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CHAPTER 4

SPAIN AND THE EUROPEAN UNION IN THE FACE OF THE ENERGY CRISIS: NEAR-TERM ADJUSTMENTS AND CHALLENGES PENDING

BANCO DE ESPAÑA
Eurosistema

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SPAIN AND THE EUROPEAN UNION IN THE FACE OF THE ENERGY CRISIS: NEAR-TERM ADJUSTMENTS AND CHALLENGES PENDING

1 Introduction

The war in Ukraine has highlighted the extraordinary level of vulnerability of the energy framework of all the EU Member States. Before the start of the war, fossil fuels still accounted for almost three-quarters of the European economies' energy consumption. This energy mix entailed considerable external dependence, given that the EU imports almost all of the fossil fuels it consumes. The EU also lacks sufficient energy interconnection infrastructure, especially for electricity and natural gas. All these factors have shaped an environment that is highly susceptible to a negative shock such as that which has occurred – a sharp drop in the volume of energy imports from some countries and a surge in energy prices – having a very substantial and uneven negative impact on the European economies. In addition, this impact could not be easily distributed or smoothed across them (see Section 2).

However, in recent quarters, the resolute response of the European authorities and the notable capacity for adjustment exhibited by the EU economies have averted potentially highly disruptive scenarios. In particular, within a very short space of time, energy supply sources have been diversified – the bulk of the imports from Russia having been replaced – and overall energy consumption in the EU has been reduced. And all this has been achieved without widespread supply cuts or significant economic contraction. Yet there have also been certain favourable factors at play – such as the relatively mild winter in Europe and the fall in Chinese liquefied natural gas (LNG) imports in 2022 as a result of the country's zero-COVID policy – that could reverse in the coming quarters (see Section 3.1).

In any event, the current energy crisis is having a highly asymmetric impact on households and firms (see Sections 3.2 and 3.3). This impact is shaped, inter alia, by households' and firms' different initial exposure to the energy goods that have risen in price (with lower income households and smaller and more energy-intensive firms most exposed, ex ante), by the extent to which they have been able to cut their consumption of those goods and by the effect of the measures deployed by the authorities (most of which have been general measures, not targeted at the most vulnerable groups). Over the last few quarters, firms have responded to rising energy costs by raising their prices, renegotiating their supply agreements and endeavouring to increase their energy efficiency, among other measures. The impact has been considerably uneven by sector and firm type, with smaller and less productive firms proving more vulnerable to the present energy crisis.

Looking forward, correcting the structural shortcomings identified in the EU's energy framework is consistent with advancing – possibly even faster than initially envisaged – the European green transition towards a carbon neutral economy. Some of the foundations for this transformation have already been laid, such as the various initiatives launched under the umbrella of the European Green Deal and the Next Generation EU (NGEU) and REPowerEU programmes.[1] In any event, despite these initiatives, achieving the – highly ambitious – commitments assumed is still a huge challenge.

Over the coming decades, reducing the EU's energy import dependency and achieving the green transition will require the large-scale deployment of renewable energy sources, additional energy efficiency gains and further development of the EU's energy interconnection infrastructure (see Section 4.1). All the foregoing will entail considerable challenges. On the technological side, for instance, some of the green technologies currently available are still at an initial phase of development or are not cost competitive. Moreover, this transformation will also give rise to a substantial increase in demand for certain commodities – such as rare earths – that are scarce in the EU. This could trigger new dependencies on imports from third countries. In any event, despite the challenges, the boost to renewable energy sources could pose a major opportunity for the Spanish economy given that, within the EU, Spain has the second-highest land-based wind power capacity and the highest solar power capacity, and it also has world-leading firms in both sectors.

For progress to be made in the energy transformation, the European policy response to the current crisis will also have to be adaptable, provide certainty and ensure that the green transition does not lead to a structural loss of competitiveness for our productive system (see Section 4.2). Within the EU there must a joint response to the risks and threats that all the Member States face. In this respect, in the framework of the joint European response to the current energy crisis, it is vital that certain key aspects continue to be reinforced. In particular, as regards funding, the volume of investment that will be necessary in the coming years to meet the challenges associated with the green transition far exceeds the sums envisaged in the current European programmes and the national possibilities of many of the region's economies. Accordingly, more resolute progress in the joint funding of these public goods for the EU will be needed, for instance by establishing a permanent EU fiscal capacity.

1 For more details on these initiatives, see Banco de España (2022b), Dormido, Garrido, L'Hotellerie-Fallois and Santillán (2022) and L'Hotellerie-Fallois, Manrique and Marín (2023).

2 The European Union's energy framework before the start of the war in Ukraine

2.1 The energy mix and its heterogeneity across countries

Despite renewable energy sources having gained weight in both the Spanish and the EU energy mix in recent decades, fossil fuels continued to account for almost 70% of primary energy consumption in 2021[2,3] (see Chart 4.1.1). Among fossil fuels, oil was the main energy source in 2021, followed by natural gas and coal. Renewable energy sources[4] accounted for 16% of total primary energy consumption in Spain and for 18% in the EU in 2021, triple the 1991 levels, while nuclear power accounted for 12% and 13% of primary consumption, respectively.

Various factors have contributed to the energy transformation, notably including greater electricity generation from renewable sources, changes in the sectoral structure of economies and efficiency gains. In particular, between 1991 and 2021, the weight of renewables in electricity generation rose by 29 percentage points (pp) in Spain and by 23 pp in the EU, to 38% and 47% of the total, respectively (see Chart 4.1.2). The proportion of natural gas as an input for electricity generation also increased considerably, while that of oil and coal fell substantially. Moreover, the change in the energy mix has been affected by the changes observed in the sectoral composition of economic growth, insofar as there is a notable degree of heterogeneity across sectors as regards the number and type of energy sources used, and by the energy efficiency gains achieved in each sector.[5] Indeed, as Box 4.1 shows, both energy intensity (defined as the amount of energy consumed per unit of output) and carbon intensity (understood as the amount of CO_2 issued per unit of output) have improved in Spain and in the EU in recent decades.

In any event, before the start of the war in Ukraine, there were significant differences in energy mix across the main European countries. These differences broadly reflect persistently different national energy policy strategies, asymmetries in national productive systems and heterogeneity in countries' natural resources. For instance, France has traditionally focused on nuclear power, which in 2021 accounted for 48% of its energy consumption, well above the 12% of Spain and the 0% of another 14 EU countries. Meanwhile, also in 2021, in Poland, the Czech Republic and Germany – the EU's main coal-producing countries – coal accounted for 47%, 31% and 19%, respectively, of their energy mix, much higher than in Spain (2%) and in the EU on average (11%).

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2 Primary energy consumption is the total amount of energy resources demanded, whether for end-user consumption or for conversion into another form of energy (for instance, electricity).

3 Outside the EU, in 2021 fossil fuels accounted, for instance, for 76% in the United Kingdom and 81% in the United States, and for 83% in China where coal is the main energy input (55% of the total).

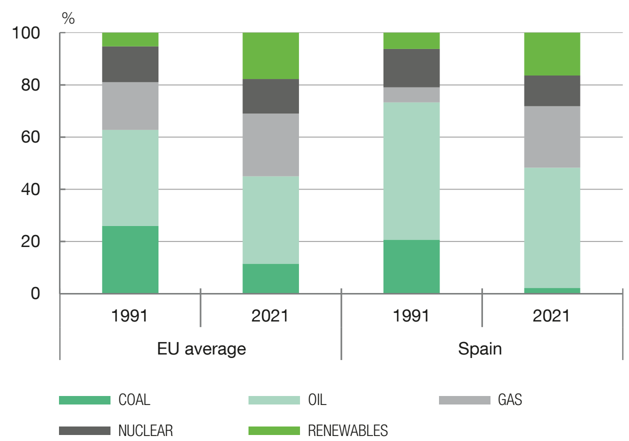
4 The following are considered renewable energy sources, according to the Eurostat definition: solar power, hydro power, geothermal energy, wind power, tidal power, biofuels and renewable energy from waste.

5 Serrano-Puente (2021).

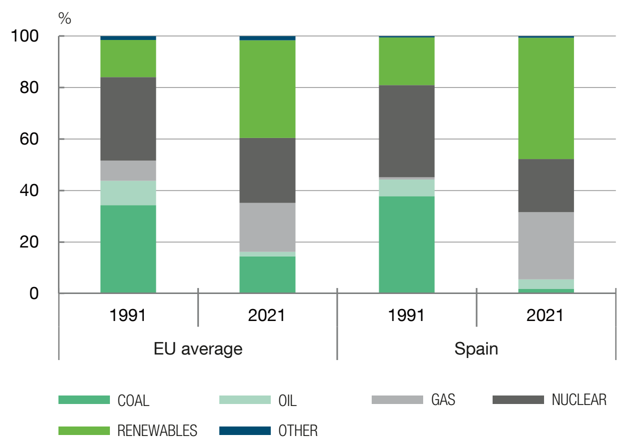
Chart 4.1
ENERGY DEMAND IN THE EU AND SPAIN

Although fossil fuels remain important, in recent decades their share of the energy mix has been reduced in favour of renewables. Energy consumption patterns are highly uneven across the European economies. In Spain, oil is still the main energy source, largely owing to the higher consumption of the transportation sector, followed by natural gas which is mainly used by industry.

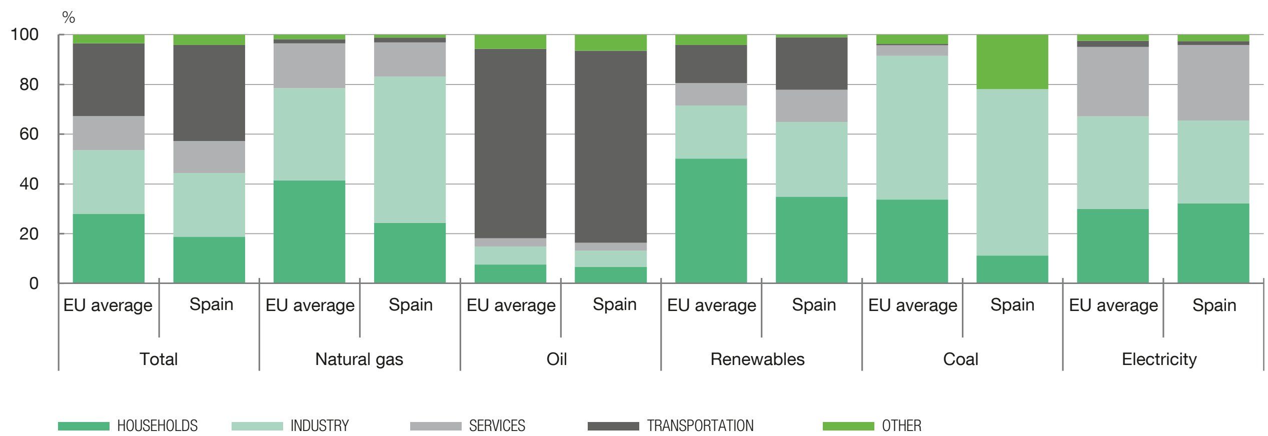
1 PRIMARY ENERGY CONSUMPTION (a)



2 ELECTRICITY GENERATION BY SOURCE (b)



3 FINAL ENERGY CONSUMPTION BY SECTOR IN 2021 (c)



SOURCE: Eurostat.

a Gross available primary consumption according to Eurostat's energy balance, which excludes secondary energy sources.
b Based on gross electricity generation, which includes the electricity sector's own consumption. "Oil" includes both the primary source and oil products. "Coal" includes coal and other solid fossil fuels according to the Eurostat classification. "Other" includes other sources, such as manufactured gases, peat products and non-renewable waste.
c Distribution based on economic agents' final consumption according to Eurostat's energy balances. The transportation sector includes different means of national transport, excluding international aviation and maritime transport. "Other" includes additional sectors, such as agriculture and fisheries. "Oil" includes both the primary source and oil products. "Coal" includes coal and other solid fossil fuels according to the Eurostat classification.

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At the European level, Spain stood out for its higher use of oil, mainly owing to the Spanish transportation sector's high consumption. Before the start of the war in Ukraine, oil accounted for a considerably higher percentage of the primary energy mix in Spain (46%) than in the EU on average (33%) (see Chart 4.1.1). This was because the transportation sector – which accounts for approximately three-quarters of all the oil consumed in Spain and in the EU (see Chart 4.1.3)[6] – was less energy efficient in Spain than in the EU overall.[7] This more than offset the fact that transportation accounted for a smaller share of the economy in Spain than in Europe (4% compared with 5.5%, in gross value added terms, in 2021).

