# Financing the Joint Implementation of the SDGs and the European Green Deal

2nd report of the SDSN Senior Working Group on the European Green Deal

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**About the SDSN**

SDSN mobilizes global scientific and technological expertise to promote practical solutions for sustainable development, including implementing the Sustainable Development Goals (SDGs) and the Paris Climate Agreement. In Europe, over 300 members and 13 national and regional networks of SDSN are part of SDSN Europe, a joint initiative that aims to align the European recovery with the Agenda 2030. Leveraging the research within the networks and the SDSN's work on the Six Transformations and other publications, SDSN Europe will play an active role in shaping a sustainable and resilient Europe.

A special thanks to the SDSN's Senior Working Group, who authored the report, including the following members. Organizations are for identification purposes only.

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**Acknowledgments**

*The cover page of the Report has been realized by Guido Bellini, Santa Chiara Lab – University of Siena*

# Contents

## Executive Summary

Agenda 2030 for Sustainable Development, co-signed by 193 UN Member States in 2015, is a globally accepted pledge for poverty eradication and sustainable development achievement on a global scale by 2030, considering three pillars of sustainable development – economic, social, and environmental.

The European Leadership has decided to integrate the Agenda 2030 into the strategic guidelines on various policy areas and the European Semester, the central process for coordinating national economic and employment policies in the EU, putting 'people and the planet at the center of EU policy.

The European Green Deal, introduced in December 2019 by the European Commission, serves as Europe's growth plan aiming to make it a climate-neutral, resource-efficient, innovative, and socially inclusive continent. It includes several goals spanning many different policy areas, such as Clean Energy, Sustainable industry, Buildings and Renovation, Sustainable Agriculture Farm to Fork, Eliminating Pollution, Sustainable mobility, Biodiversity and Sustainable Finance. Moreover, as a response to the health, environmental, and economic consequences of the COVID-19 pandemic, the European Commission introduced 2021, the "Next Generation EU", a generous package of funds to mobilize policies supporting economic recovery while pursuing Europe's green and digital transition.

In 2021, SDSN Europe established a Senior Working Group (SWG), consisting of top-level academics and stakeholders, to successfully mobilize expertise to implement the aforementioned challenging context successfully. Its first report, entitled "Transformations for the Joint Implementation of Agenda 2030 for Sustainable Development and the European Green Deal: A Green and Digital, Job-Based and Inclusive Recovery from COVID-19 Pandemic", was published in February 2021 to support policymakers with actionable strategies that can guide EU-wide and national economic recovery in line with Europe's overarching sustainability agenda.

**This second SWG Report focuses on how to finance the joint implementation of Agenda 2030 and the European Green Deal**.

**Strategic and competitive position of the EU**

The key findings and recommendations are as follows:

I. Maintain leadership in Climate Change. The EU is and should continue to lead the world in mandating and regulating change.
II. Leverage the EGD fully to maximize the impact on the SDGs. The European Green Deal policies are related to the SDGs, including Goals 16 and 17 and therefore offer the opportunity to more formally enhance the EU's contribution to the SDGs. Separately, given the EGD, the EU should consider the additional actions required to leverage the EGD to lead the world in the implementation of the SDGs.
III. Reform the legal systems to require non-financial reporting on externalities. Companies that are responsible actors are more profitable in the medium to longer term than those that are not and so the EU can lead in managing a more holistic approach to reporting profit and losses encompassing ecological transition and the value of three main types of Ecosystems: Terrestrial, Marine, and Freshwater.
IV. Create competitive advantage for the EU through multi-stakeholder innovative solutions. The EU should lead the world in the innovation of solutions to meet the

SDG shortfall, estimated at c.US$100 trillion, through collaborations between governments and NGOs with knowledge of the issues, private corporations with solutions, financial institution with capital and by empowering individuals with the information to make conscious buying choices.

V. Develop resilience plans for EU member states and EU wide measure. Measures are required to address demographic risks, social protection, economic strength, policy capacity, and global coordination for a range of potential future crises based on significant gaps in resilience and preparedness highlighted during the pandemic, but given the war in Ukraine, a broader scope is required.

VI. Maximize the value of stimulus to climate and SDG impact requirements and metrics. The EU has the opportunity in future to align stimulus and its impact goals given the finding that of the USD 2.3 trillion directed toward investments that could have been climate-friendly, total government spending earmarked for clean energy and sustainable recovery measures is only around 3%.

Taken together, these measures have the potential to position the EU economically, socially, geopolitically as a leader in sustainability and more importantly have the potential to re-orient the system of capitalism toward a more responsible form better suited to manage the transition of the world out of an industrial era and towards a more sustainable and inclusive one. Leading the world in this endeavor has significant benefits for the competitiveness of the EU relative to other world powers and for its member states, companies and individuals as well setting an example for the world at large.

**Outline of contents**

The report provides a detailed perspective on the requirements for implementing the EU's Green Deal. It starts in Section 1 by providing an overview of the wide-ranging EU policies published in 2020-21 in support of the implementation of the European Green Deal. Many initiatives have been launched in Europe during the last two years, including sectoral and cross-cutting strategies. In climate policy alone, and in response to the latest findings of the Intergovernmental Panel on Climate Change that climate change mitigation and adaptation policies need to be implemented at unprecedented scale and speed, the EU has initiated an unparalleled process of introducing more than a dozen of legislative proposals in all climate-related topics.

Then, in Section 2, we map these Policies to the 17 Sustainable Development Goals (SDGs) and the 6 Transformations of Agenda 2030 to **help decision-makers understand how the different policies affect the transformations that countries need to undertake** to achieve sustainability. This is done by building on the text-mining methodology developed in the first SWG report of 2021 and validating the mapping results through a method to automatically classify EU policy documents under the SDGs with Machine Learning techniques. Among many interesting findings, our analysis highlights the connection of European Green Deal policies not only to the expected thematic SDGs but also to Goals 16 and 17, indicating that progress towards sustainability passes through "Peace, Justice and Strong Institutions" (SDG 16) and international "Partnerships for the Goals" (SDG 17).

Section 3 sheds light on some **critical financial implications of the Sustainability Transition**. Through a combination of case studies and best practices, we identify in Sections 3.1 and 3.3. a gradually changing paradigm towards greening the financial system. Unlike in the past, it turns out that sustainable companies are rewarded in financial markets; different kinds of

public and private green bonds are introduced; central banks play a crucial role in this transition, and fiscal measures like the removal of environmentally harmful subsidies are gaining traction in real-world policymaking. However, a fundamental common characteristic of best practices is that they combine the common goal of profit creation with those of social and environmental impact. Therefore, it is essential to reform our legal systems to accommodate the move toward multidimensionality of organizational and corporate goals and to broaden too narrow boundaries that limit corporate action to the interest of shareholders. For this purpose, the development of non-financial reporting can be a solid stimulus for communication and dissemination of best practices to help organizations and companies monitor their progress in ecological transition, which is nowadays a fundamental part of their competitiveness.

Section 3.2 focuses on the importance of Natural Capital for the transition to sustainability. Although numerous studies have demonstrated the emergency of biodiversity loss, less evidence has been provided on the changes we need at a political, financial and economic level to slow down and reverse this path. Therefore, to help stakeholders anticipate the value of Nature and its contribution to society, we perform an analysis to economically evaluate the services provided by three main types of Ecosystems: Terrestrial, Marine, and Freshwater. Integrating this ecosystem valuation into the SDG framework, it is possible to translate the SDG implementation to monetary values. Our results indicate that the Willingness to Pay (WTP) of citizens varies by Ecosystem Service and by Bio-Geographical Region for all ecosystems (Terrestrial and Marine & Fresh water), and call for structural changes to tackle biodiversity loss.

However, SDGs are still significantly underfunded by governments and private investors; the actual SDG funding gap is estimated at around 10% of today's global GDP. The overall volume of financing is insufficient, but its allocation is imperfect, too. Most of the current spending appears to be allocated to advanced economies and focuses on climate and environment-oriented Goals, whereas there is a massive shortfall in funding for human, economic, and social SDGs. The world needs the coordination of governments, individuals, and private corporations beyond traditional financial services companies to remedy this. Efficient collaboration between the UN, national governments and the private sector will require a shared blueprint of goals, deliverables, roles, and actions. Section 3.4 provides an outline of such an approach.

Section 4 lays out **a framework for the post-pandemic world: mainstreaming funds to allow an SDG-based economic recovery and learning lessons from differences in pandemic resilience of world regions**. This includes assessing the aforementioned "Next Generation EU" funding package against SDGs in Section 4.1. More specifically, we look in detail at the National Recovery and Resilience Plans of seven South European Member States and identify similar patterns across countries in supporting the green energy transition while underfunding other systemic sustainability challenges. Section 4.2 looks at the resilience of eight major countries across five resilience factors related to demographic risks, social protection, economic strength, policy capacity, and global coordination. The analysis finds significant gaps in resilience and preparedness of different countries, which can only be addressed by working together across boundaries and effectively within countries.

Finally, Section 4.3 includes the latest findings of the International Energy Agency's Sustainable Recovery Tracker. Of the USD 2.3 trillion directed toward investments that could have been climate-friendly, **total government spending earmarked for clean energy and**

**sustainable recovery measures is only around 3%** of the full fiscal support unleashed in response to Covid-19 worldwide. Moreover, spending in emerging and developing economies remains only one-tenth of the level seen in advanced economies. Beyond this geographic misalignment, only a balanced, multi-sectoral portfolio of recovery measures would deliver the emissions reductions consistent with what is needed to stabilize the global climate and reach net-zero greenhouse gas emissions by 2050.

In summary, the very wide-ranging policy initiatives of 2020-2021 are tangible examples of the willingness of EU leaders to adopt SDGs as Europe's economic development framework. The substantial alignment of the European Green Deal with SDGs is a clear finding of our report's analysis. However, even this ambitious framework may fall short of the necessary action to tackle major sustainability challenges, as indicated by independent assessments outlined in Section 5. Moreover, since the financing needs are huge, sustainable finance aspects will be the main topic of further work of this Senior Working Group in the coming years.

# 1. Introduction: The Policy Framework for Implementing the European Green Deal

This introductory section provides an overview of the EU policies published since 2020 in support of the implementation of the European Green Deal. For each policy document, the most critical points are described, emphasizing those that facilitate either directly or indirectly the performance of the seventeen Sustainable Development Goals of the UN Agenda 2030.

The **European Commission introduced the European Green Deal** at the end of 2019 **(European Commission, December 2019)**. It serves as Europe's long-term growth plan and as a roadmap for establishing new policies and strategies at both EU-wide and national levels. It is a comprehensive strategy to make the European continent carbon-neutral by 2050 and resource-efficient, cutting-edge in terms of technology, and socially just. The EU is not alone in this endeavour; Box 1 outlines other Green Deals announced worldwide.

To support the implementation of the European Green Deal and the achievement of its ambitious goals, the European Commission published a series of Policy and Strategy texts for important sectors of the economy during 2020 and 2021, with a significant impact on the way the financial markets operate, as well as the social and everyday life of European citizens. Below we provide a list of the most important policies and strategies published in the past two years and accompany each one with a brief description highlighting their main points. The Policies are mentioned in chronological order based on the date they appeared publicly.

**Box 1 – Other Green Deals around the world**

The EU was the first continent to implement a Green Deal committing to carbon-neutrality by 2050. However, other countries have started to follow this example, as well.

About US$144 billion will be invested in creating 1,901,000 employment by 2025 as part of the **South Korean government's** New Deal. The Digital New Deal and the Green New Deal are at the heart of the strategy, including policy support aimed at bolstering the economy and social safety nets. Ten significant projects have been identified in Korea, spanning from green transportation to healthcare innovation. Governments from Seoul and across the country are working together to promote innovation and jobs in the region's economy. The Green New Deal focuses on renewable energy sources, green infrastructure, and the industrial sector's role (**Chowdhury, 2021**).

The Green New Deal in **Canada** is a four-pillared plan to retool the national economy to address the climate issue radically and rising inequality: **1. Listen to the science**: The Intergovernmental Panel on Climate Change (IPCC) calls for a global warming restriction of 1.5°C to prevent catastrophic consequences, and prompt action must lead to the transition of fossil fuels, **2. Respect Indigenous rights & sovereignty**: Reconciliation must be more than a slogan. In terms of climate and energy policy, that means fully implementing the UN Declaration on the Rights of Indigenous Peoples and continuously listening to Indigenous communities to seek their just climate solutions, **3. Create millions of good jobs**: Fighting climate change will necessitate an economic mobilization, and millions of decent, well-paying union jobs for workers across Canada must be generated to achieve 100% renewable energy. These initiatives are widely supported, mainly when funded by taxing

the wealthy and having significant banks and businesses pay their fair amount, **4. Finally, enshrine dignity, justice, and equity for all**: climate action must be connected to inequality and injustice and present actual solutions that leave no community, no family, and no one behind (**MacArthur 1et al., 2020**).

Crucial for achieving climate neutrality by 2050 is the bilateral agreement between **China and the US** during the 2021 United Nations Climate Change Conference (COP26) in November at Glasgow (**US Department of State, 2021**). The world's two most powerful economies vowed to work together to slow global warming. In addition to the tremendous geopolitical importance of this agreement, the tone is given to smaller countries to follow their example and join the fight against climate change. The agreement provides for establishing a joint working group in the first half of 2022 to intensify efforts to reduce emissions, notably by combating methane and illegal deforestation, in the 2020s, which will be a critical decade for climate action globally. In a joint statement, China and the United States confirmed their commitment to the Paris Agreement's objective of minimizing global warming to no more than 1.5 degrees Celsius and declared that climate finance and rules for the global carbon market are priorities.

Nonetheless, China remains unwilling to engage in signing on to a global agreement to reduce methane emissions by 30% by the end of the decade from 2020 levels, as proposed by the United States and the European Union. Instead, China will come up with its national strategy in this regard. With its massive emissions of greenhouse gases, China has a unique opportunity to assist the world in averting the most damaging effects of climate change.

Admittedly, the messages regarding the implementation of Green, Sustainable policies internationally are optimistic, as nations, in one way or another, are "forced" to implement such policies. The global health crisis due to COVID-19 has forced states to draw up recovery plans from the effects of the pandemic, and many of them have seized the opportunity and even drawn up such programs with a view to Sustainable Development.

Thus, even if a country does not implement itself or does not belong to a group of states governed by a Green Deal like EU countries, it can establish green policies and draw up a National Strategy oriented through a National Recovery Plan toward sustainable development.

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## A New Industrial Strategy for Europe

Europe's new industrial strategy was published in March 2020 (**European Commission, March 2020**). Its key priorities are:

**Supporting the business case for the green and digital transitions**. This involves a resilient regulatory framework, infrastructure, finance for innovation financing, raw materials innovation, clean energy, demand-side measures for climate neutrality, circular economy, up-skilling in labor potential, and synergies between the sustainable and digital transitions. Digital solutions, such as digital twins in advanced manufacturing can help optimise processes in all ecosystems.

**Investment in skills** is a highly appreciated component of investing in labor. The European Skills Agenda supports the green and digital transitions. Mobilization of the private sector is a critical parameter. Large-scale skills partnerships per ecosystem, skilling commitments in the essential industry fields (automotive, microelectronics, aerospace, defence industry).

## Circular Economy Action Plan

The Circular Economy Action Plan was in March 2020 (**European Commission, March 2020**). It creates a framework for new patterns of production and consumption governed by circular economy principles**.** The Circular Economy will provide high-quality, clean and affordable products and services that will positively affect the achievement of a climate-neutral, competitive and inclusive economy and represent a potential for innovation and digitalization**.** New circular value chains will also contribute to restoring biodiversity (e.g. addressing the problem of marine plastic pollution) by addressing food waste issues and increasing the sustainability of food distribution and consumption; encouraging a circular approach to water consumption in agriculture, and making drinkable tap water accessible to prevent packaging waste. In addition, a new production process and new secondary raw material will be characterized by the absence of substances of health concern.

## EU Biodiversity Strategy for 2030

EU Biodiversity Strategy for 2030 was published in May 2020 **(European Commission, 2020)**. It directly promotes the protection and restoration of biodiversity and the well-functioning of terrestrial and marine ecosystems, which are crucial for human health and economic growth. Notably, the EU has identified three key sectors highly dependent on biodiversity, namely construction, agriculture and the food and drink industry. Biodiversity is of paramount importance in safeguarding global food security by providing safely sustainable, nutritious and affordable food. At the same time, the prevention of biodiversity decline requires the support of sustainable agricultural production practices that respect the diversity and resilience of natural capital. Moreover, biodiversity is vital in the fight against the climate crisis. Indeed Nature-based solutions are essential for emission reduction and climate adaptation and mitigation. This will also include strengthening renewable energy production, i.e. offshore and onshore wind, solar PV plants, biofuels, tidal and wave energy.

In this context, investments in energy infrastructure and research and innovation knowledge are needed. As part of its global action, the EU will define a global framework that will include, among the others, the International Ocean Governance to identify and manage marine protected areas effectively; the NaturAfrica initiative to preserve the ecosystem in developing regions; and biodiversity coalitions around the world. Overall, the biodiversity strategy will be implemented following human rights, gender and health protection.

### Farm to Fork Strategy

Farm to Fork Strategy was published in May 2020 (**European Commission, 2020**). It addresses the challenges of food security and access for all citizens by implementing a sustainable food system, thus promoting healthy people status, a healthy society and a healthy planet. Sustainable food environments facilitate the choice of healthy diets, which translates into increased consumer health, reduced health-related costs for society while preserving the environment from degradation, and enabling reduced GHG emissions from food processing, packaging, and transportation. At the same time, creating a new food system, new food supply chains, and a fresh food market presents an economic opportunity. The circular bio-based economy represents a potential for farmers while supporting the transition to a climate-neutral economy. The EU also intends to promote global change to a sustainable agri-food system through external policies such as trade policy and international cooperation.

### EU Hydrogen Strategy

Europe's Hydrogen Strategy was published in July 2020 (**European Commission, July 2020**). The establishment of a resilient and Sustainable Eco-system for Hydrogen in Europe consists of:

- **Electricity-based hydrogen** through water electrolysis. If the electricity used for electrolysis comes from renewable sources, this can be characterized as green hydrogen.
- Renewable hydrogen may also be produced by reforming biogas (instead of natural gas) or biochemical conversion of biomass if in compliance with sustainability requirements.
- '**Fossil-based hydrogen with carbon capture**' means that greenhouse gases emitted during hydrogen production can be captured. The variable effectiveness of greenhouse gas capture (maximum 90%) needs to be considered.
- **'Hydrogen-derived synthetic fuels'** refer to a variety of gaseous and liquid fuels based on hydrogen and carbon. For synthetic fuels to be considered renewable, the hydrogen part of the syngas should be renewable. Synthetic fuels include, for instance, synthetic kerosene in aviation, synthetic diesel for cars, and various molecules used in the production of chemicals and fertilizers.
- **Demand-side measures** to ensure the uptake of hydrogen in end uses (e.g. hydrogen-based steel and hydrogen-based fertilizers)

### Stepping up Europe's 2030 climate Ambition

Stepping up Europe's 2030 climate ambition was published in September 2020 (**European Commission, 2020**) to mobilize a 55% reduction in greenhouse gas emissions by 2030. This will significantly contribute to EU people's well-being by providing essential co-benefits in terms of health, improved air quality, and reduced environmental damage. Furthermore, the Ambition aspires to have a positive impact on economic growth and the overall employment in the EU and calls for radical policy reforms that, among others, will provide the appropriate education and training that can help the EU economy to recover and get greener, address skill mismatches, and will encourage competition in the markets.

It can be argued that the transition to climate neutrality and the increase in the climate target could create inequalities in the European area or intensify the existing ones because a more ambitious climate objective is expected to be more difficult for the Member States and regions where fossil fuels make up a more significant part of the energy mix. Likewise, in comparison

to wealthier households, low-income households endure a more substantial burden of heating costs. For this reason, compensation policy measures should be implemented to avoid an increase in inequalities[2]. However, "Stepping up Europe's 2030 climate Ambition" is a holistic framework covering many issues. Apart from decarbonising energy supply and demand and developing cleaner and more energy-efficient infrastructure (e.g. heat networks, hydrogen pipelines, electric recharging stations) and buildings, the "Ambition" also refers to the balance between the economic and social transition to climate neutrality. Thus it is consistent with the principles of the European Green Deal and is compatible with the European Climate Law, the Multiannual Financial Framework (MFF), the Next Generation EU recovery fund, and other flagship EU actions.

### The Annual Sustainable Growth Strategy of 2021 (7 technology flagship Areas)

The Annual Sustainable Growth Strategy (ASGS) of 2021 for Europe was published in September 2020 (**European Commission, September 2020**). The green and digital transformations required unprecedented expenditures in re- and upskilling. Furthermore, reforms to direct public and private investments toward climate and environmental initiatives are needed to complete the green transition. In addition, the EU-ID and other critical digital public services, including the legal and medical systems, need to be revitalized and be accessible by all and the public administration and services, in general, will be improved by Digitalization.

The established Recovery and Resilience Facility will help rebuild and prepare the next generation, but the transition process must be equitable for all Europeans to avoid further inequalities, ensure societal support, and promote social, economic, and territorial cohesion. Reskilling and upskilling are essential to advancing the green and digital transitions, boosting innovation and growth potential, and assuring quality employment and social inclusion. The issues addressed by the ASGS 2021 include employment, skills, health, and education. Building renovation projects will help the economy by creating jobs, lowering energy costs, improving living conditions, and reducing energy poverty. Also, by setting the European Green Deal as its cornerstone, it aspires to promote global health and prosperity.

In the face of Energy, the EU should speed up the deployment of renewable energy and hydrogen and intensify efforts to improve building energy efficiency. Furthermore, promoting future-proof clean technologies to accelerate sustainable, accessible, and intelligent transportation will make European cities and regions cleaner. In this context, the EU's Recovery and Resilience Facility is relevant for green energy and will help the Member States meet the Paris climate goals. Similarly, cross-border and multi-country projects are necessary to promote specific investments, such as energy interconnectors, transportation networks, and forward-thinking digital and green projects. At the same time, economic and environmental challenges of the European energy sector have been particularly evident during 2021 and early 2022, as Box 2 illustrates.

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[2] https://www.enelfoundation.org/all-news/news/2020/06/discussing-e-quality-in-the-context-of-energy-transition

**Box 2 – The Energy Crisis, the Energy Transition and the role of gas and nuclear power**

In 2021, a severe energy crisis occurred that shook the global economy. The outbreak of this crisis was due mainly to the drastic reduction of economic and commercial activities due to the coronavirus pandemic (COVID-19) and the demand increase after economies started to reopen. The turmoil in energy markets was exacerbated by the fossil fuel supply shock as a result of the war in Ukraine in early 2022.

This is not the first time a global energy crisis has appeared, as there have been similar ones in the past, mainly due to geopolitical turmoil in oil-producing countries. However, the current energy crisis is different from the previous ones, both in terms of the causes that triggered it and the timing of the return of the prices of energy resources to "normal" levels. In previous energy crises, sharp increases in oil prices were corrected after some time through appropriate policy action. However, the issue now is that the policy actions required must be reoriented and focused on shifting the effort from the correction of oil prices towards the search for ways of producing green energy. Otherwise, achieving the objective of global climate neutrality will be put in doubt, given the limited time horizon. This poses several challenges for policymakers and governments, as the provision of greener energy is still ongoing while demand is growing.

To meet the Paris Agreement's goal of limiting global average temperature rise to 1.5 degrees Celsius over pre-industrial levels, the global economy will need to undergo significant transformations that will drastically reduce or eliminate greenhouse gas emissions.

One of the key ways to make this happen is through carbon pricing, as a significant increase in the carbon price would make new investments in fossil fuel-dependent sectors less attractive. Based on some estimates, to achieve climate neutrality by the middle of the century, the carbon price should be at least $75/t CO2 equivalent (**IMF, 18 June 2021**), while there are opinions even for at least $100/t CO2 equivalent (**Reuters, 2021**).

Through its Emissions Trading System, Europe is approaching these price levels (Figure 1). For example, early in December, ETS prices reached a new record high of about €90 per ton of carbon, nearly three times the level at the start of 2021 and more than a multiple of their level just a few years earlier.

Another factor that increases the pressure on carbon price is the transformation of the financial market operations. Investing in sustainable sectors is no longer considered a formal requirement but constitutes a critical component of most investors' portfolios. As a result, many institutional investors have dramatically reduced their exposure to fossil fuel energy producers and have shifted funds to greener alternatives.

Moreover, the introduction of policies such as Fit-for-55 proposes to revise several existing energy and climate policies in the EU (broadening the scope of the EU ETS and raising the minimum excise tax rate for polluting fuels) will lead to higher carbon prices.

The current energy crisis has exacerbated tensions between the Member States over nuclear energy expansion. On December 31$^{st}$, the European Commission launched a plan proposing to consider both nuclear power stations and gas-power stations as "green", as the Commission believes that these two energy sources can play a role in facilitating the transition to a renewable-based future, taking into consideration scientific advice and

current technological progress, as well as the differing transition problems faced by the Member States (**European Commission, 2022**). Taxonomy would imply identifying various energy sources (for example, the gas must come from renewable sources or have low emissions by 2035) under clear and strict rules.

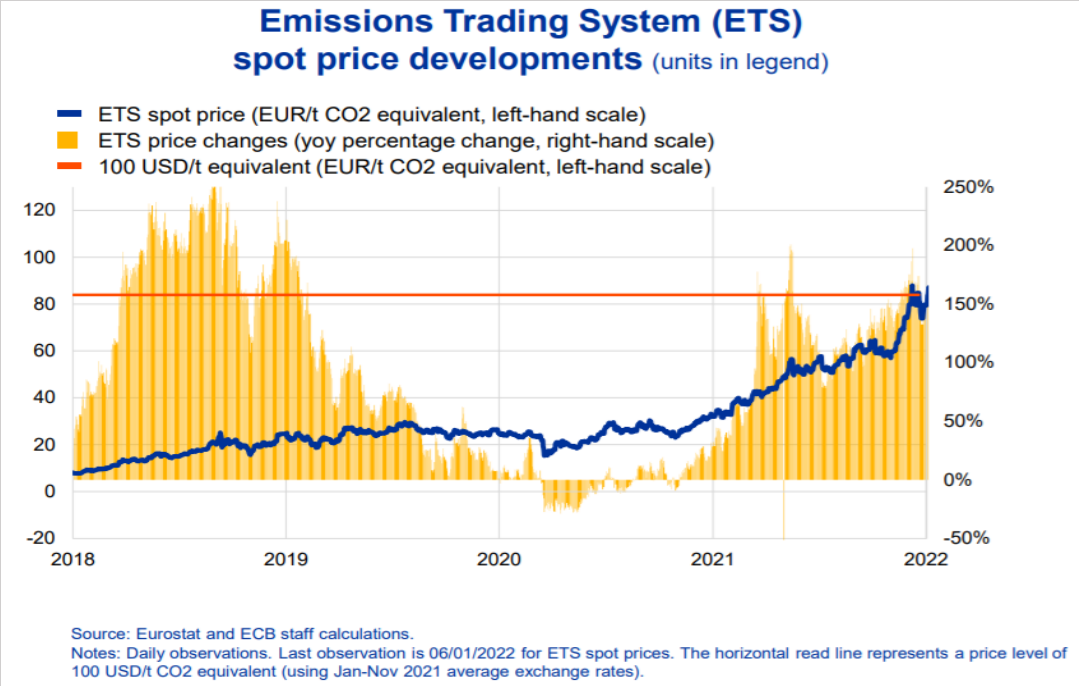



*Figure 1 Emissions Trading System (ETS) spot price developments. Source: ECB (Schnabel I., 2022)*

The ecological transition presupposes an industrial revolution of unprecedented extent. It also assumes a race of different energy sources to raise capital, and according to the Commissioner for Internal Market Thierry Breton, new-generation nuclear facilities in Europe will require decades to be developed and more than € 500 billion in investment in 2050 (**Euractiv, 2022**).

However, nuclear power's role in the energy transition has caused much discussion among the EU's 27 members. Several countries, including France and Poland, argued that the EU's green taxonomy should include nuclear energy. The campaign, also supported by Belgium, Sweden, Estonia, and the Netherlands, included Bulgaria, Romania, Hungary, Croatia, Slovakia, Slovenia, and the Czech Republic. Conversely, Cyprus, Germany, Hungary, Greece, Romania, and Malta are lobbying the EU Commission for gas energy projects. Austria, Luxembourg, and Denmark have clearly opposed both natural gas and nuclear power development (**Balkan Green Energy News, 2022**).

## Chemicals strategy for Sustainability

Chemicals strategy for Sustainability was published in October 2020 (**European Commission, October 2020**). **Human Health** and a **toxic-free environment** are the keywords summarizing the Chemicals Strategy - an ambitious approach to tackling pollution from all kinds of sources in our ordinary life and activities.

During the entire lifecycle of new chemicals and materials, their safety and sustainable utilization and disposal must be ensured. The complexity and global context of manufacturing and supply chains for critical chemicals (i.e. pharmaceuticals) should be treated with **resilient value chains** and diversified sourcing towards climate-neutral and circular economy pathways. Toxic-free material cycles and clean recycling from the EU should lead to a world-wide benchmark. Any **substances of concern in products and recycled materials** should be minimized.

Financial instruments regarding Innovation Calls of the EU Commission aspire to support the deployment of the necessary infrastructure to develop the **use, transport and storage of electricity** from renewable/carbon-neutral energy sources for the production of chemicals. Another dimension is the priority for KPIs of measurement of the industrial transition. The support of investments in sustainable innovations will anticipate the contamination of waste. In that mode, increasing recycling will become safe. The exports of waste (plastics and textiles) will be reduced. Cleaner production process and Technologies and Process approach will be supported to be cleaner, with regards to **innovative Business Models** and financial access with priority to **Start-ups.**

### EU Strategy to reduce methane emissions

The EU Strategy to reduce methane emissions was published in October 2020 (**European Commission, October 2020**) to address the challenge of Agricultural Transition. Dietary changes will be promoted through the Farm to Fork (F2F) Strategy actions. Biogas production will be supported for agricultural waste via National Strategic Plans under the Common Agricultural Policy. The gas market regulatory framework will be under review to promote the facilitation of distributed and locally connected biogas production. Best practices and technologies, feed and breeding changes, will be enabled to reduce agricultural emissions. Improvement of leak detection and repair (LDAR) regarding leaks on fossil gas infrastructure, production, transport and use will be an obligation.

Future legislation will include venting, flaring and standards for the overall supply chain and support for the World Bank 'Zero Flaring' initiative. An expert group will develop life-cycle methane emissions methods, especially for the agricultural sector. Partner countries shall be engaged in the global coordination of energy-sector methane emissions concerning diplomatic action of the EU. Methane emissions from international partners will be reduced under standards, targets (of emission reduction), and incentives for any (fossil) energy carrier imported to the EU.

### A Renovation Wave for Europe

Europe's Renovation Plan was published in October 2020 (**European Commission, October 2020**). The main Priorities in Renovation Wave and initiations on Energy Poverty are: Waste and renewable heat and cool into energy systems; Extension of the use of emission trading to emissions from buildings; Minimum proportions of renewable energy in buildings; Green public procurement criteria related to life cycle and climate resilience; Eco-design and energy labeling; Creating green jobs, upskilling workers and attracting new talent within the Frame of European Skills Agenda; Deep renovation standard; Horizon Europe and the R&I co-creation space; Building Information Modeling; 2050 whole life-cycle performance roadmap; Public buildings and social infrastructure showing the way; Tackling energy poverty and worst-performing buildings; Launching the Affordable Housing Initiative piloting 100 renovation districts; Reviewing the General Block Exemption Regulation and Energy and Environmental

Aid Guidelines; European Bauhaus platform (combination of sustainability with art and design); digitalization in the construction sector.

### EU Commission Recommendation on Energy Poverty

The Recommendation on Energy Poverty was published in October 2020 (**European Commission, October 2020**). Energy Poverty has become a real challenge for the European Union since almost 34 million citizens are estimated to suffer from a lack of access to affordable energy. The Recommendation outlines specific indicators for the proper assessment of energy-poor households, such as a) indicators for the comparison of energy expenditures versus income, b) a self-assessment on which is the current access of each household to energy services (ability on heating, cooling, warming), c) explicit monitoring by actual measurements of physical parameters/figures, such as room temperatures, as a feedback of the current situation and potential or implemented interventions, d) monitoring of the ability for households to pay for their energy bills, the quality of their home, the number of energy disconnections, as a measurement of people's weakness to finance their energy consumption/ needs, e) the electricity/fuels prices faced by end-users.

According to the residential profiles seeking energy upgrades, long-Term Renovation Strategies in every Member State should consider erasing barriers to investments relevant to energy efficiency. Furthermore, EU funding programs that enhance cohesion policies should be included to develop their distributional effects concerning energy transition models and the support of vulnerable society profiles. Finally, Energy Service Companies (ESCOs) and the relevant contracts with customers can play a crucial role in providing reliable financing solutions for necessary energy performance interventions in vulnerable households.

### EU Strategy to harness the potential of offshore renewable energy for a climate-neutral future

The offshore renewable energy Strategy of Europe was published in November 2020 (**European Commission, November 2020**). The EU has the great advantage of having the most comprehensive variety in sea basins, so the EU is in a position to develop offshore renewable energy. Spatial planning in maritime space is necessary, and there are successful pilot projects specialized in identifying the environmental benefits of offshore wind and aquaculture (MERMAID, TROPOS, Edulis, Wier en Wind). On the other hand, coordination between Transmission System Operators and Regulatory Authorities is necessary to support offshore renewables interconnection between local and central grids. Integration of large scale or distributed offshore energy systems into the grids should follow the regulatory rules. EU Sustainable Taxonomy and Grids development, innovation applications and technical maturity can support private capital investment.

Research and innovation can also support the choice of the proper materials, such as corrosion resistance, and ensure high-capacity rates and long-term efficiency and "sufficiency". Re-skill and Up-skill is a fundamental challenge with the potential of high-quality employment opportunities for skilled workers affected by the transition. The Circular Economic approach is critical to focus on recycling and reusing renewable machinery equipment components (i.e. wind turbine blades), affecting modern design and provoking niche and non-generic applications. New technologies and methods should be developed and deployed to increase the value retention of products and services within the manufacturing sector. Last but not least, through Green Deal diplomacy, the EU is engaged with its

international partners to develop an ecosystem of offshore renewables in cooperation with low-income countries and emerging markets.

### The European Climate Pact

The European Climate Pact was introduced in December 2020 by the European Commission (**European Commission 2020**) as a European Union-wide initiative to encourage people and organizations to engage in climate action and develop a more sustainable Europe by offering space to share information and spread knowledge, debate, good practices and solutions on climate action. It invites citizens, communities, and organizations to connect and share information, learn about climate change, and build, implement, and expand existing solutions that directly tackle climate change and its impacts.

The Pact prioritizes actions based on green mobility, efficient building, and training for green jobs, and then it will expand to the areas of sustainable consumption and production, quality of land and oceans, and food security**.** In addition, the direct involvement of people creates co-creation activities that unlock technological and social innovation**.** As part of its action, the Pact will encourage the consideration of social well-being, inclusion, equality, and diversity to protect the most vulnerable areas and individuals, which will benefit citizens' health and well-being.

### Smart Mobility Strategy

The Strategy of Europe for Smart Mobility was published in December 2020 (**European Commission, December 2020**). Mobility is crucial in the social life of citizens, but it must reduce its environmental impact as it adversely affects human health, well-being and biodiversity. To protect these public goods, especially the non-market goods, the mobility sector has to become sustainable and serve the energy transition towards a clean, low carbon, green fuels or other energy carriers. Charging and fuel infrastructure for zero-emission vehicles and ensuring a proper supply chain for renewable and low-carbon fuels are critical.

On the other hand, digitalization and Artificial Intelligence services can enhance circularity and efficiency in mass production and travel for vehicles, aircraft and shipping, considering mobility as a service (MAaS). Therefore, safe, comfortable, reliable, interconnected (for both urban and rural areas) and affordable for all mobility, especially for the vulnerable groups, should be maximized via digitally powered competitive advantages and logistic chains with increased resilience. All these provide good chances for all in social life, the development of new skills and, as a result, new and better opportunities for attractive jobs.

The European Commission has set specific milestones for European Smart and Sustainable Mobility: By 2030, at least 30 million zero-emission cars and 80 000 zero-emission heavy-duty vehicles should be in operation; by 2050, only these vehicle types should be on the roads. Zero-emission ocean-going vessels and large zero-emission aircraft should be introduced by 2030 and 2035, respectively. High-speed rail traffic should be twice by 2030 and three times higher by 2050. Finally, transport by inland waterways and short sea transport systems should increase by 25% in 2030 and by 50% in 2050.

### The European economic and financial system: fostering openness, strength and resilience

The European economic and financial system Policy was published in January 2021 **(European Commission, 2021**). EU climate and environmental goals rely on financial markets, as the Green Deal objectives like biodiversity protection and a circular economy will require vast

amounts of investments. The European Commission will enhance Global sanctions coordination. In addition, it will promote euro-denominated investments and has already urged banks and other financial institutions to use the euro wherever possible to ensure that EU money and economic resources are not exploited to bypass EU sanctions. Regarding the effects of sanctions on persons and enterprises, the Commission may invite NGOs and civil society to ensure that humanitarian concerns are addressed.

Especially after the UK's exit from the EU, there is an urgent need to develop local financial market infrastructures. These issues require strategies that promote growth and efficiency. By November 2020, the Commission had issued 39.5 billion euros in social bonds using the EU SURE instrument. Discussions with key players in commodities, aerospace, healthcare, and vital raw materials for renewable energy are underway, and it is expected that the European Green Deal will lead to new markets for renewable energy and other technologies, as well as the need for robust strategic supply chains for renewable energy and other technologies. The euro has made considerable strides in the energy sector, especially renewable energy. The Commission will encourage derivatives for energy and raw commodities, benchmark indices, and trading venues for new energy markets like hydrogen.

### EU Strategy on Adaptation to Climate Change

The EU Strategy on Adaptation to Climate Change was published in February 2021 **(European Commission, 2021)**. Climate change disproportionately affects vulnerable people and human rights, and we need a better grasp of the health threats posed by climate change. Adaptation is a significant component of the EU's long-term budget for 2021-2027, as it can help prevent and resolve these conflicts. Adaptation benefits must be widely and equitably shared, and the Commission needs to guarantee that funds reach the poorest communities in developing countries, especially those in unstable and conflict-affected governments.

Nature-based solutions will benefit adaptation, mitigation, disaster risk reduction, biodiversity, and health. Priority will be given to climate-vulnerable countries and proactive climate partners. At least 37% of the plans should be allocated to climate action, including mitigation and adaptation. Increasing the social dimension of the EU budget will help protect the most vulnerable.

The Commission will help increase the availability of high-quality plant reproductive material for agriculture, forestry and land ecosystem management and improve water efficiency and reuse by boosting regulations for eco-design and energy labelling products, energy generation, housing and agriculture, as well as industrial plants. Water is an essential part of many areas of the economy, yet excessive rains and floods may cause havoc on populations and infrastructure. A reliable and safe supply of drinking water is vital, but water scarcity in the EU has also impacted agriculture, aquaculture, tourism, power plant cooling, and river cargo shipping.

The UN Sustainable Development Goals and the European Green Deal must be the cornerstone of EU external adaptation action to climate change. The Commission will encourage the inclusion of climate resilience criteria in building and critical infrastructure construction and renovation. However, it will also continue to enforce current employment and social laws and, where appropriate, propose new actions to safeguard employees from climate risks as adverse effects on manufacturing capacity may harm economic growth. Furthermore, the EU will promote long-term economic diversification initiatives and policies by ensuring an adequate and highly skilled workforce.

### Directing finance towards the European Green Deal (The EU Taxonomy and CSRD)

Directing finance towards the European Green Deal Policy was published in April 2021 **(European Commission, 2021)**.

Under the European Green Deal, Business models and strategies for transitioning to a sustainable and carbon-neutral economy have to be reported according to specific rules. Compliance with the **EU Taxonomy** screening criteria and "do-no-significant-harm" restrictions will be mandatory for Corporate Sustainability Reporting compliance. This is based on the ambition of the European Green Deal goals, including climate neutrality. The EU Taxonomy Climate Delegated Act, a proposal for a Corporate Sustainability Reporting Directive (CSRD), covers four environmental objectives outlined in the EU Taxonomy Regulation (sustainable use and protection of water and marine resources, pollution prevention and control, conservation of biodiversity and ecosystems).

The proposed **Corporate Sustainability Reporting Directive** requires corporations to report sustainability information on the full range of environmental, social, and governance issues relevant to their business, including forced and child labor, in a standardized and comparable manner, increasing transparency and ensuring a consistent flow of sustainability information for all stakeholders.

### Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery

The European Commission published an update of its Industrial Strategy in May 2021 (**European Commission, May 2021**). This relies on a) the monitoring of industry trends and **Key Performance Indicators (KPIs)** of competitiveness; b) making the Single Market more resilient to anticipate crises and support the recovery; c) the toolbox development for the release of strategic dependencies; d) the boost of the twin (green and digital) transition.

