

THE EUROPEAN GREEN DEAL AND THE ENERGY TRANSITION: CHALLENGES AND OPPORTUNITIES FOR INDUSTRIAL COMPANIES

EL PACTO VERDE EUROPEO Y LA TRANSICIÓN ENERGÉTICA: RETOS Y OPORTUNIDADES PARA LAS EMPRESAS INDUSTRIALES

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SUMMARY

This article reviews the challenges and opportunities facing industrial companies in Europe as a result of the implementation of the European Green Deal, the growth and competitiveness strategy for the European Union announced by the European Commission in December 2019. The objective of achieving a reduction of 55% in greenhouse gas (GHG) emissions in 2030 relative to 1990 and zero net emissions in 2050 will force industrial companies to take urgent steps to decarbonize their activities. This will imply profound changes in their business operations and the need to invest in new technologies and processes and substitute clean energy for conventional fossil fuels. In order to support this transformation, sound innovation policies must be put in place and an efficient sustainable finance ecosystem must be developed. The article explores how industrial companies can transform their operations while simultaneously complying with the grand objectives of the European Green Deal and preserving and even enhancing their competitiveness.

Keywords: European green deal, firm competitiveness, innovation policy, green financing.

RESUMEN

Este artículo repasa los retos y oportunidades a los que se enfrentan las empresas industriales en Europa como consecuencia de la aplicación del Pacto Verde Europeo, la estrategia de crecimiento y competitividad para la Unión Europea anunciada por la Comisión Europea en diciembre de 2019. El objetivo de lograr una reducción del 55% de las emisiones de gases de efecto invernadero (GEI) en 2030 con respecto a 1990 y cero emisiones netas en 2050 obligará a las empresas industriales a tomar medidas urgentes para descarbonizar sus actividades. Esto implicará profundos cambios en su forma de operar y la necesidad de invertir en nuevas tecnologías y procesos y sustituir los combustibles fósiles convencionales por energía limpia. Para apoyar esta transformación, deben ponerse en marcha políticas de innovación adecuadas y debe desarrollarse un ecosistema de finanzas sostenibles eficiente. El artículo explora cómo pueden transformar sus negocios las empresas industriales y, al mismo tiempo, cumplir con los grandes objetivos del Pacto Verde Europeo y mantener e incluso mejorar su competitividad.

Palabras Clave: Pacto verde europeo, competitividad empresarial, política de innovación, financiación verde.

1. Energy transition, climate change and decarbonization

Although the energy transition has been unwinding for several decades now, primarily focusing on a gradual shift of the energy matrix (and, especially, the electricity generation mix) away from oil and oil-related products following the oil crises of the late 70s and early 80s (Grubler, 2012), it has not been until recently that it started to make the frontlines in newsrooms on a daily basis.

The mounting scientific evidence on the effects of greenhouse gas (GHG) concentration in the atmosphere and the expected consequences of climate change on economies and societies around the world has led to international agreements (e.g., the 2015 Paris Agreement) to curb GHG emissions and take steps to try to limit the increase in the average temperature on the surface of the planet to 1.5 °C (or 2 °C, at most).

In the European Union, this has led to a reorientation of the energy-climate strategy and its medium- (2030) and long-term objectives (2050) regarding renewables, energy efficiency and GHG emissions, as reflected in the European Commission communication “A European Green Deal” (EGD) of December 2019 (European Commission, 2019) and the subsequent approval or publication of a varied number of legislative pieces, strategies and action plans linked to it.

The EGD, which can be seen as the new long-term growth and competitiveness strategy of the European Union, will profoundly change the bases of competition in most product and services markets throughout Europe in the years to come.

The impact of the transformation proposed by the EGD on industrial companies will be far reaching. Deep innovation in production, operating, logistical and commercial processes will be required to decarbonize industrial activities. Investments in fuel substitution, digitalization and organizational changes will be needed to maintain the competitiveness of industrial businesses in a new context where markets for products and services with low environmental footprint will be the norm.

This article explores the challenges and opportunities facing industrial companies as a result of the launch of the European Green Deal process and in the context of the post-coronavirus recovery policies put in place in Europe and in other countries around the globe. The main conclusion of the analysis is that industrial companies can implement deep changes in their businesses while at the same time improving their competitiveness in the

medium and long term. To facilitate the transformation, sound and efficient innovation and sustainable finance strategies and policies must be deployed.