Natural gas consumption was similar in Spain and the EU, at around 24% of total consumption, albeit with a very different composition. In 2021, demand for gas for electricity generation was higher in Spain than in the EU. Among end users, industry's demand for gas was also higher in Spain. Indeed, industry accounted for 59% of final consumption of natural gas in Spain in 2021, partly because of the high weight of the chemical and construction sectors in the Spanish productive system. By contrast, Spanish households' consumption of natural gas was relatively low: 24% of final consumption, compared with 41% in the EU. This is mainly on account of households' lower demand for heating than in other European countries, and the still significant presence of oil-related products – essentially heating oil, butane and propane – in Spanish heating systems.

The same differences were also observed in renewable energy consumption. In 2021, renewable primary energy consumption was very similar in Spain (16%) and the EU (18%), although in Spain the breakdown was tilted more towards electricity generation and industrial demand. Specifically, industrial firms accounted for 30% of final renewable energy consumption in Spain, compared with 21% for European firms. By contrast, Spanish households accounted for 35% of final renewable energy consumption, below the EU average of 50%. There could be various reasons for this, including the regulations applicable and the various policies launched in Spain in recent decades to encourage self-consumption.[8]

2.2 The import dependencies associated with the energy mix

In recent decades, the EU's energy import dependency has increased and it is greater than that of the main world economies. Between 1990 and 2019 (before the outbreak of the COVID-19 pandemic and the war in Ukraine), the EU's energy import dependency rose by 10 pp, to 60%.[9] The EU is more energy dependent on third countries than the United States (which has been a net exporter of energy

6 Final energy consumption corresponds to the energy consumed by end-users, for instance households and firms, excluding the primary energy used in energy conversion. In this respect, approximately one-third of primary energy consumption in Spain is used to generate and distribute electricity that is subsequently demanded by end-users.

7 According to the Spanish Institute for Energy Diversification and Saving (IDEA, by its Spanish abbreviation), in 2019 the Spanish transportation sector was 21% more energy intensive than that of the EU as a whole.

8 See, for example, López Prol and Steininger (2017) and Mir-Artigues, del Río and Cerdá (2018).

9 Import dependency refers to net imports of solid fossil fuels, oil and oil products, electricity and natural gas as a percentage of gross available energy. Renewables and nuclear energy are deemed domestic production. In any event, in 2021 the share of energy imported by the EU from third countries remained very high (56% of total energy consumed).

products since 2019) and China (which in 2019 only imported 22% of its final energy consumption).

In 2019 the EU imported practically all of the oil (97%) and natural gas (90%) that it consumed (see Chart 4.2.1); **these imports were also relatively concentrated** (see Chart 4.2.2). Before the war in Ukraine began, 33% of all EU energy imports were from Russia. Other key trading partners were Norway, the United Kingdom and the United States. However, none of them accounted for more than 9% of the EU's total energy imports.

Natural gas, uranium, anthracite and oil were the European energy imports most vulnerable to global trade disruptions. The EU's vulnerability to energy imports can be quantified by calculating dependency indicators that capture the concentration of imports on a few exporting countries, the EU's scarce domestic production and the substitutability of external supply.[10] Table 4.1 depicts these three indicators for the main energy products; the closer to red the colour, the higher a good's relative vulnerability.[11] Based on these metrics, with data to 2019, the EU's most vulnerable import dependencies related to natural gas, uranium, anthracite and oil, products that are particularly scarce in the EU, hard to substitute and – except for crude oil and LNG – imported from just a few exporting countries. In addition, when considering the degree of alignment of the European economies' main suppliers of energy products with the EU's international positions,[12] there are further signs of vulnerability in the case of oil products (one-third imported from Russia), LNG (whose main suppliers are Qatar and Russia) and coal (45% imported from Russia).[13]

In 2019 Spain's energy imports were more diversified than those of the EU as a whole. Among the EU economies, Spain and France have the lowest figure in the index used by the European Commission to measure the concentration of energy imports from third countries.[14] In 2021 Spain's third-country energy import

10 The import concentration of each product is measured using the Herfindahl-Hirschman index, which is obtained as the sum of the squared shares of each exporting country in EU imports. Domestic production and the substitutability of sources are obtained via two metrics: intra-EU imports as a percentage of total imports and the ratio of extra-EU imports to total European exports. For further details on how these indicators are calculated, see European Commission (2021) and Ioannou and Pérez (2023).

11 The heatmap is constructed by standardising the dependency indicators for the different energy products, using the mean and the standard deviation calculated for the whole sample of energy goods, to obtain a vulnerability indicator. The products are classified and colour-coded according to the quintile to which their vulnerability indicators belong, with colours closer to red signalling the products whose imports are characterised by a higher relative vulnerability. In the heatmap, products are ordered by their share of European energy imports.

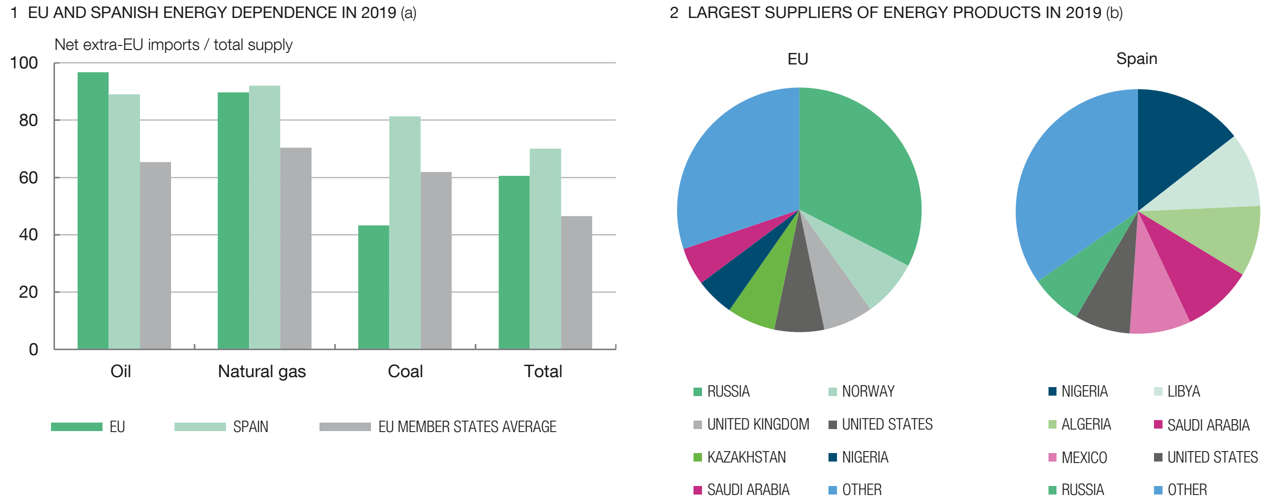
12 The last column in Table 4.1 weights the import concentration index using an indicator of differences in voting patterns at United Nations General Assembly sessions on human rights in the period 2010-2019 between the exporting country and the EU (proxied by Belgium, Germany, Spain, France, Italy and the Netherlands). According to the literature, this indicator proxies countries' geopolitical alignment (Bailey, Strezhnev and Voeten, 2017).

13 Conversely, imports of natural uranium, despite being relatively concentrated, could be slightly less vulnerable to disruptions to global trade, as more than one-half is imported from Canada, a country that is traditionally aligned with the EU's international positions.

14 Balteanu and Viani (2023).

Chart 4.2
EUROPEAN ENERGY DEPENDENCE

Compared with the EU overall, Spain is more dependent on third countries for its energy purchases, although its imports are more diversified across providers.



SOURCES: CEPII-BACI and Eurostat.

a EU: net imports from non-EU countries as a percentage of gross available energy. EU Member States average: imports from non-EU countries as a percentage of domestic production, total imports and stockbuilding. “Oil” includes both the primary source and oil products. “Coal” includes coal and other solid fossil fuels according to the Eurostat Standard International Energy Product Classification (SIEC).

b Value shares of energy imports (anthracite, coal, coke, peat, crude, oil products, natural gas, propane, butane, uranium and fuelwood). The shares of the different providers of gaseous natural gas are calculated drawing on the Eurostat NRG database (Balteanu and Viani, 2023).

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concentration was 33% below that of Germany and Italy, and 70% lower than the median value for the EU overall. Nevertheless, while in aggregate terms the Spanish economy’s external energy suppliers were highly diversified, up to 2021 a large share of Spain’s natural gas imports (43% of total imports of this input in real terms) came from Algeria.

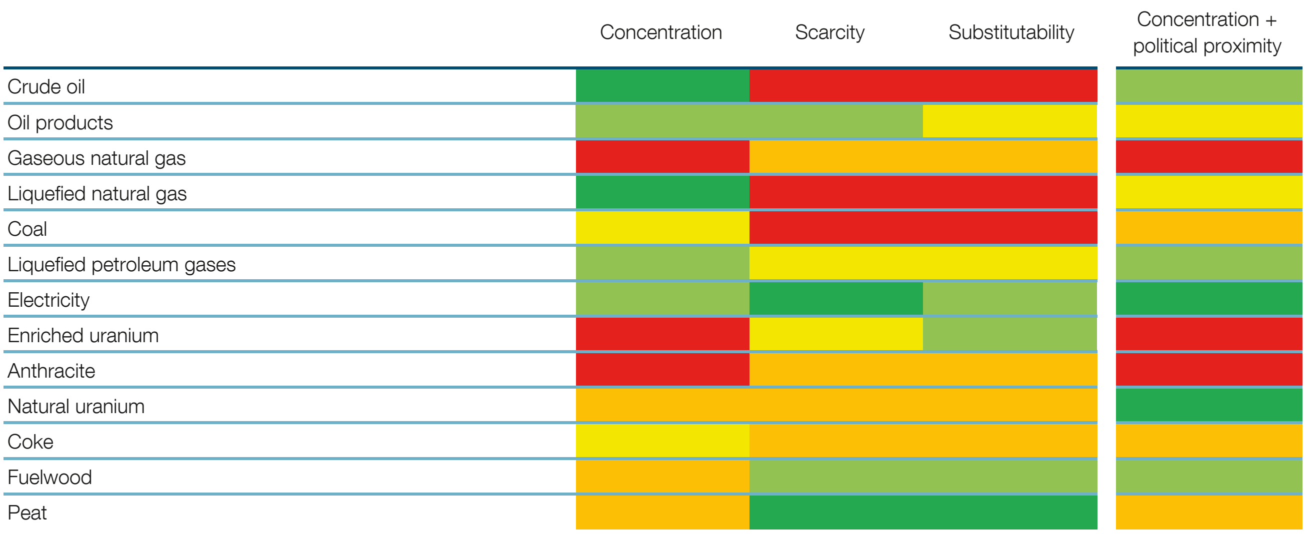
However, Spain was more dependent on foreign energy than the EU, and this energy dependence has also increased over recent decades. In Spain, the percentage of energy imported from non-EU countries rose from 63% in 1991 to 70% in 2021 (see Chart 4.1.1), placing it in the top quintile of the European economies with the highest external energy dependence.[15]

2.3 The insufficient integration of energy markets within the EU

Despite the EU having promoted the strengthening of energy interconnections between the different Member States over the last 15 years, they are still

15 Energy imports from non-EU countries as a percentage of domestic production, total imports and stockbuilding.

Table 4.1
VULNERABILITY OF THE EU'S ENERGY IMPORTS (2019) (a)



SOURCES: Banco de España, drawing on Eurostat, CEPII-BACI and Bailey, Strezhnev and Voeten (2017).

a The indicators of import concentration, scarcity and substitutability for each product are standardised by the mean and the standard deviation for the whole sample (z-score). The energy products are classified and colour-coded according to the quintile to which their z-scores belong; colours closer to red signal higher vulnerability. The last column shows the import concentration index in which each country's import shares are weighted with an indicator of "political proximity" to the EU, based on UN voting patterns and calculated following Bailey, Strezhnev and Voeten (2017). The products are ordered according to their share of European energy imports.

incomplete. The lack of sufficient infrastructure that facilitates energy market interconnection and integration within the EU is patent in the cases of natural gas and electricity. By contrast, how developed this infrastructure is for crude oil and coal is less important, as these commodities are mainly supplied by sea.

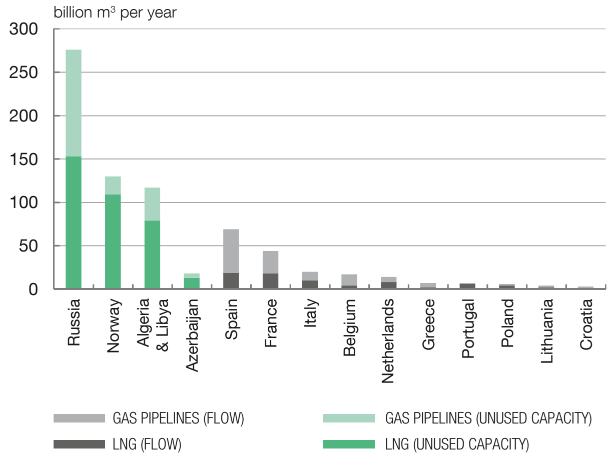
Integration of the natural gas market at European level is limited by the existing infrastructure. Before the onset of the war in Ukraine, most of the EU's natural gas imports came by pipeline from Russia, Norway, North Africa and Azerbaijan (see Chart 4.3.1). However, this gas was essentially received in just a few central European and Mediterranean countries and there was – and still is – no infrastructure to widely redistribute it across the EU. Furthermore, the EU's seaborne LNG import capacity was much smaller than its pipeline gas import capacity and was limited by the existing regasification plants, which only 30% of Member States had. In any event, the possibility of some of the European countries with high regasification capacity (such as Spain) being able to redistribute this gas within the EU was once again limited by the lack of sufficient interconnection infrastructure in the region.

