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Sustainability transition and the European Green Deal: A macro-dynamic perspective

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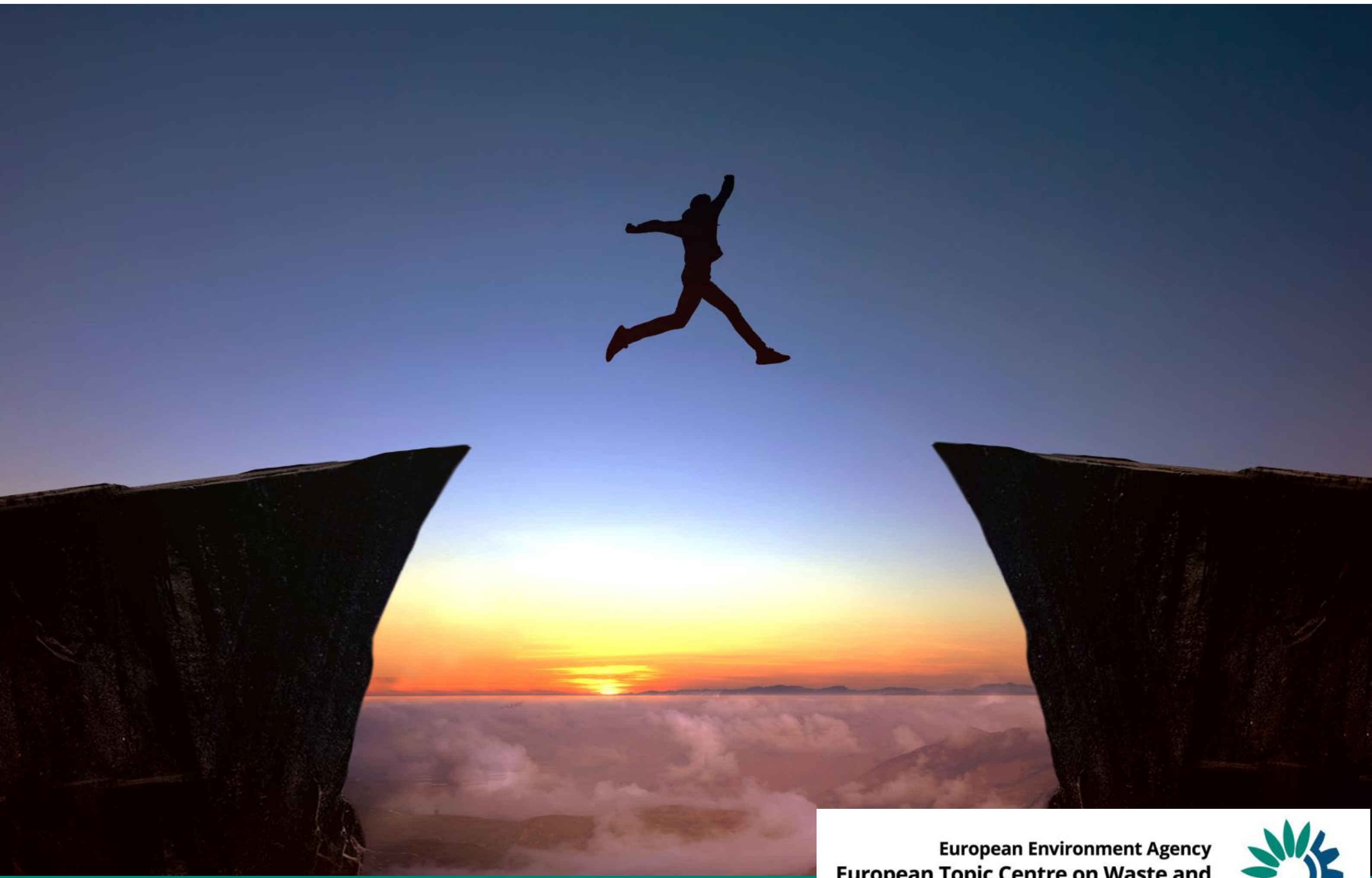

European Environment Agency
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[1] SEEDS - Sustainability, Environmental Economics and Dynamic Studies, is an interuniversity centre created by eight Italian Universities.
[2] IRCrES is the Research Institute on Sustainable Economic Growth of the Italian National Research Council.
[3] KnowlEdge is a consulting company working on socio-economic and environmental aspects sustainability.

1 Introduction and key insights

Introduction

This report presents the results of the work carried out at ETC/WMGE on *Green economy transition: Macroeconomic analytical framework* in 2020 and 2021. The main aim was to provide the arguments for adopting a macro-level perspective to the green economy transition and to the European Green Deal (EGD). Some analytical results presented in this report provided inputs to the process leading to the EEA report *Reflecting on green growth. Creating a resilient economy* (EEA 2021).

Section 2 of the report summarises the tradition of sustainability analysis in economics from a macroeconomic perspective. While the sustainability principle was born from the micro-management of natural resources, the present sustainability discourse is strongly framed into the socio-economic system-level dimension. The role of capital and investment (and consumption) for sustainability is highlighted through the weak Vs strong sustainability conceptualisation. Recent developments in the debate on degrowth and its possible link with macro-sustainability are considered, together with issues of inequality and the role of the international dimension. Evidence on human development and convergence indicators is elaborated to highlight the many open issues on the social side of the sustainability transition.

Section 3 addresses the European Green Deal (EGD), highlights how it can be seen as a new growth strategy and identifies the very key elements that link the EGD to the macro-analytical framework of Part 1: investment, industrial and innovation policy, the just transition, and exporting the EGD. The possible impact of the COVID-19 crisis and post-crisis recovery strategy in relation to the EGD is examined, with specific reference to the Next Generation EU (NGEU) and macro-economic policy developments in 2021. A specific focus on the implications of the Fit-for-55 package (proposed in July 2021) and the green features of national recovery plans connected to the NGEU is presented. The other analyses are aimed at: (i) a deeper understanding of the just transition (JT) policy, also in connection with Part 1; (ii) an exploration of the massive consequences of the EGD for a large set EU environmental legislations and policies that are relevant to almost all sectors of the EU economy.

In Sections 4, an application of causal loop diagram (CLD) modelling to the EGD is proposed, including the possible implications of the COVID-19 crisis and the recovery strategies being put in place at the EU level. Similarly, the application of a computable general equilibrium (CGE) model to the impact of the EGD, including the possible effects of the COVID-19 crisis, is presented. A parallel detailed report on the modelling approach has been published in 2021 ([4]).

[4] See: https://www.eionet.europa.eu/etcs/etc-wmge/products/modelling-the-sustainability-transition-in-between-the-egd-and-the-next-generation-eu

Key insights

- Sustainability is a systemic vision at the conceptual level and a macro-dynamic process in the real world. Then it belongs to the upper macro-level of public policies.
- Microeconomic tools can support specific policies, however large they may be, but are not sufficient for the systemic, macro-level or upper policy level of the sustainability transition.
- Natural limits and planetary boundaries do exist – they can be partly overcome by innovation (decoupling) whereas the need for degrowth can be questioned: macroeconomic policies for sustainability, like the EGD, need public resources even in the case of deep commitment of the private sector.
- Degrowth can impair public budgets and sustainability transition policies, and can have little social acceptability.
- Wellbeing and human development must be seen as priorities, and (in)equality must be an integral part of the sustainability transition, whereas the social side of the transition risks being overshadowed by the environmental side.
- The EU is a region of huge diversity and convergence across countries is limited, which can be important for the overall transition strategy and a macro-scale just transition.
- The international dimension (spillovers) matter for both the EGD and the overall effects of the transition.
- The EGD is the major world-level experiment of a policy-driven macro sustainability transition, oriented to growth-modernisation and innovation.
- The EGD brings environmental policies to the same level of importance of macroeconomic, macro-fiscal and macro-financial policies, thus putting the sustainability discourse in the driver's seat.
- The EGD's interaction with the NGEU is critically important to the transition.
- The EGD has a number of open issues. Primarily, it will change the whole picture of environmental policies but policy interactions/contradictions are not sufficiently considered (sector-level bias); many policies risk a Darwinian selection of weak companies and regions (capability bias). These risks must stimulate strong initiatives towards a green upgrade of laggard actors within the European economy.
- Another EGD open issue concerns its strong regulatory approach, and a relatively weak attitude towards market-based instruments (MBI), which would critical be given low resource prices (regulation bias).
- A further EGD open issue relates to inequality, well-being and social dimensions not being sufficiently considered within the just-transition strategy (environmentally biased) and how the Green Social Fund can possibly contribute to protecting a few social groups.
- Modelling is the right approach for assessing macro transitions in support to policies (interaction, feedbacks, time lags and complexity).
- A key message from the modelling is that the possible short-term negative effects of carbon pricing policies, aimed at achieving the Paris Agreement targets, can be (more than) offset by a proper use of fiscal revenues in the framework of appropriate fiscal policies.

2 Macro sustainability transition: analytical and empirical frameworks

2.1. Macro- and micro-economic perspectives on sustainability: a résumé

The roots of the environment-versus-economy debate can be found in the mid phase of the Industrial Revolution. Malthusian theories contributed to inspire the limits-to-growth paradigm and, to some extent, ecological economics. It is documented that Malthus influenced Darwin, who partly influenced some 19th and 20th century economists, such as Marshall, and especially influenced contemporary evolutionary economics. The latter recovers the Darwinian biological paradigm within the economics of innovation, which is at the root of the present ideas on transitions (Laurent and Nightingale, 2001; Mirowski, 1994). In contrast, the biological paradigm only partly influenced ecological economics, for example, Georgescu-Roegen looked at physics, and hardly touched environmental economics, which is manly rooted in neoclassical economic reasoning on externalities. Classical economists of the 19th century, Quesnay, Ricardo, Smith and Marx, gave a special role to land (nature), and Laperche et al. (2012) provides insights on how they addressed the ecological issue within the development of (capitalistic) economic systems ([5]).

The environment-versus-economy debate, however, enters contemporary economic thinking mainly through some early developments in welfare economics, for example, Pigou, on externalities and policies, and extra-market valuation analysis that started being addressed by the 1940s in Anglo-Saxon research. This microeconomic root is the basis of the 'polluter pays principle' and market-based instruments (MBI) in environmental policies (Baumol and Oates, 1975).

On the macroeconomic side, Keynesian thinking remained outside this debate, possibly due to the short-term emphasis on fiscal and monetary policies, while economic-growth models that included technological progress, such as the Solow-Swan model, and Harrod-Domar Keyensian models of growth, developed in the 1950s, contained some seeds of sustainability thinking. Namely, a stable path of investment for capital intensification (Keynesian roots) and (exogenous) technological progress (Solow's escape from the steady state) are the drivers of sustained, possibly optimal, consumption over time, which approximates an idea of inter-generational equity but without considering natural resource constraints (see below on growth with limited resources).

Later on, due to the environmental effects of rapid growth after World War II, the debate on the environment and (sustainable) development was triggered by different contributions pointing to the relevance of the environment and resources to the policy agenda.

A first attempt to define the trade-off between conservation choices and consumption of natural resources can be found in Garrett Hardin's 1968 article, *Tragedy of commons*. In this, the individual's interest is considered as an obstacle to the common interest of sustainability, especially when free access to limited resources is guaranteed to the community. This contribution paved the way for a new approach that acknowledges the need to reconsider the balance between economic growth and the exploitation of natural resources. The idea at the heart of this debate is that if something belongs to everybody (open access), it is cared for by no one. In other words, individual interests may undermine the well-being of the community if the resources are shared as an unappropriated commons. Ostrom et al. (2002), however,

[5] An example of the fact that the economy-environment trade off was present in the early phases of the Industrial Revolution is the Iron Bridge Gorge, a UNESCO World Heritage Site near Birmingham, UK, only made possible by the development of the first industrial coal-based furnaces. Contemporary images of the English landscape bear testimony to environmental damage, are complemented by Dickens-like narratives of polluted cities and demeaning working conditions.

provided an alternative view to the management of natural, common resources that overcomes selfishness and shows that, in many cases, the search for bottom-up approaches can be effective. This framework is emphasised in the work of Dolsak and Ostrom (2003) that highlights the importance of common-pool resources and the need, for communities, to deal with both private property and common property of resources. The authors, moreover, point out that, to effectively and efficiently manage, protect and allocate common-pool resources, different approaches are available. Policies, programmes, and plans cannot, however, be easily transferred; rather they need to be adapted to local circumstances in order to guarantee the equitable distribution of common-pool resources. That is, resource governance must fit with local identities and ideologies. This approach revolves around the conceptual framework provided by Ostrom (1990), which is hugely critical of top-down approaches, the privatisation of resources and authoritarian centralised governance. Concepts such as the tragedy of commons describe the reality of human-environment interaction in situations in which independently acting individuals have little to no mutual trust, no capacity to communicate or to enter into binding agreements, and even if they do, they cannot arrange appropriate monitoring and enforcing mechanisms to avoid overuse. Conversely, common-pool resources have been observed to be successfully managed by commons users who organise collective institutions.

The contribution by Meadows et al. (1972) in the *The limits to growth* emphasises that the demand for food, non-renewable resources and pollution by the population and industrial sectors face limits from a supply-side perspective. Drupp et al. (2020) sketch a timeline of the evolution of the concept of sustainable growth, starting in 1971 with Georgescu-Roegen's contribution on the law of entropy applied to the economic process and with the Club of Rome's reports that developed scenarios on the consequences of continuous economic growth on ecosystems and the threat to the survival of the human species.

While the Club of Rome emphasised the scarcity of resources and limits to growth, at the macro-level, on the welfare economics side, environmental economics thinking developed in the 1970s mainly through refinements of cost-benefit analysis and extra-market valuation techniques.

The connection with the real world started to be relevant; examples include the introduction of the first environmental policies, such as the United States (US) Clean Air Act, as well as non-natural disasters, for example, the Exxon Valdez oil spill in 1989 and other chemical and nuclear disasters. The polluter-pays principle was formally recognised in the 1970s as a policy principle after the work done by Organisation for Economic Co-operation and Development (OECD). By acknowledging the human impact on the environment and extent to which natural capital affects economic development, in 1972 the United Nations Conference on the Human Environment identified in its Stockholm Declaration the key principles that led to the definition of sustainable development.

This was the background for the new emphasis assigned to sustainable development in the late 1980s as a way of correcting the environmental and social distortions of the market driven economic growth.

Macroeconomic thinking was at the centre of the concept of sustainable development, formalized by the World Commission on Environment and Development in 1987 (WCED, 1987) and five years later at the United Nations Conference on Environment and Development in Rio de Janeiro. The 1990s also witnessed a strong push to strengthen EU policies that had been in place since the 1970s on waste management and disposal, which form the background of the current waste/circular economy framework, to a large extent a microeconomic-minded one.

As regards economics/economic policy thinking, a turning point was the publication in 1989 of the Pearce Report (Pearce, Barbier, Markandya, 1989), prepared for the UK Department of the Environment. This "*demonstrates the ways in which elements in our environment at present under threat from many forms* *of pollution can be costed. The book goes on to show ways in which governments are able, as a consequence of this analysis, to construct systems of taxation which would both reduce pollution by making it too costly and generate revenue for cleaning up much of the damage"*. The report contained both microeconomic welfare economics analysis (valuation) and macroeconomic sustainable development hints for policies at OECD and emerging countries levels. Development was at the core of the environmental policy discussion.

The role of sustainable development reverberates in the contribution by Pearce and Warford (1993) in which development, limited natural resources and unacceptable level of pollution have been acknowledged as interactive forces that governments should manage through policy. The authors examine whether economic growth can be environmentally sustainable, given that pollution and waste generation cannot be separated from the use of natural resources. They explore the relationship between environmental conservation and future generations, pointing out that population growth could even have environmental benefits by stimulating technological innovation and changes in lifestyles. They also analyse the strategies available to the poorest countries to cope with decreasing income and discuss the distortions introduced into the market by policies such as subsidies.

The re-appearance of Simon Kuznets' legacy, with the rise of the environmental Kuznets curve (EKC) hypothesis, also connected environmental sustainability, development and inequality. In 1995, Grossman and Krueger extend the theory originally postulated by Kuznets ([6]) to environmental degradation, assuming and testing for an inverted U-shaped relationship between economic growth and the environment. In the EKC, the initial increase in per person gross domestic product (GDP) is due to the shift in the workforce away from agriculture to industry and causes an increase in pollution. Assuming shifts in the structure of the economy towards the service sector and an improvement in the use of resources thanks to technological innovation, pollution and waste decreases as incomes continue to grow.

Similarly, Heyes (2000) shows, from a neo-Keynesian perspective, that overlooking the environment when programming economic development is a strategy for serious breakdown and that sustainable economic development needs to be supported by costly but necessary control measures and by upgraded economic standards (Sim, 2006).

Innovation was an important factor in the sustainable development debate even back in the 1970s and 1980s (Quadrio Curzio et al., 1994; Quadrio Curzio and Zoboli, 1994), largely through a macroeconomic and sector-based perspective on structural change and economic dynamics (Gilli et al., 2013). It then entered the scientific and policy arenas in the late 1990s with some more microeconomic perspectives on firms' behaviour – also due to new data availability from such surveys as the EU Community Innovation Survey (CIS).

Environmental and ecological economics further interacted with the economics of innovation: the key framework of analysis has been the assessment of the hypothesis that environmental policies may induce techno-organisational innovation the market would otherwise hardly support (Borghesi et al., 2015; Cainelli and Mazzanti, 2013; Costantini and Mazzanti, 2013; Cainelli et al., 2012), with possible impacts on jobs and economic performances (Cecere and Mazzanti, 2017; Mazzanti and Montini, 2010). Over time, the notion of innovation has broadened, including eco-, sustainable, frugal and convergent innovation, with a compelling reference to the complementarity between innovation and human resources (Antonioli et al., 2013). This reconciles the innovation framework with economic growth theory and economic development studies.

[6] The Kuznets curve describes the evolution of income distribution in relation to the stage of economic development.

Sustainable and eco-innovation (Rennings, 2000) are a key factor among the innovation capabilities of firms, as it is well known that sustainable economic growth depends upon a constant investment in technological and organisational changes to manage the production process more efficiently. Technologies in themselves, and specifically environmental innovation, are not sufficient to ensure sustainability and the potential of sustainable innovation must be considered in a systemic framework.

Innovation is in fact among the relevant factors behind sustainability. Conceptually, the IPAT hypothesis (*Impact = Population* ***x*** *Affluence* ***x*** *Technology*), as proposed by Paul Ehrlich, a critic of population-led economic growth, in *The Population Bomb* (Ehrlich, 1968), shows how sustainable-oriented technological development (resource/emission efficiency of production) can compensate for scale effects from population and affluence. Given the heterogeneity of technological and environmental performance across sectors, an understanding of the underlying forces requires in-depth meso- and micro-level analyses, which unveil the macroeconomic determinants (UNIDO, 2015). Technology is also central in the theoretical work of Brock and Taylor (2010), which updates Solow's model of economic growth (Green Solow) to incorporate technological progress in abatement.

The 2007–2008 financial crisis, together with ideas on degrowth (see below), also stimulated the idea that green growth and the green economy are intrinsically macro-minded.

Definitions of green growth are quite differentiated, according to what Smulders et al. (2014) label as weak and strong green growth (from the perspective of OECD, 2011 and UNEP, 2011 respectively). Indeed, *"…the focus in green growth is on growth in conventional income, versus a broader concept of consumption utility or overall economic welfare … this focus reflects in part a 'Realpolitik' about the importance of income growth … and concern about potential negative impacts on income growth from maintaining and recuperating environmental and ecological services*" (Smulders et al., 2014).

It is anyway clear that a macro transition towards the wider concept of sustainable development goals requires a change in the narrative in relation to growth and development, including in particular *"… a new conception of economic progress – a deeper understanding of the relationship between growth, human wellbeing, a reduction in inequalities and environmental sustainability, which can inform economic policymaking and politics*" (Ramos and Hynes, 2019). Indeed, as the authors underline, it is difficult to link wellbeing only to income growth: the last decades have, for example, have led economic growth to be linked to rising inequalities, and show that crucial trade-offs between growth and environmental quality indeed exist.

It can be concluded that the standpoint of economics on sustainability has been mainly from the meso (sector) and macro sides, and then from the perspective of systemic change in frameworks of complexity and multiple feedbacks. Microeconomics mainly provided the support for environmental policy design and market-based instrumentation (MBI), up to a broad systemic scale (for example, the cost-benefit approach of the *Stern Review on the Economics of Climate Change* (Stern, 2006), which has been based, however, largely on growth-oriented models (e.g. see Nordhaus models). Finally, the macroeconomics of sustainability is structured and rich enough to provide a basis for a sustainability-transition analysis and support to transition policy, while microeconomic approaches are necessary for specific policy design and implementation, including eco-innovation policies.

In what follows, the growth-theoretical framework (weak and strong sustainability); the degrowth and well-being framework; the inequality (distribution) framework, and the issue of trade openness are deepened as all are relevant for analysing the EGD as a development strategy.

2.2. The growth-theory framework

The macroeconomics of sustainable development pointed to the role of capital accumulation in all its forms – natural, human, man-made and social – through investment, and provided theoretical rules for the sustainable management of renewable and non-renewables, for example, the Hartwick rule or the golden investment rule to manage the rents from scarce resources properly to set a constant pattern of consumption. Genuine savings measures, used especially by the World Bank, are the most respected but also debated indicator of weak sustainability. They originate from the so-called Hartwick rule for the re-investment of rents from the depletion of natural resources (natural capital) in reproducible forms of capital. Literature on the management of resources widely debates how to achieve sustainability patterns, even including ethical and equity considerations.

The problem of resource depletion was not new in economics (see Hotelling, 1931) but only started to be included in modelling in the last fifty years. In 1974, Solow's reflections on the optimal social management of non-renewable resources (Solow, 1974a) were centred around their net price fluctuations that determined both the flow and the remaining stock of the resources. In the same year, Solow showed that a sustainable consumption programme for an economy is possible when there is perfect substitution between natural resources and capital and labour. In practical terms, this implies that society must accumulate new technological assets sufficiently rapidly so that the depletion of natural resources is exactly covered by the new capital stock produced. Robert Solow also develops a macroeconomic model that imposes the requirement that consumption per head be equalised over time, so no generation is favoured over another.

The traditional literature on economic growth in the presence of limited resources is very well represented by the 'Symposium on the Economics of Exhaustible Resources' in the *Review of Economic Studies* in 1974 (Solow, 1974).

In the wake of Solow, Hartwick (1977), defined what is currently known as the Hartwick(-Solow) rule. It states that if the rents obtained from the exploitation of exhaustible resources are saved and, therefore, invested entirely in reproducible capital, then the level of production and consumption will remain constant over time. Hartwick's idea implies that there is compensation and substitutability across different capital types, but it is based on very restrictive assumptions: the need for reserves to be exploited efficiently and for the substitutability between non-renewable resources and human capital. The concept of investing period by period to ensure a sustainable path was thus behind the weak sustainability approach that derives from economic growth theory and is confronted with the more ecological (economics) concept of strong sustainability.

This literature rests on the idea that optimal growth in the presence of finite exhaustible resources is possible in a way that balances the trade-off between consumption and growth and the trade-off between consumption and the environment (Smulders et al. 2014), depending crucially not only on the stock of resources but also on preferences and the capability of replacing natural with man-made capital.

The economic approach to the concept of sustainable development thus revolves around the substitutability between natural and produced capital, which gives rise to the identification of weak and strong sustainability (Dietz and Neumayer, 2007). The debate has also affected neoclassical aggregated growth models that included non-renewable natural resources as production factors (Hartwick, 1977; Dasgupta and Heal, 1974). These models tried to identify the optimal use of non-renewable resources based on the income that can be extracted from them, in order to capture the trade-off between current use and investment in produced capital – which should enable all generations to have the same welfare position. Non-declining welfare has been observed to be contingent on capital stock. Hartwick (1977) emphasised that rents from non-renewable resource consumption should be invested in man-made capital. From this perspective, it emerges that total net capital (investment minus depreciation/capital consumption) should not be negative – in line with the idea of weak sustainability. Conversely, strong sustainability emphasises that substitutability between produced and natural capital may be overestimated in the weak sustainability narrative. Indeed, Pearce and Turner (1990) highlight that natural capital is characterised by four types of function, i.e., the provision of raw materials, assimilation of waste, amenity services and life support. Substitutability between manmade and natural capital, however, varies according to the function under analysis. Life support systems are almost impossible to be substituted by produced capital, requiring, as a result, an optimal consumption path subject to the strong sustainability perspective (Dietz and Neumayer, 2007).

Over the 1990s, the progress was strong in academic, statistical and policy circles. A few examples describe the dynamism of the period. Climate change policy was established and consolidated its space, with the Kyoto Protocol milestone followed by the Paris Agreement in 2015. Norway established its sustainability (sovereign) fund applying the theory of natural resource management.

In the early-1990s, following the publication of the Delors White Paper, *Growth, competitiveness, employment* (EC, 1994) some northern EU Member States started implementing ecological tax reforms inspired by double-dividend objectives.

The United Nations established the standard for the System of Integrated Economic and Environmental Accounts, and Eurostat and other institutions started collecting data on economic-environmental accounts according to the system of environmental economic accounting (SEEA) standards, such as national accounting matrix including environmental accounts (NAMEA). Overall, the weak and strong sustainability approaches entered into real-world policies.

Weak sustainability: a discussion ([7])

According to Sen, Stiglitz and Fitoussi (2009), *"[…] the time is ripe for our measurement system to shift emphasis from measuring economic production to measuring people's well-being. […] And measures of well-being should be put in a context of sustainability. […] Measures of wealth are central to measuring sustainability. What is carried over into the future necessarily has to be expressed as stocks of physical, natural, human and social capital*".

In economics, the very basic notion of economic income (Irving Fisher in the 1930s, John Hicks in the 1940s) corresponds to the flow of goods and services that can be consumed while not reducing capital stocks. The maximum genuine income, and thus consumption, available to a society is just that amount. Therefore, the economic definition of income and consumption already embed a notion of sustainability ([8]).

[7] See Sen, Stiglitz, Fitoussi (2009) for a detailed discussion.

[8] An example of the Hicksian concept of income/consumption: an individual has as the only source of income a stock portfolio valued at US$ 1 million. This portfolio pays its owner a net return of 10 per cent annually. The investor's annual income is US$ 100 000 (the return on assets). This the maximum amount that the individual can consume in a year without depleting their capital investment (that is, their stock portfolio). If the individual (regularly) consumes more than US$ 100 000 per year, then the capital stock will decrease, the return on assets decrease, and the capital will depleted year after year. Or, if more than US$ 100 000 is consumed in one year (say US$ 150 000), the capital will decrease to US $ 950 000 and the return and the sustainable consumption possibility will fall to US$ 95 000.

Genuinely sustainable income requires (at least) either constant or increasing capital stock. The critical issue is which kind of capital should be transmitted? Total stock (man-made, natural, human and social) or some specific stock such as the natural capital?

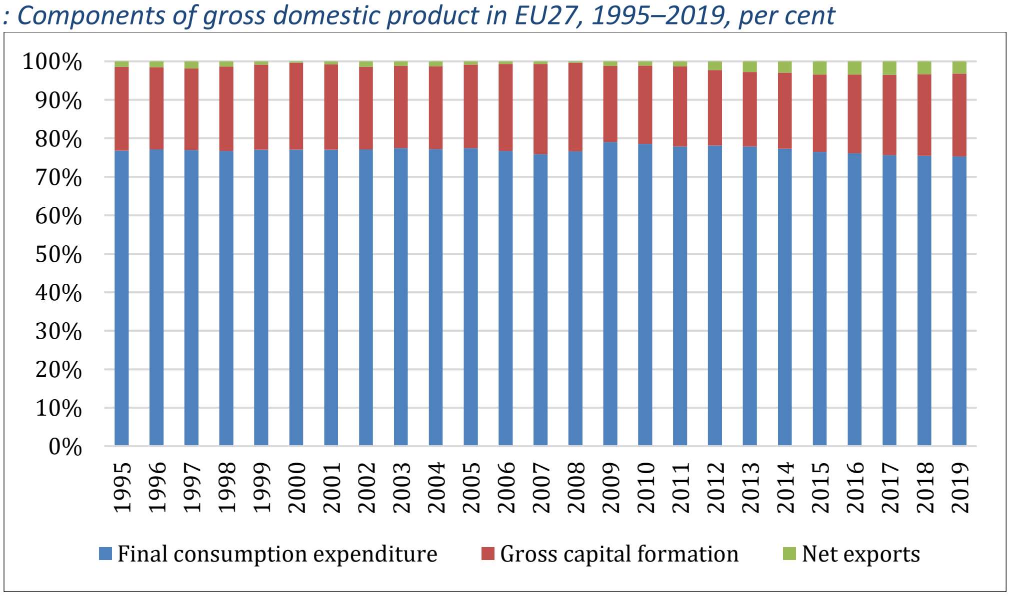
Hartwick-Solow's weak sustainability rule claims it is possible to have constant consumption for all generations even with a non-renewable resource: weak sustainability – the constancy of total natural and man-made capital, the two being perfect substitutes.

In the definition of weak sustainability, as long as there is no reduction in total capital, development is assumed to be sustainable. Natural resource stocks may be depleted, and environmental systems degraded, but this can be sustainable if degradation is offset by equivalent or greater increases in other forms of capital. Indeed, a recent definition of sustainability claims that "*each generation must bequeath to the next as large a productive base as it inherited from its predecessor*" (UNEP, 2018).

Thus, depletion of man-made and natural assets by economic processes has at least to be compensated by new investment. But investment requires saving, which is non-consumption: all investments need to be financed by a reduction of current consumption, i.e., by saving. This implies a trade-off between consuming today or delaying (saving) some consumption to support investment. Even eco-friendly consumption or greener consumption is consumption, which has to be balanced with its counterpart (opportunity cost): a unit of reduced investment. A (constant) capital stock is a benchmark against which consumption levels can be defined as sustainable. Therefore, unnecessary or excess consumption can be measured: the idea that consumption is too much, or unsustainable, must be put against a measure of constant capital stock (natural and/or manmade). Very low consumption levels with decreasing (natural) capital stock would be unsustainable, whereas very high consumption with a non-decreasing (natural) capital stock would be sustainable according to basic sustainable development criteria.

Figure 2-1 shows the trends in the components of GDP over time in the EU. Net exports increased their relevance over time whereas final consumption decreased since 2008-2009, falling by 5 per cent over the last decade; gross capital formation experienced low levels of variation over the same period; while investment dropped during the 2008 economic crisis but since then has increased albeit at a low pace.

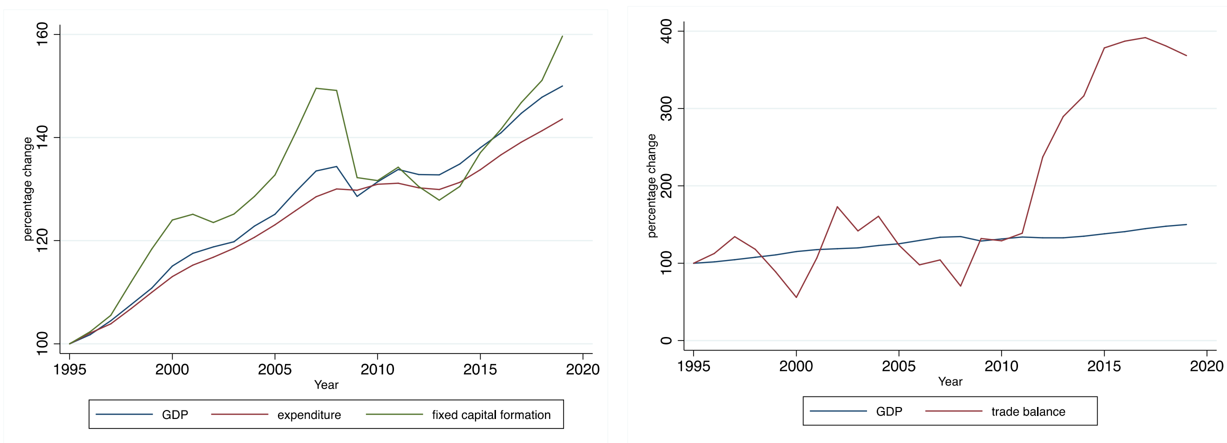
Figure 2-1: Components of gross domestic product in EU27, 1995–2019, per cent



Source: Eurostat

Figure 2-2: Growth of gross domestic product, total expenditure and fixed capital formation (A); growth of gross domestic product and trade balance (B), EU27, 1995–2019, index (1995=100)

A B

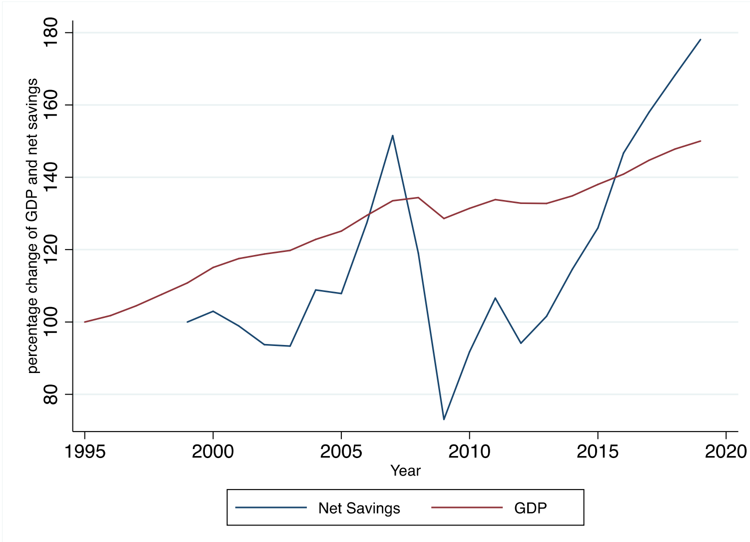


Source: Eurostat

Figure 2-2 (A) shows the growth of GDP, consumption expenditure and fixed capital formation, indexed to the first year's value, 1995. All three variables show an increasing trend over the period. In 2019, GDP was around 50 per cent higher than in 1995. Total expenditure follows closely while the increase in fixed capital formation rises more rapidly, increasing by 60 per cent by 2019. While the trend for this latter variable and GDP is more uneven around the years of the economic crisis, the pattern of total expenditure during the same period is smoother and stable around 30 per cent until 2013. Figure 2.2 (B) shows the trade balance trend for the same period. Albeit that this increases overall, the growth rate is more irregular with respect to the other variables. The fastest growth can be observed after 2010.

Figure 2-3 shows the trend in net savings from 1998 to 2019. This variable shows a hectic pattern, with a peak around 2008 and a significant fall in 2010, both responses to the economic slowdown. Since 2013, the share of savings has constantly increased, and by 2019 is almost 80 per cent higher than in 1998.

Figure 2-3: Growth of gross domestic product and net savings, EU27, gross domestic product 1995–2019, index (1995=100); net savings 1998–2019, index (1998=100)



Source: Eurostat

Box 2.1 Applied weak sustainability: the World Bank indicators of wealth and net savings

From the 1990s, the World Bank has produced a macro-level measure of wealth and adjusted net savings, and empirically estimated these measures for 141 countries (Wold Bank, 2018). Its work is the major example of the application of a weak sustainability approach. All the details of the calculations and the (many) limitations of its approach are clearly stated in the 2018 World Bank's *Changing Wealth of Nations* (World Bank 2018).

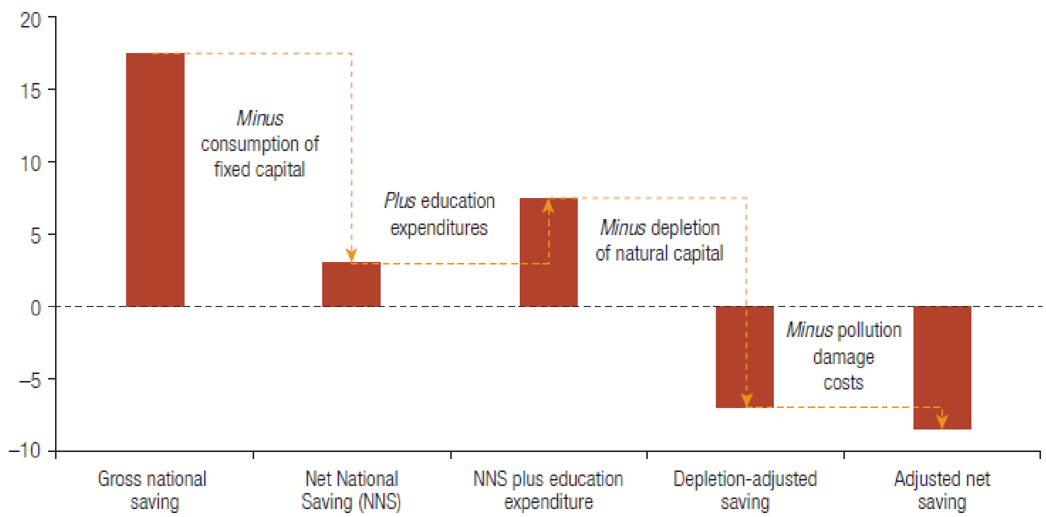
According to the World Band, "*income measures such as GDP can be understood as the annual production generated by a country's use of its asset base. Said differently, income is the annual return that a country derives from its wealth. Therefore, the key to increasing economic well-being in the future lies in building national wealth. This, in turn, requires savings to finance this investment, as well as good institutions and governance to make productive use of assets. From a wealth accounting perspective, development can be viewed as a challenge of portfolio management, with countries deciding how much to save or consume each year, what assets to invest in, and how to make the most efficient use of their assets. The wealth accounting approach provides two related sets of information: comprehensive wealth accounts (a stock measure in total and per capita values), and adjusted net (genuine) saving (a flow measure). Adjusted net saving (ANS) is measured as gross national saving minus depreciation of produced capital, depletion of subsoil assets and timber resources, the cost of air pollution damage to human health, plus a credit for education expenditures. The rule for interpreting ANS is simple: if ANS as a percentage of gross national income (GNI) is negative, the country is consuming more than it is saving, which will undermine long-term sustainability; if ANS is positive, it is adding to wealth and future well-being.*"

Wealth accounts: "*A nation's wealth consists of a diverse portfolio of assets, which together form the productive base of the national economy. These assets include: natural capital—including energy (oil, natural gas, and coal), minerals, agricultural land (cropland and pastureland), protected areas, and forests (timber and some non-timber forest products); produced capital—including machinery, structures,* *equipment, and urban land; human capital—including the knowledge, skills, and experience embodied in the workforce; net foreign assets (NFAs)—including portfolio equity, debt securities, foreign direct investment, and other financial capital held in other countries; total wealth is calculated by summing up each component of wealth ("bottom-up approach"); total wealth = natural capital + produced capital + human capital + net foreign assets.*

"This represents a significant departure from past estimates, in which total wealth was estimated by assuming that consumption is the return on total wealth, and then calculating back to total wealth from current sustainable consumption ('top-down approach')."

