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ANALYSIS OF THE SOCIO-ECONOMIC IMPACT OF THE ENERGY CRISIS

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Resumen

Las crisis energéticas pueden tener importantes repercusiones en diversos ámbitos como la sociedad, la economía, la seguridad nacional y el medio ambiente. La escasez de recursos energéticos puede provocar un aumento de los precios y de la competencia por estos, lo que puede afectar negativamente al crecimiento económico, a la competitividad de las empresas. Además, una crisis energética también puede provocar cortes en el suministro de electricidad o de otras fuentes de energía e interrupciones de los servicios esenciales, lo que puede impactar negativamente en la seguridad nacional y el bienestar de la población. Igualmente, el aumento de los precios de la energía, como el gas en este caso, puede repercutir en un mayor consumo de carbón con el correspondiente impacto en términos de emisiones de GEI. Este informe desarrolla un marco de análisis del impacto socioeconómico de una crisis energética basado en la revisión de la literatura sobre la materia. Dicho marco se aplica para profundizar en los efectos de la reciente crisis energética.

Laburpena

Energia krisiek ondorio garrantzitsuak izan ditzakete esparru askotan, hala nola gizartean, ekonomian, segurtasun nazionalean eta ingurumenean. Energia baliabideen eskasiak prezioak igotzea eta baliabide horiek eskuratzeko lehia gogortzea ekar ditzake, eta horrek eragin negatiboa izango du hazkunde ekonomikoan eta enpresen lehiakortasunean. Gainera, energia krisiak elektrizitatearen edo beste energia iturri batzuen hornidura eten dezake, baita funtsezko zerbitzuak aldi baterako bertan behera gelditzea ere. Eta horrek eragin negatiboa izango luke segurtasun nazionalean eta herritarren ongizatean. Era berean, energiaren prezioen igoerak, gasarenak kasu honetan, ikatzaren kontsumoa areagotu dezake, eta horrek berotegi efektuko gas isuriak handitzea ekarriko luke. Txosten honek energia krisi baten eragin sozioekonomikoa aztertzeko esparru bat garatzen du, gaiari buruzko literaturatik abiatuta. Esparru hori duela gutxiko energia krisiaren ondorioetan sakontzeko erabiltzen da.

Abstract

Energy crises can have essential repercussions in various areas, such as society, the economy, national security and the environment. Shortages of energy resources can lead to higher prices and increased competition for energy resources, which can negatively affect economic growth and business competitiveness. In addition, an energy crisis can also lead to outages in the supply of electricity or other energy sources and interruptions in essential services, which can harm national security and the population's well-being. Similarly, higher energy prices, such as gas in this case, can result in higher coal consumption with a corresponding impact on GHG emissions. This report develops a framework for analyzing the socioeconomic impact of an energy crisis based on a review of the literature on the subject. This framework is then applied further to explore the effects of the recent energy crisis in Spain.

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Executive summary

The energy crisis of 2021-2023, which saw energy prices and volatility rise above normal levels, began with the gradual reopening of post-pandemic economies as global health conditions improved. It was caused by the lack of sufficient investment in gas infrastructure (due to the signals sent by decarbonisation strategies) and aggravated by the Russian invasion of Ukraine, the uncertainties it raised and the use of energy as an instrument of geopolitical pressure. Moreover, it coincided with disrupted supply chains for raw materials and other commodities.

The increase in energy prices between 2021 and 2023 was higher in Europe than in other territories, such as America.

From mid-2021 onwards, upward movements in the prices of different energy sources (e.g., oil, gas, and coal) began to be felt. However, it was difficult to foresee that the situation would push gas prices above 100 EUR/MWh to levels never seen before.

Rising gas prices, in turn, pushed electricity prices to between 440 and 543 euros/MWh in summer 2022 on European wholesale markets, leading to the closure of electricity trading companies. In addition, the increase in gas and electricity prices, which boosted coal demand, pushed the price of emission allowances in the European market (reaching 100 euros/tonne of CO_2).

The effect of these electricity price levels on consumers' bills depended on the countries and the tariff structure of each type of consumer. In Spain, consumers under the Voluntary Price for Small Consumers (PVPC) were directly exposed to increases in the wholesale price, while consumers with forward price contracts suffered to a lesser extent from the increase in electricity prices and their volatility.

Inflation reached double-digit levels in the EU environment for the first time in more than two decades.

France managed to keep it below 10%, but this was different in Germany, Spain, and Italy, where it reached figures of around 12%. This loss of consumer purchasing power was accompanied by rising food prices and better containment of other products in the basket, as shown by the relative moderation of core inflation. The European Central Bank, among others, raised interest rates to contain this runaway inflation.

Rising energy prices damaged the cost competitiveness of European industry.

Despite the increase in labour productivity and the continuous improvement in energy efficiency, measured in terms of energy intensity, increases in energy prices had a high impact on the business fabric.

The increase in energy prices above the prices of industrial products and the difficulty, in many cases, of passing these increases on to customers affected all European industrial activity. Some more energy-intensive sectors (such as petroleum coking and refining, metallurgy, wood, paper and chemicals) were relatively less affected than sectors such as vehicle manufacturing, pharmaceuticals and textiles and clothing, leather and footwear, partly due to the related support mechanisms, which put a strong focus on the most energy-intensive industry.

In addition, throughout 2022, many European companies with high gas consumption reduced production in the face of rising gas prices. This imposes the need for proper management of energy price risks, energy savings, and energy efficiency as tools to cope with these situations.

Rising energy prices impacted several areas of household life.

Household savings fell in 2021 and 2022, as did consumer confidence, most notably in Spain. The slight rebound in household disposable income in 2021 was lost in 2022. The latter is related to the double impact of higher energy prices on households. On the one hand, due to the increase in the prices of energy products that households consume for different uses (transport, heating, domestic hot water, etc.) and indirectly due to the increase in the prices of products that require energy in their production processes.

It is difficult to assess the impact of the increase in energy prices on transport for each income group. On the one hand, while there was an increase in the percentage of disposable income devoted to using one's own vehicle, income devoted to using transport services did not increase and did not reach its pre-crisis level. Moreover, the lower income groups spent proportionally more on transport with their own vehicle, which is because they often live far away from public transport systems. On the other hand, there was a reduction in the number of vehicle registrations in general and of gas vehicles in particular (especially in Italy).

Regarding energy consumption in housing, in Germany, Spain, Italy and the Autonomous Community of the Basque Country (ACBC/CAPV), the share of energy expenditure (electricity, gas and others) in total disposable income has increased since 2020. In Italy, this percentage more than doubled. Despite the increase in resources devoted to household energy consumption, the number of households in energy poverty (measured in terms of inability to keep their homes adequately warm) increased, sometimes doubling since 2019 (Spain and the ACBC, for example). Moreover, in many cases, this situation detracted resources for maintaining and repairing dwellings and, therefore, adopting domestic energy-saving and efficiency measures.

The energy trade balance deficit increase highlights the risk associated with energy dependence on the outside world.

The data show that the trade balance of energy products (exports-imports), which during the last decade, was always negative, worsened in 2021, reaching the minimum of the 2014-2023 period in 2022, when Spain's energy balance deficit was the largest in its history with 53,398 million euros. The situation was even worse in Germany, Italy and France, with the energy trade deficit reaching levels above 100 billion euros. In 2023, a slight turnaround was observed, although the deficit level was worse than before the energy crisis.

The use of energy as a geopolitical weapon is not new, but the Russian invasion of Ukraine pushed the EU's quest for the security of supply to its limits.

Europe's dependence on foreign energy in 2021 exceeded 50%, reaching 89% in the ACBC. Similarly, Germany was 55% dependent on Russian gas in 2022, and the EU was 15% dependent on Russian crude oil. In this context, the Ukraine-Russia war, the sanctions adopted, and Russia's use of its energy as a geopolitical weapon, together with the decisions to cut oil

production by OPEC countries, raised the need to combat the EU's excessive energy dependence on the outside world in general and on Russia in particular.

To this end, measures were adopted in the EU and its Member States ranging from diversification of origins (the levels of concentration of suppliers have been reduced) and energy sources (moving from natural gas to liquefied natural gas, further promoting renewable energies) to the development of new regasification infrastructure, bringing idle infrastructure into use, and increasing both gas and electricity interconnections.

Also, at the EU level, the increase in inventories and the acceleration of gas storage for the following winters were promoted. The EU proposal that gas storage reaches 80% of its capacity by the winter of 2022/2023 and up to 90% by the following winter periods was rapidly implemented. By September 2022, EU storage facilities were already 80% full on average. In October 2022, the filling level reached 90%. In March 2023, after the cold season, the filling level was around 55%, above the same month in 2022 (26%) and with a rapid rate of filling. In October 2023, combined EU stocks exceeded 95% of storage capacity.

The EU adopted different packages of measures to limit the impact on the economy, and each Member State acted accordingly.

At the EU level, different initiatives and measures packages were implemented over the period 2021-2024, and others (such as the Iberian derogation) were opened for adoption at the Member State level.

Governments directed public funds to address challenges associated with the energy crisis. Thus, Germany, Spain, France and Italy devoted the largest share of public energy expenditure to financing energy accessibility/affordability (accounting for 30-60% of the total, depending on the case), sustainable mobility and energy efficiency.

To this end, they developed a wide range of fiscal measures (e.g., adaptation of tax rates, reduction of tax rates, or introduction of windfall profits taxes on companies to cover the cost of the measures that governments introduced) and non-fiscal measures (e.g., granting of subsidies, rebates, and others on energy bills, promotion of energy saving and efficiency measures).

Technology as a response tool needs to be sufficiently agile to respond to energy crises.

Technology is essential to transition to other energy sources and reduce specific dependencies on external sources (e.g., fossil fuels). However, technological developments involve long planning, investment and implementation processes. As a result, while key in the long term, the technology and its development must face other risks (e.g. dependence on raw materials essential for the development of renewable generation technologies) that make it difficult to respond quickly in the short term.

The energy crisis hurt the economy.

The energy crisis harmed an economy in a fragile post-pandemic situation. Uncertainties surrounding the war and disruptions to supply chains only slowed economic recovery in the EU.

The areas of impact are wide-ranging, as all sectors and economic actors consume energy and depend on it for their activities.

A new analytical framework and recommendations for its use

In this study, a framework of analysis has been proposed, which, based on the academic literature, presents the different areas from which to analyse the impacts of an energy crisis.

