the use of certain technologies to control pollution
- **Performance standards** (also known as emission standards/limits/norms) which put a limit on the amount of pollution that may be generated by each polluter

Direct instruments are the oldest and most widely used tools of environmental policy. Their main advantage is effectiveness, since the required pollution reduction is defined at the outset and is therefore guaranteed (assuming that the regulations are effectively enforced). On the other hand, direct instruments are not cost efficient because they are inflexible, requiring the same reduction of pollution from all economic actors, regardless of cost. Regarding flexibility, there is also a difference between technology standards and performance standards; the former being the most rigid, while the latter at least allow companies to choose the cheapest method of meeting the prescribed targets. Another disadvantage of direct instruments is that they do not create any motivation for companies to reduce their pollution below regulatory limits (Stavins 2002). It follows from the above that direct instruments are best applied in situations when effectiveness is more important than cost – namely, in the case of pollutants that are dangerous to human health or otherwise highly damaging.

2.2. Indirect instruments

Indirect instruments are also known as economic (or market-based) instruments because rather than prescribing a fixed method or target for reducing pollution, they rely on creating an economic incentive for polluters to improve environmental performance. The main types of indirect instruments are:

- **Taxes** (charges/fees) that require the payment of a certain sum after each unit of pollution that is released into the environment
- **Subsidies** paid by authorities to polluters if they reduce their emissions/adopt environmentally friendly practices
- **Permit trading systems** whereby the authorities issue a certain number of pollution permits that polluters are required to acquire to the extent that they wish to pollute

With the above instruments, polluters can freely decide how much they wish to reduce their pollution and will do so as long as they are able to do this at a lower cost than the cost of continuing to pollute (i.e. paying taxes or buying permits). (Subsidies also work by effectively creating a cost for pollution; namely, the income the polluter foregoes by continuing to pollute.) Compared to direct instruments, the main advantage of economic instruments is the cost efficiency that their flexibility creates. Polluters who are able to reduce their pollution more cheaply will be motivated to reduce more, while others who can only do this at a very high cost are not forced to do so. Therefore, the overall cost of achieving a given reduction will be as low as possible.[2] Furthermore, economic instruments create a continuous incentive for pollution reduction as there is no threshold below which pollution is free of charge. Polluters will therefore always be motivated to search for new, cheaper methods of reducing pollution. The main downside of indirect instruments is the higher degree of uncertainty regarding their effects. This is because authorities have no way of knowing exactly how much polluters will reduce their pollution when faced with a certain cost. The geographical distribution of the reductions can also be very uneven (Stavins 2002). This means that economic instruments are not the best choice when dealing with dangerous forms of pollution; in other cases, however (such as greenhouse gas emissions or non-hazardous waste) they represent a more efficient and market-friendly alternative to command and control regulation.

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[2] This only refers to the cost of the pollution reduction itself. From the polluters' perspective, economic instruments (such as taxes) may sometimes be more expensive than performance standards because, in addition to the cost of reducing pollution, the former also have to pay for any remaining pollution. From the point of view of society, however, taxes paid by polluters represent simple transfers of money from polluters to authorities rather than a true cost - it is therefore only the actual cost of making reductions that should be minimized.

2.2.1. Environmental taxes

The use of taxes or charges to control environmental pollution is based on environmental economic theory which stipulates that the external costs resulting from environmental pollution should be internalised (charged to polluters) so that pollution is reduced to a level that can be considered optimal to society[3] (Pigou 1920).

In practice, several questions need to be answered when designing and environmental taxes (OECD 2010):

- What should be the **basis for the tax**? Theoretically, this should be the pollution itself, as this gives polluters the maximum flexibility in choosing the optimal means for its reduction. However, in practice the cost of directly measuring emissions may be too high (especially in the case of diffuse sources) thus inputs such as energy or raw materials may serve as a good proxy (taxing gasoline, for example, is much more viable then individually measuring the CO_2 emissions from every car). In some cases, taxing polluting products may also be a practical option (this strategy is usually applied in relation to waste management objectives; e.g. taxing certain packaging materials).
- How high should the **tax rate** be? Here, the theory of environmental economics dictates that the tax rate should be determined based on the size of the externality (that is, the damage caused by the pollution)[4] . Once again, there are several practical problems with this approach. Firstly, estimating the amount of damage is highly challenging and fraught with uncertainty.[5] Second, applying a tax rate corresponding to the social costs of pollution may not be feasible for political reasons. (For example, several studies have shown that the social cost of road transport in the form of accidents, air pollution, noise, etc. would justify

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3 Externalities are unintended economic effects that impact the welfare of a third party who is not involved in the transaction. Pollution is a typical example of a negative externality because it creates costs for others (air pollution, for example, may damage health, reduce property values and agricultural yields, etc.). Because polluters do not bear these costs themselves, they will not take them into account when making production-related decisions and may continue to pollute even when the social cost of doing so outweighs the benefits of continuing the polluting activity and/or the cost at which the pollution could be reduced.

4 More precisely, the tax rate should be equal to the marginal cost of pollution at the socially optimal level (the point where the marginal cost of pollution is equal to the marginal benefit from the polluting activity) – see Kerekes et al. 2018)

5 The economic valuation of the environment is a field of environmental economics that addresses this issue. Several methods have been developed to estimate the cost of pollution and environmental degradation (see Marjainé Szerényi 2005), and environmental decision-making is increasingly making use of these techniques, although theoretical and practical problems with this approach continue to persist.

fuel and/or other transport taxes that are much higher than currently applied [CE Delft et al. 2011, Gössling et al. 2019], but doubling or tripling the rates of taxes – which are already perceived by motorists to be very high – is something elected decision-makers are unlikely to risk.) If tax rates are not defined according to the size of the externality, they should be determined based on the desired environmental improvement that the tax is intended to achieve. (Of course, as noted before, authorities do not have perfect knowledge about the pollution reduction costs of private actors, so they can only estimate what tax rate would be necessary to achieve the desired pollution reduction.)
In reality, the amount of public revenue to be generated from the new tax can also be an important consideration. It should be noted that the effects of a tax may also vary greatly depending on the characteristics of the goods in question. As a result of taxation the price of goods will increase, thereby decreasing consumption, but the size of this decrease is much greater for some goods than for others.6 (Taxing plastic bags, for example, leads to a dramatic reduction in their use because consumers can easily switch to using paper or textile bags instead, while taxing a vital good such as gasoline will result in a far smaller reduction in consumption.) This also means that the environmental improvement that can be expected from any tax is inversely related to the income that it will generate.

- What are the **social/economic consequences** of the tax? This of course depends on who will ultimately bear the cost of the tax (those who are ultimately affected may not be the actors who originally pay the tax – companies might under certain circumstances be able to pass on extra costs to their customers). It is especially important to consider the potential negative effects a tax may have on disadvantaged groups – energy taxes, for example, tend to disproportionately burden low-income households since they have to spend a relatively large proportion of their income on energy bills. When companies (notably industrial companies) pay such taxes, the resulting costs might threaten their international competitiveness. In such cases, measures that counter the undesired effects of the tax might be justified; however, it is important to design these compensatory measures in such a way that they do not undermine the original environmental goals. Exceptions or lower tax rates for vulnerable consumer groups or industries are therefore not desirable. Instead, policymakers can introduce other measures to help disadvantaged groups (such as, for example, reducing the value added tax rate for basic food-

6 This characteristic of goods is known in economics as the price elasticity of demand, and mainly depends on the availability of suitable substitutes for the good in question.

stuffs, or increasing social payments), or help industry adapt to the new taxes by offering support for energy efficiency investments.

- **How should the revenue** generated by the tax be used? (The compensatory measures mentioned above are, of course, one possibility.) A popular solution is to dedicate the revenue from environmental taxes to solving environmental problems (e.g. use the money from taxes on fossil fuels to fund energy efficiency or renewable energy investments) – such 'earmarking' may increase the political acceptability of environmental taxes and ensure that at least a minimal amount of funding is dedicated to environmental policy. However, it is necessary to point out that there is no theoretical connection between the amount of revenue generated by an environmental tax (the tax rate, as described above, being dependent on damage caused by pollution) and environmental protection investment needs (infrastructure for waste and wastewater treatment, clean technology investment, etc.), so the related decisions are best made independently. This means that revenue from environmental taxes can simply be used like any other source of government revenue (to finance general government spending, to reduce public debt, or to decrease other taxes).

The latter idea – that revenue from environmental taxes can be used to decrease other taxes in a way that creates benefits for society – is known as environmental tax reform and has generated much interest in recent decades (OECD 2017). Levying a huge share of taxes on labour, as is currently done in most countries, is detrimental to employment rates and economic growth alike. Reducing labour taxes and replacing the related government revenue using new or increased environmental taxes therefore has the potential to increase employment and generate environmental benefits at the same time – an effect known as the 'double dividend'. (The most commonly suggested form of such a tax shift is to increase taxes on fossil fuels and reduce social security contributions or personal income tax rates.)

Empirically testing the results of an environmental tax reform and proving the existence of the double dividend is a very difficult task because, so far, there have only been modest experiments to implement such changes in practice. However, results from model calculations suggest that the effects of an environmental tax reform would indeed positively impact unemployment rates, as well as the environment (Patuelli et al. 2005, Groothuis 2016, Hogg el al. 2016). Despite the potential benefits, implementing large-scale environmental tax reform is problematic because a relatively narrow circle of players (energy intensive, polluting industries) would have to pay the lion's share of the new taxes, leading to concerns about damage to competitiveness (and of course strong opposition from these industries) (OECD 2017).

2.2.2. Environmental subsidies

Instead of making polluters pay for pollution, it is of course also possible to positively incentivize environmentally friendly practices via subsidies. Environmental subsidies take many forms, from direct grants and preferential loans that support environmental investment to price subsidies (such as feed-in-tariffs for renewable energy generation). While not involving actual cash transfers, other forms of preferential treatment such as tax exemptions or reduced rates (e.g. for zero-emission cars) are usually also considered subsidies (Withana et al. 2012). Naturally, subsidies are more popular with economic actors than taxes (and do not raise any concerns about social or competitiveness issues) but for governments they represent a financial burden.

One of the main challenges of designing efficient subsidy schemes (environmental or otherwise) is to ensure **additionality** – meaning that public funds should only be used to support action that private actors would not undertake at their own initiative (Bennear et al. 2013). (Energy efficiency investments such as replacing windows in one's home, for example, are beneficial to the environment and also reduce heating costs. Many homeowners will therefore do this even without public support, while for others the initial investment cost may be too high. Ideally, subsidies should only be targeted at the latter group, but in practice of course this can be very difficult to achieve.) Ensuring the financial efficiency of such policies also means that subsidies should be as small as possible while still being effective – just as with taxes, finding the 'correct' rate can be challenging and rates need to be revised regularly. Subsidies are often used to overcome initial market barriers to new technologies (such as electric cars or renewable energy). In such cases, it is expected that subsidies will increase R&D and mass adoption, which will, over time, reduce costs and ultimately reduce or eliminate the need for the former.

Another important question regarding subsidies is whether they should be **technologically neutral** or technology specific. (Whether, for example, the different types of renewable energy such as wind, solar, geothermal, etc. should receive equal or differentiated levels of support.) In theory, a technologically neutral approach is preferable because allowing rival technologies to compete freely leads to a more efficient solution than policymakers 'picking a winner'. In practice, however, technology-specific subsidies can be justified in several cases, and are indeed widely used in environmental policymaking. (With regard to renewable energies, for example, a technologically neutral subsidy system would favour those technologies which are in a more mature state of development and therefore cheaper, such as wind, while others like solar would not receive any support, even though they might potentially be more promising in the long term [European Commission 2013].)

It was previously mentioned with regard to environmental taxes that it is possible to apply these systematically in the framework of comprehensive tax reform. This idea can be taken further to also rethink the expenditure side of fiscal policy (such as subsidies and public procurement) from an environmental point of view – this idea is known as **environmental fiscal reform**. Governments apply subsidies for many reasons other than environmental protection, and the effect of most of these subsidies on the environment is actually negative. Typical examples of such **environmentally harmful subsidies** include subsidies for fossil fuel production, fishing fleet modernization, preferential tax rates for household energy consumption, aviation fuel, company cars, etc. (Withana et al. 2012). The scrapping of these subsidies is a logical and important step in environmental fiscal reform, but very difficult to implement because of social concerns and vested economic interests. Next to subsidies, public procurement processes can also be reformed to take into account environmental considerations. From low-energy buildings and electric vehicles to energy efficient office equipment and recycled paper, **green public procurement** is not only useful because of its direct environmental benefits, but also because government purchases may be large enough to encourage the development of environmentally friendly products and services that may then be used more widely (European Commission 2016).

2.2.3. Permit trading systems

Permit trading systems are known under many names: emissions trading, quota trading, tradable pollution permits/emission allowances, cap-and-trade systems, etc. Under such systems, the authorities issue a fixed number of pollution permits (equivalent to the overall level of pollution that they deem permissible) and distribute these among polluting firms. Firms covered by the system can freely trade the permits among each other and may emit pollution corresponding to the number of permits that they possess.

Such a system has several advantages. As with other economic instruments such as taxes, the fact that companies can flexibly decide whether to reduce their pollution or to pay and continue polluting ensures that pollution is reduced at the lowest possible social cost. However, unlike taxes, with permits there is no uncertainty regarding the environmental outcome of the policy because the amount of pollution that is permitted is fixed at the outset by the authorities. (It is not the amount but the price of pollution – the permit price – which is freely floating and determined by the market).[7] Fixing the amount of pollution that is permissible also means that the system can automatically adjust to changing

[7] This is only true for the overall amount of pollution, while uncertainty regarding its geographical distribution remains. Firms in a given geographical area may all decide to continue polluting and buy permits from somewhere else, leading to the creation of dangerous 'hot spots' if permit trading systems are used to regulate toxic pollution. Therefore, like other economic instruments, permit trading is best suited to types of pollution that are not locally harmful, such as greenhouse gases.

economic circumstances such as inflation or new entries to the market. (With a tax, such changes would result in increased emissions unless the tax rate were raised – but with permit trading, the market price for the permits would increase and the amounts of pollution stay the same [OECD 2004].)

An important limitation of permit trading systems is that operating such systems can be expensive. As these **transaction costs** increase along with the number of players that are involved, permit trading systems are not really an option for handling diffuse sources of pollution (Convery et al. 2003). (The EU's Emissions Trading System for greenhouse gases, for example, only covers large polluters such as power plants and energy-intensive industries. Extending the system to all players who emit CO_2 – such as car owners, for example – would clearly be impracticable: this issue is much better addressed via fuel and motor vehicle taxes.)

The main practical question related to the implementation of permit trading systems is how the permits should be **initially distributed** among participating companies. The simplest solution is to auction them off to firms. However, in this case, buying permits may represent a substantial additional cost to companies, creating concerns about acceptability and competitiveness. It is therefore common practice to distribute some or all of the available permits for free (Goulder-Parry 2008). In this case, the next question is how to determine the number of permits to be given to each company. The simplest solution, called 'grandfathering', is to distribute the permits based on the historical emissions of the participating companies. (For example, if the goal of the policy is to reduce participants' total emissions by 10%, then each company will receive permits equivalent to 90% percent of their emissions for the past year. Individual firms may then: a) reduce their emissions by 10%; b) reduce them by more than 10% and sell the unnecessary permits; c) reduce them by less than 10% or not at all and buy extra permits from others who have reduced more.) While a simple approach, grandfathering is not the ideal principle according to which permits should be distributed because it allocates the most permits to companies with the highest emissions and is unfair to those who have already put in place measures to reduce their emissions prior to the implementation of the system.[8] A more complicated but fairer option is to determine a kind of benchmark for every industry based on the best (most environmentally efficient) available technology. This means that companies that use the best available technology will find their emissions largely covered by the amount of permits they receive, while those that use dirty technologies will either need to improve drastically or spend heavily on buying extra permits (Phylipsen et al. 2006). It is very important to note that the method of initial distribution (auction

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8 Also, a separate mechanism needs to be put in place to address the question of new entrants – companies which have just started operating and cannot be allocated permits based on their past emissions.

or free distribution), while of great importance to individual companies, has no effect on the final outcome of the system (the amount of pollution or the market price of the permits) (Goulder-Parry 2008).

2.3.Soft measures

Next to direct and indirect instruments, environmental policy also possesses a range of tools that constitute an even 'softer' approach (i.e. do not involve mandatory pollution reduction requirements or direct financial incentives). In an environment characterized by increasing global competition, there is substantial pressure to reduce the regulatory burden on companies. However, it is also clear that the severity of environmental problems does not permit public authorities to abandon efforts in this area (Gunningham et al. 1999). Therefore, the past decades have seen an increase in experimentation with alternative forms of regulation that may replace or complement traditional instruments. While there is less consensus in the literature regarding the taxonomy of these measures compared to the first two types (see Richards 2000), certain categories of instruments have emerged that are discussed below.

2.3.1. Voluntary agreements

Voluntary agreements, also known as negotiated agreements or covenants, are contracts between public authorities and private actors (usually industrial associations) aimed at achieving a specified environmental goal within a specified time frame (Karamanos 2001). As their name indicates, industry's participation in such agreements is voluntary – companies usually cooperate in order to avoid the government introducing stricter forms of regulation (standards or taxes) that would be more costly to comply with (OECD 1999). This type of regulation ensures maximum flexibility as to how industry reaches the specified targets and is therefore cost efficient and innovation friendly. Administrative costs for authorities are also low, since monitoring and ensuring compliance by individual companies is left to industry associations. A further advantage of voluntary agreements is that they may foster an atmosphere of constructive partnership between authorities and the private sector and encourage companies to internalise their environmental responsibilities (ten Brink 2002).

However, when it comes to the environmental effectiveness of voluntary agreements, there are serious doubts, leading many to call into question their usefulness as an environmental policy tool. In many cases, the targets set in the agreements are unambitious, essentially corresponding to 'business-as-usual'. (Due to general technological development, the environmental performance of companies tends to improve over time without any specific effort – environmental policy can only be considered successful if it leads to more than this 'normal' level of improvement.) This phenomenon is known in the literature as 'regulatory capture': when regulation is shaped by business interests instead of the public interest (OECD 1999, ten Brink 2002).

Considering all the above, voluntary agreements are perhaps most useful as the first, easily implemented steps for addressing new, emerging environmental issues. They can be put into place fairly quickly, do not involve very high costs, and can create useful experience for designing future legislation about the issues in question (OECD 1999).

2.3.2. Supporting voluntary action

In past decades, an increasing number of companies have taken steps to improve their environmental performance above and beyond legal requirements. A survey of the 100 largest companies in each of 49 countries undertaken by KPMG indicates that 72% published a corporate responsibility report in 2017 that provided information on their environmental (as well as social) performance and programmes (KPMG 2017). The initiatives described in these reports are many and diverse, from technical steps such as implementing eco-efficiency measures, investing in renewable energy and producing green products to management steps such as introducing formal environmental management systems, setting environmental targets, and educating employees and engaging suppliers about sustainability issues, etc.[9] While the sincerity of such efforts is sometimes called into question, it is clear that even with the best of intentions it is not easy for companies to tackle these issues effectively. This is where public authorities come in who may help by providing guidelines and examples of best practice (of corporate responsibility in general, or specific issues such as life cycle assessment) or independent verification (such as certified environmental management systems or eco-labelling schemes) to improve the quality and credibility of companies' efforts (European Commission 2011).

2.3.3. Provision of information

Next to mandatory legislation and private benefits such as efficiency improvements, pressure from other stakeholders including customers, NGOs or the local population can also motivate companies to improve their environmental performance. Governments may foster this process by empowering these stakeholder groups, notably by ensuring that they have access to information about companies' environmental performance (Gunningham et al. 1999).

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[9] The motivation for companies to take such voluntary steps are many and diverse, such as a desire to reduce risk and enhance their image, reduce energy and raw materials costs, motivate employees, attract customers seeking green products, etc. In recent years, investors have also become increasingly interested in companies' sustainability performance, some from a risk perspective, and others out of a desire to invest in a socially responsible manner (BSR – Globescan 2018).

Mandatory environmental disclosure requirements are increasingly common in many countries, as are schemes designed to raise the attention of consumers, such as energy labels. General campaigns that aim to educate people and raise awareness about environmental issues can also be considered as belonging to this category.