2. The European Green Deal and post-Covid economic recovery policies

The European Green Deal, announced on 11 December 2019, should be understood as a new economic growth and long-term competitiveness strategy for the European Union and a roadmap for making the EU's economy sustainable by turning climate and environmental challenges into opportunities across all policy areas and making the transition just and inclusive for all – see Fernández Gómez and Larrea Basterra (2021a), Fernández Gómez (2021).

The aim of all legislative initiatives, strategies and action plans that make up the European Green Pact is to achieve a green, digital, circular and fair economy with zero net emissions by 2050 (European Commission, 2019). Intermediate goals have been set for year 2030, including reaching a 55% reduction in GHG emissions from 1990 levels. This implies the need to accelerate the decarbonization in the hard-to-decarbonize sectors such as transport and the industry sector, which accounted for about 50% of total GHG emissions in the EU-27 in 2018.

In other words, the grand goal is to transform the European economy into a net-zero emissions economy without compromising the competitiveness of European industry (and the economy, in general) in the long term and exploiting the opportunities that the “green transition” will generate. Thus, for example, one of the concrete objectives within the EGD is to foster an innovative and competitive industry that becomes a global leader in sustainability. In this context, European industrial firms are expected to become competitive in world markets by developing innovative and environmentally sustainable products and services (Fernández & Larrea, 2020).

To achieve those ambitious goals, since December 2019, a large number of pieces of legislation, strategies and action plans have been implemented and approved related to very diverse aspects in different economic sectors, including energy, the building sector, industry, mobility, the primary sector or the environmental sector. A varied set of regulatory, economic and financial instruments and tools (e.g., grants and taxes) and other schemes and initiatives are intended to convert the European economy into a resource-efficient economy where energy and materials are optimally used and goods and services are produced, distributed and consumed in a sustainable manner.

By the end of 2021, a significant number of specific strategies and action plans had been approved by the European Commission within the European Green Deal in areas such as industrial policy, the circular economy, energy sector integration (i.e., a holistic approach to the generation and use of different forms of energy, including electricity, heat, hydrogen, natural gas, etc.), the development of a competitive hydrogen industry, offshore renewable energy, reduction of methane emissions, development of sustainable chemicals, increased efficiency in the buildings sector, sustainable mobility and the development of advanced electrochemical batteries, etc.

Eliminating pollution, developing sustainable food systems, protecting biodiversity, fostering the blue economy and increasing the sustainability of the primary sector are other areas of focus of the European Green Deal. Additionally, initiatives have been approved to boost the circular economy and align the environmental taxation scheme (including a CO₂ tax on imports in certain sectors) or innovation activities, for example, with the objectives of the PVE.

The launch of the European Green Deal coincided with the spread of the SARS-CoV-2 coronavirus around the world and the onset of a global pandemic. The negative economic impact of the pandemic was unparalleled in the history of the European Union and led to a record fall in GDP in 2020 in the EU (-6.1%).

In response to this situation, the EU agreed in July 2020 on a recovery plan to mitigate the economic and social impact of the pandemic. The EU recovery plan is designed around two pillars: (1) the NextGenerationEU program, a set of financing instruments that plans to mobilize €750 billion (in 2018 prices, or €806.9 billion, in current prices); (2) the Multiannual Financial Framework 2021-2027, within the EU's long-term budget, which will provide more than €1.2 trillion (in current prices). A significant share of the available funds (approximately 30% of the total) will be devoted to the energy and environmental transition towards a sustainable and net-zero emissions economy that is proposed under the EGD.

In July 2021, the EU gave further impulse to the EGD process by announcing the so-called “Fit for 55” package and making the 55% GHG emissions reduction in 2030 compared to 1990 levels the net-zero emissions goal in 2050 binding by law. The “Fit for 55” package includes integrated and holistic proposals aimed at updating and accelerating the decarbonization process of the European economy in order to achieve the targets set for 2030, and complements the proposals included in the European Green Deal in areas such as the European emissions tra-

ding system, renewable energy, energy efficiency, low-carbon mobility, energy and environmental taxation, carbon leakage mitigation, negative emissions or the update of key energy regulation and energy market design legislative pieces.

3. The environmental challenge for industrial companies in Europe

The grand environmental objectives embedded in the EGD encompass not only the pillars of the energy-climate policies in the decade of 2010-2020 (increased penetration of renewable energy in the energy mix, reduction of GHG emissions and increase in energy efficiency), but also the wider environmental goal of reducing the overall environmental footprint of economic activities (which includes all kinds of environmental impacts, not only GHG emissions) and materials efficiency, which is increasingly seen as a powerful tool to abate GHG emissions.