More specifically, a Single Market Scoreboard will monitor the leading indicators of the competitiveness of the European economy and the boost of the innovation ecosystems. For the resilience of the Single Market, key actions are the Single Market Emergency Instrument and the surveillance mechanism for European and imported products. On strategic dependencies, the Commission is preparing an Alliance on processors and semiconductor technologies, an Alliance for Industrial Data, Edge and Cloud, an Alliance on Space Launchers for the autonomous European access to space, an Alliance on Zero Emission Aviation for the future fuels and energy carriers for aircraft, as a complementary group to the Renewable and Low-Carbon Fuels Alliance. Finally, the Digital and Green Transition strategy involves, among others, the development of Digital Twins for the development of digital copies, historical data, and predictive analytics to assess the performance of assets of critical industrial equipment. Furthermore, an investment in skills will support the green and digital transition to enhance the just recovery. The Pact for Skills is a tool of The European Skills Agenda to improve the European labor force by mobilizing private enterprises, institutes, academia and all the relevant stakeholders.

### The EU's Blue Economy for a Sustainable Future

The EU's Blue Economy for a Future Sustainable Policy was published in May 2021 **(European Commission, 2021)**. This policy aims at integrating the recovery and protection of ocean health into the EU economic policy set by the European Green Deal. The marine environment's protection will also contribute to biodiversity conservation and restoration and drive the path toward climate neutrality and zero pollution by creating offshore renewable energy and

decarbonizing maritime transport and ports. Besides, it helps alleviate the pressure on natural resources, encouraging waste prevention into the sea, thus increasing circularity and striving for more responsible food production. This will be enabled through the development of green infrastructures and innovation activities and bridging the skills gaps for marine technologies, which on the other side, will generate economic returns and employment potential by also accounting for gender balance in the maritime professions. To achieve a sustainable blue economy, the EU will foster cooperation within and outside the EU boundaries to increase the value of protection of global common goods and services.

### European Climate Law

The Climate law **(European Commision (2021), Regulation (EU) 2021/1119)** strengthens EU efforts and commitment to tackle climate change**.** It operates within the framework of the EU Green Deal, hence supporting a new strategy of growth that combines economic prosperity with sustainability and increases society and ecosystem resilience against climate change. In accordance, addressing climate-related risks means strengthening the action against health crises, guaranteeing water and food safety, and improving conditions in impacted areas. On the other hand, the EU Climate Law enables the protection of the integrity of maritime and terrestrial ecosystems, hence preserving biodiversity against the threat of climate change. For these purposes, a new energy system (characterized by the deployment of renewables, internal energy market and improvement of energy efficiency) must be created to effectively reduce the level of greenhouse gas emissions generated by at least 55% compared to 1990 levels by 2030, and reach climate neutrality by 2050. Together with research and development investments, technological and digital transformation are critical drivers for joining climate-neutral objectives. The EU action contributes to the global response against climate change as established in the Paris Agreement.

### The Fit-for-55 package

The Fit-for-55 package was published in July 2021 (**European Commision (2021)**). To achieve the goal of carbon neutrality by 2050 as part of the European Green Deal, the EU must significantly reduce its greenhouse gas emissions over the following decades. Therefore, it has increased its 2030 climate ambition, aiming to cut emissions by at least 55% by 2030 compared to 1990. For this purpose, the EU is revising its climate, energy, and transport legislation under the 'Fit-for-55 package' to match it with the 2030 and 2050 goals. The European Commission released most parts of this package on 14 July 2021, the starting point for a two-year round of political negotiations. The package supports the implementation of the European Green Deal and proposes either the revision of existing or the introduction of new policies to reduce net greenhouse gas emissions by at least 55% by 2030. Furthermore, while maintaining and strengthening the EU industry's innovation and competitiveness, the package attempts to ensure a level playing field for third-country economic operators and reinforce the EU's leadership role in the global battle against climate change.

The Fit for 55 package includes the following legislative proposals and policy initiatives:

- a revision of the EU emissions trading system (EU ETS), including its extension to shipping,
- a revision of the rules for aviation emissions and establishing a separate emission trading system for road transport and buildings
- a revision of the effort sharing regulation on member states' reduction targets in sectors outside the EU ETS

- a revision of the code on the inclusion of greenhouse gas emissions and removals from land use, land-use change and forestry (LULUCF)
- a revision of the renewable energy directive
- a recast of the energy efficiency directive
- a revision of the directive on the deployment of alternative fuels infrastructure
- an amendment of the regulation setting CO2 emission standards for cars and vans
- a revision of the energy tax directive
- a carbon border adjustment mechanism
- ReFuelEU Aviation for sustainable aviation fuels
- FuelEU Maritime for a green European maritime space
- a Social Climate Fund

The EU Emissions Trading System (ETS) is strengthened by increasing its ambition to reduce emissions from specific economic sectors up to 2030. The Commission also proposes phasing out free aviation emission allowances up to 2027 and harmonizing with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), including shipping emissions in the EU ETS for the first time. To complement the significant climate expenditure in the EU budget, the Member States will have to devote all their revenues from emissions trading to climate and energy-related projects. A new ETS is proposed to be created for fuels used in road transport and buildings, which can be merged with the existing ETS after 2030. A part of the revenues of this new ETS will be devoted to a new Social Climate Fund, which will essentially re-distribute financial resources between EU Member States to address the potentially adverse social impact on vulnerable households, micro-enterprises and transport users.

The Effort Sharing Regulation (ESR) sets out more stringent emission reduction targets for buildings, road and inland waterway transport, agriculture, waste, and small industries in each Member State. Recognizing the different starting points and capabilities of each Member State, these objectives are based on their per capita GDP. By 2035, the EU should pursue climate neutrality in land use, forestry and agriculture (LULUCF), including non-CO2 agricultural emissions, such as those from fertilizers and animals. Energy production and use account for 75% of EU emissions, so accelerating the transition to a greener energy system is vital. The Renewable Energy Directive (RED) will increase the goal of producing 40% of our energy from renewable sources by 2030. To reduce overall energy use, reduce emissions and tackle energy poverty, The Energy Efficiency Directive (EED) will set a more ambitious binding annual target for reducing energy use at the EU level, almost doubling the annual energy saving obligation for the Member States.

The revision and tightening of CO2 emission standards for cars and trucks will accelerate the transition to zero emissions, requiring a reduction in average new car emissions of 55% by 2030 and 100% by 2035 compared to 2021 levels; all new cars registered from 2035 will have zero emissions. To ensure that drivers can charge or power their vehicles on a reliable network across Europe, the revised Alternative Fuel Infrastructure Regulation (AFIR) will require the Member States to extend the charging capacity according to the volume of zero-emission cars sold and install charging and refueling points at regular intervals on significant highways: every 60 kilometers for electric charging and every 150 kilometers for hydrogen refueling.

The ReFuelEU Aviation Initiative will force fuel suppliers to use increasing levels of sustainable aviation fuel on aircraft refueled at EU airports. Similarly, the FuelEU Maritime Initiative will encourage the adoption of sustainable fuels in shipping. Moreover, the revision of the Energy Taxation Directive (ETD) proposes the alignment of energy taxation with EU energy and

climate policies, the promotion of clean technologies and the removal of outdated exemptions and reduced rates that encourage fossil fuels. Finally, a new Carbon Border Adjustment Mechanism (CBAM) will set a carbon price on imports of selected products to ensure that ambitious climate action in Europe does not lead to carbon leakage.

### Strategy for Financing the Transition to a Sustainable Economy

The Strategy for Financing the Transition to a Sustainable Economy was published in July 2021 **(European Commission, 2021)**. The financial industry must be more resilient to climate change and environmental degradation to comply with the European Green Deal objectives regarding water usage, circular economy, pollution prevention, and biodiversity. However, climate change and biodiversity loss create systemic risks that aren't always visible. In the future, the Commission intends to review the banking macro-prudential framework to assess the ability of the existing macroprudential measures to address climate change-related financial stability risks and create a Sustainable Finance Research Forum to enhance academia-industry collaboration. In addition, 23 million SMEs in the EU need easier access to custom sustainability guidance. Thus, more transparency and coherence in financial instrument labelling could help future sustainable finance markets.

Financial institutions are increasingly subject to rapid biodiversity loss, resource depletion, and water, air, and soil contamination. Therefore, according to the relevant April 2021 communication, the European Commission will explore legislation to recognize and assist certain economic activities that help reduce greenhouse gas emissions, particularly in the energy sector, including gas.

Synergies are crucial in the context of the Strategy for Financing the Transition to a Sustainable Economy. For example, public-private risk-sharing can solve ineffective market failures, and common standards can help firms, investors, and issuers adopt sustainable practices. Moreover, through a partnership with the OECD's International Network on Financial Education (INFE), the Commission improves financial literacy.

At the same time, the EU is taking significant steps to counteract financial greenwashing. For example, the Commission will examine supervisory powers, capabilities, and obligations with the help of the European Supervisory Authorities and will encourage international standard-setters like the IFRS Foundation to develop ambitious disclosure rules and principles. In addition, aligning financial flows with European Green Deal goals demands investors to consider sustainability consequences in their strategies and investment decisions. The Commission will perform a public consultation and impact assessment to strengthen the reliability, comparability, and transparency of ESG ratings. Further, to help corporations manage sustainability risks and profit from opportunities resulting from the path to sustainability, the Commission will present a proposal on Sustainable Corporate Governance.

# 2. European Green Deal Policies and Sustainability

This section describes the approach to matching each policy document mentioned in Section 1 to the seventeen Sustainable Development Goals. Using the outcome of **Sachs et al. (2019)** for connecting the SDGs to six broad categories of transformations, we match the policy documents with these *"6 transformative pathways"*. This helps decision-makers understand how the different policies affect the transformations that Countries may undertake to become more sustainable.

## 2.1. Matching EU Policies to the 17 SDGs

### 2.1.1. Method

One of the political guidelines of the European Commission's President (**von der Leyen, 2019**) is that the process of the **European Semester**[3] must be reoriented and become an instrument that integrates the SDGs, which constitute the most widely accepted framework for sustainable development globally. Integrating SDGs into the European policy framework will help ensure Europe's pathway to achieving climate neutrality within a comprehensive economic framework that gives equal opportunities to everyone.

The linkage between each major EU Policy mentioned in Section 1 and the SDGs is made by identifying phrases or sentences in each Policy text conceptually related to each of the seventeen Goals. Then, assuming that the greater the number of relevant references, the greater the influence of the Policy on the SDGs, we assign a score to show the level of impact, using a 4-point scale, as follows:

- 3, the Policy document directly affects the SDG outcomes;
- 2, the Policy document reinforces the SDG outcomes;
- 1, the Policy document enables the SDG outcomes;
- 0, the Policy document does not interact with the specific SDG.

### 2.1.2. Results

The results for each category of Policies are presented collectively below (**Table 1**). The main conclusion is that overall, the policies resulting from the European Green Deal affect all SDGs, some to a greater extent and others to a lesser extent. The most significant impact is found in the following Goals:

**SDG 13 - Climate Action: Urgent action to combat climate change and its impacts**

Actions and measures regarding this SDG are pervasive within the European Policy context. The European Commission has decisively shown its intention to reduce greenhouse gas emissions to limit global warming to below 1.5°C compared with pre-industrial levels by mid-century. Also, a firm intention is offered regarding improving countries' resilience and adaptability to climate-related natural hazards and the disasters that result from them. A landmark example of this firm will consist of the Committee to tackle issues related to SDG 13 was the launch of the "Fit-for-55" package in 2021, which is a set of proposals for the revision of thirteen existing policies covering a wide range of activities, from the modification of the

[3] The European Semester serves as a framework for the integrated monitoring and coordination of economic and employment policies across the European Union. Since its inception in 2011, it has become a well-established forum for discussing the fiscal, economic, and employment policy challenges confronting EU countries on a yearly basis.

functioning of the **Emissions Trading System,** to the creation of a Social Climate Fund to support the weakest in the sustainable transition.

**SDG 9 - Industry, innovation and infrastructure: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation**

The European Green Deal Communication particularly emphasizes the urgency of taking early and dramatic measures to combat climate change and achieve climate neutrality in Europe by 2050. Therefore, the close link to SDG 9 was expected, as the policies stemming from the European Green Deal contain requirements on the exploitation of research results and innovation in the industry and infrastructure, aiming to increase the resilience of countries and communities to the effects of ever-worsening climate change. The characteristic of this intention is to mobilize the European research and innovation community and contribute to this fundamental goal of the Green Deal. Furthermore, the Commission established **Horizon Europe**, a EUR 95.5 billion funding program for research and innovation, which among other things, it fosters industrial competitiveness by assisting in the creation and dissemination of superior knowledge and technologies[4].

**SDG 7 - Affordable and clean energy: Ensure access to affordable, reliable, sustainable, and modern energy for all**

The Energy sector is one of the fundamental Pillars of achieving the EGD objective of climate neutrality, considering that the production and consumption of energy are responsible for more than 75% of greenhouse emissions globally, and Buildings are responsible for about 40% of energy consumption[5]. Therefore, the Policies and Strategies that support the European Green Deal incorporate many actions that need to be taken regarding the “greening” of energy production and access for all to its pure forms.

**SDG 12 - Responsible consumption and production: Ensure sustainable consumption and production patterns**

The European Commission has taken several significant initiatives concerning the goal of responsible production and consumption and the implementation of a circular economy incorporated in its Policy documents. It encourages European companies to do business in partner countries with reliable supply chains and business practices. To the greatest extent possible, it strives to ensure that supply routes within global value chains are managed sustainably so that European consumers' choices do not jeopardize environmental protection or workers' rights and opportunities in the partner countries. Furthermore, the European Commission supports partner countries' transition to an inclusive green economy that generates economic growth and decent jobs, promotes sound waste and chemical management, and supports sustainable fishing both within and outside of Europe by attempting to ensure that partner countries follow EU rules to combat illegal and unregulated fishing.

[4] European Commission, Horizon Europe, https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

[5] World Resources Institute (By Mengpin Ge, Johannes Friedrich and Leandro Vigna), February 6, 2020 4 Charts Explain Greenhouse Gas Emissions by Countries and Sectors, https://www.wri.org/insights/4-charts-explain-greenhouse-gas-emissions-countries-and-sectors

**SDG 8 - Decent work and economic growth: Sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all**

Working conditions are a priority for the European Commission, which actively assists the Member States in addressing informal employment, particularly in sectors with the most significant multiplier potential, such as agriculture and energy. In addition, it supports the efforts of partner countries to eliminate child labor, address the gender pay gap, and generate more high-quality jobs for their increasing population.

Based on employment and decent work, the Commission focuses on enhancing decent job creation and supporting job-rich growth, improving the quality of existing jobs in terms of earnings and working conditions, increasing access to decent employment, particularly for the most vulnerable, through improved employability based on better education and training, and mainstreaming jobs in all economic policies and programs, as well as other sectors such as Energy, Health and Agriculture.

*Table 1 Connection of the European Green Deal to the 17 SDGs*

| | SDG 1 | SDG 2 | SDG 3 | SDG 4 | SDG 5 | SDG 6 | SDG 7 | SDG 8 | SDG 9 | SDG 10 | SDG 11 | SDG 12 | SDG 13 | SDG 14 | SDG 15 | SDG 16 | SDG 17 | Total Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A New Industrial Strategy for Europe | 1 | 2 | 1 | 2 | 0 | 0 | 3 | 2 | 3 | 0 | 1 | 2 | 2 | 1 | 2 | 2 | 2 | 26 |
| Circular Economy Action Plan | 0 | 2 | 1 | 0 | 0 | 2 | 2 | 2 | 3 | 2 | 0 | 3 | 2 | 2 | 2 | 0 | 0 | 23 |
| EU Biodiversity Strategy for 2030 | 0 | 2 | 2 | 1 | 1 | 0 | 2 | 2 | 1 | 1 | 0 | 2 | 2 | 3 | 3 | 0 | 2 | 24 |
| Farm to Fork Strategy | 2 | 3 | 2 | 0 | 0 | 0 | 2 | 2 | 1 | 2 | 0 | 3 | 2 | 2 | 2 | 0 | 1 | 24 |
| EU Hydrogen Strategy | 1 | 0 | 0 | 2 | 0 | 0 | 3 | 2 | 3 | 1 | 2 | 2 | 3 | 0 | 0 | 2 | 1 | 22 |
| 7 technology flagship Areas, ASGS for 2021 | 0 | 0 | 2 | 1 | 1 | 0 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 0 | 1 | 2 | 1 | 26 |
| Stepping up Europe's 2030 climate Ambition | 0 | 0 | 2 | 1 | 0 | 0 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 1 | 2 | 0 | 0 | 25 |
| Chemicals strategy for Sustainability | 0 | 1 | 3 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 1 | 2 | 3 | 3 | 3 | 1 | 0 | 21 |
| EU Strategy to reduce methane emissions | 1 | 3 | 1 | 1 | 0 | 0 | 2 | 1 | 2 | 0 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 19 |
| A Renovation Wave for Europe | 1 | 0 | 0 | 1 | 0 | 0 | 3 | 1 | 2 | 0 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 20 |
| EU Commission Recommendation on Energy Poverty | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 3 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 14 |
| EU Strategy to harness the potential of offshore renewable energy for a climate neutral future | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 2 | 3 | 0 | 2 | 1 | 3 | 2 | 0 | 2 | 2 | 21 |
| European Climate Pact | 0 | 2 | 1 | 2 | 1 | 0 | 0 | 1 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 0 | 0 | 21 |
| Smart Mobility Strategy | 0 | 1 | 2 | 0 | 0 | 0 | 3 | 0 | 3 | 2 | 2 | 2 | 3 | 2 | 0 | 0 | 1 | 21 |
| The European economic and financial system: fostering openness, strength and resilience | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 1 | 0 | 1 | 3 | 3 | 17 |
| EU Strategy on Adaptation to Climate Change | 2 | 2 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 3 | 2 | 2 | 2 | 2 | 36 |
| Directing finance towards the European Green Deal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 3 | 1 | 1 | 0 | 0 | 11 |
| Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery | 1 | 2 | 1 | 2 | 0 | 0 | 3 | 2 | 3 | 0 | 1 | 2 | 2 | 1 | 2 | 2 | 2 | 26 |
| The EU's Blue Economy for a Sustainable Future | 0 | 2 | 0 | 1 | 1 | 2 | 2 | 1 | 1 | 0 | 2 | 2 | 2 | 3 | 0 | 0 | 1 | 20 |
| European Climate Law | 0 | 2 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 3 | 2 | 2 | 0 | 2 | 25 |
| Strategy for Financing the Transition to a Sustainable Economy | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 | 3 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 23 |
| Fit for 55 | 0 | 0 | 1 | 1 | 0 | 1 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 0 | 2 | 0 | 2 | 27 |
| **Total Score** | **12** | **24** | **24** | **17** | **5** | **11** | **46** | **39** | **49** | **31** | **30** | **43** | **53** | **30** | **31** | **21** | **26** | |

## 2.2. Assigning EU Policies to the 6 Transformations

### 2.2.1. Method

After connecting EU policy documents with the SDGs, we translate this linkage into the Six Transformations, using the corresponding categorization of Sachs et al. (2019):

1. Education, Gender, and Inequality;
2. Health, Wellbeing, and Demography;
3. Energy Decarbonization and Sustainable Industry;
4. Sustainable Food, Land, Water, and Oceans;
5. Sustainable Cities and Communities; and
6. Digital Revolution for Sustainable Development

**Step 1:** For each Transformation, we calculate the simple average of the contribution of SDG in each transformative category, as given by Sachs et al. 2019 (**Table 2**):

*Table 2 How SDG Transformations contribute to the achievement of the SDGs. Source: Sachs et al. (2019)*

| Transformation | Principal line ministries involved in Transformations | SDG interventions | intermediate outputs | Relationship with specific SDGs | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 1 | Education, Science and technology and Family and social affairs | Early childhood development | Education and human capital | 2 | 1 | 2 | 3 | 3 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Primary and secondary education | | | | | | | | | | | | | | | | | | |
| | | Vocational training and higher education | | | | | | | | | | | | | | | | | | |
| | | Social protection system and labor standards | Decent work and income support to vulnerable groups | 3 | 3 | 2 | 1 | 2 | 1 | 2 | 3 | 1 | 3 | 1 | 1 | 2 | 2 | 2 | 1 | 0 |
| | | Research and development | Innovation | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 2 |
| 2 | Health | Universal health coverage | Public health services | 2 | 3 | 3 | 2 | 3 | 0 | 0 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| | | Healthy behaviors and social determinants of health and well-being | | | | | | | | | | | | | | | | | | |
| 3 | Buildings/construction Energy Environment Transport | Access to clean energy | Energy access for all | 2 | 1 | 2 | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 1 | 2 | 1 | 0 |
| | | Zero-carbon electricity generation | Energy decarbonization | 1 | 2 | 2 | 0 | 1 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 1 |
| | | Energy efficiency | | | | | | | | | | | | | | | | | | |
| | | Electrification and zero-carbon fuels | | | | | | | | | | | | | | | | | | |
| | | Curbing pollution | Clean air and water | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 1 | 1 | 3 | 3 | 2 | 3 | 3 | 1 | 1 |
| 4 | Agriculture Environment Fisheries and marine resources Forestry Health Water and natural resources | Efficient and resilient agricultural systems and fisheries that support healthy diets and farm livelihoods | Sustainable land use, oceans, and food systems | 2 | 3 | 3 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 1 | 1 |
| | | Protection of terrestrial and marine biodiversity, including forests | | | | | | | | | | | | | | | | | | |
| | | Healthy food promotion and regulation | | | | | | | | | | | | | | | | | | |
| | | Trade and supply chains consistent with sustainable development development | | | | | | | | | | | | | | | | | | |
| | | Integrated land-use and water management | | | | | | | | | | | | | | | | | | |
| 5 | Transport Urban development Water and sanitation | Urban access to water, sanitation and waste management | Transport, water and sanitation infrastructure services | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 0 | 0 |
| | | Sustainable mobility and transport networks | | | | | | | | | | | | | | | | | | |
| | | More compact settlements | | | | | | | | | | | | | | | | | | |
| | | Urban adaptation and resilience | Urban resilience | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 3 | 1 | 3 | 0 | 0 | 1 | 0 |
| 6 | Science and technology Telecommunications | Universal broadband and IT infrastructure | Digital technologies and infrastructure | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 |
| | | Digital inclusion, skills, privacy protection, and universal identity | | | | | | | | | | | | | | | | | | |
| | | Mobilizing digital technologies to achieve all SDGs | | | | | | | | | | | | | | | | | | |

and a table with dimensions of 17x6 is obtained (**Table 3**):

*Table 3 Average SDG contribution to the 6 Transformations*

| | 1. Education, Gender, and Inequality | 2. Health, Wellbeing and Demography | 3. Energy Decarbonisation and Sustainable Industry | 4. Sustainable Food, Land, Water, and Oceans | 5. Sustainable Cities and Communities | 6. Digital Revolution for Sustainable Development |
|---|---|---|---|---|---|---|
| SDG 1-No poverty | 2,00 | 2,00 | 1,33 | 2,00 | 1,50 | 2,00 |
| SDG 2-Zero hunger | 2,00 | 3,00 | 1,33 | 3,00 | 1,50 | 2,00 |
| SDG 3-Good health and well-being | 1,67 | 3,00 | 2,33 | 3,00 | 1,50 | 2,00 |
| SDG 4-Quality education | 1,67 | 2,00 | 1,00 | 1,00 | 1,50 | 2,00 |
| SDG 5-Gender equality | 2,00 | 3,00 | 1,33 | 2,00 | 1,50 | 1,00 |
| SDG 6-Clean water and sanitation | 1,00 | 0,00 | 2,00 | 3,00 | 2,50 | 1,00 |
| SDG 7-Affordable and clean energy | 1,67 | 0,00 | 2,33 | 1,00 | 1,00 | 2,00 |
| SDG 8-Decent work and economic growth | 2,33 | 2,00 | 2,00 | 2,00 | 1,50 | 2,00 |
| SDG 9-Industry, innovation and infrastructure | 2,00 | 1,00 | 2,00 | 1,00 | 2,50 | 3,00 |
| SDG 10-Reduced inequalities | 2,00 | 2,00 | 1,67 | 2,00 | 2,00 | 2,00 |
| SDG 11-Sustainable cities and communities | 1,00 | 1,00 | 2,67 | 2,00 | 3,00 | 2,00 |
| SDG 12-Responsible consumption and production | 1,33 | 1,00 | 2,67 | 3,00 | 2,00 | 2,00 |
| SDG 13-Climate action | 1,67 | 0,00 | 2,67 | 3,00 | 2,50 | 2,00 |
| SDG 14-Life below water | 1,33 | 0,00 | 2,00 | 3,00 | 1,00 | 1,00 |
| SDG 15-Life on land | 1,33 | 0,00 | 2,33 | 3,00 | 1,00 | 1,00 |
| SDG 16-Peace, justice and strong institutions | 1,00 | 1,00 | 1,33 | 1,00 | 0,50 | 1,00 |
| SDG 17-Partnerships for the goals | 1,00 | 0,00 | 0,67 | 1,00 | 0,00 | 2,00 |

**Step 2:** Multiply the Table derived from step 1 by the scores of the correlation between policies and SDGs that were previously estimated (**Table 1**), and a table of dimensions of 22x6 is obtained (**Table 4**). This table essentially shows the extent to which each Policy contributes to each one of the Six Transformations.

*Table 4 Link between Policies and the Six Transformations*

| | 1. Education, Gender, and Inequality | 2. Health, Wellbeing and Demography | 3. Energy Decarbonisation and Sustainable Industry | 4. Sustainable Food, Land, Water, and Oceans | 5. Sustainable Cities and Communities | 6. Digital Revolution for Sustainable Development |
|---|---|---|---|---|---|---|
| **A New Industrial Strategy for Europe** | 42 | 27 | 49 | 50 | 39 | 50 |
| **Circular Economy Action Plan** | 38 | 23 | 49 | 55 | 41 | 43 |
| **EU Biodiversity Strategy for 2030** | 39 | 26 | 47 | 56 | 34 | 42 |
| **Farm to Fork Strategy** | 41 | 31 | 48 | 58 | 37 | 45 |
| **EU Hydrogen Strategy** | 36 | 21 | 44 | 38 | 39 | 45 |
| **7 technology flagship Areas, ASGS for 2021** | 43 | 33 | 53 | 50 | 46 | 51 |
| **Stepping up Europe's 2030 climate Ambition** | 42 | 26 | 56 | 54 | 47 | 50 |
| **Chemicals strategy for Sustainability** | 32 | 19 | 47 | 52 | 36 | 38 |
| **EU Strategy to reduce methane emissions** | 31 | 24 | 36 | 40 | 30 | 37 |
| **A Renovation Wave for Europe** | 30 | 14 | 43 | 39 | 36 | 39 |
| **EU Commission Recommendation on Energy Poverty** | 26 | 18 | 28 | 29 | 26 | 28 |
| **EU Strategy to harness the potential of offshore renewable energy for a climate neutral future** | 32 | 14 | 42 | 37 | 34 | 41 |
| **European Climate Pact** | 34 | 26 | 43 | 50 | 39 | 39 |
| **Smart Mobility Strategy** | 34 | 20 | 46 | 45 | 39 | 43 |
| **The European economic and financial system: fostering openness, strength and resilience** | 26 | 15 | 30 | 28 | 21 | 32 |
| **EU Strategy on Adaptation to Climate Change** | 57 | 40 | 70 | 77 | 61 | 65 |
| **Directing finance towards the European Green Deal** | 19 | 10 | 25 | 29 | 21 | 20 |
| **Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery** | 42 | 27 | 49 | 50 | 39 | 50 |
| **The EU's Blue Economy for a Sustainable Future** | 30 | 18 | 40 | 46 | 35 | 35 |
| **European Climate Law** | 40 | 24 | 51 | 59 | 41 | 46 |
| **Strategy for Financing the Transition to a Sustainable Economy** | 36 | 20 | 44 | 44 | 36 | 42 |
| **Fit for 55** | 43 | 24 | 57 | 55 | 50 | 54 |

**Table 4 Link between Policies and the Six Transformations**

**Step 3:** Using the data from Table 4, a Sankey diagram is produced to provide a visual representation of how each Transformation is overall influenced by the policies adopted in the frame of the European Green Deal. This is illustrated in **Figure 2**.

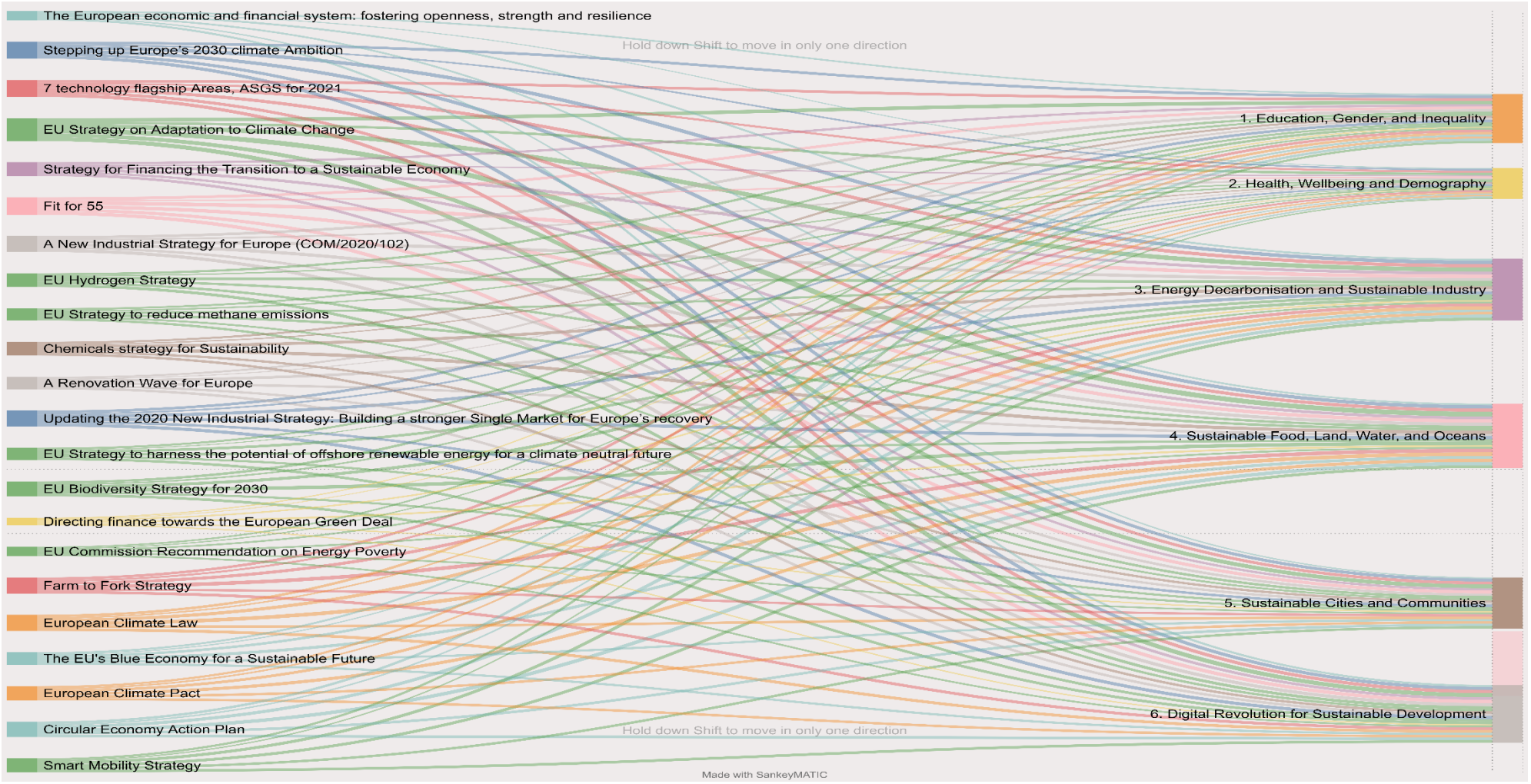



*Figure 2 Sankey diagram for the contribution of the Policies to the 6 Transformations*

### 2.2.2. Results

It is evident from **Figure 2** that the Transformation categories most influenced by the Policies included in our analysis are 4 and 3, namely the one for Sustainable Food, Land and Oceans and the one for Energy Decarbonization and Industry. This is not surprising, given that the overarching aim of the European Green Deal is to make the EU climate-neutral and that these two Transformations are the most strongly associated with the climate neutrality objective. The first one entails all actions required to transition to a model of Circular Economy and Biodiversity conservation. The second one calls for measures to decouple production from fossil fuels and the transition to renewable energy to reduce greenhouse gas emissions.

**Transformation 4. Sustainable Food, Land, Water, and Oceans**

According to the **Sustainable Development Report 2021** (**Sachs et al., 2021**), Europe as a whole faces significant challenges in achieving SDG 2 (**Figure 3**), as it faces malnutrition and obesity issues as indicated by the individual indicators – and indeed the trend of evolution of these indicators is expected to get worse (**Figure 4**).


*Figure 3* ***SDG Dashboard and Trends for Europe. Source: Sustainable Development Report***

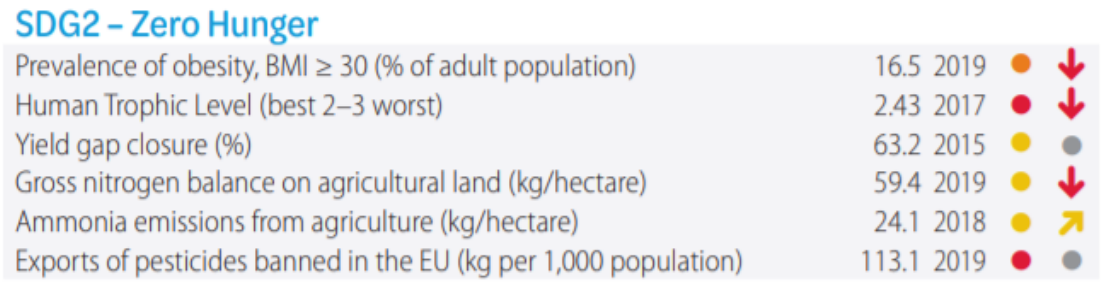



*Figure 4* ***Performance by Indicator for the European Union. Source: Sustainable Development Report***

In addition, climate change and the limitation of biodiversity are jeopardizing the efficiency of the food supply chain. Therefore, an integrated approach is required to ensure the sustainability and health of food systems, land usage, and the oceans, something that has been recognized by the European Commission, as reflected in the direction of its policies and strategies.

This policy priority is primarily relevant for ministries responsible for agriculture and forestry, environment, water and natural resources, fisheries and marine resources, and health. This calls for national governments to strengthen the mechanisms for cooperation between these ministries to formulate a coherent strategy to maximize environmental benefits.

**Transformation 3. Energy Decarbonization and Sustainable Industry**

Securing access to contemporary and clean energy sources for everyone is one of the overarching objectives of the European Green Deal, and one of the goals of this Transformation is the decarbonization of the energy system. Apart from aligning its strategy with the climate stabilization goal of the Paris Agreement, the European Green Deal aims to minimize the pollution of soil, water, and air from industrial activities. As shown in Section 1, EU Policies and Strategies encompass the entire spectrum of the energy system – ensuring a low-carbon supply of electricity and mitigating the growth in energy demand in industry, buildings, and all transport modes.

A study jointly conducted by Enel Foundation and SDSN and published in November 2021[6] analyzed the EU energy and climate policy and put forward policy recommendations for implementing the European Green Deal in full convergence with the SDGs. Following the Six Transformation pattern, the paper focused on the inter-relationships between the European Green Deal and the SDG to uncover and exploit existing synergies while reducing trade-offs within a comprehensive framework. The study also highlighted the unique opportunities offered by the Recovery and Resilience Facility to overcome the socio-economic challenges caused by the COVID-19 pandemic. In this respect, a case study of the Italian National Recovery and Resilience Plan illustrated how the European recovery could successfully operationalize climate action along with the Six Transformation framework. Furthermore, if properly implemented, the “Green Revolution and Ecological Transition” mission in the Plan will have positive spill-over effects in several policy fields, such as a net increase in jobs in the energy sector.

[6] Sachs, Papa, Armiento, Lelli, Sartori, Crete and Van Hoof, “Implementing the European Green Deal through Transformational Change: a review of EU climate action through the lens of the Six Transformations”, November 2021, available at: https://www.enelfoundation.org/content/dam/enel-foundation/news/2021/11/sdsn/211019-EGD-report.pdf

## 2.3. A Machine Learning Method for Policies classification under the SDGs

Within the scope of the report, Machine Learning was used for three main reasons: a) to validate the linkages found by the classical approach, b) to create a tool that will serve as a fast classifier for present and future work and c) to discover any new possible connections between the SDGs and the policy documents scanned that were not identified during the classical approach in the first place.

For our study, we have developed and deployed two different models. The first one is a simple Information Retrieval Model using Bag-of-Words, while the second is a more developed and complicated one using Deep Learning Techniques (BERT).

### 2.3.1 Information Retrieval

Information Retrieval (IR), as the term reveals, is the field involved with the search and retrieval of information. It is concerned with all the activities related to the organization, processing and access of knowledge of all forms and formats **(Chowdhury, 2010)**. The purpose of IR is the rapid retrieval of documents, texts and information in general, based on a user's query. An example of IR, and a relatively advanced one, is the Google Search Engine.

Bag-of-Words (BoW), a term first used linguistically by Zellig **(Zellig, 1954)**, is among the prevalent techniques used for textual Information Retrieval **(Passalis & Tefas, 2018)**. It is a simplifying representation of a document, in which words of a text are presented as a multiset (Bag), disregarding grammar and syntax while keeping simplicity.

The study used the BoW technique to quickly find similarities between energy policy documents and the 17 Sustainable Development Goals (SDGs). Specifically, 17 different vocabularies were built, each consisting of words and phrases describing the essence of each SDG.

Policy documents in a .html form were used as an input and were preprocessed by lowercasing the documents, removing numbers, punctuation, stop words, contractions and whitespaces. Finally, the vocabularies and the pre-processed policy documents were transformed into vectors using CountVectorizer provided by the sci-kit-learn toolkit.

The similarity between each policy token and each vocabulary token was calculated using the cosine similarity to ignore the magnitude of the vectors compared.

#### *Results*

Table 5 shows the correlation between each scanned Policy Document with each SDG after processing the algorithm's outputs. Again, higher scores show higher similarity. The processing of the results can be found in **Annex II**.

*Table 5 Correlation between Policy Documents and the SDGs using Information Retrieval*

| Policy Short Name | SDG1 | SDG2 | SDG3 | SDG4 | SDG5 | SDG6 | SDG7 | SDG8 | SDG9 | SDG 10 | SDG 11 | SDG 12 | SDG 13 | SDG 14 | SDG 15 | SDG 16 | SDG 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A New Industrial Strategy for Europe (COM/2020/102) | 2 | 1 | 1 | 2 | 0 | 1 | 3 | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 3 |
| Circular Economy Action Plan | 2 | 1 | 1 | 2 | 1 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 |
| EU Biodiversity Strategy for 2030 | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Farm to Fork Strategy | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 |
| EU Hydrogen Strategy | 2 | 2 | 1 | 1 | 0 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 3 |
| 7 technology flagship Areas, ASGS for 2021 | 3 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 3 |
| Stepping up Europe's 2030 climate Ambition | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| Chemicals strategy for Sustainability | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 3 |
| EU Strategy to reduce methane emissions | 2 | 2 | 2 | 1 | 0 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 1 | 2 | 2 | 2 |
| A Renovation Wave for Europe | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| EU Commission Recommendation on Energy Poverty | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| EU Strategy to harness the potential of offshore renewable energy for a climate neutral future | 3 | 2 | 1 | 2 | 1 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 1 | 1 | 3 |
| European Climate Pact | 3 | 1 | 1 | 2 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 2 |
| Smart Mobility Strategy | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 |
| The European economic and financial system: fostering openness, strength and resilience | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 3 |
| EU Strategy on Adaptation to Climate Change | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |

| Policy Short Name | SDG1 | SDG2 | SDG3 | SDG4 | SDG5 | SDG6 | SDG7 | SDG8 | SDG9 | SDG 10 | SDG 11 | SDG 12 | SDG 13 | SDG 14 | SDG 15 | SDG 16 | SDG 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Directing finance towards the European Green Deal | 2 | 1 | 1 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 2 |
| Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 3 |
| The EU's Blue Economy for a Sustainable Future | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| European Climate Law | 3 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| Strategy for Financing the Transition to a Sustainable Economy | 3 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 3 |
| Fit for 55 | 2 | 2 | 1 | 1 | 0 | 1 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 2 |

As it can be seen from **Table 5**, most scanned policy documents seem to be closely related to SDG1 “No Poverty”, SDG7 “Affordable and Clean Energy”, SDG8 “Decent Work and Economic Growth”, SDG9 “Industry, Innovation and Infrastructure”, SDG12 “Responsible Consumption and Production” and SDG17 “Partnership for the Goals”. At the same time, they are least related to SDG5 “Gender Equality”, SDG3 “Good Health and Well-being”, and SDG4 “Quality Education”.