Table Parameters and indicators of the energy crises impact analysis framework

Areas of analysis	Indicators to be analysed
I. Sectors	Structure of final energy consumption by sector Origin of GHG emissions by sector
Transport	Household expenditure on transport as a share of disposable income Use of personal vehicles vs. use of transport services Trend in new vehicle registrations by type Trend in passenger-km in road transport Trend in rail passenger use (million passenger-km, thousands of passengers) Development of passenger numbers in air transport (passengers on board, arrivals and departures)
Tertiary sector (Households– social sustainability)	Changes in the adjusted gross disposable household income per capita Changes in the household saving rate Changes in average household expenditure Changes in household energy expenditure Change in the ratio of household energy expenditure to household disposable income Adjusted consumer confidence indicator Population at risk of poverty and/or social exclusion (AROPE rate) Households with inability to keep their homes adequately warm
Industry	Industrial productivity per person Unit labour cost Ratio of gross operating surplus/value added of the sector Share price of the leading stock market indices Energy intensity of the economy and industry Evolution of the energy price index and the ratio of energy prices to the industrial price index Impact of higher energy prices on product price increases
II. Instruments	
Regulation-Politics	Regulations and related measures developed
Technology	Evolution of the electricity *mix* Evolution of electricity capacity Total investment in R&D in millions of US$ Internal R&D expenditure in the business sector and IPSFL in the ACBC Breakdown of public expenditure on energy Public expenditure on energy by category Investment prospects in the energy sector WEF Energy Transition Index
III. Sustainability	
Environment	Index of the evolution of primary energy consumption Development of domestic coal consumption Change in final energy consumption by source and territory Energy intensity Index of GHG emissions by country Change in per capita GHG emissions by country Pollutant emission trend index by country
Economy	Real GDP Inflation Underlying inflation

	Interest rates Monthly unemployment Trade balance (EXP-IMP)
Security	OPEC countries' crude oil production Recent OPEC production cuts World natural gas production Electricity production Crude oil inventories Underground natural gas inventories LNG inventories Origin of crude oil imports by country Origin of natural gas imports Annual regasification capacity. Large-scale LNG import terminals Interconnection capacity
Social	See Tertiary sector

Note 1: A more extensive list of potential parameters to be studied is given in Annex II.
Note 2: The social element of the sustainability section is analysed at the household sector level to avoid possible repetition of indicators.
Source: Prepared by the authors.

When implementing the analysis framework, the particularities of each territory and circumstance (e.g., an energy crisis following a pandemic) must be considered so that the interrelationship between the different parameters and between these parameters and energy prices can be understood.

This framework will only be valid if it is accompanied by monitoring and tracking the indicators, providing a complete picture of the effects of energy price increases. However, this monitoring and tracking is more complex because information on the indicators is not directly available. Statistics have deadlines and extraction periods, making it difficult to obtain a sufficiently complete analysis in the medium term.

Moreover, it is vital to assess not only the impacts of price increases but also the effect that the different measures taken (at the EU or Member State level) had in practice to draw possible lessons for future developments. For this analysis, the above framework can also be used, focusing primarily on those areas for which measures have been developed but not forgetting their potential direct or indirect impact on other areas of study.

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List of abbreviations and acronyms

ACBC/CAPV	Autonomous Community of the Basque Country
ACER	Agency for the Cooperation of Energy Regulators
AROPE	Rate of population at risk of poverty and/or social exclusion.
b/d	Barrels/day
BACH	Bank for the Accounts of Companies Harmonized
bcm	Billion cubic meters
CLU	Unit labor cost
CNAE	National Classification of Economic Activities
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	CO_2 equivalent
COVNM	Non-methane volatile organic compounds
ECB	European Central Bank
EGD	European Green Deal
EIA	Energy Information Administration
ESMA	European Securities and Markets Authority
ETI	Energy Transition Index
EU	European Union
EU ETS	European Union Emissions Trading Scheme
EXP	Exports
GDP	Gross domestic product

GHG	Greenhouse gas emissions
GVA	Gross value added
IEA	International Energy Agency
IHH	Herfindahl - Hirschman Index
IMP	Imports
IPC	Consumer Price Index
IPRI	Industrial price index
IPSFL	Private non-profit institution.
IRPF	Personal income tax
IS	Corporate income tax
Ktep	Kilotonnes of oil equivalent
LNG	Liquefied natural gas
mb/d	Millions of barrels per day
MIBGAS	Iberian Gas Market
MOSES	Measuring Short-term Energy Security
MRR	Resilience and Recovery Mechanism
MSR	Market Stability Reserve
NDC	Nationally determined contribution
NH_3	Ammonia
NO_x	Nitrogen oxides
OECD	Organisation for Economic Cooperation and Development
OPEC	Organisation of the Petroleum Exporting Countries

OPEC+	OPEC expanded
PAC	Common agricultural policy
PERTE	Strategic projects for economic recovery and transformation
PIC	Projects of common interest
PJ	Petajoules (10^5 joules)
$PM_{2,5}$	Particulate matter diameter 2.5
PM_{10}	Particulate matter diameter 10
RITE	Regulation of thermal installations in buildings
ROA	Return on assets
ROE	Return on equity
SO_2	Sulfur dioxide
TUR	Tariff of last resort
UAE	European Union Allowances
UNFCCC	United Nations Framework Convention on Climate Change
US$	U.S. dollar
USA	United States
VAT	Value added tax
VTC	Transport vehicle with driver
WEF	World Economic Forum
WTI	West Texas Intermediate
€	Euro

1. Context and objective of the work

1.1. Brief notes on the international context

In March 2020, the health crisis resulting from COVID-19 reached Europe, prompting numerous governments around the world, particularly many European governments, to adopt measures to reduce contagion, establishing restrictions on mobility, quarantines and confinements, among others (CIDOB, 2020). As a result of the measures adopted at the global level to contain the pandemic, significant distortions were generated in domestic supply and demand, trade and finance, which led to a reduction in economic activity (World Bank, 2020). The effects were most significant in those countries most affected by the pandemic and those whose economies depended on international trade, tourism, commodity exports and external financing.

In December 2019, the European Commission announced the Communication "A European Green Deal" (EGD), a growth and competitiveness strategy for the EU for the coming years, which became particularly relevant and urgent in the first half of 2020. It ended up becoming one of the pillars of the post-pandemic recovery strategy for the European Union (EU) economy, with the help of the Next Generation EU funds, which, in addition to emphasising the recovery of economic and industrial activity and employment in the short term, sought to focus resources and efforts on tackling the main challenges facing European economies in the medium and long term, including technological, industrial and environmental challenges (Fernández Gómez & Larrea Basterra, 2021)[1].

In September 2020, the European Commission amended the European Climate Act to include the 2030 emissions reduction target of at least 55% as a stepping stone to the 2050 climate neutrality goal. In parallel, it invited the Parliament and the Council to confirm this 55% target as the EU's new Nationally Determined Contribution (NDC) under the Paris Agreement and to submit it to the United Nations Framework Convention on Climate Change (UNFCCC) at the end of that year (European Commission, 2020).

[1] The PVE implies a green, circular, digital and fair revolution with environmental sustainability as a transversal dimension *based on (1) the development and adoption of clean technologies in electricity generation, industry, mobility... (renewables, electrification, hydrogen, etc.), (2) the improvement of efficiency in energy and material consumption (circular economy, new materials, etc.), (3) digital transformation (technologies, products, services and processes) and (4) support for the most* affected *regions and sectors* (Fernández Gómez & Larrea Basterra, 2021). The set of standards and tools that will be deployed in the EU under the EVP will enable the competitiveness of European industry to be strengthened and open the way to the development of emerging activities and value chains (e.g. circular economy, waste and natural resource management) that can contribute to economic growth and the development of a competitive business fabric). Since it was published, the EU has complied, practically in detail and on time, with the Roadmap set out in the EVP, which determined the deadlines for the revision and publication of new standards, guidelines, etc. at EU level.

In 2021, the most acute phase of the COVID-19 pandemic was overcome, but a crisis in the supply chains accompanied the economic recovery (Mecalux Esmena, 2023) and a sharp upturn in global inflation (Bank of Spain, 2022). In fact, from the second quarter of 2021, import prices began to rise, including those of energy sources, which had an impact both on production costs and consumer prices (European Council, Council of the European Union, 2023).

Thus, the recovery was hampered for several reasons, including the shocks caused by the health situation, the rebound in energy prices and the inability of supply to respond to a growing demand driven by the improved epidemiological situation and extraordinary support. Gas producers slowed down the reactivation of production due to the uncertainty of new outbreaks of COVID-19, which may have led to new confinements, and to the message from Western economies of their intention to reduce future consumption of fossil fuels.

Although price increases were initially concentrated in raw materials (including energy products) and food and appeared to be transitory, the upturn in the last quarters of the year gradually spread to the rest of the goods and services in the consumer basket. Furthermore, there were bottlenecks in the global production and transportation chains that did not abate as quickly as expected (Bank of Spain, 2022).

In the energy sector, price trends were also driven by previous energy policy decisions that aggravated the situation. In this regard, the closure of Germany's nuclear power plants and its increased dependence on Russian gas during the energy transition process (which, among other things, promoted the construction of the Nord Stream 2 gas pipeline) allowed Russia to use gas for strategic pressure. The failure to develop a European-wide renewable energy backbone network (solar from south to north and wind power from north to south), which would make it possible to take advantage of resources where they are most available, was also a factor that aggravated the situation. In Spain, for its part, a mobility policy that has promoted road transport over other means of transport and a poorly insulated building stock have led to higher dependence on crude oil than in many different countries.

Still in this process and when the end of the pandemic was beginning to be glimpsed, in February 2022, in an increasingly complex geopolitical context, the Russian invasion of Ukraine took place. As a result of the invasion and the ensuing war (which has lasted more than two years to date), inflationary pressures on raw materials worsened, economic agents' confidence deteriorated, and international trade slowed down. This situation was aggravated in 2022 by the Chinese government's strict zero-COVID measures. These measures meant that some port employees and truck drivers were unable to work, causing congestion and traffic jams (Seurat, 2022).

For its part, global demand for consumer goods exceeded supply, which, in addition to generating an imbalance, drove up inflation, which went from semiconductors to pulp, glass,

car parts, etc. Successive confinements had already impacted the balance of consumption of goods and services[2].

In this context, the Russia-Ukraine conflict further complicated geopolitics, as some countries openly positioned themselves in favour of Ukraine (e.g., EU, USA), others in favour of Russia[3] (e.g., Belarus, Syria and Nicaragua) and another group of States has avoided taking a position to reduce, as far as possible, the consequences that this could entail for them (e.g., China, India). Moreover, more than two years after the beginning of the conflict, no easy way out seems to be in sight.

This situation since October 2023 has become even more complex, if possible, due, on the one hand, to the new crisis between Israel and Gaza, which may lead to a new scenario in international relations and the positioning of States, including suppliers of oil, gas and others, with their respective implications; and, on the other hand, due to the Red Sea crisis, linked to the previous one and also starting in October 2023, which is leading to attacks by Yemeni Houthis on merchant ships of different nationalities in the Red Sea and the Gulf of Aden, which are pushing many ships to go around Africa to avoid possible attacks, lengthening the voyage by about three weeks and increasing the cost of goods.