Adjusted net saving accounts: *"Measured annually, ANS provides policy makers with immediate feedback about the direction of the economy and possible actions they may need to take to ensure long-term growth. Breaking down the components of ANS makes it easy to discuss policy interventions that could improve a nation's ANS, such as increasing the level of gross saving, improving the quality and maintenance of built capital to achieve a longer lifetime and enhance its resilience to reduce depreciation of fixed capital, increasing investment in education and innovation to boost human capital, optimizing use of natural capital (sustainable use of renewables and efficient extraction of non-renewables), or improving air quality to reduce pollution damage costs".*

Figure 2-4 World Bank procedure for estimating adjusted net savings accounts, gross national income, per cent



Source: World Bank (2018)

Strong sustainability arguments and environmental accounting

Strong sustainability can be summarised as the idea that natural capital stocks are to be conserved independently from other forms of capital. It denies substitutability between different kinds of capital and emphasises the necessity to adopt constraints on some kinds of capital, such as critical natural capital.

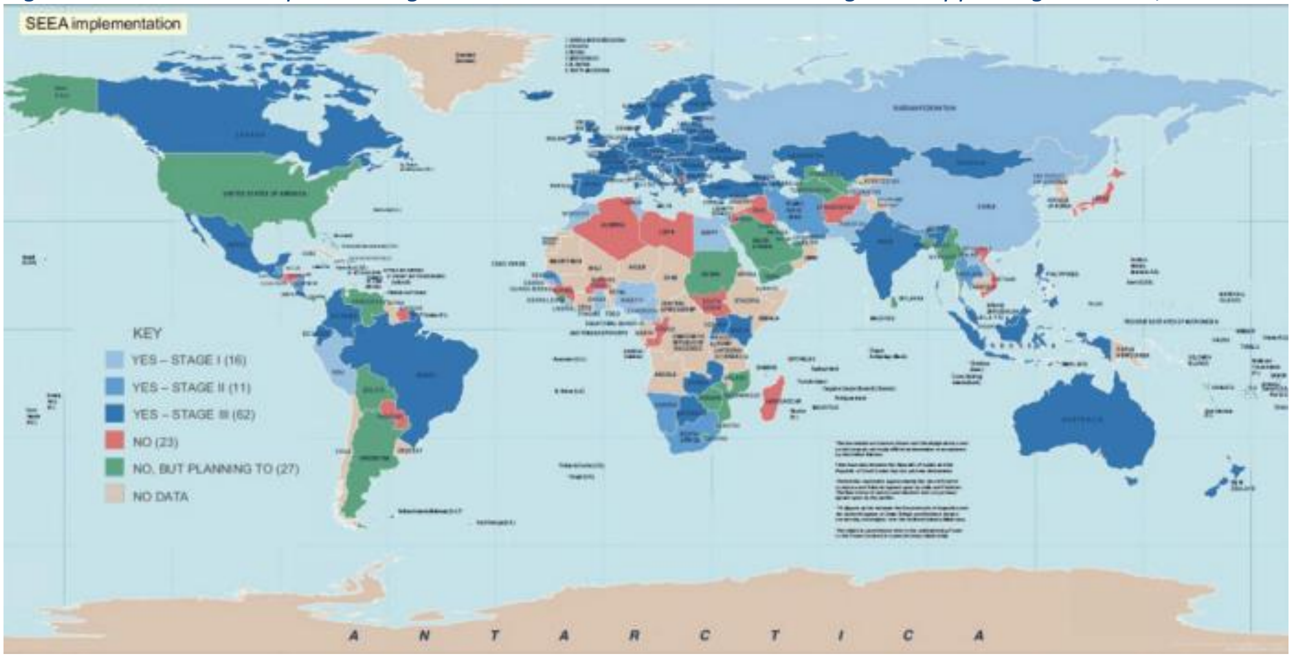
In the weak sustainability vision, since the total capital stock is to be maintained, all forms of capital must be measured in monetary terms. However, monetary measures are more suitable to value country's production of goods and services (i.e. GDP) than to value the stock of natural and physical assets. If the ultimate aim of an economy is to promote sustainability, then GDP is a poor measure of progress. Thus, the need for a more comprehensive evaluation of sustainability leads to the development of many alternative measures over time. For example, the United Nations Commission on Sustainable Development published more than 140 indicators aimed at covering the multifaceted nature of sustainability including economic and social aspects. More recently, the Inclusive Wealth Report (UNEP, 2018), which show the composition of wealth at both country and world levels, shows that the natural capital share of overall global wealth has decreased since the 1990s while the shares of both human and physical capital have steadily increased.

From a measurement point of view, strong sustainability assumes there is no reason for all forms of capital to be measured using the same units. Natural capital stocks can be measured in physical units as well as in monetary units. Indicators, such as planetary boundaries, are the measurement approach preferred by strong sustainability. As a consequence, the basic rules of strong sustainability can be: keep constant particular forms of natural capital; use resources prudently; use the precautionary principles; and, in particular, renewable resources should not be used in excess of their natural regeneration; non-renewable resources should be used carefully, prudently and efficiently and in ways that ensure their availability to future generations by, say, technological development or a shift to the use of renewable resources; sink functions should not be used beyond their assimilative capacities; and activities that cause deterioration in service functions should be avoided or at least minimised.

The reasons to pursue strong sustainability are summarised by Dietz and Neumayer (2007) as, "*we may wish to pursue strong sustainability for other reasons. Firstly, there remains considerable risk, uncertainty and ignorance attached to the way in which natural capital such as the global carbon and biogeochemical cycles works. It follows that we cannot be sure what effect damaging it will have. As Atkinson et al. (1977) point out, risk, uncertainty and ignorance are 'always a reason for being cautious, unless society can be deemed to be indifferent to risk or positively to welcome it'. Secondly, the loss of some natural capital may be irreversible. Thirdly, since there is evidence to suggest we are more averse to losses in utility than we are keen to gain it (Kahneman and Tversky, 1979), this might imply that we are highly averse to losses in natural capital functions that directly provide us with utility. Basic life support systems are obviously included, but so are amenity functions. Fourthly, there is an ethical argument for non-substitutability, which posits that increased future consumption is not an appropriate substitute for natural capital losses (e.g. Barry, 1990). Ultimately, both paradigms are non-falsifiable under scientific standards since both rest on assumptions and claims about the (distant) future that are non-refutable (Neumayer, 2003). However, we have made some suggestions about the circumstances in which one is more plausible than the other*" (see also Ekins et al. 2003; Neumayer, 2003; 2000a).

There can be relevant links between strong sustainability and official environmental accounts. The final United Nations guidelines for the compilation of environmental accounts were approved and published in 2012 (United Nations et al., 2014; SEEA, 2012) after a two-decades development process – SEEA-1993 and SEEA-2003 were intermediate milestones. As of today, as many as 69 countries, including all EU Member States, have implemented programmes on environmental economic accounting, while 22 more countries are planning programmes. Environmental accounts (for a critical discussion, see Bartelmus, 2014) are needed to identify and quantify both critical natural capital (CNC) and substitutable natural capital. Critical natural capital needs to be measured with environmental accounts in physical terms. Even though SEEA-2012 represents a crucial contribution to a systematic and coherent measurement of economy/environment trade-offs, a few important gaps, such as ecosystem services accounting, remain to be filled.

Figure 2-5: Countries implementing environmental economic accounting and supporting statistics, 2017



Source: https://seea.un.org/content/global-assessment-environmental-economic-accounting

2.3. The 'degrowth' and well-being framework

Reconnecting to the *Limits to growth* (Meadows et al., 1972) and to Herman Daly's macroeconomic theory legacy, ecological economists and social scientists introduced the theme of degrowth as a way of achieving sustainability, namely a lighter, fairer, more inclusive society. The issue has stimulated a broad interdisciplinary debate and has given opportunity to integrating theories.

Since the 20th century, society's level of development has mainly been measured through economic growth – an increase in GDP (Jackson, 2011). The idea behind this is based on the assumption that affluence correlates with wellbeing. Both production and consumption are considered to be the drivers of ever-growing prosperity (Cobb, et al., 1995). Criticisms pointing to the limitations of GDP are often misplaced in that GDP has never been, in itself, a measure of welfare, as made clear by the creators of the system of national accounts, Stone and Kuznets, and the criticisms should therefore be directed to the use of the GDP as a measure of welfare.

According to Herman Daly (1972) attaining a sustainable state of the human economy was possible: namely, the stationary or steady-state economy (SSE) that represents a physical concept related to a constant stock of population and physical wealth. Following this branch of literature, the increase in the volume of production generates an exploitation of natural resources and the consequent production of waste and pollution. But the physical dimensions are limited and in a finite world it is impossible to expand production, and consequently consumption, beyond the finite physical limits.

These arguments opened the way for the idea of degrowth to contrast the environmental, social and economic crises. Kerschner's (2010) work showed the complementary nature of the two ideas. The strength of the steady-state concept is its focus on biophysical resources on which the economy depends, and therefore the biophysical indicators proposed are largely drawn from the definition of a steady-state economy.

The strength of the concept of degrowth is its focus on social objectives. Sustainable degrowth, in fact, may be defined as an equitable downscaling of production and consumption that increases human wellbeing and enhances ecological conditions at the local and global levels, both in the short and long term (Schneider et al., 2010). The adjective sustainable refers to the transition process that in the end should be positive from a social and environmental point of view. In this context, GDP is not a good indicator of social welfare because degrowth supports human relations instead of market ones involving global and local redistribution.

According to this interpretation of degrowth, the economic–financial crisis associated with less GDP growth or even a reduction in GDP represented a good aspect for environmental conditions (Martínez-Alier et al., 2010). But it is difficult to extend this concept in general. The direct, short-term effect of reduced GDP growth may be a reduction in emissions as aggregate production falls. The long-term effect, however, is uncertain, as GDP degrowth may reduce investment in cleaner technologies, renewable energy and related research. Moreover, the short-term effect may be even worse since, during a crisis consumers, may shift to cheaper products that are produced using dirty techniques.

This highlights the role played by environmental regulation. Hueting (2010) argues that effective environmental regulation is likely to result in GDP degrowth, or at least during an initial period of transition, simply because a large part of economic growth occurs in sectors which generate a great deal of pollution. To be effective, however, the transition to a sustainable economy implies the emergence of new sectors, changes in existing practices in old sectors and a decline in the most polluting ones. In this framework it is therefore difficult to target the specific parts of the sectoral portfolio that characterise an economic system.

According to Schneider et al. (2010) it is important to distinguish between two different concepts: sustainable degrowth and unsustainable degrowth. While the latter refers to economic recession or depression and a consequent deterioration of social conditions, the first refers to decrease in GDP as currently measured, because of a reduction in the large-scale, resource-intensive productive and consumptive activities that constitute a big portion of GDP. What happens to GDP is, however, of secondary importance; the goal is the pursuit of well-being, ecological sustainability and social equity. The motivation behind this idea is the necessity to stress that qualitative differences, typically not captured in GDP, could even permit socio-environmental improvements while GDP falls.

It is quite clear that this concept goes beyond the idea of dematerialisation or of increasing efficiency and is a unique way of decreasing pollution and increasing the quality of life. Reducing the levels of production and consumption could lead to the use of a lower amount of material. This idea is not represented in the scenario depicted above in which GDP degrowth may depress investment in cleaner technologies, etc. Under sustainable degrowth, technologies, research and development activities are not reduced, but instead are redirected to cleaner sectors. As Schneider (2003) argued, research and technological innovations in a degrowth trajectory would involve innovation for consuming less through lifestyles, political measures and technologies. Innovation may help to achieve the right limit of production and consumption, instead of encouraging unlimited consumption. Althouse et al. (2020) have demonstrated degrowth as a viable, and perhaps necessary, alternative or complement to green-growth policies.

But it is important to stress the consequences that degrowth could have for low income countries suggesting the need to balance it with growth-enhancing policies to avoid a negative income shock in these countries. Without appropriate policies to coordinate areas with different levels of income, the risk could be to exacerbate the conditions of social and environmental inequality between the two areas.

In this setting, the role played by institutions must be considered. As Van der Bergh (2011) argued, if GDP growth is not a robust indicator of social welfare, and therefore can be completely ignore, then GDP degrowth is not necessary or sufficient for sustainability. Correlations between GDP and welfare or between GDP and environmental impact are not constant and fixed over time. According to the author it should be stressed that being against GDP or against unconditional GDP growth is not the same as being against growth. Removing unconditional growth means increasing support for environmental regulation that is perceived as a less radical choice than degrowth. This branch of the literature posits the necessity to rethink effective environmental policies in terms of both their design and social–political feasibility. Governments should provide the communication and information needed to motivate a change in preferences and attitudes through voluntary action. Innovation and knowledge are crucial in the creation of a sustainable inclusive society which is oriented to human development, and in which GDP is a way of achieving objectives, not the objective itself.

In conclusion, whereas it is widely acknowledged that GDP is not the most effective indicator to capture well-being, GDP degrowth, as a strategy to achieve sustainability, appears to be problematic from a number of perspectives. In particular, the role of socio-political feasibility is a pivotal challenge for this strategy. For instance, while climate targets are heterogeneous as they mirror the impact that countries have exerted on the environment, such heterogeneity would be difficult to achieve with a degrowth strategy as it would generate disparities between countries. Similarly, the acceptability of such a strategy would also be low within countries: most of the population would not agree to income reduction.

2.4. The European scenario for human development

Several crises and uncertainties have compromised Europe's macroeconomic equilibrium, shifting the EU away from its path of growth. The consequences of these slowdowns are evident by analysing all indicators of growth and development. To understand the overall development performance, the Human Development Index (HDI) ([9]) is the most widely accepted indicator for assessing not only a country's growth path, but the level of its development capabilities. Figure 2-6 shows the 2018 HDI presented in the 2019 United Nations Development Programme's (UNDP) *Human Development Report*. The comparison between European and world development levels shows all EU Member States having a higher levels than the world average. All countries Member States, in fact, exceed the world's HDI score of 0.73 by at least 0.08 points. What emerges, however, is a deep heterogeneity among EU Member States.

Figure 2-7 ranks EU Member States by their 2018 HDI scores, showing how it goes from 0.94 in Germany, Ireland and Sweden to 0.82 in Romania and Bulgaria, a gap of 0.12 points between the first and last places. It is clear that the northern European countries in general show more solid development paths. In the middle of the ranking are France, Spain, Malta and the Czech Republic with a value of 0.89, followed by Italy at 0.88.

Europe's economic development path appears heterogeneous, being influenced by policies, economic structures and shocks can modify the pattern and emphasise differences between countries. Thus it is important to reflect on what happened in different countries in terms of investment in public goods – health, education, etc. – that supports development and growth strategies. This question is particularly relevant following the period of austerity brought on by the 2007–2008 financial crisis; investment the pillar of a strategy aimed at increasing wellbeing and human development.

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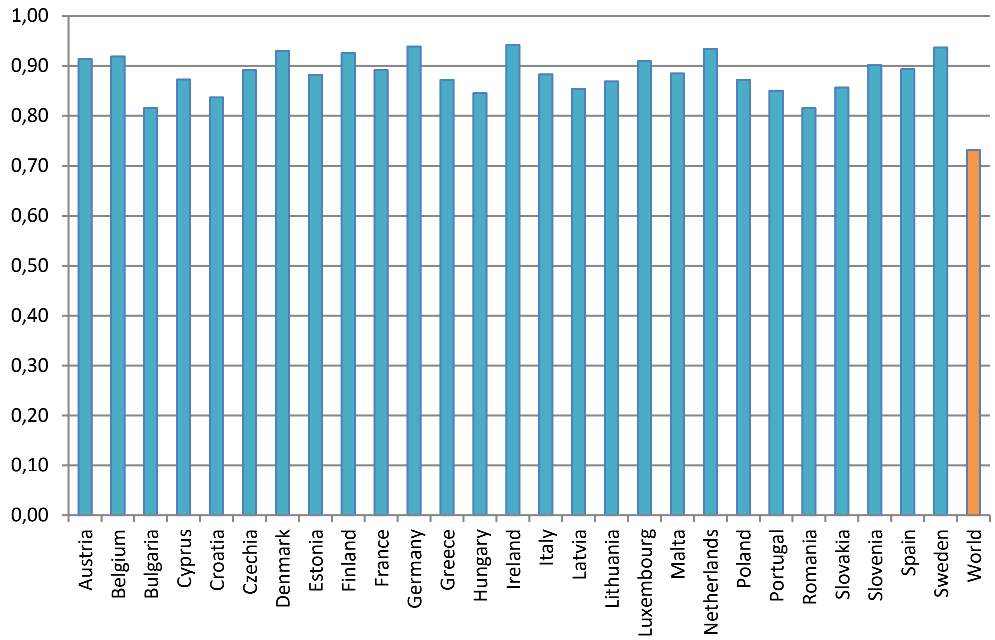
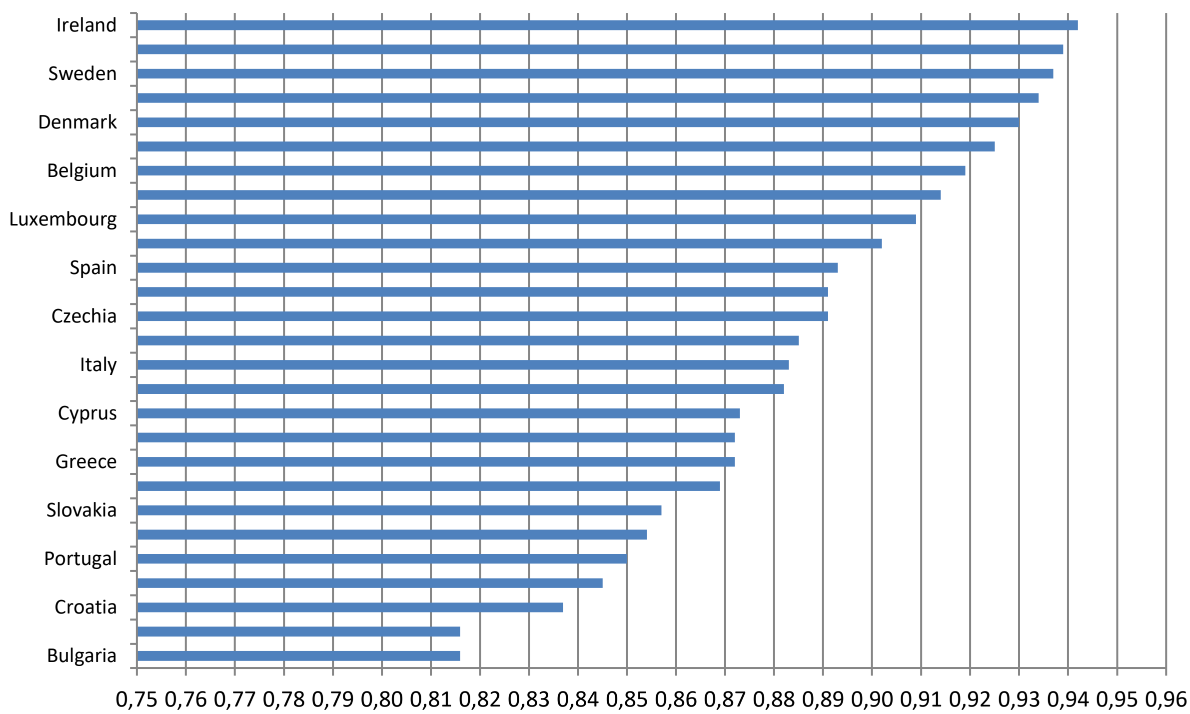
[9] The Human Development Index (HDI) is a statistic composite index of life expectancy, education and per person income indicators, which is used to rank countries into four tiers of human development.

Figure 2-6: Human Development Index, EU (7) and the world, 2018



Source: UNDP

Figure 2-7: Human Development Index ranking, EU (7), 2018

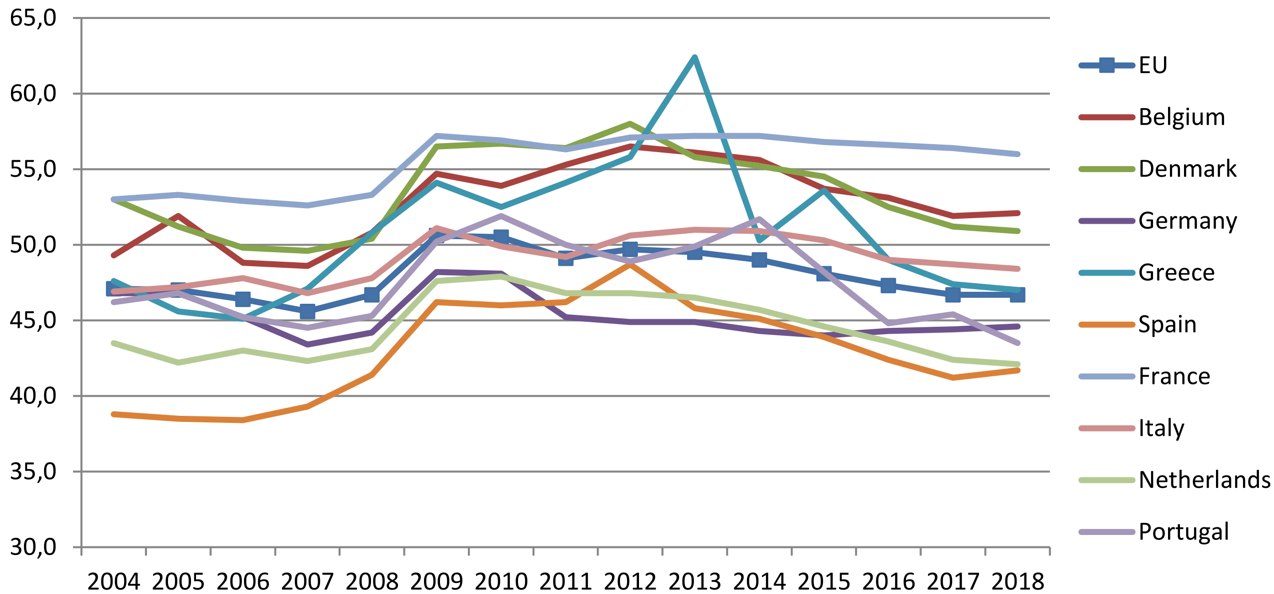


Source: UNDP

[7] Excluding the United Kingdom.

Figure 2-8 summarises the development of total public expenditure as a share of GDP in the EU. The post financial crisis situation is somewhat similar among the various countries[10]. After a sharp rise between 2008 and 2009., France remained stable in the following years, while Denmark and Netherlands show a downward trend. The Greek situation is different again, after the peak in 2013 total public expenditure as a share of GDP declined by around 15 percentage points in the five years to 2018.

Figure 2-8: Total government expenditure as a share of gross domestic product, EU (7) and selected Member States, 2001–2018, per cent

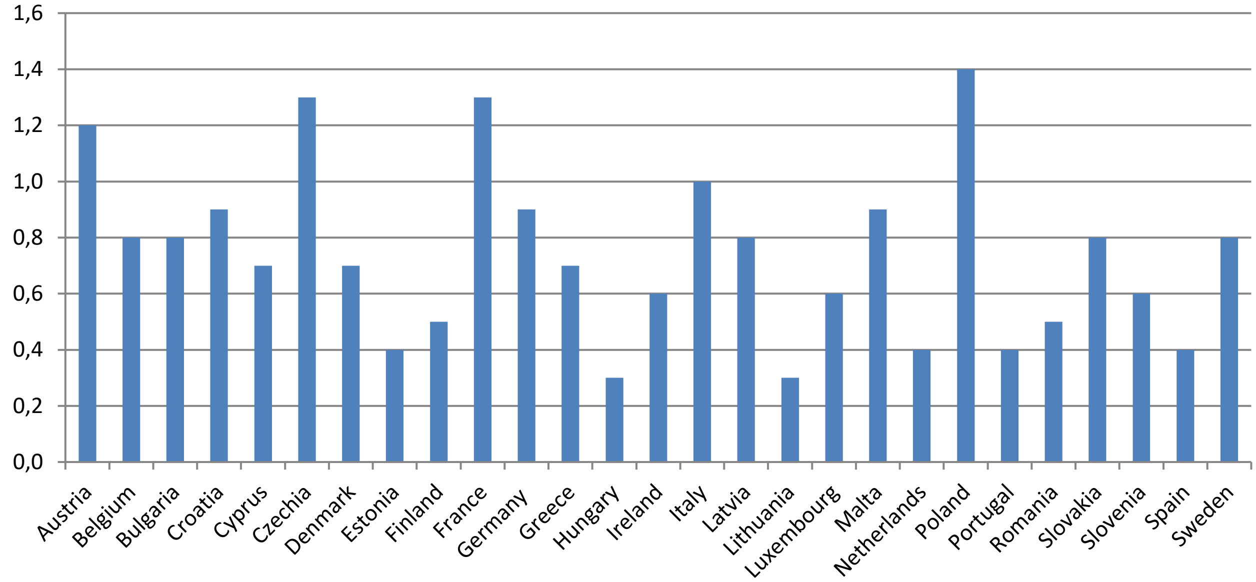


Source: Eurostat

In this context the integration of green investment and environmental policies is necessary to fully pursue different but connected development goals. As shown in Figure 2-9, in 2018, Poland invested the highest percentage of its GDP in environmental protection, 1.4 per cent, while Hungary and Lithuania reported the least, 0.3 per cent.

[10] In some cases, the comparison between all 27 European countries could be heavy and difficult for the reader to understand. For this reason, a group of countries has been selected to draw a generalised overview according to their different characteristics.

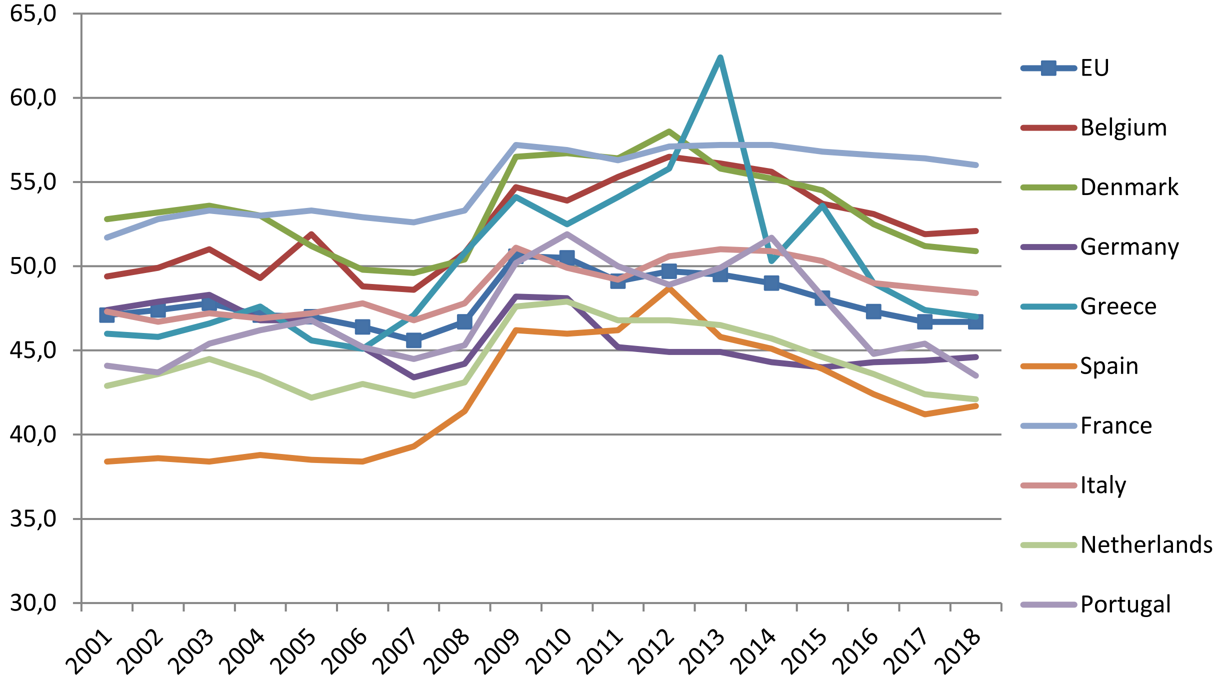
Figure 2-9: Public expenditure on environmental protection, EU, 2018, gross domestic product per cent



Source: Eurostat

Healthcare systems seem to have been strongly influenced by recent economic slowdowns. Many EU Member States adopted austerity measures involving cuts in public expenditure, including both reductions in health budgets and significant structural reforms including hospital closures, mergers and reductions in the number of hospital beds (Quaglio et al., 2013). As shown in Figure 2-10, since the 2007–2008 financial crisis, government healthcare spending contracted in all Member States, but with differently in recent years. Contractions in health spending occurred in various forms, for example, Greece experienced budget cuts in health spending from 6.9 per cent of GDP in 2010 to 5 per cent in 2018. Once again France seems to show a stable trend in recent years, and the same seems to be true of Germany and Italy. Spending also declined in Denmark and Spain, although it is not as steeply, while Portugal shows an increase in recent years after a deep decline between 2009 and 2016. The COVID-19 crisis has highlighted the shortcomings of the health system in Member States, underlining the need for a return to investment in this sector. The budget cuts made in the last ten years have prevented Member States from coping with Covid-19, leading to both life and economic losses as a result of forced lockdowns in most countries.

Figure 2-10: Total health expenditure as a share of gross domestic product, EU (7) and selected Member States, 2001–2018, per cent

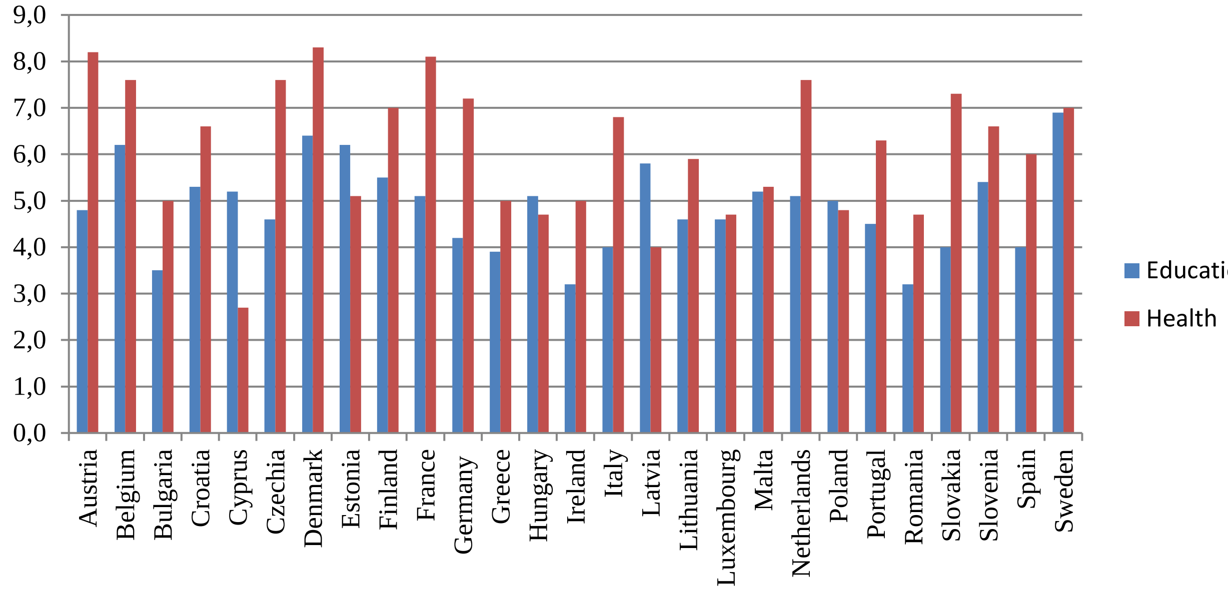


Source: Eurostat

Despite the contraction in healthcare spending, in 2018 its level as a percentage of GDP in EU Member States was still higher than that allocated to education[11], with the exception of Sweden, which, in 2018, invested similar amounts in these two sectors; and Cyprus, Estonia and Latvia, which have favoured the school system over the health system (Figure 2-11). Health and education are two important pillars of human development representing two areas in which public expenditure can be considered as an investment in a human capital (van den Heuvel and Olaroiu, 2017). Moreover, the links connecting education, research and innovation can be considered as a boost to growth from both economic and social points of view. As Tendetnik et al. (2018) argued investment in these areas can be considered as an attempt by governments to improve economic and social conditions.

[11] The total value is built on the sum of different groups according ISCED 1997 classification: ‘pre-primary and primary education', 'secondary education', 'post-secondary non-tertiary education', 'tertiary education', 'education not definable by level', 'subsidiary services to education', 'R&D education', and 'education not elsewhere classified'.'

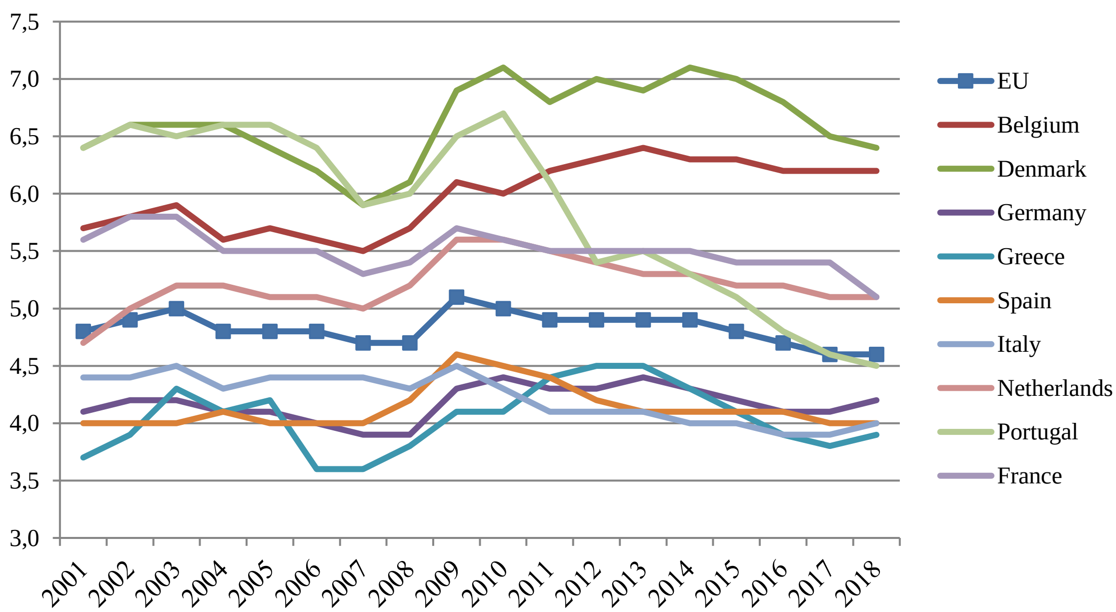
Figure 2-11: Comparison of health and educational expenditure as a share of gross domestic product, EU (7), 2018, per cent



Source: Eurostat

The share of education expenditure in the EU is also heterogeneous, ranging between 3.6 and 7 per cent. Denmark spent the highest percentage in 2010 and 2014, but this had declined by 0.5 percentage points by 2018. Portugal shows the most significant negative trend, with a decrease of 2.2 percentage points between 2010 and 2018 (Figure 2-12).

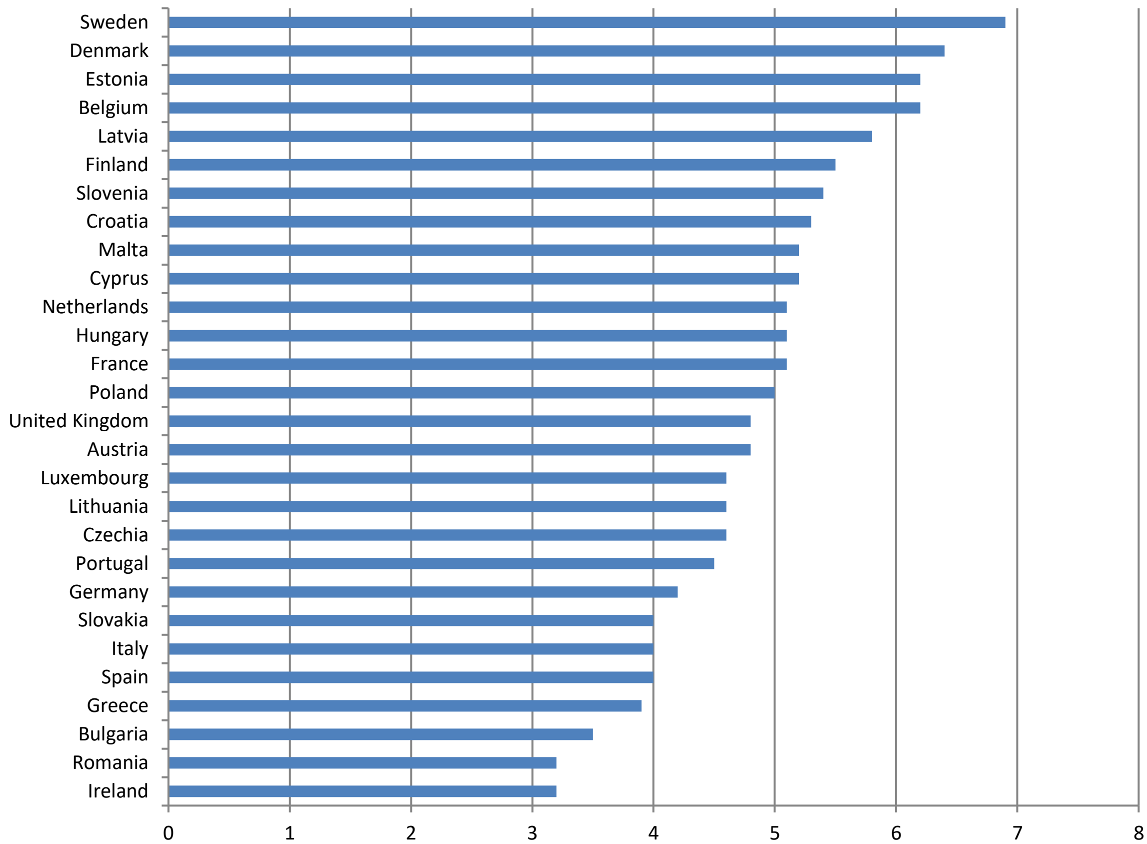
Figure 2-12: Total educational expenditure as a share of gross domestic product, EU (7) and selected Member States, 2001–2018, per cent



Source: Eurostat

Figure 2-13 ranks 2018 education expenditure as a percentage of GDP in EU Member States. It seems quite clear that public investment in the educational sector depends on the structure of the school systems. In 2018, Sweden, Denmark, Estonia and Belgium invested most resources in the school system, while Ireland spent the last place despite having the highest HDI score in the EU.