Moreover, cross-border electricity interconnection capacity is highly uneven. Despite most of the European electricity system being interconnected via continental Europe's electricity transmission grid (which makes the existence of an internal

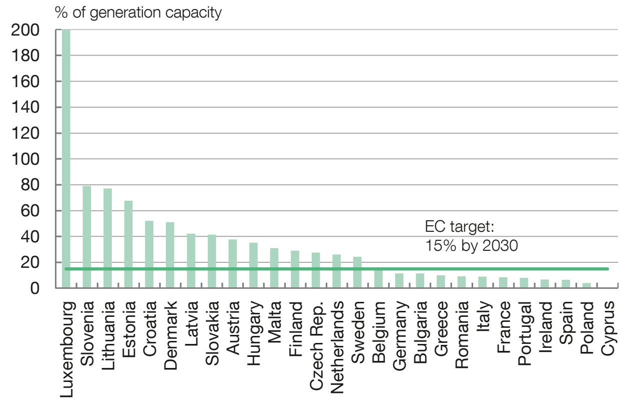
Chart 4.3
ENERGY INTERCONNECTIONS IN THE EU

Despite all the EU's efforts, European energy interconnections are still insufficient. In the natural gas market, integration is constrained by the existing infrastructure that was traditionally highly dependent on pipelines and on Russia. In addition, the slow development of electricity interconnections has meant that some countries, such as Spain, have very limited connections to the rest of the system.

1 EU GAS IMPORTS AND UNUSED CAPACITY IN 2021



2 CROSS-BORDER CAPACITY RATIO



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SOURCES: European Commission and IMF.

electricity market possible), in practical terms, electricity interconnection capacity within the EU is limited by multiple factors.[16] In this respect, the ratio of electricity import capacity to installed generation capacity (the cross-border capacity ratio) is highly uneven across Member States (see Chart 4.3.2). Specifically, in some periphery countries (such as Spain and Portugal) the electricity interconnection capacity with the rest of Europe is very low, with a cross-border capacity ratio of close to 6%, well below the European target of 15% by 2030.

Other highly diverse aspects also contribute to EU energy markets behaving particularly heterogeneously across Member States. Leaving to one side the various factors mentioned above, there are many other – essentially technical – aspects that considerably – and highly unevenly – affect how energy markets function in each Member State and, in particular, the level and volatility of energy prices for households and firms.

For example, there are considerable cross-country differences in how changes in wholesale electricity prices are passed through to retail prices. Compared with the rest of the EU, this pass-through is relatively swift and strong in Spain,

16 For example, due to the existence of technical restrictions stemming from different transmission line densities, on account of geographical features (such as mountain ranges and islands) and because of hurdles created by different national legislation on territorial organisation (including, among others, legislation on environmental protection and the demarcation of protected areas, and urban planning legislation, which determines the different uses for land (i.e. for residential, industrial, tertiary and public services use)).

where a very considerable percentage of consumers are directly bound to the daily price on the wholesale market by the regulated rate for small consumers.[17, 18] By contrast, in France, for example, since 2011 one-quarter of nuclear power is not traded on the wholesale market, but is instead sold directly to retailers at a regulated price. This therefore affects the level and volatility of retail electricity prices in France.

Moreover, taxes and other regulated charges account for a sizeable proportion of the energy prices paid by consumers, which varies considerably across the European economies. For instance, the tax burden on fuels (VAT and the hydrocarbon excise duty) in Spain is lower than the EU average (see Chart 4.4.1).[19] Meanwhile, taking 2019 as reference, taxes and regulated charges[20] accounted for a relatively high percentage of Spanish and average EU gas and, above all, electricity bills (see Chart 4.4.2). Compared with the EU, this percentage was somewhat higher in Spain in the case of bills charged to households (72% and 62% in electricity and gas bills in Spain, as opposed to 69% and 55%, respectively, in the EU), but lower in those charged to firms.

3 European economies' near-term adjustment to the energy crisis

The European authorities have responded resolutely to the Russian invasion of Ukraine and the challenges it has posed by implementing a wide range of measures in multiple areas. For instance, different packages of sanctions and restrictions have been adopted over recent quarters, aimed essentially at increasing the cost of the war for Russia and its economy.[21] In addition, to boost the EU Member States' responsiveness, in May 2022 the European Commission agreed to keep the general escape clause of the Stability and Growth Pact activated in 2023. The clause was activated at the onset of the pandemic and, before the outbreak of the war in Ukraine, was expected to be deactivated as of 2023. The Commission also approved a new State aid Temporary Framework, which relaxes the rules on grants and subsidised public loans for the sectors hardest hit by the energy crisis and aims to drive the transition to an emission-free economy.

In the energy domain, the launch of the Commission's REPowerEU programme stands out.[22] This plan comprises a series of initiatives aimed at diversifying the EU's

17 Pacce, Sánchez and Suárez-Varela (2021).

18 One of the conditions for the European Commission to approve the "Iberian exception mechanism" was the reform of the current regulated rate for small consumers (Royal Decree-Law 10/2022 of 13 May 2022).

19 Banco de España (2022b), in Section 4.1.

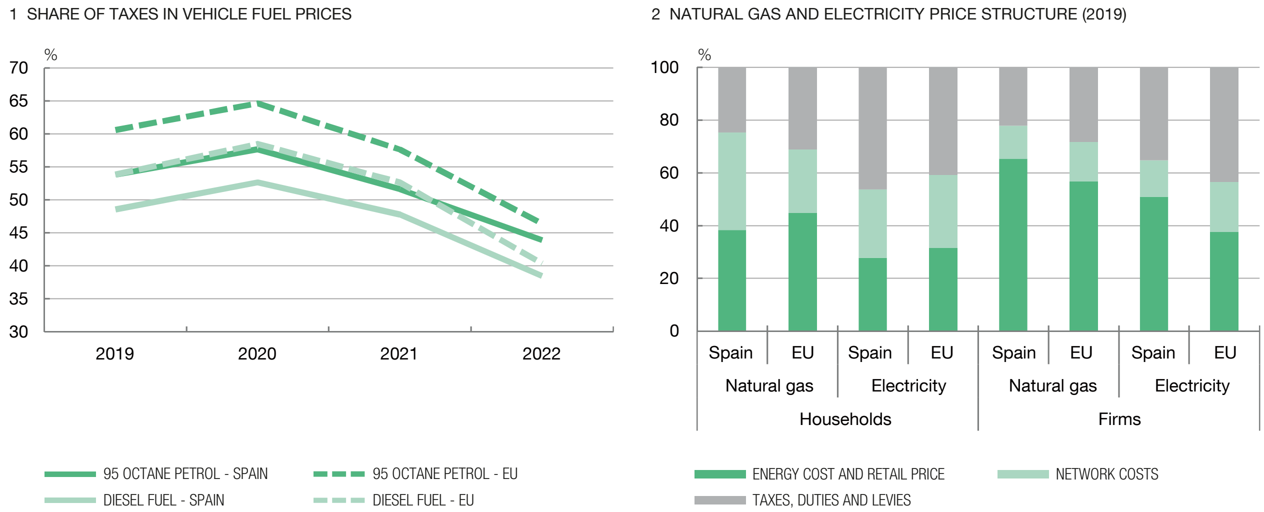
20 In Spain, these regulated charges include, for example, network costs (encompassing transmission and distribution costs). In the case of electricity, they also include the specific remuneration arrangements for power plants using renewables, cogeneration and waste, the cost of paying down the tariff deficit and the higher cost of non-mainland systems. For further details on the different components of the electricity rate in Spain, see Matea Rosa, Martínez Casares and Vázquez Martínez (2021).

21 European Commission (2022a).

22 See, for example, REPowerEU Plan, European Commission.

Chart 4.4
ENERGY PRICE STRUCTURE

Taxes and other regulated charges make up a large part of energy prices. In Spain they account for a smaller share than the EU average, save in household gas and electricity bills.



SOURCE: Eurostat.

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fossil fuel supply sources, stepping up energy saving and speeding up the deployment of renewables. To achieve these goals, among other measures, Member States can use the remaining RRF loans – and new RRF grants funded by the auctioning of Emission Trading System allowances – to adopt further energy actions. Additional regulations have also been established in the context of, for example, gas inventories, renewables targets and joint natural gas purchases.[23]

The national authorities of the EU Member States have approved manifold initiatives in response to the surge in inflationary pressures that followed Russia's invasion of Ukraine. These measures have essentially sought to limit the increase in domestic prices – energy prices above all, but also food prices, in some cases – and/or support economic agents' incomes in light of the erosion of their purchasing power since 2021. Overall, these measures – which have mostly been blanket measures, rather than targeted at the most vulnerable groups – amount to around 2 pp of euro area GDP.[24] In addition, while virtually all these measures were initially approved for a relatively limited period, persistent high inflation has meant that, in most cases, they have been extended to much of 2023.

Overall, the roll-out of all these initiatives across Europe and in the different Member States has shaped recent macroeconomic developments in the EU.

23 L'Hotellerie-Fallois, Manrique and Marín (2023).

24 Checherita-Westphal and Dorrucci (2023).

Economic activity slowed considerably in Europe – and globally – in 2022 H2, as a result of the impact of different adverse shocks to economic activity in much of 2021 and 2022 H1. Specifically, these shocks translated into a considerable cumulative loss of purchasing power for households and firms, a marked deterioration in confidence and significantly tighter monetary policy and global financial conditions. However, in part because of the roll-out of the aforementioned initiatives across Europe and in the different Member States, and also as a result of the partial reversal of some of the adverse supply shocks that were affecting activity, in the final stretch of 2022 and in early 2023, European economic activity proved considerably resilient, performing better than expected, and a sizeable contraction of GDP was avoided. During this period, there was also an intense substitution of the EU's energy sources and a sharp reduction in gas consumption, which staved off a potentially disruptive scenario where widespread gas cut-offs would have been necessary in some European countries last winter (see Section 3.1). Meanwhile, headline inflation appears to have peaked, although underlying and food inflation remain quite sticky.

Broadly speaking, activity in Spain in recent quarters has behaved relatively similarly to activity in the main European economies, although inflationary dynamics in Spain and the rest of Europe have been somewhat different, with headline inflation slowing more quickly in the former. There are many factors behind these developments. These include the aforementioned quicker and stronger pass-through of wholesale electricity prices to retail prices in Spain, some of the measures implemented by the Spanish authorities and, in particular, the cap on generation costs to lower the electricity price on the wholesale market (the "Iberian mechanism"), which had a considerable downward impact on inflation in Spain in 2022.[25] Box 1.2 of this Annual Report provides an estimation of the overall impact that the different measures implemented by the Spanish authorities to mitigate the effects of rising prices and the energy crisis have had on GDP and inflation in Spain in recent quarters. For more details on prices and activity in Spain and the euro area, and on the European Central Bank's monetary policy over recent quarters, see Chapters 1 and 3 of this Annual Report. Leaving the aggregate impacts to one side, Sections 3.2 and 3.3 below home in on the uneven impact the current energy crisis is having on different types of Spanish households and firms.

3.1 Substitution of energy sources

Partly as a result of some of the measures described above, in recent quarters EU countries have proven relatively adept at reducing their energy imports from Russia. In particular, European imports of Russian coal and coke came to a complete halt in 2022 Q4. Moreover, Russia's share of the EU's pipeline natural gas imports fell from slightly over 50% in 2021 to 13% by end-2022. The same period also

25 Pacce and Sánchez (2022).

saw a decline in the country's share of European imports of oil (from 26% to 13%) and LNG (from 16% to 10%).