By comparing the above results to the ones produced from the classical approach, it can be deduced that the algorithm worked well by adequately calculating the correlation to the scanned policy documents. Furthermore, it successfully found a high correlation to the SDGs7, SDG8 and SDG9, as also depicted in the classical approach. However, differences between the latter can be seen in SDG 1 “No Poverty”, SDG 6 “Clean Water and Sanitation”, SDG 16 “Peace, Justice and Strong Institutions”, and SDG 17 “Partnership for the Goals”, in which the interconnection between the scanned documents and the SDGs was calculated higher than expected.

The differences between the results of the two approaches occur due to the following:

- Vocabularies used to describe each SDG contain similar keywords
- Some SDGs show semantic similarity (i.e. SDG 1 “No Poverty” to SDG 2 “Zero Hunger”)
- Text preprocessing needs improvements
- Connections between specific policies to the SDGs may exist that are not easily identified by manually reading and grading their relevance

To validate the produced results, the “KnowSDGs” platform, developed by the JRC, was used. The “Know SDGs” platform offers a set of SDG Mapping Tools of the EU Policies to contribute to the implementation of the Agenda 2030 in the European Union and provide a better understanding of how high-level policy documents relate to each SDG. The tool was first used in 2017, based on the actions of the Juncker Commission and their contribution to the Agenda 2030. SDG attribution is performed automatically after different basic text mining steps, like special characters removal, stop words removal, and lowercasing.

The tool provides a deep understanding of the interconnection between the EU policies and the SDGs, as it further connects each document with each SDG target. The Targets’ scores were first summed up to produce a total score for each SDG (results are available in **Annex II**) and then transformed to create the scores presented in **Table 6**.

*Table 6 Transformed scores of the "KnowSDGs" platform*

| KnowSDGs | SDG1 | SDG2 | SDG3 | SDG4 | SDG5 | SDG6 | SDG7 | SDG8 | SDG9 | SDG10 | SDG11 | SDG12 | SDG13 | SDG14 | SDG15 | SDG16 | SDG17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A New Industrial Strategy for Europe (COM/2020/102) | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 3 | 3 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 3 |
| Circular Economy Action Plan | 0 | 1 | 2 | 2 | 0 | 2 | 1 | 3 | 2 | 2 | 1 | 3 | 1 | 2 | 2 | 0 | 1 |
| EU Biodiversity Strategy for 2030 | 0 | 2 | 2 | 3 | 0 | 3 | 1 | 2 | 2 | 0 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| Farm to Fork Strategy | 1 | 2 | 3 | 2 | 0 | 3 | 0 | 3 | 2 | 1 | 0 | 3 | 1 | 3 | 3 | 3 | 3 |
| EU Hydrogen Strategy | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 0 | 1 | 0 | 3 |
| 7 technology flagship Areas, ASGS for 2021 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stepping up Europe's 2030 climate Ambition | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 0 |
| Chemicals strategy for Sustainability | 0 | 1 | 3 | 2 | 0 | 1 | 1 | 1 | 3 | 0 | 0 | 3 | 0 | 1 | 0 | 1 | 2 |
| EU Strategy to reduce methane emissions | 0 | 3 | 1 | 0 | 0 | 3 | 1 | 1 | 2 | 0 | 2 | 2 | 3 | 0 | 1 | 0 | 1 |
| A Renovation Wave for Europe | 3 | 1 | 0 | 3 | 0 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 0 | 0 |
| EU Commission Recommendation on Energy Poverty | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| EU Strategy to harness the potential of offshore renewable energy for a climate neutral future | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 3 | 3 | 0 | 1 | 2 | 2 | 3 | 0 | 0 | 3 |
| European Climate Pact | 3 | 1 | 2 | 3 | 0 | 0 | 1 | 1 | 2 | 0 | 3 | 1 | 3 | 0 | 2 | 1 | 0 |
| Smart Mobility Strategy | 2 | 0 | 1 | 2 | 0 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 0 | 1 | 3 | 0 |
| The European economic and financial system: fostering openness, strength and resilience | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 | 3 |
| EU Strategy on Adaptation to Climate Change | 3 | 3 | 3 | 2 | 0 | 3 | 1 | 2 | 2 | 2 | 3 | 1 | 3 | 3 | 3 | 2 | 3 |
| Directing finance towards the European Green Deal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 2 | 2 | 1 | 0 | 0 |

| KnowSDGs | SDG1 | SDG2 | SDG3 | SDG4 | SDG5 | SDG6 | SDG7 | SDG8 | SDG9 | SDG10 | SDG11 | SDG12 | SDG13 | SDG14 | SDG15 | SDG16 | SDG17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery | 1 | 0 | 2 | 3 | 0 | 0 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 0 | 1 | 1 | 3 |
| The EU's Blue Economy for a Sustainable Future | 1 | 1 | 0 | 3 | 0 | 1 | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 3 | 3 | 3 | 1 |
| European Climate Law | 3 | 1 | 2 | 0 | 0 | 1 | 2 | 3 | 1 | 1 | 1 | 1 | 3 | 0 | 3 | 1 | 0 |
| Strategy for Financing the Transition to a Sustainable Economy | 0 | 0 | 0 | 2 | 0 | 1 | 1 | 3 | 2 | 0 | 0 | 0 | 3 | 1 | 2 | 3 | 3 |
| Fit for 55 | 0 | 1 | 0 | 3 | 0 | 0 | 3 | 3 | 2 | 1 | 1 | 1 | 3 | 1 | 2 | 0 | 1 |

Generally, it is seen that the heatmap balanced between the classical and the IR method results and that it validates that there might be a higher connection between the scanned policy documents and several SDGs that are not depicted using the classical approach, such as SDG1, SDG4 and SDG16. However, what might seem odd is that according to the produced table, there is no relevance between SDG5 and the examined policies, which disagrees with the results of the other two methods that linked some policies to “Gender Equality”.

Deep learning techniques were utilized to achieve higher performance to overcome the lack of semantic capabilities in the IR method.

### 2.3.2 Deep Learning

Deep learning refers to extensive neural networks with many layers (deep) that “allow computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction” **(LeCun et al., 2015)**. Simply put, machines learn from experience by representations that are expressed in terms of other, more straightforward representations **(Goodfellow et al., 2016)**. In 2017, Google Research introduced The Transformer, a deep learning model based on attention mechanisms, dispensing with recurrence and convolutions entirely **(Vaswani et al., 2017)**. This innovation led to the development of a wide range of models based on transformers, allowing the processing of entire sequences without the need for labelled data in pre-training.

As a result, and taking particularly into account the ambiguity of the Natural Language (Lexically, Syntactically, Semantically, Anaphorically, Pragmatically), we have fine-tuned a pre-trained transformer-based model to find the similarity score of each policy document with each SDG.

BERT, which stands for “Bidirectional Encoder Representations from Transformers”, was firstly introduced by Google Research in 2018 **(Devlin et al., 2018)** and revolutionized the modelling approach. Standard Language Models are unidirectional, limiting the architectures that can be used for pre-training, while BERT is a bidirectional transformer pre-trained by using masked language modelling objective and next sentence prediction.

#### *Results*

Similarity scores calculated by the model are presented in **Table 7**. The higher the score (percentage), the bigger the probability of a scanned policy being linked to a certain SDG. To get better insight, one should view the presented results with a qualitative and not a quantitative perspective.

*Table 7 Similarity scores calculated by the Deep Learning model*

| Policy Document | SDG1 | SDG2 | SDG3 | SDG4 | SDG5 | SDG6 | SDG7 | SDG8 | SDG9 | SDG 10 | SDG 11 | SDG 12 | SDG 13 | SDG 14 | SDG 15 | SDG 16 | SDG 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A New Industrial Strategy for Europe | 0.00% | 0.04% | 0.02% | 0.04% | 0.03% | 0.02% | 0.11% | 0.21% | 99.11% | 0.02% | 0.03% | 0.19% | 0.04% | 0.03% | 0.03% | 0.02% | 0.05% |
| Circular Economy Action Plan | 0.06% | 0.36% | 0.09% | 0.05% | 0.05% | 0.09% | 0.66% | 0.61% | 1.93% | 0.08% | 0.28% | 95.13% | 0.13% | 0.12% | 0.09% | 0.05% | 0.24% |
| EU Biodiversity Strategy for 2030 | 0.02% | 0.03% | 0.09% | 0.02% | 0.04% | 0.01% | 0.01% | 0.02% | 0.03% | 0.03% | 0.02% | 0.06% | 0.03% | 0.05% | 99.48 % | 0.04% | 0.05% |
| Farm to Fork Strategy | 0.14% | 90.39 % | 0.34% | 0.17% | 0.04% | 0.10% | 1.16% | 0.21% | 0.52% | 0.07% | 1.21% | 4.01% | 0.51% | 0.29% | 0.08% | 0.34% | 0.44% |
| EU Hydrogen Strategy | 0.05% | 0.09% | 0.09% | 0.03% | 0.02% | 0.11% | 92.81% | 0.07% | 0.14% | 0.05% | 0.12% | 1.19% | 2.36% | 0.11% | 0.04% | 0.62% | 2.08% |
| 7 technology flagship Areas, ASGS for 2021 | 0.05% | 0.47% | 1.58% | 0.14% | 0.08% | 0.34% | 1.64% | 0.19% | 92.25% | 0.17% | 0.21% | 0.16% | 0.94% | 0.23% | 0.10% | 0.26% | 1.17% |
| Stepping up Europe's 2030 climate Ambition | 0.12% | 0.37% | 0.16% | 0.15% | 0.12% | 0.41% | 1.10% | 0.08% | 0.76% | 0.28% | 0.31% | 0.20% | 53.88% | 0.40% | 0.29% | 14.92% | 26.45% |
| Chemicals strategy for Sustainability | 0.04% | 0.15% | 1.81% | 0.08% | 0.12% | 1.60% | 0.97% | 0.06% | 0.21% | 0.08% | 0.27% | 92.41% | 0.25% | 0.81% | 0.31% | 0.43% | 0.39% |
| EU Strategy to reduce methane emissions | 0.13% | 0.07% | 0.16% | 0.03% | 0.05% | 0.41% | 84.73% | 0.13% | 0.08% | 0.13% | 0.38% | 4.44% | 4.25% | 0.12% | 0.09% | 1.39% | 3.39% |
| A Renovation Wave for Europe | 0.01% | 0.01% | 0.02% | 0.03% | 0.02% | 0.04% | 0.08% | 0.03% | 0.07% | 0.03% | 98.96% | 0.26% | 0.24% | 0.03% | 0.03% | 0.09% | 0.03% |
| EU Commission Recommendation on Energy Poverty | 0.03% | 0.03% | 0.03% | 0.02% | 0.01% | 0.15% | 98.30% | 0.05% | 0.03% | 0.02% | 0.07% | 0.41% | 0.22% | 0.06% | 0.01% | 0.20% | 0.35% |
| EU Strategy to harness the potential of offshore renewable energy for a climate neutral future | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.02% | 99.20% | 0.05% | 0.03% | 0.01% | 0.04% | 0.26% | 0.13% | 0.03% | 0.01% | 0.06% | 0.11% |

| Policy Document | SDG1 | SDG2 | SDG3 | SDG4 | SDG5 | SDG6 | SDG7 | SDG8 | SDG9 | SDG 10 | SDG 11 | SDG 12 | SDG 13 | SDG 14 | SDG 15 | SDG 16 | SDG 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| European Climate Pact | 0.18% | 0.64% | 0.29% | 0.11% | 0.10% | 0.50% | 1.43% | 0.09% | 0.45% | 0.27% | 0.35% | 0.59% | 22.11% | 0.49% | 0.43% | 19.65% | 52.31% |
| Smart Mobility Strategy | 0.01% | 0.01% | 0.03% | 0.02% | 0.01% | 0.02% | 0.04% | 0.01% | 0.07% | 0.01% | 99.64% | 0.04% | 0.02% | 0.02% | 0.01% | 0.03% | 0.01% |
| The European economic and financial system: fostering openness, strength and resilience | 0.10% | 0.23% | 0.14% | 0.44% | 0.16% | 0.28% | 0.16% | 0.65% | 1.78% | 0.89% | 0.28% | 0.11% | 0.67% | 0.73% | 0.27% | 50.34% | 42.77% |
| EU Strategy on Adaptation to Climate Change | 0.08% | 0.26% | 0.12% | 0.14% | 0.11% | 0.27% | 0.83% | 0.07% | 0.52% | 0.20% | 0.24% | 0.14% | 74.80% | 0.28% | 0.20% | 9.26% | 12.46% |
| Directing finance towards the European Green Deal | 0.15% | 1.13% | 0.25% | 0.04% | 0.10% | 1.22% | 3.28% | 0.22% | 0.19% | 0.07% | 0.53% | 82.28% | 1.36% | 0.43% | 0.30% | 2.44% | 6.04% |
| Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe’s recovery | 0.03% | 0.10% | 0.09% | 0.13% | 0.12% | 0.11% | 1.16% | 3.69% | 87.95% | 0.11% | 0.12% | 5.61% | 0.16% | 0.12% | 0.12% | 0.10% | 0.28% |
| The EU's Blue Economy for a Sustainable Future | 0.42% | 0.37% | 0.10% | 0.11% | 0.11% | 0.33% | 3.05% | 58.78 % | 1.86% | 0.57% | 0.59% | 28.51% | 0.37% | 0.39% | 0.09% | 0.92% | 3.41% |
| European Climate Law | 0.16% | 0.56% | 0.25% | 0.23% | 0.18% | 0.41% | 0.93% | 0.09% | 0.56% | 0.26% | 0.39% | 0.17% | 47.00% | 0.46% | 0.32% | 21.71% | 26.31% |
| Strategy for Financing the Transition to a Sustainable Economy | 0.18% | 0.52% | 0.18% | 0.16% | 0.09% | 0.34% | 1.19% | 0.11% | 0.53% | 0.30% | 0.27% | 0.26% | 27.55% | 0.52% | 0.24% | 17.87% | 49.71% |
| Fit for 55 | 0.13% | 0.35% | 0.18% | 0.20% | 0.14% | 0.45% | 0.93% | 0.09% | 0.59% | 0.34% | 0.37% | 0.21% | 40.63% | 0.45% | 0.32% | 22.47% | 32.16% |

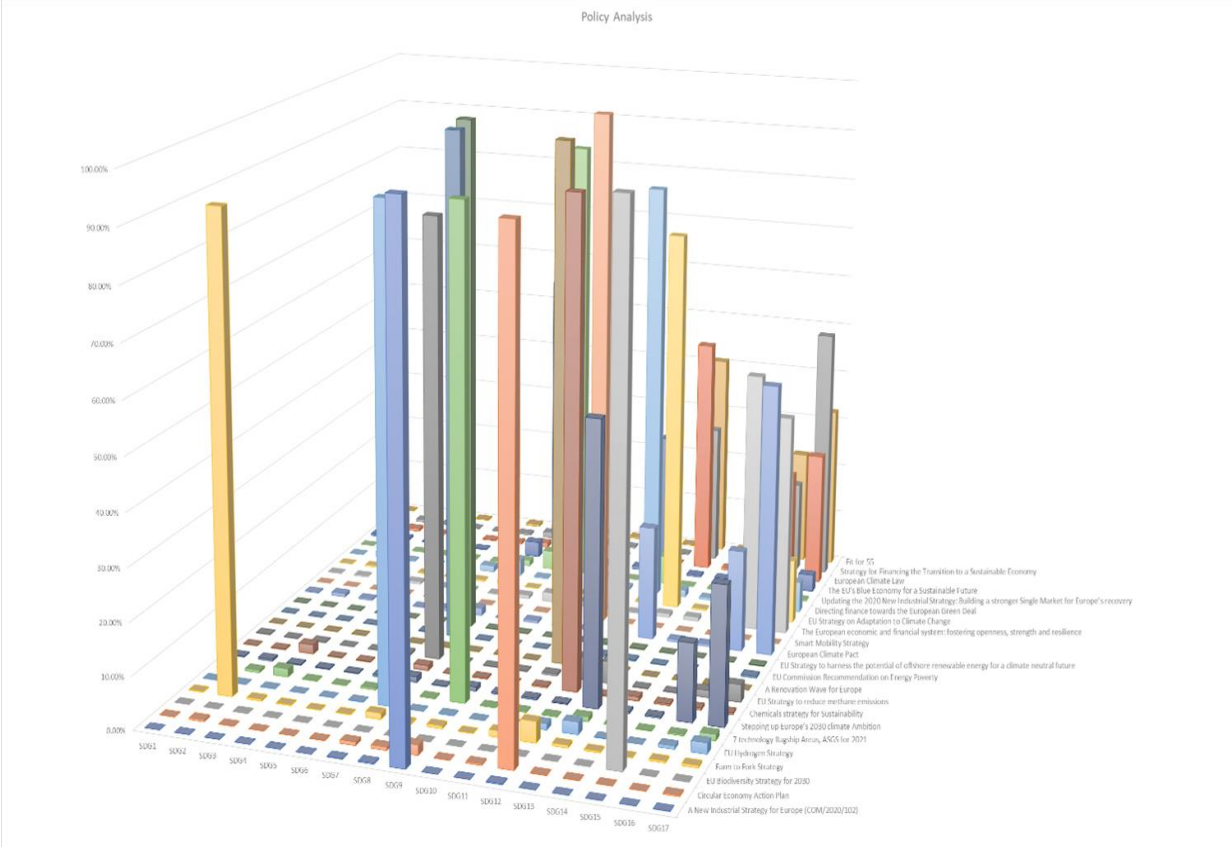



*Figure 5 Graphical representation of the similarity scores calculated by the Deep Learning model*

As it can be seen, the deep learning model utilized provides improved results as it can better assess the relevance between the scanned policy documents and the SDGs (**Figure 5**). This can be seen after examining SDG 1 and SDG 2, which have high semantic relativity, while the number of text excerpts used is close. For instance, the "Farm to Fork Strategy" is closely connected to SDG2 "Zero Hunger", as expected, rather than SDG 1 "No poverty", which is not the case in the IR method.

Overall, most policies show a high correlation to SDG 7 "Affordable and Clean Energy", SDG 9 "Industry, Innovation and Infrastructure", SDG 12 "Responsible Consumption and Production", SDG 13 "Climate Action", and SDG 17 "Partnership for the Goals". In contrast, low correlation is observed in SDG 1 "No Poverty", SDG 4 "Quality Education", and SDG 5" Gender Equality", which agrees with the results of the classical approach and the JRC tool.

To further understand the correlation between the policies and the SDGs and draw meaningful conclusions, all scores should be examined. To do so, the highest score of each policy document was excluded, and the scores (probabilities) were adjusted accordingly, as presented in **Table 8**.

*Table 8 Adjusted similarity scores (probabilities)*

| Policy Document | SDG1 | SDG2 | SDG3 | SDG4 | SDG5 | SDG6 | SDG7 | SDG8 | SDG9 | SDG10 | SDG11 | SDG12 | SDG13 | SDG14 | SDG15 | SDG16 | SDG17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A New Industrial Strategy for Europe | 0.54% | 4.04% | 2.31% | 4.86% | 3.61% | 2.50% | 12.25% | 23.41% | | 2.13% | 3.89% | 21.38% | 4.21% | 3.15% | 3.83% | 2.08% | 5.80% |
| Circular Economy Action Plan | 1.28% | 7.45% | 1.82% | 0.95% | 0.95% | 1.76% | 13.47% | 12.54% | 39.57% | 1.62% | 5.81% | | 2.73% | 2.45% | 1.78% | 0.93% | 4.89% |
| EU Biodiversity Strategy for 2030 | 3.02% | 5.11% | 16.44% | 4.43% | 7.14% | 2.28% | 1.80% | 4.38% | 5.69% | 4.87% | 2.99% | 10.85% | 5.22% | 9.12% | | 7.71% | 8.95% |
| Farm to Fork Strategy | 1.45% | | 3.51% | 1.82% | 0.40% | 1.04% | 12.03% | 2.18% | 5.40% | 0.70% | 12.60% | 41.74% | 5.27% | 3.02% | 0.82% | 3.49% | 4.54% |
| EU Hydrogen Strategy | 0.76% | 1.27% | 1.19% | 0.39% | 0.34% | 1.58% | | 0.97% | 2.02% | 0.66% | 1.71% | 16.52% | 32.81% | 1.58% | 0.59% | 8.65% | 28.97% |
| 7 technology flagship Areas, ASGS for 2021 | 0.70% | 6.04% | 20.37% | 1.85% | 0.97% | 4.44% | 21.13% | 2.50% | | 2.19% | 2.74% | 2.09% | 12.15% | 3.02% | 1.29% | 3.38% | 15.15% |
| Stepping up Europe's 2030 climate Ambition | 0.27% | 0.80% | 0.34% | 0.33% | 0.26% | 0.88% | 2.37% | 0.17% | 1.65% | 0.60% | 0.68% | 0.44% | | 0.87% | 0.62% | 32.36% | 57.36% |
| Chemicals strategy for Sustainability | 0.58% | 2.04% | 23.87% | 1.08% | 1.60% | 21.09% | 12.72% | 0.79% | 2.75% | 1.08% | 3.60% | | 3.24% | 10.65% | 4.13% | 5.65% | 5.13% |
| EU Strategy to reduce methane emissions | 0.87% | 0.48% | 1.07% | 0.19% | 0.34% | 2.72% | | 0.85% | 0.53% | 0.86% | 2.52% | 29.09% | 27.81% | 0.81% | 0.58% | 9.08% | 22.20% |
| A Renovation Wave for Europe | 1.11% | 1.04% | 2.24% | 2.95% | 2.03% | 4.31% | 7.97% | 3.24% | 6.55% | 2.52% | | 25.18% | 22.84% | 2.95% | 3.32% | 8.46% | 3.29% |
| EU Commission Recommendation on Energy Poverty | 1.55% | 2.01% | 1.66% | 0.90% | 0.75% | 8.99% | | 3.00% | 2.05% | 1.02% | 4.15% | 24.03% | 13.17% | 3.38% | 0.81% | 11.79% | 20.74% |
| EU Strategy to harness the potential of offshore | 1.33% | 0.92% | 1.64% | 1.16% | 1.06% | 2.95% | | 6.15% | 3.98% | 1.63% | 4.39% | 32.83% | 16.39% | 4.17% | 0.91% | 7.12% | 13.35% |

| Policy Document | SDG1 | SDG2 | SDG3 | SDG4 | SDG5 | SDG6 | SDG7 | SDG8 | SDG9 | SDG10 | SDG11 | SDG12 | SDG13 | SDG14 | SDG15 | SDG16 | SDG17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| renewable energy for a climate neutral future | | | | | | | | | | | | | | | | | |
| European Climate Pact | 0.38% | 1.34% | 0.61% | 0.24% | 0.20% | 1.06% | 3.00% | 0.19% | 0.94% | 0.57% | 0.73% | 1.25% | 46.36% | 1.02% | 0.90% | 41.21% | |
| Smart Mobility Strategy | 1.56% | 1.67% | 8.49% | 5.26% | 3.96% | 6.58% | 10.11% | 2.96% | 20.42% | 3.22% | | 10.09% | 6.09% | 5.42% | 3.52% | 8.37% | 2.28% |
| The European economic and financial system: fostering openness, strength and resilience | 0.21% | 0.46% | 0.28% | 0.89% | 0.32% | 0.57% | 0.31% | 1.31% | 3.58% | 1.79% | 0.55% | 0.23% | 1.35% | 1.47% | 0.55% | | 86.12% |
| EU Strategy on Adaptation to Climate Change | 0.32% | 1.04% | 0.49% | 0.55% | 0.45% | 1.08% | 3.31% | 0.29% | 2.07% | 0.80% | 0.94% | 0.56% | | 1.10% | 0.81% | 36.75% | 49.43% |
| Directing finance towards the European Green Deal | 0.84% | 6.36% | 1.39% | 0.22% | 0.54% | 6.87% | 18.49% | 1.22% | 1.06% | 0.42% | 2.98% | | 7.69% | 2.41% | 1.69% | 13.75% | 34.07% |
| Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery | 0.25% | 0.82% | 0.74% | 1.10% | 0.97% | 0.87% | 9.62% | 30.67% | | 0.95% | 1.03% | 46.54% | 1.30% | 0.99% | 0.99% | 0.86% | 2.30% |
| The EU's Blue Economy for a Sustainable Future | 1.02% | 0.90% | 0.24% | 0.26% | 0.27% | 0.80% | 7.41% | | 4.52% | 1.39% | 1.43% | 69.17% | 0.89% | 0.96% | 0.23% | 2.24% | 8.27% |
| European Climate Law | 0.30% | 1.05% | 0.47% | 0.44% | 0.35% | 0.77% | 1.76% | 0.18% | 1.05% | 0.49% | 0.73% | 0.33% | | 0.88% | 0.60% | 40.97% | 49.64% |
| Strategy for Financing the Transition to a Sustainable Economy | 0.35% | 1.03% | 0.35% | 0.32% | 0.19% | 0.67% | 2.36% | 0.23% | 1.06% | 0.59% | 0.53% | 0.51% | 54.77% | 1.04% | 0.48% | 35.52% | |
| Fit for 55 | 0.22% | 0.58% | 0.31% | 0.33% | 0.24% | 0.76% | 1.56% | 0.14% | 1.00% | 0.57% | 0.63% | 0.35% | | 0.75% | 0.54% | 37.84% | 54.17% |

After the above readjustment, SDG 17 “Partnership for the Goals”, SDG 12 “Responsible Consumption and Production”, and SDG 16 ”Peace, Justice and Strong Institutions” have the highest relevance scores in the majority of the documents. Then, SDG 13 “Climate Action”, SDG 7 “Affordable and Clean Energy”, and SDG 9 “Industry, Innovation and Infrastructure” follow.

An interesting conclusion can be drawn regarding the energy policies that are related more to industry (“A New Industrial Strategy”, “Updating the 2020 Industrial Strategy”), which appear to be more connected to SDG 8 and SDG 12 rather than SDG 7. Furthermore, “EU’s Blue Economy for Sustainable Future” seems more relevant to SDG 8, SDG 12, SDG 17 and SDG 7 rather than SDG 14 and SDG 15, which entirely agrees with the JRC results presented previously.

Finally, all policy documents seem to be closely related to SDG 16 and SDG 17, even though text excerpts used during the training were very few compared to the rest of the SDGs.

### 2.3.3 Discussion of the results

Two models were developed and used to assess the connection between EU policy documents and the SDGs: An Information Retrieval (IR) model and a Deep Learning one. The first one provides a quick way for classifying documents regarding their SDGs relevance. Some deviations between the classical approach are observed, but it is sensible since the scoring is based upon the frequency of terms appearing in each policy document rather than their actual use. This answers why no policy was classified with a zero-similarity score in **Table 5**. A robust connection between the policies scanned and SDG 1 is observed in the same table. This may occur because words used to formulate the vocabulary describing SDG 1 are prevalent in the examined policy documents or because additional text preprocessing is needed to improve the scoring. In Conclusion, this method captures high relativity between the scanned documents and the SDGs, but not so well with the SDGs, which are not very relative to the scanned policies. As a result, the IR model could classify a document fast to get the first glimpse of relativity regarding the SDGs in conjunction with the classical approach to further grade the connection between SDGs and the policy documents.

The developed Deep Learning model, on the other hand, works better, as it utilizes deep learning techniques to calculate the similarity between SDGs and the policy documents. The results, overall, seem to agree with the classical method and the JRC results, but they provide a better insight into scoring the relativity. This ranking can be helpful for a quick but adequate evaluation of policy documents, thus providing a valuable tool for understanding the interlinkages between high policy documents and the SDGs.

Several exciting insights arise using the two models, such as the connection of some energy policies to SDG 6, “Clean Water and Sanitation”, which was not found in the classical method. One of the advantages of utilizing Machine Learning is the fact that insights and correlations, which the reader/grader does not easily observe, can be quickly found.

Finally, one must highlight the fact that policies are somewhat connected to SDGs 16 and 17, which were the two goals that had the fewest labelled text excerpts used for training, showing that without “Peace. Justice and strong institutions” and without building “Partnerships for the Goals” little can be achieved.

# 3. Sustainable Finance

## 3.1. Impact of Climate Policy on Financial Performance

### 3.1.1. Context

In the past few years, many events contributed to fostering a decisive action to reduce greenhouse gas (GHG) emissions: the Paris Agreement, the publication of Sustainable Development Goals, the Special Report of the Intergovernmental Panel on Climate Change (IPCC), the launch of European Commission's (EC) Action Plan on Financing Sustainable Finance, and, more recently the European Green Deal and the EU Taxonomy. The vision that led nations to participate in the first place relates to the transition to a low-carbon and climate-resilient economy. The EU has agreed on a set of targets for 2030 regarding GHG emission reductions. Among the means to fulfil such an end, there are renewable energy and technologies for energy efficiency. To accelerate the transition, European institutions have approved rules on GHG emissions from land use as well as emissions targets for the automotive sector (for example, Commission Regulation (EU) 2019/318 of 19 February 2019 as regards the determination of the CO2 emissions and fuel consumption of heavy-duty vehicles). One of the most relevant policy actions that the EC has adopted is the launch of the European Green Deal in December 2019. This document tackles different issues, such as reaching climate neutrality by 2050 while abiding by just and inclusive transition principles. However, the main reason for the EU's commitment and actions is to engage the private sector and activate a leverage effect through private investments. To meet the EU's energy and climate 2030 targets, an estimated amount of €350 billion per year is needed **(Schutze et al., 2020)**. Nevertheless, further funds are necessary to achieve climate neutrality by 2050. Business opportunities are significant, and the private sector involvement, in terms of commitment and capital investment, appears crucial **(Monasterolo, 2020).**

However, without evidence of financial performance improvements, the achievement of low-carbon targets could be perceived as costly and economically inefficient.

The failure to achieve GHG emission targets unfolds negative uncertainties. Climate-related risks could severely impact business activities as well as financial institutions. Weather-related disasters caused a record of €283 billion in economic damages in 2017 and could affect up to two-thirds of the European population by 2100 compared with 5% today **(European Commission, 2019)**. Physical damages are just one of the climate-related risks that can affect businesses. The Task Force on Climate-related Financial Disclosure (TCFD) identified the second kind of risk: transition risk. This type of risk is associated with the costs that can arise when moving towards a less polluting, greener economy (i.e., changes in the regulation, demand shifts, etc.), and, together with physical risks, imply a risk for companies to see their assets strand. To provide some figures, CDP (ex-Carbon Disclosure Project) estimated that in the world's 500 largest companies, the amount reported which are linked to stranded assets totals US$252 billion (CDP). In order to manage this risk, companies need to identify and implement a sound resilience business strategy made of mitigation and adaptation actions.

Moreover, as stated earlier, corporates expect an improvement in their financial performance following the investments in sustainability. For this reason, scholars have begun to study the relationship between corporate environmental performance (CEP) and corporate financial performance (CFP), and several studies have linked the positive relation between CEP and CFP **(Fisher-Vanden et al., 2011; Berg et al., 2019; Busch et al., 2011; Qi et al., 2014; Trumpp et**

**al., 2017; Wang et al., 2014; Iwata et al., 2011; Fujii et al., 2013; Delmas et al., 2015).** This finding reversed the established conception according to which corporate responsibility is limited to financial performance **(Friedman, 1970).** However, literature has used different indicators to identify the CEP. ESG ratings, in this sense, were considered a useful variable, as they offered information related to companies' environmental, social and governance indicators. Indexes composing ESG ratings capture the decision-making choices of the CEOs implicitly, as they are used as guidance and benchmarking **(Berg et al., 2019).** Previous literature **(Kim et al., 2013)** notes that disclosure-based measures are better predictors of corporate sustainability performance than performance-based measures. As a matter of fact, considering environmental variables directly related to CEP, such as GHG emissions, waste, water use, etc., provides an alternative strategy to shed light on this issue. The choice of the environmental variables depends on the analyzed sector, the country and on the relevant policy framework. For example, if a country's economy is heavily reliant on fossil fuels and does not have a rigid GHG regulation, the probability that emission levels will not negatively affect firms' CFP is high **(Wang et al., 2014).** For this reason, some kind of conclusions can be drawn at the country **(Lyon et al., 2013; Qi et al., 2014)** and sector level **(Wang et al., 2014),** but overall results are too mixed to allow us to draw final conclusions in this respect, mainly because of the heterogeneity of environmental indicators **(Berg et al., 2019)**, and because of the different measurement levels that can be chosen (**Aureli et al., 2019; Busch et al., 2011).**

The above brief discussion allows us to imagine that there is some sort of link that undergoes CFP and CEP proxied as ESG scores, but still, finance could represent a serious obstacle to the achievement of the climate objectives **(Monasterolo, 2020).** For this reason, public investment is vital and might play an important role as a driver of the low-carbon transition **(Monasterolo, 2020; Wolf et al., 2021).**

Uncertainties regarding the impact of climate change and climate policy, the lack of a standardized taxonomy of sustainable investments **(Cullen, 2018; Monasterolo et al., 2020)**, and the low degree of transparency of sustainable financial instruments (**Berg et al., 2019; Busch et al., 2020)** are identified as the major barriers, alongside the consequences of a « disorderly » transition.

Starting from the Paris Agreement, institutions began to set up policy actions aimed at achieving the climate goals. In this context, the EC has demonstrated its commitment by promoting initiatives always more refined and ambitious (i.e., the Directive 95/2014/EU on mandatory non-financial reporting, the European Green Deal, the EU Taxonomy Regulation, and the Corporate Sustainability Reporting Directive proposal).

As part of the action plan on financing sustainable growth, in spring 2019, the European Commission adopted a regulation on disclosure relating to sustainable investments and sustainability risks (SFRD), laying down disclosure obligations for manufacturers of financial products and financial advisers towards end-investors. The purpose is to integrate sustainability risks in investment processes and for financial products that pursue the objective of sustainable investment.

As a consequence, the European Commission identified the necessity to define a common language and clarify what can be considered a «sustainable activity». The EU Taxonomy classification system, defined in the Taxonomy Regulation, entered into force on 12 July 2020, sets out the conditions that economic activity has to meet in order to qualify as environmentally sustainable.

The Regulation establishes six objectives, and each economic activity, in order to comply, needs to contribute substantially to at least one of them without causing significant harm to all the remaining environmental objectives.

The Corporate Sustainability Reporting Directive (CSRD) is a regulation proposal promoted by the European Commission aimed at innovating and integrating the obligations included in the Non-financial Reporting Directive (NFRD), incorporating at the same time the recommendations suggested by the Task Force on Climate-related Financial Disclosure (TCFD).

The CSRD intends to:

- Guarantee to the stakeholders, typically the financial market operators, that the corporate's sustainability reporting is aligned to their needs;
- Communicate to the stakeholders the information related to the corporate's sustainability business strategy, the financial impacts of climate-related risks and opportunities on the company's business and vice versa;
- Guarantee the coherence of the information included in corporate's climate disclosure and the information obligations established by the EU Taxonomy;
- Widen the application scope of the Directive by including the SMEs;
- Increase the quality of the data;

**The Directive 95/2014/EU**

In November 2014, the EC approved Directive 95/2014/EU, which describes the kind of information that firms in scope need to provide in their non-financial reporting document.

As mentioned before, the policy's main objective is to increase the quality and the consistency of corporate's non-financial information, enhance comparability across different companies, and improve the trust and the confidence of investors and stakeholders (**Nicolò et al., 2020).**

The directive states that undertakings shall provide "(a) a brief description of the undertaking's business model; (b) a description of the policies pursued by the undertaking in relation to those matters, including due diligence processes implemented; (c) the outcome of those policies; (d) the principal risks related to those matters linked to the undertaking's operations including, where relevant and proportionate, its business relationships, products or services which are likely to cause adverse impacts in those areas, and how the undertaking manages those risks; (e) non-financial key performance indicators relevant to the particular business" **(European Commission, 2014).**

The Commission did not specify any kind of form of the report to provide this information. As a matter of fact, the companies can choose to publish a separate non-financial statement or include such information in their annual reports.

Finally, also the choice of the reporting framework is discretionary. Firms may adopt any framework they believe to be more suitable (national, European, or recognized international frameworks), provided that such a choice is duly indicated.

**The EU Taxonomy**

To achieve the climate goals adopted, the European Commission introduced, in July 2019, the European Green Deal, which relies on several actions, in particular on the Action Plan on Financing Sustainable Growth and its EU Taxonomy. The latter measure has been built in order

to address some specific and fundamental barriers that have been identified for the achievement of the sustainability goals, such as transparency, data quality and comparability **(Monasterolo, 2020**). In particular, the final regulation (Regulation (EU) 2020/852) identifies "sustainable economic activities" according to three criteria:

1. their contribution to at least one of six environmental goals[7] (passing specific thresholds);
2. the respect of the do-not-significant-harm clause with respect to the six environmental goals;
3. compliance with the minimum safeguards.

In general, the taxonomy can be applied at two levels: the firm level and the project level. At the firm level, a company can be evaluated based on its sales or expenses that correspond to the taxonomy **(Beerbaum, 2021),** while at the project level, the taxonomy can be used to classify new investments.

**The Corporate Sustainability Reporting Directive (CSRD)**

Following the EU Taxonomy goal of increasing data quality and comparability, in April 2021, the EC launched a new proposal for corporates' sustainability reporting.

As a matter of fact, the CSRD innovates and integrates the provisions included in the Directive 2014/95/EU, also known as the Non-financial Reporting Directive (NFRD), which entered into force in 2018 and incorporated the recommendations set by the Task Force on Climate-related Financial Disclosure (TCFD).

However, the proposal's aims also to guarantee that corporate reporting is aligned to stakeholders' needs and to communicate valuable information on corporate's sustainable business strategy, the financial impact of climate-related risks and opportunities on companies' business and vice versa (double materiality). Naturally, the information included in corporate climate disclosure is coherent with the ones required by the EU Taxonomy.

The Directive will be applicable to all listed and non-listed large European companies and to companies (European and non-European) listed on European markets. The application scope should now cover 49.000 companies. The disclosure will have to be part of the annual report, requiring companies to digitally 'tag' the reported information, so it is machine-readable and feeds into the European single access point envisaged in the capital markets union action plan. The reporting framework will have to consider the following factors: (i) Environmental, (ii) Social, and (iii) Governance.

Climate change is, in fact, being progressively recognized as a significant source of risk for the financial system. However, there is still a considerable gap in methodologies to analyze climate-related financial risks due to climate risks specific characteristics such as deep uncertainty, non-linearity, and endogeneity (**Battiston et al., 2021; Monasterolo, 2020**). In addition, the climate-related financial transmission channels can be amplified due to financial

[7] The six environmental objectives pursued in the EU Taxonomy are: (1) Climate change mitigation, (2) climate change adaptation, (3) sustainable use and protection of water and marine resources, (4) transition to a circular economy, (5) pollution prevention and control, and (6) protection and restoration of biodiversity and ecosystems.

interconnectedness and can have significant feedback effects on the real economy (**Figure 6**) (**Battiston et al., 2021**).

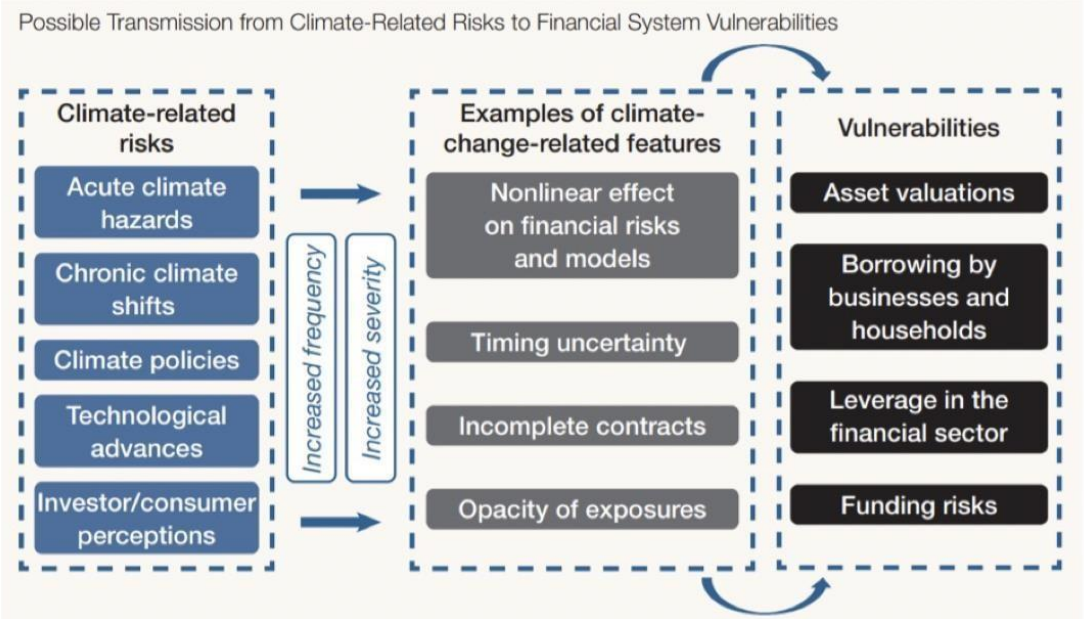



*Figure 6 Possible Transmission from Climate-Related Risks to Financial System Vulnerabilities*

However, climate policy and finance could represent a driver or a barrier to the low-carbon transition (**Monasterolo, 2020**). Uncertainties regarding the impact of climate change and climate policy, the lack of a standardized taxonomy of sustainable investments (**Cullen, 2018; Monasterolo and Volz, 2020**), and the low degree of transparency of sustainable financial instruments (**Berg et al., 2019; Busch et al., 2020**) are identified as the major barriers, alongside the consequences of a «disorderly» transition.