1.2. Objective and scope of work

Energy crises can impact society, the economy, national security and the environment. Shortages of energy resources can lead to higher prices and increased competition for energy resources, which can negatively affect economic growth and business competitiveness. In addition, an energy crisis can also lead to a shortage of some energy (e.g., Russian gas), leading to disruptions in the supply of electricity, other energy sources and other essential services, which can hurt national security and the welfare of the population.

From an environmental point of view, an energy crisis can promote climate change by increasing the use of fuels with higher levels of greenhouse gas (GHG) emissions, such as fossil fuels and other emitting energy sources. Indeed, an increase in gas price can boost coal consumption, for example, if its price is lower, with a corresponding environmental impact. In this way, energy crises can have far-reaching and long-lasting consequences for individuals, companies and states.

Given the above, this paper aims to present the impact of the recent energy crisis in an orderly manner. The RAE definition of crisis includes seven meanings, of which the first and third are the closest to the approach of this paper: (i) *profound change with essential consequences in a process or situation, or how these are appreciated*; (ii) *bad or difficult situation*.

[2] A priori, an imbalance between supply and demand is resolved with higher prices, as in the case of the German automobile industry, which increased delivery times, sometimes to more than a year, and raised prices (Seurat, 2022).

[3] For more details see (Al Rojo Vivo, 2023).

In this sense, for this paper, "energy crisis" is understood as the increase "well above the usual levels" in the prices of all or some energy sources or high volatility "out of the ordinary" and not attributable to market fundamentals (supply and demand) in the medium term, which generates uncertainty among agents. Thus, the objective is to describe the problematic situation experienced due to this increase in energy prices in an already complex context, as explained above (e.g., COVID-19, wars, disruptions in supply chains).

For this purpose, a framework of analysis of the crisis is developed, considering mainly a review of the literature, academic and/or from the business or institutional sphere. This is followed by information on the evolution of the prices of different energy sources, including at least the last four years. Next, the evolution of the variables selected for the study is presented for the European Union (EU), particularly France, Germany, Italy, Spain and, as far as possible, for the Autonomous Community of the Basque Country (ACBC). Among the elements presented are the measures adopted, mainly in the field of energy (measures to contain prices, incentives to encourage energy saving and efficiency, etc.), to reduce the impact that such increases may have on different agents; measures adopted at community, national (in the case of Spain) and regional level (for the Autonomous Community of the Basque Country, ACBC). The document ends with reflections on the evolution of the different variables under analysis.

2. Analysis Framework[4]

Although there are frameworks for analysing policy interventions in crises and others which differentiate between instruments (e.g., regulation, taxation and others) (Goulder & Parry, 2008; Navarro Arancegui, 2024), for this study, we have broadened the scope in order to understand better the impact that the increase in energy prices has had on the economy in general.

In order to proceed with the development of the analysis framework, a literature review on the subject, both academic (42% of the total number of documents reviewed)[5] and non-academic, was carried out. This type of review does not present general literature summaries on a topic of interest. On the contrary, Linares-Espinós et al. (2018) think that a systematic review involves a critical and reproducible analysis of the available results about a specific question. Therefore, systematic reviews generate different types of knowledge for review users (Page et al., 2020). In this sense, Gurevitch et al. (2018) and Gough et al. (2019) can provide results to identify future research lines. Likewise, they make it possible to address complex questions with individual studies; they identify problems and generate or evaluate theories about how or why phenomena occur.

It is a methodology with numerous benefits. Kitchenham and Brereton (2013) conducted a study on the benefits detected. Among them are new research findings, learning from studies, community recognition, publication of articles, experience, learning skills, systematic way to build evidence, more reliable results based on a literature synthesis, and replicability and identification of new research areas. Thus, this methodology helps describe a topic and its underlying concepts and theories, but it is often subjective and biased if conducted without an established methodology. They are difficult to replicate, so findings and conclusions depend highly on the authors (Aromataris & Pearson, 2014).

Therefore, a comprehensive search strategy should be developed and presented. A strategy using keywords derived from the research question is common. This preliminary search helps to identify optimal search terms, including other keywords and subject headings or indexing terms, which are then used when searching relevant databases (Aromataris & Pearson, 2014). In this regard, searches have been conducted in Spanish, English and French. The terms that have shaped the searches in Google Scholar, among others, have been energy crisis, rising energy prices, variations and volatility of energy prices. References to the energy crisis of the 1970s-1980s, the Gulf crisis of the 1990s and the energy crisis of 2021-2022 were also searched.

Of the hundred or so documents reviewed, it is worth noting that although this is a topic that has been a source of concern and inspiration for academic work since the 1970s, it is a field of

[4] The bibliographic references of reviewed texts (non-methodological) included in this section can be consulted in Annex I, where they are arranged by year.

[5] For these purposes, academic literature is understood as that collected in a periodical publication in which studies related to a particular academic discipline are presented. They serve as permanent and transparent forums for the presentation, scrutiny and discussion of research. They generally require peer review for research articles or other scrutiny.

knowledge that is repeatedly worked on, especially in situations of high energy prices or after moments of significant price tensions (1970s crisis in Sears et al. (1978) or Pendse (1980), beginning of the 21st century in Chevalier & Geoffron (2009), 2014 electricity price increases, etc.).

Likewise, although the studies are not always quantitative, nor do they constantly analyse the impact, they mention it. Indeed, many are descriptive studies (Grossman, 2014; Erker et al., 2017) and qualitatively assess certain events. Therefore, indicators that have not been the subject of a specific quantitative analysis can be raised but are valued as being of interest to the subject matter.

It should also be noted that, on many occasions, the papers reviewed have not focused on a single issue but may cover different topics (e.g., energy savings and security in Gouvernement (2022), energy security and renewables in Latif et al. (2020), inflation and deindustrialisation in Delépine (2023) or investments and security in Escribano (2023), among others).

The literature reviewed refers to different sectors of the economy. The most common reviews are those on energy shocks' impact on households (Wu et al., 2019; Torres & Fernandez, 2022) and industry (Arocena & Diaz, 2015; Junejo & Khoso, 2018). However, there is also literature on the effect on transportation (Tihansky, 1974; Neveu, 1977; Audin, 2018). In this case, work on reducing road accidents in the face of fuel price increases is raised due to lower use of own vehicles. The transfer between modes of transport is also analysed, and issues related to air transport are raised.

On the other hand, many papers analyse or present issues related to energy sustainability based on the four classic pillars of sustainability (economy, environment, society and security of supply-affordability, availability, reliability and sustainability) (Switch Energy Alliance, 2024). In the more economic sphere, perhaps most analysis focuses on macroeconomic issues, particularly the impact on inflation (Rodriguez Rodriguez, 2022; Authers, 2022) and economic growth (Chaney, 2022).

Another common area of analysis is the development of measures and instruments, many of them regulatory, to address energy crises (KPMG, 2022; Sancha, 2022; Choi & Murali, 2022). As seen in the next section, this is not a trivial issue. Many of the measures adopted are energy-related, i.e., they focus on energy taxation issues, the establishment of price caps on energy products, consumption limitations, etc. In this study, the analysis has focused on these measures, ignoring those that do not directly involve energy (e.g., VAT reduction on commodities due to the increase in energy prices).

Other instruments to address energy crises are technology and R&D&I. In this sense, there are numerous articles related to technology substitution (Caradisiac, 2022; IRENA, 2023) or the need to invest in developing new energy sources that are compatible with current environmental requirements (Navarrete, 2022; IRENA, 2023) and that also make it possible to reduce energy dependence (Belaid et al., 2023). The following table shows an aggregation exercise of the topics of the articles, where the variables studied and analysed in the literature reviewed have been ordered.

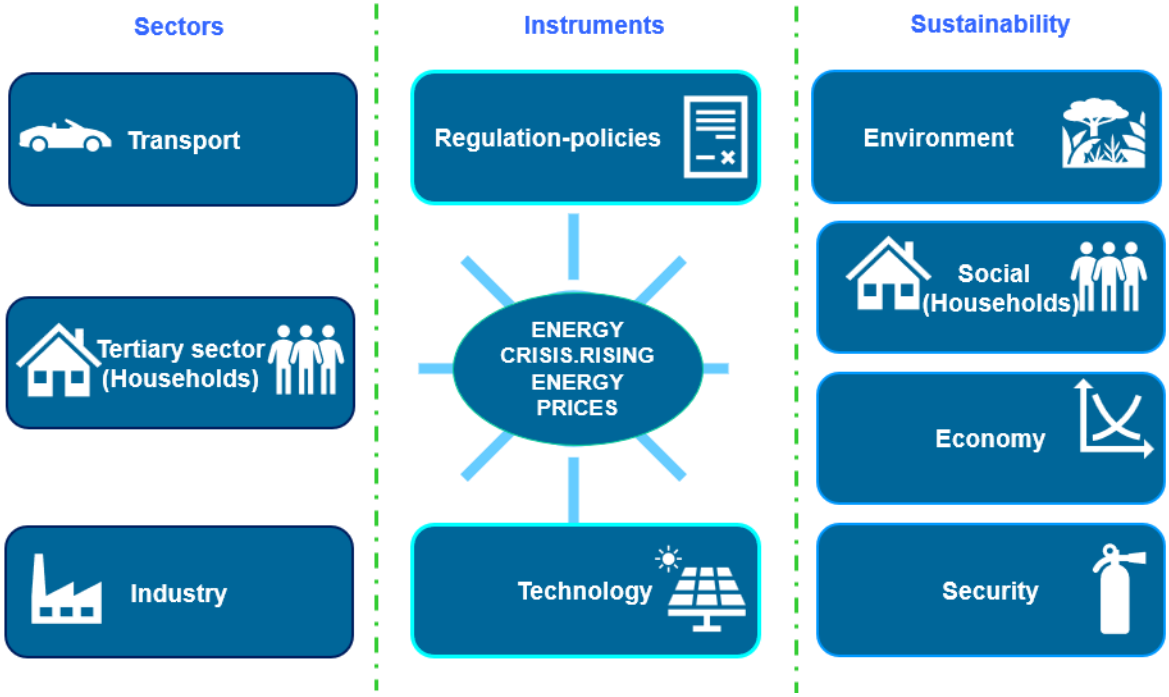
Table 1. Relevance of issues in the literature review on the impact of crises

Behaviour of household actors (e.g. behaviour, energy savings, consumer confidence, fuel poverty)	65
Prices (e.g., energy prices, cost of energy, energy expenditure)	51
Technology (e.g., energy mix, energy transition, energy infrastructure, investment or renewables)	43
Competitiveness (e.g., business, industry, profitability, production)	33
Macroeconomic impact (e.g., employment, inflation, GDP/GVA, international trade)	28
Response measures (e.g., measures, regulation, energy policy)	22
Fiscal, monetary and other policies	22
Security (e.g., geopolitics, security, dependency, supply)	18
Climate change and the environment	9
Road transport	3

Source: own elaboration.