This was possible in large part thanks to the substitution of the commodities previously imported from Russia with those from other international suppliers. For instance, recent quarters have seen an EU-wide increase in imports of pipeline gas from (in particular) Norway, North Africa and Azerbaijan. LNG imports from (in particular) the United States, Qatar and Nigeria have also risen.[26] In the case of Spain, the country imported relatively little energy from Russia before the outbreak of war in Ukraine. Thus, the need to replace such imports with those from other suppliers was somewhat less pressing in Spain than was the case, e.g. in some Central European economies.[27] In any event, over the course of 2022 the flow of gas from Algeria to Spain slowed appreciably – down 40% on 2021 – making it necessary to source this fuel (mainly in liquefied form) from elsewhere – notably, from the United States, Nigeria, Russia and Egypt – and ultimately resulting in a higher cost for the Spanish economy.[28]

The fall in gas consumption also appears to have played a part. Indeed, in 2022 gas consumption in the EU fell by 13% relative to the average of the past few years, although this reduction was notably uneven across countries, agents and sectors (see Chart 4.5).[29] Taken together, the industrial sector and households reduced their consumption by 15% in the EU and 14% in Spain. Based on more disaggregated data, which cannot always be compared across countries, consumption fell particularly sharply in the industrial sector.[30] Nonetheless, in general terms, the decline in industrial output was partially offset by the substitution of gas with other energy inputs and, in some cases, by reorienting production towards less energy-intensive goods. Meanwhile, the fall in gas consumption was less pronounced in the electricity sector – a 2% decrease in the EU and a 16% rise in Spain.[31] This can largely be explained by the 2022 decline in the generation of nuclear power – falling 14% with respect to the 2019-2021 average, mainly as a result of the problems detected in French reactors – and hydroelectric power – down 15%, owing to the drought that affected much of Europe last year. This meant that more electricity had

26 For more details, see Balteanu and Viani (2023).

27 Quintana (2022).

28 Liquefied gas is generally more expensive than its gaseous counterpart, since two additional transformation processes are needed before it can be used.

29 The data included here on the reduction in natural gas consumption shown in this chapter refer to the change in 2022 relative to the average for 2019-2021. By contrast, the voluntary target for reducing natural gas consumption in the EU is defined in terms of the change between 1 August 2022 and 31 March 2023 compared with the average of the previous five years. On ENAGÁS data, the reduction taking into account this time frame is 11%. In any event, according to Council Regulation (EU) 2023/706 of 30 March 2023, these goals should take into account exceptional circumstances in the electricity market of a neighbouring country – as was the case for nuclear and hydro generation – that entail an increase in exports. This would allow the voluntary reduction in consumption to be limited by the volume of natural gas corresponding to the additional exports.

30 Enagás (2023a, 2023b) (only available in Spanish).

31 According to estimates by the Bruegel think tank.

Chart 4.5
ADJUSTMENT FOLLOWING RUSSIA'S INVASION OF UKRAINE

Russia's invasion of Ukraine has prompted a considerable reduction in Europe's consumption of gas.

CONSUMPTION OF NATURAL GAS IN 2022 VERSUS AVERAGE FOR 2019-2021 AND SECTORAL CONTRIBUTIONS (a)

SOURCE: Bruegel.

a Change in average annual consumption broken down into electricity generation and households and firms. For those countries (Lithuania and Slovakia) for which data for the full year are unavailable, the changes to November 2022 are depicted. “EU average” refers to the average of the 21 countries for which data for the full year are available.

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to be generated using gas, a state of affairs that was particularly noticeable in Spain, associated with an increase in exports to France and the effect of the mechanism to cap gas prices in the Iberian market.[32]

In any event, it is still too early to assess the extent to which the significant capacity the European economies have demonstrated in adapting their energy demand in the short term and restructuring their energy procurement will last. It is worth noting here that, while the current energy crisis has accelerated the EU’s green transition, reducing the heavy dependence on outside energy identified in Section 2.2 will still take many years – for instance, to sufficiently boost renewable energy potential – and will pose considerable challenges – for further details, see Section 4.

For instance, certain conjunctural factors conducive to these adjustments could reverse in the coming quarters. These factors notably include the unusually milder temperatures this past winter in Europe. This prompted a fall in the demand for gas that was particularly sharp in countries where lower temperatures are the norm at this time of year. Also worth noting was the 20% drop in China’s LNG imports in 2022 as a result of the country’s zero-COVID policy, which constrained its

32 See, for example, García and Pacce (2023) and Hidalgo-Pérez, Mateo-Escobar, Collado Van-Baumberghen and Galindo (2022).

economic activity and enabled the EU to expand its options for procuring gas. If these factors were to reverse in the short term – China abandoned its zero-COVID policy in late 2022 – and certain adverse scenarios were to materialise, the possibility of natural gas prices in Europe coming under further strain cannot be ruled out, nor can shortages in the supply of this fuel in some EU countries this coming winter.[33]

Moreover, some of these adjustments were made in response to developments that, should they persist, could have a significant adverse impact on future levels of economic activity in the EU. During the current energy crisis, energy prices have risen much more sharply in the EU than in most of the world's main economies. If these developments were to become entrenched, energy consumption in the EU would in all likelihood continue to fall, albeit at the expense of a significant (and potentially structural) loss to its industrial base. Indeed, Banco de España simulations[34] reveal that, if the rise in energy costs in the EU (sharper than elsewhere in the world) seen in the current energy crisis were to persist, Europe's industrial output would fall appreciably, to be replaced by imports, particularly in the sectors that produce intermediate inputs, such as basic metals, chemical products, paper and plastic (see Chart 4.6).

3.2 Spanish households' exposure and adjustment to the energy crisis

The impact of the energy crisis on Spanish households is shaped by several factors. Notably, these include households' initial exposure to the rising cost of energy, their ability to reduce their consumption of such energy and the effect of the measures set in place by the authorities. As will become clear later on in this section, there is significant disparity across different types of household in all these respects.

The ex ante exposure of Spanish households to the rising cost of energy is particularly marked among lower-income households. Over recent quarters, various Banco de España papers have revealed this pronounced asymmetry in the initial exposure of Spanish households to the energy crisis. For example, based on the household expenditure patterns recorded in the Household Budget Survey (HBS), García-Miralles (2023) shows that lower-income households devote a larger share of their total spending to electricity and food consumption.[35] For its part, natural gas consumption is relatively similar across households, regardless of income level, while higher-income households account for a larger share of spending on fuel. As a result of these different spending habits and the differing extents to which the prices of all these goods have risen over recent quarters, lower-income

33 Alonso, López, Santabárbara and Suárez-Varela (2022).

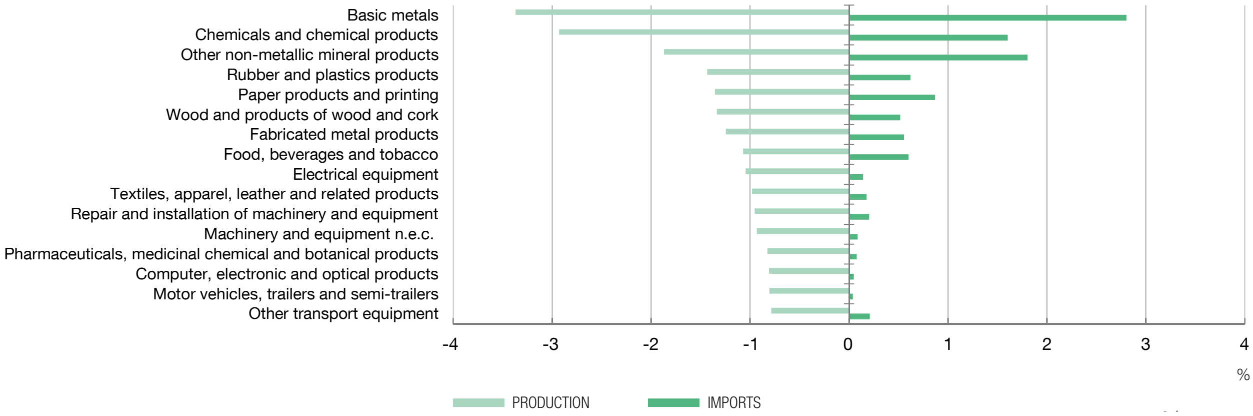
34 Using a general equilibrium sectoral model that incorporates imperfect substitution between factors of production –including energy– and an endogenous stock of capital. For more details, see Quintana (2022).

35 See Basso, Dimakou and Pidkuyko (2023) and Chart 3.16 of Banco de España (2022a)

Chart 4.6
POSSIBLE EFFECTS OF A SUSTAINED INCREASE IN ENERGY COSTS IN THE EU

Higher energy commodity prices entail a considerable increase in producer costs in the EU, especially in the most energy-intensive sectors.

CHANGE IN PRODUCTION AND SUBSTITUTION OF IMPORTS IN THE EU IN RESPONSE TO AN ENERGY PRICE SHOCK (a)



SOURCE: Banco de España.

a A permanent 30% increase in the EU's energy costs compared with those of the rest of the world is considered. The simulations are implemented in a sectoral general equilibrium model that incorporates the imperfect substitution of factors of production (including energy).

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households are estimated to have experienced a considerably higher rate of inflation over that period than their higher-income counterparts.

This disparity can also be seen in terms of the households with disproportionately high energy expenditure. The EU Energy Poverty Observatory (EPOV) defines such households as those whose share of energy expenditure in income is more than twice the national median share.[36] An analysis of data from the Banco de España's Spanish Survey of Household Finances (EFF) suggests that, at end-2020, 2.8 million Spanish households found themselves in such a situation.[37] This represents around 15% of Spanish households, a relatively small share when compared with other European countries (e.g. 20% in France and 17% in Italy and Germany). A more detailed breakdown reveals that the Spanish households with disproportionately high energy expenditure can essentially be found in the lowest 30% of the income distribution (see Chart 4.7.1). Moreover, these households spend a larger share of their income on staple goods, a category that includes food, utilities and payments related to their primary dwelling (see Chart 4.7.2).

36 This metric is one of the four official indicators used to characterise situations of energy poverty by the EPOV. The other three are hidden energy poverty (i.e. the share of households whose absolute energy expenditure is below half the national median), the ability to keep a home adequately warm and arrears on utility bills. See Energy Poverty Advisory Hub (European Commission).

37 Energy expenditure is proxied in the EFF by the total expenditure on electricity, water, gas, telephone services and internet.

The ability of Spanish households to adapt their demand for energy in the short term is relatively limited, both in historical terms and in the current environment. Indeed, estimates of how sensitive the demand for energy is to prices suggest that such demand is fairly inelastic in Spain. Specifically, based on historical data, the price elasticity of short-term demand in Spain can be put at -0.20 for diesel and electricity, and -0.24 for natural gas.[38] Nonetheless, on more recent data, referring to the current energy crisis, Lacuesta, López Rodríguez and Matea (2022) find that electricity and vehicle fuel consumption in Spain fell even less in 2022 H1 than would be suggested by the historical price elasticities estimated in previous research. This state of affairs could stem from several factors. It could, for example, be the result of an expectation on the part of households that price rises are likely to be relatively short-lived, of the compensatory measures set in place by the authorities, and of the existence of considerable savings built up during the pandemic, which have softened the impact of price rises on consumption. In any event, the ability of Spanish households to adapt their energy demand is likely to vary across different types of household – particularly in terms of income.[39]

Lastly, certain decisions adopted by the authorities have also influenced the impact of the energy crisis on Spanish households in recent quarters. Although lower-income households have been found, ex ante, to be more exposed than other households to rising energy prices, various measures approved by the authorities appear to have mitigated, at least partially, this greater initial adverse impact.[40] These notably include the increases (in varying amounts) approved in 2022 to the national minimum wage, to contributory and non-contributory pension benefits, to permanent disability benefits and to the minimum income scheme. All of these measures have a greater relative impact on the lower-income household cohort. For example:

The decision to cut VAT on food, electricity and gas, and the fuel subsidy. García-Miralles (2023) notes that the total budgetary cost of these measures (throughout their lifetime) would stand at around €9.6 billion. In terms of their distributive impact, the above article finds that, while the reduction in VAT on electricity, gas and food resulted in greater tax savings relative to total spending for lower-income households, the fuel subsidy led to higher relative savings for higher-income households. In any event, an €860 transfer targeting the most vulnerable households – particularly those found in the first three deciles of the income distribution – would have yielded levels of protection comparable to those obtained with such measures, but at a lower budgetary cost and without distorting price signals.