The EU Taxonomy tackles this first issue, serving as a standard for sustainability labels in the market for private investors and creating more transparency and comparability for end customers, giving businesses, building owners, investors and lending institutions better insights into the climate impact of their investing and financing (**Schutze et al., 2020**).

In terms of reducing emissions and achieving targets, a report by JRC states that in the best-case scenario, the EU Taxonomy would help reach the targets (**Table 9**) (**Alessi et al., 2019; Lucarelli et al., 2020**).

*Table 9 Investment Gap and EU Financial Markets. Estimated breakdown of investment gap financing across CPRS sectors and EUCO scenarios. Source: Alessi et al., 2019*

| Sector (CPRS) | | Scenarios | | | | |
|---|---|---|---|---|---|---|
| | | **EUCO27** | **EUCO30** | **EUCO+33** | **EUCO+35** | **EUCO+40** |
| Utility | Investment gap vs Ref2016 (€ bn) | 14 | 11 | 7 | 1 | -5 |
| | Investment gap vs Ref2016 (%) | 21 | 16 | 10 | 1.5 | -7.5 |
| | Ratio gap/total loans and bonds (%) | 3.5 | 2.8 | 1.8 | 0.3 | -1.3 |
| | Gap funded by bonds (€ bn) | 6.0 | 4.7 | 3.0 | 0.4 | -2.1 |
| | Gap funded by loans (€ bn) | 8.0 | 6.3 | 4.0 | 0.6 | -2.9 |
| Energy Intensive | Investment gap vs Ref2016 (€ bn) | 2 | 4 | 9 | 14 | 36 |
| | Investment gap vs Ref2016 (%) | 13 | 27 | 60 | 93 | 240 |
| | Ratio gap/total loans and bonds (%) | 0.27 | 0.54 | 1.2 | 1.9 | 4.9 |
| | Gap funded by bonds (€ bn) | 0.29 | 0.59 | 1.32 | 2.06 | 5.3 |
| | Gap funded by loans (€ bn) | 1.7 | 3.4 | 7.7 | 11.9 | 31 |
| Transport | Investment gap vs Ref2016 (€ bn) | 26 | 31 | 24 | 28 | 35 |
| | Investment gap vs Ref2016 (%) | 3.7 | 4.4 | 3.4 | 4.0 | 5.0 |
| | Ratio gap/total loans and bonds (%) | 4.4 | 5.3 | 4.1 | 4.8 | 6.0 |
| | Gap funded by bonds (€ bn) | 10 | 12 | 9 | 11 | 13 |
| | Gap funded by loans (€ bn) * | 16 | 19 | 15 | 17 | 22 |
| Buildings | Investment gap vs Ref2016 (€ bn) | 48 | 132 | 255 | 344 | 562 |
| | Investment gap vs Ref2016 (%) | 32 | 88 | 170 | 229 | 375 |
| | Ratio gap/total loans and bonds (%) | 2 | 7 | 13 | 17 | 28 |
| | Gap funded by bonds (€ bn) | 2.2 | 6.1 | 12 | 16 | 26 |
| | Gap funded by loans (€ bn) | 46 | 126 | 243 | 328 | 536 |
| **Total investment gap (€ bn)** | | **90** | **178** | **295** | **387** | **628** |

The EU Taxonomy provides better insights on the impact of firms' and financial operators' investing and financing, while the CSRD aims to improve data quality but, most importantly, holds companies accountable for their business activities.

There is evidence that information quality increases after the introduction of a legal provision (**Caputo et al., 2019**) and that legislation stringency facilitates firms to invest in climate change mitigation capabilities (**Lee et al., 2015**). Moreover, investors do look for an integrated analysis of the impact of CSR activities on key business metrics (**Du et al., 2010**), preferring long-term sustainability over short-run financial performance (**Aureli et al., 2019**), and to do so, they rely mainly on CSR/sustainability reports (**Cohen et al., 2015**). **Aureli et al. (2019)** also find that firms' market value does respond to ESG information. However, it mostly depends on the metrics used to define climate performance (**Battiston et al., 2021**).

### 3.1.2. Data and methodology

In this frame, we applied a research approach called 'event analysis' using the market model as suggested by the relevant literature (**Brouwers et al., 2016**). The following events were considered:

- Introduction of Directive 95/2014/EU on mandatory non-financial reporting (22nd October 2014);
- Taxonomy Regulation published in the Official Journal of the European Union (22nd June 2020);
- Adoption of the proposal for a Corporate Sustainability Reporting Directive (CSRD) (21st April 2021).

We then econometrically estimated a market model over 90 trading days ending five days prior to the event. The Dow Jones index was used as a market proxy to evaluate the relationship between the individual firm's stock return and the market (**Table 10**). Finally, we

explored abnormal returns and the cumulative market response over the entire event window.

*Table 10 Number of firms per country and types of GISC industry group*

| Country | Number of firms |
|---|---|
| Belgium | 1 |
| Denmark | 1 |
| Finland | 5 |
| France | 25 |
| Germany | 17 |
| Ireland | 1 |
| Isle of Man | 1 |
| Italy | 11 |
| Luxembourg | 1 |
| Netherlands | 12 |
| Norway | 2 |
| Portugal | 2 |
| Spain | 14 |
| Sweden | 9 |
| Switzerland | 14 |
| United Kingdom | 30 |
| Total | 146 |

146 companies of the Dow Jones Sustainability Index Europe.

**GICS Industry Groups**
Automobiles & Components
Banks
Capital Goods
Commercial &Professional Services
Consumer Durables & Apparel
Consumer Services
Diversified Financials
Energy
Food & Staples Retailing
Food, Beverage & Tobacco
Healt Care Equipment & Services
Household & Personal Products
Insurance
Materials
Media & Entertainment
Pharmaceuticals, Biotechnology & Life Sciences
Real Estate
Retailing
Semiconductors & Semiconductor Equipment
Software & Services
Technology Hardware & Equipment
Telecommunication Services
Transportation
Utilities

### 3.1.3. Results

The three above-mentioned regulatory events appear to have a significant effect, to a different extent and other time windows. Abnormal returns do not seem important on the event's day but on subsequent days. Parametric and non-parametric tests have been run to understand if share prices react significantly to the events.

In particular, what stands out is that, on average, the pool's returns are negative during the event's date, while the index does show positive performances. However, this is true only for the first two regulatory events, while the third (Adoption of the proposal for a CSRD) provides the opposite evidence.

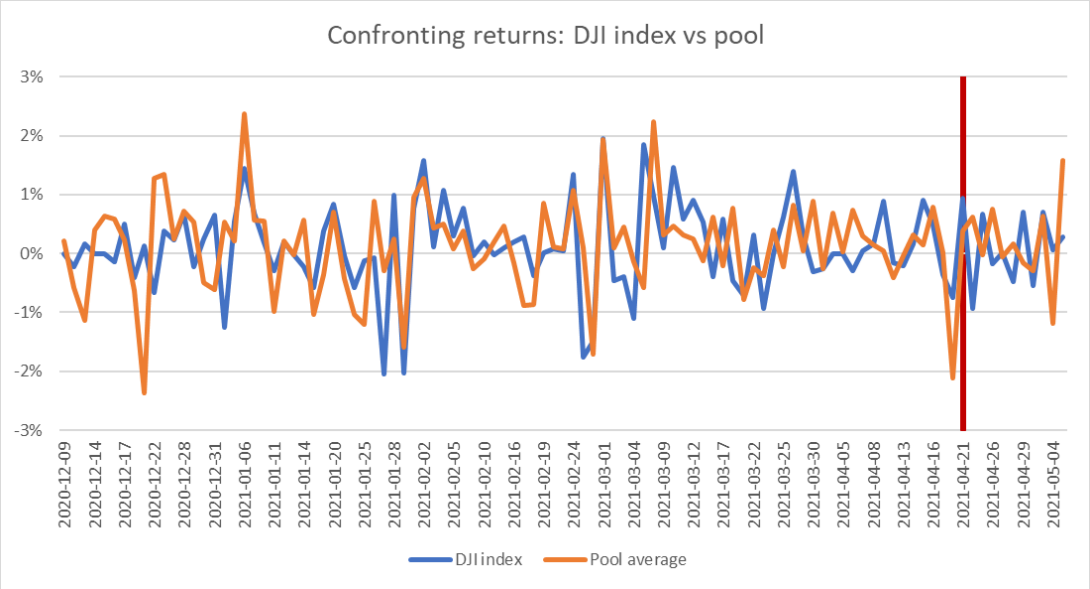



*Figure 7 Confronting returns: DJI index vs pool*

### 3.1.4. Conclusions

The change in the dynamics of market returns throughout time highlights an important aspect: In the past, the most sustainable firms were affected negatively by policy announcements, while now they are the only ones to perform positively in the market when the European Commission adopts a policy action. **Lucarelli et al. (2020)** state that "… EU Taxonomy-related topics have now been incorporated into policy measures, which reinforces expectations for positive impactful environmental effects", allowing us to assume that there might be a nexus between firms' environmental performances and their financial ones. This result could eventually suggest two findings:

- Climate-related policies became more refined over time, and sustainable firms do benefit from them;
- For a certain level of environmental performance, firms may perform positively in the markets, but below this level, they might not, even though they are more sustainable than other firms which perform better.

However, this analysis may be expanded by analyzing particularly exposed sectors and implementing additional quantitative methods to identify other relevant variables that might play an important role. Moreover, further research is needed in various areas, particularly concerning the channeling of financial flows and the companies' strategic choices.

Box 3 – Connection between ESG and financial performance

ESG refers to a broad range of **Environmental**, **Social**, and corporate **Governance** factors that might influence a company's ability to generate value. It relates to incorporating non-financial elements into business strategy and decision-making in a corporate context. While ESG factors are referred to as non-financial, there are financial implications, as they are linked to corporate competitiveness and profitability.

Companies are increasingly interested in reporting how their activities comply with generally accepted ESG standards. They recognize that apart from an improved reputation,

ESG criteria can add value to them and help them become more effective in their operations.

A good ESG performance generally implies excellent financial performance as well. By looking at the behavior of the STOXX Europe ESG Leaders 50 during the last three years, we see that COVID-19 adversely affected this index, as expected. The index fell by almost 42% in just one month (from + 20.67% on 18/2/2020 to -21.89% on 16/3/2020). However, the fall in the EURO STOXX 50 Index's price was sharper, recording a fall of almost 45% (from + 16.08% to -29.09% in the same period). This fact may indicate a greater resilience of the companies in STOXX Europe ESG Leaders 50 in crises compared to EURO STOXX 50 companies, especially if we consider the overall behavior of the index, which seems to recover faster (**Figure 8**).


*Figure 8 STOXX Europe ESG Leaders 50 (Blue) and EURO STOXX 50 (Orange) development the last three years. Source: Boerse Frankfurt*

**Koundouri, Pittis and Plataniotis, 2021**, performed an empirical examination on whether the adoption of ESG criteria boosts companies' valuation, reduces the equity risk and makes them more efficient in managing their funds.

They compared STOXX Europe ESG Leaders 50 index companies, namely companies that are global leaders in terms of ESG criteria, to EURO STOXX 50 Index Companies, namely a blue-chip representation of supersector leaders in Europe, in terms of profitability, valuation, capital efficiency and risk.

Using publicly available financial data for each company in the sample, they calculated five indicators: Beta, Total Debt/Equity, Profit Margin, Return on Assets, and Return on Equity on average per sector. These indicators are widely used to assess shareholder risk, capital structure efficiency, profitability and Asset and Equity efficiency and are considered to provide a good overview of the company's performance profile.

Below are some selected results:

**The Beta** indicator expresses the volatility, hence the risk, of a stock in the market. A stock with a beta greater than 1.0 shows higher volatility, while a beta less than 1.0 indicates

lower volatility than the market over time. Our analysis shows that companies with good ESG performance generally tend to have lower beta and, therefore, lower risk; however, this is not the case for companies in the automotive sector (**Figure 9**).

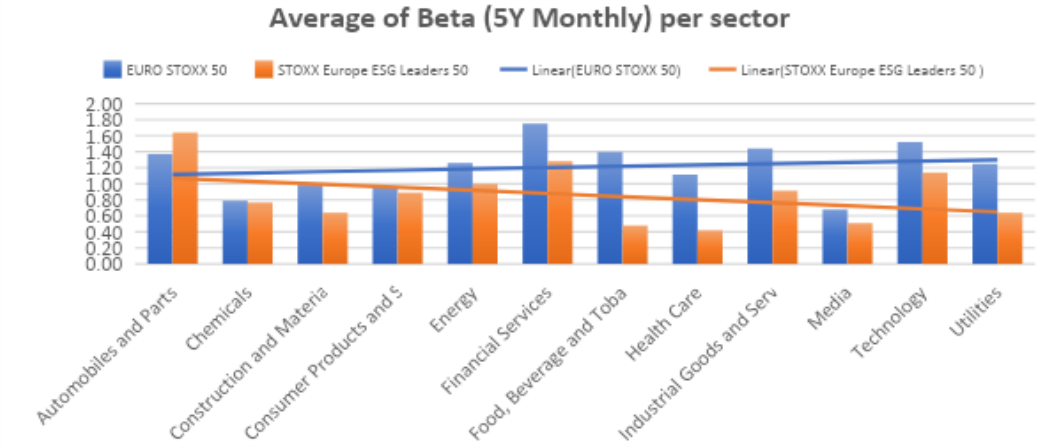



*Figure 9 Average of Beta (5Y Monthly) per sector*

**Profit margins** are one of the most basic and commonly utilized financial metrics in the business world. A company's profitability is usually measured at three levels - gross profit, operating profit, and net profit. Although, a strong positive correlation between ESG performance and Profit Margin cannot be argued. In some sectors, ESG leaders seem to have a higher profit margin, while in other sectors, the opposite is true (**Figure 10**).

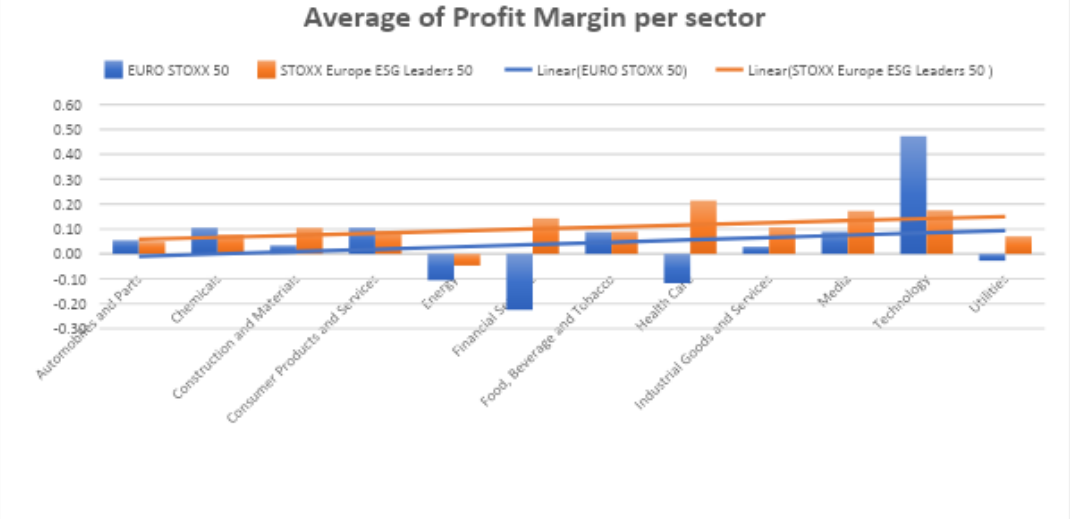



*Figure 10 Average of Profit Margin per sector*

**Return on equity (ROE)** is a financial performance metric derived by dividing net income by shareholders' equity. ROE is defined as the return on net assets since shareholders' equity equals a company's assets minus its debt. Companies with good ESG performance have a better return on equity than the others; Even in the sectors with negative returns like energy, ESG leaders demonstrate less negative return on equity than the others (**Figure 11**).

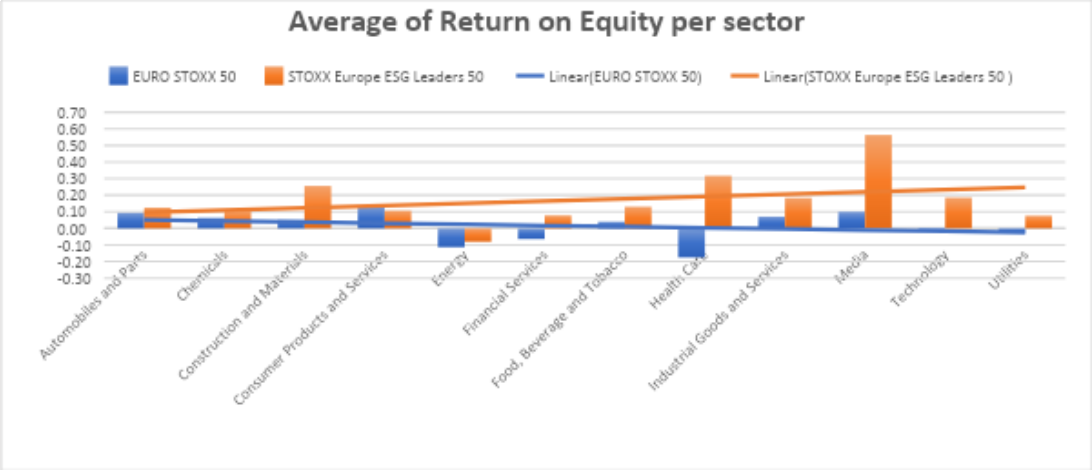



*Figure 11 Average Return on Equity per sector*

## 3.2. Valuation of Biodiversity ecosystems

Natural capital refers to the world's stocks of natural assets such as forests, fisheries, rivers, biodiversity, land and minerals. Biodiversity can be defined as the variability among living organisms from all ecosystems of which they are part, covering richness, rarity and uniqueness. This definition captures both the living and non-living aspects of ecosystems and implies that the elements of nature have value to society (**HM Treasury's Green Book**).

Numerous studies have extensively demonstrated the emergency deriving from the loss of biodiversity we are experiencing. However, less evidence has been provided on the changes we need at a political, financial and economic level to slow down and reverse this path Dasgupta (2021).

In this section, we provide a valuation of the European ecosystem services, that is we estimate the Willingness to pay for several classifications of the ecosystem services and various biogeographical and Marine regions across Europe.

### 3.2.1. Natural Capital and human society

Over time, natural capital stocks provide flows of environmental or 'ecosystem' services. These services, which are frequently combined with other types of capital (human, produced, and social), generate various benefits (**Figure 12**).

A resource's use value might be either a market value, such as minerals, wood, water and other goods, or a non-market value, such as outdoor recreation, landscape amenity, and many others. Non-use values, such as the importance people attach to specific habitats or species, are also included.

Environmental economists consider nature as a resource from which humans may benefit. The quality, quantity, and location of natural resources greatly influence their potential to produce commodities and services—background forces, management policies, and demand factors all impact these characteristics.

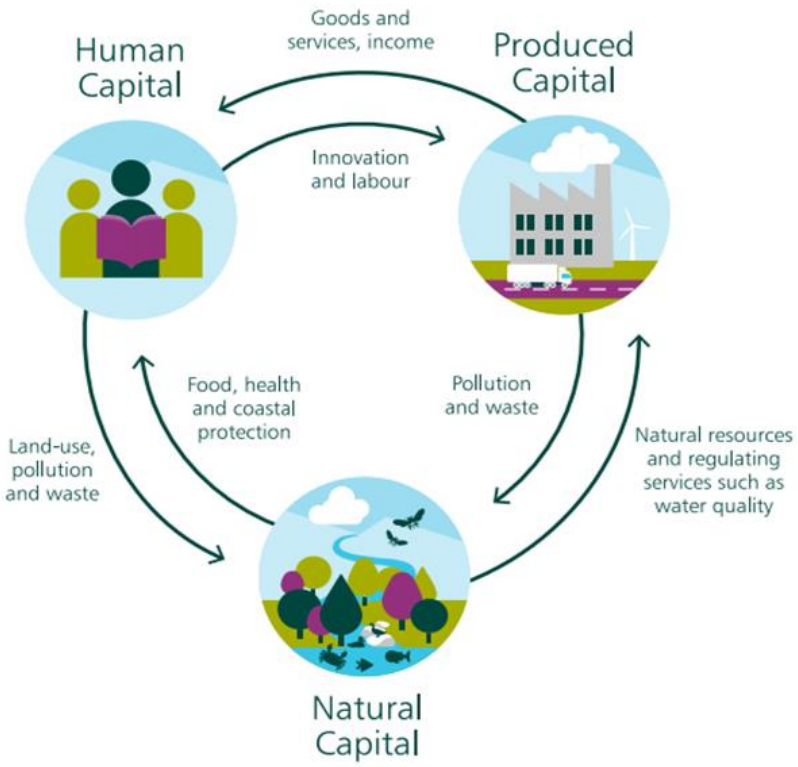



*Figure 12 The relationship between different types of Capital. Source: The Dasgupta Review, 2021*

### 3.2.2. Ecosystem services

Biodiversity is a critical component of natural capital because it enables the provision of environmental benefits and services to people. The Convention on Biological Diversity defines biodiversity as "the diversity of living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems, and the ecological complexes to which they belong; this includes diversity within species, between species, and within ecosystems." **(HM Treasury, 2020).**

The productivity of natural capital derives from its quality and quantity, in other words, its biodiversity. Therefore, maintaining the stock of this capital constant allows the provision of flows of ecosystem services which depends on human present and future prosperity TEEB (2010).

As a result of humans changing ecosystems, human well-being has been affected, as well as how ecosystem changes may affect people in the future, and what types of responses can be used at local, national, and global scales to improve ecosystem management, which in turn will make humans happier and less poor.

**Ecosystem services** are final products or results that directly and indirectly affect human well-being, and these factors can work well with an economic strategy. The main reason for valuing ecosystem services is that it will help people make informed decisions. It will make sure that policy decisions consider the costs and benefits of the natural environment and the implications for human well-being while giving policymakers new ideas. Indeed, the term "*ecosystem services*" indicates the link between natural capital and the economy, which corresponds to the utility people derive from exploiting ecosystems.

The Millennium Ecosystem Assessment (MA, 2005)[8] has recognized four categories of ecosystem services (**Figure 13**):

- **Provisioning services**: products obtained from ecosystems, e.g. water, food, fibre;
- **Regulating services**: benefits guaranteed by the regulation of ecosystem processes, e.g. climate regulation, water regulation, pollination;
- **Cultural services**: non-material benefits derived from ecosystems, e.g. recreation, aesthetic, spiritual and religious, cultural heritage
- **Supporting services**: services needed to produce all the other ecosystem services, e.g. nutrient cycling, soil formation, primary production.

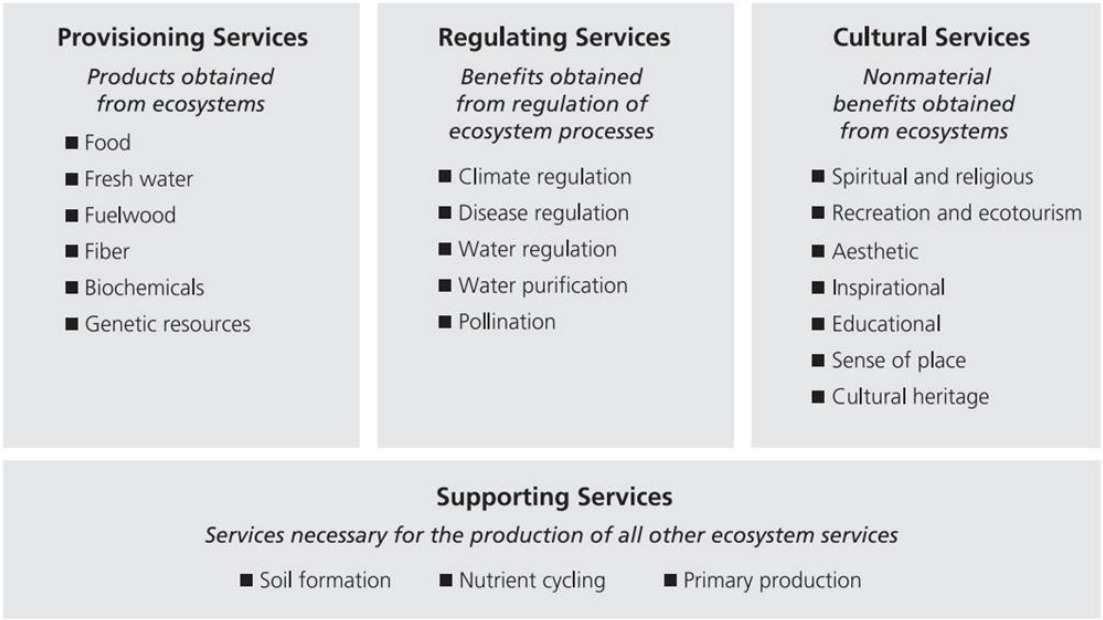



*Figure 13 Ecosystem Services. Source: Millenium Assessment*

Certain services require additional inputs to realize their benefits. However, in other circumstances, the advantage accrues automatically due to the service, without extra cash or human involvement (**Figure 14**).

[8] The Millennium Ecological Assessment (MEA) was a four-year multinational work program aiming to provide scientific knowledge on the relationships between ecosystem change and human well-being to decision-makers. Millenium Ecosystem Assessment looked at the effects that changes in the ecosystem have on human well-being. From 2001 to 2005, more than 1,360 experts from all over the world worked on the MA. Scientifically, their findings show how ecosystems and the services they provide are in a state of flux around the world. They also show how to protect and use them in a way that is healthy for the planet and for people.

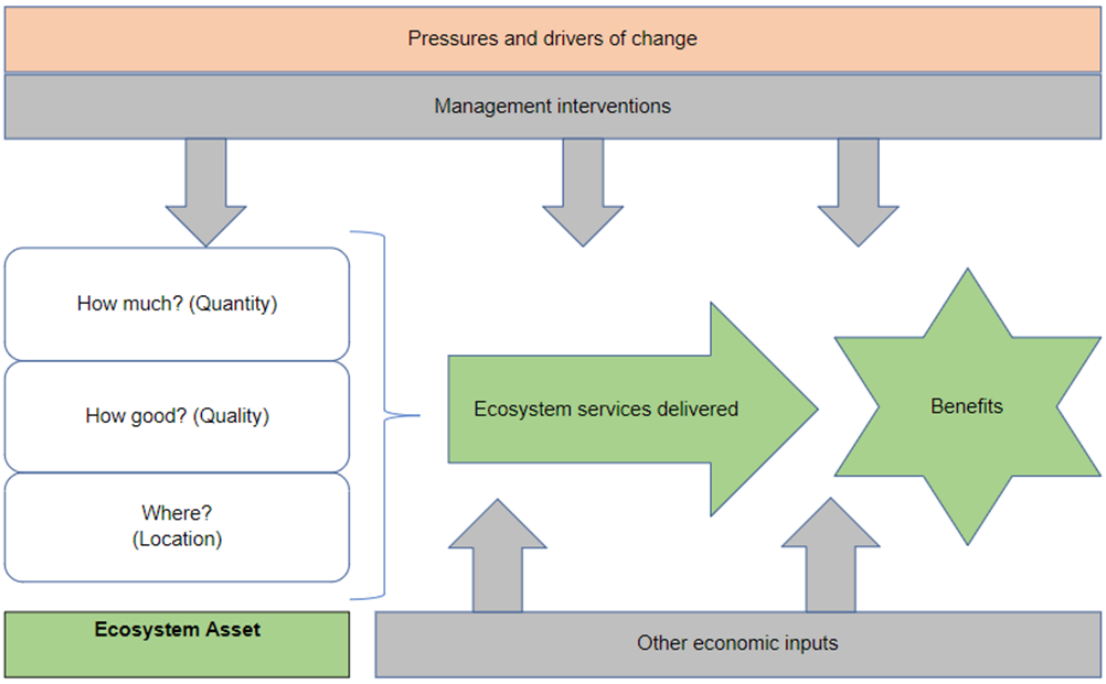



*Figure 14 The Natural Capital Framework. Source: DEFRA*

So far, only a tiny fraction of products offered by nature are considered in current metrics that measure economic progress (GDP) and human well-being (Human Development Index) **Dasgupta (2021)**. Moreover, other benefits, such as pollination, regulation and nature's ability to mitigate disasters, have failed to be captured. This incapability to account for the total economic values of ecosystems and biodiversity, jointly with the intense pace of economic activity, has significantly influenced their degradation.

Habitat destruction, over-harvesting, climate change, and pollution are among the most significant threats that biodiversity is experiencing, according to IPBES (2019). Above all, these threats are caused by human activity, ignoring the value of nature in financial accounts. Continuing on this path means jeopardizing the present and the future possibility of growth and prosperity. Consequently, reflecting the economic value of ecosystem services in the mainstream public and private decision-making is pivotal to inverting the trend of decline that ecosystems are experiencing and, therefore, positively impacting the possibility of future generations.

### 3.2.3. Valuing ecosystem services

Putting a value on ecosystem services is the last step in a long and often detailed study of how a policy change will affect them.

Based on the type of ecosystem service and the amount and quality of data that can be used to value it, the valuation method will be chosen. Some forms of valuing ecosystem services may be better at capturing the value of specific ecosystem services than others. **Benefits transfer**, for example, passes economic values from one place to another with similar features. The use of these kinds of transfers is vital for making more practical policies for the environment.

A framework called Total Economic Value (TEV) is shown in **Figure 15**. It considers both the use and non-use values that people and society gain or lose from small changes in ecosystem

services. Because many ecosystem services are not traded in markets, they do not have a price. So, to figure out how much these goods or services are worth, you need to use non-market valuation methods.

TEV represents the total benefit in well-being from a policy, which is the sum of the people's willingness to pay (WTP) and their willingness to accept the policy (WTA). We are attempting to capture the overall value of a marginal change in the underlying ecosystem services **(DEFRA, 2007)**.

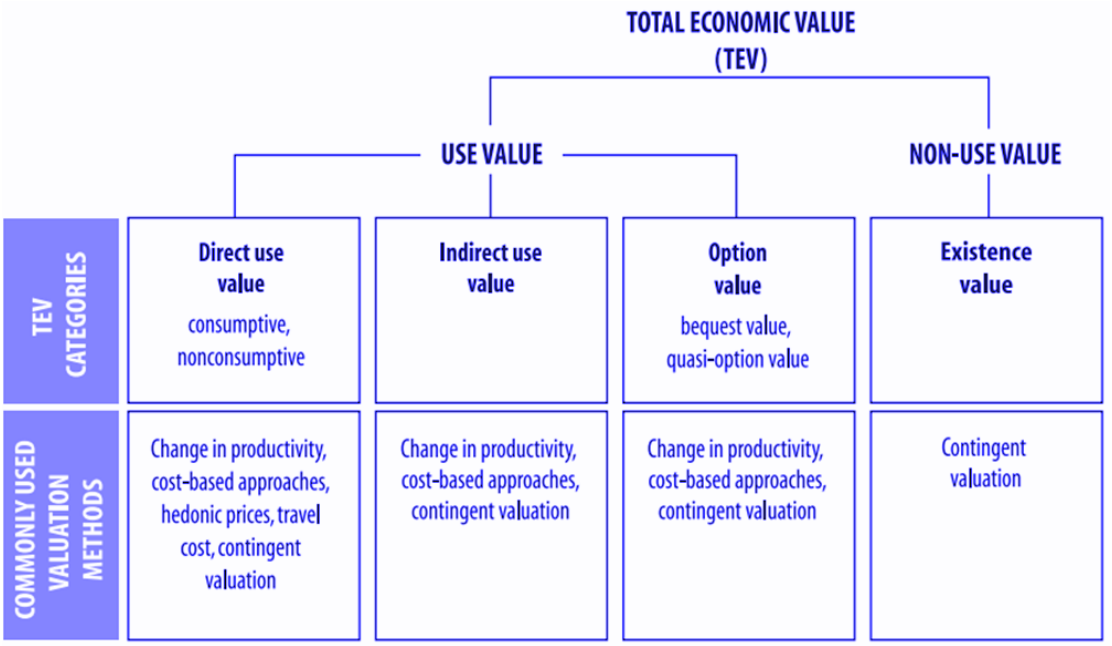



*Figure 15 The Total Economic Value Framework. Source: Millenium Assessment*

**Use value** includes direct use, indirect use and option value.

**Direct use value** is when people use an ecosystem service in the real world or plan to use it shortly. Non-consumptive use and consumptive use are two ways to think about this. Non-consumptive use is when you use the service without taking anything from the ecosystem. For example, you could use the service without taking food or wood from the ecosystem (e.g. recreation, landscape amenity). If there is a formal market for these activities, they can be traded. If there isn't, they can't be traded at all (e.g. recreation or the inspiration people find indirectly experiencing nature).

**Indirect use-value** is when people benefit from ecosystem services that are supported by a resource, but they don't use it directly. When these ecosystem services are damaged or lost, people ignore them until they're gone. They're still significant, however. These services are essential to life on Earth, like regulating the chemical composition of the atmosphere and oceans, climate regulation, water regulation, pollution filtering, soil retention and provision, nutrient cycling, waste decomposition, and pollination. These services are also crucial to life on Earth. It is much more challenging to figure out indirect use values in many cases than to figure out direct use-values. Changes in the quality or quantity of a service are often hard to measure or understand.

**The option value** is how important it is for people to be able to use a resource in the future, even if they aren't using it now. These future uses could be direct or indirect, but it doesn't matter. For example, there might be a national park where people who don't want to go there but want to keep the option open in the future might still be willing to pay a fee. Option value refers to how important it is to preserve ecosystems and the species and habitats for possible future uses, some of which may not have been thought of yet. A wide variety of species in a habitat can also be considered a form of insurance. As conditions change, different species may play critical ecological roles. Bequest value refers to the value that individuals give because the ecosystem resource will be passed on to future generations.

**Non-use value,** also known as passive use, comes from knowing that the natural environment is being looked after. Even though an individual doesn't use or plan to use an ecosystem resource, it has value because it is there. For example, it doesn't matter if people know that they won't ever get to see a whale. They'll still donate money to help keep whales safe. Non-use value is hard to get because people have difficulty putting a price on things because they aren't often asked to do so. Even in some cases, nonuse value may be more critical than use-value, and this is why.

### 3.2.4. Valuation Methodology

Below, a 2-stage approach for the valuation of Ecosystem Services is suggested (**Figure 16**). The aim of this is twofold. First, to derive the economic value of ecosystems relevant to the EU countries. Second, the unit value of ecosystems will be subsequently integrated with the SDG index to measure the social-economic value from moving to ecosystems' status quo to the full achievement of SDGs.

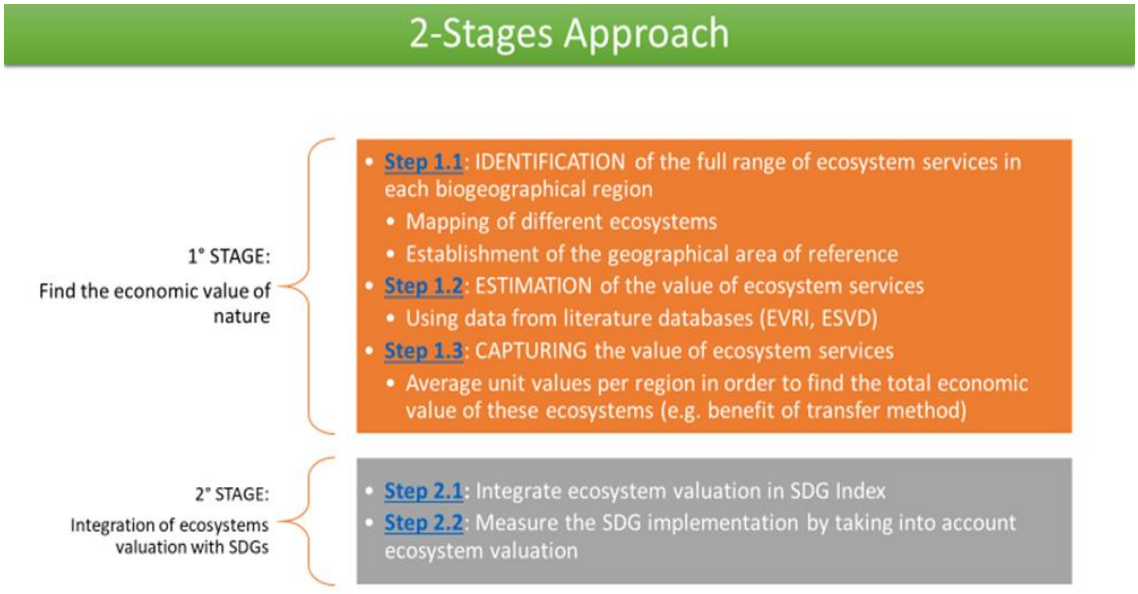



*Figure 16 A 2-stage approach for the Valuation of Ecosystems*

*1st STAGE: Valuation of the Ecosystem Services in different biogeographical regions*

## Data Collection

As for the economic valuation purpose, a meta-regression analysis has been conducted using the publicly accessible database EVRI (Environmental Valuation Reference Inventory). Primary literature related to ecosystem services valuation from 2012 to 2022 has been selected. Studies have been determined according to the ecosystem typology, the ecosystem services valued, and the geographical area in which the study was conducted.

Mapping and Assessment of Ecosystems and their Services (MAES) Typology for ecosystem classification (European ecosystem assessment-concept, data and implementation, EEA Technical Report, no 6/2015) has been followed to identify the typology of ecosystems. This includes three main groups 1) Terrestrial ecosystems: urban, cropland, grassland, forest, heathland and shrub, sparsed vegetated land, and inland wetlands; 2) Marine ecosystems: marine inlets and transitional water, coastal, shelf and open oceans; 3) Freshwater ecosystems: rivers and lakes (**Figure 17**).

On the other hand, ecosystem services have been distinguished between provisioning, regulating, cultural and supporting services in compliance with the aforementioned MA classification. Finally, since ecosystem typologies vary across regions, the geographical area of the study has been defined according to Habitats Directive (92/43/EEC) and for the EMERALD Network set up under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). This last distinguishes 9 EU biogeographical regions, i.e. Alpine, Atlantic, Black Sea, Boreal, Continental, Macaronesian, Mediterranean, Pannonian and Steppic and 5 EU marine regions, i.e. Marine Atlantic, Marine Baltic, Marine Black Sea, Marine Macaronesian and Marine Mediterranean.

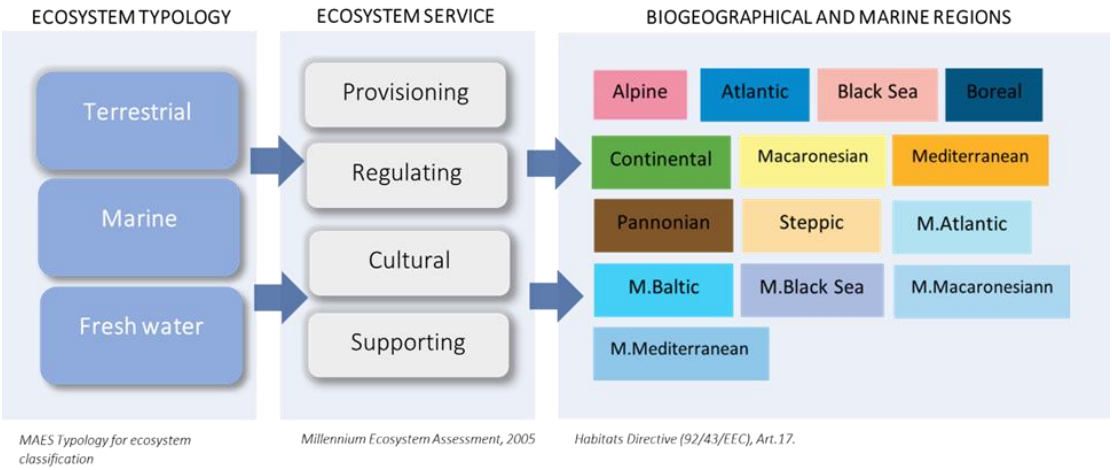



*Figure 17 Mapping of Ecosystems Typology to Services across Biogeographical regions*

## Estimation methodology: Meta-regression analysis function transfer

To summarize and synthesize the empirical findings of various studies, in our research, we rely on the meta-regression analysis function transfer using the summary statistics provided. Our purpose is to statistically explain the variation found in the studies under consideration due to identifiable characteristics among the considered studies like the valuation method,

geographic location, study-specific factors, survey mode, and other relevant determinants and demographic elements. The meta-analysis model is presented as

$$Y_i = \gamma + \beta' X_i + \varepsilon_i \qquad (1)$$

where i corresponds to each observation gathered from the studies under consideration, Y the dependent variable in our case, Willingness To Pay (WTP), γ the intercept (if necessary), and β parameters to be estimated as slopes of the specifications, X the matrix of the explanatory variables; ε is the error term with the usual properties.