Based on the above and the literature review in Annex I, the following figure presents a reflection on the areas that arise when studying energy crises to create a holistic analysis framework that can be applied to the analysis of the impact of an energy crisis. In this way, a more complete vision of issues is achieved*, which are* independent but interrelated. As can be seen, the framework of analysis is broad, although each study focuses on specific issues.

Figure 1. Areas of analysis or reference in the literature on the energy crisis



Note 1: Social aspects are analysed at the household sector level to avoid duplication.
Note 2: The primary sector is not included in the sectoral scope, despite its energy dependence, since the search did not find any references to the impact of an energy crisis on this sector.

Note 3: Specific references to the energy sector are also not included for two reasons. First, this is an industrial sector, so industry-related issues also affect it. The second is that section 3 on energy prices and a large part of section 4.2 are key elements, i.e., regulation and technologies, are directly related to the energy sector.
Source: own elaboration.

On the one hand, there are analyses of the impact of energy crises that delve into the repercussions on specific sectors. Numerous documents focus on the effect of higher prices on households, addressing issues such as disposable income and savings, changes in behavioural patterns (investment in energy efficiency), the increase in energy poverty, etc. In the industrial sector, reviews of the sectoral impact (by industrial activity) are sometimes included. In contrast, others include parameters such as investment in energy efficiency, the impact on business margins, business profits or the substitution of production factors.

There is a second group of topics, which could be defined as tools or instruments, among which we can highlight the impact of developing regulations to combat the effects on other elements. There are energy-related regulations in this area and fiscal, monetary, and other regulations. The development of new technologies is also considered, i.e. an increase in energy prices promotes the development of new technologies, investment in R&D, etc.

The last group of areas of analysis could be defined as sustainability insofar as they address or delve into issues related to environmental sustainability. (e.g., energy consumption, substitution of energy sources, environmental impact, investment in energy technologies, etc.), economic sustainability (which, as mentioned above, includes issues related to key macro parameters such as inflation, GDP and its evolution or the trade balance[6]), social sustainability (primarily related to indicators included in the household sectoral section such as disposable income, average expenditure or the population at risk of energy poverty)[7] and a fourth that has to do with security (e.g., with parameters related to energy dependence and the availability of energy capacity), with parameters related to energy dependence and the availability of regasification capacity) and which is also connected to the social and economic one.

Below is a table with the main parameters and indicators used, considering the data availability, which are analysed when assessing the impact of the energy crisis[8]. Some of these parameters and indicators are more directly related, and others could be affected indirectly.

[6] Variables such as the exchange rate or the interest rate are indirectly affected by the energy crisis since, for example, interest rates are a monetary policy instrument used in case of need.

[7] Due to its direct relationship with households and to avoid duplication, the analysis of this dimension will be addressed in the "household sector".

[8] This list may be extended by the provisions of Annex I.

Table 2. Parameters and indicators studied in the literature on the impact of crises

Areas of analysis	Parameters to evaluate	Indicators used
Sectors		Structure of final energy consumption by sector Origin of GHG emissions by sector
Transportation 	✓ Energy consumption by source ✓ GHG emissions ✓ Household spending on transportation ✓ Penetration of electric and other alternative energy vehicles (No. of new vehicles by type) ✓ Road accidents ✓ Number of trips using transportation (rail, aviation)	Household spending on transportation as a percentage of disposable income Use of personal vehicles vs. use of transportation services Evolution of new vehicle registrations (petroleum derivatives, electric, alternative energy) Evolution of passenger-km in road transportation Evolution of railroad use in passenger transportation (millions of passenger-km, thousands of passengers) Evolution of air transport passenger numbers (passengers on board, arrivals and departures)
Tertiary sector (Households - social sustainability) 	✓ Energy consumption by source ✓ GHG emissions ✓ Household disposable income and spending (savings) ✓ Average household energy expenditures ✓ Consumer confidence and behavior ✓ Population at risk of energy poverty	Evolution of adjusted gross household disposable income per capita Evolution of household savings rate Evolution of average expenditure per household Evolution of household energy expenditure Evolution of the ratio of energy expenditure to household disposable income Adjusted Consumer Confidence Indicator Population at risk of poverty and/or social exclusion (AROPE rate) Households with the inability to keep the dwelling adequately warm
Industry 	✓ Energy consumption by source ✓ GHG emissions ✓ Labor productivity ✓ Corporate profitability ✓ Energy intensity ✓ Impact of rising energy prices on business competitiveness	Industrial productivity per person Unit labor cost Ratio of gross operating surplus/industry value added Price of the leading stock market indexes Energy intensity of the economy and industry

Areas of analysis	Parameters to evaluate	Indicators used
		Evolution of the energy price index and the ratio of the energy price to the industrial price index Impact of higher energy prices on product price increases
Instruments		
Regulation-policies	✓ Adoption of energy-related policies and measures (a descriptive variable including the proposed plans, programs or measures). o At the community level o At the national level o At the regional level	Related regulations and measures developed
Technology	✓ Evolution of installed capacity by energy source ✓ Innovation, R&D expenditures ✓ Investments (prospects) ✓ Evolution of the energy transition	Evolution of the electricity *mix* Evolution of electric power Total R&D investment in US$ millions Internal R&D expenditure in the business sector and IPSFL in the ACBC Distribution of public spending on energy Public expenditure on energy by category Investment prospects in the energy sector WEF Energy Transition Index
Sustainability		
Environment	✓ Energy consumption by source (evolution, renewable vs. non-renewable power) ✓ Carbon footprint (GHG emissions, emissions intensity) ✓ Pollutant emissions ✓ Energy efficiency (energy intensity)	Primary energy consumption evolution index Evolution of domestic coal consumption Evolution of final energy consumption by source and territory Energy intensity GHG emission index by country Evolution of per capita GHG emissions by country Pollutant emissions evolution index by country
Economy	✓ GDP ✓ Inflation (CPI, core inflation) ✓ Employment ✓ Trade balance (IMP-EXP)	Real GDP Inflation Underlying inflation Interest rates Monthly unemployment Trade balance (EXP-IMP)

Areas of analysis	Parameters to evaluate	Indicators used
Security 	✓ Energy dependence and own production ✓ Evolution of inventories/stocks (energy security index, days of stock) ✓ Diversification of origins ✓ Regasification capacity ✓ Electrical interconnection	OPEC countries' crude oil production Recent OPEC production cuts Natural gas production in the world Electricity production Crude oil inventories Subway natural gas inventories LNG inventories Origin of crude oil imports by country Origin of natural gas imports Annual regasification capacity. Large-scale LNG import terminals. Interconnection capacity
Social 	✓ See Tertiary sector	Idem

Note 1: A more extensive list of potential parameters under study is included in Annex II.
Note 2: The social element of the sustainability section is analysed at the household sector level to avoid possible repetition of indicators.
Source: own elaboration.

3. Evolution of energy prices

As already indicated, the starting point of this work is conceptualising the energy crisis as a significant increase in energy prices or their volatility. In the following charts, the available information on the evolution of prices of different energy sources (oil, gas, coal[9] and electricity) is presented along with data on the variations in the period 2020-2023, as well as the prices of emission allowances.

Between December 2020 and December 2021, the price of energy imports in the eurozone more than doubled. This rise was "striking" since energy import prices, although volatile, do not usually show variations of more than about 30% over a year (European Council, Council of the European Union, 2023).

Energy consumption and prices are two variables that are closely related. Thus, it is observed that the fall in energy consumption, oil in particular, resulting from the sharp drop in economic activity due to the pandemic, pushed prices down, and the subsequent recovery of economic activity, especially in China, where demand was 10% above the pre-pandemic level at the end of 2022, pushed them up. However, a price rise can also induce a fall in demand and vice versa.

3.1. Oil prices

The evolution of the prices of the different crude oils tends to be similar. This was especially true until 2010-2011 when a minimal differential/discrepancy was observed in the case of WTI (West Texas Intermediate). The 2014 price drop was mainly due to increased production in the Permian Basin (located in West Texas and southeastern New Mexico: Permian Midland and Permian Delaware). This area generated 93% of the net increase in shale oil production between July 2016 and May 2017, according to data from Rystad Energy (Nava, 2017). Subsequently, the price evolution of the different crudes was again even/similar.

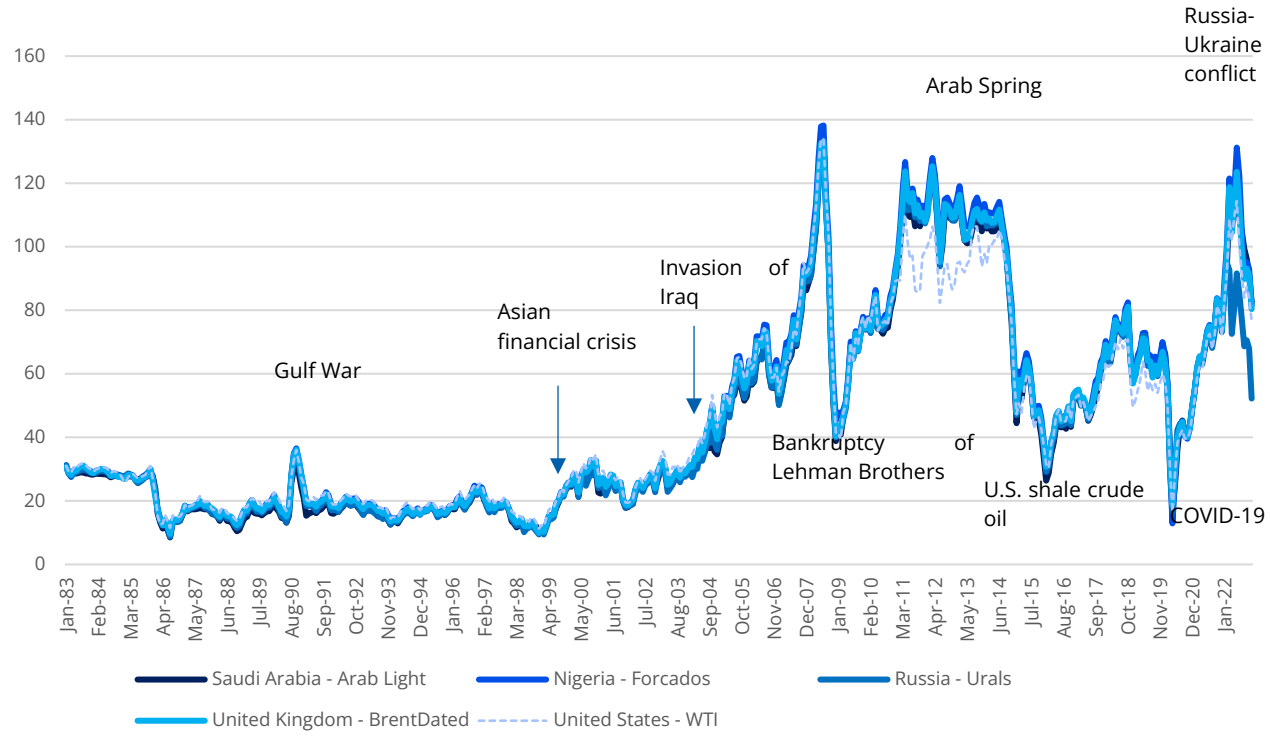
In recent years, it has been noted that the health crisis caused by COVID-19 caused oil prices to fall sharply, recovering a few months later. After a gradual recovery since March 2021, global oil production declined in August and September, among others, due to the drop in US production due to Hurricane Ida and lower investment among US oil producers[10] since mid-2020, and the reduction in OPEC+ production, which produced close to one million barrels per day (mb/d) below its quota due to maintenance and supply outages, especially in Angola, Kazakhstan and Nigeria, according to data from the International Energy Agency (IEA).