Industrial companies can (and will be required to) contribute to these goals, as other sectors, and there are a number of avenues that can be pursued in order to increase the sustainability of manufacturing and other industrial activities. The range of specific actions and solutions an industrial company can undertake to advance in the decarbonization of its activities is wide (Table 1).

Table 1

European Green Deal-related challenges for industrial firms

| Grand EU objectives | Key challenges for industrial companies |
|---|--|
| Increased consumption of renewable energy | <ul style="list-style-type: none"> • Secure energy supply contracts with an increased share of renewable energy • Adopt renewable energy self-consumption solutions |
| Reduction in GHG emissions and other pollutants | <ul style="list-style-type: none"> • Substitute clean energy sources for fossil fuels • Change core and non-core processes to use innovative zero-, low- or negative-emissions technological solutions (e.g., hydrogen, carbon capture, utilization and storage (CCUS) solutions, etc.) • Control fugitive GHG emissions and pollutants |
| Increase in energy efficiency | <ul style="list-style-type: none"> • Advance in the digitalization and automatization of business processes • Implement effective active energy demand management measures • Upgrade infrastructure, assets and equipment • Continue to implement standard energy efficiency measures (insulation, efficient lighting and climatization, etc.) |

| Grand EU objectives | Key challenges for industrial companies |
|---|---|
| Increase in material use and product efficiency | <ul style="list-style-type: none"> • Optimize the use of materials • Advance in product ecodesign • Invest in and promote innovation in materials • Substitute or reduce the use of hazardous materials and substances • Develop and implement circular activities and processes |
| Reduction of the total environmental footprint | <ul style="list-style-type: none"> • Take steps to optimize value-chain activities • Adopt waste reduction and valorization policies • Advance in product ecodesign, circularity and durability • Develop new services based on optimal use of assets and equipment (servitization, advanced maintenance services, etc.) • Implement green procurement practices (materials, products, services) • Adopt a life-cycle approach to activities and processes • Explore GHG negative emissions and compensation solutions |

Source: own elaboration, based on Fernández Gómez et al. (2021).

All these alternatives will imply profound transformations in business operations for European industrial companies, especially those operating in energy-intensive (and, therefore, emissions-intensive) sectors, and will generate risks related to the deployment of new technological solutions, the adaptation to new norms and regulations as the legal and statutory provisions in European Green Deal begin to apply, and the development of new markets for sustainable products and services. As a consequence, industrial companies will be facing an enormous decarbonization (and environmental) challenge over the next few years.

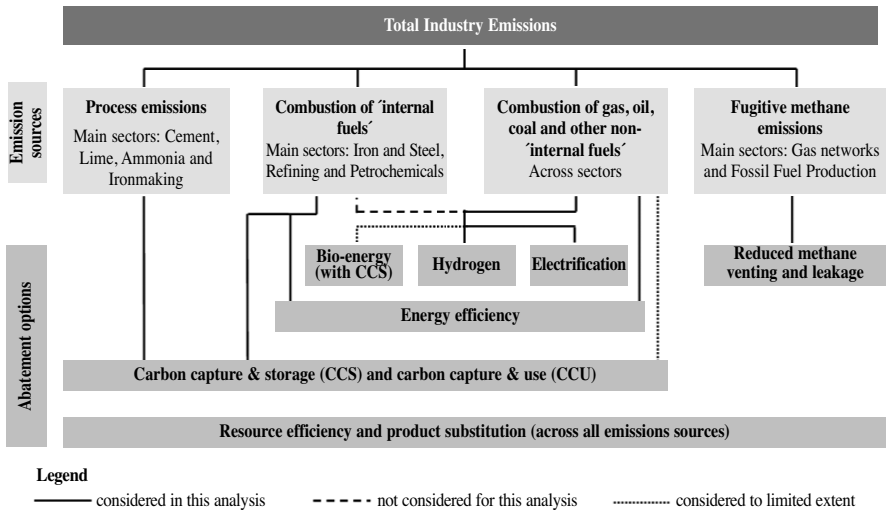
The actual decarbonization pathway an industrial company can take will depend on its specific manufacturing and logistic processes. GHG emissions by an industrial company are associated with the combustion of fossil fuels (in core business processes and in other non-core activities, such as transportation), methane leaks and so-called process emissions (i.e., collateral emissions linked to GHGs generated in core processes in the production of cement or lime, for instance).