Figure 2-13: Educational expenditure as a share of gross domestic product, EU (7), 2018, per cent

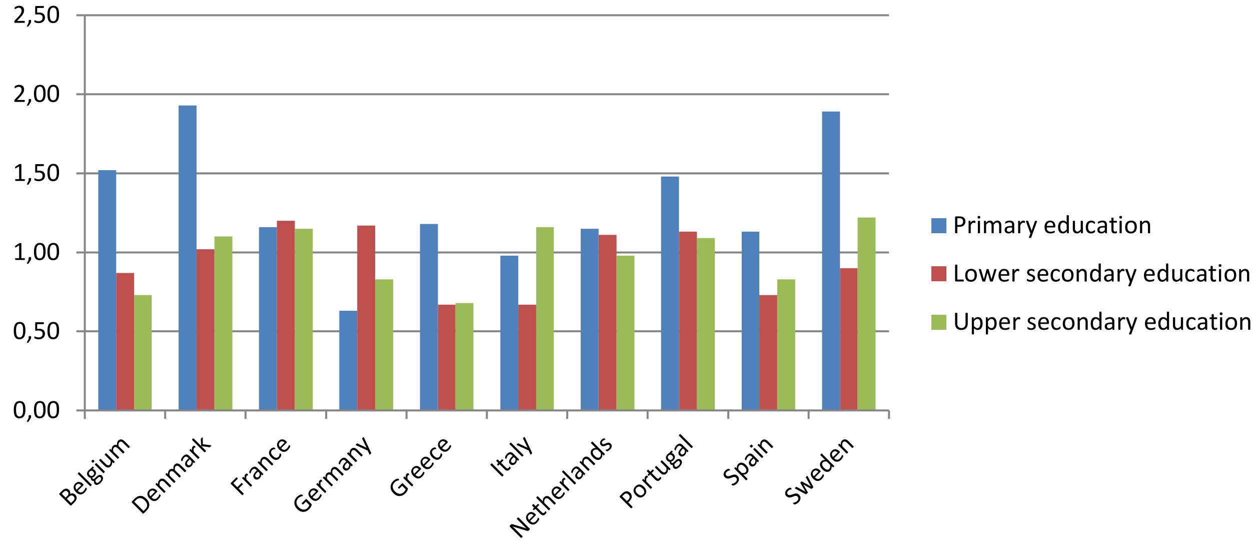


Source: Eurostat

The distribution of resources varies according to the levels of education. As shown in Figure 2-14, Denmark, Sweden and Belgium allocated most resources as a percentage of GDP to primary education in 2018 relative to other levels. In particular, Denmark has reserved 1.93 per cent for primary schooling[12] compared to 1.02 per cent for the lower-secondary level. As Bennett (1970) argued, one of the many assumptions about educational policy at the primary level, and especially for conditions in low-income rural communities, concerns the desirability of literacy as a means of achieving high-priority economic development goals for the local community. Conversely, Germany and Italy dedicated relatively fewer resources to primary education than the other school levels, prioritising lower- and upper-secondary levels respectively.

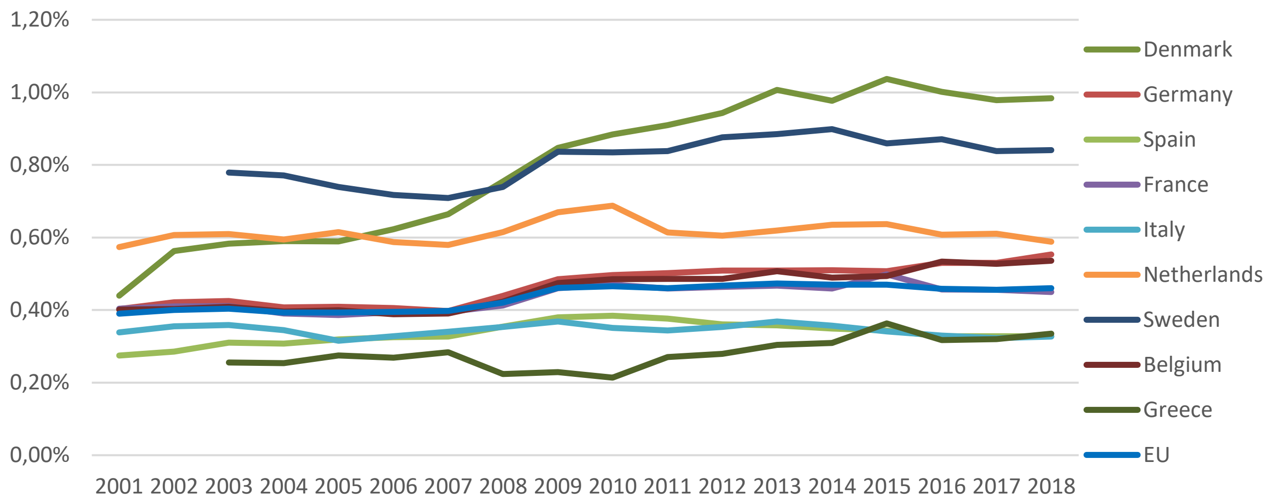
[12] In this case, as reported on Eurostat metadata, the school classification follows the ISCED 2011 classification.

Figure 2-14: Public expenditure as a share of gross domestic product on education by educational level, selected EU Member States, 2018, per cent



Source: Eurostat

Figure 2-15: Public expenditure as a share of gross domestic product on research and development in the higher education sector, EU (7) and selected Member States, 2003–2018, per cent



Source: Eurostat data

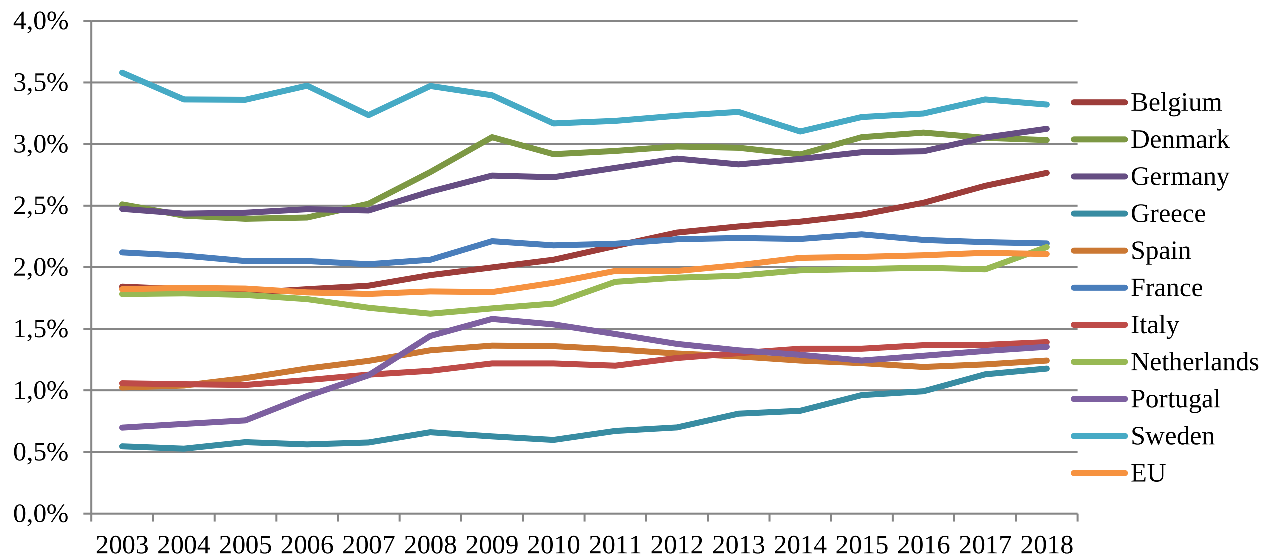
Figure 2-15 shows public expenditure as a share of gross domestic product on research and development (R&D) in the higher education sector. As can be seen for the selected countries, between 2003 and 2019 Sweden, Denmark and the Netherlands are above the EU value taken from. Despite some small downturns, the continuous growth in percentage expenditure by top investors Denmark and Sweden suggests that they are focused on R&D in this sector while Greece, Italy and Spain spend the least. The situation appears heterogeneous with percentages ranging from 0.21 in Greece in 2010 to the 1.04 in Denmark during the 2015. Some countries have increased their percentage investment in R&D in university and post-graduate education over time, or at least kept it stable and around the EU level, while in others, such as France and Netherlands, it has declined slightly in recent years.

Research and development is a key driver of invention, innovation and GDP growth. It can be argued that public expenditure should devote resources to private R&D as it as a producer of positive externalities, it can also be argued that this choice can lead firms relying on public expenditure rather than investing their private funds in R&D, which in the long term can result in distorting effects on potential growth levels (Hud and Hussinger, 2015).

Beyond the economic downturn, heterogeneous structural patterns in overall R&D investment among EU Member States are evident. Despite the Lisbon Agenda target of 3 per cent of GDP for R&D investment, the overall EU spend has been around 2 per cent in recent years and only Sweden, has historically invested more than the target level. Denmark and Germany follow with somewhat increasing patterns, but a small downturn in 2017 in Danish spending lead to Germany moving into second place. A attitude of northern selected European countries appears quite clear in terms of investment in R&D in contrast to southern European ones from the selected countries group, Italy, Portugal and Spain, that only spend 1-1.5 per cent of GDP on R&D (Figure 2-16). What emerges from European strategies on the main pillars of human development is a heterogeneous scenario as, in recent years, EU Member States reacted differently to the 2007–2008 financial crisis.

Drawing conclusions, the lack of a solid investment model in strategic areas of human development it evident among EU Member States. This weakness emerged disruptively from the first half of 2020, when the Covid-19 crisis found all Member States completely unprepared to deal with new needs generated by the virus and with the new requirements for recovery after the pandemic.

Figure 2-16: Total public expenditure as a share of gross domestic product on research and development across all sectors, EU ([7]) and selected Member States, 2003–2018, per cent.



Source: Eurostat

2.5. Testing for convergence across Europe

Data on carbon dioxide (CO_2) emissions, value added in the EU, GDP per person and the Gini coefficient ([13]) from Eurostat to build a cross sectional dataset aimed at a convergence analysis, in order to describe whether and to what extent EU Member States appear to be converging in terms of environmental performances – CO_2 production – economic growth and inequality. This accounting for issues related to inequality is an important step in the design of policies coherent with the EGD's ambitious objectives, including the need for a just transition. Table 2-1 describes the indicators used in this analysis.

Table 2-1: Description of the variables used in the convergence analysis.

Variable	Description	Year availability	Country availability	Observations	Mean	Standard deviation	Min.–Max.
Environmental productivity	Value added of the economy deflated at 2010 levels in EUR millions (by country and year) over CO_2 emissions in tonnes (by country and year)	1995–2018	European Union and United Kingdom	410	0.003	0.002	0.0006–0.009
Per person GDP	Per person GDP by country deflated at 2010 price level, EUR	1995–2018	European Union and United Kingdom	667	23161.14	15575.83	2851.709 – 85216.55
Gini coefficient	Income inequality measure by country and year	1995–2018	European Union and United Kingdom	529	29.632	4.045	20–40.2

Source: own elaboration on Eurostat data

The majority of data were available from 1995 to 2018, although with country level exceptions. Environmental productivity (Repetto, 1990) – the environmental performance indicator used – was computed as the value added per unit of CO_2 emissions for each country to capture the productivity of each unit of CO_2. The larger the value added per unit of CO_2 emissions, the larger the measure of CO_2 productivity will be or, conversely, the smaller the indicator, the larger the CO_2 intensity per unit of value added will be. Despite the availability of information on other pollutants in the Eurostat database, for example, methane and sulphur oxides, CO_2 emissions were chosen to build the indicator of environmental productivity for three reasons. First, it is the highest contributor to greenhouse gas (GHG) emissions; second, being a global pollutant, its reduction reflects the success of EU environmental policies and related coordination efforts by Member States; and third, using information on this pollutant ensured the highest coverage in terms of Member States.

Inequality is measured here using the Gini coefficient; this indicator is a statistical dispersion measure of income intended to represent income inequality within a nation. The closer the Gini coefficient to zero the lower the inequality, while a value of 100 expresses maximal inequality in the country – namely, an

[13] The Gini coefficient is the most preferred statistical dispersion measure in income inequality analysis.

extreme case where all the income is held by only 1 individual. It is believed that this measure is relevant to understanding to what extent Member States are heterogeneous in terms of income distribution, as well as whether such heterogeneity is decreasing over time, although, as will be seen, convergence may occur in a desirable or undesirable way ≠ high inequality countries catching up low inequality ones or *vice versa*.

Beta and sigma convergence: concept, methodology and results

A full representation of convergence measures is beyond the scope of this report. This section a briefly introduces to the main relevant concepts.

The concept of convergence was first introduced in economic modelling by neoclassical economists, who aimed to assess whether a convergence in GDP per person could be observed over time across countries (Barro and Sala-i-Martin 2003).

Two types of convergence processes are considered.

- β convergence occurs when countries featuring a lower initial value are showing a higher growth rate in the selected indicator as compared to countries with a higher initial value.

  To check for β convergence the growth rate of each indicator is regressed over its initial value. If the coefficient for the initial value is negative, and statistically significant, a catching-up process is taking place, in this case, within the EU.

- σ convergence is related to cross-sectional dispersion over the time period analysed. Here, the dispersion – in this case, the standard deviation – of each indicator is checked to establish whether it is increasing or decreasing over time – the trend of the standard deviation of each selected indicator over time is examined. If the dispersion is reducing, then the differences among countries values of the indicator are levelling up.

σ convergence tends to be a consequence of β convergence; however, the latter is a necessary but insufficient condition for the former. A first caveat is needed here: the results here should be interpreted as merely descriptive, potentially suggestive of further, more detailed, assessments.

The aim of this specific exercise is testing, using both β and σ convergence, whether 'laggard' countries are catching up in terms of either environmental productivity, GDP or inequality compared to 'leading' countries. Importantly, neither β nor σ convergence provide information on whether countries are tending to a specific indicator's value. Taking GDP as an example, if β convergence is present, it can only be concluded that countries that had a lower initial GDP value, i.e., in 1995, show higher rates of economic growth than those with a higher initial value of the same variable. σ convergence provides evidence on whether the distribution of GDP across countries becomes less dispersed over time.

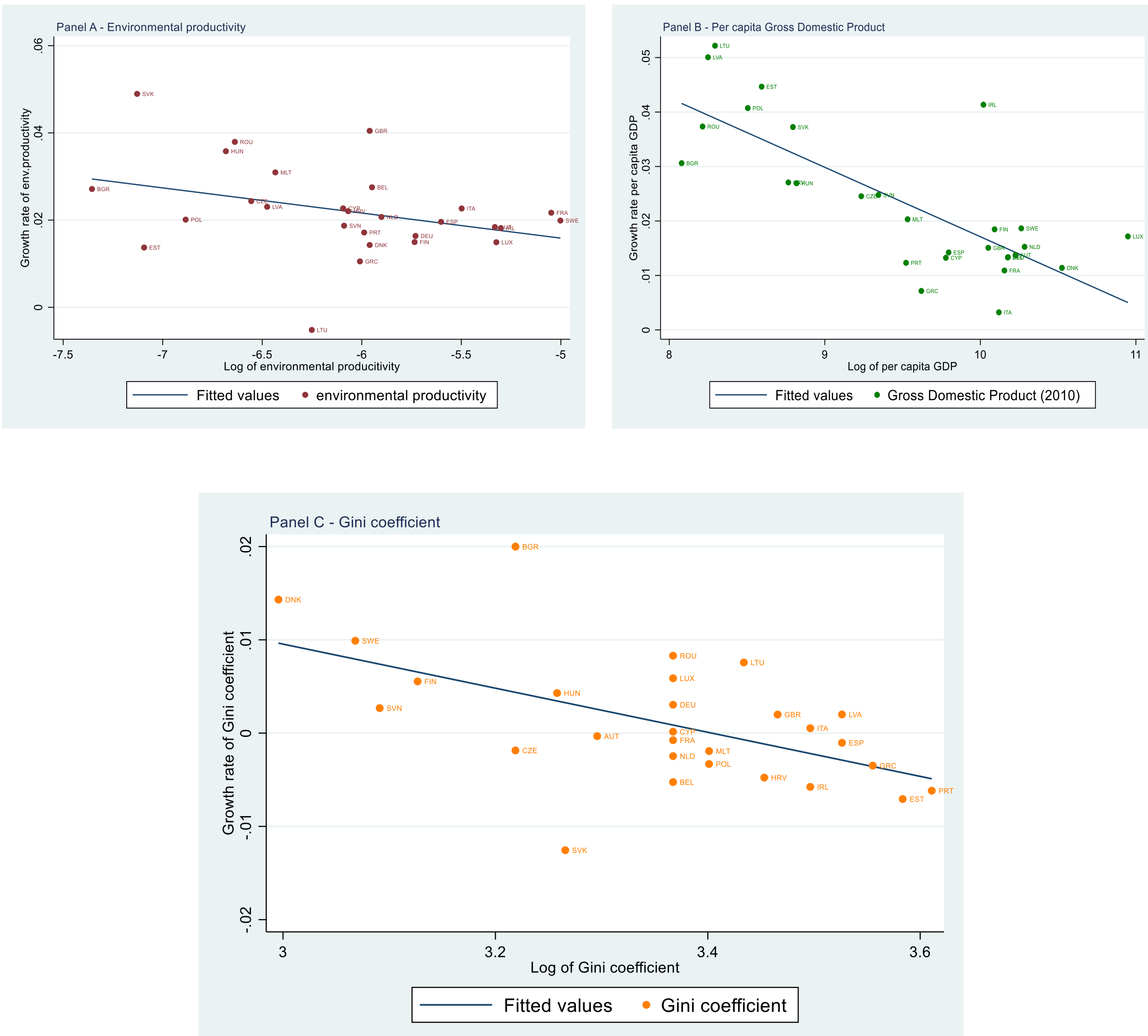
Figure 2-17 shows the analysis in relation to β convergence for the three selected indicators – environmental productivity, GDP per person and inequality: evidence compatible with β convergence can be observed, the corresponding coefficients being negative and significant ([14]).

Figure 2-18 may help to achieve a more detailed understanding. Focus is limited to six countries, two from each of three possible clusters of EU Member States, namely central-northern Europe, Denmark and Germany; southern Europe, Italy and Spain; and eastern Europe, Czech Republic and Poland.

[14] The corresponding values are: -0.006 (environmental productivity, p-value 0.066), -0.013 (GDP per person, p-value 0.0000) and -0.024 (Gini, p-value 0.0000).

Environmental productivity (Figure 2-18, Panel A) shows an increasing trend in all analysed countries, but differences do not appear to be clearly closing. Also, with reference to GDP per person (Figure 2-18, Panel B), no clear convergence appears for most of the countries under scrutiny – and even diverging patterns seem to emerge: see, for example, Germany as compared to Italy.

Figure 2-17: Convergence plots for environmental productivity (Panel A), gross domestic product per person (Panel B) and inequality (Panel C), EU + UK, 1995–2019



Source: Eurostat

Figure 2-18: Trend plots for environmental productivity (Panel A), gross domestic product per person (Panel B) and inequality (Panel C), selected Member States, 1995–2019

Source: Eurostat

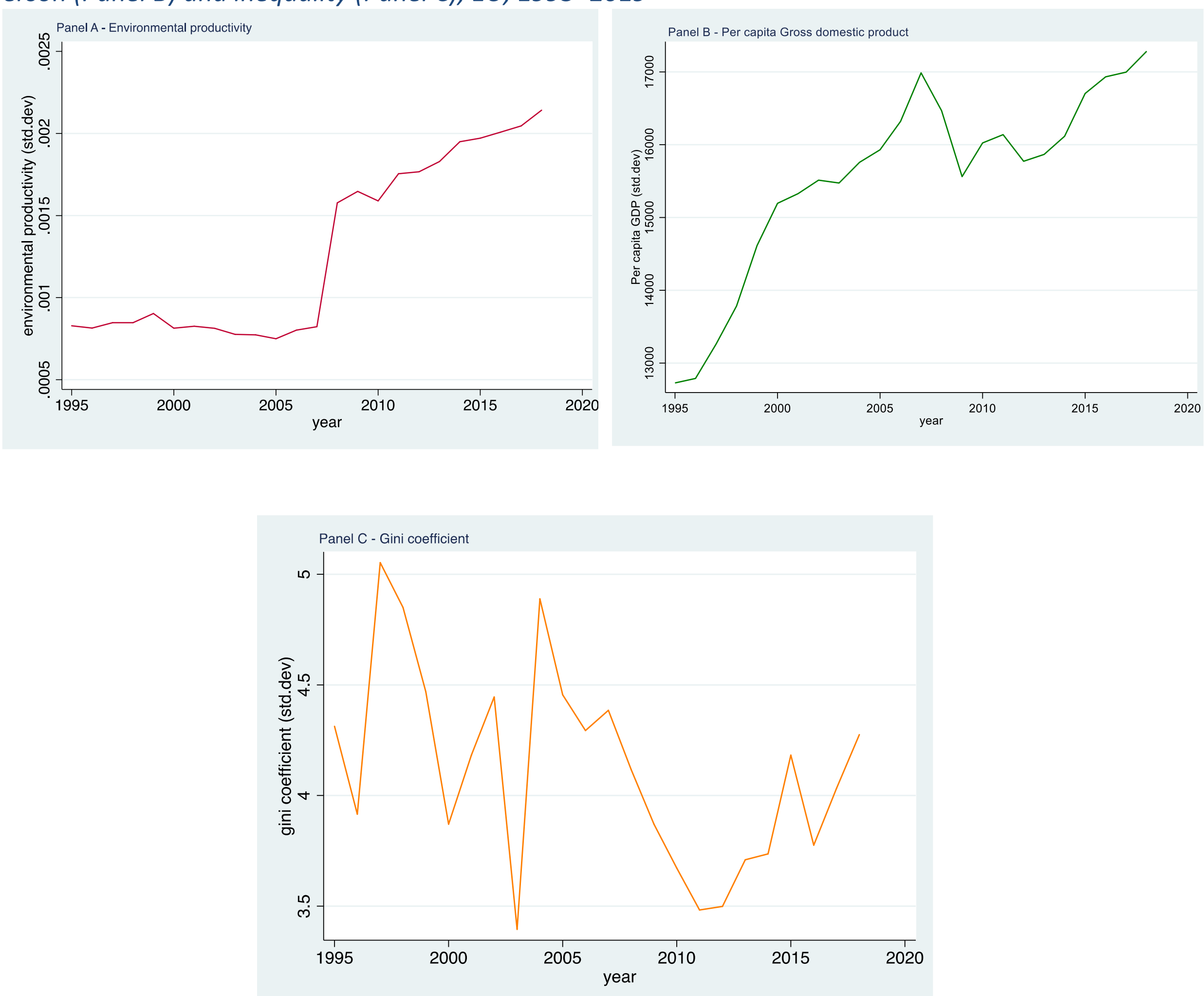
Matters are even more scattered with respect to the Gini coefficient: overall, according to Eurostat data ([15]), its evolution for the EU over the most recent available years shows very small variations and a value slightly above 30 – the value in 2019 was the same as in 2010, namely 30.2; heterogeneity can, however, be observed across the selected Member States (Figure 2-18, Panel C): those from southern Europe, Italy and Spain, are the ones with the largest value/greatest inequality in the latest years; the Gini coefficient for Spain has decreased slightly in the most recent years, while Italy's has increased. Poland shows a reduction in the Gini coefficient over time in the most recent years, after a significant increase before 2005 and, as a result, caught up first with Germany and then Denmark. Descriptive evidence is therefore mixed, featuring examples of apparently 'bad' convergence, but also cases where inequality appears to be improving.

The analysis in terms of σ convergence is reported in Figure 2-19, where the trends in the standard deviation are plotted, showing that disparities among EU Member States in terms of environmental

[15] https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_di12. Last accessed 21/10/2021.

productivity, GDP per person and inequality do not seem to be reducing over time. Specifically, both environmental productivity (Panel A) and GDP per person (Panel B) show increasing trends in most recent years. Finally, although the Gini coefficient dispersion varies year on year, its 1995 and 2019 (Panel C) values are largely the same.

Figure 2-19: Convergence plots for environmental productivity (Panel A), gross domestic product per person (Panel B) and inequality (Panel C), EU, 1995–2019



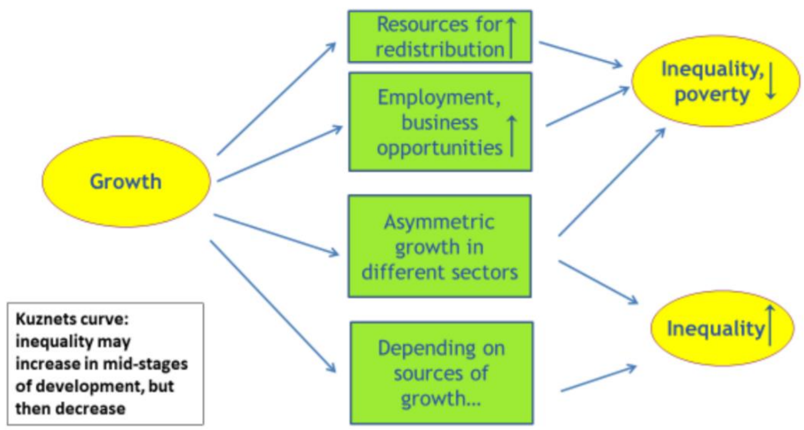
Source: Eurostat

The conclusions from this descriptive analysis are mixed. Indeed, unambiguous indications of a reduction in environmental productivity heterogeneity over time are not obvious, while, mixed dynamic evolutions of inequality can be seen. The existence of heterogeneous economic and environmental performances, together with worsening inequality in some countries, suggest that particular attention should be paid to designing sustainability transition policies that properly accounting for Member State specificities, especially in matching environmental and social objectives.

2.6. The inequality framework

The complexity of the interactions across different sustainability objectives makes it very important to couple green growth strategies with considerations related to income distribution and poverty. This is highlighted, for example, by the just transition mechanism, which is part of the EGD's overall strategy ([16]). A significant strand of the economic literature considers the linkages between economic growth and distributional issues. Though it is beyond the scope of this part to provide a full overview, it can make reference to Cerra et al. (2021), who review the relevant literature identifying drivers and policies affecting the links between growth, inequality and poverty (Figure 2-20).

Figure 2-20: Impact of growth on poverty and inequality.



Source: Cerra et al. (2021)

As Cerra et al. (2021) underline, the links are complex, and the related literature wide. While that paper (among others) should be referred to for a full account of existing contributions, the following relevant conclusions provide a brief summary.

- There is wide agreement in the literature that economic growth is expected to reduce poverty, particularly so in developing countries. Indeed, growth may be beneficial in terms of poverty reduction through channels linked to health, education and employment.
- The nexus between growth and inequality is, however, less straightforward, as it is affected by the specific growth mechanisms analysed, for example, skill-biased technical progress, or growth biased in favour of specific sectors.

Overall, according to Cerra et al. (2021), while policies fostering economic growth are important, economic growth should be seen as "*…a way to achieve human development. This requires that the benefits of growth are widely shared across society*" (Cerra et al., 2021, p. 37). As a result, policies are needed to account for losers from changing economic conditions.

[16] This issue will be addressed further in Section 3.1 – Pillar 3, and in Section 3.3.

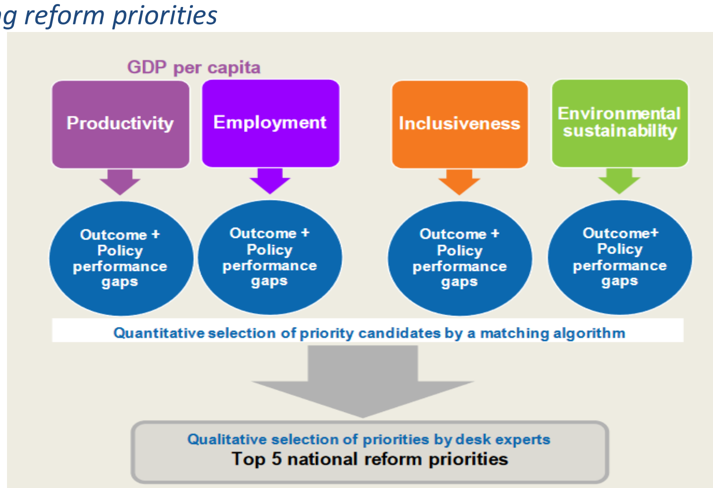
Focusing more specifically on EU Member States, Michálek and Výbošťok (2019) analyse development over the period 2005–2015, with a focus on the relationships between GDP, inequality and poverty, as well as on the capability of individual countries to cope with relevant challenges including economic crisis and migration pressures. As the authors suggest, countries have been affected in a heterogeneous way by those challenges: some countries were successful in coupling economic growth with a reduction in inequality, while in most EU Member States only a minority of people benefited from economic growth, where it occurred, resulting in increased inequality and poverty.

Though not exhaustive, the mentioned papers suggest that the issues of economic growth and income distribution must be considered jointly, making the policy picture significantly more complex.

Turning to the possible trade-offs between environmental quality objectives and distributional issues, the EEA's 2019 state of the environment report (SOER) (EEA, 2019) provides a quite interesting analysis by addressing the significant positive or negative potential interactions across different sustainable development goals, which must be accounted for in dealing with a macro-sustainability transition: in particular, Chapter 15 clearly states that *"… the relationship between Sustainable Development Goals (SDG) 12-15, crucial for environmental protection and climate action, and other SDGs (such as SDGs 1 and 7-11) potentially involve trade-offs*." (EEA, 2019, p. 342). More specifically, important trade-offs may arise between goals related to environmental protection and those related to the affordability of energy, to inequality and/or to poverty.

In a recent OECD (2019) report, reform priorities in OECD and non-OECD countries are identified with the aim of improving long-term living standards and making sure that the related enhancements are widely shared according to the framework of analysis outlined in Figure 2-21, which also encompasses inclusiveness and environmental sustainability. Relevant priorities include education, equality of opportunity and integration, R&D and the environment.

Figure 2-21: Identifying reform priorities



Source: OECD (2019)

As underlined by ETC/WMGE (2018), income distribution may be a relevant driver affecting environmental quality. Indeed, social and environmental crises may be mutually reinforcing, for example, poor people are expected to be more dependent on environmental quality and more exposed to pollution (Martinez-

Alier, 2003) and climate change (Olsson et al., 2014), while the impact of reductions in social cohesion may have a detrimental effect on cooperative efforts (Baland et al., 2007).

The ETC/WMGE (2018) suggests the possibility of a vicious cycle of income inequality and environmental degradation, at least according to a correlation-based analysis. Although just a first step, this suggests that stronger social inequalities can indeed be coupled to lower environmental quality. More generally, an important strand of the literature focuses on the links between environmental quality and income inequality, and the empirical nature of this link is still subject to research – recent examples include Aijde and Ibrahim (2021), Mader (2018) and Jorgenson et al. (2017).

Additional descriptive hints on the potential trade-offs and complementarities across environmental and distributional goals may be derived by looking at Eurostat data related to environmental pressure, on one hand, and income inequality and poverty indicators, on the other.

Figure 2-22 shows data at the national level for three indicators related to 2017 ([17]).

- Exposure to air pollution by particulate matter (PM_{10}), measuring the population weighted annual mean concentration of particulate matter at urban background stations in agglomerations in $\mu g/m^3$ ([18]).
- Inequality of income distribution (Figure 2-22, top panel), measuring the ratio of total income received by the 20 per cent of the population with the highest income, the top quintile, to that received by the 20 per cent of the population with the lowest income, the lowest quintile.
- Relative median at-risk-of-poverty gap (Figure 2-22, bottom panel), calculated as the distance between the median equivalised total net income of people below the at-risk-of-poverty threshold and the at-risk-of-poverty threshold itself, expressed as a percentage of the at-risk-of-poverty threshold. This threshold is set at 60 per cent of the national median equivalised disposable income of all people in a country.

Looking at data in Figure 2-22, a clear correlation across exposure to pollution, on one hand, and poverty or inequality, on the other, does not seem to emerge. Nonetheless, positive but low correlations of slightly below 0.20 in relation to inequality and around 0.18 in relation to poverty are identified from the data; overall, additional investigation is needed.

The assessment of these relationships is even more important if account is taken of the current COVID-19 crisis that may further worsen inequality through a deterioration of health-related status, disproportionately hitting the most disadvantaged parts of the population.

With all the needed caveats, an account can be given of an increasing body of evidence showing a link between exposure to air and other kinds of pollution, on one hand, and COVID-19 death rates, on the other. Among others, Coker et al. (2020) and Xiao et al. (2020) find an association between long-term exposure to fine particulate matter ($PM_{2.5}$) and COVID-19 related mortality, respectively, in the US and northern Italy. According to this evidence, potential links may also be anticipated, albeit in terms of conjectures and interesting avenues for future research, between exposure to pollution and distributional considerations by recalling the literature investigating the relation across housing prices and environmental quality. As shown, for example, by Mei et al. (2020) with reference to Bejing, China, a significant negative correlation may be found between the concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2), $PM_{2.5}$, and coarse particulate matter (PM_{10}), on one hand, and housing prices (see also, Minguez et al., 2013). Economic constraints may also be a potential reason behind residential

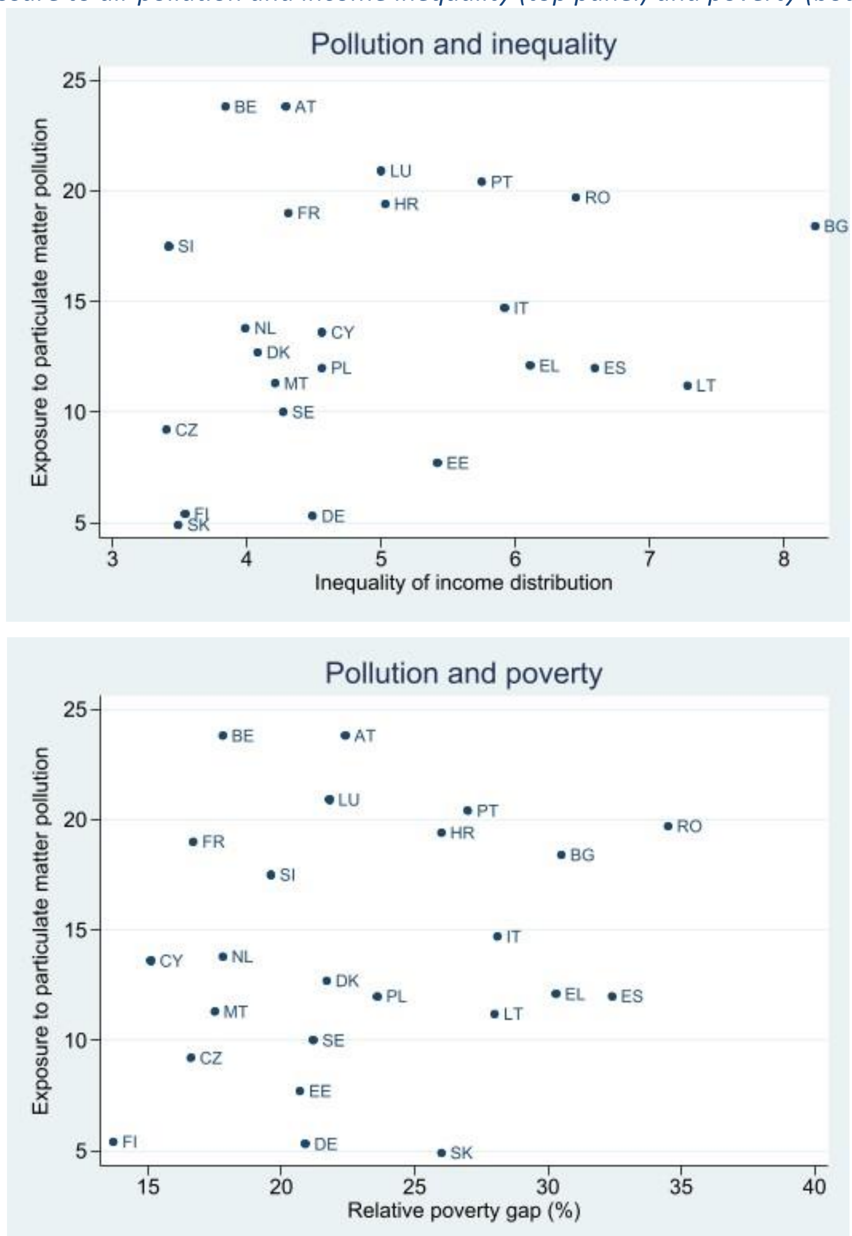
[17] Reference years for Figures 2.22–2.25, as well as countries included, vary due to data availability.

[18] Descriptions of variables here are from Eurostat.

decisions and, as a result, exposure to a polluted environment (Hernandez et al., 2015), coupled with more general socio-economic factors (Schoolman and Ma, 2012).

Although no rigorous conclusion is possible at this stage, the combination of the above pieces of evidence, if confirmed more generally, and of course if quantitatively relevant, may suggest the existence of a possible self-reinforcing cycle between income inequality, exposure to a degraded environment and health.

Figure 2-22: Exposure to air pollution and income inequality (top panel) and poverty (bottom panel) 2017

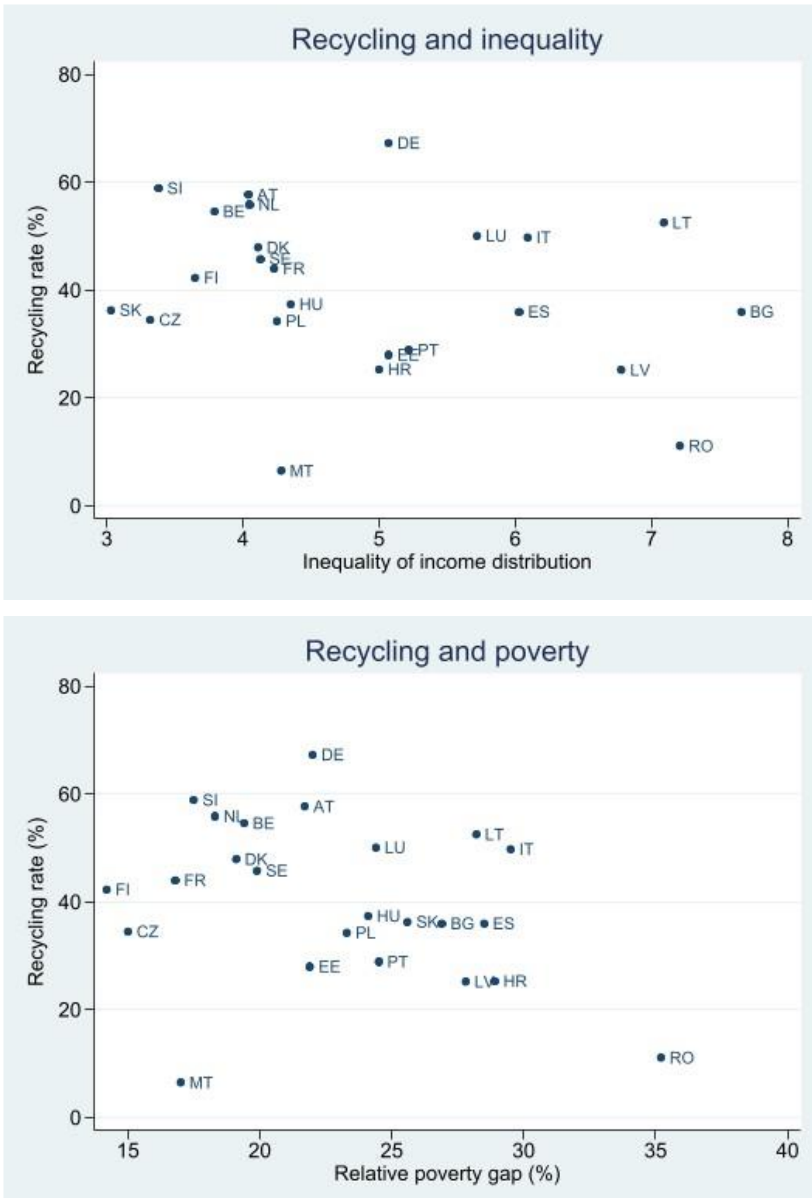


Source: Eurostat

Figure 2-23 provides data on the inequality and poverty variables outlined above (horizontal axes) and the recycling rate in individual EU Member States (vertical axes) for 2018. A hint of a negative relationship seems to emerge, at least looking at the bottom panel related to poverty. Negative, albeit small, correlations are identified, (-0.25 and -0.30 for inequality and poverty, respectively). This is again suggestive of possible complementarities between SDGs related to poverty and inequality and those related to environmental quality.