Specifically,

- **Willingness to pay**: This continuous variable expresses the annual mean willingness to pay (in euros) for ecosystem services. In cases in which the value of the willingness to pay was expressed in a currency other than the euro, the current year's exchange rate in which the study was developed was applied. In some studies in which the willingness to accept was calculated, values have been translated into a willingness to pay by assuming that willingness to pay equalizes willingness to accept. Similarly, in other studies, consumers' surplus values have been considered equal to the willingness to pay. In the estimation, the willingness to pay variable will be considered as the dependent variable;

Various explanatory variables were considered to explain the variation mentioned above. Namely:

- **Ecosystem**: is a categorical variable reporting the ecosystems' typology valued, which follows the categorization provided by MAES, i.e. Forest (42 studies), Cropland (18), Heathland and Shrub (1), Sparsed Vegetated Land(1), Inland Wetlands(3), Rivers and Lakes (14), Urban (15), Grassland (6), Marine (65). The ecosystem variable has been subsequently divided into three different dummy variables: Terrestrial (assuming value 1 if Ecosystem was equal to Forest, Cropland, Heathland and Shrub, Sparsed vegetated land, Urban, Grassland, and Inland and Wetlands and equal to 0 otherwise), Freshwater (assuming value 1 if Ecosystem was similar to Rivers and Lakes and 0 otherwise), and Marine (taking value 1 if Ecosystem was similar to Marine and Coastal, and 0 otherwise);
- **Cultural, Provisioning, Regulating, Supporting**: are dummy variables indicating ecosystems' services, per the MA Reporting categories. They assume a value of 1 if the study provides monetary value for the specific service and a value of 0 otherwise.
- **Survey design**: is a categorical variable describing the different data collection methods used by the surveys in each study, i.e. a) Computer-aided individual home interviews, b) Computer-assisted personal interview, c) Dataset, d) Focus group, e)Interviews online, f) Personal Interviews, g) Mail Survey, h) Map layers, i) Questionnaire by phone, l) Questionnaire online, m) Questionnaire in person, n) Questionnaire on-site, o) Workshop. This variable has been subsequently divided into three dummy variables Interview ( assuming a value of 1 when Survey Design was equal to a, b, d, f, m, n, o, and 0 otherwise), Questionnaire online (assuming a value of 1 when survey design is equal to e, g, h, i, l, and zero otherwise) and Secondary data (taking a value of 1 if Survey Design was similar to c, and 0 otherwise
- **Data year**: indicates the year of data collection

- **Valuation method**: is a categorical variable indicating the method used to develop the analysis, i.e. Contingent valuation, Choice experiment, Actual Expenditure/Market price, Count data model, Hedonic Price Method, Hedonic Property, Meta-analysis, Replacement costs, Travel cost method. In our final dataset, we have 76 Choice Experiment (CE) studies and 67 CVM studies and 22 studies from studies using revealed preferences. We have created three dummies: One for CE (1 for CE and 0 otherwise), one for CVM (1 for CVM and 0 otherwise), and one for Revealed studies (1 for Revealed and 0 otherwise).
- **Location**: is a categorical variable reporting the geographical area in which the analysis has been developed;
- **Country**: is a categorical variable reporting the European country in which the analysis has been developed;
- Biogeographical and marine regions of the European Union. Specifically, we have the cases of **Alpine, Atlantic, Black Sea, Boreal Continental, Macaronesian, Mediterranean Pannonian, Steppic, Marine Atlantic, Marine Black Sea, Marine Baltic, Marine Maccaronesian, Marine Mediterranean**: as dummy variables indicating the specific biogeographical and marine regions of European Union in which the study has been developed, according to with the categorization used in the Habitats Directive (92/43/EEC) and for the EMERALD Network set up under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention);
- **Value elicitation methodology**: is a categorical variable indicating the typology of elicitation used in the study

As socioeconomic variables, we have considered the following:

- **Age**: is a continuous variable indicating the mean age of the sample population expressed in years. In the studies in which grouped data were provided, the open classes have been assumed to have the same width (in red). Accordingly, the midpoint for each class has been calculated and subsequently multiplied per class frequency. The sum of the results has been finally divided by the total frequencies. As there were many missing values, we considered proxy the mean age for each country and the specific year provided by EUROSTAT.
- **Income**: is a continuous variable indicating the mean annual income of the sample population in the euro. In the studies in which grouped data were provided, the open classes have been assumed to have the same width (in red). Accordingly, the midpoint for each class has been calculated and subsequently multiplied per class frequency. The sum of the results has been finally divided by the total frequencies. In the studies in which monthly annual income was provided, the monthly amount was multiplied by twelve months. In cases in which the value of annual income was expressed in a currency other than the euro, the current year's exchange rate in which the study was developed was applied. For studies in which income data were not available, we used Eurostat data deriving from EU-SILC and ECHP surveys. Eurostat database provides mean equivalized[9] net income by year.

[9] To take into account the impact of differences in household size and composition, the total disposable household income is "equivalised". The equivalised income attributed to each member of the household is calculated by dividing the total disposable income of the household by the equivalisation

- **Gender**: indicates the percentage of males and females in the sample population. It is assumed female =1. This is a variable with 68 missing values, and it has been eventually omitted from our regression analysis. However, for the 97 existing values, descriptive statistics are provided.
- **Education**: indicates the percentage of the sample population with a high education level. It is assumed university degree=1. In the case in which educational level data were not available, we resorted to Eurostat data on Population by educational attainment level, sex and age (%), especially we considered tertiary education (level 5-8) according to the International Standard Classification of Education (ISCED 2011)

Concerning our final dataset created using the information of studies collected from the Environmental Valuation Reference Inventory (EVRI), the database has 212, of which 165 were used for estimation[10]. The constructed excel file provides the **Study name,** which contains information about the studies' authors, title, journal, and year of publication.

### 3.2.5. Empirical findings

#### *Willingness to Pay by Ecosystem type and by Country*

Relying on the above information, **Table 11** provides the descriptive statistics of the variables used in the analysis.

factor. Equivalisation factors can be determined in various ways. Eurostat applies an equivalisation factor calculated according to the OECD-modified scale first proposed in 1994 - which gives a weight of 1.0 to the first person aged 14 or more, a weight of 0.5 to other persons aged 14 or more and a weight of 0.3 to persons aged 0-13. https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do.

[10] In total 47 studies have been omitted. In general, these studies present net present values, total economic values and monetary values that are hardly compatible with the type of values expressed in the studies under review. In addition, a small number of cases were omitted because the values were too high and thus represented outliers in the database.

*Table 11* Descriptive Statistics of the proposed variables

| Variable | Mean | SE Mean | StDev | Minimum | Q1 | Median | Q3 | Maximum |
|---|---|---|---|---|---|---|---|---|
| WTP | 76.8 | 12.9 | 165.7 | 0.0 | 93000.0 | 23.4 | 64.4 | 1404.6 |
| ES Terrestrial | 0.521 | 0.039 | 0.501 | 0.000 | 0.000 | 1.000 | 1.000 | 1.000 |
| ES Marine | 0.394 | 0.038 | 0.490 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| ES Fresh Water | 0.085 | 0.022 | 0.280 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| Cultural | 0.588 | 0.038 | 0.494 | 0.000 | 0.000 | 1.000 | 1.000 | 1.000 |
| Provisioning | 0.267 | 0.035 | 0.444 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| Supporting | 0.436 | 0.039 | 0.497 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| Regulating | 0.327 | 0.037 | 0.471 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| SD Interview | 0.665 | 0.037 | 0.474 | 0.000 | 0.000 | 1.000 | 1.000 | 1.000 |
| SD Questionnaire online | 0.329 | 0.037 | 0.471 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| SD Secondary data | 0.050 | 0.017 | 0.218 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| CE | 0.461 | 0.039 | 0.500 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| CVM | 0.400 | 0.038 | 0.491 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| REVEALED | 0.139 | 0.027 | 0.347 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| Alpine | 0.133 | 0.027 | 0.341 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| Atlantic | 0.236 | 0.033 | 0.426 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| Boreal | 0.139 | 0.027 | 0.347 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| Continental | 0.212 | 0.032 | 0.410 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| Macaronesian | 0.006 | 0.006 | 0.078 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| Mediterranean | 0.279 | 0.035 | 0.450 | 0.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| Steppic | 0.006 | 0.006 | 0.078 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| Marine Atlantic | 0.176 | 0.030 | 0.382 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| Marine Black Sea | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Marine Baltic | 0.042 | 0.016 | 0.202 | 0.000 | 0.000 | 0.000 | 0.000 | 1.000 |
| AGE | 44.221 | 0.624 | 6.301 | 28.620 | 40.088 | 43.000 | 49.350 | 58.000 |
| INCOME | 27969 | 1210 | 15160 | 2398 | 18267 | 24512 | 35371 | 104030 |
| GENDER | 0.489 | 0.009 | 0.087 | 0.170 | 0.463 | 0.510 | 0.540 | 0.640 |
| EDUC | 0.554 | 0.178 | 2113.000 | 0.104 | 0.265 | 0.360 | 0.460 | 25.400 |

Next, we performed various stepwise specifications of the variables considered slightly elastic in the individual statistical significance of the explanatory variables (using Newey-West heteroskedasticity and autocorrelation Robust standard errors). Apart from the standard levels (of $\alpha$= 0.01, $\alpha$=0.05 and $\alpha$=0.1), we have considered (in such analysis) P-values less than 0.25. BIC criterion was used for the model selection. The 1% extreme WTP observations were excluded from the analysis. **Table 12** provides the meta-regression estimates and benefit transfer functions for all the models we considered; that is a model including all ecosystems and its breakdown into Terrestrial and Marine & Freshwater[11]. P values for the Newey West HAC standard errors are reported in brackets.

[11] Fresh Water ecosystem was covered only by 14 studies in our sample, so it was grouped together with the Marine Ecosystem

*Table 12 Meta Regression Estimates*

| | All Ecosystems | Terrestrial | Marine & Fresh Water |
|---|---|---|---|
| ALPINE | **148.94** | **105.93** | 43.01 |
| | [0.020] | [0.041] | [0.279] |
| ATLANTIC | **-86.23** | -21.91 | **-64.32** |
| | [0.084] | [0.487] | [0.091] |
| BOREAL | -82.96 | 19.39 | **-102.34** |
| | [0.286] | [0.748] | [0.040] |
| CONTINENTAL | -48.36 | -7.07 | -41.29 |
| | [0.162] | [0.817] | [0.269] |
| MEDITERRANEAN. | **-91.73** | **-54.37** | -37.36 |
| | [0.057] | [0.069] | [0.344] |
| MARINE_ATLANTIC | **-74.40** | **-62.46** | -11.95 |
| | [0.106] | [0.059] | [0.779] |
| PROVISIONING | **59.32** | 25.77 | 33.55 |
| | [0.075] | [0.292] | [0.259] |
| REGULATING | **53.19** | 12.98 | **40.21** |
| | [0.224] | [0.541] | [0.214] |
| SUPPORTING | **42.70** | 13.46 | 29.24 |
| | [0.117] | [0.599] | [0.312] |
| SD_QUESTIONNAIRE | -42.09 | **-50.20** | 8.11 |
| | [0.351] | [0.118] | [0.803] |
| AGE | **3.77** | **1.14** | **2.64** |
| | [0.007] | [0.127] | [0.023] |
| EDUCATION | **-5.20** | -0.60 | -4.60 |
| | [0.187] | [0.853] | [0.387] |
| CHOICE_EXPERIMENT | **-79.15** | -0.52 | **-78.63** |
| | [0.157] | [0.983] | [0.126] |
| CONTINGENT_VALUATION | -60.07 | 10.78 | **-70.84** |
| | [0.297] | [0.704] | [0.161] |
| R-squared | 0.32 | 0.27 | 0.18 |
| Adjusted R-squared | 0.20 | 0.15 | 0.04 |
| F-statistic | **87.90** | **75.71** | **1.96** |
| | [0.000] | [0.000] | [0.0229] |
| MWTP | **80.53** | **38.42** | **42.10** |

**Figure 18** and **Figure 19** present the Annual Marginal WTP per household, disaggregated by Ecosystem Service and Bio-Geographical Region for all three ecosystem specifications (Total, Terrestrial and Marine & Fresh water), respectively. **Figure 20** provides a map of the European Biogeographical Regions.

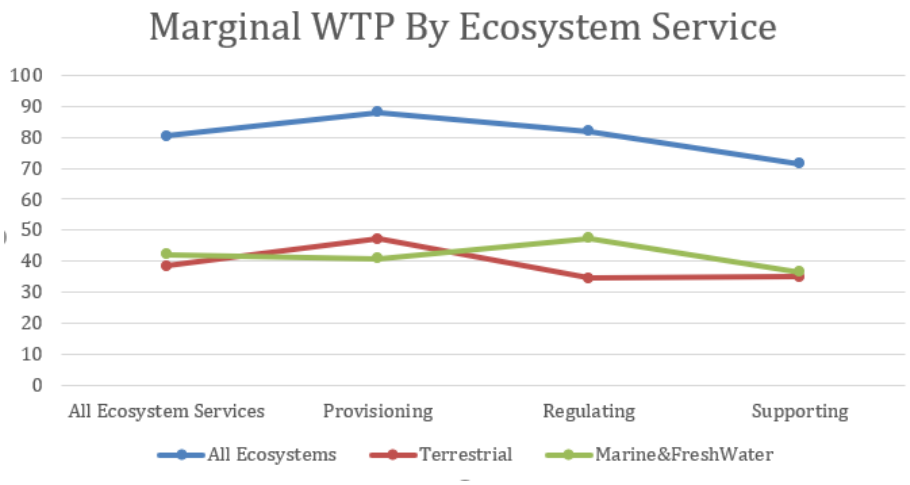



*Figure 18 Annual Marginal WTP by Ecosystem Service*

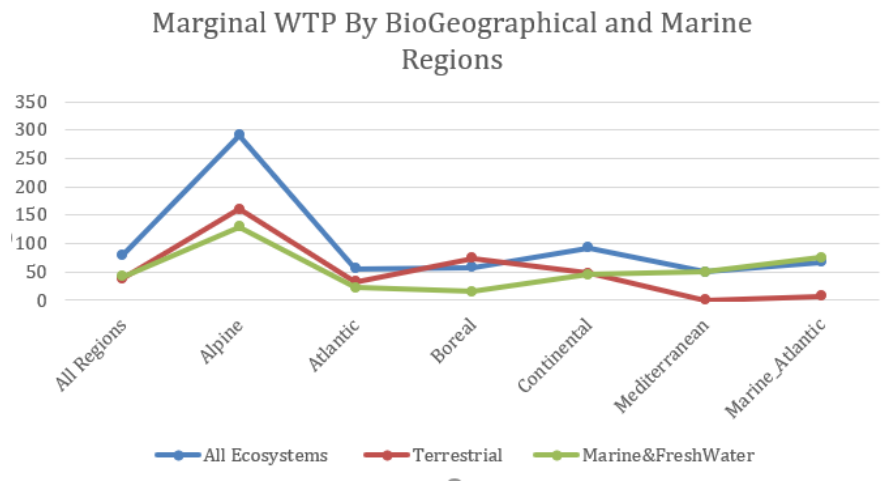



*Figure 19 Annual Marginal WTP by Biogeographical Region*

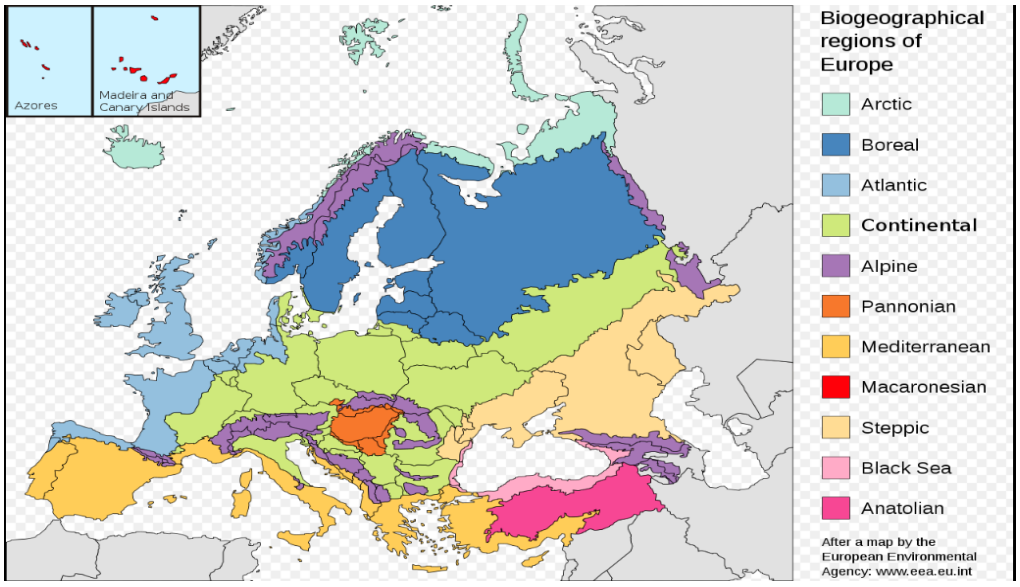



*Figure 20 European Bio Geographical Regions. Source: European Environmental Agency*

**Figure 21** presents the Marginal Willingness to pay at the national level disaggregated in Ecosystems (Terrestrial and Marine & Fresh Water. For the socioeconomic variables of the benefit transfer function (age and education), data for the year 2020 for all countries were collected from Statista (Median age of the world population 2020) and OECD (Share of people with tertiary education in OECD countries 2020). The classification of countries into Bio Geographical Regions follows the definitions by the European Environmental Agency. For all countries that mainly refer to a region not included in our model[12], we normalize all the relevant dummy variables to add to 1.

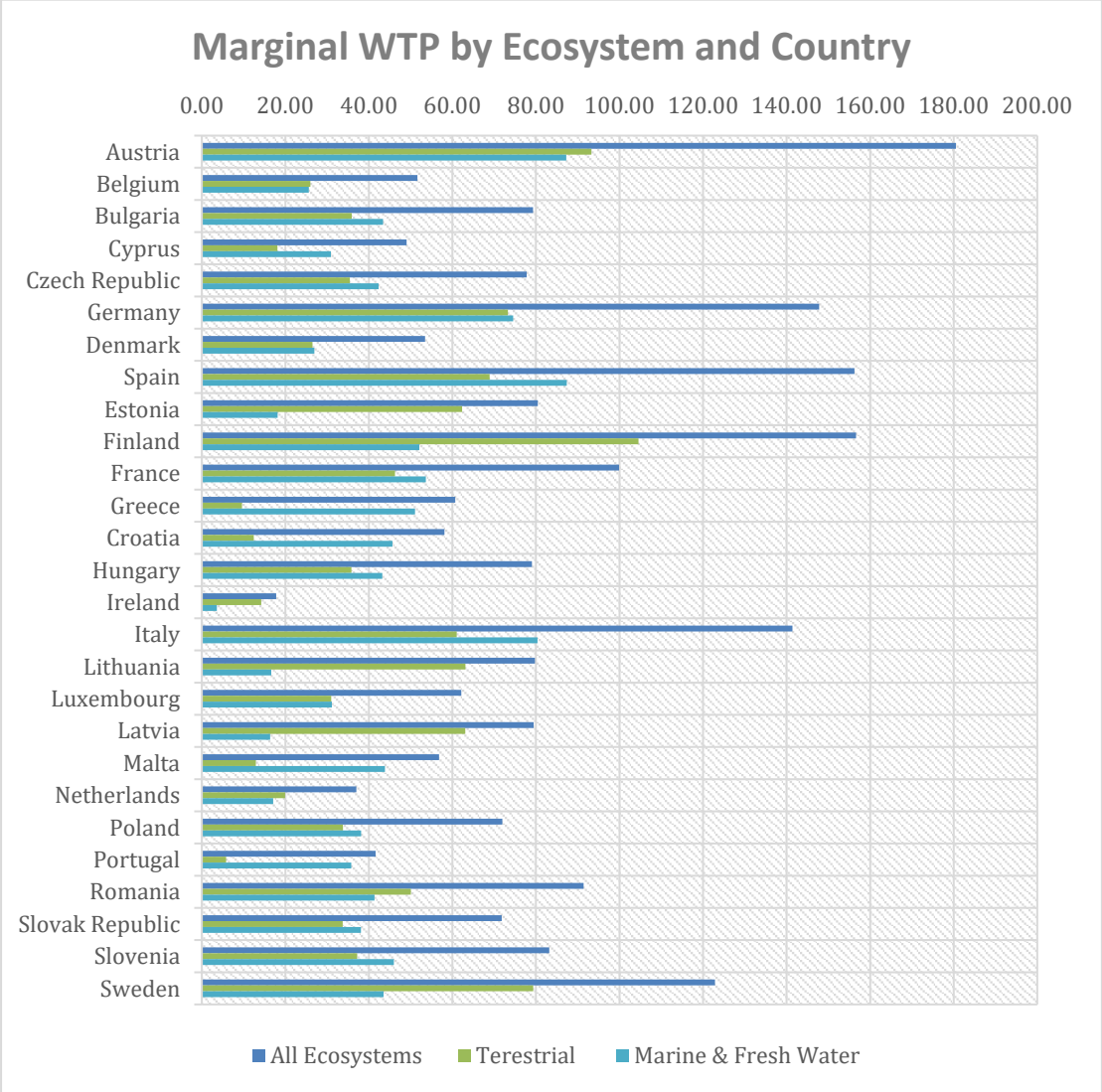



*Figure 21 Marginal WTP by Ecosystem and Country*

A quick conclusion that can be drawn from observing figure 21 is that in almost 63% of European countries (17 out of 27), the willingness to pay for the improvement of the marine & freshwater ecosystem exceeds that of the terrestrial ecosystems.

The reason why this is happening needs further investigation, which is beyond the scope of this report. However, one possible explanation, may be that the citizens of these countries

[12] For example for Hungary which is classified as Pannonian, we set all the biogeographical dummy variables included in our model equal to 0.2.

recognize that marine and aquatic ecosystems are at greater risk of collapse than terrestrial ecosystems, so they are willing to spend part of their income on the restoration or restoration of aquatic ecosystems. Another possible explanation is that the citizens of these countries are dependent on the marine or aquatic ecosystem, e.g. due to fishery production, tourism, etc., to a greater extent than terrestrial, and are willing to bear the cost of maintaining these ecosystems in good condition.

**Figure 22**, **Figure 23**, and **Figure 24** present the national WTP estimates disaggregated into three ecosystem services (Provisioning, Regulating and Supporting).

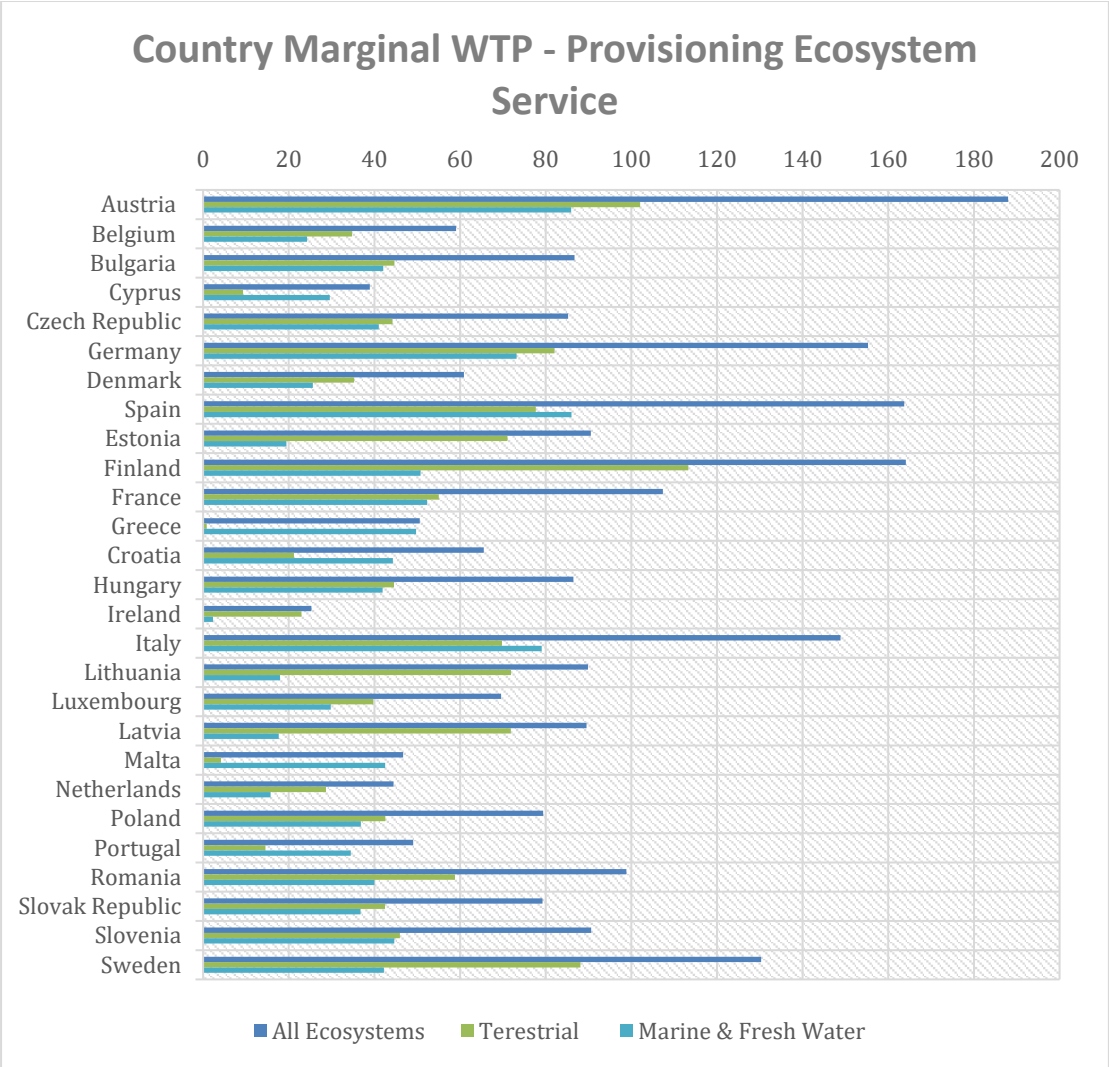



*Figure 22 Marginal WTP - Provisioning Ecosystem Service by Country*

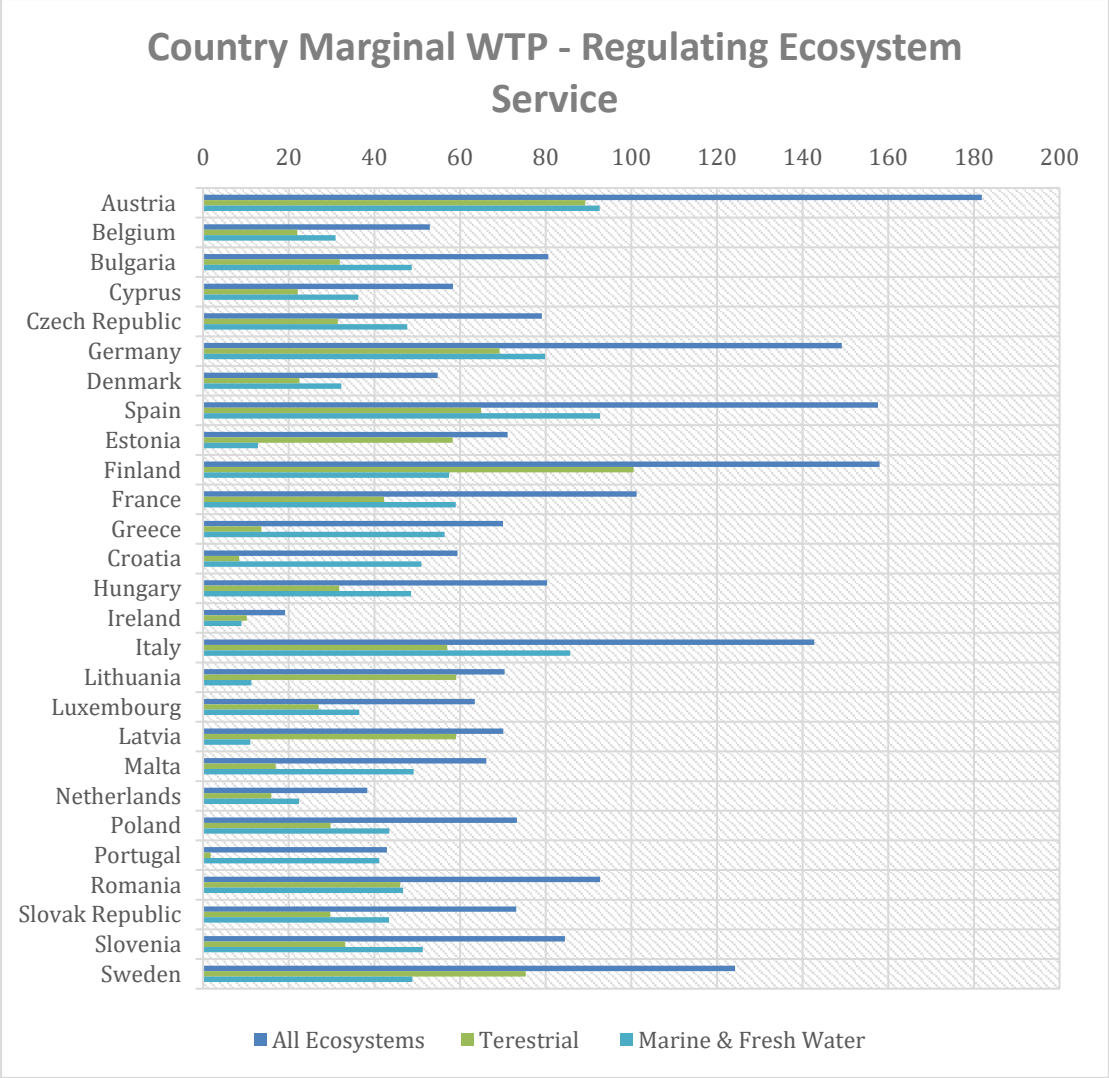



*Figure 23 Marginal WTP - Regulating Ecosystem Service by Country*

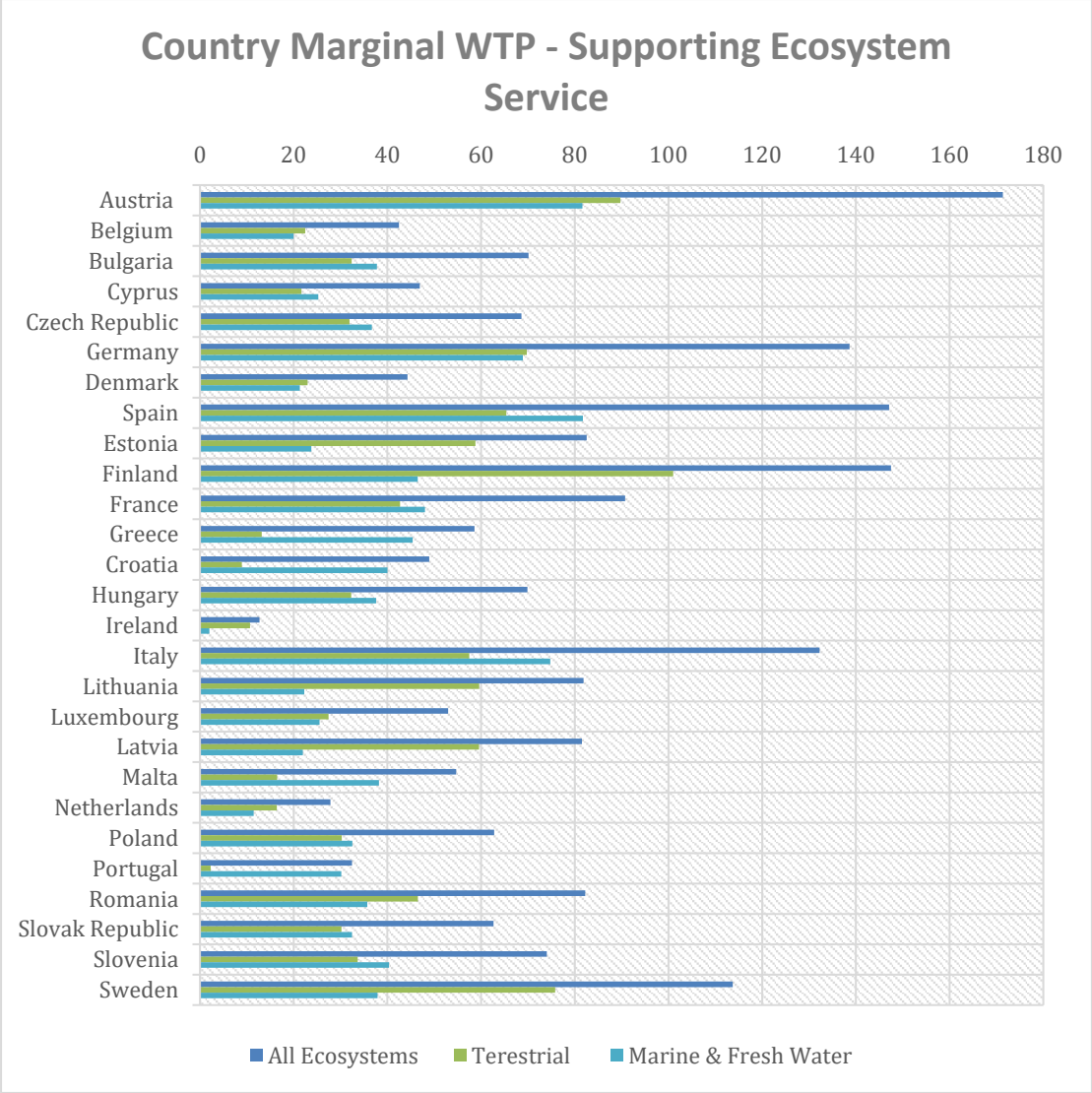



*Figure 24 Marginal WTP - Supporting Ecosystem Service by Country*

*Valuing Ecosystem Services and Sustainable Development*

Finding a balance between socioeconomic development and ecosystem services is a crucial challenge for sustainable development (**McCartney, 2014**).

In this subsection we examine the correlation between willingness to pay and the level of achievement of 17 SDGs overall, for the 27 countries of the European Union.

For the calculation of Correlation, we used the scores per SDG of each country from the UNSDSN Sustainable Development Report Europe 2021[13], and the MWTP per country calculated above.

In each of the following figures, the first entry with the label "SDG Index Score" refers to the aggregated Score for all 17 goals, while in the following entries refer to the cross-sectional (27 countries) correlation between WTP estimates and 17 SDG Score (s).

A **positive correlation** means that a high level of MWTP is associated with a high level of achievement of a specific SDG. The closer the correlation is to value 1, the stronger the association. Conversely, a **negative correlation** means that a high (or low) level of MWTP is associated with a low (or high) level of achievement of a specific SDG. Again, the closer the correlation is to the value -1, the stronger the (negative) association.

**Figure 25**, **Figure 26, Figure 27**, and **Figure 28** present the cross-sectional correlation coefficients between national MWTP estimates and SDG Index Scores and the Scores for all the 17 Underlying goals for all ecosystems and the three ecosystem services categories, respectively. Data for the SDG Scores were obtained from SDSN. Analysis was also performed using rank correlations with similar results, available upon request to the authors.

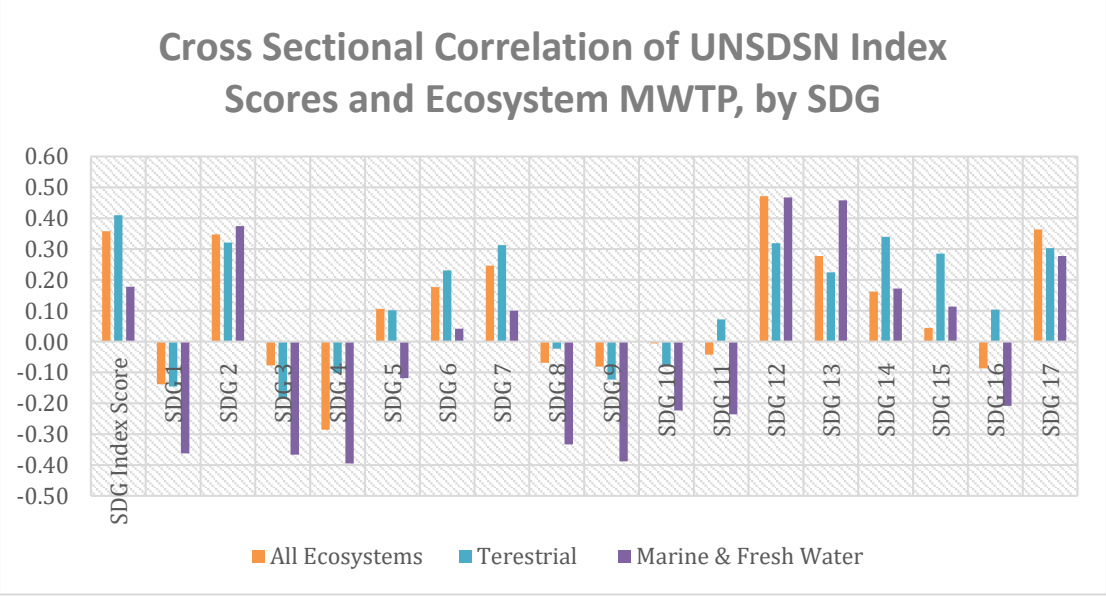



*Figure 25 Cross Sectional Correlation of UNSDSN Index Scores and Ecosystem MWTP, by SDG*

[13] https://eu-dashboards.sdgindex.org/profiles

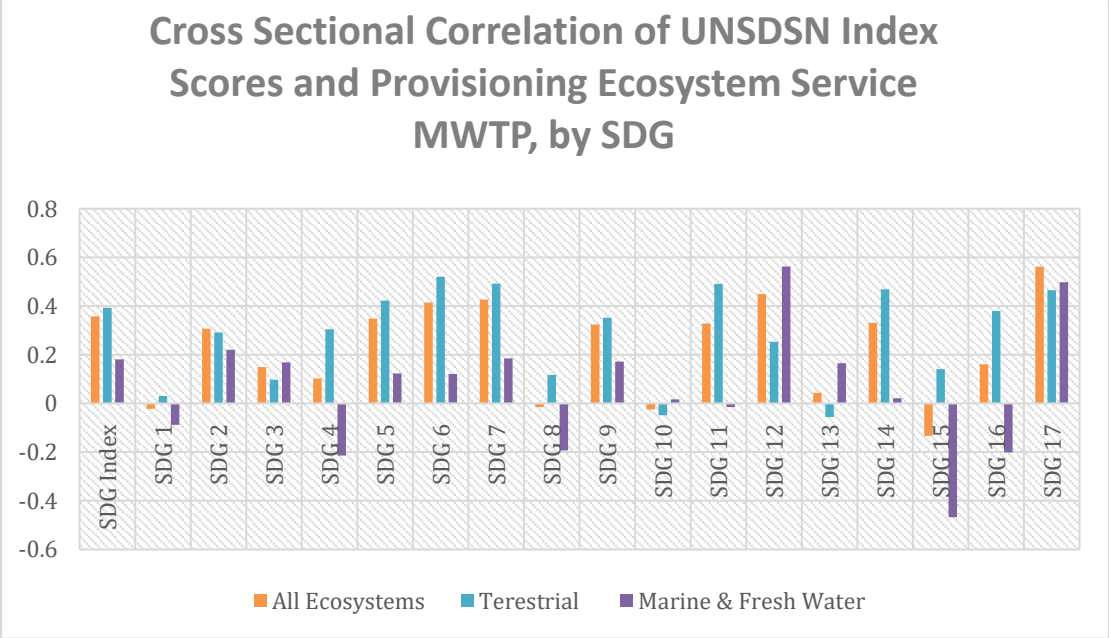



*Figure 26 Cross-Sectional Correlation of UNSDSN Index Scores and Provisioning Ecosystem Service MWTP, by SDG*

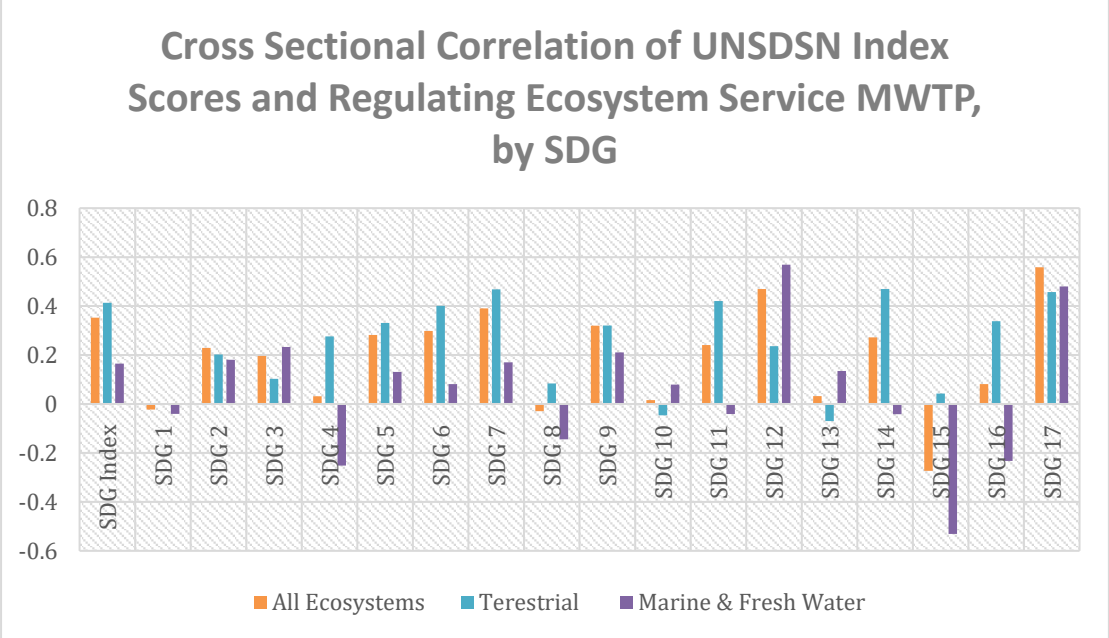



*Figure 27 Cross-Sectional Correlation of UNSDSN Index Scores and Regulating Ecosystem Service MWTP, by SDG*

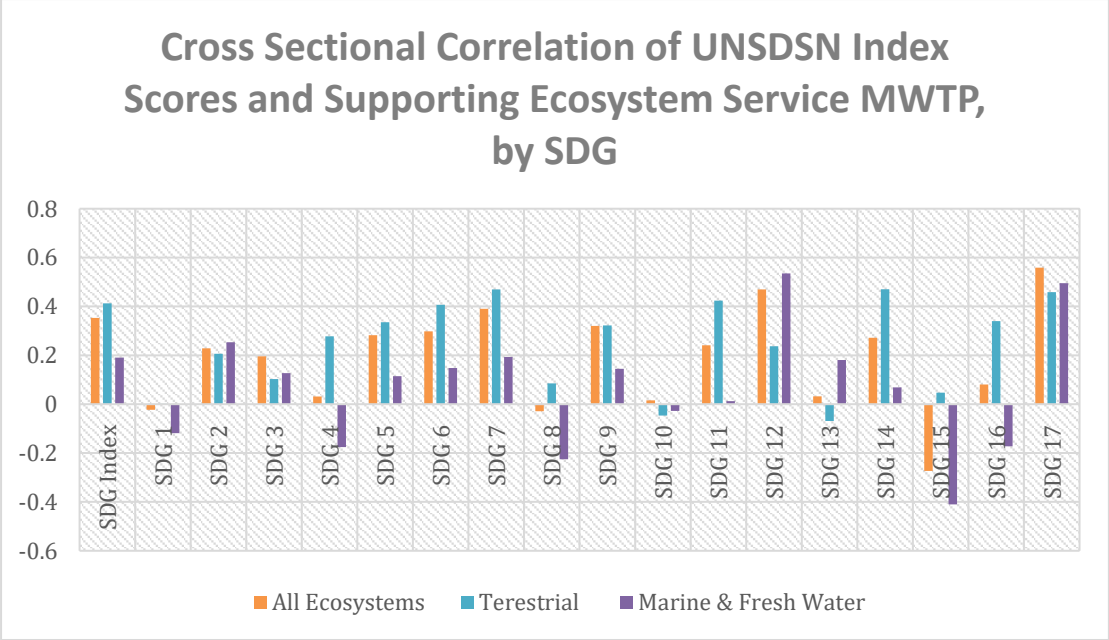



*Figure 28 Cross-Sectional Correlation of UNSDSN Index Scores and Supporting Ecosystem Service MWTP, by SDG*

## 3.3. Private and public progress toward ecological transition: policy issues and best practices

### 3.3.1. "Progressonomy" instead of "taxonomy": A simple dynamic policy approach to address ecological transition

*Metrics for DNSH (a "progress-onomy more than a taxonomy")*

The global public's bad about global warming is one of the main worries of humankind for the coming years and decades. Global warming is caused by the emission of carbon dioxide ($CO_2$) and other greenhouse gases such as methane and nitrous oxide into the atmosphere. The atmospheric concentration of $CO_2$ and other greenhouse gases grows, mainly due to emissions associated with anthropic activities. At the current level of emissions, the greenhouse effects pose the severe threat of increasing the temperature above the 1.5°C and 2°C degrees targets set in the Paris Agreement.[14]

To tackle this challenge, the European Union has set the ambitious goal of net zero emissions by 2050 from the around 4 billion tons of $CO_2$ equivalents emitted per year.[15] This goal requires a dramatic change in consumption and production styles in five main fields: energy production and transmission, agriculture, manufacturing (especially in hard-to-abate sectors), house cooling and heating, and mobility. The carbon abatement marginal cost curve tells us that the path toward net-zero emissions is flat for its first half, with transition costs that are feasible for the industry. After this first half, however, prices of transition rise steeply, and the path becomes hardly affordable, even though the carbon abatement marginal cost curve moves to the correct year by year due to the fruits of environmentally friendly technological progress.