The alternative, general abatement options for all these sources of emissions are shown in Figure 1. These include using alternative types of energy in place of fossil fuels (e.g., electric power, hydrogen or bio-energy with carbon capture), increasing energy efficiency via optimized processes and better infrastructures and equipment, using carbon capture

solutions, especially in the case of process emissions and in certain sectors (e.g., those using high-temperature steam) where fuel change options are not viable. Additionally, an increasingly relevant way for industrial companies to curb GHG emissions is to improve the efficiency in the use of materials (for instance, through product ecodesign or circular processes involving recycling and reusing materials and products).

Figure 1

Technical options for decarbonizing industrial sectors



Source: Climate Change Committee (2019).

4. How can companies take advantage of the transition towards sustainability?

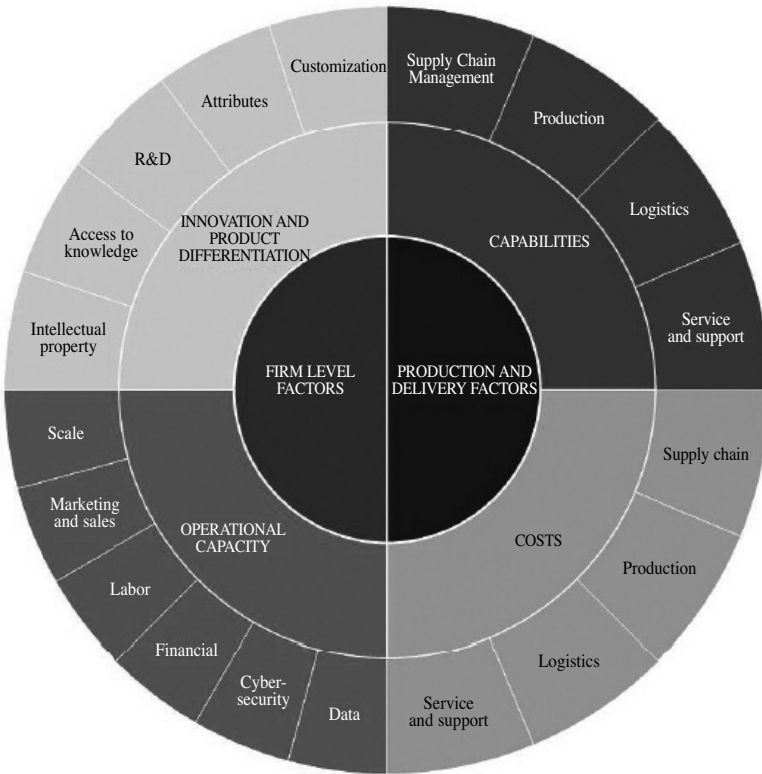
The key for industrial companies to succeed in the transformation proposed by the European Green Deal is to align their business strategies, value proposals and operations with sustainability goals and outcomes in a way that effectively boosts their competitiveness.

Environmental sustainability, one of the dimensions of the wider concept of sustainability (the other two being economic and social sustainability), implies developing and achieving economic activities and business processes with low or zero overall environmental footprint.

Taking steps to improve a company’s environmental footprint will have impact on all sources and factors of competitiveness as it will affect a firm’s costs and operations as well as its capacity to innovate and, thus, generate competitive advantages through product and service differentiation and diversification (Figure 2).

Figure 2

Competitiveness factors for manufacturing firms



Source: David et al. (2018).

The adaptation of industrial business strategies and practices to the new context will imply the need to invest in the adoption of new technologies, develop new technologies and materials and implement innovative operating and organizational solutions.

In general, deep transformations of business core processes and strategies to make them more sustainable will imply higher costs (both investment costs and, in many cases, operating costs) associated with the need to make investments in assets and equipment, digital solutions, etc., or with adapted internal processes (for instance, new activities and processes linked to product ecodesign and testing procedures, monitoring activities, etc.). The need to increase the innovation effort could also imply higher R&D costs or other costs associated with the adoption and implementation of new technical or organizational solutions.

There is a wide array of specific actions and solutions an industrial company can undertake to advance in the decarbonization of its activities and improve its overall environmental footprint. Table 2, for instance, shows specific actions that can be pursued by manufacturing companies in the iron, steel and metal sectors in order to make their businesses more sustainable and their expected impact on a company's competitiveness.

Increased investment and operating costs in the short run as a result of the transformation of processes and the upgrade of infrastructure, installations and equipment will be compensated with reduced energy costs (in the medium and long run), augmented overall technical and economic efficiency (via optimized use of energy and materials), better market positioning, improved reputation (e.g., linked to a lower environmental footprint and reduced emissions), greater capacity to innovate, improved company capacities (e.g., digital, organizational, logistic...) and a more diversified value proposal.