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3. THE ENVIRONMENTAL POLICY OF THE EUROPEAN UNION

The beginnings of EU environmental policy date back to the 1970s, the decade that marked the birth of the modern environmental movement. This was a time when increasing awareness about global environmental problems led to the creation of the international institutional framework for environmental protection (the UN's Conference on the Human Environment took place in Stockholm in 1972, creating the United Nations Environment Programme) as well as major environmental NGOs, the first green parties, and the first environmental ministries in several countries. The European Economic Community also decided on the creation of its own environmental policy in 1972 and adopted an Environmental Action Programme that came into force in 1973. The body of environmental legislation grew steadily in the coming decades, and when the European Union was established through the Maastricht Treaty of 1992, environmental policy was explicitly listed as one of its common policy areas.

3.1. Fundamental principles

EU lawmaking is based on the principle of subsidiarity, which postulates that every issue should be dealt with at the lowest possible level of decision-making – that is, the EU should only take action in situations where the desired objective cannot be effectively achieved by Member States (Treaty on European Union, 1992). In the case of environmental policy, the justification of EU-level action rests on two main arguments (EC 2014):

- **The cross-border nature of many environmental problems**: Pollution does not respect national borders and therefore international cooperation is required for it to be addressed effectively.
- **The undisturbed functioning of the European single market:** Economic cooperation and the single market are at the heart of EU integration. Without coordination, different environmental policies in EU Member States would potentially disturb the functioning of the single market. On the one hand, environmental regulations have the potential to act as trade barriers as countries with strict regulations may deny market access to foreign products that do not meet their requirements. On the other hand, environmental regulations may also increase operating costs for businesses, giving a competitive advantage to countries where environmental standards are low. The harmonisation of environmental policy across the EU ensures a level playing field and makes it easier to aim for a high level of environmental protection (although cost and competitiveness concerns related to environmental policy naturally remain important in relation to the outside world).

The **fundamental principles** of EU environmental policy were also laid down in the Maastricht treaty. These are:

- **The precautionary principle:** this means that if there is a suspicion of risk to human health or the environment, the EU may take action to prevent damage (e.g. by banning a suspicious substance) even if there is still scientific uncertainty and the risk has not been completely proven.
- **Prevention** and rectification of pollution at its source.
- The **polluter pays**. This means that it is the responsibility of (potential) polluters to prevent damage to the environment and to rectify any damage and pay compensation if damage does occur.
- **Integration** into other policy areas. This is a very important principle since many other Community policies (such as energy, transport and agricultural policy) can have significant effects on the environment and environmental protection efforts can be far more successful if environmental considerations are taken into account when developing other policy areas (instead of an isolated strategy whereby environmental policy must try to rectify problems created by, for example, policies favouring road transport, fossil fuels, or environmentally harmful farming practices).

Aiming for alignment with these principles serves as general guidance for EU environmental policy but it does not mean that they are always fully taken into account. The precautionary principle, for example, is at the heart of several important measures (including, for example, the EU's chemicals policy, its approach to the approval of GMOs, and the recent decision to ban certain pesticides suspected of harming bee populations). Such decisions are, however, always made with difficulty because of the serious economic consequences of restrictive regulations; moreover, the precautionary principle is not always applied (a notable example is the case of endocrine disruptors – chemicals that may harmfully influence the hormonal system – which are present in several consumer products but which the EU has not taken concrete steps to regulate). Prevention of pollution is a general aim to strive towards, but it is nearly impossible to fully achieve. The EU's urban air quality standards, for example, are routinely breached in numerous cities, which means that stronger measures to reduce pollution at the source (e.g. restrict cars) would be justified. The polluter pays principle is not implemented in cases when subsidies are used to foster emission reductions (e.g. to support energy efficiency or renewable energy investments, or biodiversity-friendly farming practices). Finally, the principle of integration is an area where the EU has made huge steps in past decades, reforming related policies so they are more in line with its environmental goals, but the journey is far from over (which situation is illustrated by the fact that better integration of environmental considerations into other policy areas is listed as a priority in the EU's newest (7th) Environment Action Programme – see below).

The **decision-making processes** of the EU are complex and new legislation often takes several years to finalise and formally adopt. The three main EU institutions that are involved in the decision-making process are the European Commission, the Council of the European Union,[10] and the European Parliament.

- The **European Commission** is essentially the executive branch of the EU. It does not have the power to adopt new legislation, but nonetheless plays a vital role in the policy process by drawing up legislative proposals for the Council and the Parliament to discuss. It is also responsible for the implementation and enforcement of EU law (including the management of the EU budget). The Commission is organised according to policy areas and consists of staff who do not represent countries or political parties but the general interests of the EU. In addition to its staff of ~32,000 employees, the Commission also regularly consults with experts and stakeholders to improve the quality of proposed legislation.
- The **Council of the European Union** is the EU's main decision-making body (together with the Parliament), consisting of representatives of the governments of EU Member States. Each Member State has a permanent staff at the Council to prepare decisions, which are then finalised and adopted at Council meetings attended by the ministers responsible for the given policy area from each country.[11] While initially the Council made most of its decisions unanimously, the continuous enlargement of the EU has led to this procedure being replaced in favour of voting by qualified majority (at least 55% of member countries representing 65% of the EU's population).
- The **European Parliament** is the EU's other main decision-making body, currently consisting of 751 members[12] elected directly by EU citizens every five years. The parliament is organised according to political groups. In the early days, the power of the Parliament was limited to a mainly consultative role alongside the Council, but this has gradually changed and today most new legislation is passed by the Council and Parliament together (both may change and amend proposals made by the Commission, and new legislation is only adopted if the two bodies come to an agreement about the relevant texts – a process which may occasionally take years of negotiation).

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10 Not to be confused with the Council of Europe, which is not an EU institution but a separate international organisation that mainly focuses on the area of human rights.

11 Several times a year, the EU's heads of state or government also hold summits to make decisions about the most important political issues. This institution is called the European Council, but it only decides on the strategic direction for the EU, and does not pass any laws.

12 The number will be reduced to 705 after the United Kingdom leaves the European Union.

In the case of environmental legislation, the standard procedure today is the 'ordinary legislative procedure' (formerly called the 'codecision' procedure), whereby decisions are made jointly by the Council and the Parliament. Regarding these two institutions, the Parliament has a tendency to be somewhat 'greener' than the Council, so any increase in the power of the Parliament has a positive influence on the evolution of environmental policy. (This can probably be explained by the fact that members of Parliament are directly elected by EU citizens and therefore include representatives of green parties who are not found in the Council because the latter are rarely involved in national governments. Also, the Parliament is generally more accessible to lobbyists – including green NGOs – than the Council [Burns et al. 2013].) However, in some highly sensitive policy areas (such as taxation) decisions are still made solely by the Council and require unanimity, making progress in these areas more difficult to achieve.

The two main instruments of EU law are regulations and directives. **Regulations** are binding legislative acts that must be applied across the EU in their entirety. **Directives** are legislative acts that define binding goals for Member States to achieve, but it is up to the Members States to decide how they wish to achieve these goals and adopt laws to this end. (For example, the Renewable Energy directive of 2009 establishes the proportion of renewables from total energy consumption that each country must achieve, but the specific measures required to reach this target can be different in each Member State.) Alongside the specific legal instruments, the EU also has **multi-annual strategies** (Environment Action Programmes) that lay out the overall objectives and priorities for environmental policy. The first EAP was adopted in 1973, while the current (7th) EAP covers the period 2013-2020.

3.2. Current priorities and trends

The title of the EU's 7th environmental action programme is 'Living well, within the means of our planet'. It identifies three key objectives (Decision no. 1386/2013/EU):

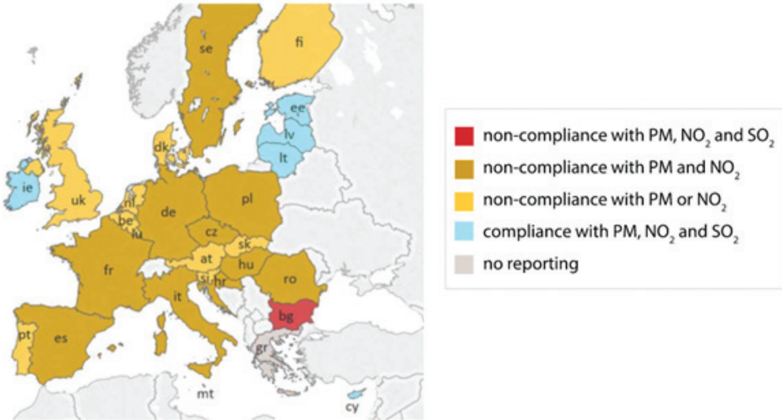
- To protect, conserve and enhance the Union's **natural capital**: this refers to the protection of healthy ecosystems that provide vital ecosystem services (for example, pollination, flood protection, climate regulation, etc.) A central element of this objective is the protection of biodiversity.
- To turn the Union into a **resource-efficient,** green, and competitive **low-carbon economy**: this objective includes the more efficient use of materials by minimising and recycling waste; as well as energy efficiency, curbing the use of fossil fuels and greenhouse gas emissions.
- To safeguard the Union's citizens from environment-related pressures

and risks to **health** and well-being: this means reducing all forms of pollution that have adverse effects on human health, such as air and water pollution, noise and dangerous chemicals.

It can be seen from the objectives that the EU wishes to address all possible aspects of environmental policy – as was also the case in the previous EAPs which contained much the same goals with slightly different emphases. Alongside the thematic objectives, the 7th EAP identifies four further goals as 'enablers' for the thematic priorities. These are very interesting because they highlight the fundamental challenges that constantly accompany environmental policy-making:

- **Better implementation of legislation**. The EU has been struggling with implementation gaps in environmental (and other) legislation for a long time. There has been some improvement compared to the previous decade, but the environment is still the policy area associated with the highest number of infringements in the EU (over 300 open cases at the end of 2018). (On average, infringement cases take over three years to resolve, and may end in Member States being fined by the European Court of Justice.) A study from 2011 estimates that non-compliance with environmental legislation costs the EU approximately 50bn EUR per year (European Commission 2011). Notable examples for this problem are the standards for ambient air quality, with which most of the EU Member States continually fail to comply (see Figure 1) – resulting in a situation where air pollution is estimated to cause 660 thousand excess deaths annually in the EU (Lelieveld et al. 2019).
- Better **information**, by improving the knowledge base. Effective environmental policy requires a lot of information that is not always readily available but which requires highly developed monitoring systems (for example, for tracking pollution or biodiversity trends, or even new scientific research in less understood areas such as climate change risks or the effects of new chemicals). The EU is aiming to adopt a more systematic approach to data collection and spend more on filling the knowledge gaps.
- More and wiser **investment** into environment and climate policy: this is a very complex goal, since it is geared not only to increasing public spending on environmental issues (the concrete target is to spend 20% of the EU's budget on climate change mitigation and adaptation), but also to mobilising private investment. The latter can be achieved by more widely utilising market-based instruments of environmental policy such as environmental taxation in accordance with the polluter pays principle.
- Full **integration** of environmental considerations into other policy areas: the EAP seeks to further progress in this field by relying on environmental impact assessments which must accompany major new policy initiatives.

Figure 1: Member States' compliance with air pollution limit values (2016)



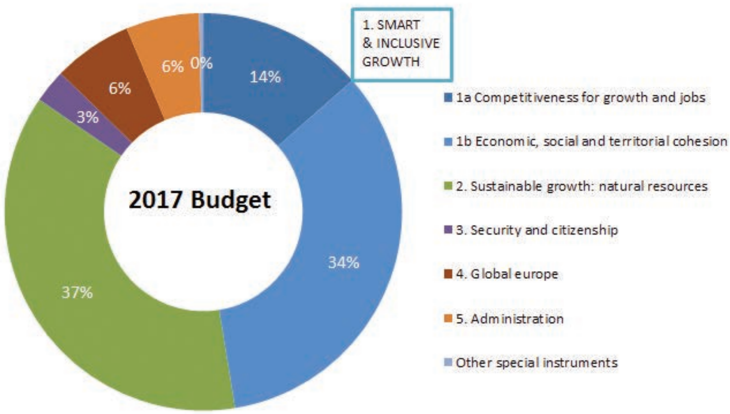
Source: European Commission DG Environment website

Finally, the EAP specifies two 'horizontal' objectives which are related to numerous environmental issues:

- To make the Union's **cities** more sustainable: this is among the few truly new priorities in the 7th EAP. As nearly 80% of the EU's population live in an urban area, the goal is to specifically address environmental issues from this perspective, mainly by encouraging cities to implement policies that promote sustainable urban planning and design and to share best practices in this field.
- To help the Union address **international** environmental and climate challenges more effectively: this means, on the one hand, that the EU should play an active role in international cooperation (such as multilateral agreements) in the environmental field. The other element of this priority is for the EU to consciously address the negative environmental impacts it may have outside its own borders (such as encouraging deforestation by creating a demand for palm oil, or overexploiting the oceans' fish stocks).

The main tool of EU environmental policy is legislation, but the achievement of objectives is also aided by financial instruments. The **EU budget** is relatively small: at 155 bn EUR/year, it represents around 1% of the EU's annual GDP. (National budgets are much larger by comparison, ranging from a low of 29% of GDP in Ireland to a high of 57% in Finland [OECD 2015].) The composition of the Budget is shown in Figure 2. It is very difficult to determine the amount spent on environmental protection as this expenditure is not classified under a separate heading but scattered across several other areas. The title 'Sustainable growth: natural resources' is actually composed largely of the Common Agricultural Policy, the main aim of which is to provide income support to EU farmers, although a certain share of the payments is tied to environmentally friendly farming practices (in line with the principle of integrating environmental protection into other policy areas). Also under this heading is the LIFE programme, the only part of the budget dedicated exclusively to environmental protection, which, however only represents ~0.3% of the total EU budget. Far more important is the possibility to finance environmentally beneficial investments within the economic tranches. Cohesion policy represents the largest chunk of the budget and is used to support the less developed regions of the EU – activities financed include the development of environmental infrastructure (such as wastewater and solid waste treatment facilities), and projects for improving resource efficiency, etc. The funds within the competitiveness tranche can also be used to finance, for example, clean energy investment or related R&D activities.

Figure 2 Composition of the EU budget



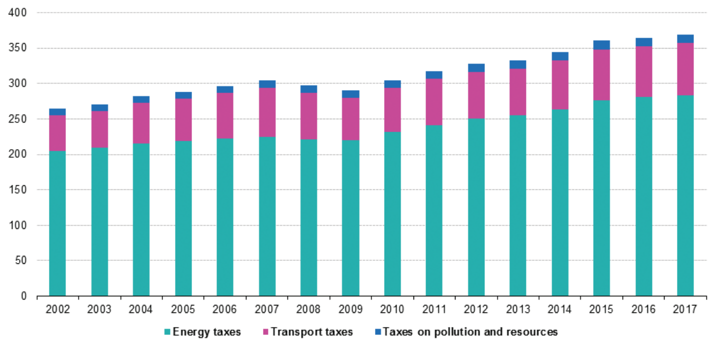
Source: EUROPA website

The environmental policy of the EU is constantly evolving. Beyond specific measures, there are some **general tendencies** that characterise its current development (some of which can be discerned from the priorities of the 7th EAP).

One such tendency is the shift in attention to include **diffuse sources of pollution**, as well as industrial polluters. In the early days, environmental protection efforts were mainly focused on industrial emissions, as such large sources of pollution represented a logical starting point in the quest to make meaningful improvements. As a result of the regulations (as well as industry's natural drive to improve operational efficiency), industrial emissions have significantly declined over the years, so that addressing emissions from other sectors (such as transport, households and agriculture) has become increasingly indispensable for further progress. Industry, of course, also has a huge impact on the emissions of other sectors via the products it offers, and regulating the environmental performance of products is also an increasingly important tool in the environmental policy toolkit of the EU. Examples of such regulations include energy efficiency standards for various household appliances, CO_2 emission standards for cars, and the ban on certain single-use plastic products that is now under discussion.

Another trend is the expansion of the environmental policy toolkit beyond command and control measures and more reliance on **market-based instruments.** Because of the advantages discussed in Chapter 2.2, the European Commission has been pushing for an increase in the use of market-based instruments in environmental policy for several years (COM(2007)140). The 7th EAP explicitly recommends a shift in taxation from labour to pollution (1386/2013/EU). However, as noted before, progress in this area is very difficult to achieve because fiscal policy is still very much a prerogative of individual Member States. Indeed, a wide range of environmental taxes and fees is applied across the EU today – some of these, such as energy taxes, motor vehicle taxes, landfill taxes and taxes on certain environmentally harmful products are (nearly) universal, while others, such as taxes on air and water pollution, are only applied in some Member States. However, the overall importance of these environmental taxes is relatively low – on average, they represent around 2.5% of the GDP and just over 6% of the total tax burden in EU countries (while labour taxes comprise around 50%), a share that has not increased over the past 15 years. The most important environmental taxes in the EU are energy and transport taxes; taxes on pollution and resources are very modest by comparison (see Figure 3).

Figure 3: Environmental taxes in the EU (billion EUR)



Source: EUROSTAT 2019

Another overarching trend in EU decision-making that has also affected environmental policy over the past two decades is the drive for '**better regulation**'. The EU has long been struggling with modest economic growth and the public perception that it is too bureaucratic and removed from its citizens (COM(2001)428, COM(2005)0097). These problems have resulted in a desire to improve the quality of decision-making, reduce regulatory burdens and 'cut unnecessary red tape' (COM(2002) 278). The main tools of this regulatory reform have included an overview of existing regulations with a view towards simplification (which resulted, for example, in dropping the much-ridiculed rules about the curvature of bananas and cucumbers allowed on supermarket shelves), increased stakeholder consultation, and the introduction of mandatory impact assessments to accompany major new legislative proposals (COM(2002)276). The aim of such impact assessments is to identify and, as far as possible, quantify all economic, social and environmental effects of proposed legislation to decide whether Community action is indeed justified, and to help select the best possible means of achieving the objectives. As problems that create the need for regulatory reform continue to persist, a better regulation agenda was put forward in 2015 by the Juncker Commission (COM/2015/0215). However, environmental NGOs are sceptical of these initiatives, fearing that they actually represent a move towards deregulation; a reduction of environmental (and social) standards that is driven by business interests rather than a desire to improve the public good (Better Regulation Watchdog 2015, Tansey 2016).

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4. CLIMATE CHANGE – DRIVERS AND IMPACTS

Among the many environmental problems that the World is facing today, many regard climate change as the most serious – so serious, in fact, that United Nations secretary António Guterres recently called it 'the most systemic threat to face humankind' (Sengupta 2018). In the EU, public opinion polls indicate that climate change (considered to be the most important among environmental issues by a majority of Europeans [Eurobarometer 2017]) now ranks as the fifth most important problem facing the EU today, ahead of issues such as unemployment, inflation and crime (see figure 4).

Figure 4 Public opinion on the most important issues facing the EU

Source: Eurobarometer 2018

Indeed, climate change has several unique characteristics that make it more serious and more difficult to address than other environmental issues:

- The global nature of the issue: driven by the increase in the atmospheric concentration of greenhouse gases, the problem is truly global and can only be addressed by effective international cooperation.
- The deep connection with the foundations of our economy: the current global economy is fundamentally reliant on fossil fuels (coal, oil and natural gas) which are the main source of greenhouse gases, meaning

that there is no quick and easy fix for reducing emissions.[13]

- The magnitude and variety of effects: increases in the Earth's global average temperature have an impact on nearly every aspect of life on Earth, from natural ecosystems to the human economy.
- The long-term nature of the problem: greenhouse gases emitted today can spend many years (in some cases, centuries or millennia) in the atmosphere, all the while affecting the climate. The impacts of climate change are only just starting to be felt and are expected to unfold over several decades or even centuries, making it more difficult to convince decision-makers and the general public of the need to act and make economic sacrifices today to counter the problem.
- The risk of irreversible effects: due to natural positive feedback mechanisms in the Earth's climate system the warming process is expected to accelerate and might reach a point where even a substantial decrease in anthropogenic (man-made) greenhouse gas emissions would not be sufficient to reduce it.