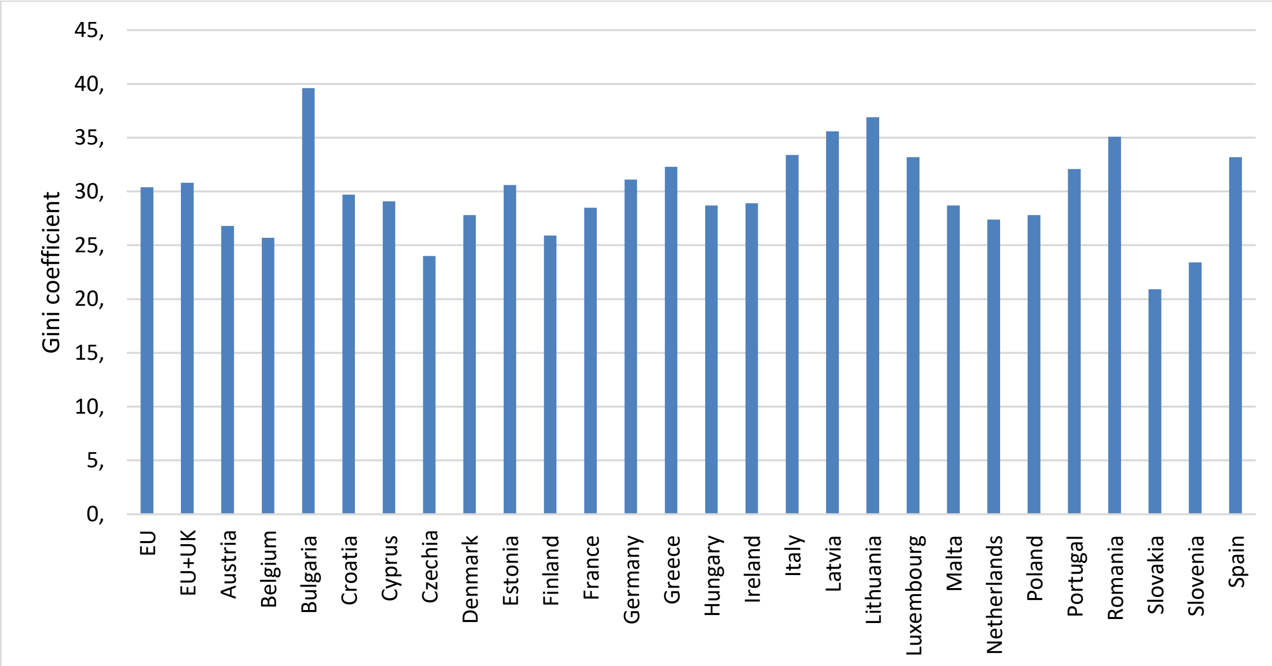
A possible trade-off, in line with suggestions stemming from the latest EEA's 2019 SOER (EEA, 2019), is linked to the heterogeneous acceptability of policies based on carbon pricing, and more generally on pricing natural resources in the presence of inequality in EU Member States.

Figure 2-23: Recycling rate of municipal waste and income inequality (top panel) and poverty (bottom panel), 2018, per cent



Source: Eurostat

Figure 2-24: Inequality, EU Member States + UK, 2018, Gini coefficient



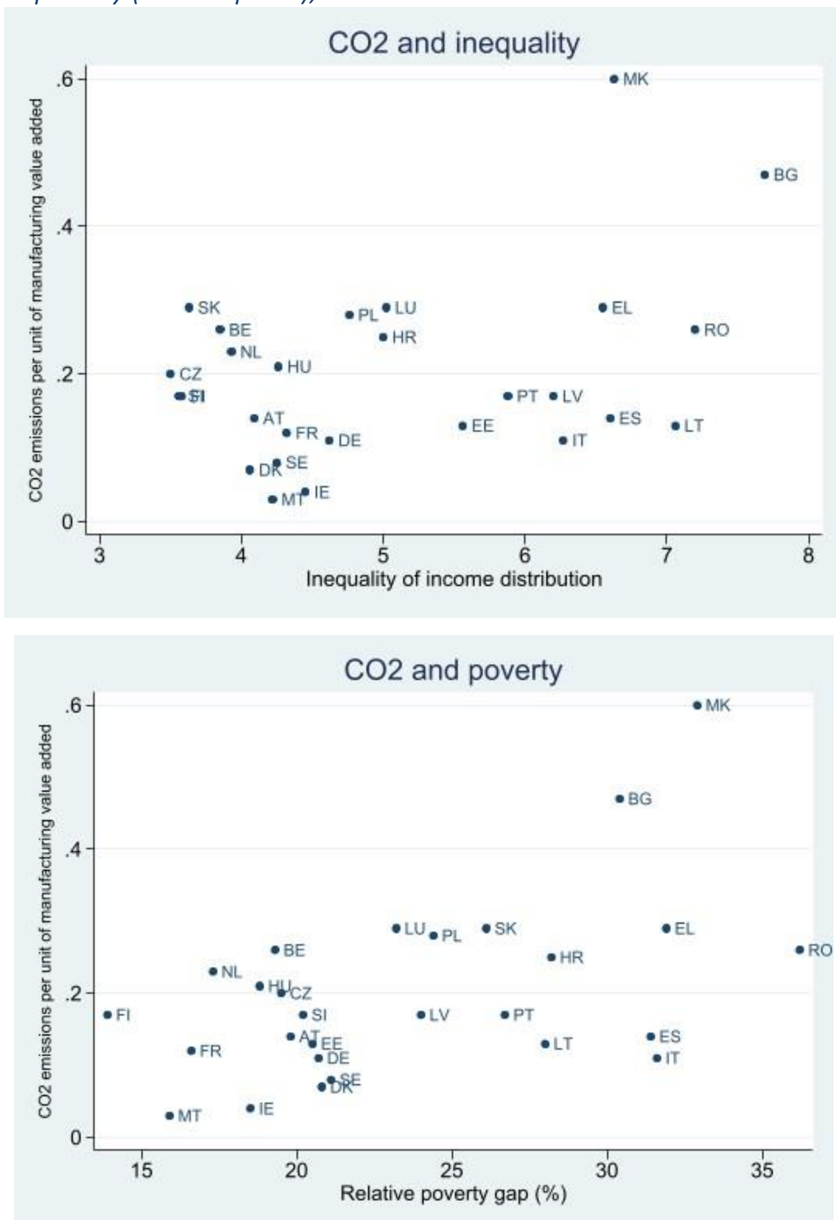
Source: Eurostat

Figure 2-24 shows the values of the Gini coefficient, measuring inequality in income distribution, across EU Member States. The presence of several countries featuring a relatively high level of inequality, in some cases above EU average, suggests that resource pricing policies would need to be properly designed if they are to reduce possible adverse distributional impacts and the generation of stranded assets (Rozenberg et al., 2020) and boost their political acceptability. Indeed, as outlined by, among others, Klenert et al. (2018) with reference to carbon pricing, in order for this instrument to work, a proper account of political and economic circumstances, including distributional fairness, revenue salience and political trust, is needed.

The assessment of the possible heterogeneity of EU economies in terms of CO_2 intensity may also be helpful in providing additional insights. Figure 2-25 reports, on the horizontal axes, 2016 data on poverty and inequality measures used so far and, on the vertical axis, CO_2 emissions per unit of value added in the manufacturing sector. The latter variable's source is the UN Open SDG Data Hub ([19]). In this case, a positive correlation may be hypothesised from graphs, confirmed by the corresponding values of around 0.39 and 0.51 for inequality and poverty, respectively. This indicates the possibility that countries featuring greater inequality or poverty are also those that may face potential negative consequences of carbon policies, if those policies are chosen to address the carbon intensity of manufacturing.

[19] Carbon dioxide emissions per unit of manufacturing value added (kilogrammes of CO_2 per constant 2010 US$) (EN_ATM_CO2MVA – accessed: 23/09/2020).

Figure 2-25: Carbon dioxide intensity in manufacturing and inequality (top panel) and intensity in manufacturing and poverty (bottom panel), 2016



Source: Eurostat, UN

Overall conclusions, albeit only descriptive ones, from this section reinforce the arguments in favour of the need to take a particular care in choosing and implementing policies coherent with the ambitious transition embedded in the EGD, with an eye to distributional and poverty related impacts. In other words, the discussion in this section suggests that strategies compatible with economic growth and improvements in environmental quality should be designed and implemented in such a way as to mitigate possible adverse impacts in a distributional perspective and, where possible, to bring enhancements in the same respect, coherently with contributions from other parts of this report (Section 3.3).

2.7. The international framework

The integration of global markets for goods, services and capital (i.e. globalisation) constitutes a key element in the macro-modelling of the nexus between environmental, economic, social and political outcomes. A first relevant dimension has to do with the contribution of globalisation to aggregate economic growth and, consequently, on the level and geographical distribution of environmental pressures, on income distribution and on competitiveness. A second dimension refers to the interaction between globalisation and heterogeneous environmental policy regimes, with relevant implications in terms of country's specialisation. Two potential outcomes emerge in this respect: a 'race-to-the-bottom' effect (i.e. Pollution Haven Effect) and a 'race-to-the-top' effect (i.e. California Effect). Specialisation has direct implications in terms of trade and foreign direct investment flows (offshoring vs reshoring) and is usually very persistent in time. A third dimension considers the importance of environmental pressures embodied in international trade flows and points to trade policy as a possible complementary lever for supporting the achievement of environmental targets.

Globalisation, economic growth and the environment

In a Communication released in 2010 entitled *Trade, Growth and World Affairs Trade Policy as a core component of the EU's 2020 strategy* (European Commission, 2010), the European Commission highlighted the importance of trade, both within EU Member States and between the EU and other countries, as a driver of prosperity – economic growth, consumer benefits and labour effects. Indeed, the positive contribution of globalisation to macro-economic growth has been the subject of an extensive stream of academic research and policy analysis both from a theoretical and empirical viewpoint.

From a theoretical point of view, globalisation contributes to GDP growth through: i. a more efficient specialisation in production that exploits heterogeneity in terms of factors' endowment and productivity across countries (Ricardo model, see Eaton and Kortum, 2012; Heckscher-Ohlin-Samuelson model, see Bergstrand, 1990); ii. an increase in the market size for firms, leading to a better exploitation of economies of scale and to a larger number of different varieties of products available to consumers (Melitz model, see Melitz, 2003; Krugman model, see Krugman, 1979); iii. the transfer of capital from low-return, high-income countries to high-return, low-income countries, helping the latter to escape the so-called poverty trap (Azariadis, 1996). All in all, empirical evidence tends to confirm the existence of these theoretical mechanisms.

According to Copeland and Taylor (2003), the discussion about the link between trade, and globalisation in general, and the environment should start from the general equilibrium effects of trade. Total change in macro-level environmental pressures could be broken down into three main components (Antweiler et al., 2001): i. change in the size of the economy (scale); ii. change in the structure of the economy in terms of the environmental intensity of production/ consumption (composition); and iii, change in sector/product specific environmental intensity (technology).

By contributing directly to economic growth (scale effect) and structural change (composition effect) through specialisation, globalisation is a key component of the macro-level link between the economic system and the environment. While the scale component will *ceteris paribus* ([20]) induce a proportional increase in environmental pressures, the composition effect, driven at least partly by comparative advantage and factor abundance, could either increase or decrease *ceteris paribus* environmental pressures. If a country has a relatively abundant endowment of environmental-intensive inputs and/or

[20] *ceteris paribus*: other things being equal.

has a comparative advantage in environmental-intensive products, trade liberalisation implies a *ceteris paribus* increase in environmental pressures. Finally, globalisation also enables the diffusion of novel and more environmentally efficient technologies, either disembodied or embodied in trade and capital flows, leading to a *ceteris paribus* reduction in environmental pressures of production activities.

Copeland and Taylor (2003), however, additionally point out that an increase in affluence also contributes to a rise in the demand for environmental quality, which is usually assumed to grow with income per person, or even grow more than proportionally, i.e. luxury good. No matter whether this growing demand is met through private (corporate social responsibility) or public (environmental regulation) supply, this mechanism partly mitigates the scale effect.

Globalisation with heterogeneous environmental policy across jurisdictions

The rapid increase in global integration of markets, though not irreversible as evidenced by the US-China trade war and the collapse of trade during COVID-19 pandemic, also interacts with the presence of cross-country heterogeneity in the setting and stringency of environmental regulation. These cross-country differences, through their influence on production costs in different sectors, play a role in trade specialisation by altering the comparative advantage of sectors that are differently environmental efficient and by changing the relative supply of production factors.

More specifically, if two countries were identical in all respects other than the stringency of their environmental policy, according to standard trade models the country with a more stringent environmental policy should specialise in the production of the environmentally intensive goods, while the country with the least stringent environmental regulation should specialise in the production of environmentally efficient goods. This phenomenon, also known as the pollution haven effect (Levinson and Taylor, 2008; Copeland and Taylor, 1995), has become very popular, even though the empirical evidence of its validity is mixed.

The pollution haven effect is likely to be even more relevant if capital is allowed to move across borders. Indeed, not only countries with non-stringent environmental regulation are likely to specialise in the production of environmental-intensive goods, but also they will receive capital inflows from countries with more stringent environmental regulation in environmental-intensive sectors (Kellenberg, 2009).

In this respect, recent episodes of reshoring back to the EU of manufacturing activities from low-income and low-stringency countries (Eurofound, 2019), further reinforced during the Covid-19 crisis (Irwin, 2020), seem to explicitly contradict the pollution haven effect. A recent ETC/WMGE report (ETC/WMGE, 2021) highlights that reshoring is still a relatively marginal phenomenon, even though it is worth understanding the reasons behind the choice of EU-based companies to bring production back from pollution havens. Despite a strong Euro, high energy and social, including labour. costs, companies attribute a growing importance to: i. being close to their customers who put increasing value to taylor-made goods and services; ii. securing their supply chains from disruptions; and iii. build a reputation as a makes-in-EU company.

The Covid-19 crisis reinforced reasons for reshoring as a consequence of growing digitalisation of processes and production and threats to the security of global supply chains due to lockdowns and bans enacted to counteract the pandemic. Finally, from the policy side, the EGD and the recent Fit-for-55 package propose ambitious trade policies to counteract the pollution haven effect in the form of Carbon Border Adjustments.

The relevance of the pollution haven effect in terms of environmental outcomes depends on the type of environmental pressure. In case of environmental pressures causing local externalities such as water pollution, the pollution haven effect reinforces the effectiveness of environmental policy in a country with stringent regulation as local damage actually decreases. What happens, however, is that environmental pressures and the corresponding damage increase in an unregulated country, leading to the creation of pollution hotspots. In short, the pollution haven effect induces a displacement of both emissions and the corresponding damage, which depends on local conditions. When referring to environmental pressures causing such global externalities as greenhouse emissions and climate change, however, the displacement of environmental pressures does not reduce local damage as that arises as a consequence of global pressures. This phenomenon, known as carbon leakage (Baylis et al., 2013; Feder and Rutherford, 1993), reduces the effectiveness of unilateral policies to tackle global externalities as global environmental pressures do not decrease. In both cases, however, the pollution haven effect is expected to destroy jobs in a country in which regulation is stringent. The EU Emission Trading Scheme is an interesting case of this in that it grants particularly generous conditions to sectors that are more at risk of carbon leakage (Martin et al., 2014; European Commission, 2009).

The pollution haven effect leads countries that use environmental policy, together with other policies such as corporate taxation, strategically with the aim of attracting foreign investment and creating local jobs in a race to the bottom'.

Cross-country heterogeneity in the stringency of environmental policy could, however, also lead to a race to the top, in which a unilateral increase in the stringency of environmental regulation is followed by a convergence by other countries. The economic mechanism behind this phenomenon, known as the California effect, arises from the fact that stringent environmental regulation for producers in one country can force producers elsewhere with weaker environmental regulation to comply with the stricter standards so that they can export their products (Vogel, 1997).

Environmental pressures embodied in trade and trade policy levers

International trade allows decouple the consumption mix from the production mix of a country, thanks to specialisation. This means that the level of environmental pressure generated by production activities within a country is different from the level of environmental pressure generated to satisfy (final) consumption by people in the same country. This dichotomy leads to the concepts of, respectively, production- *versus* consumption-based environmental pressure (EEA, 2013; Wiedmann, 2009) and to the issue of defining the responsibility of producers *versus* consumers for environmental pressures (Gallego and Lenzen, 2005). Thanks to the recent availability of detailed global multi-regional input-output databases, many different estimates of environmental pressure embodied in international trade exist as well as estimates of the environmental trade deficit/surplus of countries (Moran and Wood, 2014). For Europe, a recent report by the Joint Research Centre of the European Commission (Arto et al., 2020) uses the most recent information from the World Input-Output Database (WIOD) and estimates that in 2014 as much as 30 per cent of total consumption-based emissions of EU consumers were released outside the EU; by 2000 these had fallen to 23 per cent.

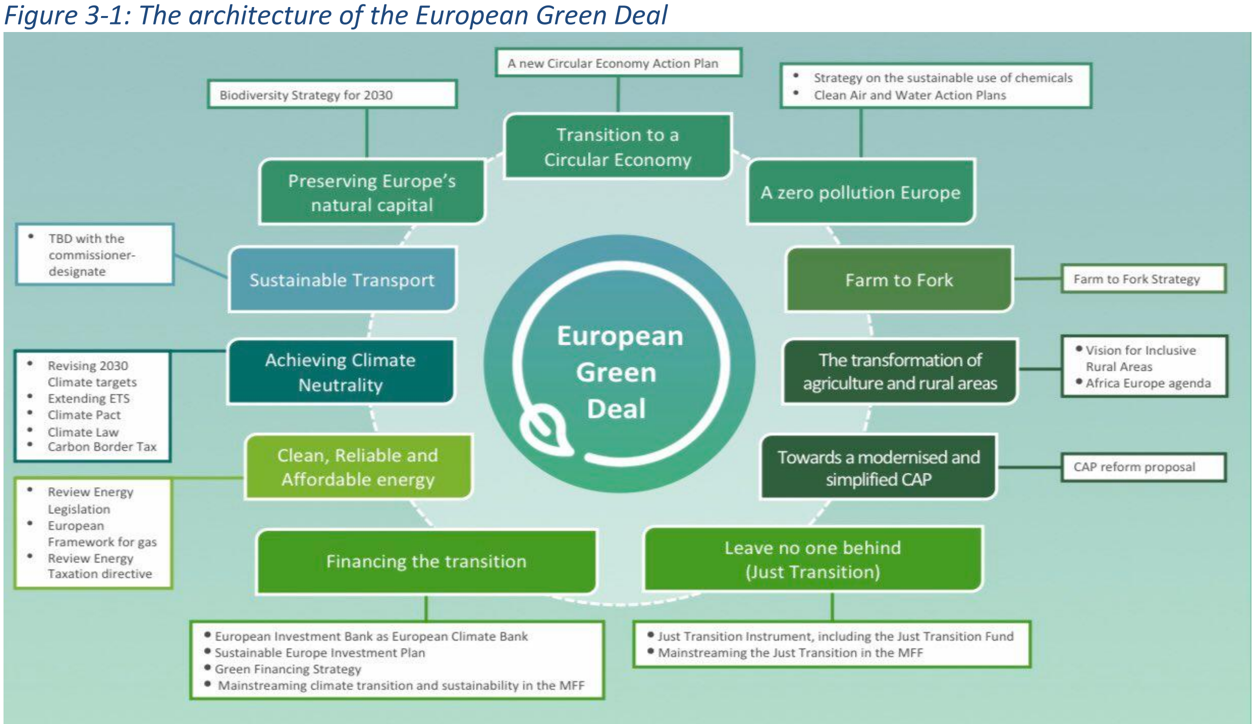
As long as the pollution haven effect impairs the effectiveness of environmental policy for global externalities, as, for example, in the case of carbon leakage, the issue of attributing responsibility to consumers and/or producers is crucial as unilateral environmental policies are not effective. Indeed, an apparent domestic reduction in production-based emissions is compensated – partially, equally or even more – by an increase in emissions released to produce goods elsewhere that are then imported by the home country. Accounting for the amount of environmental pressure embodied in international trade flows is useful for the application of environmental corrections to the price of goods imported from countries with low-stringency environmental policy (for example, border carbon adjustment, see Fischer and Fox, 2012). These measures are expected to be particularly useful because the current mix of tariff and non-tariff barriers was found to grant an implicit subsidy of about US$ 85–120 per tonne of CO_2 emissions according to recent estimates by Shapiro (2020). The objective of these corrections, however, should not be to favour autarchic outcomes in terms of production, as the risk is that the decrease in emissions abroad is more than compensated by an increase in emissions at home (Jakob and Marschinski, 2012). In this respect, the Fit-for-55 package to achieve EGD targets for 2030 proposes a concrete set of measures to implement a system of border carbon adjustments, also aimed at reducing distortions of existing instruments that were developed to limit carbon leakage, such as the exemption from auctioning of leakage-exposed industries within the European Emission Trading Scheme for the 2013–2020 phase).

3 The European Green Deal as a macro-sustainability strategy

3.1. Beyond climate action: modernising the European economy

With the EGD, the European Commission aims to make Europe the first climate-neutral continent by 2050, by addressing the socio-economic implications of this transformation and by actively promoting its industrial dimension. Climate neutrality, however, can be seen as the key lever of a broader strategy of growth and modernisation of the European economy. This can be seen from the size and the scope of the EGD (Figure 3-1).

Figure 3-1: The architecture of the European Green Deal



Source: European Commission

Reaching the EGD's objectives of climate neutrality by 2050 and overall environmental preservation will require an overhaul of the way energy is produced and consumed across the continent and, more generally, a profound transformation of the European economy. In 2020, in the midst of the COVID-19 pandemic, EU President von der Leyen pledged to further accelerate the EU decarbonisation process, putting forward a new GHG emissions reduction target of at least 55 per cent by 2030 compared to 1990 levels. In April 2021, the Council and the European Parliament reached a provisional agreement on the European Climate Law, a legislative act aimed at setting into law the new EU 2030 emissions reduction target. The agreement was finally adopted by EU ministers in June 2021.

To deliver on this new, legally binding target, in July 2021 the European Commission presented the Fit for 55 package, containing hundreds of pages of legislative proposals, from the creation of a new EU Emissions Trading System (ETS) for buildings and road transport, through a profound restructuring of energy taxation in Europe, increased renewable energy and energy efficiency targets, and the introduction of a carbon border adjustment mechanism, to revised CO_2 emissions standards for new cars.

Some of these 13 proposals represent an evolution of current EU climate policymaking. This is, for instance, the case with the toughening of renewable energy and energy efficiency targets, and with the more rapid tightening of the ETS cap (the linear reduction factor, which determines how fast the emissions in the ETS decline each year, was already made steeper when the EU jumped from the 2020 to the 2030 climate target). While not innovative from a policy perspective, this upgrade of existing instruments would deliver the majority of emission reductions by 2030.

The package also contains major new components, not least emissions trading for buildings and transport – with the related creation of a Social Climate Fund. There is a clear reason for new action in this area: so far, EU climate policy has predominantly focused on the decarbonisation of the electricity and industrial sectors, notably through the ETS and binding targets for renewable energy and energy efficiency. Consequently, emissions from the electricity sector have fallen fast, and emissions from the industrial sector have also decreased, though to a lesser extent. Emissions from the building sector, however, have not decreased significantly, while transport sector emissions have even increased steadily.

The Fit for 55 package aims to bring transport and building into the EU decarbonisation process. As the two sectors respectively account for 22 and 35 per cent of EU emissions respectively, their decarbonisation is essential if the EU is to reach its climate targets. It is also very important to foster their decarbonisation in the current decade, to avoid an unrealistically fast decarbonisation requirement between 2030 and 2050. The Fit for 55 package envisages decarbonisation in these sectors taking place within a framework involving a mix of policy instruments, primarily carbon pricing, energy taxation and environmental standards.

The package recognises the inevitable social impacts of the measures, and in particular of the creation of a new ETS for buildings and road transport, and for this reason suggests channelling 25 per cent of the revenues from the new ETS into a Social Climate Fund aimed at supporting building renovations, the uptake of clean cars by vulnerable families and small businesses, and providing temporary lump-sum payments to vulnerable households to compensate for the increase in road transport and heating fuel prices.

With the Fit for 55, the EC is also proposing an overhaul of the Energy Taxation Directive, based on the principle that taxation of energy products and electricity should be based on both their energy content and environmental performance, and that different minimum levels of taxation should be allowed for motor fuels, heating fuels and electricity in order to promote greener choices. In particular, the package proposes that an EU-wide minimum tax rate should be applied to polluting aviation fuels – except cargo-only flights – as well as to polluting boat and ship fuel, including fishing vessels. These minimum tax rates would be introduced over 10 years, starting in 2023. The package also contemplates the possibility of tax exemptions for renewable electricity, green hydrogen and advanced biofuels and biogases, again with a view to promoting greener energy sources.

The package contains a significant goal for the reduction of CO_2 emissions from new cars and new light commercial vehicles: vehicle CO_2 emissions should be cut by 55 per cent by 2030 and by 100 per cent by 2035 – with the important caveat that if manufacturers struggle to meet it, the goal can be postponed to 2040. If met, the 2035 target is thus equivalent to a ban on the sales of new internal combustion engine cars and light commercial vehicles in 14 years. The logic of the measure is to give manufacturers sufficient time to properly plan or accelerate the conversion of their fleets to electricity. As the average lifespan of these vehicles is around 15 years, the full conversion of the European car and light commercial vehicle fleet will take place between 2035 and 2050 – a timeframe in which electric cars will become affordable for all.

On top of all these important proposals is the controversial Carbon Border Adjustment Mechanism (CBAM). Already widely debated in Europe and globally, this measure is intended to ensure a level playing field for EU business, which could be put at a competitive disadvantage as Europe deepens its decarbonisation while others do not keep pace. The CBAM is about charging for the carbon content of imports, to a level equal to domestic carbon pricing. The proposal envisages that the system will initially target a select number of carbon intensive goods including cement, iron and steel, aluminium, fertilizers and electricity. Importers of these goods will be required to buy CBAM certificates, the price of which will mirror that of the ETS, and surrender them to a newly established CBAM authority. For goods subject to ETS free allocation, the CBAM price to be paid upon imports will be reduced by a corresponding amount to ensure equal treatment. Furthermore, for goods subject to a carbon price in their country of origin, a corresponding rebate will be applied, again to ensure equal treatment. The CBAM will be applied to goods imported from countries beyond the EU, but some countries shall be exempted: Iceland, Liechtenstein, Norway and Switzerland. The package proposes assigning the revenues generated by the CBAM to the EU budget. A measure that no other economy has so far taken, the CBAM will be gradually introduced from 2023, with a three-year transitional period to ensure the least possible impact on trade flows.

On top of this major legislative package, the European Commission has also taken a number of additional steps to implement the EGD. Additional major steps taken to date include the launch of a New Industrial Strategy (EC, 2020a), the establishment of the Just Transition Fund (JTF) (EC 2020f), the framing of the Farm to Fork strategy (2020c), the proposal for a new Environment Action Programme to 2030 (EC, 2020l), and the adoption of a new Circular Economy Action Plan (EC, 2020b), the Biodiversity Strategy (2020d), the Chemicals Strategy for Sustainability (EC, 2020m), the Renovation Wave Initiative (EC, 2020n) and the Strategy to Reduce Methane Emissions (EC, 2020o).

Is the EGD 'growthist'?

With reference to the analytical frameworks of Part 1, the EGD design is informed by different visions and ideas on sustainability.

1. It is 'growthist' in that it is pursuing a renewed growth and job-creation trajectory through a strong investment programme (Pillar 1, below) and through the industrial and innovation strategy (Pillar 2, below). In particular, it encompasses a macro reallocation strategy (structural change), fostering investment shifts and labour substitution in key economic sectors – a shift from fossil fuels to renewables, turning conventional cars-related jobs into electric cars-related ones, developing circular business and value chains, etc. It is thus growthist of the 'green species'.

2. It tries to be 'equalist' through the Just Transition Fund or the Social Climate Fund proposed in the Fit for 55 package. However weak they may be, it is currently being reinforced (Pillar 3, below) with the equalist element intended to fix the selection consequences of ambitious climate-energy objectives and other EGD-related policies on enterprises, sectors and regions and then prevent new socio-economic inequalities.
3. The design of the EGD is neither 'degrowthist' nor 'well-beingist' in that its social side is generally weaker than its environmental dimension. Even though the effects of the COVID-19 crisis are pushing it in the direction of rebalancing the two sides, a new social model within a new overall paradigm is not envisaged. Effectively, the human wellbeing element of the EGD is implicit in achieving a better environment, making it environmentalist. In general, the social side, or social Europe, was weak in the whole programme of the European Commission before the COVID-19 crisis.
4. Within its growthist perspective, the EGD takes a strong sustainability approach, putting climate objectives and energy efficiency at the very core of the programme, together with the conservation of ecosystem and zero pollution, which corresponds to the conservation of (critical) natural capital.
5. The EGD aspires to be internationalist (Pillar 4, below) by pushing Europe to be world leader in decarbonisation and sustainability, thus gaining, together with a politically-relevant demonstration effect, the possible first-comer advantage from a technological and economic perspective, again being growthist (of the green species).
6. The EGD is necessarily microeconomics-minded on the side of instruments (market-based instrument [MBI] regulation, see below on 'what will change for environmental policies'), but there is a propensity to see MBIs also as a source of fiscal revenue to finance investment ('growthism'), which departs from pure externality-correcting MBIs.

In what follow, the four pillars mentioned above are developed and the possible interaction with the rescue/recovery strategy from the COVID-19 crisis is discussed.

Pillar 1. The European Green Deal's investment pillar and Next Generation EU

Making Europe climate neutral by 2050 will require substantial investment in low carbon systems. Indeed, achieving this goal will require an immediate expansion of annual investment in clean and efficient energy use and transport of about 2 per cent of GDP. The middle scenario in the EC's impact assessment of the new 2030 climate target estimates additional annual investment needs of EUR 360 billion on average, with the annual investment needing to increase to EUR 1 040 billion (at 2015 prices) on average, up from the EUR 683 billion per year invested over the last decade, in order to reach the intermediate goal of a 55 per cent emissions reduction by 2030 compared to 1990. Even more investment is needed beyond 2030. As a share of GDP, this is an increase from 5.3 per cent to 7.0 per cent according to the EC. Much of this investment is required to foster energy efficiency in buildings, promote the deployment of clean cars and promote renewable electricity production.

Whatever the exact aggregate number for the green investment gap, it is important to note that the models used in these estimates tend to underestimate the investment that will be needed for the low-carbon transition. In addition, the success of technologies in the long run is highly uncertain. As a result, it might be preferable to over-invest in green R&D in the short term to insure against potentially catastrophic events in the future. Also, scenarios involving the least behavioural change on the part of citizens are generally the most expensive in terms of investment. This means that if Europeans want to preserve their current way of life as much as possible, even more needs to be invested today.

In terms of timing, political economic considerations dictate clear sequencing: these green investments need to be implemented as soon as possible, and before carbon prices rise to a high level, so that households and companies can switch smoothly to green alternatives when this happens.

To contribute to part of the EGD investment needs, in February 2020, the European Commission initially proposed a Sustainable Investment Plan aimed at mobilising EUR 1 trillion by 2030 from both the public and private sectors. As the COVID-19 pandemic erupted in Europe, however, this plan was rapidly dropped in favour of a broader green investment strategy linked to the post-Covid recovery. This new strategy, centred on the decision to devote 30 per cent of the EU 2021–2027 long-term budget and 37 per cent of the EU recovery fund – Next Generation EU – spending to climate action, is based on a key concept: seizing a moment of unprecedented economic and social disruption to reinforce the reorientation of Europe's economic model towards sustainability, and in particular to accelerate the implementation of the EGD. This concept also reflects a growing recognition that green investment has high fiscal multiplier effects and can achieve, in one swoop, a so-called triple dividend – promoting economic growth, fostering job creation and reducing greenhouse gas emissions.

Pillar 2. The EGD's industrial/innovation policy pillar

To be politically and socially accepted and supported, the EGD must translate decarbonisation into an opportunity to revitalise European industry, and thus ensure long-term economic growth and jobs. That is, while heading towards climate neutrality by 2050, the European economy has to remain highly competitive at a global level at a time of increasing competition from China and other big players. While EU Member States implement their own industrial policies, it is also important to have a broader EU-level industrial policy to prevent market distortions and allow synergies and economies of scale.

An EU industrial policy for the EGD notably needs to tackle two issues: fostering disruptive innovation and creating a market for innovative green products in Europe.

Innovation is the driving force for decarbonisation, and will be at the core of the decarbonisation of industry. To achieve climate neutrality while leading global decarbonisation from an industrial standpoint, Europe must become a global innovation powerhouse for clean energy, clean mobility and smart buildings technologies. To do so, Europe must invest more in R&D, and must invest better. According to the Climate Target Plan 2030, Horizon Europe, the new research and innovation framework programme with, *inter alia*, a dedicated climate, energy and mobility cluster, will use at least 35 per cent of its funds to support the achievement of the climate goals.

Investing more: Europe's R&D spending in relation to GDP remains lower than in other major economies. In 2015, Europe's private and public sectors combined spent 2.04 per cent of GDP on R&D, compared to 2.07 per cent in China, 2.79 per cent in the US, 3.29 per cent in Japan and 4.2 per cent in South Korea. Europe has thus not meet the target it set itself in 2010 of spending 3 per cent of GDP on R&D by 2020. The EU business enterprise sector in particular needs to invest more. Its share of total R&D expenditure at 64 per cent is much lower than in the US, 72 per cent, or China, Japan and South Korea who all invest almost 80 per cent.

Investing better: Europe is a global innovation leader in sectors such as automotive and biopharma, but is less present in the fast-growing technological, electronics and digital sectors that will increasingly underpin clean energy, clean mobility and smart buildings solutions. To turn decarbonisation into an industrial opportunity, the EU must also push the business enterprise sector to scale-up its R&D investment in these disruptive sectors.

In the framework of the EGD, two existing EU initiatives could be enhanced and used to stimulate more R&D investment in clean disruptive technologies by the business enterprise sector.

The first is the European Innovation Council (EIC), currently in a pilot phase. This is inspired by the US Defense Advanced Research Projects Agency (DARPA), an agency of the US Department of Defense that has significantly contributed to many technologies, including the internet and global positioning system (GPS). The Agency has a rather limited budget of about $3 billion per year and focuses on the identification and recruitment of, and provision of support to, top innovators. The EIC is similarly designed to financially support – through a combination of grants and equity – innovators who are developing high-risk, disruptive innovations with the potential to create new markets. The EIC could become the core innovation tool of the EGD, with a strong mandate in the areas of clean energy, clean mobility and smart buildings. To enable this, and to make the EIC truly comparable to DARPA, the EIC will have to be endowed with at least EUR 15 billion from 2021 to 2027 under Horizon Europe.

The second tool is the Innovation Fund (IF). Established under the EU ETS for the period 2021–2030, the IF supports the demonstration of low-carbon technologies and processes in energy-intensive industries, carbon capture and utilisation (CCU) and storage of carbon dioxide (CCS), and innovative renewable energy and energy storage technologies. The IF has been endowed with at least 450 million carbon allowances, amounting at current carbon price levels to about EUR 11 billion. A sensible way to further scale-up the IF would be to rapidly reduce the number of allowances allocated for free under the ETS, and to use the resulting revenues for the IF.

In general terms, it must be emphasised that fostering disruptive innovation will require a significant dose of risk-taking and an acceptance that there will be failures. New support models that provide numerous yet sizeable grants in a relatively non-bureaucratic way are crucial to enabling disruptive ideas to emerge. Accepting that a significant proportion of these ideas will fail is better than putting money on safe but non-disruptive bets.

Public funding of disruptive technological innovation does not by itself guarantee industrial development. The success of DARPA strongly relates to the overall US economic ecosystem, which strongly favours innovation, and to its ability to turn disruptive innovation into marketable products. Its limited budget shows that creating the conditions for making innovative products marketable can be more important than public funding for innovation itself.

The EU has three main tools for creating the conditions for innovative, green, European companies to flourish in a receptive market.

The first, more general, tool is the completion of the EU internal market. Fragmentation in environmental standards, energy taxation and support measures for clean technologies prevent innovative European cleantech companies from scaling up in the way that their US and Chinese competitors do on their domestic markets. It is vital to develop a solid regulatory framework, focused on ensuring competition and access to a truly single market, with common environmental standards. To do this, national industrial policies need to be coordinated – otherwise they create distortions that lead to further fragmentation of the EU Single Market. Failing to coordinate would hamper the full exploitation of the EU market and the related economies of scale.

The second, more specific, tool is public procurement, which in the EU is estimated to amount to about 16 per cent of GDP. Given its scale, public procurement represents a unique tool to foster innovation. Requiring clean mobility solutions in public procurement tenders, for example, could provide a solid boost to the demand for electric cars and buses, and help transform the European automotive industry. To become the global leader in electric cars, China did not focus on public funding for innovation, but rather on creating demand for them through supportive government policy, including public procurement programmes.