Table 2

Strategies to increase the sustainability of manufacturing processes in iron, steel and metal product sectors and expected effects on firm competitiveness

| Areas of action | Specific technological and other solutions | Main expected effects on firm competitiveness |
|---|---|--|
| Clean technologies and processes for the production of iron and steel | <ul style="list-style-type: none"> • Scrap electric-arc furnace (EAF) • Smelting reduction • Blast furnace-basic oxygen furnace (BF/BOF) with biofuels • BF/BOF with CO₂ capture • BF/BOF with hydrogen • Direct reduction of iron with natural gas and EAF • Direct reduction of iron with blue or green hydrogen and EAF • Iron electrolysis | <ul style="list-style-type: none"> • Increased investment costs • Potentially increasing operating costs • Increase in R&D costs • Reduction in energy costs |

| Areas of action | Specific technological and other solutions | Main expected effects on firm competitiveness |
|---|--|--|
| Fuel substitution and fuel use optimization | <ul style="list-style-type: none"> • Solar- and/or wind-based self-consumption • Biomass • Fuel waste recycling • Fuel-enrichment technologies with hydrogen, oxygen... | <ul style="list-style-type: none"> • Increased investment costs • Increased operating costs • Reduction in energy costs |
| Energy efficiency and waste heat recovery | <ul style="list-style-type: none"> • Upgrade of power and steam generation systems • Waste heat recovery infrastructure • Recycling of heat and fluid gas in furnaces • Optimization of compressed air systems • Efficient equipment, with better isolation (motors, pumps, compressors, fans...) • Hot delivery and hot charging equipment • Process control and automatization • Improvement of planning and optimization of processes and material flows | <ul style="list-style-type: none"> • Increased investment costs • Reduction in energy consumption |
| Electrification | <ul style="list-style-type: none"> • Electrification of low or high heat generation systems (where possible) • Electrification of motors, light vehicles, transport vehicles, industrial vehicles (e.g., forklifts) | <ul style="list-style-type: none"> • Reduction of energy costs in the medium and long term |
| Materials efficiency and optimization | <ul style="list-style-type: none"> • Products with innovative materials and improved characteristics (e.g., lower corrosion...) • Recycling of materials (e.g., metal scrap) and use of new material mixtures • Design of material mixes to facilitate recycling • Reduction of waste materials in manufacturing processes (e.g., improved shaping and cutting of metal sheets) • Management of byproducts (e.g., slag, metal scrap, gases) and use as inputs in other production processes • Medium- and high-entropy alloys • Thin slab casting • Additive manufacturing | <ul style="list-style-type: none"> • Increased R&D costs • Increased product testing and norm compliance costs • Improved market positioning • Reduced costs of materials • Reduced energy costs • Improved technical productivity • Reduced dependency on critical materials • Increased innovation capacity • Diversification of value proposal (i.e., associated with new circular services) |

| Areas of action | Specific technological and other solutions | Main expected effects on firm competitiveness |
|---|--|---|
| Process digitalization | <ul style="list-style-type: none"> • Improved quality and flaw-detection processes • Improved maintenance and repair services • Improved quantification, monitoring, data registration and evaluation and assessment processes • Optimization in the use of energy and materials and control of emissions • Improved sustainability of the supply and value chains and improved multi-installation joint management (e.g., via blockchain, cloud computing) | <ul style="list-style-type: none"> • Increase in investment costs • Increase in operating costs • Improved overall technical efficiency • Reduction of energy and materials costs • Increased capacities (new processes, data analysis, adoption and use of new technologies...) |
| Green procurement of energy, materials and supplies | <ul style="list-style-type: none"> • Green requirements along the value chain (mandatory, via a joint agreement, or voluntary) • Green-energy procurement | <ul style="list-style-type: none"> • Improved market positioning • Improved reputation |
| Product innovation | <ul style="list-style-type: none"> • More sustainable products with improved specifications and quality | <ul style="list-style-type: none"> • Increased investment and R&D costs • Improved market positioning • Product differentiation • Diversification of value proposal |
| Green certification of products and services | <ul style="list-style-type: none"> • Life-cycle approach to product and services design and procurement | <ul style="list-style-type: none"> • Improved market positioning • Improved reputation • Product differentiation • Diversification of value proposal |
| Clustering | <ul style="list-style-type: none"> • Joint management of energy consumption, emissions control, recovery and reutilization of waste heat, infrastructure development... between installations in the same or in different value chains | <ul style="list-style-type: none"> • Reduced operating costs (economies of scale and scope) |
| Data analysis, big data, life-cycle analysis | <ul style="list-style-type: none"> • Improvement in analysis, assessment and decision processes under sustainability criteria | <ul style="list-style-type: none"> • Increase in investment costs • Increase in operating costs |