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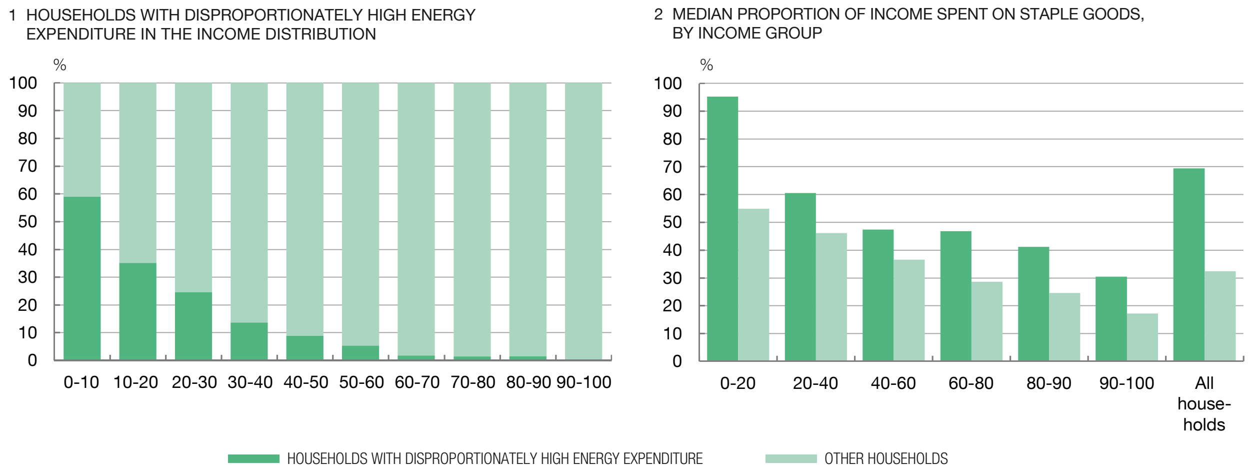
38 Labandeira, Labeaga and López (2016) (only available in Spanish).

39 Cahana, Fabra, Reguant and Wang (2022) detail some of the channels through which this can happen.

40 For more details on the measures adopted in Spain to support households and firms in response to the energy crisis, see Box 1.2 of this Annual Report.

Chart 4.7
HOUSEHOLDS WITH DISPROPORTIONATELY HIGH ENERGY EXPENDITURE

Households with disproportionately high energy expenditure are mostly in the three lowest deciles of the income distribution and spend a higher proportion of their income on staple goods.



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SOURCE: Banco de España, drawing on the Spanish Survey of Household Finances 2020.

The €200 grant approved at end-2022 for households with low income and wealth levels.[41] Estimates based on the EFF suggest that this measure could benefit around 3.6 million Spanish households, of which one-third face disproportionately high energy expenditure (see Chart 4.8.1). In this regard, with a view to improving the design of public policies, Meyer and Sullivan (2003) propose supplementing the information on income with data on the expenditure of the poorest households. This is because, for this cohort, expenditure measures tend to better capture their well-being than income measures. In any event, by income deciles, it is estimated that around one-half of the households found in the lowest 40% of the income distribution could be eligible for this grant (see Chart 4.8.2).

3.3 The sensitivity and adaptation of Spanish firms to the crisis

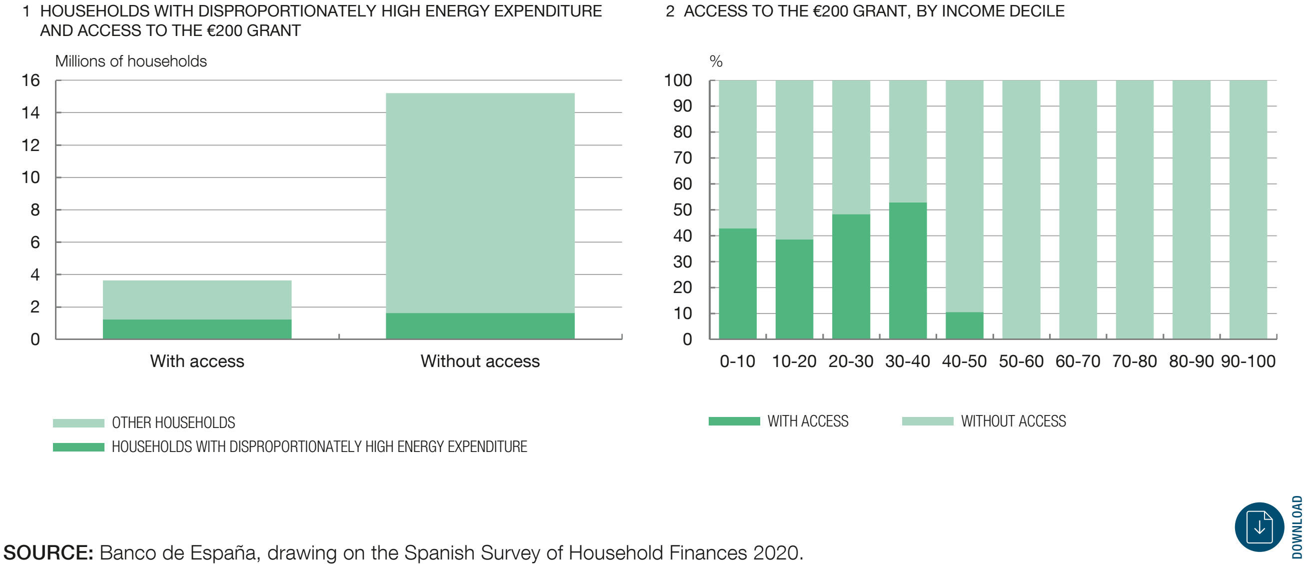
The energy expenditure of firms is highly heterogeneous in Spain, both across economic sectors and in terms of firm size.[42] Specifically, according to the INE's Structural Business Statistics, passenger and goods transportation were the Spanish subsectors with the highest energy expenditure-to-turnover ratios in 2019 (see Chart 4.9.1). In these subsectors, fuel other than natural gas accounted for the lion's share of the energy consumed. Meanwhile, in industry, the most energy-intensive subsectors were the manufacture of cement, lime and plaster (with the second largest electricity

41 Royal Decree-Law 20/2022 of 27 December 2022.

42 For a more detailed breakdown of this heterogeneity, see Matea and Muñoz-Julve (2022).

Chart 4.8
ACCESS TO THE €200 GRANT

Around 3.6 million households are eligible for the €200 grant to mitigate the effects of the energy crisis, although roughly 1.2 million of them have disproportionately high energy expenditure. Virtually all households that are eligible for this grant are in the lowest 40% of the income distribution.



SOURCE: Banco de España, drawing on the Spanish Survey of Household Finances 2020.

expenditure across all sectors), ceramic building materials and refractory ceramic goods (the last two subsectors having the highest natural gas expenditure ratios). Elsewhere, in the energy-intensive sectors, the larger the firm, the lower their energy expenditure as a share of turnover tended to be (see Chart 4.9.2).

These differences in energy intensity appear to have had a decisive influence on how the crisis has impacted the Spanish economy's different sectors and firms, and on how they have responded.[43] In 2022, Spanish firms' energy costs rose by an average of just over 30%, although the increase was significantly larger, in general terms, for firms in industrial subsectors and firms whose main source of energy was gas. Meanwhile, the percentage of firms reporting that rising energy costs had had an adverse impact on different real variables was relatively small (10% in the case of production, 15% in the case of turnover and 9% in the case of employment), albeit rising significantly in terms of the impact on certain key nominal variables. In particular, almost 40% of firms stated that higher energy costs had led them to raise their selling prices, while 46% reported narrowing profit margins.[44] Again, all these figures vary considerably depending on the energy intensity of each individual firm (see Chart 4.10).

43 See Izquierdo (2023, forthcoming) for a more detailed analysis of the results obtained in the specific module on these aspects in the Banco de España Business Activity Survey (EBAE), prepared in February 2023. The latest results of this survey can be found in Fernández-Cerezo and Izquierdo (2023).

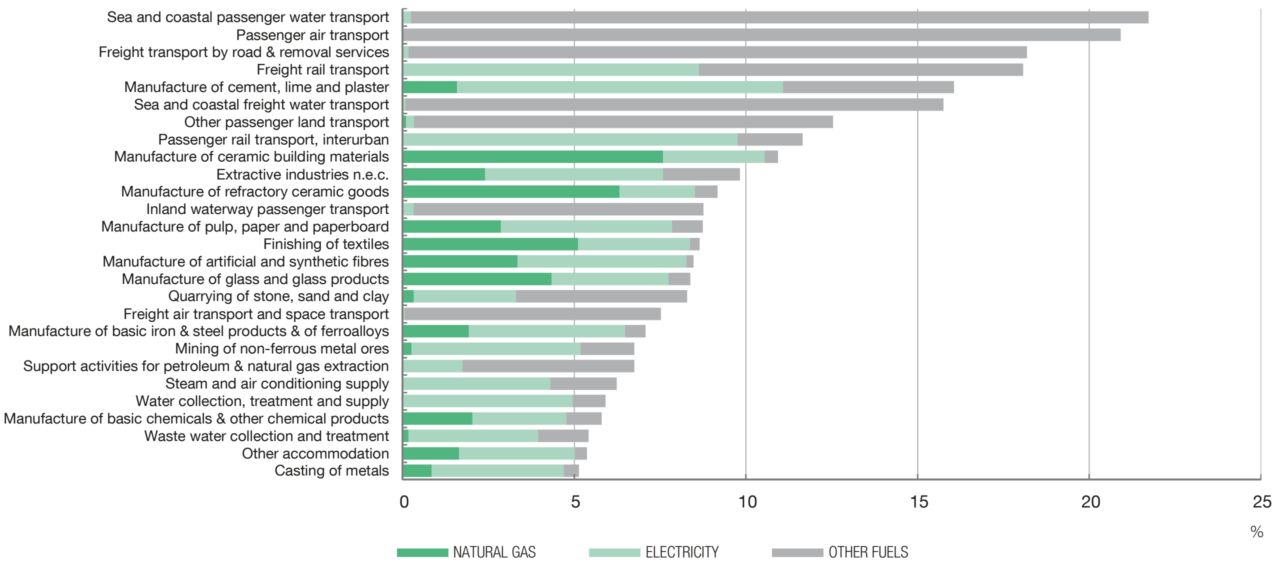
44 In line with the results published by the INE on 20 April in relation to an energy module of the Business Confidence Indicator (BCI) (only available in Spanish).

Chart 4.9

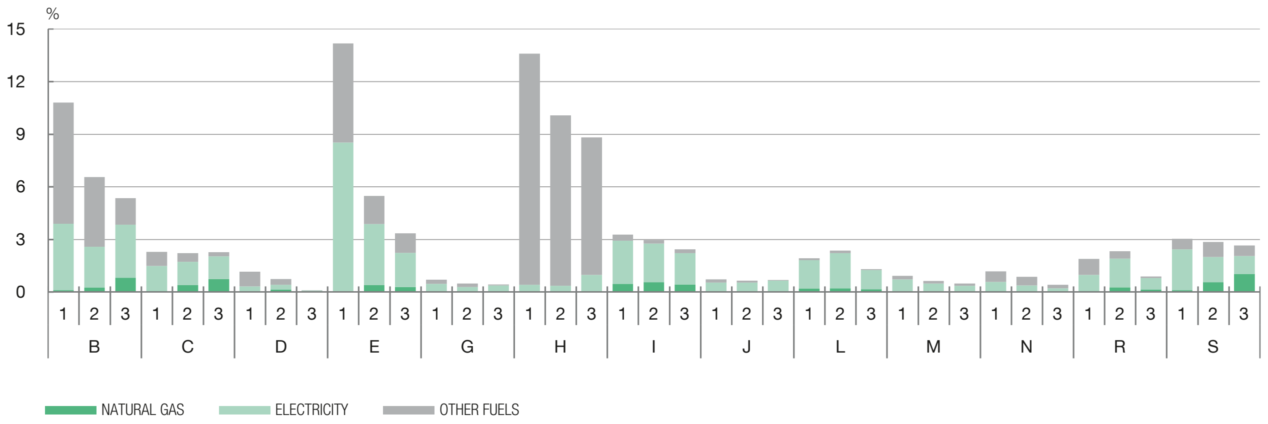
ENERGY EXPENDITURE IN 2019, BY TYPE OF ENERGY PRODUCT, SECTOR, SUBSECTOR AND FIRM SIZE

Energy expenditure in transportation is concentrated on fuels other than natural gas, whereas all other sectors are more dependent on electricity. However, this structure by sector masks large-scale heterogeneity by subsector. Within each subsector there are no major differences by firm size, although there are big differences in the energy-intensive subsectors.

1 RATIO OF ENERGY EXPENDITURE TO TURNOVER OF THE MOST ENERGY-INTENSIVE 3-DIGIT SUBSECTORS, BY ENERGY PRODUCT (a)



2 RATIO OF ENERGY EXPENDITURE TO TURNOVER OF 1-DIGIT SECTORS, BY ENERGY PRODUCT AND FIRM SIZE (b)



SOURCE: Banco de España, drawing on Estadística Estructural de Empresas 2019 (INE).

a 3-digit subsectors with a ratio of energy expenditure to turnover over 5%. "Manufacture of basic chemicals and other chemical products" corresponds to "Manufacture of basic chemicals, nitrogen compounds, fertilisers, plastics and synthetic rubber in primary forms".

b The numbers 1, 2 and 3 denote firms with 0 to 9 employees, 10 to 49 employees, and 50 or more employees, respectively. The letters denote as follows: B: extractive industries; C: manufacturing; D: electricity, gas, steam and air conditioning supply; E: water supply, sewerage, waste management and remediation activities; G: wholesale and retail trade and repair of motor vehicles and motorcycles; H: transportation and storage; I: accommodation and food service activities; J: information and communication; L: real estate activities; M: professional, scientific and technical activities; N: administrative activities and support service activities; R: arts, entertainment and recreation; and S: other service activities.