4.1. The drivers of climate change

The main driver behind climate change is an increase in the **greenhouse effect** caused by the anthropogenic emissions of greenhouse gases. The greenhouse effect is a natural phenomenon which plays a crucial role in shaping the Earth's climate. The Earth continuously receives energy from the sun in the form of solar radiation. A part of this radiation is directly reflected by the atmosphere ('bouncing' off clouds or dust particles) while the rest reaches and warms the planet's surface. This heat energy is then radiated back by the Earth into space, but a part of it is captured by certain gases in the atmosphere. These are the so-called greenhouse gases which act like a partial blanket, keeping some of the heat trapped close to the surface.[14] In fact, it is estimated

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[13] The issue of ozone depletion is often raised as a counterpoint to the problem of climate change: in this case, the gases responsible for the destruction of the ozone layer were used in a relatively limited range of applications and could be fairly easily substituted by safer alternatives once their negative effects had become known. This is probably why the ozone issue, even though it also required global cooperation, was addressed much more effectively than climate change. (The ozone layer has already started to regenerate, but the process is very slow because the ozone-depleting substances released over the previous decades will spend a very long time in the atmosphere and continue to do damage. However, with the passage of time they will eventually disappear and the ozone layer is expected to fully recover by the end of the century [IPCC 2005]).

[14] This happens because incoming radiation from the sun is of a different, shorter wavelength than the heat energy radiated back from the Earth. Greenhouse gases are those gases which allow the incoming, shorter wave radiation (light) to pass through, but capture the outgoing longwave heat radiation.

that without the greenhouse effect, the mean surface temperature of the Earth, which is currently around 14 °C, would be a much colder -19 °C. The mechanism of the greenhouse effect, and the fact that C02 is a greenhouse gas, has been well known since the nineteenth century (IPCC 2007).

It follows from the above that an increase in the concentration of greenhouse gases in the Earth's atmosphere results in a strengthening of the greenhouse effect; that is, more heat energy being trapped in the atmosphere and an increase in global temperature. In fact, our knowledge about the Earth's climate in the past indicates a strong correlation between the atmospheric CO_2 concentration and temperature (Figure 5). While there have been substantial variations in CO_2 concentration and temperature in the past without any anthropogenic influence, it is clear that the currently observable increase in atmospheric CO_2 is mainly the result of human activity, notably the use of fossil fuels that began with the industrial revolution.[15] The atmospheric CO_2 concentration prior to the industrial revolution is estimated to have been around 280ppm, but after starting to rise sharply in the second half of the twentieth century it now exceeds 400ppm[16] (EEA 2018) – substantially higher than at any time in the past for at least 800,000 years (IPCC 2014). Therefore, the Intergovernmental Panel on Climate Change[17] states that it is 'extremely likely'[18] that human activity is the main cause of the increase in global temperature that has been observed since the mid-twentieth century (IPCC 2014a).

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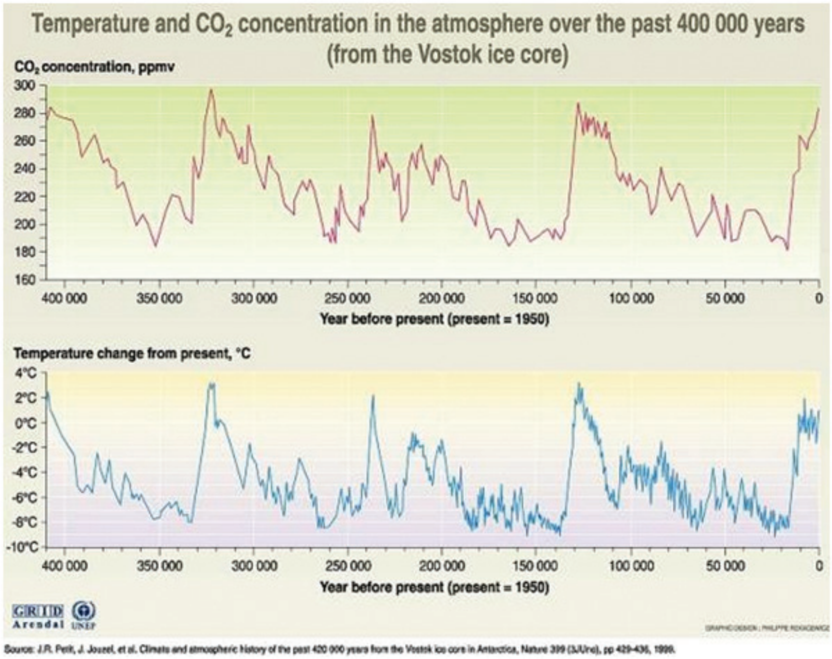
15 $C0_2$ in the atmosphere represents a stage in the global carbon cycle – a continuous flow of the element carbon between the atmosphere, the ocean, the soil and living organisms that is key to sustaining life on Earth. By burning fossil fuels, we are quickly adding large amounts of carbon to this system that was formerly deposited underground and thus which had been 'out of circulation' for millions of years.

16 The meaning of 'ppm' is parts per million; that is, in every million molecules of air, there are approximately 400 molecules of C02. For gases present in even smaller amounts, ppb – parts per billion – or ppt – parts per trillion – are used.

17 The Intergovernmental Panel on Climate Change (IPCC) is a body of the United Nations whose mission is to synthesize existing research on climate change and provide information about trends, effects and possible future scenarios. The IPCC publishes a comprehensive report on climate change every seven years, the most recent of which appeared in 2014. With thousands of contributing experts, the IPCC is widely considered as the definitive source of information on climate change, although the process of compiling reports and coming to a consensus about the text they contain is very lengthy and results in the reports lagging a few years behind the latest scientific results (meaning in practice that they tend to underestimate the magnitude of climate change).

18 In the terminology of the IPCC, 'extremely likely' means a probability of 95-100% (IPCC 2014a) .

Figure 5 Historical evolution of temperature and atmospheric CO_2[19]



Source: Petit et al. 1999

While CO_2 is the most important of greenhouse gases, several others also play an important role in the process of climate change. As can be seen in the table below (Table 1), all of these gases are currently present in the atmosphere in higher concentrations then they were prior to the industrial revolution. It can also be seen from the table that CO_2 is the most important greenhouse gas due to its quantity, which is much higher than that of the other greenhouse gases. On a molecule-per-molecule basis, however, the other greenhouse gases have a stronger warming effect than CO_2 – this is indicated by their relative global warming potential (which is measured in comparison to CO_2). The combination of global warming potential and quantity determines the actual size of the contribution of each gas to climate change[20] (Figure 6).

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19 Our knowledge about the climate of the Earth in the distant past comes from drilling deep holes in the polar ice. The age of the ice increases with depth, thus by analyzing the physical and chemical properties of each layer and the composition of air bubbles present within it, it is possible to determine the temperature as well as the atmospheric composition at the time these layers were formed.

20 For Figures 6, 7 and 8, the different greenhouse gases have been converted into CO_2-equivalents according to their relative global warming potential.

Table 1: Concentration, lifetime and global warming potential of selected greenhouse gases

Gas	Pre-industrial concentration	Current concentration	Atmospheric lifetime (years)	Global warming potential (100-year horizon)
CO_2	283 ppm0	405 ppm	variable[21]	1
CH_4	751 ppb	1850 ppb	12	28
N_2O	273 ppb	328 ppb	121	265
CFC - 12	0 ppt	505 ppt	100	10200

Source: IPCC 2014b, NOAA

Most of these gases also have natural sources,[22] but the man-made contribution is increasingly significant and is the main reason why their current concentration is higher than in past centuries (IPCC 2014b):

- **CO_2 (carbon-dioxide)**, as stated before, mainly comes from the burning of fossil fuels (coal, oil and natural gas) for energy generation, but emissions can also be caused by land-use change, notably deforestation (when forests are cleared, the carbon stored in trees is released into the atmosphere and the carbon content of the soil below them is also reduced considerably).
- **CH_4 (methane)** emissions are in part also associated with the fossil fuel industry (notably mining) but the agricultural sector also plays an important role via livestock (the digestion process of ruminant animals, such as cows, produces methane) and rice cultivation. Organic waste decomposing in landfill sites is also a source of anthropogenic methane emissions.
- **N_2O (nitrous oxide)** mostly comes from agriculture because of fertilizer use and animal manure, but a smaller part is the result of fossil fuel combustion.
- **Halogenated hydrocarbons, such as CFCs,** are entirely man-made gases that were used as refrigerants, foaming agents for plastics (such as insulation and packaging materials) and as propellants (for example, in deodorant sprays and fire extinguishers) during the second half of the twentieth century but were progressively phased out when it came to light

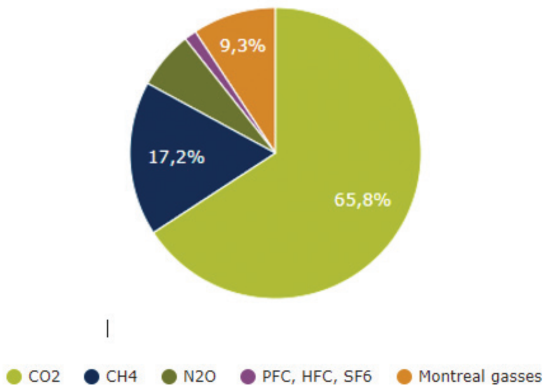
[21] It is not possible to determine a single atmospheric lifetime for CO_2 as there are several processes whereby it is removed from the atmosphere, with some (such as photosynthesis and dissolution in ocean water) occurring much faster than others (such as storage on the ocean floor, and in mineral deposits). This means that around one-third to one-half of emitted C02 will disappear from the atmosphere within a few decades, while some may remain there for thousands, or even hundreds of thousands of years (IPCC 2014b).

[22] The most important natural greenhouse gas, and in fact the most important greenhouse gas overall, is water vapour. However, the amount of this in the atmosphere is highly variable and mainly depends on air temperature, not emissions, so its concentration is therefore not directly influenced by human activity (IPCC 2014b).

that they were severely damaging the ozone layer. (They are shown in Figure 6 under the name 'Montreal gases', the Montreal Protocol being the international treaty under which they were phased out.) However, because these gases spend a long time in the atmosphere, they are still present and contributing to the greenhouse effect today. The replacement products currently in use, known as F-gases (shown in purple in Figure 6), do not damage the ozone layer but are also powerful greenhouse gases.

The above gases are not the only ones contributing to the greenhouse effect – in fact, all gases with three or more atoms are greenhouse gases – but many of these only spend a short time in the atmosphere and do not have a significant impact on the climate. One short-term gas that is known to have an important role in global warming is **tropospheric ozone (O_3)**, which is created through a chemical reaction by sunlight and certain polluting gases (mainly derived from car traffic).[23] But because the concentration of tropospheric ozone varies significantly in terms of time and place, it is very difficult to determine its overall contribution to global warming (it is therefore not included in Figure 6).

Figure 6 Contribution of various greenhouse gases to climate change



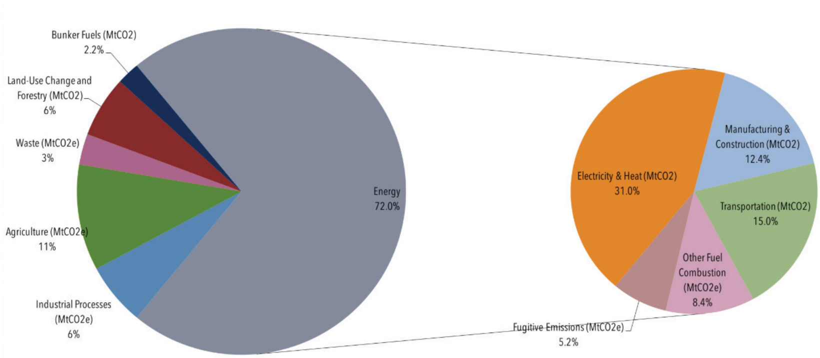
Source: EEA2018

Regarding the sectoral breakdown of greenhouse gas emissions, energy is by far the greatest contributor, whether the former is produced by the energy sector itself (in

23 The troposphere is the bottom layer of the Earth's atmosphere. Under natural conditions, a significant amount of ozone is only found in the stratosphere (about 20 kms above the surface of the Earth) where it plays a useful role by neutralizing the sun's harmful UV radiation. Tropospheric or ground-level ozone, on the other hand, is harmful because it not only contributes to climate change, but because it is also highly toxic and damaging to humans and other living organisms.

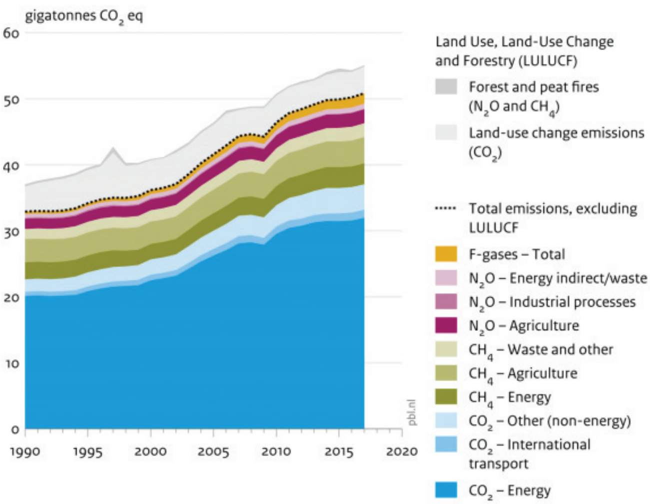
power plants) or in industry or transport (Figure 7). (Of course, most of the emissions created in the electricity and heat sector can also be attributed to those sectors where this energy is used; namely, industry and buildings [IPCC 2014a].) Trends show that the global emission of greenhouse gases continues to grow unabated (a slight, temporary reduction occurred in 2009 – the year of the global economic crisis). (Figure 8)

Figure 7 Global man-made greenhouse gas emissions by sector, 2013



Source: WRI via C2ES

Figure 8 Current trends in global greenhouse gas emissions



Source: Olivier-Peters 2018, p. 11.

In its last assessment report, the **IPCC outlined several scenarios** for future emission trends and attempted to predict the associated increase in global temperature (IPCC2014a). In these models, the point of reference is always the temperature observed in the second half of the nineteenth century, compared to which the current global average temperature has already increased by 1°C. Because of the greenhouse gases that are already in the atmosphere, warming is certain to continue and will reach at least 1.5-2°C by the end of the century. This is the most optimistic scenario, which is only attainable if greenhouse gas emissions are urgently and drastically reduced. (A new report was released in 2018 which recommends that global warming should not be allowed to exceed 1.5°C – this would necessitate that greenhouse gas emissions be reduced by 45% by 2030 and reach net zero in around 2050 [IPCC 2018].) In the worst case, if there is little effort to reduce emissions the temperature increase projected by the IPCC for 2100 is 4-5°C above pre-industrial levels. In any case, the temperature increase is not and will not be even across the globe, but generally higher over land than over the oceans, and strongest in and around the Arctic region (IPCC 2014a).

It is important to mention that, in addition to anthropogenic greenhouse gas emissions, there are several natural mechanisms which will also have an important role in shaping the future climate. Unfortunately, these natural mechanisms are mostly positive feedback loops that exist as a result of the temperature increase and act to strengthen it further (negative feedbacks also exist but the IPCC estimates that the overall effect of natural mechanisms on temperature will be positive). The most important of these **natural feedback mechanisms** are the following (IPCC 2014b):

- An increase in temperature results in more water vapour in the air, which, as previously noted, is also a greenhouse gas and therefore increases warming.
- Melting snow and ice results in formerly white, highly reflective surfaces being replaced by darker ones which absorb more sunlight (this is known as the albedo effect).[24]
- Oceans, which play a key role in removing CO_2 from the atmosphere, are able to do this to a reduced extent as they become saturated and their temperature increases.

With higher levels of global warming, there is a risk of triggering additional feedback mechanisms that could result in runaway climate change. There are currently large amounts of CH_4 stored around the world in permafrost (in regions such as Siberia) as well as under the ocean floor which may be released

[24] Albedo measures the proportion of sunlight reflected by a given surface and is much higher for snow and ice than for water and most other land surfaces.

if the temperature increase is large enough. While it is impossible to currently predict the point at which this may occur, avoiding the high temperature increase scenarios is also important for preventing these dangers.

4.2. The impacts of climate change

Increasing average temperatures are expected to have a whole range of impacts on weather patterns and physical conditions across the globe. These will in turn affect natural ecosystems, as well as human society and the economy. Some of the impacts can already be felt today, while others are expected to unfold over the course of the next decades – their magnitude is of course dependent on how much the global temperature increases. (While there is certainly a relationship between the size of the temperature increase and the size of the impacts, this relationship is not always linear. For some effects there are likely to be 'tipping points' – thresholds above which they escalate abruptly and might become irreversible.) The most important **direct impacts** of climate change are the following (IPCC 2014a):

- Shifting of climatic zones.
- Melting of ice and snow cover in the polar regions and mountainous areas (glaciers).
- Rise in global sea level (as a consequence of melting ice). Compared to the beginning of the twentieth century, sea level has risen by an average of about 20cm and this is expected to increase to 25-45cm by the end of this century under the different temperature scenarios.[25]
- Changes in rainfall patterns: the contrast between wet and dry regions and wet and dry seasons is expected to increase. (Dry regions will see even less rain and wet regions will see more.)
- Increased risk of extreme weather events (such as heat waves, floods, hurricanes, droughts, and wildfires).
- Ocean acidification. (This is in fact not a consequence of rising temperature but results directly from an increase in the atmospheric CO_2 concentration which leads to more CO_2 being dissolved in the ocean, lowering its PH).

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[25] In the long term, the greatest cause for concern regarding sea level is the fate of the Greenland ice sheet. As noted before, the temperature increase is greatest in the Arctic region, which is where the ice is receding most quickly. The melting of North Sea ice will not contribute to sea level rise, but the melting of Greenland ice will, because it is land ice and therefore adds water to the ocean as it melts. Scientists predict that a complete collapse of the Greenland ice sheet, which may well occur as a result of climate change and would be irreversible, would increase global sea level by as much as 7m, significantly altering coastlines all over the world, although this process is expected to take over a thousand years. The temperature threshold at which this may occur is not exactly known, but it is estimated to be between an increase of 1 - 4°C.

- Decrease in the dissolved oxygen content of the oceans. (Warmer water generally contains less dissolved oxygen.)
- Ocean currents may also be affected. The Gulf Stream (officially known as the Atlantic Meridional Overturning Circulation) is expected to weaken as a result of climate change, potentially leading to colder winters in Europe, although a complete collapse of the current by the end of this century is considered unlikely.
- Loss of biodiversity. Biodiversity across the globe is already declining rapidly due to human pressures (such as habitat destruction, pesticide use, etc.). Climate change will accelerate this process further as many species will not be able to adapt fast enough to changing conditions. (Coral reefs and polar ecosystems are the most vulnerable and are expected to suffer serious damage even under the lowest temperature increase scenarios.)

These direct impacts will in turn cause serious disruption to human activity around the world. The most important **socio-economic effects** of climate change are expected to be the following (IPCC 2014a):

- Damage to property and infrastructure from flooding and other extreme weather events.
- Food and water insecurity. With changes in rainfall patterns, people living in dry subtropical regions will face an increase in water shortages. While the conditions for agriculture might improve in some cold climates, the overall effect on food production in tropical as well as temperate regions is expected to be overwhelmingly negative, with the higher temperature increase scenarios posing serious threats to global food security. The global fish catch is also expected to decline due to ocean warming, acidification, and the expansion of zones with very low oxygen content ('dead zones').
- Impacts on human health. Climate change is expected to affect human health in many ways, most of which are again negative. Problems include deaths from heat waves and extreme weather events (while of course fewer people will die from cold exposure), an increase in disease-related risk (in relation to vector-borne diseases such as malaria as well as diseases related to contaminated drinking water and food poisoning) and worsening urban air quality. indirectly, the most significant health risk from climate change is malnutrition, particularly among children. The WHO estimates that these factors will lead to approximately 250,000 excess deaths annually during the period 2030-2050 (WHO 2018).

Overall, it is clear that countries in tropical and subtropical regions – mostly developing countries – will suffer most as a result of climate change, and within individual countries, it is again poor communities and households which will be the most vulnerable. In general, climate change is expected to slow down economic growth and make poverty reduction more difficult. To a certain degree, it is possible to prepare for the effects of climate change and reduce the resulting damage via adaptation measures (such as improved agricultural practices, flood protection infrastructure, health care services, etc.), but again, poor countries and communities are the least capable of making these investments. It is therefore likely that climate change will increase the pressure for migration and could lead to the displacement of large groups of people over the next century, as well as raise the risk of violent conflict in many areas (IPCC 2014a).