To successfully tackle the net-zero emission challenge, we need to innovate and profoundly change existing economies and related production and consumption patterns. However, as is well known in the literature, most mitigation in $CO_2$ equivalent emissions occurs not by adapting the existing productive capital stock but by replacing it with more energy-efficient means of production through new investment. This is why we propose in this section an approach for creating corporate incentives consistent with ecological transition and proportional to the mitigation effect of new investments. More specifically, we suggest providing public funds (either in the forms of guarantees or subsidized loans) to new investments in proportion to their capacity to reduce carbon dioxide emissions.

We devise a practical approach to activate the guarantee or the subsidy based on minimum admissible thresholds of progress in $CO_2$ abatement and adherence to the "Do Not Substantially Harm" (DNSH) principle introduced with the EU Taxonomy[16]. Once principles have been identified, the next step is to define metrics and indicators applicable to the purpose (Becchetti et al. 2022).

[14] The Paris Agreement | UNFCCC 2030 Climate Target Plan | Climate Action (europa.eu)

[15] Total greenhouse gas emission trends and projections in Europe — European Environment Agency (europa.eu)

[16] EU taxonomy for sustainable activities | European Commission (europa.eu)

More specifically, we set two criteria for investment eligibility to the guarantee/subsidy compared to the counterfactual (i.e., the business as a usual scenario without the investment):

i) The investment must improve climate change mitigation (reduction of greenhouse gas emissions) above a minimum per cent threshold consistent with reaching net-zero emissions by 2050.
ii) The investment must produce a "green Pareto improvement" fulfilling the DNSH principle, i.e., without worsening other environmental areas.

The definition of fit-for-purpose metrics and indicators is crucial for successfully implementing this approach.

To support new investment decisions, environmental, social, and governance (ESG) criteria set the most relevant DNSH domains for sustainable finance (**Migliorelli, 2021**). As pointed out by several studies (**Yilan G., Cordella M., Morone P.**), reliable metrics and guidelines are needed to provide credible information about companies' sustainability claims by addressing environmental topics and activities related to sustainable finance. Several metrics and KPIs exist and enable an assessment and monitoring of investments (**Parmenter D., 2015**).

A landmark at the European level is represented by the recent EU Taxonomy Regulation (later referred to as "Taxonomy"), which aims at defining the minimum criteria that economic activities should comply with to be considered environmentally sustainable, with the ultimate goal of facilitating sustainable investments among financial market participants and improving the non-financial disclosure. Criteria of the Taxonomy address six objectives: (1) Climate change mitigation; (2) Climate change adaptation; (3) Sustainable use and protection of water and marine resources; (4) Transition to a circular economy; (5) Pollution prevention and control; (6) Protection and restoration of biodiversity and ecosystems.

For those objectives, the Taxonomy establishes that an environmentally sustainable economic activity must contribute to the substantial improvement of at least one environmental goal and DNSH the other purposes. However, defining all possible investment types for the six DNSH domains and finding agreement among the EU Member States on the proposed taxonomy can require a long time and compromises. Furthermore, there is a risk that a taxonomy becomes obsolete when it is eventually completed since technological innovation has created new investment types not covered by the taxonomy itself.

To keep our approach practical and impact-oriented, we do not refer to a full-fledged taxonomy defining specific requirements for each admissible investment type. Instead, we build upon and complement the Taxonomy by offering an approach which is:

1. Consistent with the ecological transition goal of reaching net-zero emissions by 2050 – essentially a dynamic goal expressed in terms of the rate of change.
2. Based on the assessment of rates of changes in the six DNSH domains of the Taxonomy, where we define key performance indicators (KPI) to evaluate the potential effects produced by the investment.

The approach (see **Table 13**) consists of the identification and quantification of a set of enhanced KPIs, defined referring to life cycle assessment (LCA), which can allow companies, as well as policymakers, to assess the environmental sustainability performance of new investments from a system-thinking perspective, i.e., considering all upstream activities

necessary to materialize an investment (e.g., producing and installing a solar panel in a building) and the post-investment effects (e.g., using and maintaining the solar panel until the end of life management process).

The KPIs, which can be flexibly updated to reflect future methodological and political developments, are designed in a modular way and can be used both by large companies and small and medium enterprises. Indeed, a crucial issue for the successful introduction of such metrics is whether costs of adoption are affordable, especially for small and medium-sized enterprises (SMEs), given that corporate social responsibility (CSR) reporting can quickly transform itself into a competitive barrier for SMEs when fixed costs of reporting are too high. We find that this is the case, as shown by data from **Table 14**.

**Climate change mitigation (Objective 1)**

The first KPI measures the improvement of investment in terms of climate change mitigation (Objective 1 of the Taxonomy). This corresponds to the 'net emission of GHGs', measured as kg CO2, eq. and characterized based on their Global Warming Potential over 100 years **(Zampori L. and Pant R., 2019, EU Commission, 2021)**. Additional KPIs are set to fulfil the DNSH principle, mirroring the objectives of the Taxonomy (see below).

**Climate change adaptation (Objective 2)**

Climate change adaptation entails complex modelling and assessment of climate scenarios and associated risks on ecological, social and economic systems (**GIZ, 2014, ISO14080:2018, ISO14090:2019, ISO14091:2021**). A simplified qualitative indicator is proposed for this area that takes vulnerability and adaptive capacity factors into account.

**Sustainable use of water and transition to a circular economy (Objectives 3 and 4)**

In a circular economy, wastes are recycled into resources, either through technological or natural ecosystem feedback mechanisms, to preserve the stock of resources (**Peña C. et al., 2021**).

A variety of circular economy metrics exist (**Moraga G. et al., 2019**), including both absolute and relative indicators of different levels of complexity, with ISO/TC 323 on 'Circular Economy' currently working on the development of harmonized metrics.

Among the most complex indicators, some aim to measure the relative circularity of product systems and organizations **Ellen MacArthur Foundation; Razza F. et al., 2020)**, while others differentiate materials by taking their scarcity into account (e.g. Abiotic Depletion Potential) **(Zampori L. and Pant R., 2019)**.

Considering that the goal of a circular economy is an overall reduction of natural resources consumption and non-recyclable waste generation (**Cordella et al., 2020**), four KPIs addressing specific elements of circularity are considered (separately):

1. Depletion of fossil fuels [MJ]
2. Depletion of non-renewable primary materials [kg]
3. Production of non-recyclable waste [kg]
4. Water footprint – scarcity corrected [$m^3_{eq.}$ of water]

**Pollution prevention and control (Objective 5)**

Pollution prevention and control refers to a broad set of indicators and methods described in the Environmental Footprint (EF) method recommended by the European Commission **(Zampori L. and Pant R., 2019)**. Such indicators address multiple targets (e.g., human health and quality of aquatic and terrestrial ecosystems). A set of KPIs was selected to (separately) consider effects associated with the emission of key pollutants such as particulate matter (PM2.5), non-methane volatile organic compounds (NMVOCs), nitrogen oxides (NOx), sulfur oxides (SOx), and ammonia (NH3). These include:

- 'Emission of particulate matter (PM)', measured as disease incidence (**UNEP, 2016a**) model).
- 'Photochemical ozone formation', measured as kg NMVOCeq. (LOTOS-EUROS model).
- 'Acidification', measured as mol H+eq. (Accumulated Exceedance model).
- 'Freshwater eutrophication', measured as kg Peq. (EUTREND model).

**Protection and restoration of biodiversity and ecosystems (Objective 6)**

Protection and restoration of biodiversity and ecosystems is an area partly addressed by the indicators presented so far and mainly affected by land-use changes (**Marques A. et al., 2019**). Land uses different from original natural states (e.g., primary forests) can result in a dramatic loss of biodiversity and ecosystem services (**García-Vega D. and Newbold T., 2020**). The need for protecting land areas and primary forests is highlighted, among others, in the recent Biodiversity Strategy of the European Commission (**European Commission, 2020. COM(2020) 380 final**).

Parameters that can reflect these aspects are, for instance, the net area of land (green areas excluded) directly transformed (m2) or used (m2a) for delivering certain functions, including deforestation/afforestation activities. Indirect land-use change is another crucial aspect to consider, where there is, however, an inherent level of uncertainty (**Finkbeiner M., 2014**).

Biodiversity equivalence factors for different types of land use have also been developed (**Huijbregts M. A. J. et al., ReCiPe2016**). However, methodological development efforts are required to satisfactorily evaluate impacts on biodiversity (loss/abundance) and ecosystem services in a systematic way (Crenna et al., 2020; Huijbregts et al., 2016; Zampori and Pant, 2019; European Commission, 2021b).

To reflect these aspects, the following parameters are (separately) considered:

- Direct land use for anthropic activities (m2a), measuring the extension of land directly occupied for anthropic activities related to the investment project (e.g., urban areas, industrial activities) and not covered by green areas.
- Net deforestation balance (ha), measuring the difference between the area directly deforested to sustain the investment (positive value) and the area reforested or afforested (negative value).

Whenever it comes to evaluating the use of public resources, the issue of additionality comes in. We must wonder whether resources made available for the purpose are well used and not wasted. In our case, the relevant question is whether the private sector would have nonetheless executed the green investment even without the guarantee/subsidy. On this point, evidence on the upward sloping carbon abatement marginal cost curve tells us that costs of ecological transition can be prohibitively high for companies if they are not supported

by public investment. In addition, even though investment in environmental change can produce benefits in the long run, short-termism and dependence on management to stay in power from short term outcomes can discourage them from choosing this path of action. The recent theoretical and empirical literature supports the hypothesis that public support creates significant additionality effects in ecological transition. In their "green directed technological change" theory, **Acemoglu et al. (2012)** show that government support is essential to foster the environmental transition. Countries lagging in it are forced to provide more public resources in the future to reach the right ecologically consistent expansion path. **Becchetti et al. (2022)** perform an inquiry on the Italian Multiscopo survey on the universe of medium and large firms and a large representative sample of small firms accounting for 84.4% of the national added value, employ 76.7% of the total workforce and 91.3% of Italian employees. Their research shows with a propensity score matching approach that the introduction of EU and domestic investment subsidies rose to 20 % of the share of companies choosing environmentally friendly investment in 2018.

*Table 13* ***Key Performance Indicators considered in the first version of GIFT. Note: KPIs were defined with reference to a primary environmental objective. Due to the interconnected nature of the environment, KPI can also influence other objectives.***

| *Objective* | *KPI (unit)* | *Methodological references* |
|---|---|---|
| *1. Climate change mitigation* | I1. Net emission of GHGs (kg $CO_{2,eq}$) | Calculation of life cycle GHG emissions to and removals from the atmosphere, and characterisation of their overall Global Warming Potential over 100 years (GWP100) based on the IPCC model, as described in EF (**Zampori and Pant, 2019**). |
| *2. Climate change adaptation* | I2. Climate change vulnerability proxy (dimensionless) | Characterisation of the vulnerability of the analysed system through the quali-quantitative assessment of its exposure (E), sensitivity (S) and adaptation capacity to extreme climatic events (adapted from **GIZ (2014)).** |
| *3. Sustainable use and protection of water and marine resources* | I3. Water scarcity footprint ($m^3_{eq.}$) | Calculation of the overall water consumed from a life cycle perspective, corrected for its scarcity according to the AWARE model, as described in EF (**Zampori and Pant, 2019**). |
| *4. Transition to a circular economy* | I4a. Consumption of fossil fuels and non-regenerative biomass (MJ)<br><br>I4b: Consumption of primary minerals (kg)<br><br>I4c: Production of non-recyclable waste (kg) | Calculation of a) consumption of fossil fuels and non-regenerative biomass, b) consumption of primary minerals, c) production of non-recyclable waste, adopting an LCA perspective aligned to EF (**Zampori and Pant, 2019**). |
| *5. Pollution prevention and control* | I5a. Emission of particulate matter (disease incidence)<br><br>I5b. Photochemical ozone formation (kg NMVOCeq.)<br><br>I5c. Acidification (mol H+eq.)<br><br>I5d. Freshwater eutrophication (kg Peq.) | Calculation of life cycle emissions of pollutants of concern (e.g., PM2.5, NMVOCs, NOx, SOx, NH3) and characterization of the impacts associated with emission of particulate matter (UNEP (2016a) model), photochemical ozone formation (LOTOS-EUROS model), acidification (Accumulated Exceedance model), freshwater eutrophication (EUTREND model), as described in EF (**Zampori and Pant, 2019**). |
| *6. Protection and restoration of biodiversity and ecosystems* | I6a. Direct land use for anthropic activities ($m^2a$)<br><br>I6b. Net deforestation balance ($m^2$) | Calculation of a) direct land-use (green areas excluded) related to the investment project, b) difference between direct deforestation (positive value) and reforestation/afforestation (negative value), adopting an LCA perspective aligned to EF (**Zampori and Pant, 2019**). |

*Table 14 Costs in EUR of CSR reporting for different sizes of companies*

| Type of company | A. Cost for conducting a LCA study | B. Cost for quantifying GIFT's KPIs for an investment* | C. Other costs (digital platform, audit, certification) * | D. Total costs in case no LCA information is available (D=A+B+C) | E. Total cost in case LCA information is available (E=B+C+D) | D as % of net sales ** | E as % to-F ratio ** |
|---|---|---|---|---|---|---|---|
| Type I: | | | | | | | |
| - Net sales (F): < EUR 100 million | 10,000-18,000 | 1,800-3,000 | 1,000-1,500 | 12,800-22,500 | 2,800-4,500 | 0.013%-0.023% | 0.003%-0.005% |
| - Products/services offered: < 10 | | | | | | | |
| Type II: | | | | | | | |
| - Net sales (F): EUR 100-1000 million | 12,000-20,000 | 2,000-3,500 | 1,000-1,500 | 15,000-25,000 | 3,000-5,000 | 0.003%-0.005% | 0.001%-0.001% |
| - Products/services offered: 10-50 | | | | | | | |
| Type III: | | | | | | | |
| - Net Sales (F): > EUR 1 billion | 20,000-30,000 | 2,800-4,000 | 1,000-1,500 | 23,800-35,500 | 3,800-5,500 | 0.002%-0.004% | 0.0004%-0.001% |
| - Products/services offered: < 100 | | | | | | | |
| Type IV: | | | | | | | |
| - Net Sales (F): > EUR 1 billion | 30,000-50,000 | 3,500-5,000 | 1,000-1,500 | 34,500-56,500 | 4,500-6,500 | 0.003%-0.006% | 0.0005%-0.001% |
| - Products/services offered: > 100 | | | | | | | |

* The cost implies that the ESG evaluator makes at least 100 evaluations per year.

** EUR 100 million for type I, EUR 550 million for type II, EUR 1 billion for types II and III.

### 3.3.2. The removal of environmentally harmful subsidies: issues at stake

For a long time, world countries discussed the removal of "Environmentally Harmful Subsidies" (from now on, EHS), which are grants or tax reductions that benefit consumers and producers by increasing their incomes or reducing production costs but have an overall negative effect on the environment (**OECD, 2005**). Despite this, their removal would have a significant positive impact on government budgets, on the level of greenhouse gas emissions and pollution and the overall welfare of the society – leading to a more efficient resource allocation and sustainable growth – progress in this direction has been slow, and subsidies are still an issue in most countries.

The current Covid-19 economic crisis provides a unique opportunity to put new momentum behind this agenda, considering the increase in fiscal expenditures, the problem required, and the need for fiscal consolidation and budgetary discipline in the coming years. Therefore, removing EHS will be an essential source of revenues that governments can seriously consider in this historical economic period.

The main reason beyond the slow removal of EHS relies on the high-cost policymakers face when attempting to eliminate them. In addition, their disposal will generate direct adverse effects on target beneficiaries and a high effort is required of policymakers to identify the EHS that can potentially improve social welfare and avoid widespread disapproval, that in some cases can even lead to social riots and political instability, as happened with the Yellow Vests movement in France.

Despite it, there is a long list of countries worldwide attempting to reform EHS, and from their positive experience, there is a lot that can be learned. For example, there has been a slow removal of energy subsidies in Indonesia. In Northern European countries, there has been an implementation of environmental tax reform packages, reducing implicit subsidies. For example, company car taxation schemes have been introduced in Belgium, the Netherlands, and the United Kingdom; in Sweden, such a measure has been accompanied by a tax exemption for biofuel vehicles.

Good practices can be learned from these successful examples, which can help policymakers overcome the many hurdles faced while attempting to remove EHS.

First, introducing such reforms requires a high level of transparency and good quality information. The impact existing subsidies have on the environment, the cost they impose on society, and the beneficial and distributional effect of the proposed reforms have to be communicated clearly to the public to generate civil and political support.

Second, compensatory measures, for example, through cash transfers, can also increase public acceptance of the proposed reform where the money saved through the reform is at least partially transferred to groups that used to benefit from the subsidy. Such practice has been adopted in the Netherlands, where part of the tax revenues from the removal of red diesel subsidies has been transferred to the agricultural sector through green subsidies. However, while such compensation can lower social costs, individual damages and political protests do not affect individuals' behavior. For example, in the case of the reform of commuter subsidies in the Netherlands, the relatively favorable fiscal treatment of company cars and commuting costs covered by employers lessened the impact of the proposed reform.

Third, compensatory practices can also have a broader scope. Sometimes, the removal of a subsidy can hit a whole industry and linked economic segments. In this case, the policymakers can intervene through measures aiding both employees and self-employed workers in the hit sectors to find other jobs or activities in alternative sectors. For example, this kind of compensation can be applied in the framework of coal mining subsidy phase-out in several countries, pushing the industry composition of the communities toward a greener, sustainable growth path.

Finally, legislation and commitments at an international level are also important. Coordinated action is indeed required to accelerate reforms worldwide by reducing the loss of competitive disadvantage in the short run that may arise from reform efforts that occur at different periods and building civil support for the process from as wide a range of actors as possible.

*An example of the Italian case*

In Italy, the Ministry of the Environment (now Ministry of Ecological Transition) provides a detailed classification of environmentally harmful subsidies (EHS) every year. According to it, environmentally harmful subsidies amount to around 19 billion euros, while 6.5 billion euros are subsidies of uncertain classification and 15 billion euros environmentally favorable subsidies (**Table 15**). The most relevant item relates to subsidies for diesel on car vehicles, with the latter being taxed less than gasoline car vehicles. The government has created an inter-ministerial commission to examine all EHS and identify those whose removal was considered politically feasible. The excluded EHS have been those related to truck drivers and agricultural activities. In the end, the commission identified a subset of EHS that could be eliminated. The most important of them is diesel car vehicles. The proposal was a ten-year progressive upward adjustment of taxation up to the level of that of gasoline car vehicles. The evaluation of the impact of such measures (based on the average yearly diesel consumption of car owners) has been no more than a few hundred euros per year. In addition, the commission has evaluated a proposal for full reimbursement of such costs by creating a green voucher for the corresponding amount that diesel car owners could use to purchase environmentally sustainable goods and services. The proposal has been regarded as technically feasible given the domestic experience of cashback on credit cards already in operation.

From a theoretical point of view, the approach would have been based on a Slutsky decomposition between income and substitution effect. As is well known, according to Slutsky, any change in the price of a given good can be decomposed into a substitution effect (a difference in the relative cost of that goods concerning any other interest or to the average price level of a bundle of goods) and an income effect (based on the ex-ante bundle of goods purchased by a given consumer the increase in the price of already consumed goods has a negative income effect while a reduction of the price a positive income effect. The rationale is that there is not enough income to purchase the previous consumption bundle after the price change in the first case; there is additional income in the second case.

The proposal of total compensation with the green voucher would eliminate (fully compensate) the negative income effect of diesel price increase on diesel car owners while leaving the substitution effect unchanged. The result would be that the incentive to reduce consumption of the less environmentally friendly energy source given by the substitution effect (change in relative price) would remain. In contrast, the negative social impact of the policy would have been eliminated with the neutralization of the income effect.

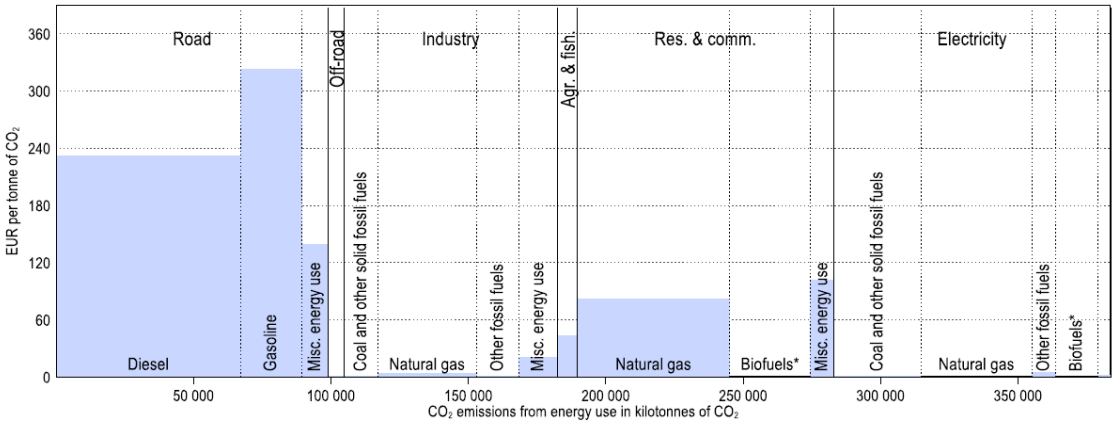
*Table 15 Characterization of environment-related subsidies in Italy*

| | (million €) | |
|---|---|---|
| | 2017 | 2018 |
| Environmentally harmful subsidies | 19.195,34 | 19.748,44 |
| Uncertain classification | 6.552,20 | 8.649,83 |
| Environmentally favorable subsidies | 15.224,65 | 15.305,64 |
| Total | 40.979,19 | 43.703,91 |

### *An alternative OECD perspective*

The suggestion of OECD takes a different way. It starts from the principle of "taxing bad and not goods", which translates into the idea of shifting taxation from labor to pollution. In Italy, there is no direct carbon tax but a system of green and white certificates so that companies have to pay to pollute, and certificates can be exchanged on the market. The OECD calculates the implicit carbon tax paid by households and firms based on the ratio between taxation and polluting emissions. What comes out is that families pay a high implicit carbon tax due to the stratification of following steps of tax increases on gasoline and diesel to increase revenues for the government budget without specific reference to pollution (Figure 29). As a result, the choice of levelling diesel and gasoline taxes does not address the issue of designing the proper incentives for the corporate system and does not consider that taxation on the household is already very high. Therefore, the OECD proposal creates a carbon tax for corporations (i.e. from a base of 60 euros per ton of CO2) that is progressively raised by 10 euros per year. However, the aggregate revenues should be used to reduce the tax wedge on labor. The suggestion closely follows the policy adopted in Germany in the last decade. As is always the case, any policy decision must consider political and social reactions. The problem with this policy is that it is budget balanced in aggregate but not for individual companies. If such removal is proportionally spread across all firms, companies in hard-to-abate industries will presumably have a higher tax take offset by a less than proportional tax reduction on labor. The solutions can be two. The first is that of netting out at the industry or firm-level the difference between a higher tax on pollution and a lower tax on labor. The second is adding to this choice a premium for companies in hard-to-abate sectors.

The idea is to introduce Contracts for Carbon Differences in these sectors. CCDs work as follows: the government commits to a premium of 150 euros for any tons of CO2 avoided. The premium is divided between the avoided carbon tax and a government payment in cash. For example, if the carbon tax level is 80 euros, the government adds 70 euros to achieve the 150 euro premium fixed in advance. The CCDs approach can reward actual outcomes in terms of ecological transition instead of expected results, as in the case of the incentives to DNSH consistent investment explained above. A second advantage is that there is an implicit incentive for an increase in the carbon tax to reduce the government outlay.




Note: The figure includes emissions from the combustion of biomass.

*Figure 29* ***Effective energy tax rates in Italy in 2018 across sectors. Source:*** *OECD (2021)*

### 3.3.3. Best practices in an ecological transition

*Co-written with Laura Berry, Adriana Kokornik-Mina and Martin Rohner*

The dramatic challenges of ecological transition urgently require a mix of policy instruments and financial markets that promote sustainable production and consumption patterns. The transition can be successful if fostered by a blend of proper regulatory changes, environmentally friendly incentives and voluntary choices of financial intermediaries. The rationality of forward-looking economic actors can in itself be a strong, even not sufficient, stimulus to this change since the inheritance of rules moving in the opposite direction (such as environmentally harmful subsidies) and the hysteresis and costs of changing production processes of important actors of the market can slow down the transition.

To contribute positively to this process, we propose the first draft of examples of green finance best practices that can inspire and stimulate further fostering of ecological transition.

Dissemination of best practices has a fundamental inspiring role, and it seeds hope. It is easier to say “yes, we can” if we come to know that someone has already done it somewhere. Of course, the best practice in a given country of the world does not guarantee that the same experience can be exactly replicated in another geographical area, given the heterogeneity in local conditions and concurring factors. Nonetheless, the best practice can inspire innovators to start similar experiences adapted to local needs in other parts of the world. The value of best practices in green finance is even higher. In some cases, we deal with processes (i.e. active shareholders for sustainability) that can be replicated. The best practice is a new financial contract or financial package that can be easily standardized and reproduced in other parts of the world and, if needed, modified and adapted to the different local frameworks and conditions.

In what follows, we briefly describe some of the most promising experiences of green finance around the world, try to outline some common characteristics that can be an ingredient of further advancement in the field and draw some policy implications from them. We also indicate guidelines to progress in this work from our first draft by creating a G20 sustainable finance hub where green finance best practices can continue to be exchanged through a codified and defined process.

*Global Alliance for Banking on Values (GABV)*

The Global Alliance for Banking on Values is a movement of innovative leaders and frontrunners in the banking industry who holistically and intentionally use the money to finance change, having integrity, human dignity and environmental and social impact at the core of their business model. While our members are highly diverse, they have one thing in common: a shared mission to use finance to deliver sustainable development, focusing on helping individuals fulfil their potential and build stronger communities. Our members also understand that financing change is not enough and that a paradigm shift is needed. Thus, they proactively lead the transformation of banking and finance in their respective countries and communities.

The GABV counts 64-member banks with EUR 200 billion combined assets under management, serving over 60 million people worldwide. Research shows that values-based banks are financially more resilient than the Global Systemically Important Financial Institutions (GSIFIs) due to their clear and explicit focus on sustainability and the real economy.

The Partnership for Carbon Accounting Financials (PCAF) is an example of the GABV's ability to scale up transformation: PCAF has become the world's leading initiative for financial institutions to measure and disclose greenhouse gas (GHG) emissions of lending and investment portfolios to reduce their climate impact. As a result, 118 banks and asset owners representing over EUR 30 trillion in assets have signed up. The GABV has been instrumental for PCAF in reaching this goal.

Intentionality, ambition, coherence, and accountability are the key ingredients for genuinely sustainable and transformational finance. ESG will not work if the criteria are not sufficiently ambitious. A sustainable and green product offer will not impact if harmful activities continue to be financed. The GABV stands ready to engage with policymakers and regulators based on its global experience in sustainable and values-based finance.

For over 20 years, UmweltBank has been using its customers' money exclusively to finance environmentally friendly and social projects, mainly in **renewable energies** and **ecological and social housing**. UmweltBank is committed to offering only products and doing business that visibly promote the goal of a world worth living in. To guarantee this, UmweltBank has developed far-reaching positive and exclusion criteria. These provide the framework for all activities of the UmweltBank, including credit approvals. UmweltBank is committed to all 17 United Nations Sustainable Development Goals but is focused on its core business to goals 7, 11 and 13. Projects must have a positive SDG influence and must not display significant controversy in one or more social and ecological criteria (exclusion criteria).

In terms of loans for **building constructions**, every project is reviewed for its economic viability and ecological and social criteria. The rating system is based on a detailed catalogue of criteria that is divided into two categories: on the one hand, construction criteria such as energy efficiency, resource conservation and climate protection, and on the other hand, social aspects such as co-responsibility, integration into the neighborhood and mobility. The credit conditions are based on the premise: The better the environmental rating, the more favorable the loan. The goal is to create affordable, ecological housing and energy-efficient commercial properties.

One example of financed affordable, ecological housing is the project "City quartier Güterbahnhof" in the German city Tübingen. Of the 157 flats, 93 belong to social housing. These are rent-controlled for 25 years and are priced one third below the rent index. They are only available to tenants with a housing entitlement certificate. One-third of the subsidized flats were occupied by unemployed people, another by single parents with children and the last third by student families. The freely financed apartments are also offered at rents below the market level. The construction project meets the social and ecological requirements of UmweltProjekt AG: all flats require only 40 per cent of the energy of a comparable existing building.

UmweltBank pursues the vision of "100 per cent renewable energy" through financing projects in renewable energy. All financed projects support the transition to a carbon-neutral, sustainable economy. UmweltBank's current most significant investment to date in energy projects, regarding the installed capacity, is the "Solar park Schornhof" near the city of Ingolstadt. It currently is the largest solar park in Bavaria with an installed capacity of 120 MWp, of which 90 MWp are Power Purchase Agreement-backed. The $CO_2$ savings of the project amount to 82,000 tonnes.

### *Shareholders for change*

Public shareholders' long, influential tradition of activism has been deeply aligned with the global public good for over 50 years. The idea of responsible, sustainable capital and the expectations of forward-looking investors may well have originated with religious investors in the early 1970s.

The history of this activism began in 1971 when institutional investors in North America began to exercise their rights as shareholders in the fight against apartheid in South Africa. At that time, the abhorrent policy of apartheid, the legislated segregation of races in South Africa, became a clarion call to action for faith communities. In 1971, the Episcopal Church in the U.S.A. filed the first justice-inspired shareholder resolution with General Motors, the world's largest corporation by market capitalization. The longtime institutional investors were newly minted shareholder activists. Their proxy resolution asked the company to withdraw its operations from South Africa until apartheid was abolished. Other faith organizations joined their campaign and organized themselves as the Inter-Faith Committee on Social Responsibility in Investment. Many consider this to be the moment the responsible investment movement was established. The original committee became the Interfaith Center on Corporate Responsibility, now the leading voice in global shareholder activism on topics as far-reaching as climate change and the energy transition, human trafficking and modern-day slavery, healthcare inequality, and pharmaceutical pricing.

Since that time, investors around the globe have experienced the persuasive power of the shareholder's voice as multinational companies adopt more just and sustainable policies and practices that honour the license to operate afforded them by society at large. Green finance can benefit enormously from the best practices developed by these shareholder coalitions and policies to strengthen the investor's voice, and engagement will accelerate advancement in the field toward the shared goals of all forward-looking economic actors. In this section, we reinforce the necessity of policy guidance to maintain the unmistakable voice of shareholders to ensure green finance takes hold.

Although the anti-apartheid movement is frequently cited as the progenitor of today's global movement to divest from fossil fuels, shareholder power has as its core the ownership interest

of shareholders. There has been a tremendous value in the impact of divestment movements, particularly in coalition building and delivering a message driven by deeply held moral principles. However, divestment movements are built upon moral choices to "opt out". The question posed by green finance and forward-looking ethical actors is how to "opt-in" to best practices as participants in public markets. Avoiding "sin stocks" of companies or entire sectors has traditional roots in religious tradition and practice. Avoiding companies engaged in practices contrary to one's ethical framework is always a choice. Divestment from whole industries that have the potential to cause significant harm, such as the current fossil fuel divestment movement or liquidating positions in companies unwilling to change practices after years of exposure and engagement, is to be celebrated as ethical choices. The future of green finance requires investors to "opt-in" for better options.

There has been a considerable fascination with the increasing efficacy of shareholder engagement. With the expansion of analysis of environmental, social and governance factors, the issues taken on by shareholder activists are expanding. Given the urgency of the global climate crisis, the current COVID19 crisis and increasing worldwide inequality, it is no surprise that the role of investors is subject to closer scrutiny.

In one ethnographic study, **Ferraro and Beunza (2018)** described their experience observing how ICCR investors voice their concerns to companies whose shares they own. They sought to explain how investor activists influence companies to change business practices and act more responsibly. They took a closer look at "shareholder engagement."

Rather than confrontational tactics such as boycott and protest, shareholder engagement is an approach in which investors conduct dialogues with corporate management, "engendering mutual respect between shareholders and management." Over time, this process described as "sensitizing" allowed the investors to reframe issues, articulating the business case for more just and sustainable practices. Both the investors and management were then willing to commit to a long-term relationship where value for the company could be created, one that "breached" the long-standing organizational inertia that has prevented change. These steps, sensitizing, reframing, committing and breaching, have proven so effective that in 2017, an independent regional coalition was launched to meet the needs of European investors.

This three-year-old shareholder coalition, Shareholders for Change (SfC), exemplifies the evolution in shareholder activism, adopting ICCR's decades-long learning to meet the needs of European investors. The alliance has grown to represent a dozen members and over $25 billion. The story of this nascent coalition may well guide the ways policymakers can support the incorporation of investors' voices to strengthen green finance and the march toward more sustainable and just economies. When SfC was launched in 2017, it had main objectives: staying administratively light and introducing new issues and strategies to companies, issues other global coalitions had not yet taken on. Acknowledging organizations like PRI and the ICCR worked closely with European investors, neither had the specific goal of engaging European investors with European companies. However, with newly developed platforms for online interaction and data collection, SfC realized an opportunity to connect without creating additional burdensome administrative infrastructure. This approach has proven to be prescient, as global activists have confronted the COVID19 pandemic.

In a recent **Engagement Report (2020)**,[17] President Aurélie Baudhuin of Meeschaert Asset Management (France) writes that the coalition succeeds on both fronts. Driven by original research, SfC has developed engagement strategies on two "orphaned issues": tax avoidance in the telecommunications sector and the ESG risks linked to the extraction of rare metals. Both issues were at the forefront of challenges faced in the pre-pandemic world, and both have been exacerbated in these challenging times.

The same report highlights the range of issues taken on by SfC members, through individual and collective engagement efforts, including forced labor in supply chains of the European information and communication technology companies, exposure to fossil fuels of destructive bond issues, governance issues throughout a wide variety of global companies, engagements with governments acceding the UN Biological Weapons Convention, to name a few. **One could argue that policymakers could predict tomorrow's emerging economic issues by focusing on the activities of today's shareholder coalitions. As regulatory frameworks are developed, including a mechanism by which these investor voices are heard would strengthen the likelihood of sound and forward-looking policy.**

Despite the challenges posed by the restrictive operating environment, SfC engaged 100 companies and one country on issues related to climate/environment, governance and executive remuneration, human rights/worker rights and tax practices. 80% of the engagements were with companies based in Europe. These engagements occur via three routes; network-driven, single member-led teams or engagement by a single member on behalf of the entire coalition. Each approach requires investors to access information and key indicators to engage and monitor progress. **Transparency initiatives and reporting standards are critical to investor efforts' success; thus, continued attention to rule-making favouring investors' access to high-quality data and reporting taxonomies is essential for meaningful progress.**

Finally, much engagement work depends on how investors can reinforce engagement activities with access to public areas such as a company's Annual General Meeting (AGM). Although this past year was exceptional, **any policies that improve shareholder access to formal governance structures, such as proxy statements and in-person AGMs, are important avenues through which these important issues are brought forth to strengthen companies' efforts to operate in compliance with ESG best practices.**

*Private green bonds*

On the international scene, BlackRock - the world's largest investment firm with approximately $8 trillion in assets under management - has recently embarked on a long series of initiatives geared toward sustainable investing. By way of example, BlackRock has integrated and enhanced the measurement of ESG criteria into the investment strategies it offers over the past year.

The firm is also involved in the growth of the green bond market: as of March 31, 2020, BlackRock held more than $16 billion in green bonds. To increasingly promote these instruments, it has developed a proprietary taxonomy that assigns a color to each green bond on a scale from very light green to dark green depending on the intended use of the bond's

[17] https://www.shareholdersforchange.eu/wp-content/uploads/2021/12/SfC-ENGAGEMENT-Report2021-DEF.pdf

proceeds, the associated environmental benefits, and its issuers' commitment to impact allocation and reporting.