[9] Although coal is not a relevant energy source for the ACBC, we have chosen to include it, given that, on numerous occasions, there has been an increase in its consumption, replacing gas, for example, in Germany for electricity generation.

[10] Organization of the Petroleum Exporting Countries. OPEC+ is the expanded OPEC, made up of OPEC members, plus other producers**:** Azerbaijan, Bahrain, Brunei, Kazakhstan, Malaysia, Mexico, Oman, Russia, Sudan and South Sudan.

The price increase was also due to higher COVID-19 vaccination rates, the relaxation of pandemic-related restrictions, and a growing economy. Thus, global crude oil production increased less[11] than demand, driving prices higher.

Chart 1. Crude oil price evolution (US$/barrel)

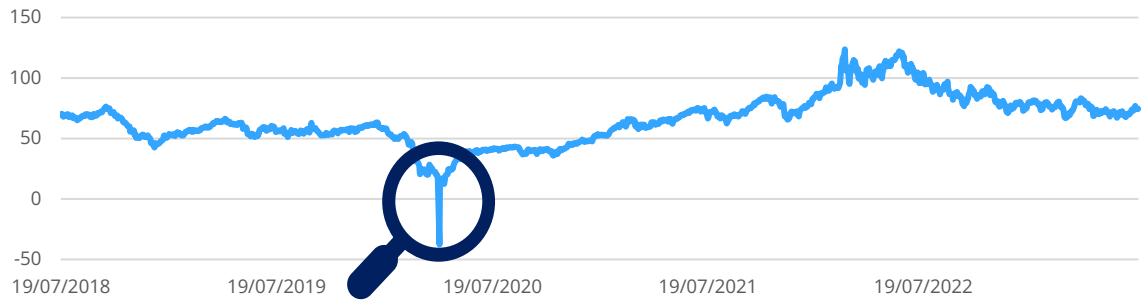


Source: own elaboration based on OPEC (2023).

In the U.S., hostile WTI prices of as much as -US$ 38 were seen due to producers' lack of storage space and a result of the shortage of demand that occurred in the period of large confinement (Ambrose, 2020). For its part, Brent crude oil (the European benchmark) did not reach hostile prices, with a minimum value of approximately 17 €/barrel. In 2021-2022, Russian crude oil prices were decoupled, whose price level was well below the rest.

[11] According to EIA (U.S. Energy Information Administration) estimates in December 2021, U.S. crude oil production decreased by 0.1 million barrels per day (b/d) from 2020 and by 1.1 million b/d from 2019.

Chart 2. WTI price evolution 2018- 2022



Source: Prepared by the authors based on Bloomberg.

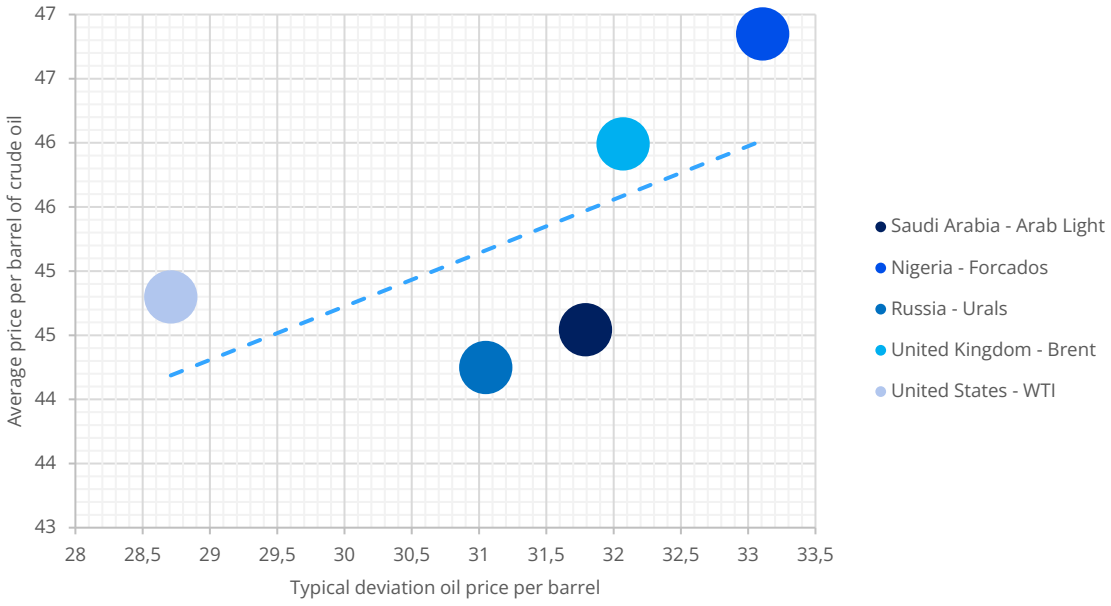
Following the impact of the health crisis, prices rose sharply in the first quarter of 2021 and continued to rise in October. This increase was, to some extent, due to supply shocks. Thus, although the pandemic-related downturn in global economic activity largely explains the plunge in oil prices in 2020, the subsequent rise above their pre-pandemic level is attributable to increased demand and supply-related factors.

Thus, (Lane, 2022) considers that supply constraints may be related, in part, to the transition to a low-carbon economy. However, production disruptions in some regions, OPEC+ supply strategies, and the indirect impact of oil supply disruptions in the gas market would also have played a role. Indeed, oil prices have also been supported by higher natural gas prices, which boosted demand for oil for heating and power generation.

As noted above, in February 2022, Russia undertook a "special military operation" against Ukraine, which has led to significant increases in the price of oil (as noted in the gas, wheat and other commodities (Kamp, B., & Gaztañaga, M., 2022), for example, in copper and nickel (Larrea Basterra & Cisneros Artiach, 2023).

The following chart shows the average (the historical average of prices) and the standard deviation (on average how far the different values deviate from the average) of the crude oil benchmarks for the market. The barrel with the highest average price has been the Nigerian Forcados, which has also shown the highest price variability. On the other hand, the barrel with the lowest variability was West Texas Intermediate (WTI).

Chart 3. Volatility of crude oil price per barrel



Source: Prepared by the authors based on Bloomberg.

3.2. Gas prices

The following chart shows the evolution of gas prices in Europe, the United Kingdom, the United States and Japan. As can be seen, after the exit from the most complicated moments of the pandemic, natural gas prices increased in a way never seen before, reaching very high and unknown levels (Ari et al., 2022) particularly in Europe (mainland Europe and the United Kingdom). The largest decoupling occurred in Europe in the wake of the Ukraine conflict due mainly to the dependence of some member states on Russian gas and the use of this energy source as a geopolitical weapon (Ortiz, 2022). Indeed, according to Alvarez Pelegry (2022), Russia had sought to increase Germany's dependence on its gas to employ it for political purposes and prevent the supply of gas by Ukraine. For its part, Germany wanted to secure Russian gas supplies in the context of its renunciation of nuclear power and eventual elimination of coal use. The United States wanted to increase its energy supplies and prevent Russia from monopolising them.

By July 2023, gas prices had recovered to levels that, without being at pre-pandemic levels, were well below the most complicated moments of the pandemic (Hernández & García, 2023), where prices reached 230 €/MWh in the TTF, 150 €/MWh in the United Kingdom and 71 €/MWh in Japan.

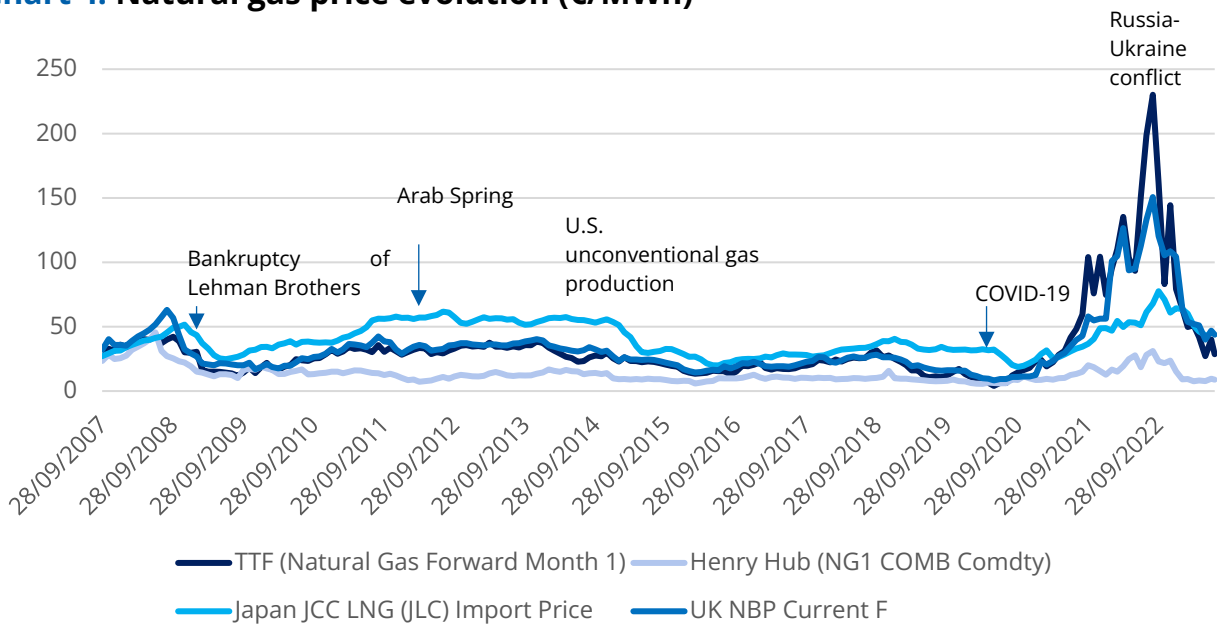
As a result of this situation, there has been a reduction in dependence on Russian gas between 2021 and 2022 by 22%, accompanied by an increase in supply from other origins such as the United Kingdom, Norway or in the form of Liquefied Natural Gas (LNG), which has increased by 14% (Ortiz, 2022). This reduction in dependence on Russian gas is not due to the price increase

per se. On the contrary, it resulted from a political decision by EU member states and other countries that opposed Russian action.