Numerous attempts have been made to quantify the economic damage associated with climate change. Since efforts to reduce greenhouse gas emissions come at a cost, it would be easier to make decisions regarding these investments knowing whether they are justified in cost-benefit terms. There is, however, a lot of uncertainty involved in such calculations. The most widely publicized study of the economic impacts of climate change is the so-called Stern Review (prepared by Sir Nicholas Stern for the government of the United Kingdom in 2006). The main conclusion of the report is that failing to prevent climate change would lead to an economic loss equivalent to 5-20% of global GDP per year (continuing forever). The investment needed to avoid such a scenario is only ~1% of global GDP annually, so the benefits of vigorous and early action far outweigh the costs (Stern 2007). (Since such vigorous action has not been taken since the publication of the report, the cost of prevention is now likely to be higher.) However, the conclusions of any such analysis that compares present costs and effects in the distant future are heavily dependent on the discount rate used in the calculations. The main criticism regarding the Stern Review is that it applied a discount rate that some regarded as too low – with a higher discount rate, future impacts appear smaller and therefore justify smaller prevention-focused investment (Nordhaus 2007). The choice of a ‘correct’ discount rate is, however, more of an ethical than a scientific issue, meaning that there is no objective way to decide how much sacrifice should be made in the present to prevent the future consequences of climate change.[26]

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[26] Discounting is the mechanism used in finance to express how the value of future sums of money is less than the value of the same amount today (because people generally prefer to consume now rather than later, and because today’s money can be invested to generate interest that accumulates into the future). For conventional investment decisions, the market interest rate is usually used as the discount rate. The application of the usual discount rate of 4-6% means that the value of impacts in the more distant future (such as climate change impacts that may occur in the latter half of this century) is close to zero. While some do not regard this as a problem (essentially saying that instead of spending on preventing climate change, money should be invested to ensure that future generations are as rich as possible), others argue that such ‘discounting of the future’ is ethically unacceptable (because of climate change, future generations may in fact be poorer than we are today), and a lower discount rate (called the social discount rate) should be applied (Weisbach-Sunstein 2008).

Indeed, many entirely reject the application of a cost-benefit analysis approach to the problem, pointing out that vital ecosystem services threatened by climate change cannot be replaced by money (Neumayer 2007).

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5. INTERNATIONAL EFFORTS TO ADDRESS CLIMATE CHANGE

Concerns regarding the influence of anthropogenic greenhouse gas emissions on the climate system began to emerge in the middle of the twentieth century. Mounting evidence over the following decades led to increasing political attention to the issue that resulted in a series of international conferences and treaties that continue to this day. Within this framework, many countries have made commitments and introduced a range of measures to address climate change: however, as can be seen from the emission trends described in the previous chapter, these efforts have hitherto been insufficient to effectively tackle the problem.

The two basic categories of measures for addressing climate change are called **mitigation** and adaptation. Mitigation refers to the prevention of warming mainly by reducing greenhouse gas emissions but also by enhancing so-called 'sinks' that remove greenhouse gases from the air (such as forests that bind CO_2). **Adaptation**, as previously mentioned, means preparing for a warmer world via making investments into flood protection, irrigation systems, drought-tolerant crops, health care, etc. Although the proportion of effort and resources that should be devoted to mitigation and adaptation measures is debatable, it is clear that these must be seen as complementary strategies rather than mutually exclusive options. Because climate change is no longer completely avoidable, adaptation is necessary to reduce the damage – but even with significant investment, our capacity for adaptation has its limits, meaning that mitigation is also indispensable for stopping the temperature increase before it becomes unmanageable (IPCC 2014). In the early stages, the international climate negotiations focused largely on mitigation, with adaptation emerging as an important topic later as it became clear that a certain degree of climate change is inevitable.

Effectively mitigating climate change is made difficult by the fact that it requires joint efforts by all large emitters of greenhouse gases. In economic terms, a stable climate can be understood as a public good. Public goods represent a form of market failure[27] that can be resolved by government intervention (for example by introducing taxes to finance their creation). The climate, however, is a global public good with no global governance authority to ensure

[27] The central characteristic of public goods is that they are non-excludable, meaning that it is not possible to prevent people who have not paid for them from having access to them (typical examples include national defence or street lighting). This gives rise to the 'free-rider' problem, where individuals can take advantage of these goods without contributing to their creation – however, if too many people take this approach, the good will not be provided and everyone will suffer a loss of welfare.

that it is protected. As we will see below, the incentive for individual countries to free-ride (wait for others to shoulder the economic cost of emission reductions while not making significant sacrifices themselves) continues to be a huge problem. (Weitzman 2017)

5.1. The United Nations Framework Convention on Climate Change

The first major step towards addressing climate change at the international level was taken at the United Nations Conference on Environment and Development (colloquially known as the 'Earth Summit' or the 'Rio Summit') in 1992: the adoption of the United Nations Framework Convention on Climate Change (UNFCCC). As a framework convention, this treaty did not contain any specific greenhouse gas emission reduction targets; rather, it formulated the general objective of 'stabiliz[ing] greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system' (United Nations 1992, Article 2), and established the mechanisms for negotiating future, more specific treaties to this end. One concrete task set out by the Convention is the establishment of national greenhouse gas inventories to monitor countries' emissions (as well as removal by carbon sinks), which can also serve as baselines for future emission reduction commitments.

The UNFCCC entered into force after achieving the required number of ratifications in 1994 and currently has 197 parties, meaning that the vast majority of countries are involved (Figure 9). The Convention acknowledges that developed countries are responsible for the majority of historical greenhouse gas emissions[28] and that their per capita emissions are also higher than those of developing countries. It therefore establishes the principle of 'common but differentiated responsibilities', meaning that developed countries should take the lead in addressing climate change. These developed countries are listed in Annex I of the treaty and are therefore known as Annex I countries (they include most OECD member countries as well as several former Soviet republics). A narrower circle of the world's most advanced countries (listed in Annex II) are also expected to provide financial assistance to support developing countries' mitigation and adaptation efforts (United Nations 1992).

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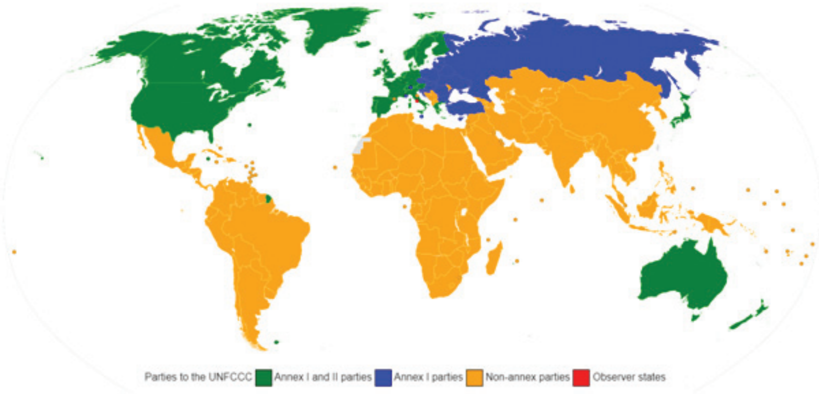
[28] Historical emissions are significant because, as explained earlier, a significant portion of such greenhouse gases remain in the atmosphere and influence the climate for many years after they are emitted.

Figure 9 Parties to the UNFCCC



Source: Wikipedia

Each year (starting from 1995) the parties to the UNFCCC meet (usually in November or December) to discuss the implementation of the convention and make decisions regarding further steps. (These meetings are known as COPs, or conferences of the parties.)

5.2. The Kyoto Protocol

The third COP, held in 1997 in Kyoto, saw the adoption of the first (and so far, only) treaty under the UNFCCC with concrete, legally binding emission reduction requirements: the Kyoto Protocol. The Kyoto Protocol entered into force in 2005.

5.2.1. Targets

The Kyoto Protocol covers six greenhouse gases: CO_2, CH_4, N_2O, HFCs, PFCs and SF6. Changes in carbon sinks (related to land-use change and forestry) are also taken into account when calculating the reductions. In line with the principle of common but differentiated responsibilities, in this first round of commitments only the developed countries of Annex I were required to reduce their emissions, on average by around 5% (with a separate target for each country), from 1990 to 2008-2012 based on the average emission for those years (United Nations 1998).

The EU (then consisting of 15 Member States) had a reduction target of 8% (which was internally broken down into different individual targets for each Member State). The USA signed the treaty and agreed to a reduction of 7%, but then (after a change of government) decided not to ratify it (citing as a reason that, since developing countries were not required to make any reductions, the treaty would seriously harm the US economy) (Bush 2001). Japan had a target of 6%, Russia 0% (effectively promising not to increase its emissions), and Hungary 6%. For some Eastern European countries, the base year was not 1990 but earlier (for Hungary, it was the average of the years 1985-1987 [United Nations 1998]). This is a significant fact, because in the early 1990s the collapse of the heavy-industry-oriented communist economy in these countries led to huge emission reductions, meaning that they were able to meet (and often greatly overachieve) their Kyoto targets without any dedicated effort.[29]

5.2.2. Flexible mechanisms

The Kyoto protocol also established several mechanisms for fostering international cooperation to reduce emissions, the so-called Kyoto flexibility mechanisms. The underlying logic is that, since the atmospheric concentration of greenhouse gases only depends on the total amount of global emissions, not their geographical location, reductions should be made wherever this can be done at the lowest possible cost. Countries are therefore allowed to finance reductions elsewhere in the world and count these toward their own targets. The Protocol establishes three flexibility mechanisms by which this may be done: International Emissions Trading (IET), Joint Implementation Projects (JI), and the Clean Development Mechanism (CDM) (United Nations 1998).

International Emissions Trading allows Annex I countries which are able to exceed their own targets to 'sell' the surplus emission reduction to countries who are struggling to meet their own goals.[30] In practice, it was mainly the former communist countries of Eastern Europe which, for the above-mentioned reasons, were able sell emission allowances under this system to countries such as Japan, Austria, Spain, etc. However, as the reduction of emissions in Eastern European countries happened independently of any conscious effort and was already apparent by the time the national Kyoto targets were established, many criticized the practice, pointing out that allowing other countries to use these 'unnecessary' emission allowances (often referred to as 'hot air') was detrimental to the climate goals. To alleviate these concerns, countries selling their emission allowances usually pledged to use the resulting income

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29 In Hungary, this phenomenon is known as the 'environmental bonus effect' of the (economically and socially traumatic) restructuring process that accompanied the transition to democracy and market economy (in Hungarian: '*a rendszerváltozás környezeti ajándékhatása*').

30 While following a similar logic, it is important to distinguish this mechanism from the permit trading systems described in Chapter 1.2.3, whereby individual polluters – companies – trade emission quotas/allowances. Some such systems, such as the EU's Emission Trading System, have links to the flexible Kyoto mechanisms, as described later, but are still separate instruments.

to finance further emission reductions (such as investments into renewable energy or energy efficiency) under so-called Green Investment Schemes. Nevertheless, it is probably the criticism of such 'hot air' purchases that resulted in the IET being, in terms of the quantity of emission credits transferred, the least used of the three flexible mechanisms (Grubb et al. 2011).

The other two mechanisms, **Joint Implementation Projects** and the **Clean Development Mechanism** allow Annex I countries to finance specific emission reduction projects in other countries and count the reductions they achieve toward their own targets. The difference between the two is that in the case of the JI, the country where the project is taking place is also an Annex I country – the two Annex I countries that are involved finance the project together and divide up the resulting emission reduction credits. (For example, when the Kazincbarcika power plant in Hungary was converted from coal to biomass in 2002, the Netherlands paid around EUR 3 billion of the EUR 10 billion investment cost and received 700,000 emission reduction credits in exchange [Népszabadság 2002].) CDM projects, on the other hand, take place in developing countries and are financed entirely by Annex I countries – through these projects, developing countries which have no reduction obligations of their own can also become involved in the implementation of the Kyoto protocol. In practice, CDM has proven more popular with investors than JI (or the IET), and its main beneficiaries have been more advanced developing countries, with China being by far the largest recipient, followed by India, Brazil and South Korea, with African countries only accounting for 2% of emission reduction credits (Shishlov et al. 2016).

Views about these project-based mechanisms, especially the CDM, are mixed. On the one hand, they allow Annex I countries to meet their reduction obligations at a lower cost while encouraging FDI inflows and technology transfer toward developing countries. On the other hand, the accounting of emission reductions can be problematic. Unlike emission allowances traded under the IET, which represent reductions that have already taken place, the reductions 'produced' by JI and CDM projects can only be estimated against a hypothetical baseline and are therefore less certain (Grubb et al. 2011). (Building a wind or a solar power plant, for example, will not in itself reduce CO_2 emissions, but only if we assume that without this investment from the Annex I country the host country would have built a fossil power plant instead.)

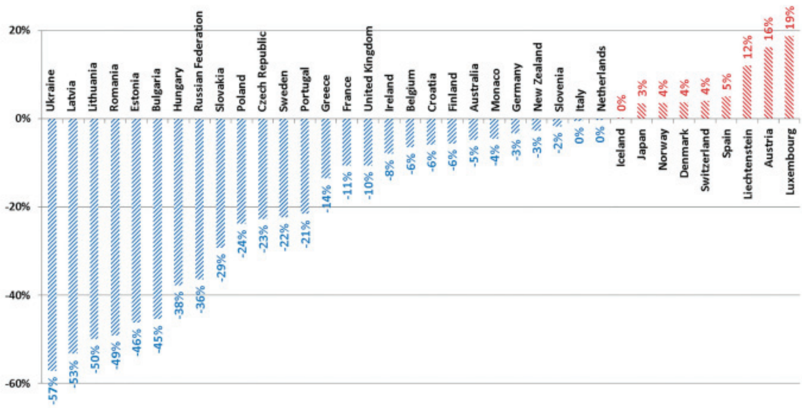
Indeed, the CDM has repeatedly come under fire for financing projects whose environmental benefits are doubtful. In the early days of CDM, one of the most popular projects was the destruction of industrial gases such as HFC-23. This gas is a by-product of refrigerant production and a potent greenhouse gas, so destroying it instead of releasing it into the environment is clearly beneficial. However, demand for the resulting emission reduction credits by Western investors made HFC-23 destruction so lucrative that in some cases the gas was manufactured solely in order to be destroyed in the framework of CDM projects. Upon realizing this problem, the rules were changed so that new facilities would not be eligible for CDM. Over time, renewable energy projects became the most important ones under the CDM, but ensuring additionality is also a challenge with these. Hydropower plants, for example, generally produce energy at a low cost, so it is likely that host countries would have built these anyway, without CDM assistance. And since the construction of large hydropower plants is usually accompanied by huge ecological damage, their overall environmental benefit is questionable. (Even investments in fossil fuels are not excluded from the CDM if it can be shown that they are 'cleaner' than the average coal power plant.) In order to ensure an added environmental benefit, CDM projects are subject to a complex approval and monitoring process which, while creating legitimacy, also causes delays and greatly increases the associated transaction costs. Nevertheless, it should be acknowledged that CDM projects have played an important role in laying the foundations for the renewable energy industry in countries such as China which is now one of the World's leading investors in the field (Grubb et al. 2011).

5.2.3. Compliance and results

Although the UNFCCC states that the compliance mechanism of the Kyoto protocol 'is among the most comprehensive and rigorous systems of compliance for a multilateral environmental agreement', the consequences for countries that fail to meet their emission reduction targets are in fact quite limited. The main 'punishment' for non-compliance is that Annex I countries that do not meet their reduction targets can be required to reduce their emissions by an additional 30% during the next phase (the so-called second commitment period) of the Protocol. Countries can also be suspended from participating in the flexible mechanisms (UNFCCC 2019a). It is, however, highly questionable whether any country which failed to reach their target in the first period would have any motivation to participate and meet the more stringent target in the second period.

Despite the lack of a strong enforcement mechanism, all Annex I countries were able to achieve full compliance with their targets for the first commitment period 2008-2012. The single exception is Canada, which had a reduction target of 6% but instead saw its emissions rise by over 33% and decided to formally withdraw from the Protocol in 2011 rather than find itself in a situation of non-compliance. (The provisions of the Protocol allow withdrawals even at such a late stage.) All the remaining countries successfully met their targets, although some were only able to do so with the help of the flexible mechanisms – these are the countries shown in red in Figure 10, which illustrates the *domestic* emissions of countries relative to their Kyoto targets.

Figure 10 Relative difference between the average annual domestic emissions of countries for 2008–2012 and their respective Kyoto targets



Source: Shishlov et al. 2016, p. 4.

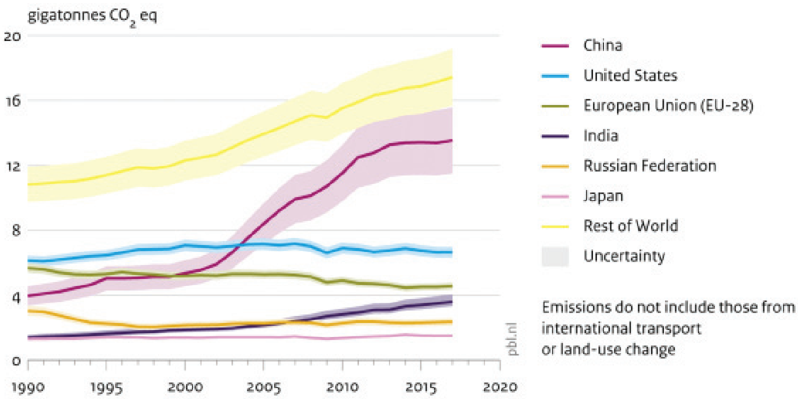
The aggregate emission reduction in Annex I countries was 24%, much greater than the required 4% (the overall reduction requirement was reduced from the previously mentioned 5% due to non-ratification by the USA and the withdrawal of Canada). This ‘overachievement’ can be attributed to several factors – notably, the results of the economic transition in the ex-communist countries (which, as previously mentioned, were already known at the time that the Protocol was signed, but it was expected that the USA and Canada would buy up most of the surplus credits.) However, according to estimates by Shishlov et al. (2016), the overall Kyoto target would have been achieved even without these ‘hot air’ credits. Another factor contributing to the overachievement was the economic crisis of 2008-2009 which led to a (temporary) reduction in global energy consumption and GHG emissions. Last but not least, it should be acknowledged that during the period in question, many Annex I countries made substantial efforts to reduce GHG emissions by introducing a range of policy measures such as energy taxes, emissions trading schemes, and support schemes for renewable energy and energy efficiency investment.

Despite the fact that its formal targets were exceeded, the Kyoto protocol fell far short of achieving the UNFCCC’s goal of preventing dangerous climate change. This is mainly due to the limited coverage of the agreement: as developing countries had no reduction targets and the USA and Canada also exited, the Protocol in fact covered only around a quarter of the World’s total GHG emissions.

5.3. Efforts in the post-Kyoto period

As it was clear that the Kyoto protocol only represented a first step towards addressing climate change, the international community started discussions about a new agreement for the post-Kyoto period in 2007, with the objective of adopting a new, binding treaty by 2009 (United Nations 2008). The most important change compared to previous negotiations was the realisation that in order to achieve meaningful results, it would be necessary for developing countries to also commit to limiting their greenhouse gas emissions. (While the per capita GHG emissions of developing countries continue to be much lower than in the developed world, their absolute emissions have increased rapidly and now account for a larger share of global emissions – see Figure 11.) However, this has made reaching an agreement that is acceptable to all sides considerably more difficult. The greater involvement of developing countries also drew more attention to issues that are important from their perspective. One is the question of the financial assistance that developing countries view as a prerequisite for agreeing to cut their emissions. The other is the increase in efforts to reduce deforestation, which compared to in developed countries plays a much greater role in the emissions of the developing world (Ekholm-Lindroos 2015).

Figure 11 Evolution of GHG emissions by country/region



Source: Olivier-Peters 2018, p. 20.