The third tool is carbon-based contracts for difference, which could be a technology-neutral support mechanism for the deployment of low-carbon technologies. As in the renewables sector with auctioned feed-in premiums, industrial producers of carbon-intensive products would obtain a public subsidy for each unit sold. For example, a steel producer that only needs 0.5 tonnes of CO_2 to produce one tonne of steel, compared to a benchmark of 1.5 tonnes of CO_2 per tonne of steel, and that managed to secure a carbon price of EUR 50 per tonne through the system of carbon-based contracts for difference, would receive EUR 25 for each tonne of its low carbon steel when the EU ETS price is at EUR 25. These contracts for difference can be auctioned to ensure competition between companies for the most efficient technologies.

These three complementary tools could foster the emergence of the necessary ecosystem that will enable innovative green European companies to grow in a receptive market.

Pillar 3. The EGD's (in)equality issue and a just transition

The EGD has at its core the aim of making the transition towards a climate neutral Europe just. This implies two different elements: addressing the distributional effects of climate policy and addressing the problem of regions that are particularly dependent on the production of fossil fuels, such as coal, and will thus be affected by the disappearance of some industries and jobs.

With regards to the distributional effects of climate policy, it should be stated that climate policies including emissions standards for cars, renewables supported through financial levies on households' electricity consumption and carbon pricing for heating fuels can disproportionately affect poor households, and might thus lead to an increase in inequality.

The impact will be particularly significant for the lowest deciles of the income scale, for those in rural and suburban areas, who will be affected by the rise in fuel prices, and for regions that are particularly dependent on the production of fossil fuels, such as coal, and will thus be affected by the disappearance of some industries and jobs. This means that some segments of the population and some regions particularly affected by the transition will require special assistance.

While climate policies can have adverse distributional consequences, inaction cannot be the answer. Not acting would make everybody worse off, ultimately with a greater negative affect on low-income households compared to high-income ones. There is hence no trade-off between climate and equity.

From a political perspective, what makes the situation more difficult is that the gains from climate policies will mostly be invisible if these policies succeed and disaster is avoided, while the cost of climate policies are immediate and tangible, especially for the most vulnerable population groups.

To avoid a dangerous backlash against climate policies, such as the reaction that was at the root of the *Gilets jaunes* movement which led the French government to abandon an expected carbon tax increase, the question is how climate policies and compensation schemes should be designed to counterbalance these adverse distributional effects.

The first solution is to prioritise less regressive policies and focus on less regressive sectors first. Climate policies for different products/services have different distributional impacts. In order to reduce the regressive effects, climate policy makers might prioritise the least-regressive elements. Putting high prices on carbon in transport, and in particular on aviation will, for example, have less dramatic distributional consequences than a similar high price on heating or electricity.

Policy makers should also focus on less regressive policy tools. Different instruments can be used to decarbonise a sector and some policy instruments are more regressive than others. Policy choices should, therefore, be concerned not only with effectiveness and efficiency considerations but should also take distributional aspects into account. In the discussion on taxes *versus* technology standards, distributional concerns provide an additional argument for the former.

Most importantly, policy design should seek to minimise regressive effects. Giving free allowances to companies whose face value is priced in for consumers, for example, is an unnecessarily regressive instrument.

The second solution is correcting regressive climate policies through compensation. Policies dealing with the social consequences of the transition and ensuring that no-one is left behind will take two complementary forms.

First, it will be important to use the revenues from climate policies, and in particular the increased revenues resulting from a more comprehensive carbon pricing system, to compensate the citizens most affected by the rise in carbon prices. To do this, money raised from taxing emissions could be returned to citizens in the form of a so-called dividend. This could take the form of lump sum transfers, as in Switzerland where two thirds of the revenues from carbon levies go back to the population through this means. Money can also be targeted at the lower deciles of the income scale. This is the case, for example, in British Columbia, Canada, where revenues from the carbon tax have been used to reduce taxes for the lowest paid, plus provide an additional transfer conditional on low income levels. In the light of the fiasco of the increase in the French carbon tax in 2017–2018, which resulted, in combination with a large increase in oil prices, in the emergence of the *Gilets jaunes* movement, it has been proposed to fully redistribute the French carbon tax revenues through transfers based on income and geographical criteria, targeting the most affected locations such as rural and small urban areas with limited access to public transport. Using this combination of criteria would minimise the number of people negatively affected by the rise in carbon prices – in the French case such a system of transfers would fully compensate the six lowest income deciles.

This is the approach adopted by the European Commission in the proposal for the Social Climate Fund in the context of the Fit for 55 package. The initiative aims to make use of the revenues generated by the proposed ETS from road transport and buildings, to: i. finance temporary direct income support for vulnerable households; ii. support measures and investment that reduce emissions in the road transport and buildings sectors and as a result reduce costs for vulnerable households, micro-enterprises and transport users.

The size of the Social Climate Fund will correspond to a dedicated share of the revenues from the auctioning of emission allowances under the new system. The Fund should provide funding to Member States to support measures and investment in increased energy efficiency of buildings, decarbonisation of heating and cooling of buildings, including the integration of energy from renewable sources, and granting improved access to zero- and low-emission mobility and transport. These measures and investments need to principally benefit vulnerable households, micro-enterprises or transport users. Pending the impact of those investments on reducing costs and emissions, the Fund will also be able to finance temporary direct income support for vulnerable households.

Second, given that the reallocation of capital resulting from the fight against climate change will also result in a reallocation of employment, it is crucial to put policies in place to facilitate the transition to new employment for those whose jobs are at risk. Even if the overall the net effect on employment is neutral or even slightly positive, the transition will make some jobs disappear, while creating new ones. The transitional issue related to climate change is not very different from the challenges of globalisation or technological change, so the solution could be the same: if a change in the demand for skills is rapid, there is a role for authorities to play to ensure that the workforce, and in particular low-skilled displaced workers, can be retrained successfully and quickly. It is thus crucial to invest heavily in human capital: adult education, re-training and policies to improve the labour mobility of older workers to avoid a high level of unemployment in particularly affected regions.

A key issue is that these declining sectors, and those either in need of or undergoing transformation, are not evenly distributed across European regions. Regions that are heavily reliant on these sectors for economic growth and employment will thus be disproportionately negatively affected by the transition. They will suffer heavier job losses, and lose key drivers of their economic growth, as well as industries that might be an important part of their cultural identity.

This is especially the case for the coal mining industry, which will have to be fully closed down if the EU is to reach its climate objectives. In 2018, there were still 207 coal-fired power plants spread across 21 Member States and 103 NUTS-2 regions[21], accounting for 15 per cent of Europe's power generation capacity. Additionally, 128 coal mines were still being exploited in 12 Member States and 41 NUTS-2 regions. This industry as a whole provides 237 000 jobs, 185 000 of which are in coal mining. An additional 215 000 jobs are indirectly dependent on coal activities. On a country level, Poland faces the greatest risk for job losses, followed, in order, by Germany, Romania, Bulgaria and Spain. On a regional level, the highest proportion of employment in these sectors is found in Silesia, Poland, and in Sud-Vest Oltenia, Romania. Silesia could lose up to 40 000 jobs, which is about half of the total employment in the region. Three other regions located in the Czech Republic, Romania and Bulgaria could each lose more than 10 000 jobs in the transition, roughly a third of total regional employment in each case.

Having acknowledged that supporting energy-intensive regions in their transition to climate neutrality is necessary for the social viability and the political feasibility of the EU's transition, the European Commission's first concrete policy within its EGD framework was to adopt a Just Transition Mechanism (JTM) aimed at providing financial support to territories facing serious socio-economic challenges derived from the transition to climate-neutrality, by using EU funds as well as by leveraging funds from the private sector.

To reach the EUR 100 billion of financing for the period 2021–2027 promised by the European Commission, the initiative relies on three main pillars.

i. The creation of a JTF: the Commission wants to add EUR 7.5 billion of fresh money to the total amount proposed in 2018 for the 2021–2027 Multiannual Financial Framework (MFF). This is supposed to lead to EUR 30–50 billion of additional funding for the regions most affected by the transition.
ii. The use of a fraction of the InvestEU financing devoted to climate to mobilise a total of EUR 45 billion for investment in just transition projects between 2021 and 2027.
iii. The creation a public sector loan facility at the European Investment Bank (EIB), partly guaranteed by the EU budget, to mobilise EUR 25–30 billion of additional public investment in 2021–2027.

Based on best practices from other just-transition initiatives around the world, it is possible to identify four key characteristics that are most important for such a transition: it must be locally driven; include targeted welfare and labour policies; be included in a long-term strategy for the decarbonisation and development of local economies; and allow for regular assessment and modification.

[21] Nomenclature of Territorial Units for Statistics (NUTS) is a geocode standard for referencing the subdivisions of countries for statistical purposes. NUTS-2 refers to regions usually having between 800,000 and 3 million inhabitants.

In the context of the EU, this translates into three key objectives for a just-transition instrument: strong mechanisms to ensure social dialogue and the involvement of communities throughout the whole transition process; consistency with other EU programmes and policies; and the whole process should be structured based on clear goals for the progressive phase out of coal as well as decarbonisation pathways consistent with the objective of climate neutrality by 2050.

Pillar 4. The international dimension: exporting the EGD

The EU produces less than 10 per cent of global GHG emissions. This implies that to have an impact on global temperature levels, the EU needs to push the principles of EGD beyond its borders.

There are two main instruments the EU could use to do this: i. The EU budget and Next Generation EU; and ii. The EU development policy.

→ *The EU budget and Next Generation EU*

As previously mentioned, the EU has pledged to devote 30 per cent of its long-term budget and 37 per cent of Next Generation EU spending to climate action. This means that, albeit in different forms and timings, between 2021 and 2027 around €600 billion of fresh EU resources will be made available for the green transition. Part of these resources earmarked for climate action could also be used to export the EGD to neighbouring countries and beyond. Such an approach, basically entailing the provision of grants, loans and guarantees for sustainable energy projects in partner countries, would represent a triple win for the EU. First, it would help meet global climate objectives more efficiently, as countries in the EU neighbourhood and in the developing world have lower marginal abatement costs for the reduction of CO_2 emissions than European countries. It is therefore important that the EU pushes for internationally agreed progress on the Internationally Transferred Mitigation Outcomes (ITMOs) within the Paris Agreement implementation. Second, it would enable EU industry to enter new, rapidly growing, markets – turning it into a formidable tool of EU green industrial policy. And third, it would help economic development and diversification in the EU's partner countries, and most notably in oil and gas producing countries, providing an invaluable foreign policy dividend for the EU.

→ *The EU development policy*

The EU and its Member States are the world's leading donor of official development assistance, with EUR 75.2 billion disbursed in 2019 - i.e., 55 per cent of global assistance. With its new budget for 2021–2027, the EU will have at its disposal a new tool designed to bring altogether EU funds for external policies: the Neighbourhood, Development and International Cooperation Instrument (NDICI). The introduction of NDICI – the budget of which is under negotiation but will be around EUR 70–90 billion for 2021–2027 – represents a sensible step to increase the EU's visibility and leverage in developing countries. One problem related to the EU development policy has so far been the fragmentation of its instruments, which lead to overlaps, gaps and inefficiencies. As proposed in 2019 by the High-Level Group of Wise Persons on the European Financial Architecture for Development, a further step towards the consolidation of Europe's development policy would be to create a single entity, such as a European Climate and Sustainable Development Bank (ESDB). The NDICI and a new ESDB could become the key tools to export the European Green Deal to the developing world, starting with Africa.

3.2. The European Green Deal and the COVID-19 crisis

To contain the spread of COVID-19, governments have been forced to adopt stringent lockdowns, which brought a significant part of economic activity to a halt. These measures have notably led to sharp contractions in economic output, household spending, corporate investment and international trade. Given the unprecedented scale of this exogenous shock, the world has quickly fallen into what the International Monetary described as "*the worst economic downturn since the Great Depression*".

Lockdowns initially caused a profound shock to aggregate supply. Certain households were no longer allowed to go to work, and many businesses were no longer been to operate. Indeed, some businesses have been forced to close and lay off workers. Consequently, consumer and business spending dropped significantly. Both businesses and households faced significant financial difficulties and have been less able to service debt repayments, placing stresses on financial markets. Combined with an acute environment of uncertainty, credit conditions have dried up, and it has become increasingly difficult for businesses or households to access credit. All this has been exaggerated by interactions with the rest of the world. Almost all external trading partners have experienced similar lockdown periods, and hence foreign demand for goods has been reduced at exactly the same time that domestic demand dried up. On top of all this, both firms and households have adopted wait-and-see attitudes, postponing non-essential investment and consumption, further reducing aggregate demand.

The level of COVID-19 economic contagion in Europe has been estimated by the European Commission to have caused of loss 7.4 per cent of GDP in 2020. The overall level, however, might ultimately be even greater than currently estimated. This will notably depend on the effects of the different waves of the contagion, and on the extent to which the initial economic effects will perpetuate. Two factors are likely to define this latter point: the extent to which the initial shock destroyed valuable supply-side capital, and the extent to which COVID-19 shifts endogenous expectations and behaviour of market participants into the medium and longer term.

The economic policy response to COVID-19 can be schematised into three phases: relief, recovery and fiscal consolidation.

In Phase 1, governments put in place small selective and nationally-based measures to provide emergency liquidity support to firms and workers. These measures, allowed by the relaxation of EU state-aid rules, are meant to keep firms and workers afloat in the face of near-universal cash shortfalls. As the economic crisis lengthens and bankruptcy risks loom, governments will also have to provide solvency support through direct recapitalisation to certain, selected, firms.

In Phase 2, governments – also with the support of the EU Recovery Plan – will put in place economic policy measures to reboot their economies from the severe contraction, with interventions aimed at stimulating both aggregate supply and demand. Considering the successive wave of the contagion, this phase might be at certain points also accompanied by a return of Phase 1 measures. As COVID-19 will have long-term effects on expectations and economic behaviour, a key role for governments will be to improve and positively shape the expectations of economic agents. Reduced confidence, supply-side disruption, and weak credit conditions will all depress the immediate economic recovery. Under worst-case scenarios, these factors could contribute towards the repeat of vicious, depressionary cycles akin to those in lockdown periods. The role of governments will be to break this vicious cycle, namely through fiscal measures to stimulate aggregate demand. This can be attempted directly through increases in government expenditure, or indirectly through incentive mechanisms to increase investment and consumption from the private sector.

In Phase 3, governments will necessarily have to implement fiscal consolidation measures. Policies followed during both the relief and recovery phases will significantly increase public debts across Europe – countries with higher initial levels of debt might see alarming increases. It is thus likely that expansionary measures will be followed by a phase of fiscal consolidation akin to the timeline followed in many major economies following the global financial crisis. Typical measures would include increases in taxation or cuts to public spending. Ricardian equivalence ([22]) tells us that the expectations agents hold for this future phase of fiscal consolidation are perhaps just as important as the actions governments take today.

As the economic policy discussion progressively broadened from the immediate emergency support measures to solvency support measures as well as to the design of the recovery phase, the green element has gained relevance.

From governments to businesses, from the academia to international organisations, an increasing number of voices have joined the same chorus over the last few months: let's make the post COVID-19 a green economic recovery.

As previously mentioned, the rationale is clear: the disruption caused by the pandemic offers an opportunity to build a new eco-friendly system, to the benefit of both current and future generations. While designing their recovery policies, governments should thus prioritise low-carbon sectors, or only support carbon-intensive companies with green strings attached.

The recipe is also more or less defined: position post-COVID-19 public investment towards housing renovation, clean energy infrastructure and clean transport to create well-paying local jobs that boost economic growth in the short term, while at the same time bringing long-term climate and environmental gains. In addition, boost investment in hydrogen and batteries, to position Europe at the forefront of two technologies that are widely expected to be the decade's breakout.

All this looks sensible. It must, however, be recalled that a similar narrative was developed in 2008, as Europe and the world designed their recovery plans in the aftermath of the financial crisis. Back then, the European Commission also presented a European Economic Recovery Plan aimed at speeding up the shift towards a low-carbon economy, with a focus on clean infrastructure, energy efficiency in buildings and green cars. But the results of this initiative have been unconvincing, considering Europe's poor development of housing renovation and clean cars since then.

This time it can – and at least in Europe, it looks to be – different. With the EGD, the EU has made climate change its top priority for the coming years. The priorities of the EGD are already being used by both the EU and Member States in the elaboration of their recovery initiatives.

In practice, this has notably meant setting a 37 per cent minimum target for spending on climate objectives under the Recovery and Resilience Facility (RRF), the largest component of Next Generation EU.

The EU Member States' recovery and resilience plans shows that all have so far met this 37 per cent minimum requirement, albeit showing different spending priorities in the green field (Darvas et al., 2021). The EC has identified three flagship areas for green spending under Next Generation EU: Power up, Renovate, Recharge and Refuel – referring, broadly, to cleantech, energy efficiency of buildings and sustainable transport. This provides an understanding of overall spending priorities.

For the EU as a whole, Recharge and Refuel is the main green spending priority, accounting for more than a third of it, or EUR 86 billion. For countries including Estonia, Germany, Hungary, Latvia and Romania, this item even accounts for 50 per cent or more of all green spending. Italy and Spain also have notably high sustainable transport allocations.

[22] An economic hypothesis holding that consumers are forward-looking and so internalise the government's budget constraint when making their consumption decisions. This leads to the result that, for a given pattern of government spending, the method of financing such spending does not affect agents' consumption decisions, and thus, it does not change aggregate demand.

The Power up priority has been allocated around a quarter of spending at the EU level, EUR 55 billion. Shares are, however, much larger in countries including Cyprus, Czech Republic and Poland, which have allocated close to two-thirds or more to this area.

The smallest green flagship area is Renovate (energy efficiency of buildings), which received EUR 48 billion in the EU. Belgium, France, Greece, Latvia and Slovakia have bucked the trend by devoting considerably higher shares to improving their building stocks.

While the EC flagship-based classification is useful to get an overall idea of green spending priorities, it is also interesting to go deeper into the Member States' spending. Doing so reveals that in EU aggregate terms, spending to increase the energy efficiency of buildings of EUR 45 billion. represents the largest share amounting to almost a fifth of total green spending. Belgium and France have made this the largest component of their green spending, devoting around 28 per cent to it.

The second biggest category at the EU level is public transport, at EUR 34 billion, or 15 per cent. This is a particularly large part of planned green spending in Romania, 47 per cent, and also in Austria, Hungary, Latvia and Lithuania, where it accounts for more than a third of green spending.

High-speed trains rank third in size with EUR 26 billion, or 12 per cent. Almost all the planned investments are in Italy, EUR 24 billion, where it is one of the largest spending categories. The rest of the spending on high-speed trains is most notably planned for Czech Republic and Germany.

The fourth biggest category in the EU is renewable energy, which receives EUR 23 billion, or around 10 per cent of green spending. Most of this spending will be concentrated in three countries: it the biggest green component in Poland at 37 per cent, or EUR 9 billion with Italy and Spain and also being big spenders in absolute terms, with EUR 6 billion and EUR 5 billion respectively.

Finally, it is interesting to note that measures specifically targeting hydrogen come in seventh place at the EU level, behind electric mobility and climate adaptation. Countries will spend a total of EUR 11 billion, or 5 per cent of green spending, on this category, with EUR 3 billion of spending planned both Germany and Italy, EUR 2 billion in France, and around EUR 1 billion each in Poland and Romania.

Depending on which classification system is used, at the EU level some EUR 220 billion of the RRF funds is set to be spent on green elements. This is certainly a welcome and necessary effort, but it pales in comparison to the EUR 350 billion per year of investment that will be needed by 2030 to realise the aspirations of the EGD. Timely disbursement and implementation of the approved plans will then be essential if the RRF is to have an impact on the European economy, and on the European climate and environmental transformation.

3.3. The European Green Deal and the Just Transition

In its communication of December 2019 (European Commission, 2019a), the European Commission states that the EGD must be just and inclusive and positions the JTF as the main tool for achieving this.

The JTF (European Commission, 2020f) was established within the framework of the cohesion policy, its objectives in the specific context of the transition to climate neutrality. It focuses on the high carbon intensity regions and it has three, complementary and mutually-reinforcing, components: social support, territorial transition support and economic revitalisation. The social support component relates primarily to the provision of assistance for the re-employment or re-skilling of workers impacted by the transition. The territorial transition support relates to the provision of assistance for the regeneration and decontamination of sites, land restoration and repurposing projects. Economic revitalisation relates to public investment strategies aimed at promoting economic diversification and innovation in territories impacted by the transition.

The JTF represents an important tool but is not sufficient to guarantee a just transition. It provides for an economic transfer to the regions mostly affected by the implementation of the transition (*'high carbon intensity regions'*), but essentially exclusively supports the economic-productive sector, without taking the needs of civil society into consideration, except for the provisions for workers who need to be re-skilled.

It is relevant to note the need to expand the JTF's focus from the industrial transition and workers' rights, bearing in mind that the Just Transition concerns various aspects of the transition, including the distributional impacts of climate change policy more broadly (IMPACT, 2017; International Labour Organisation, 2015; Jakob and Steckel, 2014; Newell and Mulvaney, 2013) ([23]). Although there is no internationally shared explicit definition for vulnerable populations (Alber et al., 2017; Mazorra et al., 2017), studies including by Reckien et al. (2018) and Klinsky et al. (2016) show the need for policy makers to incorporate equity and inequality concerns in climate change policy analysis.

The existing literature shows that most climate policies can generate both co-benefits and adverse side-effects (Klinsky and Winkler, 2018; von Stechow et al., 2015; Ürge-Vorsatz et al., 2014), with the direction of co-impacts and inequality outcomes depending on contextual factors, policy design and implementation, and action taken to address the potentially negative social co-impacts. Well designed and carefully implemented climate change mitigation policies, for example, have the potential to generate social and economic co-benefits that can reduce poverty and provide opportunities to address gender, health and economic inequalities. The co-impacts of climate change mitigation will not, however, be exclusively positive or equally distributed. Some people are likely to lose out unless measures are taken to ensure equitable access and actively mitigate inequitable outcomes. Poor and marginalised population sub-groups that are highly exposed to the negative impacts of climate change, and thus are among the greatest beneficiaries of successful efforts to limit global warming to 1.5–2°C, are also most vulnerable to the adverse effects of poorly designed or inadequately implemented climate change mitigation policies.

The European Commission, in its communication (European Commission, 2019), only partially takes the redistributive problems connected with climate policies into account, limiting itself to mentioning the economic inequalities. But, inequalities from policies may be different and at different scales – individuals, households, social groups and communities.

Much of the literature on inequality focusses on wealth and income (economic inequality), but there are also unjust health and social effects which have to be taken into consideration (Markkanen and Anger-Kraavi, 2019).

Economic inequality

Positive outcomes for economic equality, the reduction in economic inequality, emerge when policies improve opportunities for economic participation among poorer households, regions or countries. Benefits can occur because of various different types of policies, such as new opportunities for income generation in deprived areas through participation in forest carbon markets, improved access to

[23] In particular, the importance of considering social aspects to gain approval for the low-carbon transition and the necessity of providing appropriate support for negatively affected individuals and communities was recognised in the Solidarity and Just Transition Silesia Declaration adopted at the Katowice Climate Change Conference (COP24) in December 2018 (Markkanen and Anger-Kraavi, 2019).

electricity, better public sector transport connectivity and the strategic location of large-scale renewable energy systems in areas with limited employment opportunities (Markkanen and Anger-Kraavi, 2019).

The transition to a low-carbon economy will create new jobs in renewable energy generation, in the public transport sector, in retrofitting existing buildings, and in the development and production of energy efficient technologies. In developing countries, many of these new jobs are likely to be more secure and better paid than previous employment opportunities in the informal economy (Markkanen and Anger-Kraavi A., 2019).

But economic inequality tends to rise when policies have regressive distributional impacts through, for example, increasing the cost of essential goods, such as food, energy or mobility, reducing employment opportunities, or limiting people's access to natural resources (Marcu and Vangenechten, 2018; Mercure et al., 2018; Hayer, 2017; IMPACT, 2017; Work, 2017).

Any increase in the price of basic consumer goods, such as food and electricity, and services, such as public transport, will affect the poorest and most vulnerable members of society who spend a large proportion of their income on such goods, and who rely more heavily on public transport for their mobility needs most severely (Ürge-Vorsatz et al., 2014; World Health Organization, 2011). Low-income households also tend to spend a larger proportion of theirincome on energy-intensive products such as space and water heating, electricity, fuel, and lack options for substitution (Hayer, 2017; OECD, 2015). Policies that have regressive distributional impacts can also exacerbate health inequalities (Ekins and Lockwood, 2011; Walpole, Rasanathan, and Campbell-Lendrum, 2009).

Projects such as those under the Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing countries) and REDD+ programmes can exacerbate income inequalities and increase the risk of conflict if the financial benefits are not equally distributed, if property rights are granted to only some of the local beneficiaries, or if marginalised groups such as women or indigenous communities or distant forest users, whose participation may be constrained by informal rules, customary laws, social norms, and bias, are not given opportunities to engage with the projects (Bee, 2017; Work, 2017; Duker et al., 2018).

Restrictions to participation, such as selective entry requirements or a need for large up-front investment, can also increase the likelihood of economic inequality. Negative equality outcomes because of inequitable access have been reported in relation to renewable electricity programmes, forest protection initiatives and biofuel cultivation (Mazorra et al., 2017; Garvey and Barreto, 2016; Robinson et al., 2016). Mitigating strategies, such as subsidies, exemptions and various types of revenue recycling mechanisms, can often, however, be utilised effectively to prevent or minimise adverse economic outcomes. Measures such as micro-credit, extended payment schedules, grants and interest-free loans can, for example, be used to make electricity access more affordable and to facilitate equitable access to new energy saving, and economic, technologies (Yaqoot et al., 2016).

Health inequality

Climate change mitigation policies included in the analysis in this report have the potential to improve health equality, largely as a result of reduced air pollution and greater living comfort, due to energy efficiency improvements, and indirectly as a result of policies that improve households' financial circumstances. The positive impacts are the greatest when energy efficiency improvements are implemented in fuel-poor homes or among households that previously underutilised heating or cooling services due to financial constraints. Improved ability of such households to afford a comfortable indoor temperatures can reduce health and other social inequalities by improving living conditions and household finances, leading to better educational performance and improved overall wellbeing (Miller, Vine and Amin, 2017; European Commission, 2016; Hills, 2012; The Marmot Review Team, 2011).

Not all climate change mitigation policies, however, realize their potential to achieve positive health impacts and, in some instances, poorly implemented policies result in negative health outcomes. Insulation improvements that are carried out by unskilled traders, for example, can reduce air flows and damage indoor air quality, outweighing the positive health effects of improved indoor living comfort. Similarly, failure to compensate involuntarily relocated populations adequately – for example, by providing them access to affordable clean energy, irrigation and better health services – can lead to mental and physiological health problems as a result of community breakdown, environmental degradation, ecological changes, in-migration, social problems, and loss of land and livelihoods (Miller et al., 2017; European Commission, 2016; Cernea, 2004).

Social inequality

Policies that reduce economic inequality can also reduce gender and ethnic inequalities, especially in contexts where female-headed households and minority ethnic populations are over-represented in low-income groups. Positive gender equality outcomes emerge when policies improve women's access to economic or educational opportunities or reduce the domestic workload, especially in rural communities where traditional gender roles and heavy domestic workloads have previously limited opportunities for women. Energy access through renewable energy sources, for example, can help progress towards gender quality as well as poverty reduction and climate objectives. The impact on gender inequality tends to be greatest when gender concerns are actively incorporated in policy design and implementation, and conscious efforts are made to enable women to take active roles and improve their circumstances (Mazorra et al., 2017; Sanchez et al., 2015; Sapkota et al., 2014). Ethnic equality outcomes are also largely determined by how and where policies are implemented. In the existing body of literature, such impacts have been most frequently cited with specific reference to indigenous populations and the urban poor in contexts where poverty and ethnicity are linked (Brugnach et al., 2017, Ramos-Castillo et al., 2017). Large-scale ethnic inequalities tend to arise when members of a specific ethnic community are forcibly relocated or lose access to traditional livelihoods and cultural sites to make way for largescale infrastructure developments or forest. However, forest conservation initiatives can improve ethnic equality if communal land rights are formally acknowledged and the financial and other benefits from project participation exceed any negative impacts due to loss of livelihoods for the local populations. In developing countries, access to renewable energy systems and small-scale biofuel production can help indigenous communities and other remote rural populations achieve greater energy security and better living standards, reducing both ethnic and regional economic disparities (Borges da Silveira Bezerra et al., 2017, Renewable Energy Policy Network for the 21st Century, 2017; Khatun et al., 2015,).

Urban inequalities

If the specific context of cities is taken into consideration, several authors are beginning to delve deeper into the issue of how to distribute benefits derived from green infrastructure and nature-based solutions among city inhabitants, or to what extent such initiatives contribute towards reducing inequalities (Botzat et al., 2016; De la Barrera et al., 2016a; Wachsmuth et al., 2016). Green infrastructure and urban greening projects – green roofs, resilient parks and green ways, rain gardens, or detention basins and canals – are often ways of protecting cities against the impacts of climate change. These measures include improved storm water management and mitigation of hazards such as flooding, the urban heat island effect, and landslides (Anguelovski et al. 2019). As such, green infrastructure projects often require lower operating and repair costs than informal infrastructure projects and planners and elected officials often portray them as a no-regrets solutions (Mees and Driessen, 2011) with win-win resilience, adaptation, and mitigation climate benefits. In addition to serving as an adaptation measure, urban greening is portrayed as accruing economic and social value and benefits. New green spaces, for instance, contribute to increased property values, economic growth, and business investment while offering opportunities for recreation, environmental learning, tighter social ties, strengthened civic networks and social capital, and overall improved health (Anguelovski et al., 2019). Yet, recent research suggests that green infrastructure planning for climate change is rooted in green and resilient city orthodoxy (Connolly, 2018; Anguelovski and Connolly, 2018) that integrates nature-driven solutions into urban sustainability policy. This orthodoxy either overlooks or minimises negative impacts for socially vulnerable residents while selling a new urban brand of green and environmentally resilient 21st-century cities to investors, real estate developers, and new sustainability-class residents (Anguelovski et al., 2019; Gould and Lewis, 2018; Checker, 2011).

Nature-based solutions (NBS) are not fair or just *per se* but embedded in the complex systems of cities with all their political, institutional and power relationships as well as market/capitalist economies; they can, under various circumstances, lead to unjust solutions or result in more instead of fewer injustices (Krueger and Gibbs, 2007). It is believed by some that under certain circumstances, greening strategies carry a paradoxical risk of fostering greater inequality among social groups rather than fostering social cohesion and inclusiveness. Haase et al. (2017) suggest that greening cities, installing new parks and using the space along the streets for diverse greenery, for example, contributes to an increase in well-being and enhances the attractiveness of open spaces in cities. Some studies (Heckert and Mennis, 2012; Saphores and Li, 2012; Brander and Koetse, 2011; Conway et al., 2010; Nicholls and Crompton, 2005), however, have analysed real estate market price trends, finding that proximity to green areas increases house prices, whereas others (De la Barrera et al., 2016a) show how unequal socio-spatial distribution is reflected in different quantities, sizes, quality and structure of green areas. Poor areas often have less vegetation, compared to more well-off ones, often rich in private gardens and shaded green areas which provide a vast range of ecosystem services (De la Barrera et al., 2016b). The rise in inequalities documented across cities is reflected in an increasingly inhomogeneous distribution of assets among urban residents, for example, access to urban green spaces or recreational areas, the possibility of living in a healthy place or exposure to risks (Kabisch and Haase, 2014). Maintaining access to greenery is becoming a problem in many eastern European cities currently experiencing a post-socialist phase, in which the regulation of this aspect is rather weak and, coupled with a strong will to maximise the potential of a free market, results in the transformation of numerous public green areas into private gardens (Kronenberg, 2015; Hirt, 2012).

Very often urban regeneration leads to environmental displacement (Beretta and Cucca, 2019). The case of the High Line Park, a 2.5 kilometre long park built on a disused elevated railway in New York, is well known. Its creation was part of an urban planning scheme which also included the contemporary transformation of the surrounding mixed retail area, targeting the transformation of a middle-class segment into a luxury area. Between 2003 and 2011, the price of properties within a 5-minute walk from the park more than doubled, exceeding average prices in Manhattan and favouring the area's gentrification, resulting in changes to retail and catering businesses which adjusted to accommodate a new type of clientele (Millington, 2015). Many observe a rise in the use of green strategies, which are officially adopted as ingredients of updating and revitalising projects for urban renewal, but are, in reality, business oriented, mostly intended to appeal to higher income residents (He, 2017; Anguelovski, 2015; Wolch et al., 2014; Lim et al., 2013; Heckert and Mennis, 2012; Saphores and Li, 2012). Haase et al. (2016) illustrate, as typical examples of such strategies, the transformation of the waterfronts in decommissioned ports or industrial areas across numerous European cities, such as Amsterdam, Barcelona, Bristol, Copenhagen, Hamburg, Liverpool and London, and in the United States, as in Baltimore, Chicago, New York City and Pittsburgh. These projects involve the construction of high quality and expensive housing for the wealthy, whereas less well-off people are moved away or otherwise excluded. Such circumstances are even described by some (Dale and Newman, 2009) as exclusionary displacement.

Lastly, it is also worth briefly considering a specific new topic, which is yet to be studied extensively and therefore requires further enquiry: the correlation between displacement and urban interventions carried out for climate adaptation purposes. The issue of removing the most fragile portions of the population for environmental reasons is not exclusively linked to a desire to gentrify specific urban areas or the need to redevelop others for reasons of hydrological safety, but also to land planning decisions made by governments in response to the problem of climate change impacts (Beretta, 2019). Indeed, studies carried out in some cities show how the most disadvantaged groups bear the brunt of the social costs of climate adaptation, are usually excluded from the planning phase, and are sometimes required to move to areas which are even more vulnerable to drought, heat, flooding and disease (Wachsmuth et al., 2016). The issue was studied in particular by Anguelovski et al. (2016), who analysed the climate adaptation plans of eight cities – Dhaka, Bangladesh, Santiago, Chile; Medellin, Colombia; Surat, India; Jakarta, Indonesia; Metro Manila, the Philippines; and Boston and New Orleans in the US – showing how territorial planning designed to bolster urban resistance against climate change often gives rise to new socio-spatial inequalities.

Inclusive climate change policies

Generally speaking, the evidence highlights that the materialisation of potential outcomes, both positive and negative, depends on contextual factors and the way in which climate change policies are implemented; where, what and how all matter when seeking to identify and manage the potential inequality impacts of climate change policies. Strategic thinking and inclusive design and implementation, through consultation processes, are essential to avoid negative equality outcomes (Markkanen and Anger-Kraavi, 2019).

Inclusive design and implementation refer to a practice of carefully considering who might be impacted by a given policy, and involving these groups or communities in the decision-making process and project delivery. Tools such as community consultations can be used to identify interests and concerns, potentially adverse side-effects and possible co-benefits. Particularly when delivering a project in a foreign context, community consultations can enable project organisers to tap into local knowledge and use this information to guide their action, including measures to minimise and mitigate any adverse side-effects, and determine how best to maximise potential co-benefits and address existing inequalities. Any consultation process must be inclusive and comprehensive, involving people from across the community, including women, minority ethnic groups, poorer members of the community and people living on the edges of the affected areas (Gambhir, Green and Pearson, 2018, Mazorra et al., 2017; Khatun et al., 2015; Larson et al., 2015; Nhantumbo and Camargo, 2015).

In project delivery, the local workforce should be utilised where possible and efforts should be made to ensure equitable distribution of benefits at the local level. The socio-economic gains from forest carbon projects and forest protection initiatives, for example, are greatest when the project design and set-up costs enable all local residents, including the poorest, to participate and the financial rewards are equitably distributed or directed towards civic projects, such as for improved water sources or housing; livelihood projects, for example, agro-forestry systems; or social benefit funds (Greiner and Stanley, 2013; Bhattacharya et al., 2010). The risk of negative social and distributional outcomes, however, is high in contexts with high levels of poverty, corruption or economic and existing inequalities, and where no or limited action is taken to identify and mitigate potentially adverse side-effects. In such contexts, inclusive design and implementation is particularly important but not always possible (Petrini et al., 2017; Robinson et al., 2016).

From this point of view, to facilitate a just transition at a European level, all stakeholders, including policy makers and members of civil society, will need to work together to identify potential negative outcomes at local, regional and national levels, while paying specific attention to the most vulnerable cohorts in society. In particular, the European Climate Pact (EC, 2020w) can be considered as a useful tool to give everyone a voice and space to design new climate action, share information, launch grassroots activities and showcase solutions that others can follow.

The European Climate Pact will encourage broad societal engagement on climate and environment through a range of activities.

- Through communication activities and events, and by using multiple channels and tools, the Pact will raise awareness and build understanding of climate change based on reliable scientific evidence, inspire people and organisations to become involved and encourage sustainable behaviour.
- The European Commission will promote pledges (public commitments) and support relevant initiatives with knowledge/capacity-building to boost their impact and inspire further action across Europe and globally. For selected areas, such as buildings, mobility, tree-planting, nature regeneration and the greening of urban areas, the Commission could provide targeted support.
- the Pact will provide opportunities for communication, learning and networking, online and offline. Direct citizen consultations could be organised using formats such as citizen dialogues, citizen assemblies, and more. As appropriate, these platforms will link to existing initiatives, such as the Covenant of Mayors for Climate and Energy, or CITIZENV dialogues with young people across Europe.

3.4. The European Green Deal and EU environmental policies: what will change?

To achieve its objectives, the EGD addresses all sectors of the economy though a wide range of policy and legislative measures. These measures have been further specified by the adoption of a set of strategic documents and legislative proposals based on the EGD – namely, the EU Industrial Strategy (EC, 2020a); the new Circular Economy (CE) Action Plan (EC, 2020b); the Farm to Fork Strategy (EC, 2020c); the 2030 Biodiversity Strategy (EC, 2020d); the energy strategies (EC, 2020i; EC, 2020j; EC, 2020r); the Climate Target Plan 2030 (EC, 2020k); the proposal for a Decision on a General Union Environment Action Programme to 2030 (EC, 2020l); the Chemicals Strategy for Sustainability (EC, 2020m); the Renovation Wave Initiative (EC, 2020n); the EU Strategy to reduce methane emissions (EC, 2020o); the Sustainable and Smart Mobility Strategy (EC, 2020s); the EU Adaptation Strategy to climate change (EC, 2021a); the Action Plan for the development of organic production (EC, 2021b); the Zero Pollution Action Plan for air, water and soil (EC, 2021c); the Communication on a new approach for a sustainable blue economy in the EU (EC, 2021d); the Fit for 55 package, including the EU Forest Strategy (EC, 2021e; 2021f); and the European Climate Law (EU, 2021a).