The EU agreed with Azerbaijan in May 2022 to double gas imports by 2027, i.e. to account for at least 20 billion m^3 a year over 15 years (Euronews, 2022a). For its part, the Italian government has strengthened its ties with Algeria (Moreno, S., 2022).

Europe has also turned to distant markets such as the United States, Qatar, and Nigeria, which ship their supplies via LNG carriers. LNG flows increased by 67% year-on-year, accounting for 40% of the gas consumed in Europe in 2022. Consequently, Germany, for example, focused on LNG by commissioning three LNG terminals in December 2021, reducing its dependence on Russia (which, before the conflict, accounted for 55% of total imports).

Chart 4. Natural gas price evolution (€/MWh)



Source: Prepared by the authors based on Bloomberg.

Gas price volatility is inversely related to the level of reserves (Lane, 2022). In particular, a shock that might have little impact on gas prices when stocks are high can significantly impact when stocks are low.

The most significant periods of volatility occurred in 2021-2022 and were in the TTF gas market, followed by the UK National Balancing Point, where the most significant changes were seen. On the other hand, the US is the market where the least volatility has occurred.

Table 3. Variability of natural gas prices (%)

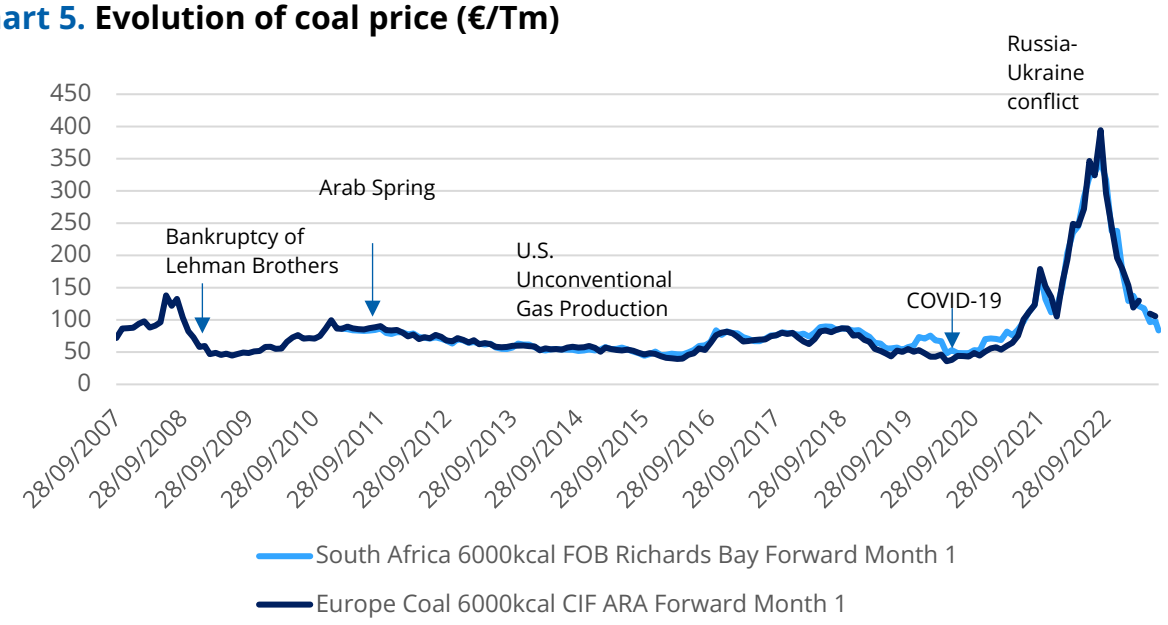
Period	TTF (Natural Gas Forward Month 1)	Henry Hub (NG1 COMB Comdty)	Japan JCC LNG (JLC) Import Price	UK NBP Current F
2019-2020	5,01	1,46	5,42	4,34
2020-2021	29,66	3,92	7,63	17,17
2021-2022	55,13	6,34	14,95	40,03

Note: Variability has been estimated as the standard deviation of prices for each set of years.
Source: Prepared by the authors based on Bloomberg.

3.3. Coal prices

As seen in the following chart, coal has not been unaffected by the variations that have occurred or by the imbalances in the oil and gas markets and has served as a substitute energy source for natural gas in many cases. Moreover, several countries have extended the life of coal-fired power plants which were scheduled for closure or have reopened some closed plants or increased operating hours to reduce gas consumption (World Energy Trade, 2022). The entry into force in August 2022 of the embargo on Russian coal added pressure to the prices of this energy source (Euronews, 2022b).

Chart 5. Evolution of coal price (€/Tm)



Source: Prepared by the authors based on Bloomberg.

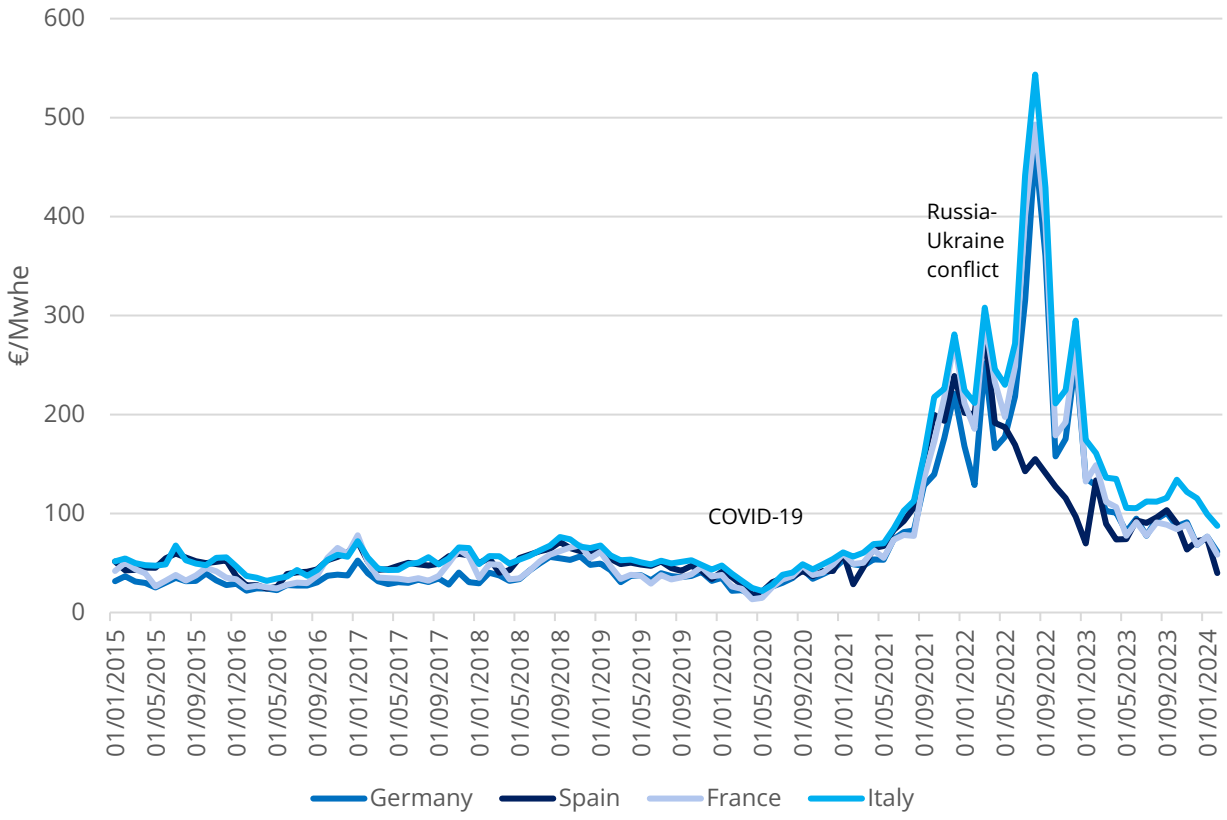
After years of decline, coal sales increased in 2022, although a lack of investment in new mining basins was detected, hindering the ability to increase coal production for the European market (Roca, 2022).

3.4. Electricity prices

The following chart presents the evolution of electricity prices in the wholesale market for the different countries under study. Between 2015 and 2020, there was a significant period of price stability, where variations occurred, for example, between summer and winter and where levels, except during the pandemic, rarely fell below €30/MWh nor rose above €70/MWh. However, 2021 was accompanied by a growth path, one year before the Ukrainian invasion, which hardly seems to have returned to previous levels below €100/MWh in 2024.

The chart below shows that the prices in Germany, France and Italy have been closely coupled. This is not so in the case of Spain, which, from May 2022 until early 2023, maintained levels well below those of its European counterparts.

Chart 6. Evolution of the wholesale electricity market price



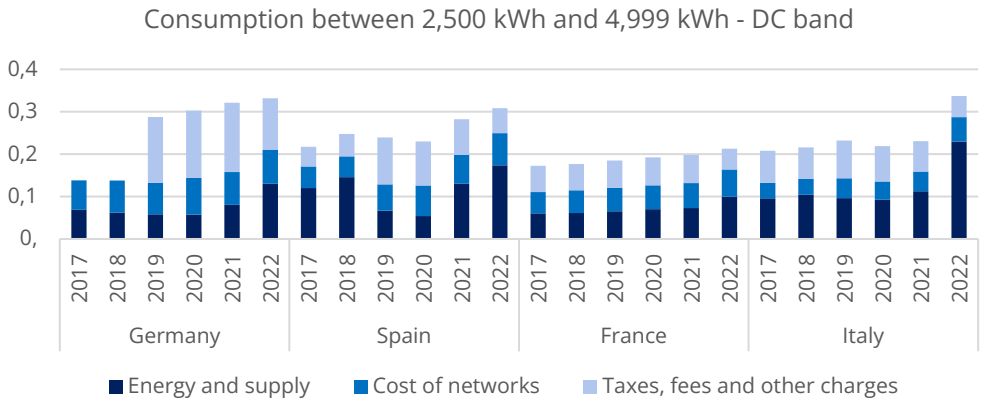
Source: Prepared by the authors based on Ember (2024).

Retail electricity prices by bands or consumption levels for domestic and non-domestic consumers are shown below[12]. Due to its characteristics, only data for EU Member States are presented. As can be seen, while in 2019 and 2020, there was a slight fall in electricity prices in some countries, significant price increases were experienced in 2021 and 2022.

3.4.1. Electricity prices for domestic consumers

As can be seen, in 2022, the main element of increase was the component related to the cost of energy and supply. That year, there was a reasonably generalised drop in the taxes, fees, and other charges components, mainly due to the measures adopted by the states to counteract the effect of the generalised price increases.

Chart 7. Electricity price evolution for households by component (€/kWh)



Source: Prepared by the authors based on Eurostat.

This is due to the impact of natural gas on electricity prices (although also depending on the *mix*). In organised electricity markets, natural gas is the technology that usually sets the daily price. Therefore, an increase in gas prices will mean an increase in the price of electricity in the daily wholesale market.