Adopting a new treaty was the main goal of the **Copenhagen Climate Conference** (COP 15 of the UNFCCC) in December 2009. Expectations were high (not least because the new US administration under Barack Obama promised to take a constructive stance) and the summit was accompanied by consider-able attention from NGOs and the media. The negotiations, however, failed to deliver a new treaty and instead resulted in the non-binding Copenhagen Accord (reflecting the position of the USA and the BASIC countries – Brazil, South Africa, India and China). The Accord states for the first time the goal of limiting the global average temperature increase to 2°C but does not contain any specific national targets to this end. Instead, countries were asked to individually adopt and announce their own targets (for the year 2020) in the period following the conference, which was done by 85 countries (United Nations 2010). In line with the expectations formulated in the text of the Accord, developed countries submitted actual reduction targets (some of which were conditional upon other countries also taking meaningful action), while developing countries instead made pledges to reduce the carbon intensity of their economies or to reduce emissions compared to a business-as-usual scenario – effectively meaning that these countries only pledged to slow down the growth of their carbon emissions rather than to actually reduce them (UNFCCC 2010). An analysis by the UNEP of these national pledges indicated that they were overall insufficient to limit global warming to 2°C (UNEP 2010).

The Copenhagen Accord also contains a pledge to substantially increase **financial assistance** from developed countries to help developing countries with their mitigation and adaptation efforts. (Several multilateral funds were already in existence to serve this purpose under World Bank or UN auspices – the Green Climate Fund established by the Copenhagen Accord has since become the largest such fund.) The goal set out by the Accord is to reach USD 100bn/year by 2020 (United Nations 2010), but so far the actual funding has fallen far short of this promise (Climate Policy Initiative 2018).

Stepping up efforts in the field of **forestry** was also on the agenda of the post-Kyoto negotiations. Afforestation/reforestation measures (planting new forests) were already eligible as CDM projects in the Kyoto framework, but efforts to prevent deforestation (the protection of existing forests), although potentially much more important, could not be counted due to methodological difficulties. (One such difficulty is the aforementioned additionality issue – how can we be certain that without implementing the measures in question a forest would be destroyed? Another problem specific to deforestation is the question of ‘leakage’ – this happens when the protection of forests in one area leads to deforestation in another.) However, since the issue is too important to be ignored (the 2014 IPCC report estimates that around 10-15% of global annual GHG emissions are from land-use change), a new UNFCCC initiative was launched to develop methods for the reliable measurement, reporting and verification of forest-management-related action and its results. The programme, called REDD+ (Reducing Emissions from Deforestation and Forest Degradation in Developing Countries) was first conceived in 2005, but it was not until 2015 that all the details of implementation were finalised. Under

REDD+, participating countries (mostly tropical countries) are required to develop strategies and action plans to protect and manage their forests, and to develop specific projects with measurable emission savings, for which activity they will receive international funding (United Nations 2016).

As it became clear that attempts to negotiate a new treaty for the post-Kyoto period would not succeed in time, some parties to the Protocol decided to fill the gap by extending the Kyoto Protocol (due to expire in 2012) until 2020. The extension, known as the **Doha Amendment**, was adopted in December 2012 and contains new reduction commitments by Annex I parties but still no such commitments for developing countries (the extension is known as the second commitment period of the Protocol) (United Nations 2012). However, from the original Annex I parties to the Protocol, Japan, Russia and New Zealand decided not to participate in the extension, thus the only participants with reduction targets are the EU, Australia, and Kazakhstan, representing only around 15% of global GHG emissions. (As of March 2019, the amendment is still not in force due to the insufficient number of ratifications, but the EU has already achieved its promised reduction of 20%.)

5.4. The Paris Agreement

The continuing series of negotiations in the framework of the UNFCCC finally resulted in the adoption of a new climate treaty at the 21st COP in Paris in December 2015. The Paris agreement was signed by 194 countries and entered into force in October 2016. (The United States signed and ratified the treaty, but later the Trump administration announced its intention to withdraw from it as soon as possible.[31])

The central aim of the Paris Agreement is stated as 'holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C' (United Nations 2015, Article 2). However, unlike the Kyoto Protocol, the Paris Agreement does not contain any actual emission reduction targets for participating countries. Instead, it requires them to set and submit their own targets (called 'nationally determined contributions', or NDCs), essentially extending the approach taken by the Copenhagen Accord. These targets should be revised every five years, with each new target more ambitious than the previous one. The targets are not legally binding and there is no enforcement mechanism to ensure that they are met. However, the treaty does contain legally binding requirements for parties to regularly report on the evolution of their greenhouse gas emissions and their mitigation activities, the idea being that a system of 'naming and shaming' underperforming countries will motivate them to step up their efforts (Roberts-Arellano 2017).

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[31] The provisions of the treaty allow countries to formally announce their withdrawal no earlier than three years after ratification, which in the case of the USA is in November 2019, with the withdrawal becoming effective one year later.

Further issues addressed by the Paris Agreement include climate finance (re-affirming the intention to provide USD 100bn/year to help developing countries), an increased focus on adaptation measures, as well as provisions regarding international cooperation for achieving emission reductions (essentially a continuation of the Kyoto flexible mechanisms). On this last issue, the Paris Agreement establishes a framework for the 'international transfer of mitigation outcomes' (ITMO), similar to the IET mechanism in the Kyoto protocol, and a Sustainable Development Mechanism, similar to CDM. However, the specifics regarding the functioning of these mechanisms were not laid out, and some countries (such as those within the EU) have indicated that they plan to reach their emission reduction targets domestically, without recourse to the former.

Indeed, many important details regarding the implementation of the Paris Agreement were left to be clarified by subsequent meetings. Key rules regarding the measurement and reporting of countries' emissions and mitigation efforts were adopted at the 24th COP in Katowice in December 2018, but some other questions (such as the rules governing the international cooperation mechanisms) remain unsettled.

After the adoption of the Paris Agreement, many expressed disappointment about the lack of legally binding targets in the treaty (Clémençon 2016). However, the absence of legally binding targets may not be as crucial to the success of the treaty as it initially seems. Since participation in any international treaty is voluntary, binding targets and strong enforcement provisions may actually be counter-productive in that they reduce countries' willingness to join an agreement (or countries may decide to join but only take on very weak targets that are unlikely to cause compliance problems). Legally binding agreements are therefore not necessarily more effective in terms of achieving their purpose – what ultimately matters is whether there is sufficient motivation for countries to join and subsequently implement the provisions of any international agreement, and this motivation is often of a political nature (international pressure, trading favours, public opinion, etc.)(Chang 2010).

In the case of the Paris Agreement, it is largely the flexible approach regarding national targets that made it possible to get so many countries on board (Clémençon 2016). This flexibility may also be beneficial because the regular review of the NDCs allows targets to be progressively strengthened.[32] Moreo-

[32] The rapid transformation of the Chinese economy, for example, may well lead to the country significantly overachieving its current targets – if the mechanisms for the international trading of emission credits continue in the Paris era, this could lead to a huge surplus of credits in the system (similar to the issues surrounding 'hot air' from ex-communist countries under the Kyoto regime). However, unlike the Kyoto regime wherein national targets were fixed at the outset, under the Paris framework China's target may be modified upward in its next NDC to reflect changing conditions and avert this problem (Grubb 2016).

ver, the strong transparency requirements create a good basis for countries to hold each other accountable for their contributions. Ultimately, the success of the Agreement depends on countries' readiness to apply political pressure on each other to make sure that all live up to their responsibility for protecting the climate (Herz 2017). It must be noted, however, that the current targets (the first round of NDCs) submitted by the parties are overall insufficient to achieve the goal of limiting the global temperature increase to 1.5-2°C (UNEP 2018), as is discussed in detail below.

A comprehensive review of the implementation and progress under the Paris Agreement is foreseen for 2023.

5.5. Current situation and questions for the future

Although much progress has been made towards addressing climate change since the world gradually became aware of the threat in the final decades of the twentieth century, assessments show that current efforts are still falling behind what is needed to effectively tackle the problem. Indeed, instead of closing, the so-called 'science-policy gap' regarding the climate issue has widened considerably in recent years, with policy makers failing to act upon the recommendations of the scientific community who are calling for much faster and steeper emission cuts in light of improving knowledge about the process and impacts of climate change. (Faragó 2016)

Each year (since the approach of countries adopting their own targets was adopted as a result of the Copenhagen conference), the UNEP publishes an assessment analysing these commitments and comparing them to what is needed to stay within the 1.5 and 2°C temperature limits (the so-called 'emissions gap report'). According to the latest such report (UNEP 2018), implementing all current NDCs for 2030 would put the world on the path to an approximately 3-3.2°C temperature increase compared to pre-industrial levels by the end of the twenty-first century (with warming expected to continue further beyond 2100). Staying within the 2°C limit would require countries to approximately triple their proposed reductions and staying within the 1.5°C limit would require a fivefold increase. The report also notes that the majority of countries are not yet on track to reach their 2030 targets and need to adopt additional policy measures to do so.

Indeed, global GHG emissions have increased again in 2017 after three years of stagnation and are not expected to peak before 2030 based on current targets and policies (although an increasing number of countries have already passed their peak and are now seeing absolute emission reductions). However, the 2018 emissions gap report acknowledges that significant changes have started to occur worldwide in areas such as renewable energy investment, electric mobility, energy efficiency, etc. and the world is finally moving away from its dependence on fossil fuels – the main problem is that these changes are not happening nearly as fast as necessary. The pace of change is of course limited by existing infrastructure (including everything from coal power plants and gas pipelines to diesel cars and poorly insulated buildings), and delaying action can make this 'carbon lock-in' effect worse[33] (UNEP 2018).

5.5.1. An evaluation of countries' efforts

The current NDCs of the top 10 GHG-emitting countries for 2030 are as follows (UNFCCC 2019b):

- Brazil: 43% reduction since 2005
- Canada: 30% reduction since 2005
- EU: 40% domestic emission reduction since 1990
- China: 60-65% reduction of emissions per unit of GDP since 2005, with a peak in absolute emissions expected by 2030 at the latest
- India: 33-35% reduction of emissions per unit of GDP since 2005
- Indonesia: 29-41% below business-as-usual emissions
- Japan: 26% reduction since 2013
- Mexico: 25%-40% below business-as-usual emissions, with a peak in absolute emissions expected around 2025-26
- Russia (has not yet ratified the treaty): 25-30% reduction since 1990
- USA (intends to withdraw from the treaty): 26-28% reduction from 2005 - 2025 (expected)

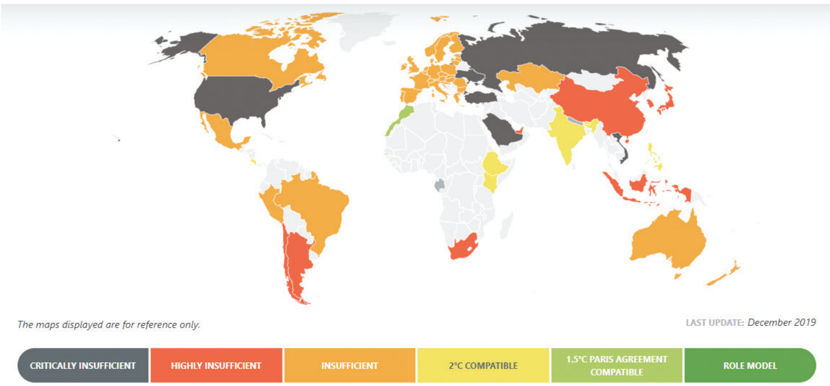
As the list shows, with countries taking their own approach to target setting, comparison of targets has become quite difficult. First, countries are using different baselines: as most countries (with the notable exception of Russia) increased their GHG emissions from 1990 to 2005, a 2005 baseline implies a smaller reduction than a 1990 baseline (Canada's 30% emission reduction target from 2005, for example, is equivalent to a 15% reduction from 1990 levels). Second, a major difference between developed and developing countries' commitments is still that developing countries are usually only prepared to pledge a reduction relative to their GDP, which means that their absolute emissions continue to grow – although some developing countries, such as China, have indicated the point at which they intend to start making absolute reductions. Some countries have conditional targets (the higher numbers in the case of Indonesia and Mexico, for example), which they are ready to implement only under certain conditions

33 If the world decides to shift to a low-carbon economy, existing fossil fuel reserves and infrastructure will need to be written off as 'stranded assets' (coal power plants will need to be shut down before they reach the end of their technical lifetime, oil reserves left in the ground, etc.), causing significant economic losses. The more we continue to invest in such infrastructure, the greater the potential loss and the more difficult it becomes to commit to making a change (UNEP 2018).

(which are usually quite vague, such as that other countries should also take ambitious action or that developing countries receive financial support). Last but not least, countries' commitments also vary regarding the inclusion of land use and forestry emissions. As previously mentioned, these may be very important in some countries, but because their estimation is highly uncertain, their inclusion makes it more difficult to evaluate a country's progress. (A positive approach is therefore taken by some countries, for example, India, which set itself a forestry target not as a part of but in addition to its overall emission reduction target.)

Figure 12 shows an assessment of countries' current commitments published by an association of three independent research institutes (Climate Action Tracker 2019). Colours indicate whether the level of ambition reflected in each country's target is in line with the Paris temperature goals, taking into account the individual situation of each country. While opinions may differ as to what exactly can be considered the 'fair share' that countries in different positions should contribute to the fight against climate change (the assessment in Figure 12 combines various approaches to determine this), it is clear (as is acknowledged by the principles of the UNFCCC) that more can be expected of prosperous nations than developing countries. (This is why, for example, India's target is rated favourably by the assessment, even though in absolute terms it is much lower than the pledges of many other countries such as the EU or Canada.)

Figure 12 Evaluation of current climate pledges according to Climate Action Tracker

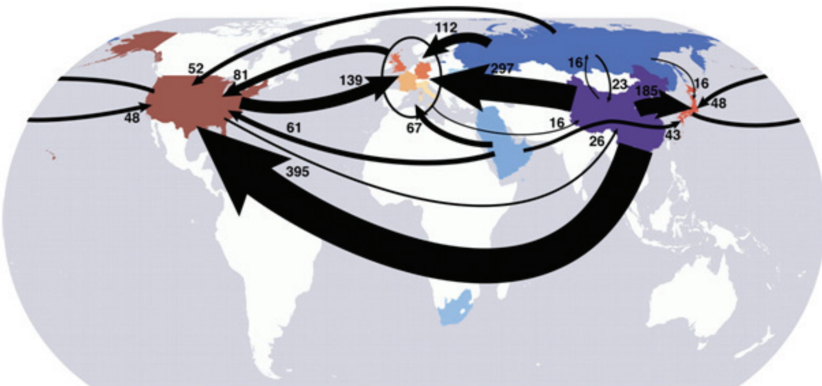


Source: Climate Action Tracker 2019

When it comes to evaluating countries' GHG emissions and reductions, all international treaties currently adopt the principle that each country is responsible for the emissions originating from within its own national borders. However, given the fact that today's globalised economy is characterized by high volumes of international trade, this may not be the best approach for **accounting for GHG emis-**

sions. It is questionable whether, for example, CO_2 emissions associated with the production of a smartphone (or any other product) made in China but sold and used in Europe or the USA should indeed be considered part of China's emissions rather than those of the importing countries whose consumer demand was the reason for producing the product. Some suggest that the current production-based accounting of emissions should be replaced by a consumption-based system whereby a country's emissions are calculated by subtracting exports and adding imports to domestic emissions. This would make a huge difference for many countries, reducing the emissions of big exporters such as China (whose emissions would be more than 20% lower under a consumption-based system) and generally attributing more to OECD nations (see Figure 13) (Davis – Caldeira 2010). A consumption-based system is generally regarded as being more favourable to the attainment of climate goals since developed countries usually have more ambitious climate targets which would then cover a larger proportion of global emissions – and they could no longer achieve reductions by 'outsourcing' polluting production activities to developing nations. The problem is that calculating consumption-based emissions is far more complex and involves more uncertainty than a production-based system and is therefore unlikely to replace the current production-based system in the foreseeable future[34] (Csutora – Vetőné Mózner 2013, Alfionis et al. 2017).

Figure 13 Largest flows of carbon emissions embedded in international trade



Source: Davis-Caldeira 2010

[34] The fairest approach would probably be to somehow divide the responsibility for emissions embedded in international trade between consumer and producer countries because they both enjoy the benefits of these activities (consumer countries benefit from the use of products, while producers benefit in the form of income and jobs). Various principles have been put forward to create such GHG accounting systems based on 'shared-responsibility' but none are developed enough to represent a realistic alternative (Csutora – Vetőné Mózner 2013, Alfionis et al. 2017).

5.5.2. Alternative approaches

Given the insufficiency of current policy measures and targets for tackling the problem of climate change, there is a lot of discussion about how to step up efforts and what, if any, complementary or alternative approaches could be more successful.

One such alternative is the suggestion that instead of focusing on setting fixed reduction targets, the de-carbonisation of the economy could be promoted more effectively by setting a **global price for carbon** emissions. Making polluters pay the cost of the pollution they cause is the fundamental principle of environmental economics and has huge potential to motivate emission reductions. The pricing could be done in the form of a tax or an emissions trading system – indeed, many countries already have such systems in place, but out of concern for international competitiveness, they are reluctant to impose prices that are high enough to have the necessary impact. Therefore, several prominent economists advocate the idea that countries should commit as a group to a globally harmonised (minimum) carbon price, something that they believe would be easier to negotiate than quantitative reduction targets (Weitzman 2015, Nordhaus 2013, Stiglitz 2015).

So far, this approach has not yet appeared at the international climate negotiations (in the Paris framework, carbon pricing is viewed simply as one possible tool for helping meet national targets), so countries continue on their own path, but the number and scope of carbon pricing schemes around the world is growing continuously. As of February 2019, according to the World Bank around 44 countries as well as 27 sub-national actors (cities, states or regions) have implemented carbon pricing schemes, covering just under 14% of global greenhouse gas emissions (World Bank 2019; see Figure 14), with several more planning to do so in the near future. Notably, following several successful regional pilots, China is currently in the process of setting up a nationwide emissions trading scheme (initially covering only the power sector). (It should be noted that in addition to the ones shown in Figure 14, most other countries also have energy or fuel taxes in some form, but they are not based explicitly on the carbon content of fuels.)

The problem is that carbon prices under most of these schemes – although increasing – still fall far short of what is necessary. The World Bank estimates that by 2020 a price of 40-80 USD/tonne would be needed to meet the Paris targets (World Bank – Ecofys 2018), while the OECD uses a similar but slightly lower range of 30-60 EUR/t[35] – but states in its 2018 report that actual carbon prices across all industries in OECD countries (taking into account all forms of fossil fuel taxes) are overall 76.5% lower than the low benchmark of 30 EUR/t (OECD 2018).

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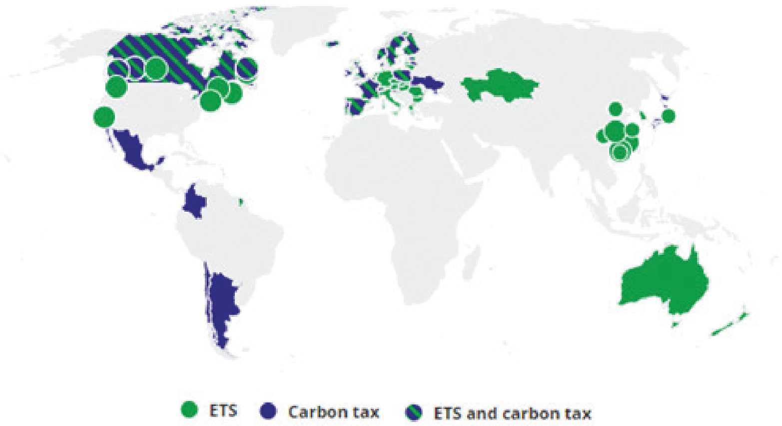
[35] The values used by the OECD are based on calculations regarding the climate-change-related costs associated with the emission of each additional tonne of CO_2. While this approach (calculating the size of the externality that needs to be internalised) can be considered theoretically superior (because of the previously discussed huge uncertainty inherent in estimating future damage from climate change), it is also less reliable than the World Bank's method of estimating the ideal carbon price based on the reductions required to achieve the Paris targets.

Figure 14 Summary map of national, sub-national and regional carbon pricing initiatives



Source: World Bank 2019

With global emission trends continuing in an unfavourable direction, efforts are also continuing to find new technological solutions to the climate problem. Collectively known as climate engineering or geoengineering, these techniques aim at deliberately altering the Earth's climate system and fall into two broad categories: carbon dioxide removal (CDR), which seeks to reduce greenhouse gas concentrations by creating additional carbon sinks, and solar radiation management (SRM), which aims to limit global warming by reducing the amount of solar radiation that the Earth absorbs (IPCC 2014). Potential CDR techniques (in addition to simple afforestation) include bioenergy with carbon capture and storage (using plants to absorb CO_2 from the atmosphere and then storing it in geological formations underground when the plants are burned to create energy),[36] biochar (which also relies on plants to absorb CO_2, but these are then converted to charcoal and spread onto the soil, improving its quality and creating long-term storage for the carbon), as well as various technologies for the direct air capture of CO_2. Several options have also been proposed for SRM, such as injecting aerosols into the stratosphere, spraying seawater to brighten marine clouds, and even launching giant mirrors into space, all of which would produce a cooling effect by increasing the share of solar radiation that is reflected from the Earth.