| Areas of action | Specific technological and other solutions | Main expected effects on firm competitiveness |
|--|--|--|
| Compliance with ESG (environmental, social & governance) standards | <ul style="list-style-type: none"> • Alignment with regulatory and market trends • Optimized resource management • Reduction and management of operating risks and increased resiliency | <ul style="list-style-type: none"> • Improvement in company reputation • Lower cost of capital • Greater access to “sustainable finance” |
| Cooperation with competitors, clients and suppliers | <ul style="list-style-type: none"> • Improved operating and logistic practices (e.g., joint use of infrastructure or logistic platforms, joint management of common risks...) | <ul style="list-style-type: none"> • Increase in investment costs (if joint investments are made) • Reduce operating costs • Reduced risks • Development of new capabilities (e.g., collaboration, resource sharing, etc.) • Innovation in services |
| Servitization | <ul style="list-style-type: none"> • Increase in asset utilization rates along the value chain, both upstream (machines and equipment) and downstream (sale of services to end customers) | <ul style="list-style-type: none"> • Improved market positioning • Improved reputation • Product differentiation • Diversification of value proposal |

Source: own elaboration, based on Bhatnagar (2021), Colla and Branca (2021), Parsons Brinckerhoff and DNV GL (2015a, 2015b), Raabe et al. (2019), Horton et al. (2019) and von Gleich (2006). See also Fernández Gómez et al. (2021).

5. Supporting innovation by European industrial companies

In order to effectively transform their production processes and their business models into more sustainable approaches, industrial companies will need to invest in new technologies and equipment and increase the resources devoted to innovation activities.

Innovation and technological and organizational change will, therefore, play a critical role in achieving the desired sustainability goals and boosting economic, industrial and technological opportunities.

The need to abate emissions and improve the environmental footprint of industrial activities as fast as possible (given the stringent 2030 objectives set out by the EU) places innovation at the center of the European

Green Deal implementation process. Innovative solutions (both technological and non-technological) will be required, as the current technologies are not yet economically or technically viable to decarbonize activities in sectors such as transport or the industrial sectors.

Substantial amounts of investment along the innovation value chain will be needed, from low to high TRLs (technology readiness levels), and in areas ranging from new energy sources and vectors (e.g., hydrogen) to low- or zero-emissions materials and processes. The ability of R&D and innovation systems to speed up the transfer of new knowledge and technologies to firms and industries in the form of commercially viable solutions will be a relevant success factor.

Firms will be forced to assign resources and capital to R&D activities and take risks in relation to the development and adoption of new technologies and operational models. Innovation in data capture, processing, transmission, storage and analysis and the development of new digital solutions will support smart operational processes incorporating artificial intelligence, automation, etc., and facilitate the development of new business models and new ways to provide services (i.e., aggregation services in the energy sector, digital twins for products and infrastructures, servitization of assets in the industrial sector, vehicle-sharing in mobility, etc.). This radical innovation-based transformation represents a major challenge not only for companies, but also for the workforce and the institutions in a territory.

Additionally, both company managers and boards and public institutions will need to adapt their stances and mindsets in order to foster innovative ways of public-private and private-private collaboration and create the right conditions for disruptive innovation.

European policies linked to the deployment of the European Green Deal can support the innovation effort by the industrial sector in two ways: a) facilitating innovation by developing adequate policies and R&D and innovation ecosystems; b) facilitating the access of companies to capital and financial resources.

Boosting innovation through mission-oriented policies

The traditional approach to innovation policies in recent decades has focused on trying to fix market failures that limit innovation activities due to technological, regulatory or market risks.

This traditional role is currently being modified due to the uncertainty associated with the profound technological, economic and social transformation implied by major transitions, such as the transition towards a zero-emissions economy. In addition, the approach to major challenges through strategies and policies (e.g., industrial, innovation, decarbonization, transformation of public service systems, etc.) oriented towards specific missions and objectives (mission-oriented policy approach) increases the role of governments and public entities in the transformation processes. Under this approach, governments become active agents that not only regulate and set the general direction of innovation, but also invest and finance investments, assuming risks (and, ideally, also capturing part of the upside of the investments).

In the case of the EGD, it must be noted that the “green, circular and digital transition” it proposes is regulatory- rather than technology-driven. That is, it is the regulatory and legal changes embedded in the EGD, aligned with the major global climate agreements (Kyoto, Paris, successive COP conferences...), that are shaping the regulatory framework and markets in which European industrial companies will have to compete in the future.