Given that in Spain, consumers under the Voluntary Price for Small Consumers (PVPC) are directly exposed to the wholesale price, they have been greatly affected by the increase in the price of natural gas (Morell Dameto, Barrella, Chaves Ávila, & Gómez San Román, 2023). Similarly, the Spanish regulation obliges vulnerable consumers who want to benefit from the

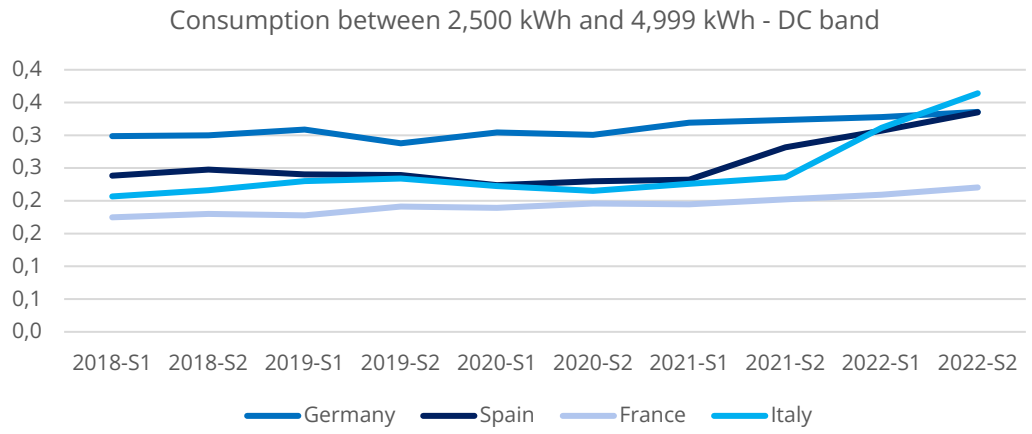
[12] According to Eurostat (2023p), the average standard domestic consumer or household has an annual electricity consumption in the band between 2,500 and 5,000 kWh. On the other hand, an average standard non-domestic consumer is considered to be one with a consumption band between 500 MWh and 2,000 MWh.

The graphs for the rest of the consumption bands for both types of consumers, domestic and non-domestic, are shown in Annex III.

social bonus to join the PVPC, which means exposing the most vulnerable consumers to market volatility[13].

By country, an upward trend in prices can be observed in all of them, although lower in France, probably due to the greater weight of nuclear production in the generation mix, as will be pointed out later, and because it has benefited from the import of subsidised energy from Spain due to the so-called "Iberian exception"[14]. In addition, it is the country with the lowest variations due to the importance of nuclear generation. The variability has been more pronounced in Spain and Italy, even though it is in Germany, where price levels are generally higher. Similarly, as the consumption band increases, prices decrease.

Chart 8. Evolution of electricity prices for households by country (€/kWh)



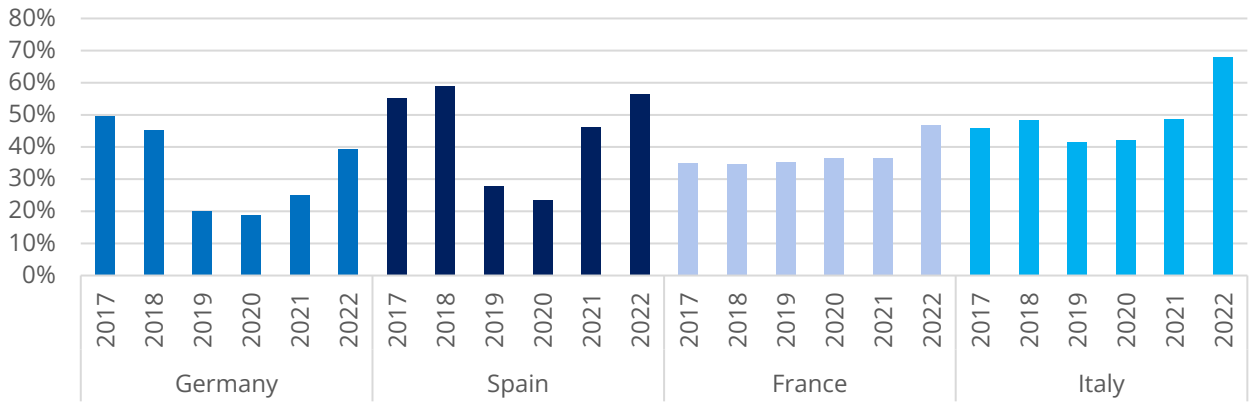
Source: Prepared by the authors based on Eurostat.

Of the total price, in general, the weight of the energy and supply cost component has increased in 2021 and 2022 in most cases, accounting for more than half of the electricity price. However, in Germany and Spain, in 2018 and 2019, the energy component as a share of the total price was also high and even higher than in 2021 and 2022.

[13] Likewise, the PVPC is the electricity price taken as a reference in the basket of products for the calculation of the CPI, which also increases the impact on the CPI since other forms of fixed-price contracts for consumers who have not suffered the consequences of the price increases in the pool are discarded.

[14] For more details see 4.2.1.

Chart 9. Evolution of the weight of the energy component in the price of electricity for households



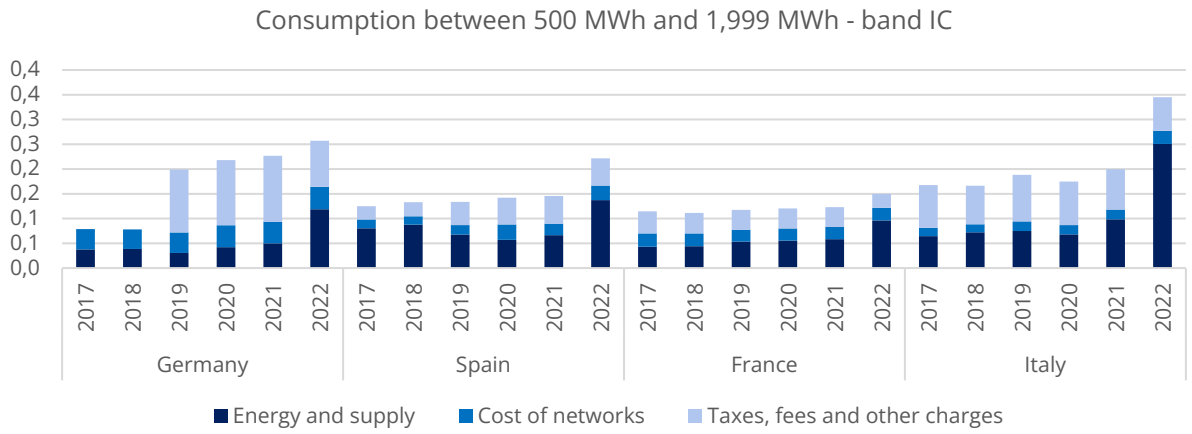
Source: Prepared by the authors based on Eurostat.

3.4.2. Electricity prices for non-domestic consumers

Regarding electricity prices for non-household consumers, France is the country which, except in the lower consumption band, has seen the lowest electricity prices. However, in 2022, an increase in electricity prices was also witnessed. This is mainly due to its generation park, which is highly dependent on nuclear facilities, as mentioned above. In fact, in 2022, 61% of electricity generation was nuclear and 23.6% renewable (hydro, wind, solar photovoltaic and biofuels) compared to 10.6% gas (Low Carbon Power, 2024). On the other hand, this is partly caused because France imported subsidised electricity from Spain for the Iberian exception. In this regard, for several days in February and March 2022, France purchased cheap electricity in Spain that was subsequently exported at higher prices to the UK. While Germany had higher prices for industrial consumers, Italy had higher prices in 2022. Spain has also positioned itself slightly ahead of Germany in several consumption bands.

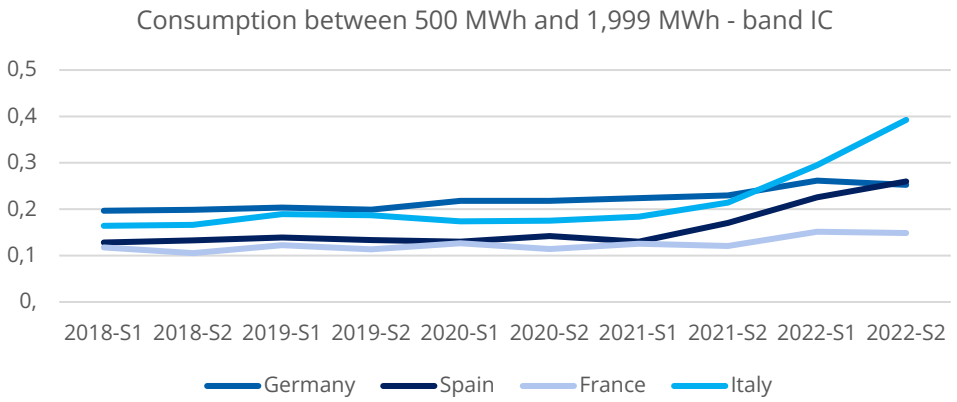
By component, consumers in the lower bands bear a more significant burden of network costs, taxes, fees and other charges. Generally, consumers in higher consumption bands observe a greater weight of the energy price component. In any case, and as mentioned above, the relevance of this component in 2022 is observed to have increased.

Chart 10. Electricity price evolution for non-domestic consumers by component (€/kWh)



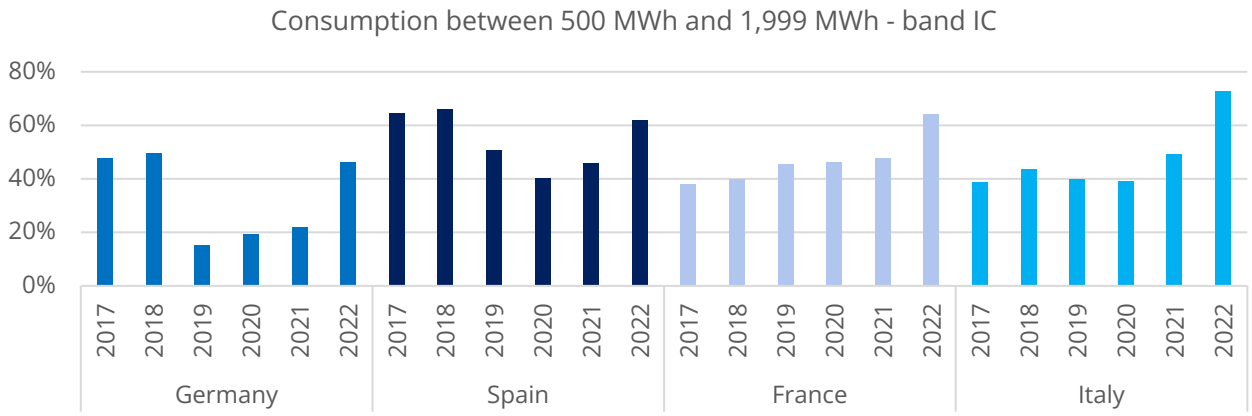
Source: Prepared by the authors based on Eurostat.