[36] Carbon capture and storage technology can of course also be used with fossil fuel power plants to prevent CO_2 emissions into the atmosphere, but if used in conjunction with biomass it can potentially result in the net removal of the gas.

Most of these techniques are currently in the early stages of development and have several problems such as cost (which are generally high for CDR, but can be very low in the case of some SRM solutions) and a range of potentially unfavourable side effects (the sustainability of solutions involving biomass is always questionable because of land-use change impacts, while large-scale interference with the climate system called for by SRM techniques is inherently very risky [IPCC 2014]). According to critics, the greatest problem is that experimentation with these technologies can be used as an excuse to delay reducing greenhouse gas emissions (Hamilton 2015). Nevertheless, most scenarios developed by the IPCC assume that CDR techniques (notably bioenergy with carbon capture and storage) will be used, complementary to other mitigation options (mainly in the second half of the century), because this represents the only way to sufficiently reduce atmospheric GHG concentrations (IPCC 2014).

5.5.3. The role of private actors

Beyond policymakers, other actors such as **businesses** and individuals can also contribute to the fight against climate change and, seeing the inadequacy of policy efforts, some even believe that the voluntary actions of such private actors might be the solution. While this book largely focuses on public policy, we consider it worthwhile to briefly outline the role of these other actors to see whether such high expectations are justified.

Regarding businesses, it has already been discussed in Chapter 2.3.2 that an increasing number of the former have environmental programmes that go beyond legal requirements, and in recent years climate change and greenhouse gas emissions have clearly emerged as a top priority with regard to these efforts (BSR – Globescan 2018). The drive to reduce operating costs has always pushed companies to strive to increase the efficiency of the use of resources such as energy, but today many companies are going further by using a rapidly developing range of tools to address their contribution to climate change and the associated risks. A recent survey of the world's 1200 largest companies showed that nearly 80% have programs in place to reduce GHG emissions, and around half also have a concrete, quantified GHG reduction target. Another new trend is that, instead of setting these targets arbitrarily, leading firms are now relying on complex methodologies to derive their individual emission reduction targets from the global 2°C or 1.5°C climate goals. If companies are to effectively address their contribution to climate change, it is also essential to look beyond their organisational boundaries as a huge share of GHG emissions related to their activities occur elsewhere in the supply chain, from the abstraction of raw materials through transport and manufacturing to product use and disposal. Many companies have now completed the huge task of calculating these emissions (an exercise known as carbon accounting) and are seeking to reduce them via various measures such as selecting and influencing their suppliers and improving product design. Interestingly, when evaluating investment decisions or the performance of divisions, many large multinationals are now applying an internal carbon price (treating GHG emissions as if they represented an actual cost). These internal prices (averaging 38 USD in 2017) are typically higher than the existing carbon taxes or quota-related prices for carbon described in the previous chapter, showing that these businesses are expecting to face more stringent climate policies in the foreseeable future (Greenbiz – Trucost 2019).

Thanks to such ambitious measures, GHG emissions from the world's largest companies are now in decline (a 9% reduction from 2013 to 2017 for the largest 1200 firms, including supply chain emissions). On the one hand this is promising because it shows that even such profit and growth- oriented entities as multinational companies are able to make not only efficiency improvements but also absolute reductions in their carbon emissions. On the other hand, these reductions are still critically insufficient – the targets of the 1200 largest companies only amount to around a quarter of the reductions that would be needed from them to be compatible with the Paris goals (Greenbiz – Trucost 2019). And, more importantly, the impressive toolbox described above is only used by a select group of the world's largest companies, while the vast majority of firms are far less conscious in the management of their carbon emissions, and small companies often struggle to identify and make even those technological improvements that would create clear economic as well as climate benefits (Dobes et al. 2017). This is why the corporate sector as a whole has so far not been able to reduce its emissions (which grew by 1% globally in 2017) (Greenbiz – Trucost 2019).

Some believe that instead of relying on policymakers or companies to make the necessary changes, it is **individuals** who will need to embrace more sustainable lifestyles, and are hopeful that such lifestyles will become mainstream in the near future. Indeed, studies from around the world show that the majority of people are concerned about environmental problems such as climate change (Pew Research Center 2019) and believe that environmental protection is an important issue. According to the latest Eurobarometer survey of the topic, 94% of EU citizens say that protecting the environment is important to them personally, with climate change considered the most important problem (Eurobarometer 2017). Such positive attitudes toward the environment are, however, not always reflected in actual behaviour – many studies have highlighted this discrepancy and identified a number of potential causes, including unwillingness to make sacrifices, a lack of available options, a lack of knowledge, as well as established habits and social norms (Zsóka et al. 2013). Even so, a growing proportion of people in developed nations are actively trying to pursue a more sustainable lifestyle in a way that is influencing their daily consumption-related decisions. (A study from the USA now puts the share of the most environmentally committed consumers at 23% [Natural Marketing Institute 2019], and recent market research from Germany also shows that the market share of green products across all product categories is growing rapidly [Umweltbundesamt 2017].)

The problem is that the changes that such environmentally conscious individuals are making are not necessarily profound enough to achieve meaningful reductions in their environmental impact. A surprising study by Csutora (2012) found no significant difference between the average ecological footprint of consumers who engage in pro-environmental behaviour and those who do not. The proposed explanation for this counter-intuitive result is that most green consumers practice ‘marginal’ forms of environmentally friendly behaviour (such as separating waste, which requires relatively little sacrifice but is also much less effective at reducing the individual ecological footprint than, for example, turning down the thermostat at home or reducing meat consumption). Furthermore, people are also limited in their decisions by structural factors (in many places, environmentally conscious individuals also have to rely on fossil fuels for heating and electricity in the absence of renewable energy options, or might need to travel by car if the public transport network is inadequate) (Csutora 2012). Similarly, the previously mentioned German study also found that, despite the increasing market share of green products, the CO_2 emissions associated with private consumption in Germany have not declined in recent years. The explanation in this case is that green products are least available in those categories where the benefits would be the greatest (such as passive houses or electric cars), and that the benefits of environmentally friendly products have been offset by an increase in the overall quantity of consumption (Umweltbundesamt 2017).

Based on the above considerations, we conclude that while businesses and individuals can indeed play an important role in achieving environmental goals, this can never substitute for policy action which continues to be indispensable both for creating an incentive for private actors to make more sustainable decisions, as well as shaping the infrastructure around which those decisions are made.

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6. CLIMATE POLICY OF THE EUROPEAN UNION

In absolute terms, the climate targets of the EU are among the most ambitious in the world. The climate and energy package adopted as a part of the 'EU 2020' strategy (European Commission 2010) has three main targets:

- to reduce greenhouse gas emissions by 20% (from 1990 levels)[37]
- to reach a 20% share of renewable sources in final energy consumption (with a sub-target of 10% renewable energy use in the transport sector)
- to improve energy efficiency by 20%[38]

The targets for 2030 are as follows (they will be reviewed with the possibility for upward revision in 2023) (European Commission 2019a):

- to reduce greenhouse gas emissions by 40% (from 1990 levels)
- to reach a 32% share of renewable sources in final energy consumption (with a sub-target of 14% renewable energy use in the transport sector)
- to improve energy efficiency by 32.5%[39]

The European Commission has also developed a long-term vision for the EU: for it to become fully climate neutral by 2050 (via the nearly complete phase-out of fossil fuels and tackling the remaining emissions via carbon capture and storage and enhanced sinks) (European Commission 2018a). (As of May 2019, this target is not binding as it has so far not been endorsed by the Council due to opposition from Germany and several CEE nations) (Simon 2019).

Progress towards the EU's 2020 and 2030 climate and energy targets is shown in Figure 15 below. It can be seen that the 20% GHG reduction target for 2020 was met ahead of time and looks to be tenable despite the fact that the Union's emissions have slightly increased in the last few years. There is more uncertainty regarding the other two targets, with current trends concerning energy efficiency being especially unfavourable. The recent increase in overall energy consumption also makes it more difficult to achieve the renewable energy target, since the latter is defined as a percentage of energy consumption, meaning that, in abso-

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37 The target does not include emissions from land use change but does cover GHGs from international aviation. The EU also formally stated its willingness to increase this target to 30% provided that a global agreement could be reached in which 'other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities' (European Commission 2010 p. 11.), but as we have seen earlier, these conditions were not met.

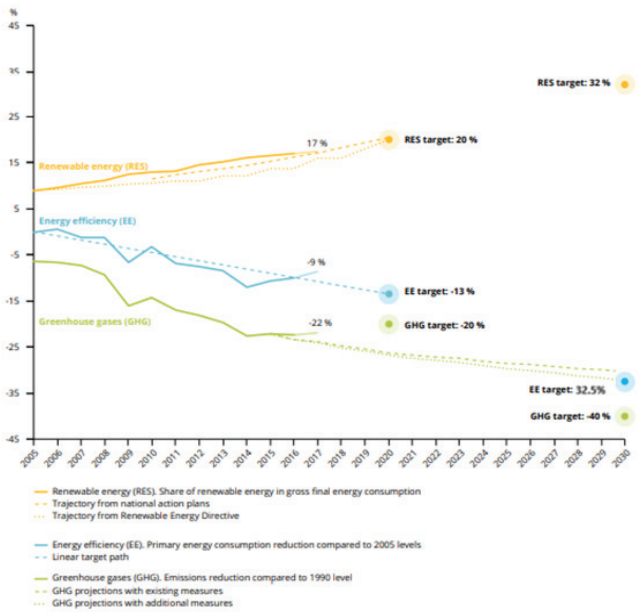
38 The exact requirement is that primary energy use should be 20% lower than the business-as-usual levels projected for 2020 and is thus defined as an absolute amount (equivalent to a net reduction of primary energy consumption of 13.4% from 2005).

39 The target is again defined in a similar way as for 2020 and is equivalent to an absolute reduction of 26% from 2005 levels.

lute terms, more renewable energy is needed to reach 20% of final consumption.

Figure 15 also shows that the targets for 2030 are quite challenging and achieving them will require additional policy measures. The targets are of course connected, with progress on renewable energy and energy efficiency essential for meeting the overall GHG target. The Commission's calculations show that if the renewables- and energy efficiency targets for 2030 are met, this will mean a decrease of at least 45% in GHG emissions, overachieving the 40% reduction target (European Commission 2018b).

Figure 15 EU progress towards 2020 and 2030 targets for climate and energy



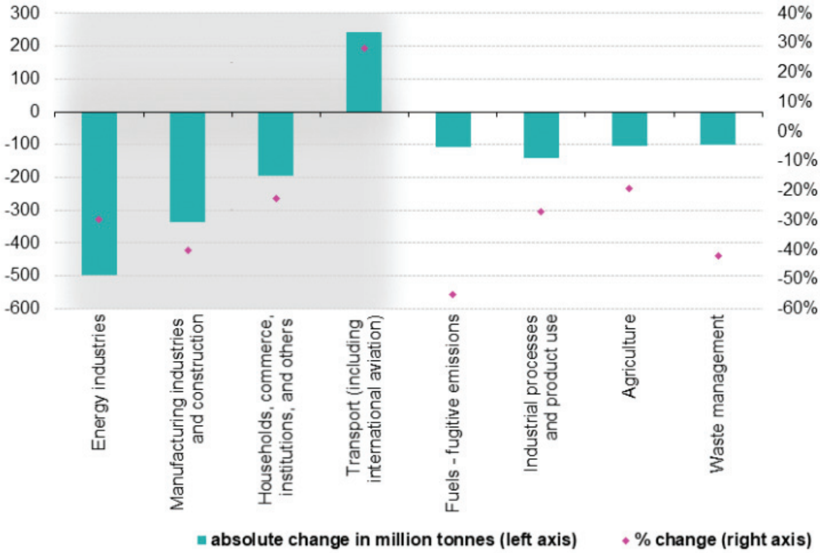
Source: based on EEA (2018)

Behind the overall decrease in the Union's greenhouse gas emissions, huge differences can be observed between various sectors (see Figure 16). Compared to the base year 1990, the power sector and industry were most successful in reducing their emissions, but most other sectors (such as agriculture and households) were also able to improve their performance. The notable exception is the transport sector, which emits nearly 30% more GHGs today than it did in 1990 and is now responsible for around a quarter of the EU's emissions (Figure 17).[40]

40 The largest category, fuel combustion, includes the burning of fossil fuels in power plants, industrial installations as well as households.

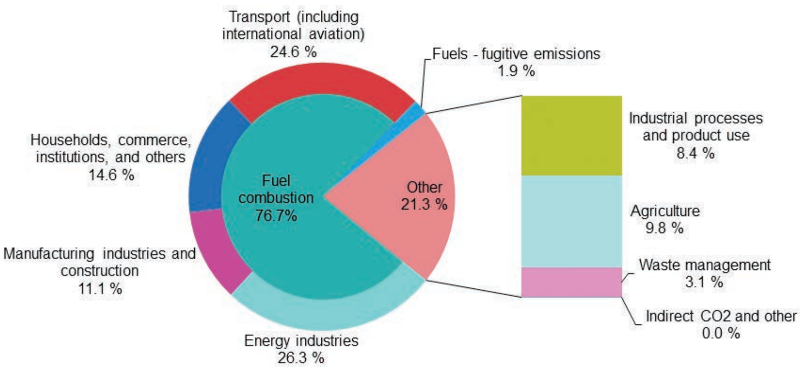
The following sections will present an overview of the EU's most important policy measures for achieving its climate and energy targets.

Figure 16 Evolution of EU greenhouse gas emissions by sector, 1990-2016.



Source: EUROSTAT 2018

Figure 17 Breakdown of EU GHG Emissions by sector in 2016



Source: EUROSTAT 2018

6.1. The EU Emissions Trading System (ETS)

The EU's main policy tool for motivating GHG emission reductions at large emitters is the Emissions Trading System (ETS) introduced in 2005. This was the world's first major carbon market and remains by far the largest until this day. As discussed in Chapter 2.2.3, emissions trading is an attractive policy option because it allows authorities to set fixed reduction targets while maintaining the flexibility for individual polluters to decide on their own emission reduction, thereby minimising total reduction costs. Greenhouse gases like CO_2 represent an ideal application for cap and trade systems, because they do not cause direct environmental damage at the local level, which renders the geographical distribution of emissions and their reduction unimportant. However, the devil lies in the details, and as we will see below, in practice it is not easy to design a well-functioning emissions trading system.

The EU ETS covers over 11000 large installations that are responsible for around 45% of the Union's GHG emissions. These include power plants, energy intensive industries (such as oil refineries, the production of metals, cement, ceramics, pulp and paper, certain chemicals, etc.) and airlines (from 2012 onwards). The goal is for ETS sectors to reduce their emissions from 2005 levels by 21% until 2020, and 43% until 2030. The most important questions surrounding the operation of the ETS relate to the determination of the total amount of permits – called emission allowances under the ETS – to be issued and deciding how to distribute these to participating companies (for free or by auction). The ETS operates in phases (also known as trading periods) spanning several years, with the rules regarding these and other issues adjusted between each phase based on previous experience (European Commission 2016).

The **first phase** (2005-2007) was essentially a pilot period intended to set up and test the system. During this phase, individual Member States were responsible for deciding the number of emission allowances to be issued, which were mostly distributed for free to companies based on their previous emissions ('grandfathering').[41] While the pilot phase was successful in establishing the carbon market as well as the system for monitoring, reporting and verifying participants' emissions, it turned out that the number of allowances issued by the Member States was too high, and consequently, the quota price (which peaked at around 30 EUR in 2006) fell to zero in 2007 (European Commission 2019c).

In the **second phase** (2008-2012), the number of allowances was reduced (and the share of free allocations declined slightly, to around 90%), but the economic crisis which unfolded during this time meant that the energy use in the sectors

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[41] With a certain number of permits set aside for potential new entrants – companies who start operating after the launch of the ETS and thus cannot receive any permits based on past emissions.

covered, and thus the demand for emission allowances, declined even more, once again leading to an oversupply of permits and low permit prices. Another factor contributing to the oversupply of permits was the possibility for ETS participants to obtain a certain amount of additional allowances by buying credits under the Kyoto flexible mechanisms (CDM and JI). Other developments during this phase were Iceland, Norway, and Switzerland joining the EU ETS, and the extension of the system to include the **aviation sector**[42] (European Commission 2019c). The latter step proved quite controversial because the EU initially wanted to include all flights to and from EU airports. This sparked huge resistance from industry as well as countries like the USA and China (The Economist 2012) and led to the scope of the ETS being limited to intra-EU flights.[43] (The rules for airlines under the ETS are also different and less strict than for other sectors – see below.)

The **third phase** of the ETS (2013-2020) saw significant changes regarding the allocation of emission allowances. This was necessary because the oversupply of permits and the low permit price in previous periods meant that the ETS was not successful in motivating substantial changes toward de-carbonisation. Therefore, in the third phase, the decision about the number of allowances was moved to the EU level (instead of leaving this to Member States), and it was determined at the outset that this cap would decrease by 1.74% per year (except for the aviation sector, where it remains constant at 5% below the 2004-2006 average emission level).

The other major change was shifting the method of allocating the permits gradually from free distribution to auctioning. This means that approximately 57% of allowances issued during the third phase were auctioned. Free allocation remains dominant for the aviation sector (where 82% of permits were distributed for free) and for those industries where the risk of 'carbon leakage' is judged to be high. The term carbon leakage refers to the problem that, in industries faced with strong international competition, companies might decide to transfer their production outside the EU if the cost of complying with the ETS (i.e. buying permits) is too high (which would be detrimental from an environmental as well as an economic perspective).[44]

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42 Responsible for around 3% of the EU's GHG emissions, aviation is currently not one of the largest emitters but needs to be addressed because the growth rate of emissions is very high (European Commission 2019b).

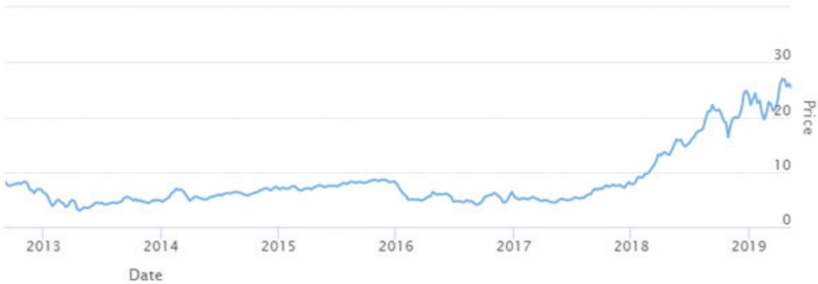
43 This limitation is, in principle, temporary and conditional upon the International Civil Aviation Organization (ICAO) taking steps to effectively address CO_2 emissions from international flights. The ICAO complied with this request by passing a resolution that, from 2020, airlines will be required to offset growth in their CO_2 emissions (by buying credits from emission reduction projects such as renewable energy investments). (European Commission 2019b)

44 Sectors are deemed vulnerable to carbon leakage if the cost of buying permits would increase production costs by at least 5% AND the sector's trade intensity with non-EU countries (imports and exports) is above 10%; or if either of the above is over 30% (European Commission 2019d).

These sectors continue to receive their allowances for free, but the method of allocation has changed from grandfathering to a system based on industrial benchmarks, which rewards the most efficient companies (see Chapter 2.2.3). The third major group of participants, power plants, have not received any permits for free since 2013, with the exception of power plants in the new Member States of Central and Eastern Europe (European Commission 2016). The increase in the share of allowances distributed via auction also means that the ETS now generates significant public revenue for Member States. The rules of the ETS require that at least 50% of this revenue be spent for climate-related purposes, and in practice many Member States have exceeded this obligation, reaching 80% on average (European Commission 2018b).