In order to make rapid and effective innovation progress (i.e., reaching the highest TRLs in a short time and commercializing new solutions, developing new proposals to the market, etc.) both in technological innovation (new clean technologies, digitalization, etc.) and non-technological innovation (forms of organization, relationships between agents, business models, etc.), the EU has updated its innovation support framework to better align it with the grand sustainability and competitiveness goals embodied in the EGD.

Thus, in addition to increasing the budget of the now-called Horizon Europe R&D program, it has created the European Innovation Council, with a special focus on “missions” and the development of new collaboration schemes between public and private stakeholders. The “missions” are specific objectives towards which concrete projects are oriented that constitute achievable milestones to solve major societal challenges and that act as frameworks and stimuli for innovation in general (Mazzucato & Dibb, 2019). Five EU-wide missions have been identified, four of which are directly related to the European Green Deal (Figure 3). The EU missions are expected to mobilize R&D resources, catalyze actions, generate concrete impacts, demonstrate new solutions and produce public goods.

Figure 3

European Union innovation missions

Source: European Commission (n.d.).

Innovation missions within the EGD are expected to be pushed by so-called “green partnerships” that bring together public and private agents and pool resources from companies, foundations and public institutions, as well as third-countries. These partnerships may be “co-programmed European partnerships” (between the European Commission and private partners, mainly), “co-funded European partnerships” (involving EU Member States, research funders and public institutions) or “institutionalized European partnerships” (involving the EU, Member States and the industry)

The EU’s research, development and innovation strategy is also based on two key principles: 1) the innovation principle, which implies that legislative and regulatory developments will be designed with the aim of creating the best possible conditions for innovation activities; and 2) an open-science policy leading to easy access to publications and other innovation resources.

Efficient and competitive green financing ecosystems

This new strategic approach by the EU to innovation policies must be coupled with new, innovative ways to finance sustainable projects facing technological, market and regulatory uncertainty. The new vision about innovation, based on mission-oriented sustainable projects aligned with major societal challenges, requires a holistic, long-term and “patient” vision of the transformation processes by Governments and public institutions.

The allocation of public financial resources should be based on the overall global transformation strategies in place and the social profitabi-

lity of projects. This, in turn, may imply discarding a short-term vision of investments in infrastructures and innovation and tying capital to projects and investments with long payback periods. This will require new capacities and forms of organization in public administrations and the use of new tools for evaluating and assessing projects to identify those that are most relevant from the point of view of society (i.e., those that are aligned with major social objectives and have the greatest potential to increase social welfare).

The role of governments goes beyond becoming active and transformative agents in major transitions and fostering innovation. They must also lay the foundations for financing ecosystems that generate incentives for private agents to generate capital flows that are oriented towards transformative projects. In order to lever public resources and attract private capital, governments will also have to exercise leadership and facilitate the development of new forms of governance and collaboration between different types of agents, including companies, business associations, cluster associations, universities and technology and research centers, etc.

Increasing the likelihood of success and efficiency of the transformation process will require a comprehensive strategy for financing sustainable transitions that aligns financial policy measures and available capital resources with industrial, innovation and (overall) sustainability policies.

Fernández Gómez and Larrea Basterra (2021b, 2021c) study the policies, strategies and measures that can be fostered by Governments to facilitate the financing of sustainable and green projects and an easier access of industrial companies to the available funding sources.

Governments should direct their actions in the area of promoting a competitive financing ecosystem towards: (1) boosting the supply of financing resources (by generating new public resources and facilitating private capital flows, both institutional and non-institutional); (2) fostering the demand for financing (e.g., by facilitating the identification of transformational projects with high social returns); (3) promoting the development and strengthening of the financial market's key institutions and infrastructures (e.g., expanding the role of existing institutions, such as public guarantee institutions or public investment companies, creating specialized fora, etc.); (4) creating stable and transparent (but also clearly oriented) policy and regulatory frameworks that facilitate investment decisions; (5) developing new financial skills and knowledge in public

administrations, the education sector and companies; and (6) fostering innovation in financial products and services (i.e., new products tailored to better match the risks faced by investors in green or digital technologies).

6. Conclusions

Given mounting evidence and growing knowledge about climate changes and its consequences and given the political response to the scientific challenge, in the form of a global agreement to fight climate change (the Parsons Brinckerhoff & DNV GL, 2015a), the European Union has embarked on a decades-long trip towards achieving an environmentally sustainable economy. The European Green Deal acts as a compass in this transformation journey.