This section provides an overview of the most important changes in the EU environmental legislation/policy envisaged by the EGD and the related implementing documents (for further details see the Annex). It mainly focuses on the regulatory impacts of the EGD on environmental policy areas, namely energy, climate change, air pollution and air quality, transport, freshwater, marine water and environment, waste and resources, chemicals, and biodiversity and land use. In addition, some reference is made to selected environmental measures to be introduced in other policy areas. The deadlines for the implementation of the planned measures are updated according to the adjusted Commission Work Programme 2020 (EC, 2020g).

To guide the EU environmental policy, the Commission has presented a proposal for the 8th Environment Action Programme in 2020 to replace the 7th Environment Action Programme which ran until the end of that year (EC, 2020l). The Programme assumes all the main EDG objectives as its own.

With regard to climate change, the Commission has already adopted a new European Climate Law (EU, 2021a), setting out a binding target of climate neutrality in the EU by 2050. As an intermediate step, as suggested by the Climate Target Plan 2030 (EC, 2020k), the European Climate Law establishes that the EU will achieve a domestic reduction of net GHG emissions, emissions after the deduction of removals from Land Use, Land-Use Change and Forestry (LULUCF) by at least 55 per cent compared to 1990 levels by 2030. In July 2021, the Commission has presented a broad package of proposals aimed to make the EU Fit for 55, while ensuring a fair, competitive and green transition. The package operates across a range policy areas and economic sectors – climate, energy and fuels, transport, buildings, land use and forestry – and consists, *inter alia*, of the following legislative proposals and policy initiatives.

- A revision of the EU ETS, including its extension to shipping; the revision of the rules for aviation emissions, with a decrease in the number of the EU ETS allowances allocated free to airlines; and the establishment of a separate ETS for road transport and buildings (EC, 2021k and 2021r).
- A revision of the Effort Sharing Regulation to assign strengthened emissions-reduction targets to each Member State in sectors outside the EU ETS (EC, 2021h).
- A revision of the LULUCF Regulation (EC, 2021g).
- A revision of the Renewable Energy Sources (RES) Directive (EC, 2021i).
- A recast of the Energy Efficiency Directive (EC, 2021j).
- A revision of the Directive on the Deployment of Alternative Fuels Infrastructure (EC, 2021n), requiring Member States to expand their charging capacity in line with zero-emission car sales.
- An amendment of the Regulation setting CO_2 emission standards for new cars and vans (EC, 2021o).
- A revision of the Energy Taxation Directive (EC, 2021q) to align the taxation of energy products with EU energy and climate policies.
- A carbon border adjustment mechanism (EC, 2021p) to put a carbon price on imports of a targeted selection of products, so that ambitious climate action in Europe does not lead to carbon leakage;
- ReFuelEU Aviation for sustainable aviation fuels (EC, 2021l) to oblige fuel suppliers to blend increasing levels of sustainable aviation fuels in jet fuel loaded at EU airports.
- FuelEU Maritime for a green European maritime space (EC, 2021m) to stimulate the uptake of sustainable maritime fuels and zero-emission technologies by setting a maximum limit on the GHG content of energy used by ships calling at European ports.
- A Social Climate Fund (EC, 2021s) to provide dedicated funding to Member States to help citizens finance investments in energy efficiency, new heating and cooling systems, and cleaner mobility.
- A new EU Forest Strategy for 2030 (EC, 2021f) setting out a plan to plant 3 billion trees across Europe by 2030.

Overall the above proposals should allow the achievement of the following objectives:

- a reduction of GHG emissions by 61per cent compared to 2005 levels by 2030 by the sectors covered by the revised ETS, including shipping, building and road transport;
- a reduction of CO_2 emissions of 55 and 50 per cent respectively from new cars and new vans by 2030 and zero CO_2 emissions from new cars by 2035;
- an increase of RES to 40 per cent of gross final energy consumption by 2030;
- higher energy efficiency, with final and primary energy consumption achieving savings of 36–39 per cent by 2030.

- an increase in the net carbon sink of 310 million tonnes of CO_2 equivalent by 2030.

In addition, with the Climate Target Plan 2030 (EC, 2020l), the Commission aims to reduce non-CO_2 GHG emissions by up to 35 per cent compared to 2015 by 2030. A specific Strategy has been adopted by the Commission to reduce methane emissions from the energy, agriculture and waste sectors (EC, 2020o). Within this context, by 2021 the EC will present a legislative proposal on compulsory measurement, reporting and verification for all energy-related methane emissions. This will also introduce an obligation to improve the detection and repair of leaks on all fossil gas infrastructure. Furthermore, the Commission will examine the options available in view of:

a) proposing legislation on eliminating routine venting and flaring in the energy sector covering the full supply chain, up to the point of production; and

b) shaping possible methane emissions reduction targets/standards or other incentives on fossil energy consumed and imported into the EU.

In revising the National Emissions Ceilings (NEC) Directive (EU, 2016) by 2025, the Commission will explore the possible inclusion of methane among the regulated pollutants. The potential to expand the sectoral scope of the European Pollutant Release and Transfer Register Regulation (EU, 2006d) to report methane emissions will be also assessed. With regard to waste, the Commission will consider further action to improve the management of landfill gas, based on the revision of the Landfill Directive (EU, 1999a), planned for 2024.

By September 2023 the consistency of EU measures with its climate-neutrality objective will be reviewed (EU, 2021a) and progress on adaptation assessed – a new Strategy on adaptation to climate change was adopted in 2021 (EC, 2021a). Other planned measures include the following: the setting up of a Just Transition Mechanism – the Commission adopted a Just Transition Fund in 2021 (EU, 2021b), which is part of the Mechanism – focussing on the regions and sectors that are most affected by the transition because they depend on fossil fuels or carbon-intensive processes; the introduction of a new regulatory framework for certifying carbon removals in 2023 (EC, 2020b and 2020i); and the launching of a Climate Pact focussing on the engagement with the public on climate action already published in 2020; EC, 2020w).

With regard to climate adaptation, the related strategy (EC, 2021a) aims at making the EU climate-resilient and adaptation smarter, more systemic, and swifter by 2050. Climate-induced stress on buildings and infrastructure will have to be taken into account in their renovation (also based on the Energy Performance of Buildings Directive and the Construction Product Regulation; EU, 2010b and 2011b), while storm water overflows and urban runoff will be addressed as part of the revision of the Urban Wastewater Treatment Directive (EU, 1991). The EU Taxonomy Regulation will be further developed to foster climate adaptation (EU, 2020).

The EU EGD recognises that sustainable energy and transport systems are critical to reaching carbon neutrality. With regard to energy, the EC has already adopted the EU Strategy for Energy System Integration (EC, 2020i) to better coordinate the planning and operation of the energy system as a whole, across multiple energy carriers, infrastructures and consumption sectors; the EU Hydrogen Strategy (EC, 2020j); and the Strategy on offshore renewable energy (EC, 2020r) to multiply the current capacity for offshore renewable energy 5-fold and 30-fold by 2030 and 2050, respectively. In the context of the revision of the RES Directive (EC, 2021i), the EC has proposed a comprehensive terminology for all renewable and low-carbon fuels.. Energy efficiency has been mainly addressed by the Renovation Wave Initiative (EC, 2020n).

In particular, in addition to the effects of the legislative initiatives of the Fit for 55 package (EC, 2021e) on the RES Directive (EC, 2021i), the Energy Efficiency Directive (EC, 2021j), the Energy Taxation Directive (EC, 2021q) and the Alternative Fuels Infrastructure Directive (EC, 2021n) to deliver on increased climate ambition, the EC will also revise the following.

- ✓ The Energy Performance of Buildings Directive (EU, 2010b): the EC will propose mandatory minimum energy performance standards and update the Energy Performance Certificates (EPC) framework (EC, 2020o). The provisions on charging infrastructure for e-mobility will be also enhanced (EC, 2020t).
- ✓ The Directive on eco-design requirements of energy-related products (EU, 2009c) and the Regulation on energy-labelling (EU, 2017a) will be widened/further developed to continue promoting high environmental standards (EC, 2020b and 2020n). In particular, the requirements for heating appliances will be revised to tackle air pollution from buildings (EC, 2021c).

Moreover, in 2020 the Commission published its legislative proposals for the revision of the Trans-European Network (TEN) Energy Regulation (EC, 2020t and EU, 2013a) to reflect new policy priorities, such as the accelerated take up of RES and smart sector integration, which links energy sectors to help them reduce carbon emissions.

In the transport sector, the EC has adopted a comprehensive Strategy for Sustainable and Smart Mobility (EC, 2020s) to shape new international standards for safe, sustainable, accessible, secure and resilient mobility. In line with the 2030 climate target, the Strategy is aimed at achieving a 90 per cent reduction in overall GHG transport emissions by 2050 compared to 1990 levels (EC, 2020s). To meet this objective, the EC has identified 82 actions to be implemented in 2021–2025 and has set the following milestones:

- ✓ by 2030, at least 30 million zero-emission cars and 80 000 zero-emission lorries will be in operation on European roads; 100 European cities will be climate neutral; high-speed rail traffic will have doubled across Europe; scheduled collective travel for journeys of under 500 kilometres will be carbon neutral; automated mobility will be widely deployed; and zero-emission marine vessels will be market ready;
- ✓ by 2035, zero-emission large aircraft will be market ready;
- ✓ by 2050, nearly all cars, vans and buses as well as new heavy-duty vehicles will be zero-emission; rail freight traffic will double; a fully operational, multimodal Trans-European Transport Network (TEN-T) for sustainable and smart transport with high-speed connectivity will be in place.

With regard to legislation, in 2021–2022 the EC will put forward proposals to revise the legislation on CO_2 emissions:

- emissions performance standards will be established for buses and strengthened for lorries (EU, 2019b);
- a legislative initiative for new cars and vans has already been launched under the Fit for 55' package (EC, 2021o) and legislation on air pollution planned with the introduction of Euro 7/VII standards for cars, vans, lorries and buses and a revision of the Directive on ship-source pollution (EU, 2009d; 2007; 2005).

To make the price of transport reflect its environmental impact, the maritime and road transport sectors will be included in the EU ETS (EU, 2003), and the Eurovignette Directive (EU, 1999b) will be revised. Moreover, to boost multimodal transport, the Commission has suggested new measures to better manage and increase the capacity of railways and inland waterways and will revise the regulatory framework for intermodal transport with a special focus on the Combined Transport Directive (EC, 2017; EU, 1992). The work on adopting the Commission's proposal on a truly Single European Sky will be restarted (EC, 2013).

A Zero Pollution Action Plan for Air, Water and Soil was presented in 2021 (EC, 2021c). According to the Action Plan, by 2030 the EU should reduce:

- ✓ the health impacts (premature deaths) of air pollution by more than 55 per cent;
- ✓ the share of people chronically disturbed by transport noise by 30 per cent;
- ✓ EU ecosystems in which air pollution threatens biodiversity by 25 per cent;
- ✓ nutrient losses, the use and risk of chemical pesticides, the use of more hazardous pesticides, and the sale of antimicrobials for farmed animals and in aquaculture by 50 per cent;
- ✓ plastic litter at sea by 50 per cent and microplastics released into the environment by 30 per cent;
- ✓ total waste generation significantly and residual municipal waste by 50 per cent.

With regard to air pollution and air quality, in addition to legislative initiatives covering air pollution from transport, the EC will revise the Air Quality Directive (EU, 2008a) and the Fourth Daughter Directive (EU, 2004) to align air quality standards with World Health Organization (WHO) recommendations. The EU measures regulating pollution from large industrial installations under the Industrial Emissions Directive (IED) (EU, 2010) will also be revised in 2022 so that: the scope of the Directive is extended to cover emitting sectors not yet included; a safer use of chemicals by industry is ensured; on-site risk assessments are required and the use of substances of very high concern is restricted; circular economy practices are integrated in upcoming Best Available Techniques reference documents, which could also be more focussed on methane emissions; ammonia emissions from the intensive rearing of livestock are curbed; and operators of large industrial installations are made responsible for remediating contamination from their industrial operations or major industrial accidents (EC, 2020b; 2020i; 2020j; 2020m; 2020o; 2020s). The Directive on Environmental Noise could also be eventually revised, with the possible introduction of EU noise reduction targets (EU, 2002). Moving to water, the EC plans to revise the Directive on Environmental Quality Standards (EU, 2008d), the Directive on Groundwater (EU, 2006e), the Urban Wastewater Treatment Directive (EU, 1991), and, eventually, the Bathing Water Directive (EU, 2006f) and the Marine Strategy Framework Directive, in which special attention will be paid to the need to reduce plastic/other litter and underwater noise (EU, 2008e).

Finally, soil pollution will be addressed, *inter alia*, by proposing legally binding EU nature restoration targets to restore degraded ecosystems and revising the Directive on the Sustainable Use of Pesticides (EU, 2009b), as well as the Mercury Regulation (EU, 2017b) to phase out the use of dental amalgam and prohibit the manufacture of and trade in a number of products containing mercury (EC, 2020d; 2020m; 2021c).

To promote a toxic-free environment, the Commission, in 2020 developed a Chemicals Strategy for Sustainability (EC, 2020m). Since the global production of chemicals is expected to double by 2030, the key objective of the Strategy is to boost innovation for safe and sustainable chemicals to avoid harm to the planet and to current/future generations. In particular, by 2030, the use of chemical pesticides, the loss of nutrients from fertilisers, as well as the overall EU sales of antimicrobials for farmed animals and in aquaculture should be reduced by 50 per cent. The chemical legislation to be revised include includes the following.

- ✓ The Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation (EU, 2006a). The following aspects will, *inter alia*, be addressed (EC, 2020b and 2020m):
  - Registration: the EC will strengthen the principles of no data–no market and the polluter pays. Information requirements will be amended to enable the identification of substances with critically hazardous properties and of all carcinogenic substances manufactured or imported into

the EU, irrespective of their volume, as well as to reflect the overall environmental footprints of chemicals, including emissions of GHGs. A proposal will be made to apply the duty of registration to certain polymers of concern and the introduction of a mixture assessment factor(s) for the chemical safety assessment of substances will be considered.
- Authorisation and restrictions: authorisation and restriction processes will be reformed; restrictions on intentionally added microplastics to mixtures used by consumers or professionals will be shaped; and authorisations and derogations from restrictions for recycled materials will have to be exceptional and justified.
- Professional users and workers: the level of protection granted to consumers will be extended to professional users. Workers protection will be strengthened by introducing endocrine disruptors as a category of substances of very high concern.

- ✓ The implementing Regulations under the plant protection products framework by 2021 (EU, 2009a; EC, 2020c);
- ✓ The Directive on the Sustainable Use of Pesticides by 2022 (EU, 2009b; EC, 2020c).

Moreover, the EC will:

- ✓ prepare a new Nutrient Management Action Plan with Member States by 2022 (EC, 2020d);
- ✓ extend the generic approach to risk management ([24]) to ensure that consumer products do not contain harmful chemicals ([25]) and, in the meantime, prioritise all harmful substances for restrictions for all uses through grouping, instead of regulating them one by one (EC, 2020m);
- ✓ define criteria for essential uses to ensure that the most harmful chemicals are only allowed if their use is necessary for health or safety, is critical for the functioning of society or if there are no suitable alternatives. These criteria will guide the application of essential uses in all relevant EU legislation for both generic and specific risk assessments (EC, 2020m);
- ✓ propose new hazard classes and criteria in the Classification, Labelling and Packaging (CLP) Regulation (EU, 2008c) to fully address environmental toxicity, persistency, mobility and bioaccumulation. The CLP Regulation will become the central piece of hazard classification (EC, 2020m);
- ✓ propose the establishment of legally binding hazard identification of endocrine disruptors and apply it across all legislation (EC, 2020m);
- ✓ introduce or reinforce provisions to take account of the combination effects of chemicals in relevant legislation, in addition to REACH, such as legislation on water, food additives, toys, food contact material, detergents and cosmetics (EC, 2020m);
- ✓ develop EU safe and sustainable-by-design criteria for chemicals;
- ✓ review the definition of nanomaterials and ensure its coherent application across legislation.

In the waste and resources policy area, most of the planned measures are provided by the new Circular Economy (CE) Action Plan (EC, 2020b), aimed at doubling the circular material use rate by 2030. They include:

- ✓ the revision, by 2022, of the Waste Framework Directive (WFD; EU, 2008b) to introduce waste prevention targets, for example for food waste, improve the rules on the proper treatment of waste oils and, eventually, establish material recovery targets for construction and demolition waste.

[24] This is a preventive approach across legislation resulting in the general ban of carcinogenic substances from most consumer products and for uses that expose vulnerable groups.

[25] Starting with chemicals that cause cancers, gene mutations, affect the reproductive or the endocrine system, or are persistent and bioaccumulative and then extending the generic approach to substances affecting the immune, neurological or respiratory systems and chemicals toxic to a specific organ.

Further EU-wide end-of-waste and by-product criteria will probably be defined through EC implementing legislation related to the WFD;

- ✓ the revision in 2021 of the Waste Shipment Regulation (EU, 2006b) to restrict exports of waste that have harmful environmental and health impacts in third countries or can be treated domestically within the EU (special attention will be paid to end-of-life vehicles (ELVs) (EC, 2021c);
- ✓ the revision in 2021 of the Packaging Waste Directive (EU, 1994) to reinforce the essential requirements for packaging, reduce (over) packaging and packaging waste;
- ✓ the revision in 2021 of the Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (EU, 2011a) and the clarification of its links to REACH and eco-design requirements;
- ✓ the revision in 2020 of the regulatory framework for sustainable and safe batteries (ongoing; EC, 2020u; EU, 2006c) to shape new rules on recycled content of batteries and measures to improve their collection and recycling rates;
- ✓ the revision in 2021 of the provisions on ELVs (EU, 2000) with a view to promoting more circular business models by linking design issues to end-of-life treatment, considering rules on mandatory recycled content for certain materials for components, and increasing recycling efficiency;
- ✓ for plastics, the development of a policy framework for bio-based and biodegradable/compostable plastics, including for use in agriculture in 2021 (EC, 2021b); a legislative proposal on re-use in food services to substitute single-use food packaging, tableware and cutlery by reusable products probably through the revision of the Directive on single-use plastic (SUP) products (EU, 2019a); by 2021); the establishment in 2021/2022 of mandatory requirements on recycled plastic content and of plastic waste-reduction measures for key products, such as packaging, construction materials and vehicles; and the adoption of provisions on the safe recycling of plastic materials other than polyethylene terephthalate (PET) into food-contact materials;
- ✓ the revision by 2023 of the Regulation on the recycling of ships (EU, 2013b), to improve standards and, eventually, extend its scope (EC, 2021d).

Other initiatives promoted by the Circular Economy Action Plan (EC, 2020b) and/or the new EU Industrial Strategy (EC, 2020a) address different industrial products/value chains, such as: the legislative proposal for a sustainable product policy, including the extension of the eco-design framework, to be presented in 2021 (EU, 2009c); the Circular Electronics Initiative, to be launched in 2021; the EU Strategy for Textiles, to be shaped in 2021; the EU Strategy on clean steel, to be prepared in 2020; and the Strategy for a Sustainable Built Environment, along with the Renovation Wave Initiative and the revision of the Construction Product Regulation (EU, 2011b), to define recycled content requirements, to be adopted in 2021. With regard to consumers, the Commission will put forward (mainly in 2022) legislative proposals on substantiating green claims, establishing a new right to repair, setting up mandatory green public procurement criteria and targets, and empowering consumers in the green transition.

The 2030 Biodiversity Strategy (EC, 2020d) addresses the main drivers of biodiversity loss –changes in land and sea use; overexploitation of natural resources, climate change, pollution and invasive alien species) With the headline goal to ensure that, by 2050, all of the world's ecosystems are restored, resilient and adequately protected, it establishes a set of key commitments by 2030. These include commitments to ensure 30 per cent of the EU's land and sea areas are legally protected; 3 billion new trees are planted in the EU; 25 000 kilometres of free-flowing rivers are restored; at least 25 per cent of agricultural land is farmed organically; and 30 per cent of habitats and species reach favourable conservation status or at least show a positive trend; the number of Red List species ([26]) threatened by invasive alien species should

[26] The European Red List, compiled by the International Union for the Conservation of Nature's (IUCN) Global Species Programme, Species Survival Commission and European Regional Office, identifies those species that are

be halved. A set of new legislative/policy measures have been planned mainly in the area of biodiversity and land use. Apart from the Zero Pollution Action Plan for Air, Water and Soil, the EC, in 2021, will update the EU Soil Thematic Strategy (EC, 2006); propose an EU Forest Strategy (EC, 2021f); set legally binding EU targets to restore degraded ecosystems, which, *inter alia*, will have to restore major fish spawning and nursery areas and promote depolluted and renaturalised sites (EC, 2021c and 2021d); and develop methods, criteria and standards to describe the essential features of biodiversity, its services, values, and sustainable use. In 2023, the Commission will assess the effectiveness of the new cooperation-based biodiversity governance to eventually decide on the introduction of a legally binding approach. With reference to protected areas, the EU's progress in meeting the related 2030 targets will be evaluated by 2024 and the need of additional legislative or other action will be considered. As regards marine water/environment, in 2021 the EC will adopt a new action plan to conserve fisheries and protect marine ecosystems, which will introduce measures to limit the use of fishing gear most harmful to biodiversity, such as the use of bottom-contacting fishing gear. The Commission, in proposing further legislation and guidance on green public procurement in 2021, is committed to ensuring that they will integrate criteria and monitoring to boost nature-based solutions. Finally, in 2021, a renewed Sustainable Finance Strategy was shaped to ensure that the financial system contributes to mitigating existing and future risks to biodiversity.

The transition to fair, healthy and environmentally-friendly food systems is specifically addressed by the Farm to Fork Strategy (EC, 2020c), with regulatory impacts on both environmental and non-environmental policy areas. A new 2021–2027 Action Plan for the development of organic farming has also been adopted by the Commission (EC, 2021b). Some of the measures provided by the Strategy and the Action Plan have already been mentioned under the different environmental policy areas – for example, the introduction of a new regulatory framework for certifying carbon removals and of waste reduction targets for food waste. In addition, in 2021 the EC will adopt an EU Code of Conduct for responsible business and marketing practices in the food supply chain; in 2021–2022 marketing standards to provide for the uptake and supply of sustainable agricultural, fisheries and aquaculture products; in 2023 a framework legislation for a sustainable food system, including fishing and aquaculture. The Commission in 2020 also revised the EU promotion programme for agricultural and food products. With regard to consumers, initiatives of the Farm to Fork Strategy include the adoption, in 2023, of minimum mandatory criteria for sustainable food procurement to promote healthy and sustainable diets; the introduction of a sustainable food labelling framework by 2024 and, eventually, labelling providing information on animal welfare.

The Communication on a new approach for a sustainable blue economy in the EU (EC, 2021d) mainly builds on selected objectives and measures shaped by other EGD strategic documents on mitigation and adaptation to climate change and the development of nature-based solutions and green infrastructures including offshore RES, mobility in the maritime sector, pollution reduction, circular-economy solutions to plastic litter, encouragement of biodiversity, sustainable food systems, and organic aquaculture (EC, 2021a; 2021b; 2021c; 2020b; 2020c; 2020d; 2020k; 2020r; 2020s;).

Finally, some of the measures listed by the EGD and its related implementing documents are broad in scope and relevant to several environmental policy areas. For instance:

- ✓ in 2021 Commission will put forward a new initiative on sustainable corporate governance, eventually to become a legislative proposal, addressing human rights, environmental duties of care and due diligence across economic value chains (EC, 2020b; 2020c; 2020d).

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threatened with extinction at the European level. To date 15 060 species have been listed (https://ec.europa.eu/environment/nature/conservation/species/redlist).

- ✓ the review of the reporting obligations of businesses under the Non-Financial Reporting Directive (EU, 2014), which should be finalized before the end of 2021, covers environmental aspects of non-financial disclosures, such as on biodiversity and the transition to a circular economy (EC, 2020b; 2020d; 2020o);
- ✓ the revision of state aid rules, in 2021, addresses energy and environmental aid, as well as the phasing out of direct fossil fuel subsidies (EC, 2020a; 2020b; 2020i);

the update of the Skills Agenda, as of 2020, should ensure that the food chain has access to sufficient and suitably skilled labour, supports the transition to a circular economy and fights against biodiversity loss (EC, 2020b; 2020c; 2020d)..

4 Modelling the European Green Deal as a macro sustainability strategy

4.1. Introduction

The EGD, a strategy aligned with the United Nation's 2030 Agenda and the sustainable development goals, was designed to benefit all economic actors, providing cleaner air, water and soil; healthier food; and better health for current and future generations. It is planned to be implemented with a Just Transition Mechanism, aligning the interests of investors and beneficiaries to achieve considerable societal gains. In practice, it links a low carbon future to sustainable and more equitable development in the EU ([27]).

Part 3 presents the results of a hybrid modelling exercise, linking systems thinking (ST) with a computable general equilibrium (CGE) model to assess the potential outcomes of the EGD. The improved systemic understanding achieved with ST informs the development of the CGE model and the formulation of scenarios, in addition to supporting the interpretation of quantitative results.

The goal of this modelling exercise is to assess the societal value of EGD policy interventions and investment, clarifying the connections existing between low carbon and development in a low-carbon development strategy such as the EGD. It builds on earlier EEA work on global macrotrends (Bassi et al., 2020; EEA, 2020), which included a description of methods and models used for green economy assessments, namely: a. economy-wide and sectoral models; b. thematic or integrated models; c. coarse or spatially explicit, as well as the underlying methodology used to solve equations, for example, optimisation, econometrics and simulation.

The analysis explicitly considers the dynamics triggered by the COVID-19 pandemic, both as a result of the policies implemented to reduce the spread of infections and the structural changes triggered by new behavioural paths. As such, it contributes to policy making by providing indications on synergies and trade-offs emerging from the implementation of green investment, supporting the creation of a roadmap to the goal of decarbonisation by 2050. Further, the introduction of COVID-19 allows consideration of the potential opportunity of a transition to a cleaner energy system in the EU as part of the recovery strategy.

The analysis combines the already existing financial mechanisms envisaged within the EU climate policy, such as the Emission Trading Scheme and the Innovation Fund, with new insights from the theoretical debate on carbon tax revenue, recycling mechanisms and endogenous technical change. When these intervention options are analysed in the context of COVID-19, the relevance of ST becomes even more evident. It shows that the EGD is not only an environmentally oriented development strategy but also a

[27] This chapter is a summary of the ETC/Eionet report *Modelling the sustainability transition in between the EGD and the Next Generation EU* (ETC/WMGE, 2021/6) available at https://www.eionet.europa.eu/etcs/etc-wmge/products/modelling-the-sustainability-transition-in-between-the-egd-and-the-next-generation-eu.

radical shift towards a more sustainable growth paradigm. These findings address concerns over the potential economic losses resulting from competitiveness reduction, which many skeptics associate with climate policy, showing how initial costs transform into medium- and long-term benefits that far outweigh initial investments.

4.2. Systemic impacts of low carbon development with systems thinking

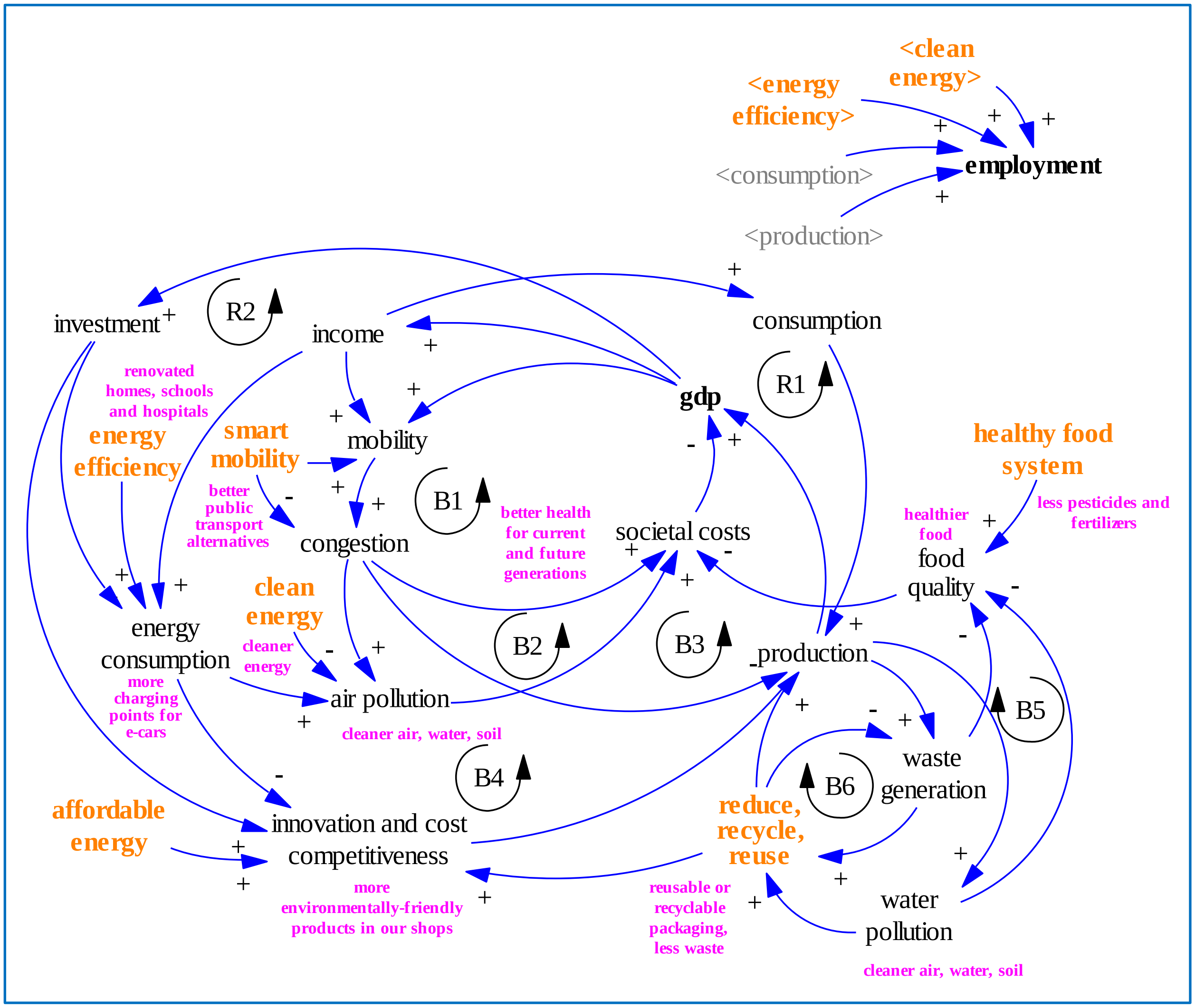
The starting point for the systemic analysis is the review of past drivers of change and the dynamics these have triggered. With an understanding of known patterns of change that brought about the need to introduce the EGD, it will be possible to identify stated entry points for interventions as well as their direct, indirect and induced outcomes.

Figure 4-1shows that when GDP increases, a stable trend in the past decades, with only a few exceptions, two main outcomes emerge: (a) consumption increases, leading to higher GDP directly and indirectly via production (Figure 4-1, reinforcing loop R1) and (b) investment increases, leading to more innovation and cost competitiveness, in turn increasing production and GDP (Figure 4-1, reinforcing loop R2). These reinforcing loops (R1-R2) also trigger economic growth through employment creation and trade.

On the other hand, economic growth has given rise to various balancing factors/balancing loops. One of these is the growing need for mobility, resulting in congestion. Congestion increases time spent in traffic and away from work and families (Figure 4-1, B1), creating societal costs. It also reduces the potential to grow productivity, production and value added (Figure 4-1, B3). It further leads to air pollution (Figure 4-1, B2) resulting from energy use for transport, industry and in buildings, which affects labour productivity through health impacts. Finally, the increase in energy use resulting from higher investment and income has led to higher vulnerability to market dynamics, price volatility and extreme weather events impacting the supply of energy (Figure 4-1, B4), which has negative impacts on production. Production in turn, leads to the generation of waste, which affects water pollution and food quality, creating societal costs both in urban and rural areas (Figure 4-1, B5). These are only a few examples of growing costs to society, those highlighted in the EGD. In addition, these costs do not emerge to the same extent in all countries and regions. As an example, urban areas are more strongly impacted by air pollution than rural ones.

When considering historical trends, it emerges that the reinforcing loops R1 and R2 (Figure 4-1) have dominated the dynamics of the system. This is because GDP, consumption and investment have grown over time, as have congestion and societal costs. In 2009, after the financial crisis of 2007–2008, GDP and investment decreased by 4.3 and 11.7 per cent respectively (Eurostat, 2019a). Between 2015 and 2018, however, GDP increased by 2–2.5 per cent each year, while investment also grew by 2.3–4.9 per cent. Moreover, consumption expenditure increased by 9.8 per cent between 2008 and 2018, or about 1 per cent per year (Eurostat, 2019a), On the other hand, thanks to improvements in energy efficiency, there has been little change in energy consumption and emissions. Gross inland energy consumption was relatively stable between 1990 and 2017, increasing only by 1,6 per cent (Eurostat, 2019b) while greenhouse gas emissions were around 22 per cent lower than in 1990 (EEA, 2019). Waste generation slightly increased to 940.0 million tonnes in 2016 from 904.9 million tonnes in 2004 (Eurostat, 2019c). This highlights that the emergence of balancing loops has been countered by energy efficiency; the use of renewable energy; and the collection, sorting, recycling and reuse of waste. Limiting these balancing factors has allowed GDP to continue growing by 1.5–2.5 per cent in the last decade, but more should be done both to support the economy by way of reinforcing loops and reducing constraints to growth through balancing loops.

Figure 4-1: A simplified representation of the dynamics influenced and triggered by the European Green Deal



Legend:
- All key areas of intervention are covered in the causal loop diagram (CLD): energy, buildings, industry, mobility (https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6714)
- Pink: EGD benefits for future generations (https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6717)
- Orange: all key intervention options (areas) (https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0640&from=EN)

The EGD is designed to use various strategies (in orange in Figure 4-1) to influence energy, buildings, transport and food production. The expected outcomes (in pink) include cleaner air, water and soils (through interventions on energy efficiency, clean energy, waste reduction, and improved agriculture practices), as well as better human health, better transport alternatives and access to distributed power generation options, and thus better access to more modern and resilient services).

Specifically, (a) energy efficiency, (b) clean energy and (c) affordable energy are designed to reduce energy consumption and air pollution, as well as to stimulate innovation and increase competitiveness. As a result, these interventions strengthen reinforcing loops R1 and R2 (Figure 4-1) through GDP, consumption and investment. At the same time, balancing loops B2, B3 and B4 become weaker, further stimulating economic growth by reducing societal costs and making production more effective. Investment to realize these opportunities includes renovating homes, schools and hospitals (energy efficiency), renewable energy use, the installation of charging stations for e-vehicles, and the adoption of environment-friendly technologies (clean and affordable energy).

(d) Smart mobility through better public transport and non-motorized transport will weaken B1 and B2 by reducing congestion, energy use and emissions, leading to lower societal costs, including health costs, and more effective production activities. Outcomes include better health for current and future generations as a result of cleaner air, water, soil – also in conjunction with waste reduction, recycling and reuse.

(e) Waste reduction, recycling and reuse primarily affect B5 and B6, which then indirectly affect R1 and R2. As a result, reducing waste both unlocks opportunities for existing drivers of growth, and stimulates new paths for sustainable growth by stimulating innovation and competitiveness.

(f) Healthy food systems are expected to increase food quality by reducing the use of fertilisers and pesticides. This reduces societal costs (B2, B3), increasing labour productivity and lowering public and private costs, resulting in a stimulus taking place through R1 and R2.

Practically, the EGD aims to make balancing factors weaker, so that the economy can continue to grow, but in a more sustainable and resilient way. This results in lower costs for society, higher productivity and improved wellbeing.

4.3. COVID-19: what has changed? Will there be permanent changes?

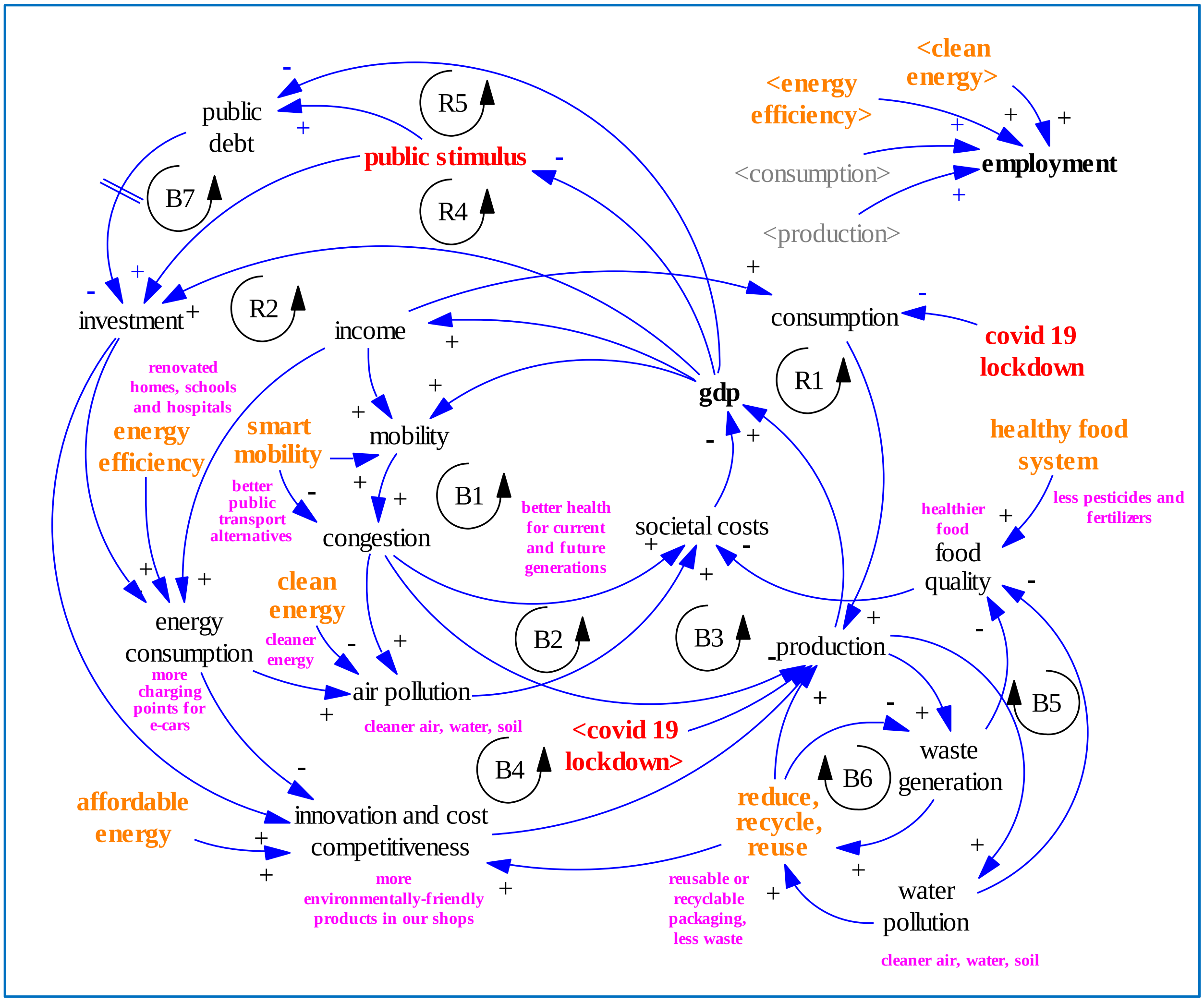
The inclusion of COVID-19 in the CLD requires the addition of several variables, representing (i) impacts of the outbreak, such as on consumption, and (ii) response measures, for example, public stimuli. The addition of these variables introduces new dynamics and feedback loops (McKibbin and Fernando, 2020) (Figure 4-2). Reduction of GDP as a result of the reduction of production, due to demand and limited labour force availability, brings;

1. a reduction of GDP through the reduction of consumption due to social distancing and avoided travel;
2. a reduction in economic performance due to the higher cost of doing business and insurance premiums;
3. a reduction of in-country performance due to the increase in risks and public costs – higher in-country risks lead to higher debt costs and higher public costs related to health and stimulus packages.