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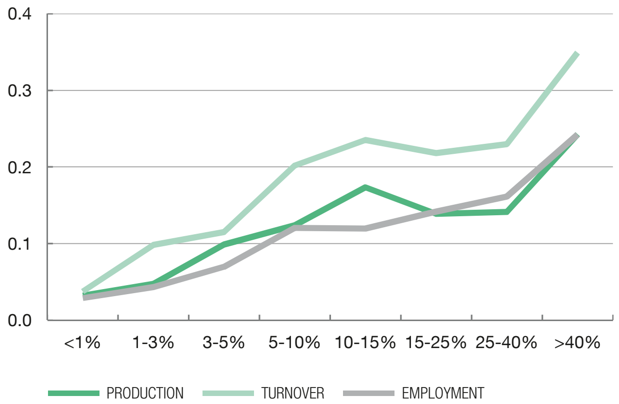
In a bid to reduce their energy expenditure, firms primarily sought to renegotiate their supply contracts (46% of the firms surveyed) and to improve their energy efficiency (40% of the total). To a lesser extent, albeit still very significantly, almost

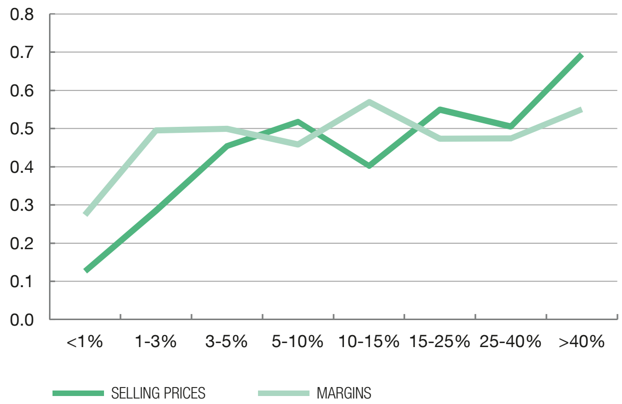
Chart 4.10
IMPACT OF THE ENERGY CRISIS

The energy crisis had most impact on prices and margins, while less than 10% of firms saw an impact on real variables, such as production and employment. However, the higher the proportion of energy costs, the higher the impact on these variables, so for firms with a higher proportion of energy costs the negative impact on their activity has been very significant.

1 PROPORTION OF FIRMS REPORTING A NEGATIVE IMPACT BY WEIGHT OF ENERGY COSTS



2 PROPORTION OF FIRMS REPORTING A NEGATIVE IMPACT BY WEIGHT OF ENERGY COSTS



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SOURCE: EBAE, module on the impact of the energy crisis.

30% of firms reported having invested in renewable energies, while a further 7% stated that they have plans to do so at some point in 2023. Overall, these sorts of mitigation initiatives were implemented more frequently at firms that experienced a sharper rise in energy costs, at larger firms and at firms whose main energy source was gas. Meanwhile, various alternatives with a direct impact on production, such as temporary stoppages, replacing production with imported inputs or the substitution of domestic suppliers with foreign ones, were deployed by firms comparatively less frequently. Specifically, these types of measures were adopted by only 5%, 4% and 5%, respectively, of the firms surveyed, generally the most energy-intensive ones.

Smaller and less productive firms generally proved more vulnerable to the rise in energy costs.[45] Indeed, an analysis of the likelihood of the firms surveyed reporting an adverse impact on production reveals, even after controlling for firms' energy intensity and for the extent of the energy cost increase they experienced, that smaller and less productive firms were more likely to suffer an adverse impact on their production levels in 2022 (see Chart 4.11). Moreover, the impact on selling prices was greater at smaller firms and firms with higher debt levels, which is consistent with the fact that firms in a worse financial position are more likely to have passed rising energy costs on to their customers.

45 Analysis conducted by combining the responses in the energy module of the EBAE with the available data on the Central de Balances Sheet Data Office integrated database.

4 The challenges posed by the energy transition

Despite the notable adaptability demonstrated by the European economies over recent quarters, numerous challenges on a huge scale will have to be addressed decisively in the coming years if the structural vulnerabilities identified in the EU's energy framework are to be mitigated. For the most part, remedying such vulnerabilities goes hand in hand with pressing forward (perhaps even faster than was initially envisaged) with the EU's green transition towards a carbon-neutral economy. Some of the groundwork for this transformation process has already been laid. Noteworthy examples include the various initiatives falling under the European Green Deal and the NGEU and REPowerEU programmes.[46] In any event, and notwithstanding these initiatives, following through on the (highly ambitious) commitments undertaken remains a huge challenge.[47]

Given the size of the challenges entailed by the EU's energy transition, all policy responses and economic agents must play a very active role in forging ahead with the process. In this regard, Chapter 4 of the Banco de España's *Annual Report* 2021 looks in detail at the role to be played (within the remit of their competences) by national governments, central banks and the financial system as a whole (among other key players) in driving the green transition. Following on from that analysis, the rest of this section delves deeper into two specific aspects: the challenges and opportunities entailed by (accelerating) the roll-out of renewable energies, and certain challenges posed by the transformation of EU's energy system in terms of funding and the public policy response, particularly at a supranational European level.

4.1 Promoting renewable energies: challenges and opportunities

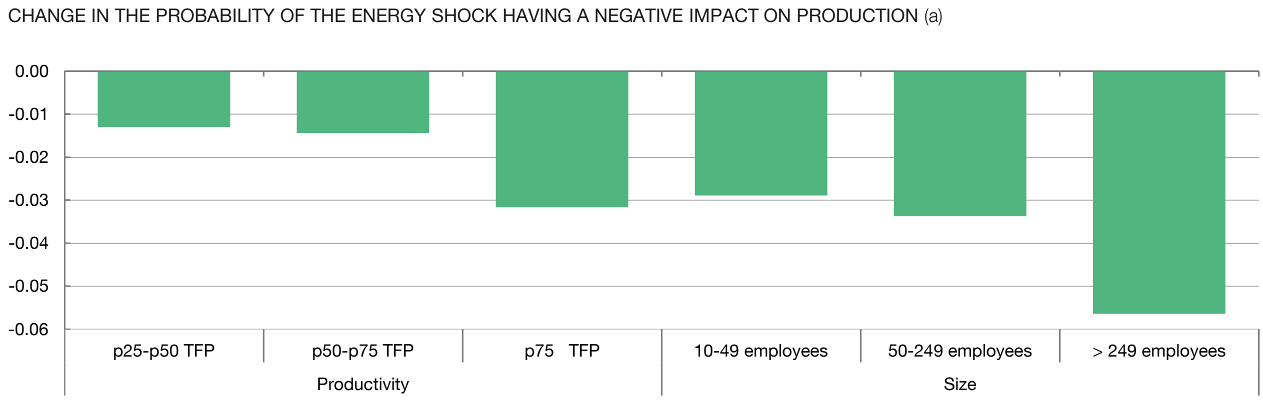
Reducing the EU's external energy dependency and the green transition will require a large-scale deployment of renewable energy sources (which have higher levels of domestic production) and additional energy efficiency improvements over the coming decades. By way of illustration, Chart 4.12 shows how demand for energy would change in the EU at the end of this decade if renewable energies were boosted in line with the green transition scenarios envisaged by the Network for Greening the Financial System (NGFS). In particular, renewable energy sources, which in 2021 accounted for 19% of the EU's total primary energy

46 For further details of these initiatives, see Banco de España (2022b), Dormido, Garrido, L'Hotellerie-Fallois and Santillán (2022), and L'Hotellerie-Fallois, Manrique and Marín (2023).

47 Indeed, various international institutions have stated that the investment needed to achieve climate neutrality, both globally and at European level, would have to be doubled from its current level – for example, International Energy Agency (2021a) and IRENA (2021). Thus, the European instruments currently in place would only cover part of such stimulus in the short and medium term – see, for instance, Lenaerts, Tagliapietra and Wolff (2022).

Chart 4.11
IMPACT OF THE ENERGY SHOCK BY FIRM TYPE

Less productive and smaller firms were more likely to reduce their production in the face of higher energy costs.



SOURCE: EBAE, module on the impact of the energy crisis.

a On the estimated probability for a firm in the 25th percentile of productivity in its economic sector and with fewer than 10 employees. For this reference, the estimated probability of the energy shock having had a negative impact on production is 0.116. The regression controls for economic sector, firms' energy intensity, the increase in energy costs, the main energy source and the debt ratio.

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consumption, would have to represent between 32% and 43% of such consumption in 2030, depending on how ambitious the climate goals are.[48]

The promotion of renewable energies could represent a major opportunity for the Spanish economy: Spain has the second highest onshore wind power generation potential and the highest solar power generation potential in the EU (see Chart 4.13.1). Among other factors, this is due to its geographical location, its weather conditions and the availability of land for facilities. In this connection, the Integrated National Energy and Climate Plan 2021-2030 (INECP) envisages that between 2015 and 2030 Spain's installed wind power capacity will increase from 23 GW to 50 GW and its photovoltaic solar capacity will do so from 5 GW to 40 GW.[49]

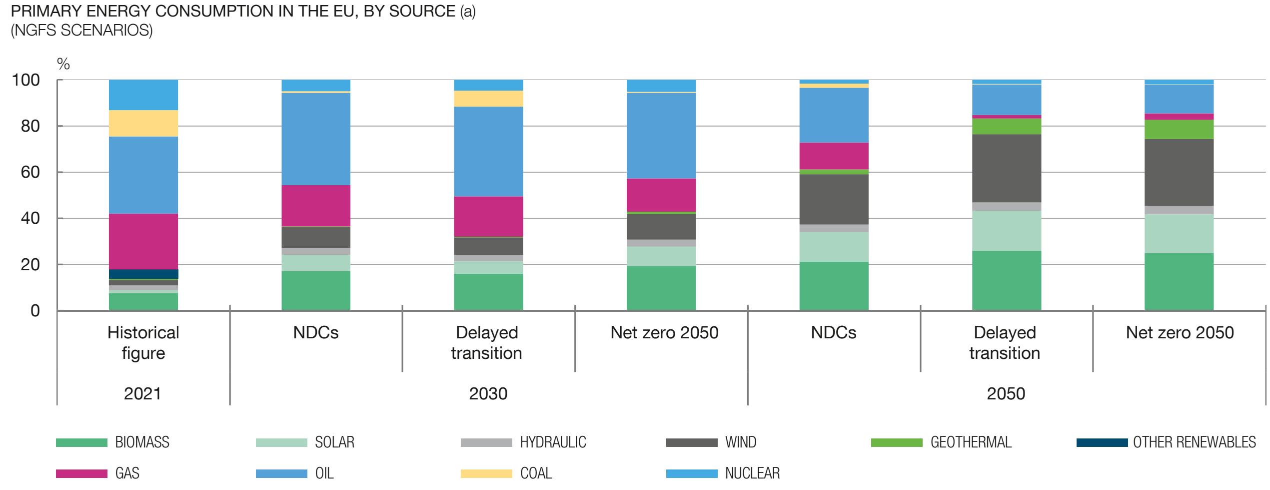
Spain also has firms that produce an important portion of the components required to install wind and solar power technologies. In particular, Spain is home to global leading wind turbine manufacturing firms, with annual exports of around €500 million, making it the third EU economy by export volume, after Germany

48 The NGFS has prepared three illustrative scenarios (see also, Monasterolo, Nieto and Schets (2023)): (i) the "Net Zero 2050" scenario, which assumes that a gradual application of mitigation policies will reduce global warming to 1.5ºC by 2100 relative to pre-industrial levels; (ii) the "Delayed Transition" scenario, with the same goal, but with a more delayed application of mitigation policies; and (iii) the Nationally Determined Contributions" (NDCs) scenario, the least ambitious one, which reflects the application of the current national commitments under the Paris Agreement framework.

49 At 31 December 2022 Spain's installed wind power and photovoltaic solar capacity stood at 30 GW and 20 GW, respectively.

Chart 4.12
NGFS ENERGY TRANSITION SCENARIOS

The change in energy consumption and production patterns stemming from the mitigation of climate change will help reduce the EU's dependency.



SOURCES: Eurostat, IIASA and NGFS.

a Historical figure based on gross available consumption according to Eurostat's energy balance, excluding secondary energy sources. The three scenarios are from the REMIND-MAgPIE model of the IIASA NGFS climate database. "Other renewables" includes additional renewables according to Eurostat's Standard International Energy product Classification.