The energy transition must be understood, in the context of the EGD, in a holistic manner, as an integral transformation of the energy system and the role of energy in the entire economy in order to achieve long-term sustainability. This transformation affects both the supply and the demand side of the energy sector and how energy is generated, transported, distributed, stored, transformed and, eventually, consumed.

This wide-ranging transformation process is driven by policy, rather than technological innovation, and involves multidimensional, complex, non-linear, non-deterministic and uncertain subprocesses in various areas: regulation, politics, technology, markets... Hard-to-decarbonize sectors, such as mobility or the industrial sector, will face enormous decarbonization challenges in the years to come.

Arguably, the greatest challenge facing the industrial sector is the urgency to start decarbonizing effectively all industrial activities and processes. The solution to curbing GHG emissions in industrial companies will be multidimensional and will involve not only new energy sources as substitutes for fossil fuels, including energy vectors such as hydrogen or biofuels with carbon capture, utilization and storage (CCUS), but also increased process, materials and product efficiency and, even, deploying solutions to achieve negative emissions.

These transformations of manufacturing, procurement, logistic, operating and commercial processes will imply significant investments and the need to develop innovative solutions based on increased R&D and innovation expenses. Fortunately, in the context of the European Green Deal, the requirement to transform businesses into sustainable enterpri-

ses also creates opportunities for companies, stemming from the development of new markets for sustainable products and services.

The key for industrial companies to succeed in the transformation of their production and logistic processes is to reorient their business strategies, value proposals and operations towards achieving sustainable outcomes in a way that enhances their competitiveness. This will imply increasing investment and (potentially also) opex costs in the short run.

By carrying out economic activities and business processes with low or zero overall environmental footprint companies can not only reduce their energy costs (in the medium and long run), but also increment their technical and economic efficiency (via an optimized use of energy and materials) and improve their reputation and market positioning. Companies can also benefit from a greater capacity to innovate, improve their digital, organizational, operational and logistic skills and the ability to identify and develop more diversified value proposals.

Lowering the environmental footprint of industrial activities while simultaneously increasing a firm's competitiveness can be done through a wide array of specific actions and solutions, including fuel substitution and fuel use optimization, the adoption of clean technologies and processes, increased efficiency in the use of energy and heat, circular activities and other practices (e.g., ecodesign) that increase the efficiency in the use of materials, increased digitalization of activities and other practices that aim to improve the sustainability of a company's business (e.g., green procurement, clustering of industrial sites for energy and materials management, use of data analysis, big data and life-cycle analysis, compliance with ESG standards, increased cooperation with competitors, clients and suppliers or the development of new services based on asset servitization, for instance).

But industrial companies will not be able to make the transition just on their own. Robust energy and environmental regulatory frameworks must be developed, with clear incentives to invest in new technologies and transform production processes and energy systems while at the same time defending economic activity and employment in energy-intensive industrial activities exposed to carbon leakage. Likewise, well-functioning markets that send appropriate economic signals in the short- and long-run (i.e., efficient prices of energy) must be put in place.

In order to induce efficient economic decisions while preserving the competitiveness of the industrial sector, European policies must be oriented towards fostering R&D and innovation activities and the deve-

lopment of efficient innovation ecosystems and creating sustainable finance environment that facilitates the access of companies to capital and financial resources.

Boosting cooperation between public and private agents around well-defined mission-oriented strategies and policies is the way chosen by the European Union to induce deep, innovative transformations in hard-to-decarbonize sectors. The development of “hydrogen valleys” throughout Europe, with significant public and private support at the local level, is an example of how to jumpstart large-scale transformations in the energy system.

Mission-oriented innovation policies must also be coupled with efficient sustainable finance ecosystems that allow industrial companies to raise the capital they need to invest in new technologies and develop new business models in the face of significant technological, regulatory and market risks. Governments can help to mitigate all these risks by putting in place integral policies that aim to develop both the supply and demand side of the sustainable finance market, creating new financial capacities across the board in public institutions, companies and the education system and facilitating the development of new financial products and services.

To sum up, given the scale of the sustainability transition, effective, disruptive innovation will be required across the board to achieve energy and environmental goals in 2030 and 2050, especially in hard-to-decarbonize sectors such as transport or the industrial sector. Making sure the conditions are adequate for the deployment of ambitious R&D activities that lead to the effective adoption of low-carbon innovative solutions and for financing the transformation of industrial infrastructures, technologies and processes becomes, then, an essential pillar of the energy transition and of sound sustainability policies and strategies.

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