BlackRock is also an active market participant member of the ICMA Executive Committee on Green Bond Principles.

ICMA, which groups lending and investment institutions worldwide, launched working groups on sustainable finance long ago, particularly on green bonds.

The Association has developed the so-called Green Bond Principles (GBP), in addition to the Social Bond Principles (SBP) and Sustainability Bond Guidelines (SBG), a set of voluntary guidelines that were initially developed in 2014 and updated regularly most recently in 2018[18].

The principles are intended for broad market use: they guide issuers on the critical components of launching a credible Green or Social Bond; they help investors by ensuring that the information they need to assess the environmental and social impacts of their green and social bond investments is available, and they assist underwriters by moving the market toward standardized disclosures that facilitate transactions.

In October 2019, the Executive Committee in charge of the Principles established a working group on Climate Transition Finance with a mandate to consider, among other things, what a climate strategy would mean for issuers and how to assess the consistency between the plan and corporate spending. The Committee also established a working group on Sustainability Bonds to examine them in-depth and develop guidance for issuers. According to the definition developed by ICMA, these instruments are intended to finance both environmental and social projects, thus becoming a kind of hybrid between Green and Social Bonds.

As for Italy, a central player is Cassa Depositi e Prestiti (CDP), issuing ESG Bonds since 2017 and has developed the so-called “Green, Social and Sustainability Bond Framework” based on principles developed internationally by ICMA. The proceeds of the bonds issued by CDP are linked to sustainable objectives such as urban development and new essential infrastructure, support for SMEs, social housing and energy transition (CDP, 2020).

Similarly, Intesa San Paolo has launched several experimental initiatives that have led to the issuance of two Green Bonds[19].

The first, issued in June 2017 for 500 million, is related to financing projects dedicated to renewable energy and energy efficiency. According to the 2020 Report, 76 loans were granted, mainly in photovoltaic and wind power projects and hydroelectric and biomass. For instance, in the Province of Ferrara, the construction of a biomethane plant was financed.

Instead, the second Green Bond was issued in late 2019, with a stated focus on the circular economy. Specifically, proceeds are directed towards financing solutions that extend the life cycle of products (12.5%), employ recycled resources in manufacturing (36.9%), improve resource consumption efficiency (32.7%), contribute to the design and manufacture of recyclable or compostable products (5.6%), and support innovative circular economy technologies (12.3%).

[18] https://www.icmagroup.org/sustainable-finance/

[19] https://group.intesasanpaolo.com/it/sostenibilita/ambiente/prodotti-servizi-verdi/Green-bonds.html

Other institutions which undertook experimentation are Etica SGR and Poste Italiane. The former offers ethical investment funds with different risk profiles and is divided into two thematic categories: climate change and ESG. On the other hand, Poste Italiane has adopted responsible investment policies in its Poste Vita and Bancoposta Fondi SGR businesses. The group, therefore, follows ESG and Responsible Investment Principles (PRI).

The "SACE Guarantee" recently introduced by Decree 76/2020 can also be considered an essential element in the attraction of sustainable investments: in fact, the regulation envisages the possibility of issuing State-backed guarantees for circular economy projects, the reduction of emissions and sustainable mobility; a measure of particular importance for small businesses that often lack the necessary liquidity for these investments[20].

*Green Minibonds*

The largest source of capital for small and medium-sized companies in the banking sector, in its various forms. According to Thomä et al., non-commercial banks are better suited for these companies than commercial banks. Among the main reasons: are a greater propensity for long-term non-bank loans, lower denominations, and a more widespread presence on the territory. Therefore, it is essential to ensure the so-called banking diversity to facilitate access to green finance for SMEs.

As for bond issuance, although there are dedicated platforms, in most cases, they involve larger-than-average SMEs, even exceeding the size of an SME. Bonds indeed can allow medium-sized companies to "scale up" and access even greater capital. To meet the needs of small companies, the so-called Mini Green Bonds could be decisive, along the lines of what has already happened in Italy with the Minibond market (Extra-MOT Pro)[21]. According to the Polytechnic of Milan, although Minibonds have costs that are not always competitive with traditional bank loans, they are a valuable tool to allow SMEs to diversify their sources of funding, acquire new skills and opportunities in the financial market and signal openness and transparency to the market (**Osservatorio minibond, 2019**).

In a study on sustainable finance, the European Commission has defined the Italian initiative of the Minibond Market as a "best practice" and has indicated Mini Green Bonds as a valuable complement to "standard" Green Bonds to increase access finance for SMEs. However, the Commission warns of the possible risks for investors and points out the need to strengthen the risk management aspects (**EU Commission, 2016**).

According to the **World Bank (2017)**, national governments should develop guidelines for SME lending, including providing technical assistance in assessing standards (something the Ministry of the Environment is experimenting with). Investors and lenders, in turn, should continue to develop systems for measuring environmental and social risks and impacts. At the same time, companies could implement green policies internally and throughout the value chain (for example, by requiring higher sustainability standards from suppliers).

[20] https://www.sacesimest.it/media/comunicati-e-news/dettaglio-news/green-new-deal-una-nuova-missione-per-sace

[21] https://www.borsaitaliana.it/notizie/focus-small-cap/strumenti/cosa-sono-i-minibond.htm

*Government green bonds*

According to the last report of the Climate Bond Initiative, the total amount of private and government green bonds totaled an adjusted **USD257.7bn** in 2019, a 51% increase from the previous year[22] .

Government green bonds are purpose-oriented bonds that aim to stimulate environmentally sustainable government expenditure and find the best financing conditions by meeting investors willing to pay for ecological transition. The market for government green bonds is significantly growing and evolving toward high-quality standards. The best practice consists in the preliminary issue of a green bond framework where governments communicate transparently to investors the main characteristics of their future issues. The framework is built together with independent third parties that release a final opinion on it. The dialogue with independent third parties is a stimulus to include in the set of admissible investments only those with high green standards to have a better reaction from green investors and to earn a negative premium for brown bond equivalents (i.e. non-green bonds with the same maturity characteristics). Quality factors of government green bonds include a significant share of financial resources directed to new innovative projects, standard yearly reporting, ex-ante evaluation and ex-post impact analysis of the financed investment.

*Central banks and green finance*

Other relevant financial actors, such as Central Banks, are coordinating and contributing to the implementation of green finance: the Network of Central Banks and Supervisors for Greening the Financial System (NGFS), created in 2017, is one of the fora where this is happening. More recently, the European Investment Bank (EIB) announced that by 2021 it will stop financing fossil fuel-based projects and that it will mobilize 1 trillion euros in sustainable investments.[23]

The European Central Bank (ECB) announced that by 2021 it would accept green bonds as collateral with payouts linked to sustainability goals and include them in its asset purchase schemes[24]. “Green Quantitative Easing” effects are considered part of the Bank monetary policy decisions for the post-COVID-19 recovery (**Ferrari and Nispi Landi, 2020**).

We believe that, shortly, Central banks are going and should include green characteristics together with the return, risk and liquidity as leading criteria in their reserve management strategies, thereby giving a further stimulus to green finance

### 3.3.4. Policy implications for enhancing the development of best practices

A first straightforward policy implication is that the development of non-financial reporting can be a solid stimulus for communication and dissemination of best practices, a set of indicators that can help organizations and companies to monitor their progress in ecological transition, which is nowadays a fundamental part of their competitiveness. However, further reflection is needed to understand whether its development goal should be left to voluntary

[22] https://www.climatebonds.net/resources/reports/2019-green-bond-market-summary

[23] https://www.eib.org/en/press/all/2019-313-eu-bank-launches-ambitious-new-climate-strategy-and-energy-lending-policy

[24] https://in.reuters.com/article/us-ecb-policy-climatechange/in-green-shift-ecb-to-accept-and-buy-sustainable-bonds-idINKCN26D1C0

mechanisms or supported by mandatory rules enforcing non-financial reporting for companies above a given size threshold. An intermediate tool can be a system of incentives that can positively affect reporting decisions.

A fundamental common characteristic of best practices is that they combine the common goal of profit creation with those of social and environmental impact. Therefore, it is essential to reform our legal systems to accommodate the move toward multidimensionality of organizational and corporate goals and to broaden too narrow boundaries that limit corporate action to the interest of shareholders.

The ecological transition will be successful if it changes the behavior of households and companies toward responsible consumption and production (i.e. goal 12 of the UN Sustainable Development Goals). A system of green subsidies or tax allowances can significantly help achieve this goal, as shown by the economic literature on green directed technological change. Green investment involves incorporating new technologies and, therefore, higher informational asymmetries between investors and financiers than under conventional investment. This is why subsidies can have a significant role in reducing higher costs of external finance or financial constraints when investment, as is most often the case, cannot be self-financed. The need for green subsidies can be higher, especially in cases (small firms and firms working in less developed areas) where financial asymmetries and entrepreneurial risks are higher.

## 3.4. Sustainability of Assets under Management - Financing the Green Recovery

### 3.4.1 The Urgent Need to Fund the SDGs

The global coronavirus pandemic spotlighted our global interdependencies and interconnectedness, reinforcing the urgency of meeting the United Nations Sustainable Development Goals (SDGs) and representing a potential red line between a carbon past and a cleaner, more empowered future. The coming transition period between these two eras calls for unprecedented responses by states, organizations, and individuals.

The 17 SDGs represent a baseline level of progress that needs to be achieved in the next decade to establish a sound foundation of sustainable development for future generations. However, with less than a decade to go until the 2030 target date, the achievement of the SDGs is today at serious risk. And with the goals being deeply interconnected, the failure to address any one of them hinders progress on others. This interconnectedness also creates systemic risk for the world should the goals be missed, creating a potentially vicious circle of environmental degradation, political upheavals, economic disruptions and conflict, and human security risk, making the need to meet the SDGs an urgent one for the world.

### 3.4.2. Funding Requirements…and Gaps

Continued underspending, the increasing actual costs of meeting the goals, and the setbacks suffered due to the global coronavirus pandemic are all widening the overall SDG funding gap previously estimated at US$4.2 trillion per annum[25]. However, a more recent bottom-up estimate that included the costs of meeting increasing commitments under the Paris Agreement and the cost of creating financial inclusion and prosperity for large parts of the world found that the actual funding gap was likely twice as high or more.

The actual SDG funding gap is estimated to range from US$8.4 trillion to US$10.1 trillion, equal to 9-11% of the estimated 2021 global GDP[26]. This compares to an estimated current annual spending against the SDGs of US$3.2 to US$4.1 trillion[27], bringing the total yearly cost of achieving the SDGs to US$11.6-14.2 trillion every year through to 2030 (**Figure 30**).

[25] OECD, 'Global Outlook on Financing for Sustainable Development 2021'

[26] Force for Good: 'Capital as a Force for Good: Capitalism for a Sustainable Future', 2021

[27] UNCTAD 'World Investment Report 2014' Estimates updated for global inflation 2014-2020

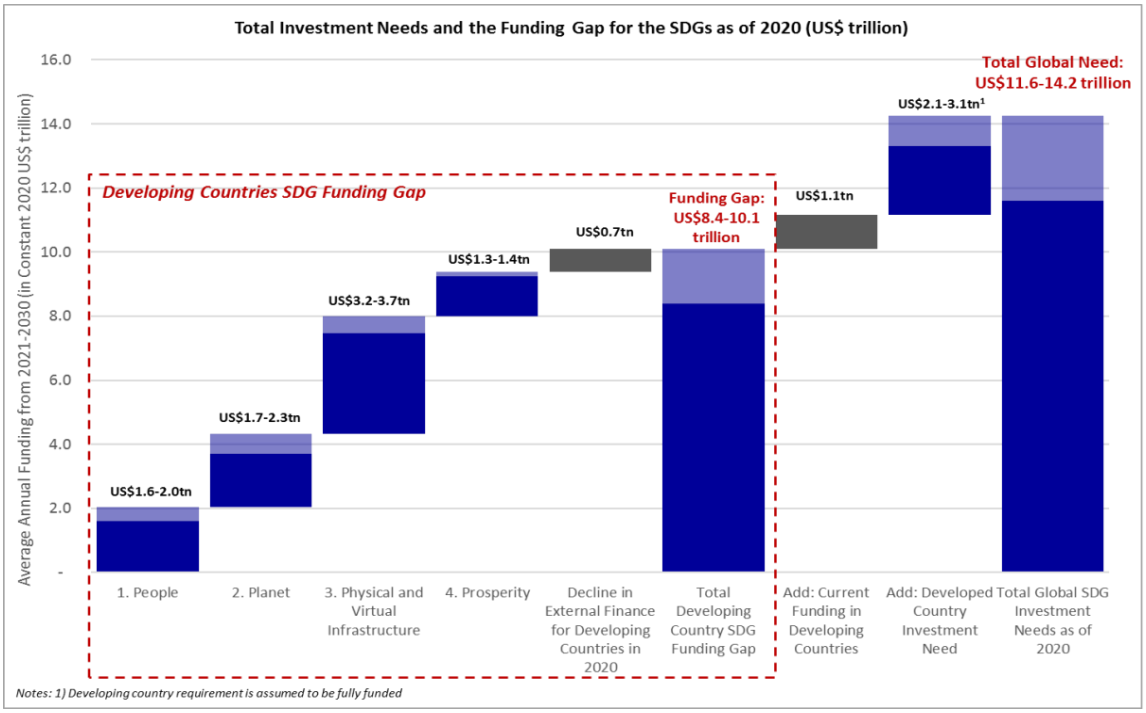



*Figure 30 The Annual Sustainable Development Goal Funding Gap*

An analysis of current spending against the SDGs highlights that the overall volume of financing is insufficient but that its allocation is imperfect. In 2020, 40 of the world's leading financial institutions that have committed explicitly to supporting the SDGs deployed a record total of US$2.1 trillion of capital in furtherance of the 17 goals (**Figure 31**). However, despite these record amounts, their stated priorities in terms of individual SDGs under their strategies, fiduciary and commercial mandates, and the distribution of their funding points to gaps for consideration, particularly on specific SDG goals.

For example, while climate-related goals account for c.22% of the total SDG funding requirement, they receive c.44% of the current SDG funding deployed. This is to be expected, given that a strong business case has been established for renewables and green investing. However, the total funding need still exceeds current commitments, and the climate targets are unlikely to be met (even with sufficient funding) if the other SDGs relating to uplifting the developing world economically and socially are not sufficiently addressed.

While most institutions do not specifically indicate the location of their sustainability investments, it is apparent from the analysis of the disclosed information that most of the current spending appears to be allocated to advanced economies. This is natural for many reasons ranging from the location of the financial institutions and where carbon polluting industries sit (given the concentration of SDG funding on climate goals), but it leaves developing countries with more outstanding shortfalls in investment to address other SDGs.

There is a significant shortfall in funding for human, economic, and social SDGs. The SDGs related to these goals are materially underfunded, accounting for c.40% of the total need but only 32% of actual current funding by finance industry leaders. As the shortfall is unlikely to be made up elsewhere – from local government transfers, charities, government aid, international organizations, and other stakeholders – these goals stand to be unmet.

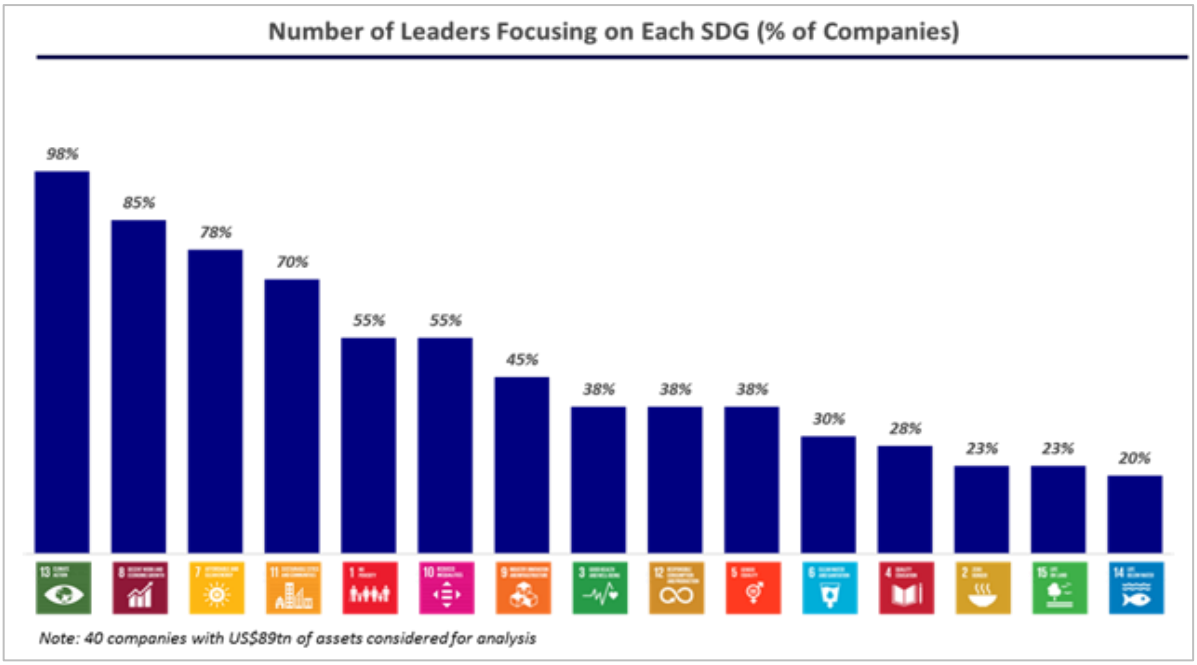



*Figure 31 SDG Focus and Spending by Finance Industry Leaders*

### 3.4.3. A Multi-Stakeholder Funding Effort, With an Overweight Role for the Finance Industry

Funding the US$84-101 trillion shortfall through 2030 is a challenge clearly beyond governments' capacity and ability to support and will require private sector capital deployed at scale.

On the positive side, the largest global financial institutions are rapidly scaling their commitments in this regard through multi-pronged engagement strategies. They are making investments using increasingly comprehensive ESG tools promoting businesses and activities related to the goals, increasing their sustainability financing, and engaging with stakeholders more broadly, particularly in community financing, to drive inclusion and prosperity. In addition, a small number of the largest institutions are breaking new ground in this respect, engaging in a 'race to the top' in both the depth and breadth of their engagement by developing the business cases that allow them to deploy their capital for both profit and impact (see inset).

**Race to the Top – Ground-breaking Commitments by Finance Industry Leaders**

**Trillion Dollar Financial Commitments to Drive the SDGs - US$7.0 trillion** of capital committed to the SDGs (by five institutions)

**Redefining Scale in Climate Change Commitments - US$690 billion** mobilized for environmental finance (by ten institutions)

**Driving Inclusion for Under-Served Communities - US$407 billion of community finance** for sustainable and inclusive deployed (by ten institutions)

**Championing Underfunded SDGs – US$104 billion of commitments** targeting neglected SDGs focusing on ending hunger, delivering clean water, and cleaning the oceans

**Prioritising Critical Social Issues - US$33 billion committed** to advance racial equality over the next ten years (by five institutions)

However, while the finance industry, as the steward of over 85% of the world's gross liquid assets, clearly has a critical role in funding sustainable development, it cannot solve the challenge alone, given the multi-stakeholder nature of both the SDGs and the financial system itself. For example, asset managers have a requirement to deploy capital following the mandates that clients sign up for, and these have parameters such as themes, sectors, geographies, returns, risks, and duration as part of the scope and limitations. Changing these factors is one that the client needs to be aligned on. Once the broad spectrum of specific issues is examined, it becomes apparent that solving the deployment of capital requires cooperation and is, therefore, a collective issue and needs a range of specific multi-stakeholder solutions.

Funding sustainable development and a transition to the future will require the coordination of governments, individuals, and private corporations beyond traditional financial services companies. Individuals own US$255 trillion of liquid assets and represent 80% of the world's consumption. Acting collectively, the individual can mobilize systemic change and redirect the global flow of funds. Unlocking this collective action will likely require technology platforms, mainly social media platforms, which have built deep relationships with over half the world's population, implying an essential role for 'Big Tech'. Further, despite their limited direct spending capacity, both developed and developing country governments have vital roles in unlocking development investment from the private sector, acting as arbiters of policy and bridges and as enablers for private capital. Development finance institutions, for example, have long invested in projects and countries where the risk-return requirements of financial institutions and their clients have excluded the private sector and so have the depth of experience. They also have a clear mandate to drive capital towards sustainability and development and partner with the private sector finance industry by filling gaps where it is not viable for private financial institutions to provide funding alone.

However, efficient collaboration between these parties will require a shared blueprint of goals, deliverables, roles, and actions for the world to own. This would need to include new rules of engagement, new principles of competition and collaboration, new regulations of resource management, and fiscal and monetary policy principles while encompassing a diverse range of national strategies, power blocs, and international coalitions. Such global blueprints have traditionally been the remit of the UN, which has convened its member states to build consensus on the most significant issues facing the world and promote united action.

Given the projected future flows of global capital, the UN will need to include the four major power blocs (initially the US, EU and China and, given its scale and rise, India) at an early point and will quickly need to expand beyond national governments to become a true global compact. However, existing political and economic structures are not on track to develop this blueprint for financing, despite its urgent priority.

### 3.4.4. Funding the Future – Key Themes for Execution and Investment

The capital to fund the SDGs, the future and the transition between the two cannot be mobilized as a charitable endeavor, funded by governments through taxes, or deployed at a loss by private sector investors. Hence, the vast majority of the world's capital requires investment themes where profits are made at sufficient levels to reward bold action and risk-taking, allowing for reinvestment in the future while providing for employment, taxes, social security, and pensions today.

Taking a lesson from the business case for climate change, simplicity is critical, and these need to make the SDGs more accessible. The SDGs can be grouped into four crucial financial investment platform categories: people, planet, prosperity, physical and virtual infrastructure, and an enabling one that cuts across them all, peace and partnerships.

The macro investment themes, from the work of 2021 'Capital as a Force for Good: Capitalism for a Sustainable Future' report, which conducted an extensive analysis of and engagement with 100 leading financial institutions, DFIs, tech companies and fintech businesses, indicating the scale of challenge and ambition required, whose funding will determine the shape of this global transition provide examples:

**I.** **Platform.** A better and more sustainable future platform for the world, including laying the foundations for the future. Key focus areas include:

- **Closing the SDG Funding Gap,** investing US116-US$142 trillion, an additional US$84-101 trillion, over the next decade, with major financial institutions partnering with other stakeholders to adopt the SDGs, particularly the most neglected
- **Mobilizing the Individual,** shaping the flows of US$49 trillion of annual household spending globally[28] as the individual becomes a responsible consumer and investor (reflecting the growing awareness and power of the individual as a collective and potential force for good)
- **Stakeholder Aligned and Resilient Companies,** influencing the priorities of the majority of global companies not yet fully aligned to the SDGs[29] (reflecting the resilience that comes with businesses that are relevant to the values of sustainability in the world and ready to tap the US$12 trillion business opportunities associated with the SDGs)[30]
- **Radical Energy Breakthroughs,** enabling a step-change in human civilization with energy sources that breakthrough in functionality while being clean, affordable, reliable, and abundant (funding the future energy for a new society).

**II.** **People.** Addressing basic human needs. Key focus areas include:

[28] [IMF, 2020] Individual consumptions is the consumption by households and non-profit institutions serving households (NPISH)

[29] World Economic Forum: 'UN Sustainable Development Goals: How Companies Stack Up', 2021

[30] Business & Sustainable Development Commission 'Better Business, Better World Report' 2017

- **Food and Water Security,** increasing global food production by 70% to meet rising demand by 2050, providing safe, nutritious, and varied food for 9.7 billion people (turning low productivity arable land into industrial-scale yield while maintaining farmer ownership)
- **Resilient Healthcare and Social Security Systems,** caring for the 3.9 billion people lacking access to critical healthcare services (recognizing universal health and social security as a fundamental human right)
- **Mass Education and Skill Development,** providing mass education, skills and better awareness and mental resilience using digital platforms to break the boundaries of location and local restrictions (a beyond schooling to a more inclusive, aware, and resilient population)

**III. Prosperity.** Creating shared prosperity. Key focus areas include:

- **Mass Financial Inclusion**, providing financial access and services to the 67% of the world's population that remains un- or underbanked (beyond basic bank accounts to meaningful inclusion in the financial system)[31]

**IV. Planet.** Saving the planet. Key focus areas include:

- **Mass Scaling of Existing Green Energy Solutions** replacing the 83% of global energy still generated by fossil fuels[32] with renewables
- **Regeneration of the Environment and Ecosystem,** renewing the 25% of global land that has been degraded[33] and cleaning cities and industries (enhancing the SDGs by also revitalizing urban and industrial environments for what has been destroyed, at scale) **V. Physical and Virtual Infrastructure—e**nabling human activity.
- **Reimagined Urban Life,** creating sustainable living for the 2.4 billion new urban inhabitants by 2050[34] in the face of migration within and across boundaries (beyond 2030, reflecting the rise in urbanization)
- **Global Digital Participation and Inclusion,** providing inclusion to the over three billion people without internet access[35xi] (a universal project beyond the agreed SDG goals of access to move forward together)

Realizing these themes holds the promise of a stable transition to a very different world from today's sustainable information age. This world would be one of the universals – universal connectivity, universal inclusion, universal education, and universal healthcare access – eliminating hunger, illiteracy, diseases, and countless unnecessary deaths. Such a world would also be one of abundance – abundant food and water, abundant energy, and great essentials – eliminating absolute poverty and creating economic opportunities for all. And such a world would be one of balance – with regenerated ecosystems and artificial and natural environments operating in harmony, balancing biodiversity and thriving communities.

[31] The World Bank Group, The Global Findex database, retrieved 2021

[32] BP, plc, 'Statistical World Energy Review 2021

[33] United Nations Convention to Combat Desertification 'Global Land Outlook (GLO)', 2017

[34] United Nations Conference on Housing and Sustainable Urban Development, Habitat III, 2016

[35] Datareportal: Digital 2021 Report

# 4. Sustainable Recovery and Resilience

## 4.1. Assessment of National RRPs and Comparison with Europe Sustainable Development Report 2021 Results

The European Union is among the pioneers pursuing the United Nations' Agenda 2030. As explained in Section 1, EU leaders integrated the SDGs into the bloc's formal annual procedures to coordinate national economic policies (the so-called European Semester process). In summer 2020, the EU responded to the challenges posed by the COVID-19 pandemic with a package of policies and funds to boost economic recovery while pursuing Europe's green transition. Several countries worldwide have announced similar packages since the summer of 2020, and there are several 'trackers' that assess ex-ante their compatibility with environmental or broader sustainability objectives[36]. However, few other countries or regions have announced medium-term programs (and not annual budgetary plans), covering the entire economy (and not just packages for specific economic sectors) and addressing recovery spending (and not just monetary relief spending). Therefore, the EU's approach can serve as a valuable case study to assess the consistency of short-and medium-term policy priorities with the officially declared long-term goals towards the sustainability transition.

The central part of the EU's legally adopted recovery package provides funds to the Member States according to specific National Recovery and Resilience Plans (NRRPs). These Plans contain investments and reforms that national governments submitted to the European Commission, the EU's executive body, in April and May 2021 (European Commission, 2021). Among other legal obligations, countries must align these plans with policy recommendations made by the Commission through the European Semester process. In addition, they must contain a minimum amount of funds devoted to climate policies and digitalization (at least 37% and 20% of the NRRP budget). However, EU countries were not obliged to align their NRRPs with SDGs. This lack of explicit linkage makes it challenging to assess whether the recovery packages indeed address all significant environmental, social and economic sustainability challenges in each country beyond the minimum requirements for climate- and digitalization-related spending.

This section presents a sustainability assessment of the NRRPs of seven South European Member States (Bulgaria, Croatia, Cyprus, Greece, Italy, Slovenia and Spain) submitted to the European Commission in spring 2021 and adopted by EU leaders in summer 2021. Altogether, they plan to receive more than 50% of the €338 billion grants made available by the EU's Recovery and Resilience Facility and an equally substantial portion of the €386 billion to be provided through loans. The number of measures and amount of grants depends on the size of each country but also on the structure of each NRRP. For example, Croatia and Slovenia grouped their interventions (investments and reforms) in a small number of total measures (16 and 22 measures, respectively), whereas Spain has presented 396 measures. As a result, NRRP grants range between €1 billion (for Cyprus) and €69 billion (for Italy and Spain).

We mainly address how much each country's NRRP contributes to SDGs and which The Plan insufficiently addresses SDGs. Although the several EU Member States have provided an SDG-

[36] See e.g. the Sustainable Recovery Tracker of the International Energy Agency, also highlighted in Section 4.3 of this report, the OECD Green Recovery Database, the Global Recovery Observatory of the Green Fiscal Policy Network, the Greenness of Stimulus Index, the European Green Recovery Tracker, CarbonBrief's Green Recovery Tracker and others.

related appraisal of their NRRPs, the assessment shown here goes beyond official reports by comparing this assessment with the country's score in SDSN's Europe Sustainable Development Report 2021 (ESDR), thereby underlining the gaps in policy design that need to be remedied by national authorities. It must be noted that the analysis for Italy and Spain has been adopted from ESDR 2021 (**Lafortune et al., 2021**), and the study for Cyprus comes from a broader assessment conducted for the country (**Zachariadis, 2021**).

For this purpose, the description of all measures included in the NRRP of each country was studied in detail, either from the original NRRP text submitted by the national government to the European Commission or from the Implementing Decisions published by the European Council after the approval of each NRRP. In addition, linkages of each measure with one or more SDGs were identified by connecting each action with one or more of:

- The 169 targets of the SDGs
- The 107 indicators that are used to compile the score of each SDG in ESDR

As a result, it was possible to create a matrix of (RRP measures x SDGs) per country and link the budget of each action with the corresponding SDG(s) that this measure addresses. Thus, the relevance of each country's NRRP can be expressed in two ways: the number of NRRP measures addressing each SDG and the fraction of the NRRP budget devoted to each SDG.

Figure 32 provides the main results of the analysis by a number of measures per country, while Figure 33 demonstrates the aggregate analysis of the budget allocation of the NRRPs of all seven countries. Detailed findings and graphs per country are provided in **Annex I**.

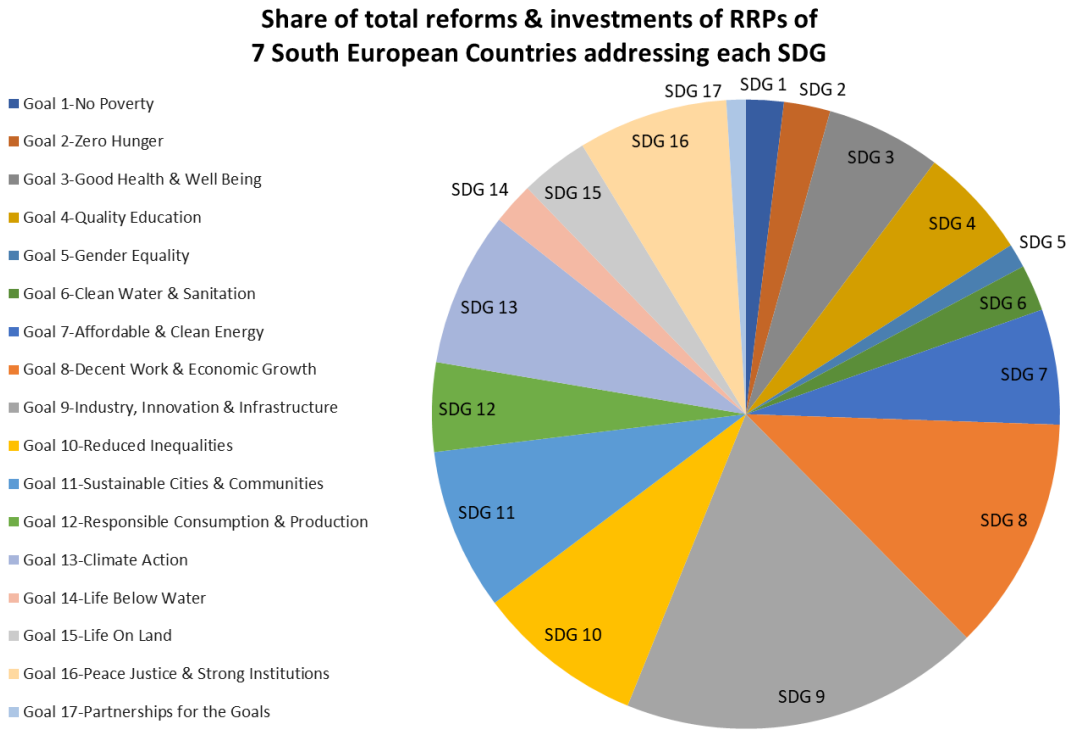



*Figure 32 Relevance of the recovery investments and reforms of seven EU Member States for each SDG.*

Overall, the analysis has found that all SDGs are addressed in the recovery plans, albeit to different degrees. SDGs that are mostly covered, in terms of several stimulus measures and budget allocated, are not always those on which countries face their biggest sustainability challenges. In particular, although several European nations demonstrate relatively poor performance in transforming food systems and diets and to biodiversity goals, these challenges have received lower attention in NRRPs than those related to other SDGs like green energy, electrification of transport, and energy efficiency measures. Although this misalignment is partly understandable because the 'Next Generation EU' package must be executed by 2026 and should therefore include 'shovel-ready' projects, the minor focus on systemic issues such as the agri-food sector and biodiversity calls for increased attention of EU nations to these topics through other post-pandemic public and private investments.

It is possible to expand the analysis by highlighting those measures of NRRPs which contribute to several SDGs. These can be regarded as 'lighthouse' interventions, i.e. those measures yielding a more significant sustainability impact. Although an exhaustive list is not provided here, the analysis has shown that some of the 'best' interventions in this regard contribute to several sustainability objectives simultaneously, e.g. modernising the economy, enabling the low-carbon low-pollution transition promoting social inclusion. At the level of individual measures, examples of such 'lighthouse' interventions are:

- Research and innovation funding on green transition
- Strengthening digital, green, blue and entrepreneurship skills of the unemployed or people over 55 and with particular emphasis on unemployed women
- Upskilling the existing farmers' community
- Valorization of livestock waste and construction of biogas production units
- Promoting renewables and individual energy efficiency measures and tackling energy poverty in households with disabled people.

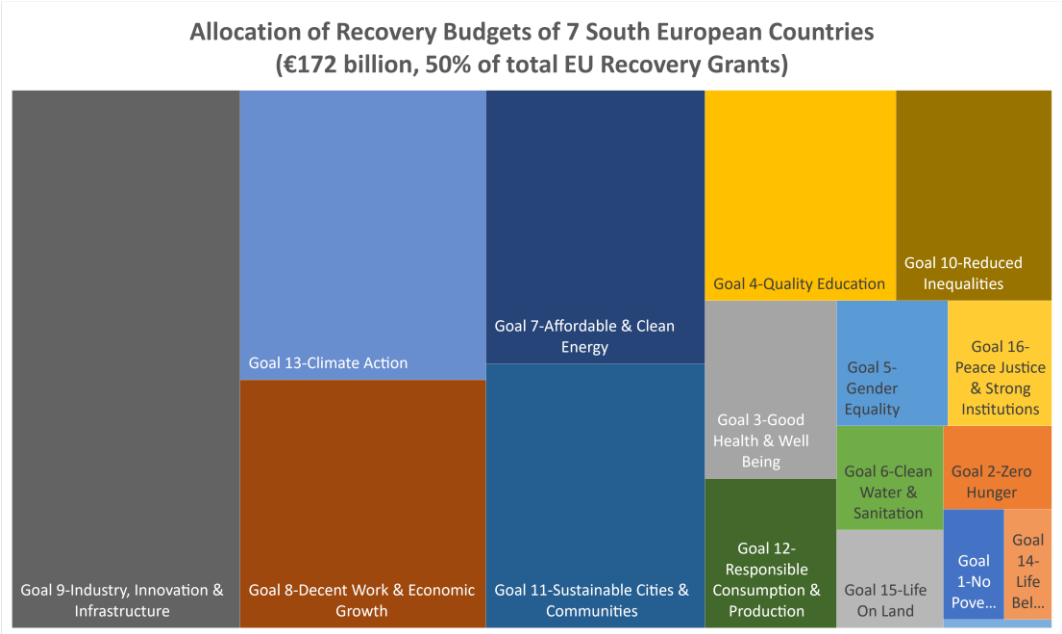



*Figure 33 Allocation of the recovery funds of the seven EU Member states analyzed to different SDGs.*

**Figure 34** illustrates the broader framework in which this methodology can be applied. The first row corresponds to the outcome-based assessment of SDG scores as produced in ESDR 2021. Suppose one compares such an ex-post assessment with the ex-ante analysis (second row in Figure 28). In that case, it is possible to identify financing gaps and propose corrective actions for mainstreaming sustainability in national policies, both in public funding and in support of private sector investments. Primarily regarding support for private investments, this procedure can complement the rules that have partly been prepared and are partly under development in the EU Sustainable Finance initiative framework and can guide decision-makers and stakeholders.

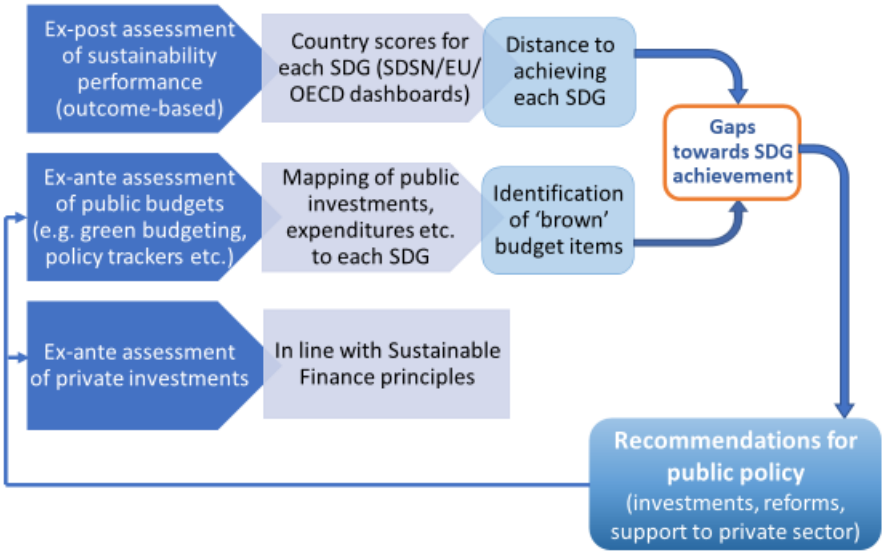



*Figure 34 Schematic framework for mainstreaming SDGs in national policies.*

To the extent that an appropriate appraisal of an economic stimulus package, as outlined above, has been carried out, this framework should then be expanded and applied in all medium-term monetary policy plans of a country. In the EU, for example, NRRPs will be a significant source of funding for investments and reforms in the EU Member States up to 2026, but it will not be the only one; hence the analysis can be transferred and employed for all funds included in the regular EU budget, i.e. the so-called European Structural and Investment Funds. Similar plans worldwide, such as China's 14th Five-Year Plan for 2021-2025 or the United States' American Jobs Plan and the Infrastructure Deal decided during 2021, are examples where this framework can be effectively applied.

In 2020-2021, initiatives at OECD and EU levels put a strong focus on 'Green Budgeting' (OECD, 2020), which tracks the greenness of public budgets for one or more environmental objectives. This is an important starting point towards full consideration of SDGs in governmental actions, and national administrations that can go beyond Green Budgeting to 'SDG Budgeting' can offer a valuable service to the welfare of their societies. As suggested by Lafortune et al. (2020) and briefly shown here, it is possible to quickly identify gaps in the sustainability orientation of public policies by combining 'outcome-based' approaches such as SDG scores with forward-looking assessments of budgets that link all budget measures with SDGs and the Six Transformations. Figure 34 has provided a simple schematic of this framework, which, apart from public policies, can also be used for the targeted support of private investments.

## 4.2. The Coronavirus Pandemic, Assessment of Resilience[37]

The coronavirus pandemic has swept across most of the world, leaving a trail of human and economic destruction. In this crisis, the' enemy' is a silent, invisible and deadly pathogen that has successfully overcome border protections. It has been able to exploit the world's interconnected and networked economies and societies to spread worldwide and threaten people's way of life, testing the resilience of public health and economic systems. The evidence suggests that defeating it requires mass mobilization of healthcare resources and financial tools and community and individual action within and across countries of the kind that has usually been seen only during periods of war or significant economic dislocation.

The pandemic has revealed many cracks in the world's existing political, economic and governance systems, including public health, international cooperation, monetary flexibility and government effectiveness. These cracks are the results of a series of deeper underlying issues facing the world today, including the problems facing inequitable and disparate public healthcare systems within and between countries; unaddressed market and regulatory issues; the loss of political cohesion stemming from populist, isolationist and exceptionalist politics across the world, and; demographic challenges facing industrialized countries with large elderly populations.