These dynamics effect of existing reinforcing loops (R1 and R2), having a negative impact on GDP through lower consumption and production, possibly triggering a vicious cycle and hence a recession. The introduction of public stimuli, however, add reinforcing loops R4 and R5. The former represents a short-term solution implemented by governments to stimulate investment. The latter represents the expectation that, once the economy starts growing again, it will generate additional growth that allows the reduction of debts accumulated in the short term. The dynamics triggered by the increase in debt are represented by the balancing loop B4. Higher debt will reduce the potential for new investment in the future, due to the higher cost of debt servicing, and to budget constraints related to financial stability.

Effectively, COVID-19 has turned two drivers of growth (R1 and R2) from virtuous to vicious cycles, potentially causing of recession. That triggers balancing loop B7, which highlights the limited (finite) amount of financial resources available to a government. The expectation is that, if the stimuli are well allocated (R4), they will kick-start production and consumption to levels that will stimulate employment, increase government revenues (R5) and limit the constraints posed by medium- and longer-term debt (B7) once the lockdown ends.

Figure 4-2: A simplified representation of the dynamics influenced and triggered by the European Green Deal, including COVID 19



As regards environmental performance, the reduction of economic performance reduces energy consumption and air pollution, and hence societal impacts, driven by R2, as well as B1, B2, B3 and B4. With economic recovery, the opposite dynamics will return, as described earlier. As a result, little change is expected to these dynamics, unless permanent impacts, such as smart working remaining a common practice, emerge.

Box 4.1 The economic impacts of COVID-19

The economic impacts of COVID-19 are many, varied and growing by the day. Following the outbreak, financial conditions worsened at an unparalleled speed, weakening economies worldwide (IMF, 2020a). Emerging dynamics include the increased risk of defaults by private companies due to weaker demand, higher volatility in the stock market due to future uncertainty on the profitability of businesses, and impacts on the solidity of national finances due to growing expenses and reduced revenues. These impacts depend on both global and local dynamics, with local consumption as well global trade being impacted by the number of infected countries, and the duration and severity of epidemiological shocks (McKibbin & Fernando, 2020). The uncertainty of impacts, effectiveness of policy responses, and duration of current challenges leads to consideration and creation of various scenarios for a possible recovery.

The forecasts created in 2020 expected that the GDP of all major economies would decrease substantially in 2020. The forecasts published by the International Monetary Fund (IMF) in January 2021 show a recession in 2020, ranging from 3.4 per cent in the US, through 5.4 per cent in Germany and 9 per cent in France, to 11.1 per cent in Spain. The IMF expected a recovery in 2021 in part offsetting 2020 losses with economic growth ranging from 3.5 per cent in Germany, through 5.1 per cent in the US and 5.5 per cent in France, to 5.9 per cent in Spain(IMF, 2021).

The expected magnitude of the economic downturn has generally declined over time, with projections of the IMF published in the *World Economic Outlook* showing larger expected declines in June 2020, in relation to the first period of lockdown in most Asian and European countries, than in October 2020. Indeed, further reductions in economic impacts were estimated for 2020 in the January 2021 forecasts when compared to the estimates published in October 2020. The forecasts beyond 2020 show similar patterns, with a stronger recovery suggested in the 2021 forecasts, primarily due to the increased certainty of the availability of vaccines (IMF, 2021).

More specifically, larger economic impacts were expected and measured for smaller economies that are less diversified and more reliant on tourism and trade. China's GDP, for example, was forecast to decline by 2–3 per cent, relative to baseline expectations (OECD, 2020; Institut Montaigne, 2020), while recessions were expected in various western economies, including in the US, -5.9 per cent; and -7.5 per cent in the Euro Area (IMF, 2020b). Overall, global GDP was expected to decline by 0.3–2.4 per cent in 2020 (Baldwin and Di Mauro, 2020; McKinsey & Company, 2020a,b; OECD, 2020;) triggering a global, albeit temporary, recession.

When comparing the financial crisis of 2007-2008 with EUROSTAT and EC European Economic Forecast (European Commission, 2020) expectations for economic contraction in 2020 and rebound in 2021, it emerges that the economic recession of 2020 is steeper than that observed in 2009 for most EU countries. Exceptions include Estonia, Latvia, Lithuania, the countries most exposed to speculation in the construction sector and subprime loans. For the EU the recession in 2009 reached -4.3 per cent while the expectation for 2020 is -7.4 per cent. The rebound is also expected to be stronger in 2021 when compared to 2010. The growth rate of GDP in 2010 was 2.2 per cent but for 2021 is expected to reach 6.1 per cent.

Finally, the impacts of the current crisis are of similar magnitude across all EU Member States. This is due to the simultaneous impact on both production and consumption, similar durations of the impact on mobility, and the degree of integration of EU Member States' economies.

While all the forecasts reviewed expect a rebound in 2021of around 6 per cent globally, it is unclear the extent to which there will be permanent negative impacts on economic performance. This will be determined both by the impact of COVID-19 and by the responses implemented to counter the crisis, such as investment in technology to reduce vulnerability and modernise value chains, further exploitation of remote services and permanent social distancing.

The most severe economic risk posed by the current pandemic is unemployment, which hinders recovery due to lower consumption and the erosion of savings. In the Asia-Pacific region alone, unemployment is only forecast to return to 2019 levels in 2023 (S&P Global Ratings, 2020a; b; c) with the possibility of losing four years of job creation potential. Worst-case scenarios are less likely to occur for GDP (McKinsey & Company, 2020c) due to the recent implementation of several response measures and the adaptive behaviour including the increase in online purchases and the provision of remote services, and the definition of regional and national recovery strategies. On the other hand, these same interventions may have further negative impacts on employment when, for example, production and services switch to less labour intensive sectors and activities.

Companies are already at risk from the pandemic, and the severity of the economic consequences of the virus will depend on three factors: impacts on demand, length of the pandemic, and effectiveness of recovery packages.

4.4. Dynamic computable general equilibrium modelling

This section aims to analyse the mechanisms behind the potential advantages from the implementation of the EGD by taking a global perspective, in which the world economy is included in the dynamics.

It provides a broad description of the modelling approach and the assumptions for the scenario building exercise, as well as presenting the main findings from an EU perspective on selected aspects of the economic system. These mainly focus on impacts on GDP and the economic growth rate, competitive advantages, sector specialisation, and aspects related to the energy system. Simulation design is based on assumptions in line with the overall EGD framework, as described in Part 2, and results can be fully compared with the main expectations from other models used for impact assessments of the EGD.

Scenarios start from a business-as-usual reference case (BAU), that was tested both with and without the impacts of the economic shock from the COVID-19 crisis, modelled through specific shocks designed on the basis of the literature review synthesized in Box 4.1. This helps investigating the role played by investment in clean energy technologies (CETs) in contributing to the exit from the crisis as part of an additional component of the recovery strategy. By comparing the GDP growth rate with the COVID-19 shock with growth patterns associated with a general economic recovery, it is possible to highlight the magnitude of the investment required to escape from the crisis in the short-term. By adding investments in CETs associated with the implementation of the EGD targets, the additional impact played by financing longer -term structural changes can be emphasised.

Scenario analysis with a dynamic computable general equilibrium model

The dynamic CGE model is based on RunDynam designed for Global Trade Analysis Project (GTAP)-type models. The specific GTAP-type version of the model is called GDyn-EP and all details on the modelling approach are provided in Bassi et al. (2020). With respect to the model version used in Bassi et al. (2020), some novel elements related to the construction of the base year, the emissions data and the regional aggregation were introduced.

- Base year: the current version has been updated with the GTAP 10 database, meaning that the starting point has been shifted from 2011 to 2014, with updated values also for Leontief input-output matrices for the factor costs of sectors included in the database.

- Emissions: while the former model included only combustion-based CO_2 emissions, the current version also introduces non-CO_2 emissions associated with the use of energy commodities in production and consumption activities;
- Regional aggregation: while the former model was based on a regional aggregation with the United Kingdom included within the EU aggregate, the current version excludes the United Kingdom due to the Brexit process, including just 27 EU Member States.

The dynamic setting is ensured with eight periods, the first step with one year from the base data in 2014–2015, and then seven steps of five years each. The sources on which the scenarios are based are divided between the current period, 2014–2020, and projections for 2025–2050. The different variables on which the baseline and the policy scenarios are based are listed.

The BAU scenario is projected with shocks associated with GDP, population, a skilled and unskilled labour force, and CO_2 and non-CO_2 emissions that are considered as exogenous and are calibrated with the increase in production and consumption efficiency. A further element for building the BAU case is reflected in the energy balances for all regions, and in particular the proportion of renewable and fossil fuel source in the electricity production process. On the basis of the projections available from the Joint Research Centre (JRC) model and the EU reference case for PRIMES, the two electricity sub-domains have been treated as exogenous, thus calibrating the BAU case at the end of 2050 with a share of RES on total electricity for the EU compatible with the JRC baseline case (Keramidas et al., 2020; EC, 2016; Peters, 2016; Fourè et al., 2013).

The policy shocks are based on a general abatement target for the EU compatible with the fulfilment of the Paris Agreement targets. Given that the GDyn-EP model is an economic-energy model without enough technological details to simulate the role played by land use, land-use change and forestry, and carbon capture and storage (CCS) activities, the final emissions in 2050 account for gross emission levels without the impacts of carbon sinks, around 9 per cent of the BAU case.

In order to obtain the first policy scenario in which the EU will respect the abatement target for the full implementation of the Paris Agreement (called EU-PA), a policy instrument based on a Pigouvian carbon tax ([28]) is adopted. According to the model version in Bassi et al. (2020), by considering the EU as an aggregated region it is worth mentioning that the cost effectiveness criterion is fully respected, since the value at the margin of the carbon tax is perfectly equivalent to a carbon price level if an emission trading system is applied. The only difference between the EU-ETS and the modelling approach adopted is that in GDyn-EP all sectors are involved in the carbon policy with the same instrument, without differentiated treatment for energy-intensive and non-intensive sectors (Corradini et al., 2018).

To make an economic assessment of the impacts associated to the EGD, on top of the first policy scenario, based on a simple carbon tax instrument, a policy mix strategy was added by developing a revenue recycling mechanism for financing the development and diffusion of CETs. The recycling mechanism was based on the hypothesis that at least part of the carbon tax revenues (CTRs) collected by a government could be redirected to financing CETs.

In the description of model results, different shares of CTR to be allocated to two CETs, energy efficiency and renewable sources in electricity production, were tested, and the amount of public resources directed to green technologies, with the required private and public resources discussed at the EU level as optimal for financing the IF, compared.

The first three scenarios that are available can be synthesised as follows:

[28] A Pigouvian tax is a tax on a market activity that generates negative externalities.

- BAU: the reference case based on exogenous projections of GDP, population, the labour force and CO_2 and non-CO_2 emissions;
- EU-PA: a policy scenario with an abatement target implemented at the EU level that is compatible with the Paris Agreement obtained with the imposition of a carbon tax, that is endogenously determined by the target;
- EU-GD: a policy scenario that replicates the previous scenario, EU-PA, with the additional element of the carbon tax revenue recycling mechanism devoted to investment in the development, deployment, diffusion and adoption of CETs.

Scenarios accounting for COVID-19 economic impacts

Together with these three scenarios the economic impact of the COVID-19 crisis was added to the BAU case. Starting from BAU, a policy shock in 2020 was added with an exogenous reduction of GDP with reference to BAU with an impact associated to the main regions (Table 4-1), according to the distribution of the impact estimated by McKibbin and Fernando (2020) compatible with the IMF and the World Bank estimates at the world level (IMF 2020a; b; c). The average reduction at the world level is estimated around -6 per cent in 2020 with reference to BAU and around -3 per cent with reference to the GDP level in 2019.

The assumption is that once the shock has been assigned to the 2020 policy scenario then the GDP is left to be determined endogenously by the model. It is worth mentioning that in the case of a COVID shock without any recovery measure, the GDP growth pattern can be lower than in the case of a no-COVID BAU case because the amount of capital stock for the economic system is dependent on savings produced in the previous period in a System of National Account methodology. This BAU case with the COVID shock with no recovery measures is named BAU_C.

Table 4-1: Percentage shock to gross domestic product in 2020 due to COVID-19 in the Global Trade Analysis Project

Region	*% change w.r.t. BAU 2020*
Australia	-6.3%
Brazil	-6.5%
Canada	-5.5%
China	-6.3%
EU	-7.4%
India	-3.2%
Japan	-7.5%
Republic of Korea	-4.2%
Russia	-7.4%
United Kingdom	-5.5%
United States	-7.4%
Rest of the World	-3.3%
World	-6.0%

Source: McKibbin and Fernando (2020)

A second scenario is built with an exogenous shock that allows GDP in 2025 to return to original BAU 2025 value before the COVID-19 crisis. This means that the shock is calibrated to give impulse to the economic system to completely cover the negative impacts in a short period. To make sure that the amount of resources is compatible with feasible policy solutions, the endogenous increase in capital formation required to recover from the crisis was computed. As a benchmark, the resources allocated by the EU in different forms during the 2020 was looked at, that amount was around 6 per cent of the EU's GDP. In 2025, according to the recovery scenario, the total resources to be invested in the five-year period required going back to a GDP pre-COVID amount of around 9.5 per cent of GDP in 2025. Considering that in 2021–2027 additional resources would be invested within the Next Generation EU fund, expected to be a total of around EUR1.8 trillion at 2018 constant prices (EC, 2021), together with additional private resources, a total of 9.5 per cent of GDP in the form of capital investment is reasonable. The same mechanism is applied to all regions belonging to the GDyn-EP, with examples of resources invested in other large economies including 4 per cent of GDP in China and 8 per cent in the US.

On the basis of the new BAU that includes the COVID GDP shock with and without recovery, a new emissions trend was computed for the BAU case; that is also modelled as endogenous in the COVID policy case. Accordingly, together with GDP, emissions will also change with respect to BAU with no COVID, and the two policy options associated with simple carbon taxation and additional measures planned within the EGD are implemented and evaluated in this new reference case.

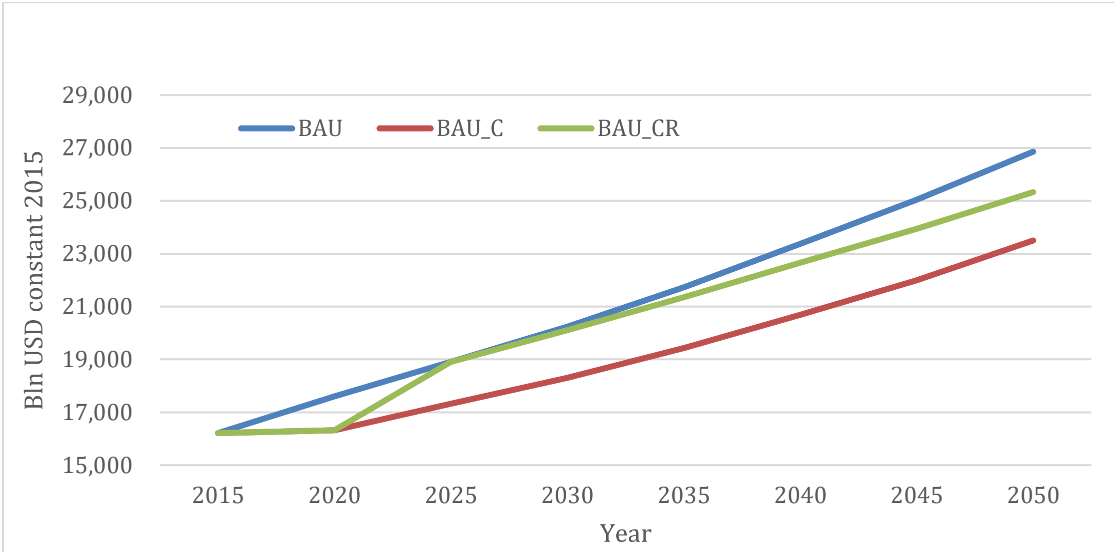
4.5. Quantitative assessment of the European Green Deal framework and COVID-19

The introduction of the economic shock associated with the COVID-19 lockdown s represented for the EU as a region formed by the current EU Member States (Figure 4-3) and for the rest of the world (Figure 4-4).

The difference highlighted by the two alternative patterns is explained by the introduction of a generally designed recovery package that is supposed to be implemented over five years, from 2020 to 2024, and achieve a full recovery by 2025. In this case, the only way for endogenously determining the full recovery case is to change the GDP projections from endogenous to exogenous ones in 2025. This is to say that after 2025 the GDP pattern is endogenous again and the recursive nature of the dynamic CGE implemented here demonstrates that without a long-term perspective in the design of the implementation of investments under the recovery measures, the positive impulse to GDP is large in the short-term but loses weight in the medium- to long-term. The reason behind this result is simple: from 2020 to 2025 a huge portion of capital stock will have been wasted, and the resources deployed for short-term recovery will not be enough to ensure a return to the same GDP growth pattern.

Together with the EU, Japan and the US also present a similar trend, while for the rest of the world taken as an aggregate, such distance is lower.

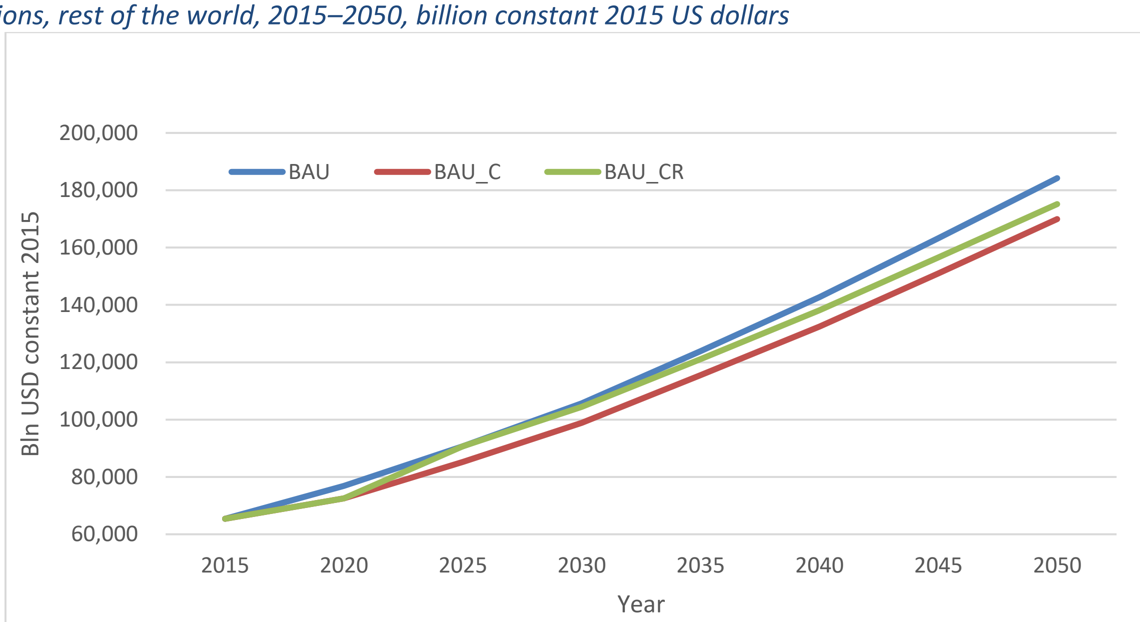
Figure 4-3: Gross domestic product in the business-as-usual scenario under different COVID-19 recovery options, EU, 2015–2050, billion constant 2015 US dollars*



**Excluding the United Kingdom*

Source: GDyn-EP results

Figure 4-4 Gross domestic product in the business-as-usual scenario under different COVID-19 recovery options, rest of the world, 2015–2050, billion constant 2015 US dollars



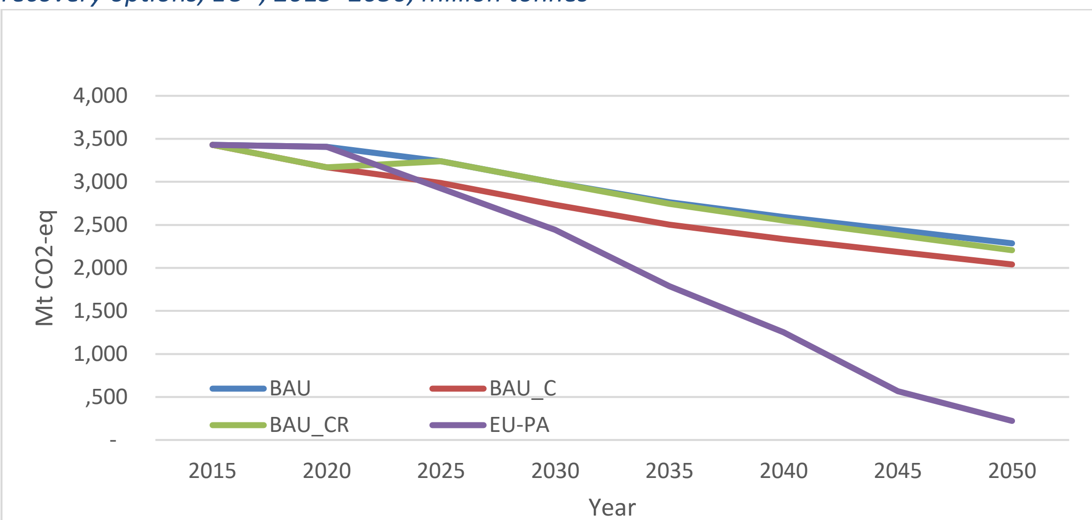
Source: GDyn-EP results

The CO_2-eq emissions included in GDyn-EP are also left free to evolve according to the economic patterns at the regional level. As a result, the reduction in economic activities, even in the case of a full recovery in

2025, will lead to a decrease in emissions in the BAU case according to the GDP growth gap. This result is valid both for the EU aggregate (Figure 4-5) and for the rest of the world (Figure 4-6).

In the case of the emissions trend for the rest of the world, although the COVID-19 crisis will bring a reduction in global emissions by 2050 relative to the BAU scenario, even with a full recovery, the implementation of a unilateral carbon policy by the EU will bring a reaction at the global level with an increase in emissions levels, as a typical carbon leakage effect (Antimiani et al., 2016). This means that the efforts by the EU to reducing emission levels are partly compensated for by the increase in emissions in the rest of the world, with a leakage rate by 2050 of around 53 per cent.

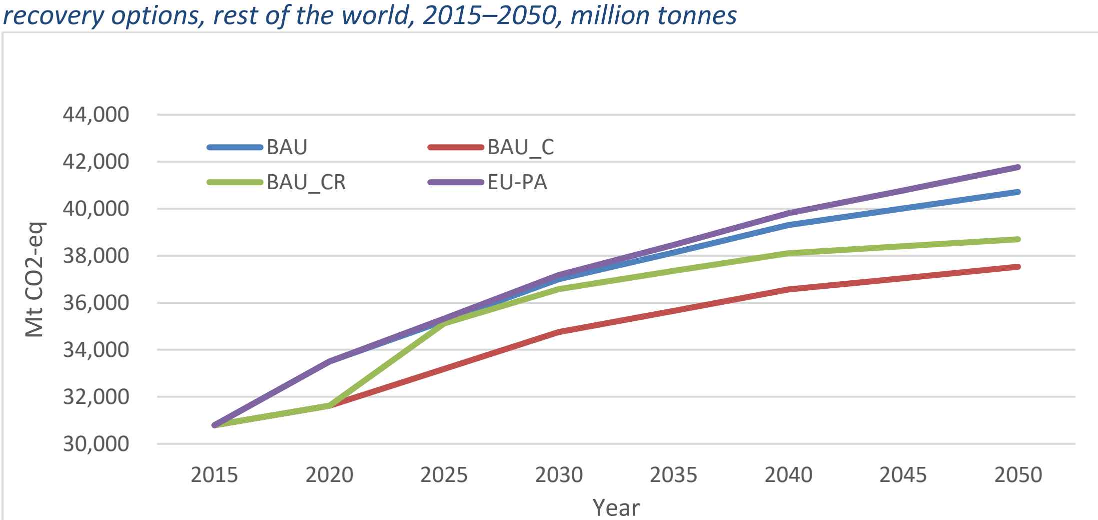
Figure 4-5: Carbon dioxide equivalent in the business-as-usual scenario under different COVID-19 recovery options, EU, 2015–2050, million tonnes*



**Excluding the United Kingdom*

Source: GDyn-EP results

Figure 4-6: Carbon dioxide equivalent in the business-as-usual scenario under different COVID-19 recovery options, rest of the world, 2015–2050, million tonnes



Source: GDyn-EP results

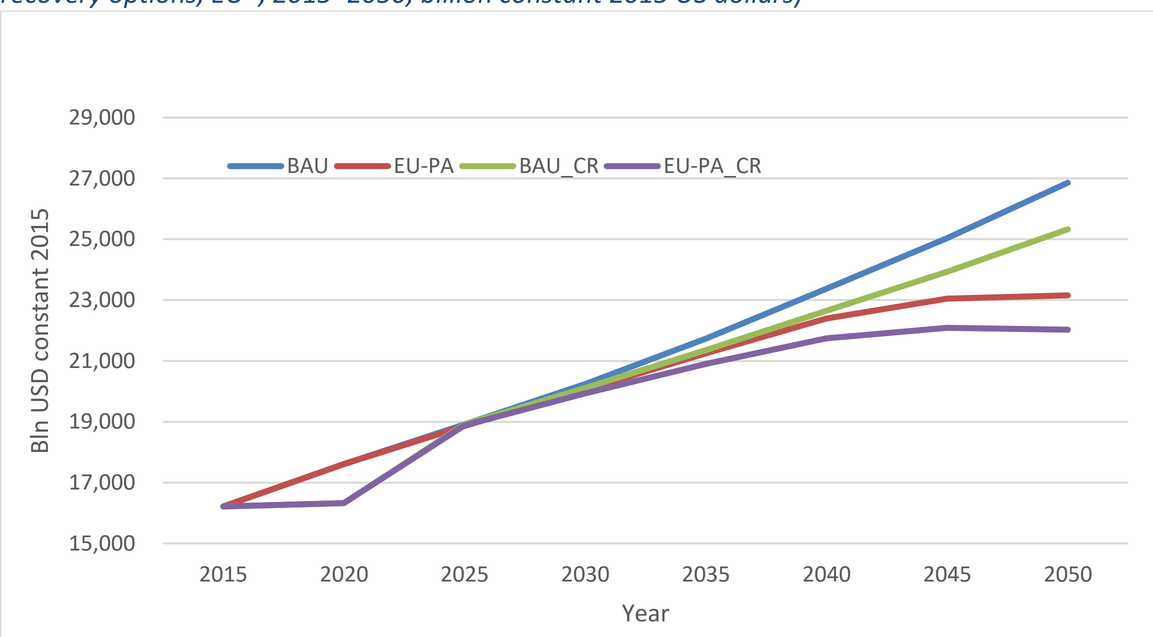
Focusing on the EU, in Figure 4-7 the GDP pattern associated with a policy scenario in which the Paris Agreement emission target is achieved is introduced.

Whatever BAU scenario is considered, the achievement of the emissions level in line with the Paris Agreement target obtained by a pure carbon tax policy without any support from efficiency and innovation has costs for the EU which bring a substantial drop in GDP.

Competitiveness losses are obviously more evident for energy intensive sectors, such as those included in the EU-ETS. When computing a revealed comparative advantage (RCA) index for the BAU and the EU-PA scenarios, if the absolute value of the RCA is higher than 1, the country under scrutiny has a competitiveness gain relative to others when exporting that sector's products.

A negative change in the index comparing the policy scenario with the baseline means that energy intensive sectors are particularly disadvantaged on the international market due the implementation of the carbon tax. Conversely, those sectors with a positive change in RCA improve their competitiveness. As an example, pharmaceuticals and other manufacturers are sectors that have relatively low energy intensity and a high added value due to relative technological intensity. However, even if such high added-value sectors gain from the implementation of the carbon policy, the overall impact on the economic system is nonetheless reflected by a reduction in GDP levels and growth rates (Figure 4-7).

Figure 4-7: Gross domestic product trend in the business-as-usual scenario under different COVID-19 recovery options, EU, 2015–2050, billion constant 2015 US dollars)*



**Excluding the United Kingdom*

Source: GDyn-EP results

When adding the public support to CETs deployment and diffusion thanks to financial efforts under the IF mechanism, however, the overall cost of achieving the target is considerably lower and the situation changes. The unitary cost of abating one tonne of CO_2-eq by 2050 is more than halved when the half of the CTR is recycled for CET improvement. The same relative impact is associated with the case when the 2019 COVID crisis is included in the baseline and in the policy.

In addition, it is worth mentioning that a higher share of CTR devoted to CETs is a key element for the EU's cost competitiveness as the unitary carbon price is inversely correlated to the recycled share of the CTR.

The introduction of public support to the deployment and diffusion CETs is expected to help the EU economy achieve its low carbon targets without being excessively harmed by a reduction in competitiveness relative to the rest of the world.

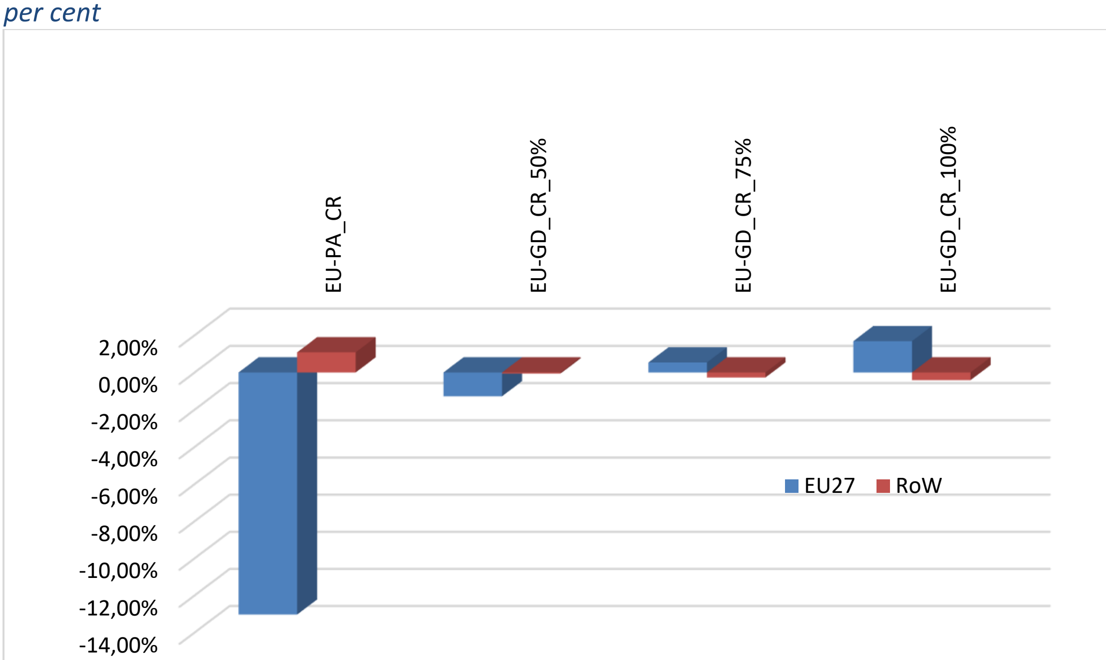
Turning to the impact of COVID on the EGD assessment, when the recovery action with general forms of capital investments up to 2025 is introduced, the carbon price is higher, but lower than in the no-COVID case, and the IF is higher than in the COVID no-recovery case.

Turning to the key issue of the potential benefits associated with the adoption of a complex climate-energy policy mix, as in the EGD strategy, a first sign of the relevant role played by the deployment and diffusion of CETs financed through public support to RD activities can be detected by comparing different GDP patterns under different CTR shares devoted to CETs.

For the sake of simplicity, only data for the year 2050 are report and the GDP change in alternative policy scenarios is compared with BAU adopting a baseline that includes the economic impacts of COVID-19 and the effects of a full recovery up to 2025 policy (Figure 4-8).

By introducing the financial mechanism of the IF with the CTR, the negative impact in GDP is substantially smoothed. Quite intriguingly, with a CTR share larger than 60 per cent (in Figure 4-8 a 75 per share is used as an example) the overall impact on the EU's economic system is positive.

Figure 4-8: Gross domestic product change relative to business as usual, EU and rest of the world, 2050, per cent*



**Excluding the United Kingdom*

Source: GDyn-EP results

If the whole amount of revenue from carbon pricing is invested into the IF for financing CETs, a share of 100 per cent in the model design, the EGD turns into a long-term strategy that effectively helps the EU to become a more competitive and carbon neutral economy and outweighs the negative economic growth impacts of the COVID-19 crisis.

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Section 1

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Section 3

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Annex: Environmental legislative/policy measures to be adopted according to the EU Green Deal and the related strategic documents/legislative proposals [29]

Legislative/policy measures to be adopted	Deadline	Prop. Climate Law	Industrial Strategy	CE Action Plan	Blue Economy	Zero Pollution AP	Farm to Fork	Biodiversity Strategy	AP organic farming	Energy system integ.	Hydrogen Strategy	2030 Climate Target	Adaptation Strategy	Renovation wave	Methane Strategy	Chemical Strategy	Off-shore energy	Sust. mobility	Pharmaceuticals	Green Deal
CLIMATE CHANGE[30]																				
• To ensure a fair transition in carbon intensive regions, the EC has proposed a Just Transition Mechanism, focusing on the regions and sectors highly dependent on fossil fuels or carbon-intensive processes (COM/2020/22 final).	In progress		x																	x
• Eventual revision of Reg. EU 2018/1999 on the Governance of the Energy Union (options will be explored to set a new 2030 target of 50%-55% emission reductions compared to 1990).	2020	x										x								
• Revision of climate legislation implementing the 2030 target (ETS Dir. 2003/87/EC; non-ETS Reg. EU 2018/842 and LULUFC Reg. EU 2018/841) to achieve the -55% GHG emissions reduction target by 2030. **ETS** will include emissions from maritime transport (at least from intra-EU maritime transport). Emissions from buildings and road transport to be considered for inclusion; free allowances to airlines to be reduced. Revisiting the current linear reduction factor may eventually be combined with a one-off reduction of the cap. Incentives to the production of renewable and low-carbon hydrogen may be considered, while taking due account of the risk for sectors exposed to carbon leakage. The revision will also address methane emissions. The revision of the **LULUCF Regulation** may result in the inclusion of GHG non-CO_2 emissions into the sector. As an alternative a new regulated sector could be created covering agriculture, forestry and land use. The **Effort Sharing Regulation** may maintain or reduce its scope (e.g., in case of a full transition to an EU ETS covering all fossil fuel combustion emissions, the Regulation would predominantly cover non-CO_2 emissions). If all other	2021	x			x			x		x	x	x		x	x			x		x

[29] The information provided by the table is updated to 31 May 2021.

[30] Excluding energy and transport; initiatives on methane emissions reduction in the energy, agriculture and waste sectors are reported under those sectors.

objectives of the Regulation were sufficiently targeted by other legislative instruments, the Regulation could even be repealed as a whole. The revision will also address methane emissions. The revision of the ETS and LULUCF Regulation will have to be informed by the EC Study on the sustainability of the use of forest biomass for energy production (to be finalized in 2020).																				
• Adoption of a Climate Pact, including a Carbon Farming Initiative.	2020/ CFI 2021						x													x
• The EC will propose a Carbon Border Adjustment Mechanism to reduce the risk of carbon leakage for selected sectors, in line with World Trade Organization (WTO) rules (as an alternative to the measures addressing carbon leakage in the EU ETS).	2021		x																	x
• By 30 September 2023, and every five years thereafter, the EC shall review the consistency of EU measures with the climate-neutrality objective and the adequacy of EU measures to ensure progress on adaptation.	2023	x																		
• New regulatory framework for certifying carbon removals.	2023			x			x			x										
• The EC will develop a roadmap leading up to 2050 for reducing whole life-cycle carbon emissions in buildings (see also 'Industry, products, value chains').	2023													x						
• Adoption of delegated acts by the EC to review the trajectory at Union level to achieve the climate-neutrality objective (within 6 months after each global stocktake provided by the Paris Agreement).		x																		
ENERGY (including biofuels)																				
• Evaluation and review of the Trans-European Network – Energy Regulation (Regulation EU 347/2013; COM 2020/824 final). The energy efficiency first principle will be promoted, as well as a more integrated energy system. Moreover, the EC will propose a framework under the revised TEN-E Regulation for long-term offshore grid planning by the Transmission System Operators, involving regulators and the Member States in each sea basin, including for hybrid projects.	In progress		x							x		x					x			x
• The EC will present dedicated guidelines to better promote energy efficiency wherever cost-effective in all areas of the entire energy system, as well as in all relevant sectors where activity affects demand for energy (e.g., in the transport and the agriculture sectors). The guidelines will also help public authorities to properly take into account all costs and wider benefits of the investments in the built environment.	2021											x		x						
• Revision of the RES Directive (Dir. EU 2018/2001) to deliver on increased climate ambition (RES should reach 38% to 40% of gross final consumption to meet the -55% GHG reduction target by 2030). Biomass sustainability criteria will be revised. The data on biofuels with high indirect land-use change risk will be revised and a trajectory for their gradual	2021					x		x		x	x	x		x	x		x	x		x

phase out by 2030 will be established. The revision of the Directive will also be informed by the EC Study on the sustainability of the use of forest biomass for energy production (to be finalized in 2020). Requirements for heating appliance will be revised to tackle air pollution from buildings. The revision will explore additional support measures for renewable and low-carbon fuels (including hydrogen) ([31]), tackle remaining barriers to a high level of renewable electricity supply and (eventually) establish minimum mandatory GPP criteria and targets in relation to renewable electricity, as well as facilitate the reuse of waste heat from industrial sites. Opportunities for further targeted support to accelerate the development of the market for biogas will be considered. Moreover, the EC will develop specific measures for the use of renewable electricity in transport, as well as for heating and cooling in buildings and industry. The EC will consider strengthening the level of existing indicative heating and cooling targets and introducing a requirement to use minimum levels of renewables in buildings. The use of decarbonized gas will be promoted. The revision will provide a fully updated and fit-for-purpose enabling framework to cost-effectively deploy clean energy, including renewable offshore energy. Under the RES Directive implementing legislation will be adopted setting out methodologies for measuring GHG emissions savings and promoting renewable and low-carbon fuels.																				
• The EC will propose a comprehensive terminology for all renewable and low-carbon fuels and a European system of certification of such fuels (building on existing provisions including in the RES Directive).	2021									x		x								
• Revision of the Energy Efficiency Directive (Dir. 2012/27/EU) to deliver on increased climate ambition. The primary energy factor ([32]) will be reviewed and the reuse of waste heat from industrial sites will be facilitated. Requirements for heating appliance will be revised to tackle air pollution from buildings. Moreover, in this context the EC will also propose to: a) increase the annual renovation obligation for buildings (doubling and more the annual energy renovation rate of buildings -currently around 1%- in the period up to 2030); b) extend the scope of the requirements for the renovation of public buildings to all public administration levels and c)	2021					x				x		x		x						x

[31] For example, minimum shares or quotas of renewable fuels/hydrogen or its derivatives in specific end-use sectors such as aviation and maritime.