However, even the new, tighter cap has not been able to solve the issue with the oversupply of permits that the ETS has been suffering from since the outset. This is because a large surplus of allowances was brought over ('banked') from the second phase, and also because companies are still able to obtain additional allowances via CDM projects outside the EU (such international credits are comparatively cheap and are thus driving down the EU quota price). The EU initially attempted to solve the problem by postponing the auctioning of new allowances ('backloading'), but this was not sufficient to solve the problem and it became clear that only a permanent mechanism could be truly effective at 'fixing' the ETS. This mechanism, called the market stability reserve, was launched in January 2019 and works by automatically removing allowances from the market if the number of allowances in circulation exceeds a pre-determined amount (should the number of allowances on the market be too low, a certain amount will be automatically released from the reserve) (European Commission 2018b). In anticipation of the launch of the market stability reserve, the price of quotas started increasing in 2018 and, as of May 2019, was around 25 EUR (see Figure 18).

Figure 18 Evolution of the EU ETS quota price (EUR/t)



Source: Sandbag 2019

The rules for the **fourth phase** of the ETS (2021-2030) were finalised in 2018 and contain the following changes: the annual reduction in the number of allowances issued will increase to 2.2% per year; the criteria for carbon leakage will be tightened, reducing the number of sectors eligible for free allowances; and companies will no longer be allowed to use international credits to fulfil their ETS obligations (European Commission 2018b).

Thanks to the new rules – notably the market stability reserve, which will drastically reduce the number of allowances in circulation over the next few years –, analysts are generally optimistic about the future performance of the ETS. Quota prices are expected to increase even further, reaching levels that may trigger significant change, mainly in the energy sector where a high price for carbon emissions threatens the viability of coal and lignite power plants. (The risk remains, of course, that in such a situation, political pressure from the heavily coal-dependent countries of Europe could lead to changes that weaken the system) (Stam 2018, Olsen 2019).

6.2. Effort sharing

Greenhouse gas emissions from other (individual) smaller sources that do not fall under the scope of the ETS (certain industries, as well as sectors such as buildings, transport, agriculture and waste) are regulated via the so-called 'effort sharing' system. The term refers to the fact that for these sources, reduction targets are defined at the Member State level, determining the contribution expected of each country to the common effort of reducing GHG emissions. The overall goal for effort sharing sectors is a 10% reduction by 2020 and 30% by 2030 compared to 2005 levels.[45] The targets of individual Member States vary considerably depending on their level of economic development, with smaller reductions expected from countries with a lower GDP/capita (these economies are expected to grow faster and also have lower investment capacity, making it more difficult to cut emissions). As can be seen in Figure 19, the 2020 targets even allowed CEE countries to increase their emissions. The national targets are mandatory, and progress toward them has to be made year by year in a linear fashion (with some limited flexibility between years). The effort sharing legislation also allows Member States to use flexibility mechanisms similar to the ones that exist under the Kyoto protocol to meet their obligations. Specifically, underperforming countries have the possibility to buy the 'missing' reduction credits from other Member States who were able to overachieve their target for the given year[46] (European Commission 2018b).

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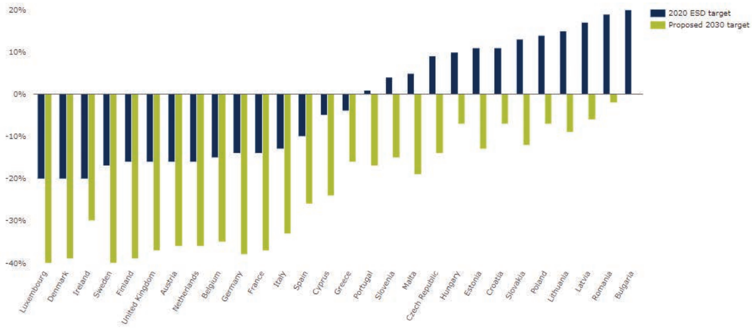
[45] The targets are set in a way that, together with reductions from the ETS sectors, they should deliver the total GHG reductions defined in the EU's climate strategy.

[46] Credits from certain types of CDM and JI projects can also be counted toward national targets, but this option will not be available after 2020.

Figure 19 National GHG emission reduction targets under the effort sharing system



Source: based on EEA 2017

Reducing greenhouse gas emissions in sectors covered by effort sharing legislation is primarily the responsibility of Member States, who may use a wide range of policy tools to achieve this (from making improvements to public transport systems and promoting electric cars to supporting schemes for building renovation, climate-friendly agricultural practices, etc.) Nevertheless, several specific measures are also taken at the EU level which target GHG emissions in these sectors. The most important of these are presented below for each sector.

6.2.1. Transport

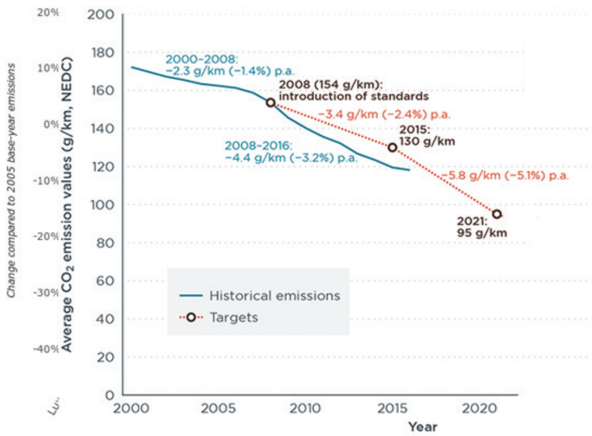
As we have seen above (Figure 16, Figure 17), the transport sector is one of the most problematic areas from the point of view of climate change. Within transport, road transport is the most important, causing nearly 75% of transport emissions (Eurostat 2018). Reducing the latter can be achieved through a wide array of measures, from promoting more environmentally friendly transport modes and alternative fuels to more efficient vehicles and using information technology to optimize the flow of traffic and various financial incentives (fuel taxes, road charges, etc.) to support these solutions. At the EU level, the two most important initiatives are the fuel efficiency standards for road vehicles and a mandate to increase the use of alternative energy in the transport sector.

The EU introduced mandatory fuel efficiency standards for new vehicles in the form **of CO_2 emission standards** (in g/km) in 2009 (with a first deadline of 2015) for cars (Regulation 2009/443/EU) and in 2011 (with a first deadline of 2017) for vans (Regulation 510/2011/EU). The targets and the historic evolution of fuel efficiency for cars can be seen in Figure 20.[47] (The numbers shown represent

47 The targets correspond to fuel consumption of about 5.6 l/100 km for petrol and 4.9 l/100 km for diesel cars for 2015 and 4.1 and 3.6 l /100 km in 2021 (European Commission 2019e).

the EU-wide fleet average; targets for individual manufacturers can be higher or lower depending on the average mass of their vehicles, taking into account the fact that larger, heavier cars will always consume more fuel than small ones.) Figure 20 shows that the introduction of mandatory targets was able to significantly foster the improving trend towards greater fuel efficiency.[48] The targets for 2030 were officially adopted in early 2019 (-37.5% for cars and -31% for vans from 2021 levels[49]) (Regulation 2019/631/EU), and, for the first time, the EU is also introducing CO_2-related targets for heavy duty vehicles (trucks): -15% by 2025 and -30% by 2030 (from 2019 levels) (European Commission 2018c).

Figure 20 Fuel efficiency trends and standards in the EU



Source: Mock 2017

Regarding alternative fuels, the currently best-established option is the use of **biofuels**. They represent the simplest solution regarding the use of renewable energy in the transport sector because they are compatible with the existing infrastructure (internal combustion engine cars, and fuel stations). However, it has been increasingly called into question over past years whether

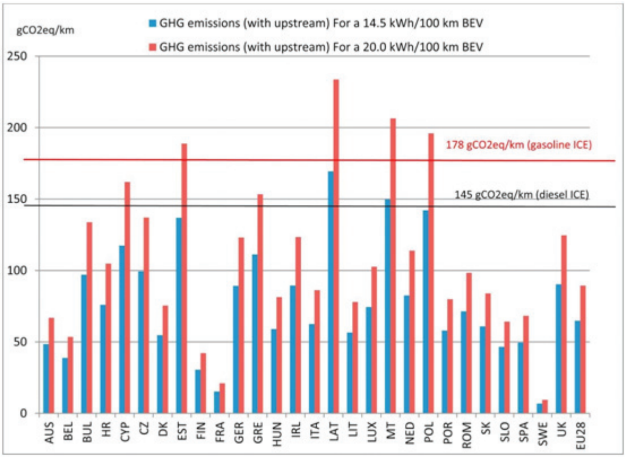
48 Prior to introducing the mandatory targets, the Commission sought to reduce CO_2 emissions from cars via a voluntary agreement with the European Automobile Manufacturers Association (ACEA) (European Commission 1999). However, industry failed to deliver the agreed reduction in time (the target was 140 g/km for 2008), leading the Commission to abandon the voluntary approach in favour of mandatory standards.

49 The new targets are defined as % reductions instead of absolute values because the official vehicle testing procedures of the EU are currently undergoing reform and it is therefore not yet possible to know what the exact starting point in 2021 will be in g/km (Mock 2017).

biofuels (notably, so-called ‘first generation’ biofuels made from food crops) can truly be considered environmentally sustainable and this has resulted in a shift in EU policy, as will be discussed in detail in Chapter 6.4.3.

The other solution that is now rapidly increasing in popularity is **electric cars**. These do not directly emit any air pollution and therefore have huge benefits in terms of urban air quality (as well as noise reduction). The amount of greenhouse gas emissions they cause is of course dependent on the source of the electricity they use, but in most cases it is also less than the emissions from conventional cars. A recent study (Moro-Lonza 2018) that compared GHG emissions from electric cars to petrol and diesel cars in the EU found that, on average, emissions from the former are approximately 50% lower (see Figure 21). The figure also highlights the huge variations between Member States due to the different energy mixes. In countries that rely mostly on coal to generate electricity (such as Poland or Latvia) the usage of electric cars currently offers no climate benefit, while in countries with a high share of nuclear power or renewable sources (such as France, Sweden and Finland) it is much more favourable. It should also be noted that, as the share of renewables in electricity generation is expected to increase in the future, so will the CO_2 reduction potential of electric cars.[50]

Figure 21 GHG emissions from electric vehicles in the EU compared to conventional cars



Source: Moro-Lonza 2018

50 In sufficiently large numbers, electric cars may themselves help to bring about the transition to renewable electricity because, while not in use, their batteries could be used for storing electricity. (Currently one of the main barriers to developing certain types of renewable electricity such as wind and solar is that their production is variable and does not necessarily match demand, so finding ways to increase electricity storage capacities in a cost-effective manner is of key importance.)

While the EU in principle supports the development of e-mobility, it has so far refrained from setting mandatory targets for the sale of electric cars (in the first quarter of 2019, their market share stood at 2.5% [ACEA 2019a] but this is expected to increase rapidly). However, the fuel economy standards discussed above represent strong pressure for car makers to sell more electric cars as they are otherwise unlikely to be able to reduce their fleet average CO_2 emissions to the required level. In addition, the EU also requires Member States to increase the availability of charging infrastructure for electric as well as other alternative fuel vehicles (such as those that use hydrogen and compressed or liquefied natural gas) (Directive 2014/94/EU).

As the car industry is of strategic importance in the EU (representing 6.8% of GDP, 6.1% of jobs and creating a sizable trade surplus [ACEA 2019b]), the above measures have not only environmental but also far-reaching economic and social implications and continue to be the subject of much heated debate. While environmental groups have, of course, campaigned for tighter CO_2 standards and mandatory sales targets for electric cars (Transport & Environment 2018), industry representatives have called the new targets highly demanding and unrealistic (ACEA 2018). Because electric cars are generally associated with a lower profit margin for carmakers, EU companies have so far not invested significantly in the area and now have to turn to China when importing batteries (which country, while no threat to EU companies when it comes to conventional cars, has been aggressively pushing electric cars in the last few years and now has the competitive advantage). In the near future, EU firms may even have to sell electric cars at a loss to meet CO_2 standards or face heavy fines for exceeding them[51] (Campbell – McGee 2018). Industry experts therefore strongly criticise EU decision makers for jeopardising profits and jobs in one of Europe's last highly successful industrial sectors (Reuters 2019) – while environmental NGOs argue that, since electric cars likely represent the future of the industry, it also represents good economic strategy to push companies in that direction sooner rather than later (Transport & Environment 2018).

6.2.2. Buildings

Buildings (primarily because of their heating and cooling needs) are massive users of energy and are responsible for ~36% of the EU's CO_2 emissions. The

[51] Another important factor causing EU companies to end up in this position is the decline of diesel cars. These emit less CO_2 than petrol cars and were an important part of the strategy of EU manufacturers to bring their fleets' average emissions down. However, the diesel emissions scandal of 2015 resulted in many consumers turning away from the technology and buying petrol cars instead (a few years ago, diesel accounted for over half of new car sales in the EU, but this had fallen to 37% in 2018), causing an increase in fleetwide emissions and necessitating a reliance on electric cars that is greater than expected (Campbell – McGee 2018).

energy performance of buildings varies widely – it is possible to build buildings that require little to no external energy input, and EU legislation mandates that all new buildings built after 2020 fall into this category ('nearly zero-energy buildings'). However, the majority of the EU's building stock is old and often highly inefficient, and it is of course not realistic to expect it will all be replaced within a few years or even decades. Therefore, the EU also has measures in place to promote the energy efficient renovation of existing buildings, including a mandatory annual renovation rate of 3% for government buildings (Directive 2012/27/EU) and a requirement for all countries to draw up long-term renovation strategies with targets and incentives to stimulate the renovation of buildings outside the government sector. It is also an EU requirement that owners provide energy performance certificates every time a building is sold or rented. (Directive 2018/844/EU)

6.2.3. Agriculture

Agriculture differs from other sectors in relation to climate change because most of its emissions do not result from fossil energy usage but from other processes, notably the usage of nitrogen-based fertilisers, the enteric fermentation process of some animals (notably cattle and sheep), and manure management. The main greenhouse gases created in the sector are therefore N_2O and CH_4. The continuous reduction of emissions observable in the agricultural sector over the past decades (see Figure 16) can be mainly attributed to the reduction in fertiliser use and livestock numbers. (At the same time, the EU's food imports have grown substantially, meaning that the GHG emission reduction in the EU was at least partly offset by growth in other parts of the world.) (Eurostat 2017)

The Common Agricultural Policy – one of the EU's most important common policies, aimed at supporting farmers – has several elements that are relevant for climate change (and the environment in general).[52] The direct payments provided under the CAP are linked to several environmental conditions, and grants awarded under the rural development heading are also available for environmental investments. The Commission estimates that approximately of 25% of CAP payments during the period 2014-2020 are related to the promotion of climate-friendly farming practices (European Commission 2015).

[52] Aside from direct environmental aspects, the fundamental structure of the CAP is also of key importance – since 2003 most payments have been provided in the form of direct payments based on land area instead of market price support (as was previously the practice) which is clearly better for the environment because it no longer encourages increasing production.

6.2.4. Waste management

Waste management contributes to GHG emissions primarily via the landfilling of biodegradable waste. Buried in landfills, waste degrades without the presence of oxygen, creating CH_4 which is a more potent greenhouse gas than CO_2. Burning waste in incinerators also leads to GHG emissions, but the resulting energy can reduce the need for other energy sources and may therefore result in net benefits depending on the type of fuel that is replaced. Recycling waste is beneficial because it not only helps to reduce emissions resulting from other forms of waste management, but also the energy use associated with the production of virgin raw materials. For garden and food waste, the best option is composting, which avoids the creation of methane and results in valuable fertiliser (Smith et al. 2001).

The EU has a strong waste policy framework with mandatory national targets for increasing recycling rates, diverting biodegradable waste from landfills and collecting and neutralising CH_4 emissions. As a result, GHG emissions from waste management operations have declined considerably in past decades (see Figure 16) and a further substantial reduction is expected thanks to new and ambitious waste targets adopted in 2018 (Directive 851/2018/EU). Notably, the proportion of municipal solid waste diverted to landfill in all EU Member States will have to be reduced to 10% by 2035 (the deadline is 2040 for countries with high current landfill rates, such as Hungary), and separate waste collection extended to bio-waste (by 2023) and textiles (by 2025). The best option regarding waste is of course to prevent its creation in the first place – in this area, the EU has not been very successful in the past due to ever increasing consumption levels. There are no concrete targets for reducing the amount of waste that may be generated, only guidelines and best practices to help Member States develop their own prevention programmes. One specific area that has received a lot of attention recently in the media and from the general public is plastic waste – the EU has responded to the issue by adopting a new directive on single-use plastics, including bans (effective from mid-2021) on some products such as plastic straws, cutlery, etc. and is encouraging Member States to reduce the usage of others (Directive 2019/904/EU).

6.3. Emissions from land use (LULUCF)

One area that is not covered either by the ETS or the effort-sharing system is the natural carbon sinks of Europe's lands. Soils and vegetation store large amounts of carbon, and, depending on how they are managed, can help to mitigate emissions from other sectors or add to them further. Forests, for example, are estimated to absorb around 10% of the EU's annual GHG emissions, but action such as clearing forests, ploughing grasslands, or draining peat bogs results in the release of GHGs into the atmosphere (European Commission 2019f). Currently, the balance of land emissions in the EU as a whole is negative, meaning the sector acts as a net carbon sink, removing over 300Mt CO_2-eq annually from the atmosphere (this represents around 7% of the EU's current emissions), but the tendency over the past years has been unfavourable and is expected to continue in the near future (EEA 2018a).

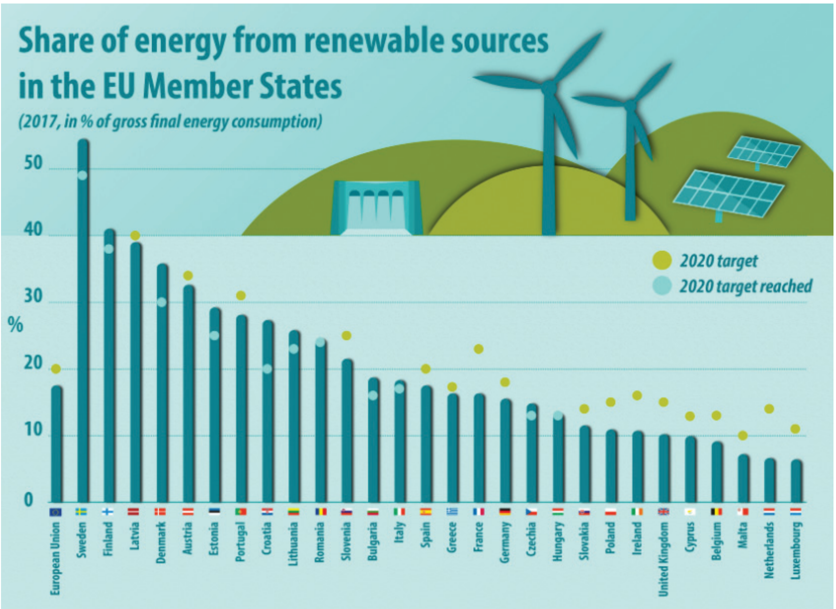
While the LULUCF sector was originally not included in the EU's GHG emission statistics and targets, increasing international attention to the issue and the development of accounting methodology has led to the adoption of specific rules for the sector. As its central principle, the new LULUCF Regulation governing the period 2021-2030 (Regulation 2018/841/EU) adopts the 'no-debit' rule, meaning that net emissions from the sector in all Member States must remain negative, so that any land-use changes that result in the release of GHGs will have to be offset by measures that result in the removal of at least an equivalent amount elsewhere in the sector.[53]

6.4. Renewable energy

Increasing the usage of renewable energy is key to reducing GHG emissions, and as we have seen above, has its own target of 20% by 2020 and 32% by 2030 (relative to final energy consumption). The 2020 target was broken down into different individual targets for each Member State, with more expected of countries where the share of renewable energy was already higher at the outset (Directive 2009/28/EC). It can be seen in Figure 22 that several Member States were able to meet their targets ahead of time, but the EU as a whole still has some way to go. The 2030 target was not defined at the Member State level in the directive (Directive 2018/2001/EU) – instead, countries were required to submit national energy and climate plans specifying their targets and outlining the main measures they plan to implement in order to achieve them (Regulation 2018/1999/EU). These national plans must be approved by the Commission while the targets are expected to be finalised by the end of 2019.

[53] A certain degree of flexibility is permitted between Member States, as well as between the LULUCF and the effort-sharing sectors.