The assessment, undertaken in April 2020 to provide risk assessments that might aid policymakers, examined the capability to resist and act to address the pandemic, with a primary focus on the resilience of eight major countries, along with five resilience factors (**Table 16**):

1. Population and Demographic Risk.
2. Healthcare and Social Protection.
3. Economic Strength Against Macro-Shocks.
4. Policy Capacity for Economic Stimulus.
5. Global Coordination, Collaboration and Cohesion.

[37] Ketan Patel, Christian Hansmeyer et al. Summarised and extracted from, 'The Coronavirus Pandemic - A Global Test of Resilience, Leadership and Values, April 2020' and 'The Coronavirus Pandemic - Waging the War, May 2020', with permission from the authors, Greater Pacific Capital Research, specifically authors Ketan Patel, Christian Hansmeyer et al.

*Table 16 Qualitative Summary of Resilience Indicators: Major Nations Ill-Prepared for Global Pandemic*

| | US | China | India | Germany | France | UK | Italy | Japan |
|---|---|---|---|---|---|---|---|---|
| ***Resilience Factor 1: Population and Demographic Risk[38]*** | | | | | | | | |
| **At-Risk Population** | | | | | | | | |
| **Risk of Spread** | | | | | | | | |
| **Poverty/Inequality** | | | | | | | | |
| **Communication and Information (Credibility)** | | | | | | | | |
| ***Resilience Factor 2: Healthcare and Social Protection[39]*** | | | | | | | | |
| **Critical Care Capacity** | | | | | | | | |
| **Virus Testing** | | | | | | | | |
| **Social Protection for Job Loss** | | | | | | | | |
| **Healthcare Access and Quality** | | | | | | | | |
| ***Resilience Factor 3: Economic Strength Against Macro Shocks[40]*** | | | | | | | | |
| **Economic Growth** | | | | | | | | |
| **Unemployment Rate** | | | | | | | | |
| **Informal Employment** | | | | | | | | |
| **Corp/Household Indebtedness** | | | | | | | | |
| **Structural Risk** | | | | | | | | |
| ***Resilience Factor 4: Policy Capacity for Economic Stimulus[41]*** | | | | | | | | |
| **Monetary Policy** | | | | | | | | |
| **Ability to Introduce Stimulus** | | | | | | | | |

[38] **Resilience Factor 1:** Population and Demographic Risk. Risk Summary: The US stands out as among the most vulnerable from the perspective of its population, demographics and long-term provision of healthcare to its mass population. At the other extreme, India as a large developing country also faces enormous challenges.

[39] **Resilience Factor 2:** Healthcare and Social Protection. Risk Summary: On the protection offered by the healthcare system for the population, the US stands out as the most vulnerable for its people among richer countries (its excellent cover for the well-insured notwithstanding) given its lack of testing capabilities, relative size of its hospital infrastructure, and the quality and breadth of general healthcare access. The UK stands out among the same group for its inadequate healthcare capacity but does and has provided cover for all over a long period. And India, as a developing country, has the least medical capacity to deal with such a crisis and is therefore the most exposed as a result, and so critically subject to the effectiveness of its containment and suppression measures

[40] **Resilience Factor 3:** Economic Strength Against Macro-Shocks. Risk Summary: While low growth and high levels of corporate and household indebtedness poses a risk to the US and UK on both and China, France and Japan are particularly exposed on corporate indebtedness, weak structural employment is likely to put pressure on the US in a prolonged downturn, just as Italy's dependence on these services is disproportionately impacting its economy during its lock-down.

[41] **Resilience Factor 4:** Policy Capacity for Economic Stimulus. Risk Summary: The developed world is highly constrained in terms of headroom for monetary stimulus compared to during the Global Financial Crisis, increasing the importance of fiscal stimulus at a time when major countries, particularly the US and Italy, are already running deficits and high debt levels well above the levels seen before the crisis. However, given the potential extent of the fallout being created by the coronavirus this may not constrain them from injecting money supply into their economies and taking the impact on currencies and inflation, thereby diluting the qualities of their economies as a result.

The analysis revealed that almost all significant countries examined are significantly underprepared for the potential impact of COVID-19 from multiple perspectives. Some of the key figures are extracted in **Table 17**:

*Table 17* ***Summary of Resilience to Coronavirus Pandemic for Major Countries (Sub-set of Parameters[42] from 15 Key Quantitative Indicators for Four Major Areas)***

| | Population and Demographic Risk | | | Healthcare and Social Protection[43] | | | Economic Resilience Against Macro-Shocks | | | Policy Capacity for Economic Stimulus | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Pop. without Health Insurance [44] | % of Pop. Below Poverty Line[45] | % of Pop. Aged 65+[46] | Hospital Beds / 1,000 people[47] | Testing Capacity per Week / million Pop.[48] | % of Unemployed Receiving Benefits[49] | Historic GDP Growth Rate[50] | Informal Employment [51] | Corp. Debt to GDP[52] | Fiscal Deficit as % of GDP[53] | Gov. Debt as % of GDP[54] | Sovereign Credit Rating[55] |
| **US** | **9% (45%)** | 1.2% | 15.8% | **2.8** | **761** | **28%** | 2.6% | **18.6%** | **150%** | **-4.6%** | **107%** | AAA |
| **China** | 5% | **23.5%** | 10.9% | 4.2 | NA | **19%** | 6.5% | **54.5%** | **208%** | **-4.2%** | 51% | A+ |
| **India** | **56%** | **60.4%** | 6.2% | **0.7** | **58** | **3%** | 6.7% | **88.2%** | 55% | **-3.3%** | 68% | **BBB-** |
| **Germany** | 0% | 0.2% | **21.5%** | 8.3 | 4,581 | 100% | **1.5%** | 10.2% | 111% | 1.5% | 62% | AAA |
| **France** | 0% | 0.1% | **20.0%** | 6.5 | **444** | 95% | **1.7%** | 9.8% | **201%** | **-3.0%** | 98% | AA |
| **UK** | 0% | 0.5% | **18.4%** | **2.8** | **412** | 60% | **1.5%** | 13.6% | **171%** | **-1.8%** | 87% | AA- |
| **Italy** | 0% | 1.5% | **22.8%** | **3.4** | NA | **38%** | **0.9%** | **19.0%** | 110% | **-1.6%** | **135%** | **BBB** |
| **Japan** | 0% | 0.9% | **27.6%** | 13.4 | **415** | **20%** | **1.2%** | **18.7%** | **161%** | **-3.8%** | **237%** | A |

When the resilience indicators are looked at as a whole, they reveal that the world was critically ill-prepared for Covid-19, creating significant risks to human life and severe damage

[42] Key metrics have been highlighted to illustrate the assessment of resilience; please refer to the complete paper for detailed metrics

[43] As of late March 2020

[44] Source: OECD

[45] Source: Word Bank, % of the population in 2011 earning less than US$3.20/day

[46] Source: World Population Review

[47] Source: OECD, American Hospital Association

[48] Source: 2020, AEI, Institute, India Health Ministry, Public Health England, France-Director General of Health, German Health Ministry

[49] Source: ILO

[50] Average GDP growth from 2017 – 2019; Source: IMF

[51] Source: ILO

[52] Source: IMF

[53] Source: US Treasury, Reserve Bank of India, Federal Statistical Office, INSEE, Office for Budget Responsibility – UK, Japan Ministry of Finance, China Ministry of Finance

[54] Source: IMF

[55] Source: Fitch Rating Agency

to substantial economies. While there were substantial gaps between the levels of resilience of individual countries, all major countries lacked preparedness to deal with a pandemic on the scale of Covid-19, along multiple fronts, with the data highlighting the following:

- **The US was severely exposed due to systemic shortcomings and structural factors.** Large segments of the US population were critically exposed due to a lack of adequate long-term healthcare cover. In addition, US economic stability rested on its ability to increase the money supply (and co-opting its banking system, subject to its markets playing along), which seemed feasible. Given its near-zero interest rates, a high fiscal deficit and indebtedness at the level of the Global Financial Crisis, the US would likely need to rely on effectively printing money in what may be seen as a 'heroic' or desperate fashion, depending on one's perspective, to shore up its economy.
- **Aside from Germany, Europe was also exposed**, with the UK's situation appearing to be particularly vulnerable and therefore much at risk from poor policy and any failures in the execution of proper measures.
- **India emerged as the most at risk,** given its size, population density and development stage. So, it had the most critical need for radical solutions covering multiple areas, including emergency healthcare and economic and social measures.
- **China's overall resilience was one of the strongest,** and so it stood to emerge in a relatively superior position from this crisis.
- Threats to the successful implementation of sound policy existed from the lack of adequate, reliable public information and a 'populist' approach. The prevalence of unreliable news on social media made clear and efficient communication a challenge in countries where trust in mainstream media is low and social networks are the primary source of information for the population, particularly given the alleged existence of targeted disinformation campaigns underway and the populist stances of confident political leaders.
- **Global coordination, collaboration and cohesion[56] were not of the level required for a pandemic**, particularly given the US administration's political positions on the pandemic and its 'America First' program, which had affected its leadership position. However, major international institutions, such as the World Bank and IMF, UN and WHO, were better funded relative to the global financial crisis. However, the US was not exerting the same leadership in these as during the global financial crisis. Central Banks also had substantial stocks of reserves to make interventions.

The work concluded that given the significant gaps in resilience and preparedness of countries, and the urgency of actions required, these could only be addressed by working together across boundaries and effectively within countries, cooperating to galvanize people and resources, including the vast body of knowledge in the world on medical illnesses, managing crises (most recently, from the Global Financial Crisis, 9/11 and multiple wars from

[56] **Resilience Factor 5:** Global Coordination, Collaboration and Cohesion. Risk Summary: Major international financial institutions such as the World Bank and IMF are better funded relative to the global financial crisis, major global policy institutions such as the UN and WHO are also better financed than at that time. However, the US power is shifting away. The WTO has an important role in providing a level playing field. Central banks have substantial stocks of reserves to make international interventions, the highest risk in terms of reserves were the US, UK and Italy, with China far stronger than all others. There was an important additional role for charitable and NGO funds to play in supporting relief efforts.

the last century), the on-the-ground peace and aid experience of numerous international institutions and the strong legacy of post-war allied leadership.

## 4.3. How Recovery Spending is aligning with needs in a net-zero scenario and the projected impacts on energy employment

In June 2021, the International Energy Agency (IEA) produced its landmark Net Zero by 2050 (NZE) scenario which lays out a roadmap for the global energy sector to reduce emissions in line with what is needed to limit global surface temperature rise to 1.5oC by the end of the century.[57] In the World Energy Outlook 2021, the IEA compared how countries' pledges to reach net-zero compared with this roadmap in its Announced Pledges Scenario (APS), which included European countries' collective and individual pledges.[58] Globally, these pledges are now sufficient to limit global warming to 1.8oC by 2100—the first time that governments have come forward with targets of sufficient ambition to hold global warming to below 2 °C. However, 1.8 °C is still above the Paris Agreement target of limiting global warming to well below 2 °C and pursuing efforts to limit it to 1.5 °C. Furthermore, as of November 2021, today's policies and implementation still lag countries' announced pledges sufficiently, and ambitions in the critical period from now to 2030 still leave a 70% gap in the amount of emissions reductions needed by 2030 to keep 1.5 °C within reach (**IEA, 2021**).[59]

Some countries have used their economic recovery packages in response to the Covid-19 packages to bring implementation closer in line with these targets while rebooting their economies and putting people back to work. In this section, we explore how global recovery packages align with levels of spending needed to support the world in its shift to a net-zero by 2050 trajectory. We also explore how these ambitions are beginning to reshape global energy employment and how countries are parlaying recovery packages into successful industrial policies to support an emerging new energy economy.

57 International Energy Agency: 'Net Zero Emissions by 2050 Scenario (NZE), https://www.iea.org/reports/world-energy-model/net-zero-emissions-by-2050-scenario-nze

58 International Energy Agency: 'Announced Pledges Scenario (APS), https://www.iea.org/reports/world-energy-model/announced-pledges-scenario-aps

59 International Energy Agency: 'COP26 climate pledges could help limit global warming to 1.5°C, but implementing them will be the key', https://www.iea.org/commentaries/cop26-climate-pledges-could-help-limit-global-warming-to-1-8-c-but-implementing-them-will-be-the-key

### 4.3.1. Recovery spending and its impact on a green recovery

From the outset of the pandemic, national governments have mobilized an unprecedented amount of fiscal support to manage the impacts of the crisis on citizens and the global economy.60 In total, Covid-19-related fiscal outflows have grown to an unprecedented USD 18.2 trillion worldwide. Many of these measures focused on liquidity support for vulnerable businesses and workers and supporting health care provisions.

The IEA's Sustainable Recovery Tracker—which covers more than 1,000 policies and measures related to sustainable recoveries—estimates governments have committed so far over USD 710 billion to long-term sustainable recovery measures by 2030, a 50% increase from the amount recorded in the IEA Sustainable Recovery Tracker in October 2021 (**IEA, 2022**).[61] This lifts the fiscal response directed to sustainable recoveries to unparalleled levels, nearly 40% above the amounts earmarked for clean energy and the environment in the national stimulus plans after the 2008-2010 global financial crisis (**OECD, 2020**). This corresponds to about 4% of the total fiscal support unleashed in response to Covid-19 worldwide (**Figure 35)**. This corresponds to about 43% of the total fiscal support unleashed in response to Covid-19 worldwide (**Figure 35)**. This corresponds to about 4% of the total fiscal support unleashed in response to Covid-19 worldwide (**Figure 35)**.

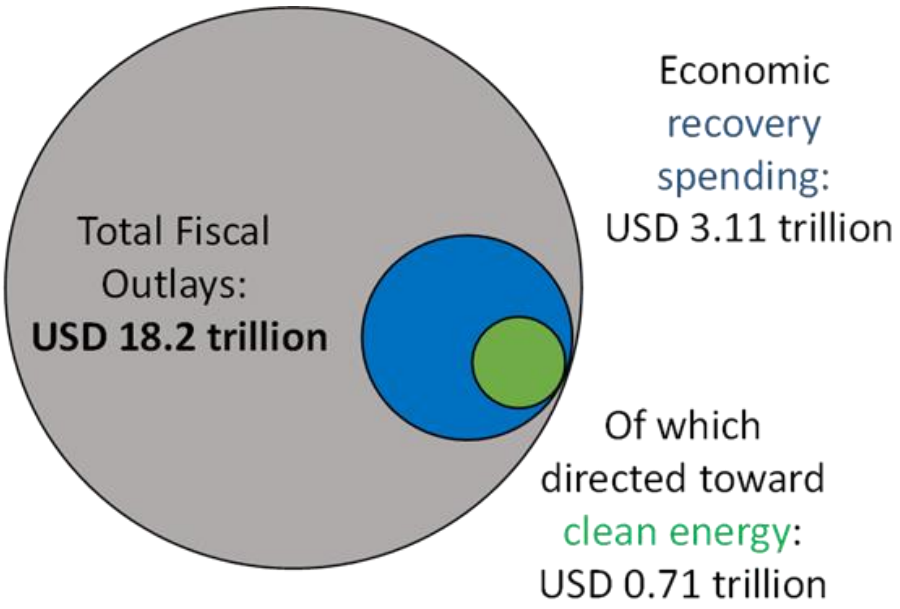



*Figure 35* ***Long term economic and sustainable recovery spending, as of the end of March 2022***



***As of the end of March 2022, governments had spent around USD 710 billion on sustainable recovery measures as part of their response to the pandemic, around 4% of the total fiscal response***

60

61 International Energy Agency, 'Sustainable Recovery Tracker', https://www.iea.org/reports/sustainable-recovery-tracker

A closer look at regional spending profiles reveals concerning imbalances. In advanced economies, governments have now earmarked amounts nearly aligned to the short-term spending levels needed to be on track for net-zero emissions by mid-century. However, this spending still needs to find its way to the real economy, and much greater efforts are required beyond 2023 for spending levels to remain broadly in line with the Net Zero Emissions by 2050 Scenario. The packages that contributed the most to sustainable recovery measures are the American Infrastructure, and Jobs Act and the France 2030 investment plans, followed by Australia's Long-Term Emissions reduction plan and the supplementary Japanese national budgets voted for the period 2020/2021 and 2021/2022.

EMDEs governments have earmarked ten times less spending for sustainable recoveries in total and less than a quarter of what would be needed in the short term to be on track with the Net Zero Scenario (**Figure 36**). International catalysts like development assistance could be vital to increasing clean energy investment in emerging and developing economies (**IEA, 2021**).[62]

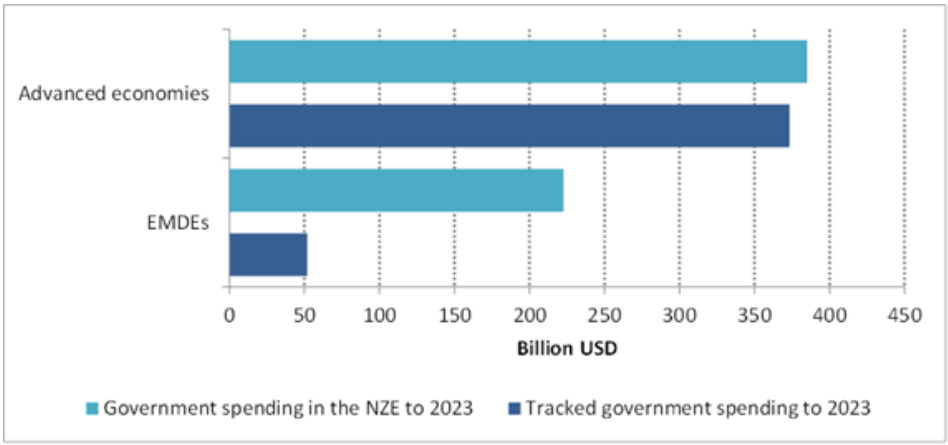



*Figure 36 Government sustainable recovery spending earmarked to 2023, by region, compared to short-term Net Zero Scenario levels*



***Advanced economies are nearing levels needed to shift trajectories toward net-zero, but emerging and developing economies are only at 20% of the levels and face narrowing fiscal options as the pandemic wears on.***

62 International Energy Agency, 'Sustainable Recovery Tracker: Key Findings', https://www.iea.org/reports/sustainable-recovery-tracker/key-findings

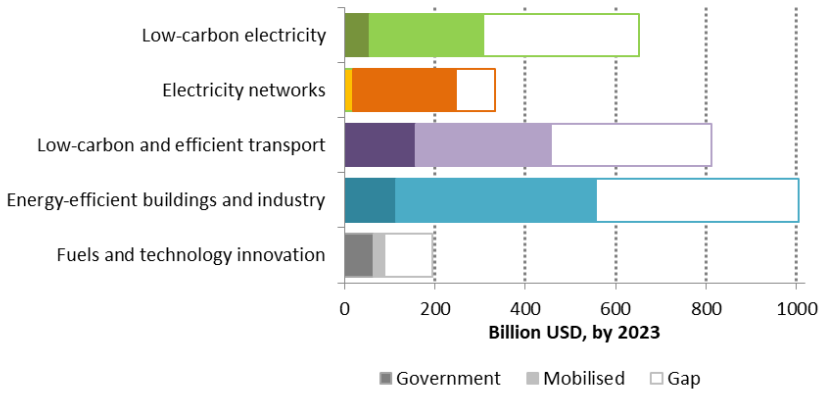



*Figure 37 Additional investment expected to be mobilised by government spending by sector compared with Net Zero Scenario levels*



***All key sectors saw increases in government spending. However, the balance across these sectors in each geography could result in fewer emissions reductions than if these measures were carried out proportionally.***

The unprecedented global sustainable recovery effort by governments will only bear fruit if most of the earmarked spending reaches market actors during the crucial 2021-2023 recovery period. Long lead times in project development and implementation delays could threaten these objectives. Governments need to focus on setting up programs to award grants, select contractors or subsidy recipients. One crucial aspect is consumer-facing spending — such as the USD 72 billion available for energy efficiency retrofits between now and 2023—making households aware of the available offer and supports and taking down administrative barriers should be key endeavors for policymakers.[63]

Russia's invasion of Ukraine has further thrust global energy markets into uncertainty and reinforced supply chain bottlenecks born from global lockdown implementations. The impact of these disruptions on shipping and manufacturing costs may also cause projects to be shelved or scaled back. Labor shortages are a continuous challenge. Government spending programs should urgently consider and address these limitations.

### 4.3.2. Clean energy transitions' impacts on energy employment

Aligned with recovery spending and countries' long-term pledges to reach net-zero, employment in clean energy and related sectors is expected to grow substantially, more than offsetting a decline in traditional fossil fuel supply sectors. We estimate that an additional 13 million workers will be employed in clean energy and related sectors by 2030 in the IEA's Announced Pledges Scenario, which doubles in the IEA's Net Zero Scenario (**Figure 38**).

63 International Energy Agency, 'Sustainable Recovery Tracker', https://www.iea.org/reports/sustainable-recovery-tracker/tracking-sustainable-recoveries

Growth will be most notable in renewable power generation, energy networks, energy efficiency (retrofits and energy-efficient appliances), and car manufacturing (efficient vehicles and EVs). These are particularly dramatic if the world is to hit net-zero by 2050—as detailed in the IEA's Net Zero Emissions by 2050 scenario.[64] However, even under today's announced pledges (represented in the IEA's Announced Pledges Scenario, marked shifts are seen, albeit more gradual, with sharp regional variations.[65]

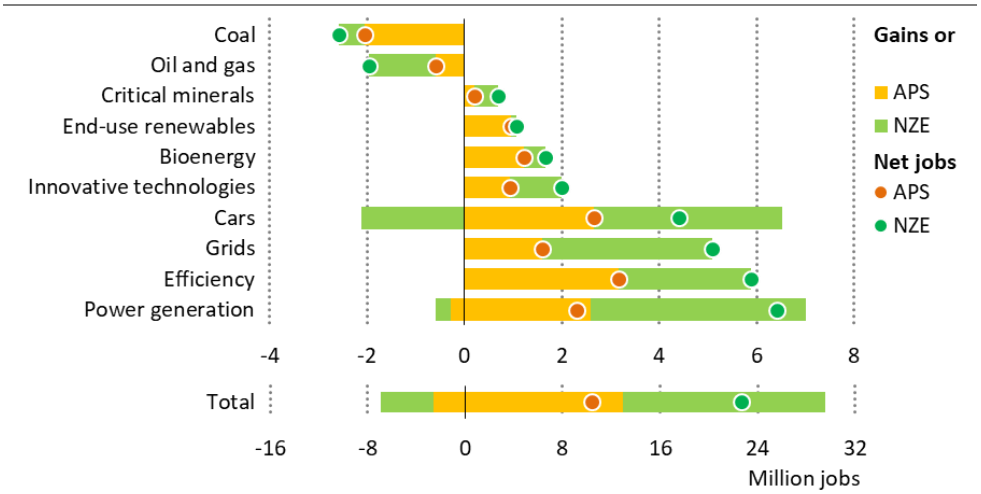



*Figure 38* ***Employment growth in clean energy and related areas to 2030***



***Clean energy job gains outpace losses in fossil fuels jobs in the APS and job growth in clean energy and related segments doubles in the NZE***

The new jobs created in the energy transition are not necessarily made in the same places and sub-sectors where jobs are lost. Skill sets are not automatically transferable, and new skills are needed. This is true within single countries and internationally. Accordingly, governments have a vital role in managing these impacts in a coordinated way. Naturally, governments will seek to design transition pathways that maximize opportunities for new, high-quality jobs that align with existing strengths or skill sets and mobilize long-term support for workers and communities where jobs are lost. Getting this right typically means robust social dialogue among employers, workers, communities, international organizations and governments. Again, governments need to manage the impacts in a coordinated way, seeking long-term transition planning.

Many countries are looking to retool their economies to maximize the employment growth benefits within their countries, and have been a prominent aspect of recovery plan spending. Most clean energy jobs are created close to the project's location, whether a wind farm or new energy-efficient housing. However, we estimate that a quarter of energy employment is tied to supply chains that may be located in other countries, particularly for solar, wind, batteries, grid components, and vehicle components. However, the prominence of these supply chains is not fixed over time, as a new manufacturing capacity is needed to meet the

64 International Energy Agency: 'Net Zero Emissions by 2050 Scenario (NZE), https://www.iea.org/reports/world-energy-model/net-zero-emissions-by-2050-scenario-nze
65 International Energy Agency: 'Announced Pledges Scenario (APS), https://www.iea.org/reports/world-energy-model/announced-pledges-scenario-aps

growing demand for these technologies as spending grows 1.6-fold over the next decade to keep pace with countries' announced pledges.

Many governments, especially in advanced economies, are mobilizing economic recovery funds to bolster home-grown industries for mature technologies like solar, wind and EVs, or making strategic investments in emerging segments, like CCUS, batteries, advanced biofuels, and hydrogen. These latter industries, although nascent today, will grow to employ nearly 1 million workers worldwide by 2030 in the Announced Pledges Scenario.[66]

Announced pledges also have consequences for jobs in fossil fuel employment. The Announced Pledges Scenario does not mark the end of coal-fired power generation, but it has clear implications for coal-related employment, particularly in mining, where the opportunities for worker transition are more limited than in the power sector. Direct coal-related jobs are set to continue the declines seen over the past decade, driven by environmental and demand pressure, especially in advanced economies and increased productivity, particularly in Asia. By 2030, 30% fewer people will work in coal than in 2019; one-third of those declines are associated with productivity gains in coal mining. The drop is most notable in China, although this is mainly the result of continued restructuring in the industry rather than lower demand (**Figure 39**).[67] Coal employment in India, which has the second-largest number of coal workers worldwide, could be bolstered by the policy ambition to increase domestic output, but there are significant uncertainties over domestic demand, especially if policies tighten.

While energy transitions create substantial job growth on the net, there are limits to which jobs lost in traditional sectors can be transitioned to clean energy on a one-to-one basis. Rising demand for critical minerals offers some transfer of employment in the mining sector, but these opportunities are not always located in the same area as coal supply. Miners working at fully modernized mines have skills that could be readily transferred. However, over 90% of coal miners are in emerging market and developing economies and are often unskilled and have historically usually transferred to other sectors of the economy as mines closed, notably in China. Most of the scope to re-deploy existing workers to new clean energy projects in practice is in the oil and gas sector. Coal employment is only a tiny portion of total employment in most countries (less than 0.5% in China and less than 0.1% in India), but it accounts for a high percentage of total earnings and tax revenues in many communities. There is a need to help workers and communities where coal plant closures are likely to have cascading effects on communities and supporting businesses.[68]

66 International Energy Agency: 'Announced Pledges Scenario (APS), https://www.iea.org/reports/world-energy-model/announced-pledges-scenario-aps

67 International Energy Agency: 'World Energy Outlook 2021', https://www.iea.org/reports/world-energy-outlook-2021/phasing-out-coal

68 International Energy Agency: 'World Energy Outlook 2021', https://www.iea.org/reports/world-energy-outlook-2021/phasing-out-coal

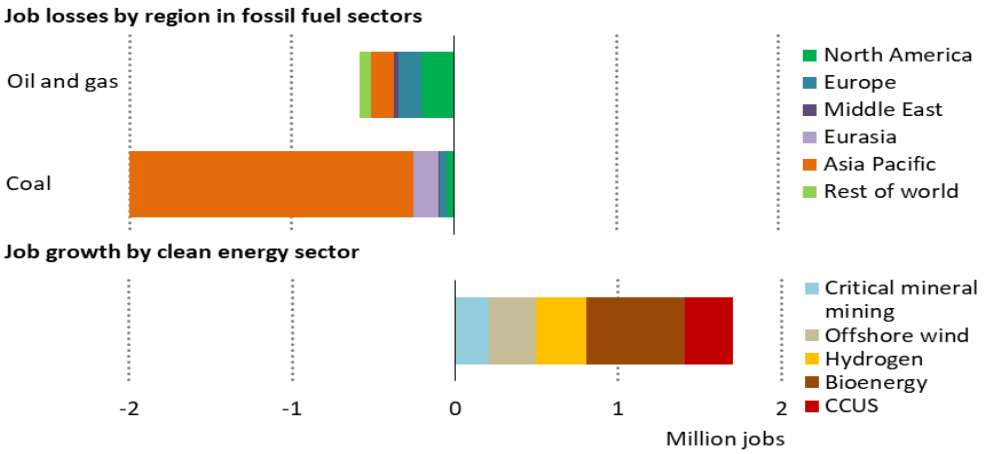



*Figure 39* ***Changes in fossil fuel employment and energy areas with overlapping skills in the Announced Pledges Scenario to 2030***



***Skilled fossil fuel workers have opportunities to transition to clean energy jobs, though the options are not a direct match for most coal sector jobs lost in Asia***

Long-term planning can minimize immediate adverse impacts and provide time to retrain workers and people in the community. However, proper long-term planning requires wide-stakeholder participation, with labor unions being of particular importance (see the section on coal phase-out below).

By 2030, the Announced Pledges Scenario anticipates that oil and natural gas employment will decline gradually from today's levels with small decreases, with the significant cutbacks in the workforce in 2020-21 already bringing headcount to levels roughly in line to meet projected oil and gas demand in 2030.[69] Nonetheless, many parts of the oil and gas industry are already focused on diversifying their workforce, ensuring they retain critical skills while applying current capacities to emerging industries. Russia's invasion of Ukraine and the ensuing oil and gas market disruptions underscores this point. Traditional oil and gas knowledge and skills will remain important through the transition, as nimbly responding to distributions to the security of supply is critical to ameliorating public perception risks that could threaten an orderly clean energy transition. However, many workers within the oil and gas industry possess skills that can find a place in the new energy economy, particularly skills related to large-scale project management expertise, engineering services, offshore and sub-surface projects, logistics, trade and finance. These skills are of immediate relevance to clean technology areas, such as offshore wind, CCUS, hydrogen, geothermal, biofuel production, and low-carbon gasses (**Figure 39**).

Accounting for these jobs and skills needs is of great importance for decision-makers as they shape clean energy transitions. Governments who have invested in more granular energy labor reporting have seen the benefits by better informing transition planning and plan for education and skills development programs and redeployment initiatives. Best-in-class examples of such reporting include the United States Energy Employment Report, which

69 International Energy Agency: 'Announced Pledges Scenario (APS), https://www.iea.org/reports/world-energy-model/announced-pledges-scenario-aps

assesses all energy employment down to the sub-sectoral level and across all parts of the energy value chain (i.e. from raw materials to decommissioning).[70]

70 National Association of State Energy Officials: United States Energy Employment Report 2021, https://www.usenergyjobs.org/

# 5. Conclusions: Strategic Approaches for Europe's Sustainability Transition

The Intergovernmental Panel on Climate Change, in its recently published reports (e.g. IPCC, 2021), has urged policymakers to act decisively to fight climate change because action at unprecedented scale and speed is required for global climate stabilization. Indeed, the European Union has taken significant steps toward climate change mitigation and adaptation in recent years, within a broader agenda encompassing the entire sustainability transition.

A critical component of the **European Green Deal** is the attempt to fully implement the EU's emission reduction commitment under the Paris Agreement, supported by wide-ranging policy measures and very substantial financial resources. In June 2021, the **European Climate Law** was adopted, making both a revised 2030 (55% reduction in GHG emissions compared to 1990) and the aim of climate neutrality by 2050 legally binding. In July 2021, the European Commission unveiled its "**Fit for 55**" bundle of policy recommendations to achieve the new 2030 objective.

Sustainable development and action against climate change are at the heart of European political action. Starting from the ambitious goals of the European Green Deal and with a significant number of policies, strategies, and guidelines that support it, the European Commission puts its intentions into practice to make Europe a continent that is climate neutral, protects the environment and biodiversity, and addresses social challenges fairly, leaving no one behind.

In this 2nd Annual Report of SDSN Europe's Senior Working Group, we focused on 22 policies, strategies and other texts published after the launch of the European Green Deal and assessed whether they are in line with the 17 SDGs. It is crucial that, except for Sustainable Agriculture, the 22 policies presented in Chapter 1 cover all other policy areas of the European Green Deal, such as Biodiversity, Building and renovation, Clean Energy, Climate Action, etc. This means that they set the framework for the transition to sustainability, climate neutrality and the development of just societies in Europe (**Table 18**).

*Table 18 Mapping of Policies/Strategies to the European Green Deal Policy areas*

| EGD Policy Area | Name of Policy/Strategy |
|---|---|
| Biodiversity | • Biodiversity Strategy for 2030<br>• Circular economy action plan<br>• Blue economy strategy |
| Building and renovating | • A Renovation Wave for Europe – Greening our buildings, creating jobs, improving lives |
| Clean energy | • Hydrogen Strategy<br>• Offshore Renewable Energy Strategy<br>• Methane Strategy<br>• Energy poverty recommendation |
| Climate action | • European Climate Law<br>• European Climate Pact<br>• Adaptation Strategy<br>• Stepping up Europe's 2030 climate Ambition |
| Eliminating pollution | • Chemicals strategy for Sustainability |
| From Farm to Fork | • Farm to Fork' strategy |
| Sustainable industry | • Industrial strategy |

| | |
|---|---|
| | • Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery |
| Sustainable mobility | • Smart Mobility Strategy |
| Overarching | • Fit-for-55<br>• Strategy for Financing the Transition to a Sustainable Economy<br>• Annual Sustainable Growth Strategy (ASGS) 2021 - 7 flagship areas<br>• The European economic and financial system: fostering openness, strength and resilience<br>• Directing finance towards the European Green Deal |

With policies such as the *New Circular Economic Action Plan and the Biodiversity Strategy for 2030, the European Commission helps the Economies* shift **from a Linear to a Circular production model**, which plays a crucial role in drastically reducing greenhouse gas emissions. Second, policies such as the "Farm to Fork Strategy" on sustainable food support the provision of food for a growing population and restore the natural resources exploited. Third, the *Climate law* and *Mobility Strategy* promotes the use of **renewable energy**, the service of **climate-neutral transportation**, and the construction and improvement of **energy-efficient buildings**. Further, policy initiatives such as the *Just Transition Fund* and the *Climate Pact* facilitate the development of social inclusion by empowering minorities and contributing to **regional and rural development**.

The above Policies and Actions are tangible examples of the EU leadership's willingness to adopt SDGs as Europe's economic development framework. The fact that the Policies accompanying the European Green Deal support the implementation of the 17 SDGs sufficiently is the main conclusion of our analysis in Chapter 2, carried out both with manual textual analysis and through Machine Learning techniques.

At the same time, even this ambitious framework may fall short of the necessary global action to tackle the major sustainability challenges. For example, according to the Climate Action Tracker[71], the EU's climate targets, policies, and finance are overall "**Insufficient**". For "**Policies & Action**", the Tracker's assessment is that they are "**Almost Sufficient**" (as shown in **Figure 40**).

[71] https://climateactiontracker.org/countries/eu/

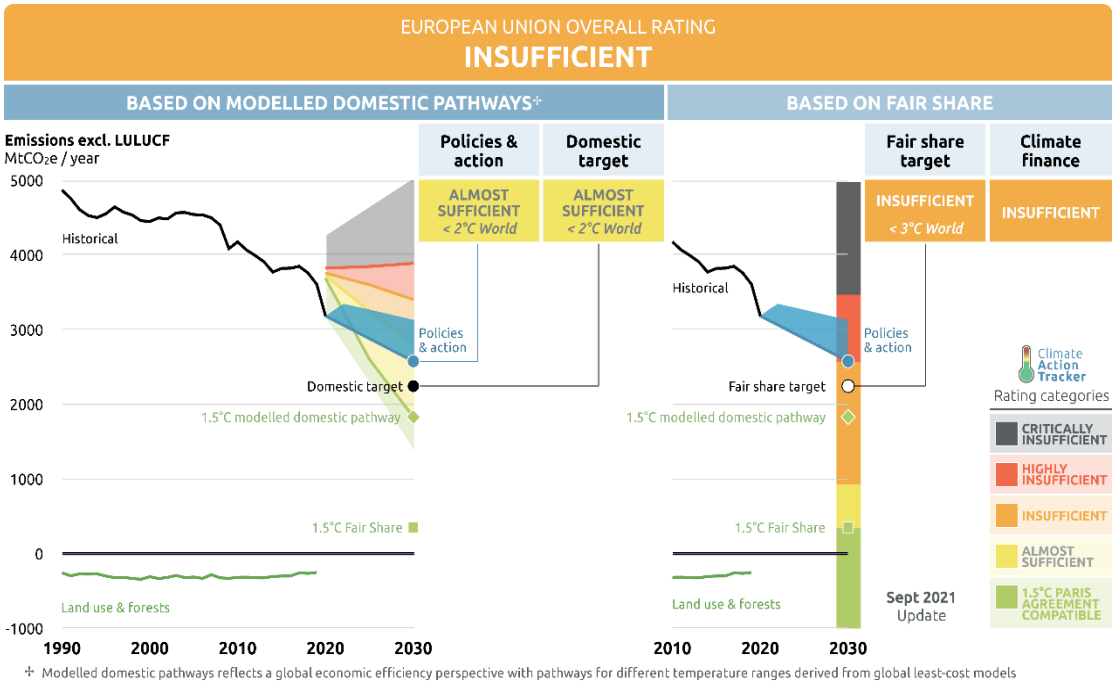



*Figure 40 The CAT rates the EU's climate targets, policies, and finance as "Insufficient". Source: climateactiontracker.org*

This rating implies that the EU's climate policy still has potential for further development, particularly speeding up the coal phase-out, increasing funding for climate action abroad, and moving beyond the existing 55 per cent emissions reduction target by 2030.

Apart from enacting EU-level policies, implementation is crucial. Therefore, the EU must ensure that all Member States adopt climate policy measures because the action in individual countries has been inconsistent in the past. For example, although EU leaders adopted the 'Next Generation EU' recovery fund in 2021, with at least 37% of the budget dedicated to climate action, certain nations are pressing for EU funding to be spent on natural gas infrastructure development. The EU is currently revising the Trans-European Networks for Energy (TEN-E) Regulation[72], which defines which transboundary projects can be labelled as Projects of Common Interest and gain access to EU funds. As a result of this modification, the EU may continue to subsidize some natural gas infrastructure using public funds rather than focusing on zero-emission energy sources and intelligent energy solutions.

The global economy relies heavily on the financial sector to supply sufficient capital for the transition to sustainability. This explains why academic research and the finance industry are increasingly turning to **Sustainable Finance,** namely the concept of incorporating Environmental, Social, and Good Governance (ESG) criteria in all financial investment decisions.

Sustainable finance is critical to achieving the policy goals set out in the European Green Deal and the EU's international climate and sustainability commitments. Very substantial amounts must be channeled through private investment for the transition to a climate-neutral, climate-

72 https://energy.ec.europa.eu/topics/infrastructure/trans-european-networks-energy_en#:~:text=Linking%20the%20energy%20infrastructure%20of%20EU%20countries.&text=The%20Trans%2DEuropean%20Networks%20for,thematic%20areas%20have%20been%20identified.

resilient, resource-efficient, and fair European economy as a supplement to public funds. In addition, sustainable finance will ensure that investments promote a resilient economy and a long-term recovery from the COVID-19 pandemic.

In 2020, the **Taxonomy Regulation** (EU) 2020/852 on the Establishment of a Framework to Facilitate Sustainable Investments went into effect. For its full implementation, a rigorous classification system is required to precisely describe the requirements that sustainable or green investment products must meet. A taxonomy like this could help investors make informed judgments, avoid greenwashing, and channel cash into long-term projects. Moreover, the **Sustainable Finance Disclosure Regulation** (Regulation (EU) 2019/2088 (SFDR)) has considerably enhanced the legal framework for ESG-compatible financial products.

The financing needs are huge. As highlighted in several sections of Chapters 3 and 4 of this report, the envisaged transformation of the EU will require massive investments from both the public and private sectors to meet the SDGs. The €1 trillion estimated by the European Commission for the green transformation of the European economy to support the Green Deal is not enough. Although this is a substantial figure, at least another €2.5 trillion is needed mainly by the private sector; this requires a rigorous regulatory environment and appropriate incentives to support further ESG investments (**Brühl V., 2021**).

Almost all sectors of our economy, including but not limited to power generation and consumption, mobility, manufacturing, and agriculture, require a green transformation. Therefore, we need the private sector to succeed wholly committed to the sustainability shift. Moreover, to align demand with supply and ensure that sustainable products and services are both available and affordable, fiscal policies are crucial: Tax structures, subsidies and pricing will need to reflect the product's total environmental and social costs, as outlined in Chapter 3 of the report.

Additional financial incentives to encourage green investments should be explored because of the apparent need to accelerate the implementation of the European Green Deal. Several aspects of this necessary transition have been discussed in our report and will be the main subject of further elaboration in the work of this Senior Working Group in the coming years.

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## Online Annexes

This report is accompanied by the following Annexes:

- **ANNEX I** - Assessment of National Recovery and Resilience Plans of seven South European EU Member states and Comparison with their SDG Scores according to the Europe Sustainable Development Report 2021
- **ANNEX II** - Machine Learning Method for Policies classification under the SDGs
- **ANNEX III** - Studies used for Meta-regression analysis function transfer
- **ANNEX IV** - Financing the Anthropocene - The European Green Deal (EGD) and Future Shocks
    - New forms of financial engineering to hedge, fund, coordinate and manage unchecked risks and unmet opportunities *By Stefan Brunnhuber Trustee WAAS*