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and Denmark.[50] The solar tracker manufacturing industry in Spain is also among the global leaders. However, Spain does not have firms that manufacture photovoltaic panels – which account for around 35% of the cost of a photovoltaic plant and are largely imported from Asia.[51]

In any event, the deployment of renewable energies will also entail considerable challenges, for instance in technological development.[52] In recent years, wind and photovoltaic solar power have become substantially more competitive and their generation costs are currently lower than those of new fossil fuel energy generation plants (see Chart 4.13.2). Nonetheless, achieving the medium-term decarbonisation goals assumed will require further advances in technologies that are currently in the early stages of development or are not yet cost competitive.[53] This is the case, for instance, of key products and technologies such as batteries, green hydrogen, and carbon capture, use and storage systems.

50 Eurostat provides information on wind turbine exports. In 2021 Germany exported €2,084 million, Denmark €1,620 million and Spain €500 million.

51 UNEF (2022).

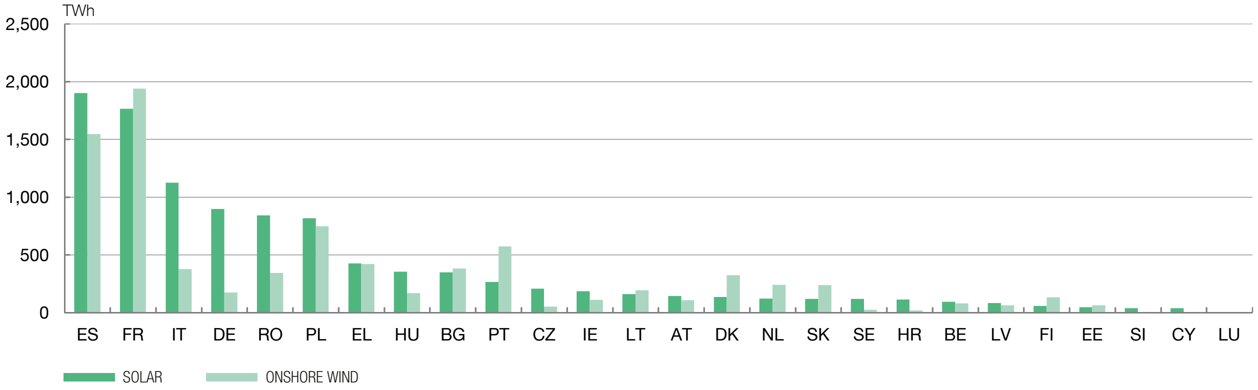
52 Another challenge is that some investments in renewable energies can generate negative externalities in the places they are deployed, – for instance, by causing biodiversity loss – without generating local benefits, e.g. in terms of creating stable jobs in the affected municipalities. Mitigating this asymmetry may require some kind of compensatory public policy. See Fabra, Gutiérrez, Lacuesta and Ramos (2023).

53 International Energy Agency (2023).

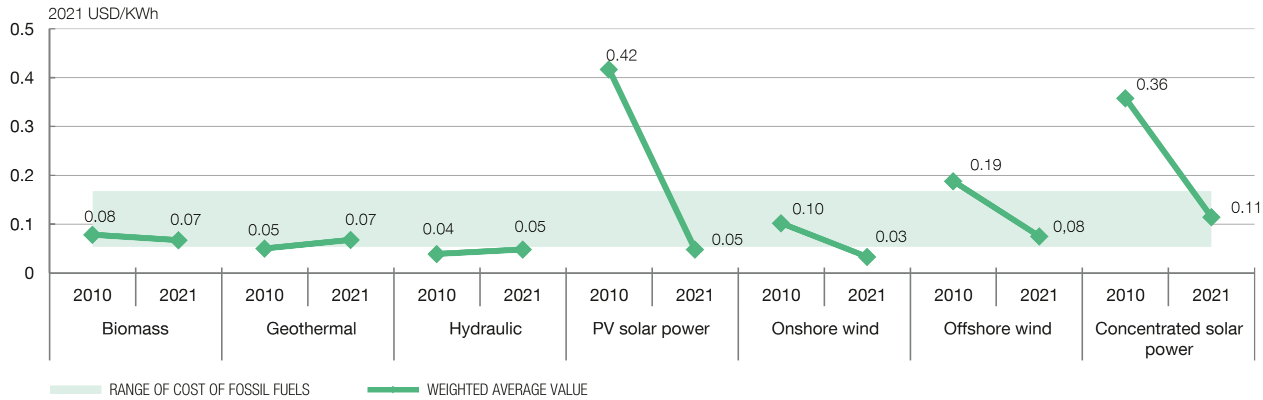
Chart 4.13
THE EFFICIENCY OF RENEWABLES AND THE COMPARATIVE SITUATION OF SPAIN

The cost of renewable energy generation has fallen considerably over the last decade. In this situation, the Spanish economy's renewable energy potential would be very high compared with Europe, due to its favourable geographical and weather conditions.

1 RENEWABLE ENERGY POTENTIAL (a)



2 LEVELISED COST OF ELECTRICITY FROM RENEWABLE ENERGY GENERATION TECHNOLOGIES, 2010-2021 (b)



SOURCES: International Renewable Energy Agency and Joint Research Centre (ENSPRESO).

a The ENSPRESO dataset provides technical wind, solar and biomass potentials, based on geographical location scenarios. For wind, resource evaluation also considers setback distances and wind speed. For solar, potentials are derived from irradiation data and available area for solar applications.
b The levelised cost of electricity is a measure of the average cost of electricity generation for a generator over its lifetime. It is used to compare the costs of the different electricity generation methods.

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The energy transition will also lead to a substantial increase in the demand for certain very specific raw materials. The European Commission estimates that in 2030 demand for rare earths (used in the manufacture of wind turbines and fuel cells) and lithium and cobalt (used in the manufacture of lithium-ion batteries) will be five times higher than now.[54] Similarly, according to the green transition scenarios envisaged by the NGFS, total demand for critical raw materials will be up to seven times higher than at present.[55]

54 European Commission (2020) and International Energy Agency (2021b). Other key raw materials in the manufacture of green technologies are nickel, manganese and graphite.

55 Miller, Dikau, Svartzman and Dees (2023).

In the absence of supply-side adjustments, this greater demand for certain raw materials could give rise to price pressures, bottlenecks and new external dependencies for the EU. Many raw materials that are critical for the green transition are concentrated in a few producing countries: China, the Democratic Republic of Congo and Australia in extraction, and China in refining.[56] A greater demand for these products by the EU could, therefore, increase its dependency on external trading partners, with potential geopolitical implications. To mitigate these risks, the European Commission announced a set of actions, within the framework of the Open Strategic Autonomy, to enhance European economies' resilience and reduce strategic dependencies on key products. To this end, in March 2023, the European Commission proposed the Critical Raw Materials Act,[57] to ensure the EU's access to the supply of critical raw materials over the coming decades – through trade agreements with some of the main producing countries – while controlling the transformation processes of these materials, which are needed for industrial uses.

The transition towards a greener and more sustainable economy may cause sharp changes in the demand for labour. According to Eurostat, between 2014 and 2021 employment in renewable energy generation in Spain practically tripled, to 52,000 jobs. In the same period, total employment in the environmental goods and services sector increased by 65%, to 541,000 jobs. Despite these developments, the green transition will require many more of these jobs, both in Spain and globally. Some studies[58] suggest that the training opportunities needed to fill these green vacancies are not growing fast enough and this could ultimately slow down, and even increase the cost of, the energy transition process.

Lastly, the promotion of renewable energies does not take away from the importance of developing better energy interconnection infrastructure among EU Member States. It is still essential to enhance integration between energy generating areas and the main areas of consumption, to create energy networks that are more flexible and interconnected across the different systems, to improve local energy generation and storage capacities, and to avoid the energy isolation of some regions, such as the Iberian Peninsula. According to European Commission data,[59] the completion of the European electricity infrastructure interconnection projects currently under way would reduce wholesale electricity prices by 2.5% on a permanent basis. It would also help to ensure the security of energy supply and to substantially mitigate the negative impact on the EU economies as a whole that would derive from potential future adverse energy supply shocks, such as that triggered by Russia's invasion of Ukraine in recent quarters.

56 International Energy Agency (2021b).

57 European Commission (2023).

58 See, for example, Linkedin (2022).

59 European Commission (2022b).

4.2 Funding the green transition and other public policy challenges

To press ahead with the economy's energy transformation, public policies must play a leading role. As detailed in Chapter 4 of the Banco de España's *Annual Report 2021*, these policies must act decisively across multiple spheres. For example, through green taxation, an aspect in which the Spanish economy, compared with European ones, has ample room for manoeuvre. This would enable economic agents to better internalise the climate-related consequences of their decisions. Also, by boosting public investment and innovation, both being key instruments for accelerating the development of new green technologies and which, in the current situation, may benefit from European programmes that are already in place, such as NGEU and REPowerEU.[60] In any event, it is essential for public policies to attempt to provide certainty and a stable operational framework for economic agents, to bear in mind the considerable asymmetric impact which the green transition implies for various types of households, firms and sectors, and to pursue an ongoing assessment of the different actions deployed (see Figure 4.1).

These actions are especially important at European level. Both the COVID-19 pandemic and the war in Ukraine have proven the importance of responding jointly within the EU to the risks and threats that are common to all Member States, even though their effects may occasionally be uneven across countries. Within the framework of Europe's joint response to the current energy crisis, it is essential to continue reinforcing certain key aspects.

The European policy response to the current crisis must be agile, provide certainty and ensure that the green transition does not lead to a structural loss of competitiveness for the European economies. Along these lines, the Green Deal Industrial Plan, which was recently presented by the European Commission, seeks to enhance the competitiveness of Europe's industry and, as one of the pillars it is based on, addresses the creation of a simplified, faster and more predictable regulatory framework.[61] In any event, avoiding a loss of competitiveness in the EU vis-á-vis the rest of the world during the green transition process will be no easy task. Especially in a setting in which, at the same time, some of the main world economies have already started to invest massively in green innovation, such as the United States with the approval of the Inflation Reduction Act, while others show a relatively limited climate ambition, which may also give them a certain competitive advantage in the short term.

Many highly diverse initiatives are being considered to reduce the risk of delocalisation of European industry, but it will be necessary to wait until the

60 Within the NGEU programme, part of the funds associated with the Recovery and Resilience Facility (RRF) must be dedicated to green R&D&i activities. In Spain, this percentage is 8% of the total funds available (slightly above that required by the European authorities) and includes initiatives such as the PERTE for renewable energies, renewable hydrogen and storage.

61 The Green Deal Industrial Plan, European Commission.

Figure 4.1
THE ROLE OF KEY PLAYERS IN THE FACE OF THE GREEN TRANSITION (a)

GOVERNMENTS

- Increasing green taxation and boosting public investment.
- Deploying compensatory measures to mitigate adverse effects on the most vulnerable groups.
- Enhancing the regulation of economic activity, setting standards on environmental issues and efficiency gains.
- Providing economic agents with certainty and a stable operational framework.

FINANCIAL SECTOR

- Efficiently channelling the huge volume of funds that needs to be invested in the green transition.
- Properly assessing its own and other economic agents' exposure to climate risks.
- Developing and harmonising new financial instruments.

CENTRAL BANKS

- Incorporating climate considerations into their monetary policy operational frameworks.
- Monitoring the risks to financial stability posed by climate change and the green transition.
- Enhancing the regulation and prudential supervision of climate risks.

SOURCE: Banco de España.

a The leading role played by public policies in the green transition is discussed in detail in Section 4 of Chapter 4 of the Banco de España's *Annual Report 2021.* Section 5 of Chapter 4 addresses the different aspects of the key role played by the financial system, while Section 6 analyses the role played by central banks, within their respective remits.

final proposals have been drawn up and to diligently assess their ability to efficiently fulfil the proposed goals. This broad range of initiatives includes, in addition to some of those already mentioned, the review of the Emissions Trading System, the creation of a carbon border adjustment mechanism and the plans to reform the European electricity market design. Generally speaking, overall, the aim is for the cost of energy – which has recently increased more in the EU than in the other main world economies – not to become a structural competitive disadvantage for European firms.

In addition, it is essential for European policies to contribute to maintaining a level playing field within the EU. Although, as has been mentioned throughout this chapter, a very important part of the response to the energy crisis has been coordinated at European level – such as in the case of joint gas purchases and reductions of consumption – and has had a supranational component from a budgetary viewpoint, public actions have been primarily national since the outbreak of the crisis. This has been reflected in the heterogeneity of the measures adopted, in terms of design, scope and cost. In this connection, the existence of highly differing budgetary headroom between countries in a setting of a more relaxed enforcement of State aid regulations could distort the functioning of the European single market and introduce diverging economic dynamics among Member States.