Figure 22 Share of renewable energy consumption in EU member states and targets for 2020s



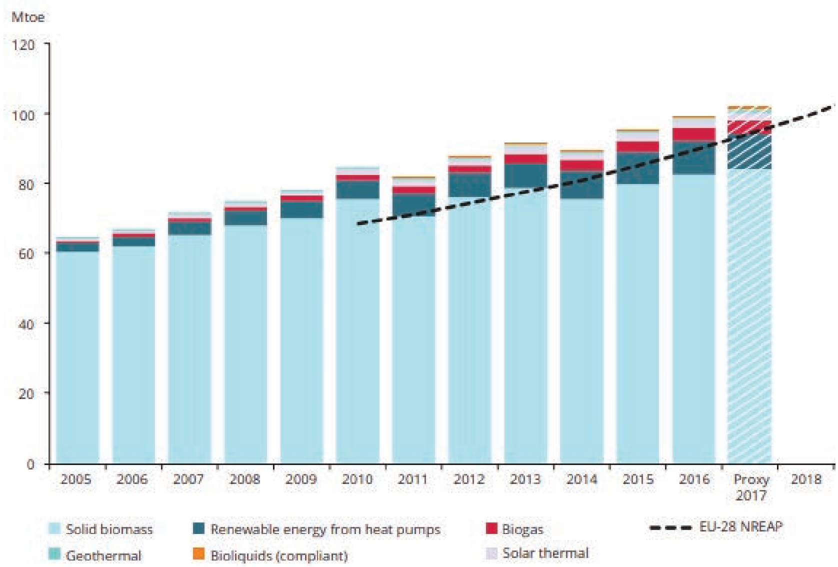
Source: EUROSTAT 2019a

The share of renewables in final energy consumption stood at 17.5% in 2017 overall, up from 8.5% in 2004. The increase can be attributed to various policy measures as well as the rapidly falling price of many renewable energy technologies. The situation regarding renewables is very different in the three main energy-using sectors: heating and cooling, electricity, and transport – these will be described in the following sections.

6.4.1. Heating and cooling

With a share of 30.2% in 2017, renewable energy is most prominent in the heating and cooling sector (EEA 2018a). The lion's share comes from solid biomass (mostly various forms of firewood), which is used by households as well as district heating centres and industry; Figure 23). However, from an environmental point of view, biomass is not necessarily the most favourable source of energy, because burning it creates air pollution (particulate matter, CO, etc.), and, depending on the type and source of the biomass that is used, may contribute to biodiversity loss (deforestation). From the point of view of climate change, the use of biomass is theoretically neutral because while CO_2 is released into the atmosphere when the former is burned, the same amount is removed as the plants grow.[54] In practice, the use of biomass always results in some GHG emissions from processing and transport, but the amount is substantially lower than fossil-fuel-related emissions – the decisive factor is whether biomass stocks are managed sustainably (forests should not be harvested at a faster rate than they are able to grow).

Figure 23 Evolution of renewable energy usage in the heating and cooling sector in the EU



Source: EEA 2018b

6.4.2. Electricity

The share of renewables in the EU's total electricity consumption was 19.3% in 2017 (EEA 2018a). Sources here are far more diverse than in the heating sector (see Figure 24), with the previously dominant hydropower being overtaken by rapidly growing wind energy in 2017. Solar energy (which is the most expensive type of renewable electricity) still plays only a minor role, but strong policy support and rapidly falling costs have resulted in high growth in the last decade. Biomass (solid and biogas) is also used for the generation of electricity but is far less important here than in the heating sector.

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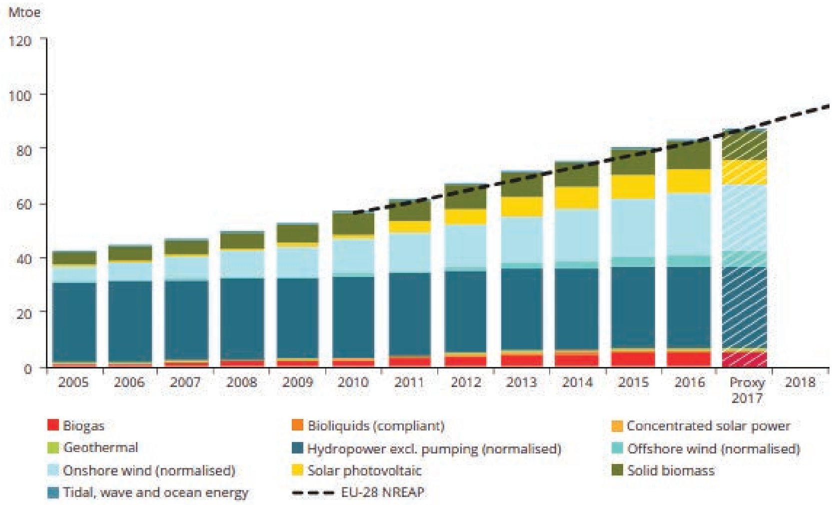
54 By contrast, burning fossil fuels releases CO_2 into the atmosphere that has been stored underground for hundreds of millions of years.

Figure 24 Evolution of renewable energy usage in the electricity sector in the EU



Source: EEA 2018b

While solid biomass for heating is typically cheap enough to be a viable alternative to fossil fuels without public support, most forms of renewable electricity would not be able to attract investors without state subsidies. (Although, as previously noted, costs are falling rapidly and an increasing number of renewable electricity projects are competitive on a purely market basis.) EU countries therefore all have public **support schemes** in place to spur the growth of renewable electricity. Designing these schemes is primarily within the competence of Member States, but the former must be in accordance with the rules for state aid laid down by the Commission (European Commission 2014) to ensure that market distortions are kept to a minimum. As a general rule, the support that is provided should be as minimal as possible with the aim of reducing and removing it as renewable technologies mature and become viable on their own. Furthermore, subsidies should be awarded on a competitive basis to drive efficiency improvements and reduce cost.

While investment grants are the typical form of support for renewable heating projects, in the electricity sector schemes that provide ongoing support for renewable electricity production are more common. These can also take several forms (CEER 2016):

- **Price-based schemes** work by allowing producers to sell electricity from renewable sources at prices above the market price.
    - o **Feed-in-tariffs (FIT)** guarantee a fixed price for renewable electricity plant operators over a given period.

  - o In the case of **feed-in-premiums (FIP)**, producers sell their electricity directly to the market (at variable prices) and additionally receive a premium as a support element.

  FIT schemes provide more certainty for investors while FIP programs are better at encouraging them to respond to short-term market signals, adjusting the volume of production as needed (producers of solar and wind energy, which are dependent on the weather, are of course less able to do this than operators of biomass-based or hydro power plants). Both FIT and FIP can be provided through administrative procedures whereby eligible applicants are automatically awarded the higher price, or through tendering procedures whereby producers of renewable electricity compete with each other and only those who offer the lowest price are awarded support.
  In the past, FITs and administrative procedures were most widespread, and have been able to considerably boost renewable electricity production in Europe. However, in the case of administrative procedures, determining the necessary rate of support is challenging and failing to adjust rates to account for the rapidly decreasing costs of some renewable technologies (notably solar cells) has led to the overshooting of targets and excessive costs for electricity consumers in some countries. In recent years, in line with the new Commission requirements, there has been a strong shift toward FIPs and tender-based systems to encourage better market integration and cost-efficiency in the renewable electricity sector. (Many countries, including Hungary, now have mixed schemes with automatically awarded FITs for smaller installations and tender-based premiums for the largest ones.) (CEER 2018)
- The alternative to price-based support systems are **quantity-based schemes**, commonly called green certificates. In this case, it is the amount of green electricity that is determined by the authorities, while the price freely floats on the market (similarly to pollution control schemes based on tradable permits). Producers of renewable electricity must sell their electricity on the market for the regular price, but they receive green certificates after the amount they produce that they can also sell, and this provides them with extra income. Demand for the green certificates is created by placing a legal duty on participants of the electricity market to purchase a certain amount of the former (corresponding to the share of renewable electricity that policymakers wish to support).
  While this system allows authorities to better control the amount of green electricity and also creates competition among providers, for the providers themselves it results in a far more uncertain environment than price-

based systems (because of the volatility of market prices for the green certificates). As a result, only a handful of European countries are currently operating green certificate schemes (Hamburger – Harangozó 2018).

The support schemes described above are relevant for commercial-scale installations. However, some renewable electricity technologies (such as solar cells) can also be deployed on a much smaller, household scale. Promoting such decentralised production is an important aim of the EU's new renewable energy directive (Directive 2018/2001/EU). This requires Member States to remove administrative barriers and discriminatory practices that currently make it difficult or unattractive for consumers in many countries to produce their own electricity and sell their surplus to the grid. It also lays down a framework for the creation of renewable energy communities that allow such small players to unite and maximise their benefits.

6.4.3. Transport

Standing at 7.2% in 2017, the share of renewable energy in the transport sector is considerably lower than in the other two areas and also significantly lagging behind the trajectory needed to achieve the 2020 target of 10% (EEA 2018a). As mentioned in Chapter 6.2.1, the main renewable energy sources used in the transport sector are biofuels. (The other currently existing alternative is renewable electricity, but since the market share of electric cars is still very low, and even these only use renewable electricity to the extent that it is present in the energy mix of each country, that option only accounts for a very small part of renewables in the transport sector - although in the future it is likely to grow.)

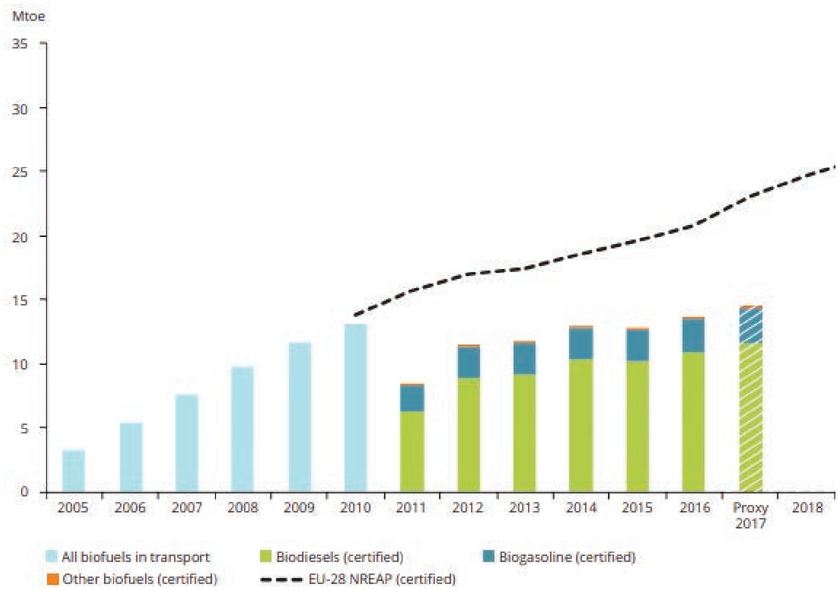
The EU's approach to biofuels represents one of the very rare instances when policymakers essentially performed an about-turn and completely changed their goals within just a few years. Initially, biofuels were considered an environmentally friendly option because of their renewable nature and perceived climate benefit. The target for 2020 was put in place and measures were adopted across EU Member States to promote the production and use of biofuels.[55] However, this policy was increasingly criticised by environmental groups who called into question the benefits of biofuel usage. The main reason for the criticism is that today's biofuels are primarily made from food crops (so-called first-generation biofuels)[56] and their production requires high energy input (fertilisers, tractors, processing, etc.), which means that they are far from being climate-neutral. Con-

[55] The key instrument applied in many countries is blending obligations that require companies that sell motor fuels to use a certain percentage of biofuel in their products.

[56] Biodiesel is made from oily plants such as sunflowers, rapeseed and oil palm, while biogasoline/bioethanol comes from crops with a high sugar content such as corn.

verting natural areas to agricultural land for the sake of biofuel production is also clearly detrimental to the environment. The Commission reacted to these criticisms by introducing so-called 'sustainability criteria' for biofuels (Directive 2009/30/EC), mandating that only biofuels that make a certifiable GHG emission saving of at least 35% (later increased to 50% and 60%) can be considered towards the target, and that they must not be produced on natural areas. (This change caused the drop in use of biofuels that occurred in 2011, observable in Figure 25, which only shows biofuels that meet the sustainability criteria.)

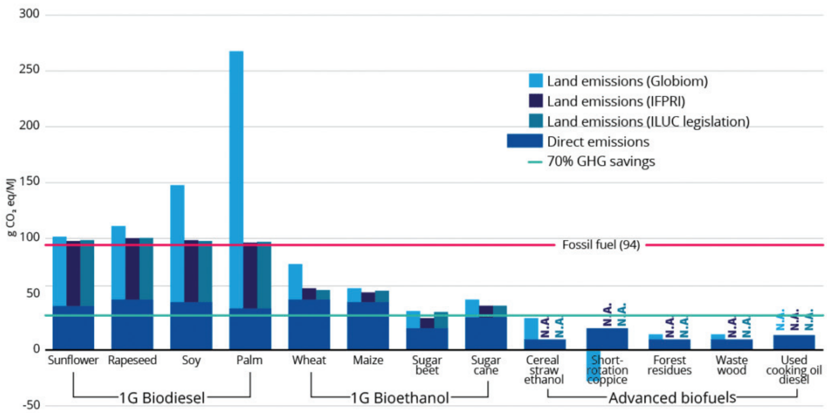
Figure 25 Evolution of renewable energy usage in the transport sector in the EU



Source: EEA 2018b

However, the new rules were not enough to lay concerns to rest as they did not address a very important aspect of the problem: indirect land-use change (ILUC). This refers to the fact that even if the biofuels themselves are not produced on land that is converted from natural areas, the increasing demand for these commodities may nevertheless drive agricultural expansion. The prime example of this is palm oil, which is very widely used in the food and cosmetics industry, the rapidly growing demand for which is one of the leading causes of deforestation in South-east Asia. Using palm oil as biofuel (or indeed any other vegetable oil such as rapeseed or sunflower oil, which are substitutes with largely the same uses) adds to this demand and results in more deforestation, with negative consequences for biodiversity as well as GHG emissions. Because of its indirect nature, ILUC is notoriously difficult to quantify, which is the reason why it was not included in the methodology for calculating GHG emission savings in the Commission's sustainability criteria. However, a growing number of studies show that it is indeed a major factor which may completely undermine the promise of biofuels, especially biodiesel (which accounts for the majority of biofuel use in the EU; see Figure 25) as a climate-friendly option. (Figure 26 shows that if the ILUC is taken into account, the GHG emissions from biodiesel are equivalent to or even greater than emissions from fossil fuels.) (Transport & Environment 2019)

Figure 26 Studies about the GHG impact (including ILUC) of various types of biofuels



Source: Transport & Environment 2019

This has led to the Commission fundamentally reconsidering its approach toward food-based biofuels, whose contribution toward the target is now limited to 7% of transport energy consumption (Directive 2015/1513/EU). Furthermore, biofuels deemed to be a high risk of ILUC will be completely phased out by 2030 (they can still be used, but will not count towards renewable energy targets) (Directive 2018/2001/EU). The decision as to which biofuels will be classified as high risk is still not final (as of May 2019), with the Commission naming palm oil (but not soy and other types of biodiesel) and defining certain exceptions under which some palm oil may still be accepted.[57] Instead of biofuels made from food

57 The cause of the prolonged debate about this issue has to do with the sensitivity surrounding the topic for exporting countries such as Malaysia and Indonesia, who have gone so far as to threaten retaliatory trade measures (Valero 2019). (While the decision to classify soy as low risk was condemned by environmentalists, it was welcomed by its main exporter, the USA.) (Michalopoulos 2019)

crops, the EU is now promoting so-called advanced biofuels which have a much better environmental profile (see Figure 26) but which are also more expensive and are currently being used in only very small amounts (see 'other biofuels' in Figure 25). These benefit from multipliers (meaning they can be counted more than once) when determining Member States' progress toward the transport renewable energy targets.[58]

While certainly justified from an environmental point of view, this unusually sudden shift in policy has created difficulties for investors who were previously encouraged to develop biofuel production capacity. Strangely, the new regulations do not make a general distinction between biodiesel and bioethanol, the latter which appears to be far more environmentally beneficial than fossil fuels even if ILUC is taken into account. This approach is in line with the view of environmental groups, who see renewable electricity (and perhaps advanced biofuels) as the best way to decarbonise transport. Industry representatives, on the other hand, stress that such a transition will necessarily be slow, while first generation ethanol represents a readily available solution for quickly starting to cut transport emissions (Fortuna 2018).

6.5. Energy efficiency

Among the EU's 2020 climate and energy targets, meeting the energy efficiency goal currently appears to be most problematic (see Figure 15). While energy consumption is still below 2005 levels (by 9.2% in 2017), it has been increasing since 2014 and it appears unlikely to decline sufficiently to meet the target in time (Eurostat 2019b). Past reductions can mainly be attributed to structural changes in the European economy (an increase in the share of the service sector at the expense of more energy intensive industrial activities) and efficiency improvements in individual sectors (industries as well as the residential sector), while the transport sector has only been able to achieve modest results.[59] And, in recent years, efficiency improvements have not been able to keep pace with stronger economic growth, leading to the observable increase in total energy consumption (EEA 2018a).

It has long been observed by economists that there is generally much less investment in energy efficiency than would be optimal for society given the potential for economic and environmental benefits (and indeed less than what would be justified from a purely financial perspective) – this phenomenon is

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58 The multipliers result in a very complicated system, and also mean that Member States can officially meet the 14% target for renewable energy in transport in 2030 with a share of renewable energy that is significantly lower.

59 Energy consumption (mainly in the residential sector) is of course also heavily influenced by the weather, notably winter temperatures that determine heating needs.

known as the 'energy efficiency gap' or 'energy efficiency paradox'. There are several explanations for the existence of this gap, such as limited access to capital (as the up-front costs of energy efficiency investments are often high), a lack of consumer awareness, and the fact that energy prices do not reflect their full social and environmental cost (on the contrary, many countries even have subsidies for the production and consumption of energy that reduce their cost and further distort the market). Given this situation, policy intervention is essential for promoting energy efficiency, although the EU's requirements in this area are relatively weak (Zgajewski 2014).

The framework is designed so that individual Member States set their own energy efficiency targets which together are intended to deliver the overall EU target (but are, in fact, less ambitious overall) (EEA 2018a). The main problem is that, unlike effort sharing and renewable energy targets, national energy efficiency targets are non-binding (this is the case for the 2020 targets as well as the new ones for 2030). This means that countries that fail to meet their targets will not have to face any sanctions, and this may be a factor behind the insufficient level of progress. The energy efficiency directive of 2012 (Directive 2012/27/EU) does contain a binding obligation for Member States to reduce final energy consumption by 1.5% per year until 2020; however, several exemptions, forms of flexibility in implementation, and problems with the monitoring and verification of savings make this requirement much weaker in practice (Rosenow et al. 2016).

Alongside the general targets, EU energy efficiency policy also includes various sector-specific measures which have been able to successfully drive energy savings. Alongside the requirements for buildings described in Chapter 6.2.2, there are energy efficiency standards for several product categories such as light bulbs, boilers and air conditioners, pumps, transformers and a wide range of household appliances (refrigerators, washing machines, etc.) (Directive 2009/125/EC). For many products, the EU has not only minimum energy efficiency requirements but also a mandatory labelling system which enables consumers to choose products that consume less energy (Regulation 2017/1369/EU). In other areas, there are no mandatory technology standards, but there is an obligation to conduct assessments in order to make sure that the potential for improving energy efficiency is not overlooked. Large companies are required to conduct an energy audit every four years and, in the power sector, the opportunity to use highly efficient co-generation[60] technologies must be examined any time a heat or electrical installation is built or refurbished (Directive 2012/27/EU).

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[60] Cogeneration means the simultaneous production of electricity and useful heat. In conventional thermal power plants, the heat generated during the production of electricity is lost – utilising this 'waste' heat in district heating systems or industry can result in huge energy savings.

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Environmental and climate policy

This book offers an insight into some of the most important questions of environmental policy, along two main themes. First, it offers a general overview of the most important tools of environmental policy and the main features of EU environmental policy. Second, it presents the issue of climate change, including drivers, impacts and the current standing of international efforts to address it. Finally, these two themes are combined in a detailed discussion of the climate policy of the EU. As a guide to both the fundamentals and the current state of play of environmental and, specifically, climate policy, this book can be useful to students, academics and anyone looking to deepen their knowledge about these important issues.

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