[32] The primary energy factor indicates the amount of primary energy used to generate a unit of final energy (electrical or thermal), allowing a comparison of the primary energy consumption of products with the same functionality using different energy carriers.

extend energy audits requirements to larger and more complex non-residential buildings (hospitals, schools, etc.). The use of ESCOs and energy performance contracts will be expanded to make buildings renovation affordable for all households. Overall, in line with -55% GHG emissions reduction target by 2030, final and primary energy consumption should further reduce in 2030, achieving savings of 36–37% for final energy consumption (total energy consumed by end users) and 39–41% for primary energy consumption (total energy used to meet final energy needs).																				
• The EC will propose mandatory minimum energy performance standards, as part of the revision of the Energy Performance of Buildings Directive (EPBD). The introduction of a 'deep renovation' standard will be considered, to enable anchoring significant private financing to transparent, measurable and genuinely "green" investments. The EC will propose to update the EPC (Energy Performance Certificates) framework (Directive 2010/31/EC), including looking at a uniform EU machine-readable data format for the certificates and more stringent provisions on availability and accessibility of databases for EPCs. Moreover, provisions on charging infrastructure for e-mobility will be enhanced. Climate resilience considerations will be integrated into the criteria applicable to construction and renovation of buildings and critical infrastructure.	2021												x	x				x		
• Proposal for a revision of the Energy Taxation Directive (Dir. 2003/96/EC). In particular, the EC will align the taxation of energy products and electricity with EU environment and climate policies, ensure a harmonised taxation of both storage and hydrogen production, avoiding double taxation and phase out direct fossil fuel subsidies. Tax exemptions currently applied to maritime and aviation fuels will be carefully looked at. The revision of the Directive will have to ensure that users are encouraged to choose less polluting energy sources.	2021				x	x				x		x						x		x
• Review of the Alternative Fuels Infrastructure Directive (Dir. 2014/94/EU). In this context the deployment of different refuelling infrastructure, including for electric and hydrogen vehicles will be accelerated.	2021				x					x	x							x		x
• The EC will deliver a legislative proposal on compulsory measurement, reporting, and verification for all energy-related methane emissions, building on the Oil and Gas Methane Partnership (Oil and Gas Methane Partnership 2.0) methodology. This will also include the obligation to improve leak detection and repair of leaks on all fossil gas infrastructure, as well as any other infrastructure that produces, transports or uses fossil gas, including as a feedstock.	2021														x					
• The EC will introduce: 1) a common low-carbon threshold/standard for the promotion of hydrogen production installations based on their full life-	2021										x									

cycle GHG performance; 2) a comprehensive terminology and European-wide criteria for the certification of renewable and low-carbon hydrogen (see also above).																				
• The EC will develop operational guidance on the new sustainability criteria on forest biomass for energy.	2021							x												
• Revision of Dir. 2009/125/EC on eco-design for energy-related products and related Commission's implementing regulations (to be widened and further developed to continue promoting high environmental standards and to revise requirements for heating appliance to tackle air pollution from buildings). See also 'Sustainable Product Policy Initiative' under 'Industry, products, value chains'.	2021			x		x								x						
• Measures supporting hydrogen infrastructure development and related market rules will be adopted in the context of the revision of Directive 2009/73/EC concerning common rules for the internal market in natural gas and Regulation (EC) 715/2009 on conditions for access to the natural gas transmission networks. More in general, issues such as the connection to infrastructure and the market access for distributed and locally connected production of renewable gases (e.g. biogas) will be considered.	2021									x	x				x					
• The EC will draw up a framework for Member States to formulate a joint long-term commitment for the deployment of offshore renewable energy per sea basin up to 2050.	2021																x			
• The EC will establish a trusted scheme for certifying energy efficiency meters in buildings that can measure actual energy performance improvement.														x						
• Regulation (EU) 2017/1369 setting a framework for energy labelling and related Commission's implementing regulations will be further developed to continue promoting high environmental standards and to revise the requirements for heating appliance to tackle air pollution from buildings.	2021					x								x						
• The EC will examine options as regards possible methane emission reduction targets or standards or other incentives on fossil energy consumed and imported in the EU.															x					
• The EC will examine the options available in view of proposing legislation on eliminating routine venting and flaring in the energy sector (methane emissions) covering the full supply chain, up to the point of production. It will also make it a priority to explore a more precise standard for flaring efficiency, with the objective of further reducing both fugitive emissions and emissions from incomplete combustion of fuels.															x					
• The EC will encourage remedial work to eliminate methane emissions from the EU's active or unused coalmines and abandoned oil and gas sites, eventually through enabling legislation.															x					
TRANSPORT (including GHG emissions, air pollution, noise)																				

• To make the price of transport reflect its environmental impact, the Eurovignette Directive (Dir. 1999/62/EC) will be revised.	In progress																	x		x
• Assessment of legislative options to boost the production and supply of sustainable alternative fuels for the different transport modes.	As of 2020																			x
• Review of the Regulation on Trans-European Transport Network (Reg. EU 1315/2013). In this context the deployment of different refuelling infrastructure for hydrogen will be accelerated and a more integrated energy system will be supported.	2021				x					x	x	x						x		x
• Revision of Regulation (EU) No 595/2009 on emissions from heavy duty vehicles (Euro VI) and Regulation (EC) No 715/2007 (Euro 6) to set new standards.	2021					x												x		
• Initiatives to increase and better manage the capacity of railways and inland waterways.	2021																			x
• Proposals for revision of CO_2 emissions performance standards for combustion-engine vehicles and in particular for cars, vans (Reg. (EU) 2019/631) and lorries (Regulation (EU) 2019/1242). Introduction of CO_2 emissions performance standards for buses. The need to limit the emissions of $PM_{2.5}$ and nanoparticles from all types of combustion engines will be also considered.	2021/ 2022					x				x		x						x		x
• Revision of the ship-source pollution Directive (Dir. 2005/35/EC) to promote zero-emissions from ports.	2022				x													x		
• Review of the regulatory framework for intermodal transport, including the Combined Transport Directive (eventual withdrawal of current proposal – COM(2017)648 fin – to amend Dir. 92/106/EEC), to support multimodal and green freight operations.	2022																	x		x
• Development of an environmental label programme for aviation by EU Aviation Safety Agency (EASA).	2022																	x		
• Eventual revision of the Directive on environmental noise, with the possible introduction of EU noise reduction targets (Directive 2002/49/EC).	2022/2023					x												x		
• EC proposal on a Single European Sky.																				X
AIR POLLUTION & AIR QUALITY (excluding transport)																				
Review of the Industrial Emissions Directive (Dir. 2010/75/EU), including curbing ammonia emissions from the intensive rearing of livestock, making operators of large industrial installation responsible for remediating contamination from their industrial operations or in case of major industrial accidents and integrating of circular economy practices in upcoming Best Available Techniques reference documents. Within the revision process, options to support the further decarbonisation of industrial processes, including through electrification and energy efficiency will be assessed. With regard to methane emissions, the revision could e.g. result in an extended scope of the Industrial Emissions Directive (IED) to cover emitting	As of 2021 2022			x		x				x	x				x	x				x

sectors not yet included and in a greater focus on methane during the reviews of Best Available Techniques Reference Documents (BREFs). With regard to chemicals, the EC will ensure that the IED promotes the use of safer chemicals by industry in the EU by requiring on-site risk assessments and by restricting the use of substances of very high concern.																				
• The EC will assess the potential to expand the sectoral scope of the European Pollutant Release and Transfer Register Regulation (Regulation (EC) No 166/2006) to report methane emissions and improve public access to information.	2021/2022					x									x					
• Revision of the Air Quality Directive (2008/50/EC), to align air quality standards with WHO recommendations and to improve air quality near airports.	2022					x												x		x
• Revision of Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air *(Fourth Daughter Directive)* to align air quality standards with WHO recommendations.	2022					x														
• The EC will review the National Emission Reduction Commitments (NEC) Directive (Directive (EU) 2016/2284) and, as part of this review, explore the possible inclusion of methane among the regulated pollutants.	2025														x					
FRESHWATER																				
• Revision of the Directive on environmental quality standards (2008/105/EC) to monitor and reduce pollution from key substances.	2022					x														
• Revision of the Directive on groundwater (2006/118/EEC) to monitor and reduce pollution from key substances.	2022					x														
• The Commission will help address storm water overflows and urban runoff, as part of the revision of the Urban Wastewater Treatment Directive (Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment). Moreover, it will increase the ambition level to remove nutrients from wastewater and make treated water and sludge ready for reuse and address emerging pollutants such as microplastics and micropollutants.	2022					x							x							
MARINE WATER AND ENVIRONMENT (including fishery/aquaculture)																				
• The EC will propose a new action plan to conserve fisheries resources and protect marine ecosystems. It will include measures to limit the use of fishing gear most harmful to biodiversity, such as the use of bottom-contacting fishing gears.	2021				x			x												x
• Review and eventual revision of the Bathing Water Directive (2006/7/EC, also relevant to freshwater) and eventual introduction of new parameters.	2021-2023					x														
• Review and, if necessary, revise the Marine Strategy Framework Directive (2008/56/EC), focusing on the need to reduce plastic and other litter, as	2021-2023					x														

well as underwater noise (threshold values for maximum levels of underwater noise).																				
• Adoption of the proposed revision of the EU's fisheries control system (Reg. (EC) 1224/2009), which will have to include measures to reduce the damage from lost and abandoned fishing gears. It will also support the use of advanced digital control mechanisms for fisheries.					x		x													
• Adoption of EU guidelines for Member States' sustainable aquaculture development plans.							x													
WASTE AND RESOURCES																				
• Revision of the Directive on Waste Batteries and Accumulators (2006/66/EC) to introduce rules on recycled content and measures to improve the collection and recycling rates of all batteries (COM 2020/798-3). The Regulation will ensure that batteries placed on the market are sustainable and safe. See also 'Industry, products, value chains'.	In progress			x														x		x
• Scoping the development of further EU-wide end-of-waste and by-product criteria (through EC implementing acts related to WFD Dr. 2008/98/EC).	2021			x																
• Revision of the Waste Shipment Regulation (EC) 1013/2006 to restrict exports of waste that have harmful environmental and health impacts in third countries or can be treated domestically within the EU (special focus on ELVs).	2021			x		x														x
• Development of a policy framework for bio-based plastics and biodegradable or compostable plastics. It will cover all plastics, including for uses in all types of agriculture, and will therefore also be highly relevant for organic farming.	2021			x					x											x
• Legislative initiative on re-use in food services to substitute single-use food packaging, tableware and cutlery by re-usable products (Single-use plastic (SUP) Directive EU 2019/904).	2021			x			x													
• Revision of the rules on ELVs (Dir. 2000/53/EC).	2021			x																
• Revision of legislation to reinforce the essential requirements for packaging and reduce (over)packaging and packaging waste (Dir. 94/62/EEC).	2021			x																x
• Revision of the Restriction of Hazadous Substances (RoHS) Directive 2011/65/EU. Guidance will also be provided to clarify its links with REACH and Ecodesign requirements.	2021			x																
• Mandatory requirements on recycled plastic content and plastic waste reduction measures for key products such as packaging, construction materials and vehicles. See also 'Industry, products, value chains'.	2021/ 2022			x										x						x
• The EC will also assess (probably in the context of the revision of the WFD 2008/98/EC) the feasibility of a harmonised model for separate collection of waste and labelling to facilitate separate collection.	2022			x																
• Revision of the WFD (Dir. 2008/98/EC) to introduce waste prevention targets for selected waste streams (e.g. for food waste), revise the rules on	2022-2024			x										x						

the proper treatment of waste oils and the material recovery targets for construction and demolition waste. With regard to food waste, according to the Farm to Fork Strategy, the EC will introduce legally binding targets to reduce food waste across the EU in 2023. See also 'Consumers' legislation.																				
• Revision of Regulation on ships recycling (Reg. (EU) No 1257/2013), to improve standards and, eventually, extend its scope.	2023				x													x		
• In the review of the Landfill Directive (1999/31/EC) the EC will consider further action to improve the management of landfill gas, minimize its harmful climate effects, and harness any of its potential energy gains.	2024														x					
• Adoption of rules for the safe recycling into food contact materials of plastic materials other than PET.				x																
• The EC will consider taking measures to limit the emission of GHG from sewage sludge (probably through the revision of the related Directive 86/278/EEC).															x					
BIODIVERSITY AND SOIL ([33])																				
• Birds (Dir. 2009/147EC) and Habitat Directive (92/43/EEC): the EC will provide criteria and guidance to Member States for identifying and designating additional protected areas and ecological corridors.	2020							x												
• Full implementation of the EU Pollinators initiative (COM 2018/395 final) and possible revision with the proposal of additional measures.	2020							x												
• Update of the EU Soil Thematic Strategy (COM/2006/231).	2021							x				x								
• An EU Forest Strategy will be proposed, which will enhance, inter alia, natural sinks.	2021							x												x
• The EC will develop guidelines on biodiversity-friendly afforestation and reforestation.	2021							x												
• Proposal for legally binding EU nature restoration targets to restore degraded ecosystems, including major fish spawning and nursery areas. In this context, depolluted and re-naturalised sites will be promoted.	2021				x	x		x												
• The EC will assess the effectiveness of the new cooperation-based biodiversity governance in 2023 to eventually decide the introduction of a legally binding approach.	2023							x												
• Revision of the animal welfare legislation (animal transport Reg. EC 1/2005 and the slaughter of animals Reg. EC 1099/2009).	2023						x													
• Possible new legislative proposals, if the 2030 biodiversity targets on protected areas are not met.	2024							x												

[33] Including animal welfare, excluding measures specifically addressing the marine environment.

• Full implementation of EU Invasive Alien Species Regulation (EU 1143/2014) to decrease the number of Red List species they threaten by 50% by 2030.								X												
CHEMICALS																				
• Revision of the relevant implementing Regulations under the Plant Protection Products framework (Reg. EC 1107/2009).	2021						x													
• The revision of REACH (Reg. (EC) 1907/2006) will address the following: *Registration* The EC will strengthen the principles of ‘no data, no market’ and the ‘polluter-pays’, in particular by requiring compliance of all registration dossiers and revoking the registration numbers in case of non-compliance. REACH information requirements will be amended to enable an effective identification of substances with critical hazard properties, including effects on the nervous and the immune systems and to enable identification of all carcinogenic substances manufactured or imported in the EU, irrespective of the volume. The EC will consider how to best introduce information requirements under REACH on the overall environmental footprint of chemicals, including on emissions of GHG. A proposal will be made to extend the duty of registration to certain polymers of concern. The EC will assess how to best introduce in REACH a mixture assessment factor(s) for the chemical safety assessment of substances. *Authorisations and restrictions* Restriction of intentionally added microplastics to mixtures used by consumers or professionals will be introduced, as well as measures on unintentional release of microplastics. The EC will ensure that authorisations and derogations from restrictions for recycled materials under REACH are exceptional and justified. The REACH authorisation and restriction processes, based on key findings from its practical implementation, will be reformed. *Professional users/workers* The level of protection granted to consumers will be extended to professional users. Workers’ protection will be strengthened by introducing endocrine disruptors as a category of substances of very high concern. *Children* Specific requirements will be introduced to ensure the safety of children from hazardous chemicals in childcare articles and other products for children. *Recycled materials* Methodologies will be developed to track and minimize the presence of substances of concern in recycled materials (and articles made thereof) and	From 2021			x	x											x				x

to harmonise information systems for the presence of substances of concern.																				
• Revision of the Sustainable Use of Pesticides Directive (2009/128/EC).	2022					x	x													
• Revision of the Mercury Regulation (EC 2017/852) to phase out the use of dental amalgam and prohibit the manufacture and trade of a number of mercury-added products, including certain lamps.	2022					x														
• The EC will work with Member States to develop an Integrated Nutrient Management Action Plan (fertilisers).	2022							x												
• Revision of the Pesticides Statistics Regulation (Reg. EC 1185/2009).	2023						x													
• Implementation of the new Regulations on veterinary medicinal products and medicated feed (Reg. EU 2019/6; Reg EU 2019/4).							x													
• Proposal to amend the annexes to the Regulation on Persistent Organic Pollutants (Reg. EU 2019/1021), in line with scientific and technical progress and the international obligations.				x																
• The EC will extend the generic approach to risk management ([34]) to ensure that consumer products (e.g. food contact materials, childcare articles, cosmetics, detergents, furniture, and textiles) do not contain harmful chemicals ([35]). In the meantime, the EC will prioritise all harmful substances for restrictions for all uses and through grouping, instead of regulating them one by one.																x				
• The EC will define criteria for essential uses to ensure that the most harmful chemicals are only allowed if their use is necessary for health, safety or is critical for the functioning of society and if there are no alternatives that are acceptable from the standpoint of environment and health. These criteria will guide the application of essential uses in all relevant EU legislation for both generic and specific risk assessments.																x				
• The EC will develop EU safe and sustainable-by-design criteria for chemicals.																x				
• The EC will propose new hazard classes and criteria in the Classification, labelling, packaging (CLP) Regulation (Reg. EC 1272/2008) to fully address environmental toxicity, persistency, mobility and bioaccumulation. The CLP will become the central piece of hazard classification.																x				
• The EC will introduce or reinforce provisions to take account of the combination effects of chemicals in relevant legislation (in addition to																x				

[34] This is a preventive approach across legislation resulting in the general ban of carcinogenic substances from most consumer products and for uses that expose vulnerable groups.

[35] Starting with chemicals that cause cancers, gene mutations, affect the reproductive or the endocrine system, or are persistent and bioaccumulative and, then, extending the generic approach to substances affecting the immune, neurological or respiratory systems and chemicals toxic to a specific organ.

REACH), such as legislation on water, food additives, toys, food contact material, detergents and cosmetics.																				
• The EC will propose to establish legally binding hazard identification of endocrine disruptors and apply it across all legislation. Moreover, it will ensure that endocrine disruptors are banned in consumer products as soon as they are identified. Information requirements will be reviewed across legislation to ensure that sufficient and appropriate information is made available to authorities to allow the identification of endocrine disruptors.															x					
• The EC will strengthen the protection of workers from harmful chemicals by e.g. the upcoming Strategic Framework for Health and Safety at work and by proposing lowering existing occupational limit values for lead and asbestos and establishing a binding limit value for di-isocyanates.															x					
• The EC will ban all PFAS ([36]) as a group in fire-fighting foams, as well as in other uses, allowing their use only where they are essential for society; address PFAS with a group approach, under relevant legislation on water, sustainable products, food, industrial emissions, and waste.															x					
• The EC will review the definition of nanomaterial and ensure its coherent application across legislation.															x					
CROSS-CUTTING (environmental and non-environmental)																				
• Proposal for an 8th Environment Action Programme.	In progress																			x
• Assess the resilience of the food system and develop a contingency plan for ensuring food supply and food security.	2021					x											x			
• Adoption of a Framework legislation for a sustainable food system (including fishing and aquaculture). Organic products to be integrated into the minimum mandatory criteria for sustainable food public procurement to be developed as part of the legislative framework for sustainable food systems (see also Green Public Procurement (GPP)).	2023				x		x		x											
OTHERS																				
AGRICULTURE																				
• Under the Common Agriculture Policy (COM/2018/392), CAP Strategic plans will be assessed against robust climate and environmental criteria and will have to support the reduction in the use/risk of chemical pesticides, fertilizers and antibiotics and to promote afforestation, reforestation and tree planting. From 2021, biological waste and residues from agriculture, food and forestry sectors will be mobilized for bioenergy production. The uptake of mitigation technologies related to methane emissions will be supported through the wider deployment of 'carbon farming'. Moreover, MS should focus on increasing their organic area by defining target percentages or encouraging positive trends.	2020/ 2021						x	x	x	x					x					x

[36] Per- and polyfluoroalkyl substances.

• Revision of the Farm Accountancy Data Network Regulation (Reg. EC 1217/2009) to transform it into a Farm Sustainability Data Network.	2022						x													
CONSUMERS and PUBLIC PROCUREMENT																				
• Adoption of a legislative proposal on substantiating green claims.	2021			x																x
• Adoption of mandatory GPP criteria and targets in sectoral legislation and phasing-in mandatory reporting on GPP. When proposing further legislation and guidance on GPP, the EC will integrate criteria and monitoring to boost nature-based solutions.	As of 2021			x				x												
• Adoption of legislative and non-legislative measures establishing a new 'right to repair'.	2021			x																x
• Adoption of a legislative proposal empowering consumers in the green transition.	2021			x																
• (Eventual) proposal to require origin indication for certain products.	2022						x													
• Revision of the EU rules on date marking to reduce food waste (Reg. EU 1169/2011). See also 'Waste and resources'.	2022						x													
• The Commission will look into the possibility to develop GPP criteria for public buildings.	2022													x						
• Development of an environmental label programme for aviation by the EASA.	2022																	x		
• Adoption of minimum mandatory criteria for sustainable food procurement to promote healthy and sustainable diets, including organic products, in schools and public institutions. Organic products to be integrated into the minimum mandatory criteria for sustainable food public procurement to be developed as part of the legislative framework for sustainable food systems (see above).	2023						x		x											
• Introduction of a sustainable food labelling framework. In particular in 2022: proposal for a harmonised mandatory front-of-pack nutrition labelling and setting up of nutrient profiles to restrict the promotion (via nutrition or health claims) of foods high in fat, sugars and salt.	2024						x													
• The EC will consider options for animal welfare labelling.							x													
• The EC will provide a recommendation to promote Building Information Modelling in public procurement for construction.														x						
EXTERNAL POLICY																				
• An Action Plan on the Custom Union will be adopted to reinforce custom controls and ensure that imported products comply with environmental rules.	2020		x																	
• The EU will shape proposal for further tightening of the rules on EU ivory trade.	2020							x												
• Leading efforts towards reaching a global agreement on plastics.	As of 2020			x	x															

• Mainstreaming circular economy objectives in free trade agreements, in other bilateral, regional and multilateral processes and agreements, and in EU external policy funding instruments.	As of 2020			x																
• The EU will broker an agreement for an ambitious post-2020 biodiversity framework at the 15th Conference of the Parties to the Convention on Biological Diversity. It will include a global agreement to protect at least 30% of the world's sea area.	2020/ 2021				x			x												
• The EU will support the conclusion of an ambitious, legally binding agreement on marine biological diversity of areas beyond national jurisdiction at the 4th Intergovernmental Conference of the UN Convention on the Law of the Sea.	2021				x			x												
• The EU will revise the Action Plan against Wildlife Trafficking.	2021							x												
• Proposing a Global Circular Economy Alliance and initiating discussions on an international agreement on the management of natural resources.	As of 2021			x																
• The EC will propose to make the respect of the Paris Agreement an essential element of all future comprehensive trade agreements.			x																	
• The EU will combat overfishing, including through WTO negotiations on a global agreement to ban harmful fisheries subsidies.					x			x												
• The EC will support the establishment of an independent international methane emissions observatory anchored in the UN framework, in cooperation with international partners. The observatory would be tasked with collecting, reconciling, verifying and publishing anthropogenic methane emissions data at a global level and will address, in the long-run, all major emitting sectors (energy, agriculture, waste). A Methane Supply Index will be developed in this context.															x					
• The EC will consider methane emission reduction targets, standards or other incentives for fossil energy consumed and imported in the EU in the absence of significant commitments from international partners.															x					
• The EC will strive for the adoption of global strategic objectives and targets for the sound management of chemicals and waste beyond 2020 to reflect life cycle approaches for chemicals, in line with the post-2020 global biodiversity targets.																x				
• The EC will promote the development of common standards and innovative risk assessment tools internationally, notably with the OECD.																x				
FINANCE																				
• Carry out preparatory work on EU Ecolabel criteria for financial products.	In progress			x																
• A Renewed Sustainable Finance Strategy will be adopted to guide private investments more towards green recovery and sustainable economic activities and to help ensure that the financial system contributes to mitigating existing and future risks to biodiversity.	In progress							x				x	x	x						x

Within the renewed Strategy the EC will identify and promote best practices in financial instruments for risk management, in close cooperation with the European Insurance and Occupational Pensions Authority (EIOPA) and explore the wider use of financial instruments and innovative solutions to deal with climate-induced risks.																				
• Integrate the circular economy objective under the EU Taxonomy Regulation (Reg. EU 2020/852). Sustainable taxonomy criteria will have to be established for all modes. Moreover, the taxonomy will be developed to foster climate adaptation.	2021			x									x					x		
• The EC will adopt a delegated act under the Regulation on EU taxonomy (COM 2018/353 final) to: 1) establish a common classification of economic activities that substantially contribute to protecting and restoring biodiversity and ecosystems; 2) set technical screening criteria for the buildings sector, to direct private capital towards sustainable investments in energy renovation, relying on Energy Performance Certificates and nearly zero-energy building standards	2021							x						x						
• The reviews of the Mortgage Credit Directive (Directive 2014/17/EU) and the Consumer Credit Directive (Directive 2008/48/EC) will provide opportunities to adequately reflect a possible lower credit risk of sustainable financial product.														x						
• The EC is considering measures to incorporate environmental, social and governance risks into prudential regulation in its reviews of the rules for banks (the Capital Requirements Regulation EU 575/2013 and Directive 2013/36/EU) and insurers (the Solvency II Directive 2009/138/EC).														x						
FISCAL POLICY																				
• The current Commission's proposal on value-added tax (VAT) could allow Member States to make more targeted use of rates to support organic fruit and vegetables (COM(2018) 20 final).	In progress						x													
• Review of VAT exemptions for international passenger transport to ensure pricing carbon.	2022																	x		
• Broaden the application of well-designed economic instruments, such as environmental taxation, to enable Member States to use VAT rates to promote circular economy activities that target final consumers, notably repair services.				x																
FISHERY and AQUACULTURE																				
• MS should be encouraged by the EC to include the increase of organic aquaculture among the objectives of their reviewed Multi-annual National Strategic Plans for aquaculture.									x											
INDUSTRY, PRODUCTS, VALUE CHAINS																				
• In 2020, the EC launched a review of the reporting obligations of businesses under the Non-Financial Reporting Directive (Dir. 2014/95/EU),	In progress			x				x							x					x

to improve the quality and scope of non-financial disclosures, including on environmental aspects such as biodiversity and circular economy. Reporting standards could take account of the pre-existing Oil and Gas Methane Partnership (OGMP) standards for supply chains in oil, fossil gas and coal supply chains.																				
• Proposal for a new regulatory framework for batteries (COM 2020/798-3). See also 'Waste and resources'.	In progress			x														x		x
• Support the circular economy transition through forthcoming Action Plan for Social Economy.	2020			x																
• Review of the EU promotion programme for agricultural and food products.	2020						x													
• The EC will adopt an EU Strategy on Clean steel to support zero carbon steel-making processes by 2030	2020		x																	x
• Circular Electronics Initiative.	2020/ 2021			x																
• Adoption of a Strategy for a Sustainable Built Environment which will address, inter alia, soil sealing and rehabilitation of contaminated brownfields. A 'Renovation Wave initiative' has also been launched, with the aim of doubling and more the annual energy renovation rate of buildings (currently around 1%) in the period up to 2030 (in line with -55% GHG emissions reduction target). The Initiative will promote the further electrification of buildings' heating, the deployment of on-buildings renewable energy, and the roll-out of electric vehicle charging points.	2021		x	x				x		x		x		x						x
• Adoption of an EU Code of conduct for responsible business and marketing practice in the food supply chain accompanied with a monitoring framework**.**	2021						x													
• Adoption of an EU Strategy for Textiles.	2021			x																
• EC will put forward a new initiative on sustainable corporate governance (eventually as a legislative proposal), addressing human rights and environmental duty of care and due diligence across economic value chains. Circular economy objectives will also be mainstreamed in this context. This initiative will also include a requirement for the food industry to integrate sustainability into corporate strategies.	2021			x			x	x												
• The EC will develop methods, criteria and standards to describe the essential features of biodiversity, its services, values, and sustainable use, including measuring the environmental footprint of products and organisations on the environment.	2021							x												
• Revision of the Feed Additives Regulation (Regulation (EC) No 1831/2003).	2021						x													
• Adoption of a legislative proposal for a Sustainable Product Policy Initiative, including the extension of the eco-design framework (currently Dir.	2021/ 2022			x						x		x				x				x

2009/125/EC only applies to some energy-related products; see also energy) to make it applicable to the broadest possible range of products and make it deliver on circularity. Under the Sustainable Product policy initiative, extended producer responsibility (EPR) requirements will eventually be strengthened. Moreover, information will be provided to customers on the sustainability of industrial products (in particular steel, cement and chemicals) by 2022. With regard to chemicals, the EC will introduce requirements to minimise the presence of substances of concern in products, giving priority to product categories that affect vulnerable populations (e.g. textiles, packaging, ICT, etc.), as well as information requirements to ensure the availability of information on chemical content and safe use.																				
• Revision of marketing standards to provide for the uptake and supply of sustainable agricultural, fisheries and aquaculture products (to provide comparable information to consumers and operators in the supply chain on the environmental and social sustainability of food/seafood and on its carbon footprint).	2022				x		x													
• The EC will launch of an industry-led industrial symbiosis reporting and certification system.	2022			x																
• Revision of the food contact materials legislation to improve food safety and public health.	2022						x													
• Revise regulatory requirements in the pharmaceutical legislation, applicable to medicines for human use that contain or consist of GMOs (also to minimize harmful impacts on the environment).	2022																		x	
• Revise the manufacturing and supply provisions in the pharmaceutical legislation to ensure overall environmental sustainability.	2022																		x	
• Revise the pharmaceutical legislation to strengthen the environmental risk assessment requirements.	2022																		x	
• The EC will develop a roadmap leading up to 2050 for reducing whole life-cycle carbon emissions in buildings (see also 'Climate change').	2023													x						
• An Action Plan on Critical Raw Materials will be adopted including efforts to broaden international partnerships on access to raw materials.			x																	
• Review of the Construction Product Regulation (Regulation. EU 305/2011) to include the introduction of recycled content requirements and address the sustainability performance of construction products. See also 'Waste and resources'. Climate resilience considerations will be integrated into the criteria applicable to construction and renovation of buildings and critical infrastructure.			x										x	x						x
• The EC will introduce specific requirements in the General Product Safety Directive (Directive 2001/95/EC) to ensure the safety of children from																x				

hazardous chemicals in childcare articles and other products for children. See also ‘Chemicals’.																				
• The EC will address the impact on the environment of the production and use of pharmaceuticals in the upcoming pharmaceuticals strategy for Europe.															x					
• The EC will reinforce the regulation of chemical contaminants in food (Reg. 315/93/EEC) to ensure a high level of human health protection.															x					
• The Directive on the marketing of forest reproductive material (Council Directive 1999/105/EC) will be amended to encourage collaborative, transnational production and transfer of seeds and planting material through active policies and actions.												x								
• The Marketing Directives on seed and planet propagating material ([37]) and other propagating material will be amended to encourage collaborative, transnational production and transfer of seeds and planting material through active policies and actions.												x								
• The EC is considering the revision of marketing rules for traditional crop varieties (Dir. 66/401/EEC, 66/402/EEC, 2002/53/EC, 2002/54/EC, 2002/55/EC, 2002/56/EC, 2002/57/EC, 2008/72/EC, 1998/56/EC, 92/33/EEC, 2008/90/EC, 1999/105/EC), to contribute to their conservation/sustainable use. It will also take measures to facilitate the registration of seed varieties.								x												
COMPETITION																				
• The EC will ensure revised State aid rules are in place in a number of priority areas, including energy and environmental aid. In this context a reflection will be developed on CE objectives. Moreover, the EC will work to phase out direct fossil fuel subsidies and will ensure that the state aid framework supports cost-effective decarbonization of the economy where public support remain necessary. The revision will provide a fully updated and fit-for-purpose enabling framework to cost-effectively deploy clean energy, including renewable offshore energy.	2021		x	x						x							x			x
• Adoption of stricter dissuasive measures and better import control to combat food fraud.	2021/ 2022						x													
• Clarification of competition rules in the TFEU for collective initiatives that promote sustainability in supply chains.	2022						x													
• Monitor the implementation of the Unfair Trading Practices Directive (Directive (EU) No 2019/633).							x													
JUSTICE																				

[37] https://ec.europa.eu/food/plant/plant_propagation_material/legislation/review_eu_rules_en

• The EU will possibly revise the Environmental Crime Directive (Dir. 2008/99/EC) by expanding its scope and introducing provisions on types/levels of criminal sanctions.	2021					x		x												
• Eventual revision of the Directive on environmental liability, including its pollution-related aspects.	After 2023					x														
• The revision of the Aarhus Regulation will be considered, in order to improve access to justice in national courts in environmental matters for citizens and NGOs.								x												x
TRANSPORT (non-environmental legislation)																				
• Possible inclusion of new propulsion systems in the current review of the Directive on recreational craft and personal watercraft (2013/53/EC).	In progress				x															
• Regulatory measures to enable innovative and flexible tickets that combine various transport modes and give passengers true options for door-to-door travel will be proposed.	As of 2021																	x		
• Revision of the Directive on Intelligent Transport Systems (Directive 2010/40/EU), including a multimodal ticketing initiative.	2021																	x		
• Revise the Rail Freight Corridor Regulation (Regulation (EU) No 913/2010) to boost rail freight.	2021																	x		
• Revision of Regulation 95/93/EEC on common rules for the allocation of slots at Community airports and of Directive 2009/12/EC on airport charges to promote zero-emission airports.	2021/ 2022																	x		
• Revision of the Weights and Dimensions Directive (of heavy-duty vehicles; Directive (EU) 2015/719) to promote the uptake of zero-emission vehicles	2022																	x		
OTHER																				
The EC will extend the scope of public access to environmental information in the INSPIRE Directive (Dir. 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community) to include climate-related risk and losses data.												x								

List of acronyms and abbreviations

ANS	Adjusted net saving
AT	Austria
BAU	Business as usual
BE	Belgium
BG	Bulgaria
BREF	Best Available Techniques Reference Document
CBAM	Carbon border adjustment mechanism
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CE	Circular economy
CET	Clean energy technology
CGE	Computable general equilibrium
CIS	Community innovation survey
CLD	Causal loop diagram
CLP	Classification, labelling, packaging
CNC	Critical natural capital
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent
CTR	Carbon tax revenue
CY	Cyprus
CZ	Czech Republic
DARPA	Defence Advanced Research Projects Agency
DE	Germany
DK	Denmark
EASA	European Union Aviation Safety Agency
EC	European Commission
EE	Estonia
EEA	European Environment Agency
e.g.	*exempli gratia* (for example)
EGD	European Green Deal
EIB	European Investment Bank
EIC	European Innovation Council
EIOPA	European Insurance and Occupational Pensions Authority
EKC	Environmental Kuznets curve
EL	Greece
ELV	End-of-life vehicle
ES	Spain
EPR	Extended producer responsibility
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificates
EASA	European Union Aviation Safety Agency
ESCO	European Skills, Competences, Qualifications and Occupations
ESDB	European Climate and Sustainable Development Bank
ETC/WMGE	European Topic Centre on Waste and Materials in a Green Economy
ETS	Emissions trading system
EU	European Union
FR	France
FI	Finland
GMO	Genetically modified organism

GPP	Green public procurement
GPS	Global positioning system
HDI	Human Development Index
IED	Industrial Emissions Directive
HR	Croatia
ICT	Information and communications technology
i.e.	*id est* (that is)
IED	Industrial Emissions Directive
IF	Innovation Fund
IMF	International Monetary Fund
IPAT	Impact ≡ Population **x** Affluence **x** Technology
IT	Italy
ITMO	Internationally Transferred Mitigation Outcome
IUCN	International Union for the Conservation of Nature
GDP	Gross domestic product
GHG	Greenhouse gase
GNI	Gross national income
GTAP	Global Trade Analysis Project
JRC	Joint Research Centre
JT	Just transition
JTF	Just Transition Fund
LU	Luxembourg
LULUCF	Land use, land-use change and forestry
MBI	Market based instrument
MFF	Multiannual financial framework
MS	Member States of the European Union
MT	Malta
NBS	Nature-based solutions
NDICI	Neighbourhood, Development and International Cooperation Instrument
NEC	National emissions ceilings
NFA	Net foreign assets
NGEU	Next Generation EU
NGO	Non-governmental organisation
NL	Netherlands
NO_2	Nitrogen dioxide
OGMP	Oil and Gas Methane Partnership
OECD	Organisation for Economic Co-operation and Development
PA	Paris Agreement
PET	Polyethylene terephthalate
PFAS	Per- and polyfluoroalkyl substances
PL	Poland
$PM_{2.5}$	Fine particulate matter with at diameter of 2.5 microns or less
PM_{10}	Coarse particulate matter of 10 microns or less
PT	Portugal
RCA	Revealed comparative advantage
R&D	Research and development
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
REDD	Reducing Emissions from Deforestation and Forest Degradation
RES	Renewable energy sources
RO	Romania
RoHS	Restriction of Hazardous Substances
RRF	Recovery and Resilience Facility
SD	Sustainable development

SDG	United Nations Sustainable Development Goals
SE	Sweden
SEEA	System of environmental economic accounting
SI	Slovenia
SK	Slovakia
SOER	State of the Environment Report
SSE	Steady-state economy
ST	Systems thinking
SUP	Single-use plastic
TEN	Trans-European Network
TEN-T	Trans-European Transport Network
TFEU	Treaty on the Functioning of the European Union
UK	United Kingdom
UN:	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
US	United States
VAT	Value-added tax
WB	World Bank
WFD	Waste Framework Directive
WHO	World Health Organization
WIOD	World Input-Output Database

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