Among other actions, this will require more decisive advances in the common funding of public assets at EU level. Just as international coordination in the field of regulation is essential to face the green transition, so too is the use of joint investment coordination and funding instruments. These instruments facilitate the creation of synergies, improve efficiency and help countries address the investment gap in new technologies. Some of these mechanisms, such as NGEU and REPowerEU, are already in place. However, the volume of investments that will be needed in the coming years to address the challenges associated with the energy transformation goes well beyond the amounts envisaged in such programmes and the domestic capacity of many European economies.[62] Among other actions, this will call for further progress in the development of a permanent fiscal capacity at the European level to finance these types of investments (in line with the European Commission's proposal for a European Sovereignty Fund)[63] which will ultimately become European public assets (see Chapter 2 of this Annual Report for further details about the challenges pending in the configuration of the European institutional framework).

In any event, without the active involvement of the financial system, it will be impossible to efficiently channel the large volume of funds needed to carry out the green transition. Financial institutions, central banks and public authorities – within the scope of their mandates – must continue to collaborate and progress decisively in the development of sustainable finances worldwide (see Figure 4.1 and, for further details, Chapter 4 of the Banco de España´s *Annual Report* 2021). In the European context, these initiatives should be supplemented with a greater boost from the capital markets – completing the steps pending in the EU capital markets union – to facilitate innovative firms' access to finance. In this respect, developing the venture capital markets further would foster the growth of private sector firms capable of coming closer to the technological frontier. Occasionally, such development may stem from public-private collaboration, following the example of the EIC Accelerator, which combines direct grants with access to venture capital funds.

62 The RRF, a key instrument of NGEU, aspires to use €724 million in investment projects and structural reforms mainly to fast-forward the green and digital transitions. Until 2026, these funds would cover around 25% of the EU's annual investment needs under the most ambitious scenario (zero emissions by 2050).

63 Conclusions of the special meeting of the European Council (9 February 2023).

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Box 4.1

ENERGY INTENSITY AND CARBON INTENSITY IN SPAIN AND IN EUROPE

The trends in an economy's energy intensity and carbon intensity are key to understanding the behaviour of its CO_2 emissions and to assessing its ability to reduce them with the smallest possible impact on the level of economic activity. The "Kaya identity"[1] shows how these variables are related:

$$CO_2 = \text{Population} \times \underbrace{\frac{\text{GDP}}{\text{Population}}}_{\text{Economic activity}} \times \underbrace{\overbrace{\frac{\text{Energy}}{\text{GDP}}}^{\text{Energy intensity}} \times \overbrace{\frac{CO_2}{\text{Energy}}}^{CO_2\text{ per unit of energy}}}_{\frac{CO_2}{\text{GDP}} \rightarrow \text{Carbon intensity}}$$

According to this identity, the volume of an economy's CO_2 emissions can be broken down into several factors: population, level of activity (in particular, the level of GDP per capita) and carbon intensity, which is defined as the amount of CO_2 the economy emits per unit of output produced.

Historically, the first two variables of the Kaya identity (population and the level of activity) have been the main drivers of an economy's greenhouse gas emissions (i.e. the higher their values the greater the emissions). However, in recent decades, some (mainly developed) economies have managed to gradually loosen the link between their economic growth and their CO_2 emissions (a process known as "decoupling") by reducing their carbon intensity.

This box analyses carbon intensity trends in Spain and in Europe over recent decades. It is helpful for this purpose to break down carbon intensity into two new variables. First of all, energy intensity, which is defined as the amount of energy the economy consumes per unit of GDP. A reduction in this variable can thus be interpreted as an improvement in the economy's aggregate level of energy efficiency. And second, the amount of CO_2 emissions per unit of energy consumed, which declines, for example, when progress is made in decarbonising energy generation.

As seen in Chart 1, between 1991 and 2020, global CO_2 emissions increased, essentially as a result of the development of emerging market economies (such as China and India). In the United States, Europe and Spain, meanwhile, emissions fell. In these economies, emission reductions were compatible with economic growth and were driven by a decline in carbon intensity. These emission reductions stemmed from an improvement in energy efficiency and a decrease in CO_2 emissions per unit of energy consumed, the contributions of these two factors being practically identical in the case of the Spanish economy.

To better understand these dynamics, Chart 2 shows, at sector level, carbon intensity and its two main components for Spain and for the aggregate of the four main euro area economies, during the period 2000-2020.[2] As seen in the chart, carbon intensity fell during this period in all the sectors considered. That said, the magnitude and composition of this fall varied considerably from one sector to another.

In Spain, there were significant falls in carbon intensity in services and manufacturing, which were essentially driven by the decarbonisation of their energy mix. In transport, by contrast, the reduction in carbon intensity was more modest and stemmed solely from energy efficiency improvements.

This sectoral divergence appears to be related to the composition of energy demand in each subsector and, in particular, its degree of electrification. As seen in Chart 3, the electrification of transport is limited both in Spain and

1 Y. Kaya and K. Yokoburi. (1997). *Environment, energy, and economy: strategies for sustainability.* United Nations Univ. Press.

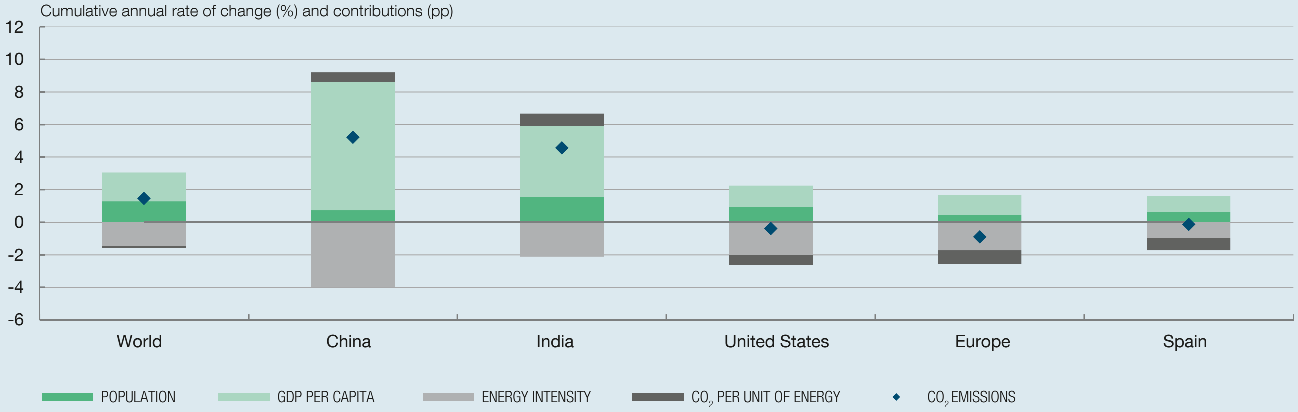
2 Data at this specific sector level are only available for these countries from 2000 onwards.

Box 4.1

ENERGY INTENSITY AND CARBON INTENSITY IN SPAIN AND IN EUROPE (cont'd)

Chart 1
KAYA IDENTITY: DETERMINANTS OF CO_2 EMISSIONS AND THE ROLE OF ENERGY EFFICIENCY

CONTRIBUTION TO CO_2 EMISSIONS GROWTH (1991-2020) (a)

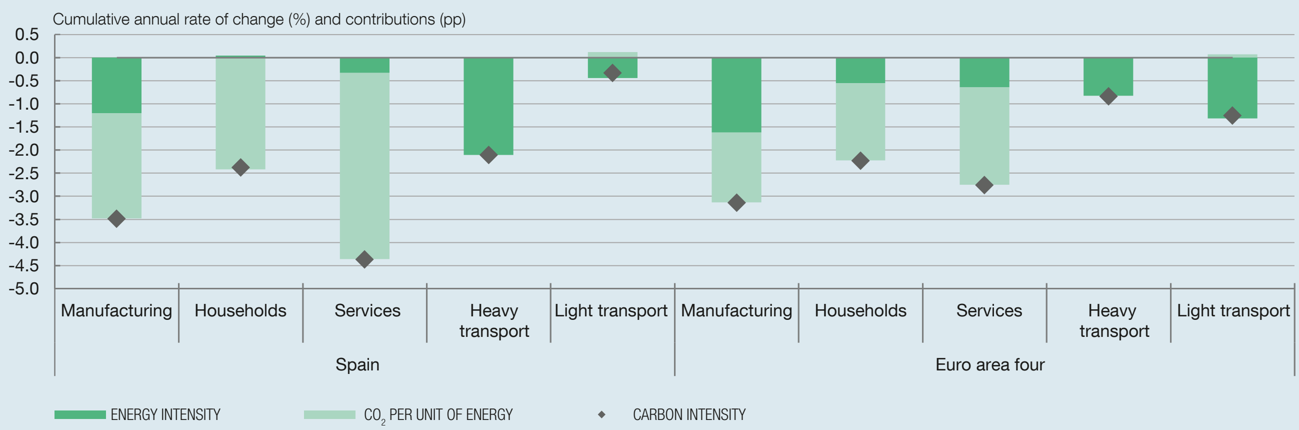


SOURCE: International Energy Agency (Greenhouse Gas Emissions from Energy, 2022).

a The Europe aggregate refers to those EU countries that belong to the OECD.

Chart 2
SECTORAL CHANGES IN CARBON INTENSITY IN SPAIN AND IN THE EURO AREA FOUR (2000-2020)

CO_2 PER UNIT OF GDP (2000-2020) (a)



SOURCE: International Energy Agency (Energy Efficiency Indicators, 2022).

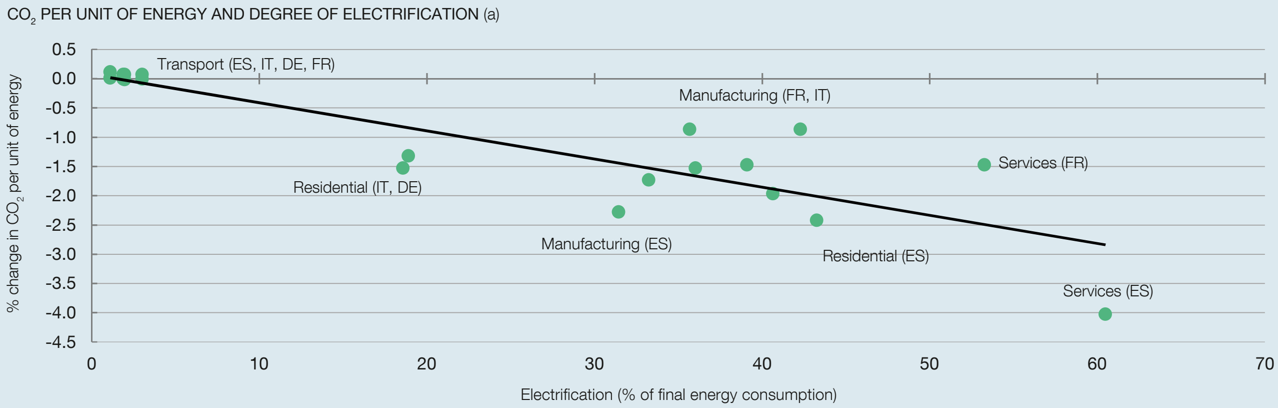
a In Italy, the carbon intensity data for the services sector are only available up to 2019. The euro area four aggregate is composed of Spain, Italy, France and Germany, weighted by their respective shares in the total emissions of the aggregate for 2019. The CO_2 indicator per unit of energy is based on final energy consumption data.

Box 4.1

ENERGY INTENSITY AND CARBON INTENSITY IN SPAIN AND IN EUROPE (cont'd)

Chart 3

DEGREE OF ELECTRIFICATION OF ENERGY DEMAND AND DECARBONISATION OF THE ENERGY MIX IN SPAIN AND THE EURO AREA FOUR



SOURCES: International Energy Agency (Energy Efficiency Indicators, 2022) and Eurostat.

a Data on CO_2 emitted per unit of energy for the residential, manufacturing, services and transport (distinguishing between heavy and light transport) sectors in Spain, Italy, Germany and France, for the period 2000-2020, are used. For the degree of electrification, information on the final consumption of economic agents, obtained from Eurostat's energy balances for 2020, is used.

in the main European countries, and this appears to have hampered the decarbonisation of their energy consumption over recent decades. By contrast, in the residential sector and in services (and, to a lesser extent, in manufacturing), the higher share of electricity in energy demand appears to have facilitated the decarbonisation of energy consumption during the period analysed.

At any rate, it should be noted that, when composition effects are taken into account, i.e. the share of each sector in the economy's productive system, and how it has changed in recent years, transport's contribution to the reduction in carbon intensity in Spain over the period analysed has been very significant, given the importance of this sector in Spain's total CO_2 emissions.[3]

3 This box focuses on the factors behind changes in CO_2 emissions. A similar analysis, focusing on the determinants of changes in Spain's final energy consumption reveals that in recent decades the efficiency improvements at sector level (in transport, for example) and the shifts in the Spanish economy's productive system have made practically identical contributions to the reduction in final energy consumption in Spain.