Chart 11. Evolution of electricity prices for non-domestic consumers by country (€/kWh)



Source: Prepared by the authors based on Eurostat.

Chart 12. Evolution of the weight of the energy component in the price of electricity for non-household consumers



Source: Prepared by the authors based on Eurostat.

3.5. EU emission allowance prices

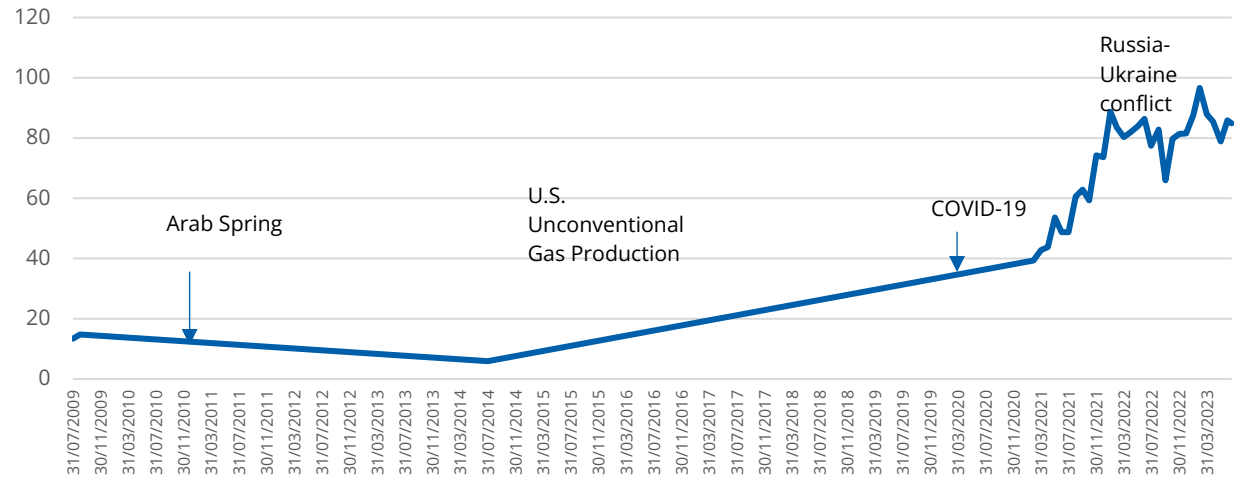
Unlike in the case of energy sources, the price of EU emission *allowances* (EUA)[15] took longer to start a downward trend. This is despite the measures included in the REPowerEU package (De Aragón, 2023), which, although not aimed at emission allowances but at reducing dependence on Russian hydrocarbons, had no effect on the price of allowances. In fact, in February 2023, the maximum level of 100 €/MT was reached, after which prices began to fall, reaching below 60 €/MT in the spring of 2024.

[15] EU Emissions Trading Scheme (EU ETS) allowances are purchased through auctions and the price is set by the interaction between supply and demand. In addition, some allowances are allocated free of charge to certain industrial activities. There has been a Market Stability Reserve (MSR) in place since 2015, and in principle until 2030, which aims to align supply with demand. Thus, if demand increases and there is a shortage of permits, permits are released and in the opposite case, the reserve is increased by removing permits from the market.

Following the European Green Pact, the EU Emissions Trading Scheme was updated to reduce GHG emissions from industry by 62% by 2030. In addition, from 2024 emissions from municipal waste incineration facilities will be included, the scheme will be extended to include shipping; from 2026 the aim is to eliminate free allowances for aviation and encourage the use of sustainable aviation fuels and, in 2034, the phase-out of free allowances for industry will begin.

From 2027/2028, the creation of an emissions trading scheme (ETS II) for the domestic sector and road transport, independent of the EU ETS, together with a price stability mechanism, is envisaged, so that if the price of an allowance in the ETS II were to rise above 45 euros, 20 million additional allowances would be released (European Parliament, 2023).

Chart 13. Evolution of the price of EU emission allowances (€/Mt CO_2)



Source: Prepared by the authors based on Bloomberg.

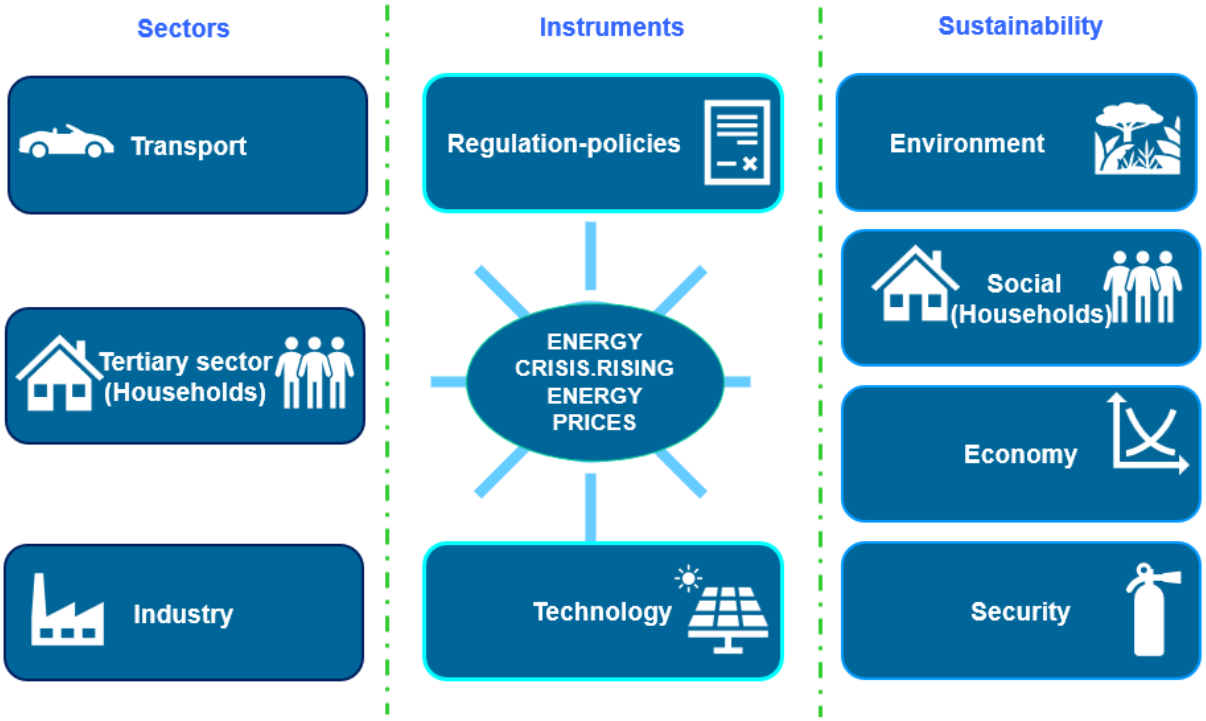
The drop from the spring of 2023 onwards is more likely due to the reduction in industrial activity in Europe associated with the pandemic and the subsequent crisis, which reduced the demand for emission allowances in the auctions.

By way of a summary, as has been observed throughout this section, the prices of the different energy sources have increased, together with their volatility, due to various reasons, including geopolitical (such as the war between Russia and Ukraine) or economic (such as the reduction of investments in exploration and exploitation of resources), among others. At the same time, the price of EU emission allowances has risen, reaching 100 euros per tonne.

4. Impact of the increase in energy prices. Evaluation of implemented measures

Considering the analysis framework presented in the second section, the most recent evolution and changes in the indicators for evaluating the crisis and the measures adopted are presented below[16]. The most up-to-date data available is presented, and, as far as possible, data for the ACBC is included.

Figure 2. Areas of analysis or reference in the literature on energy crises



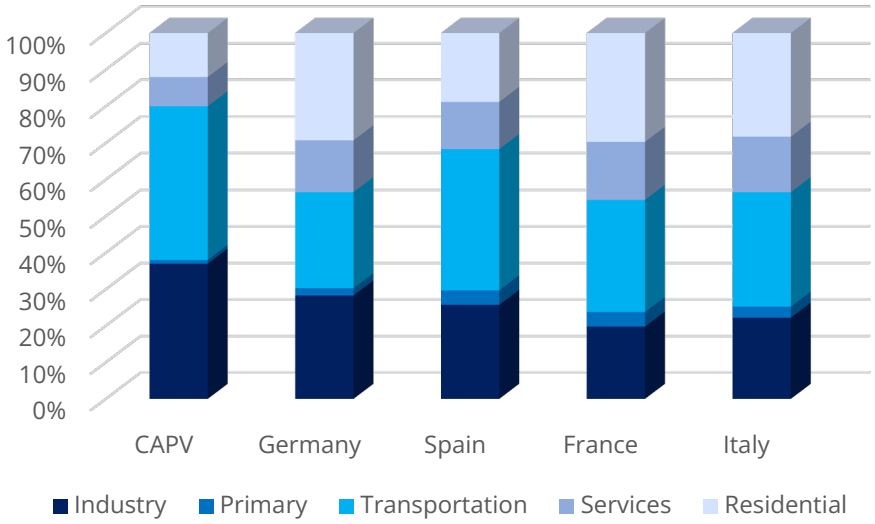
Note 1: Social aspects are analysed at the household sector level to avoid duplication.
Note 2: The primary sector is not included in the sectoral scope, despite its energy dependence, since the search did not find any references to the impact of an energy crisis on this sector.
Note 3: Specific references to the energy sector are also not included for two reasons. First, this is an industrial sector, so industry-related issues also affect it. The second is that section 3 on energy prices and a large part of section 4.2 are key elements, i.e., regulation and technologies, are directly related to the energy sector.
Source: own elaboration.

[16] Notes: (i) There is a time lag between the application of the different measures and the possibility of having data on the results obtained or at least on the evolution of the indicators; (ii) there are other types of measures that may have been taken (of a macroeconomic nature, for example), which have also influenced the results of the parameters under analysis and which are not included in this work; and (iii) the detail of this section depends on the information available. The data presented are those available and collected up to December 2023.

4.1. Sectors

The energy consumption of each territory and the impact of an energy crisis on it depends on many factors, including the sectoral economic structure. Below is a breakdown of the energy consumption of each of the territories under study for 2021. The following chart shows the high weight of energy consumption in industry and transport in the ACBC compared to the rest of the territories, where the most significant similarity is found in the case of the weight of transport in Spain.

Chart 14. Final energy consumption structure by sector (2021)



Note: Final energy is what consumers use in their professional or domestic equipment: liquid fuels, gases, electricity, coal, etc. They usually come from primary energy sources through the transformation of the latter. The industrial sector includes energy consumption in construction.
Source: Prepared by the authors based on EVE (2022).

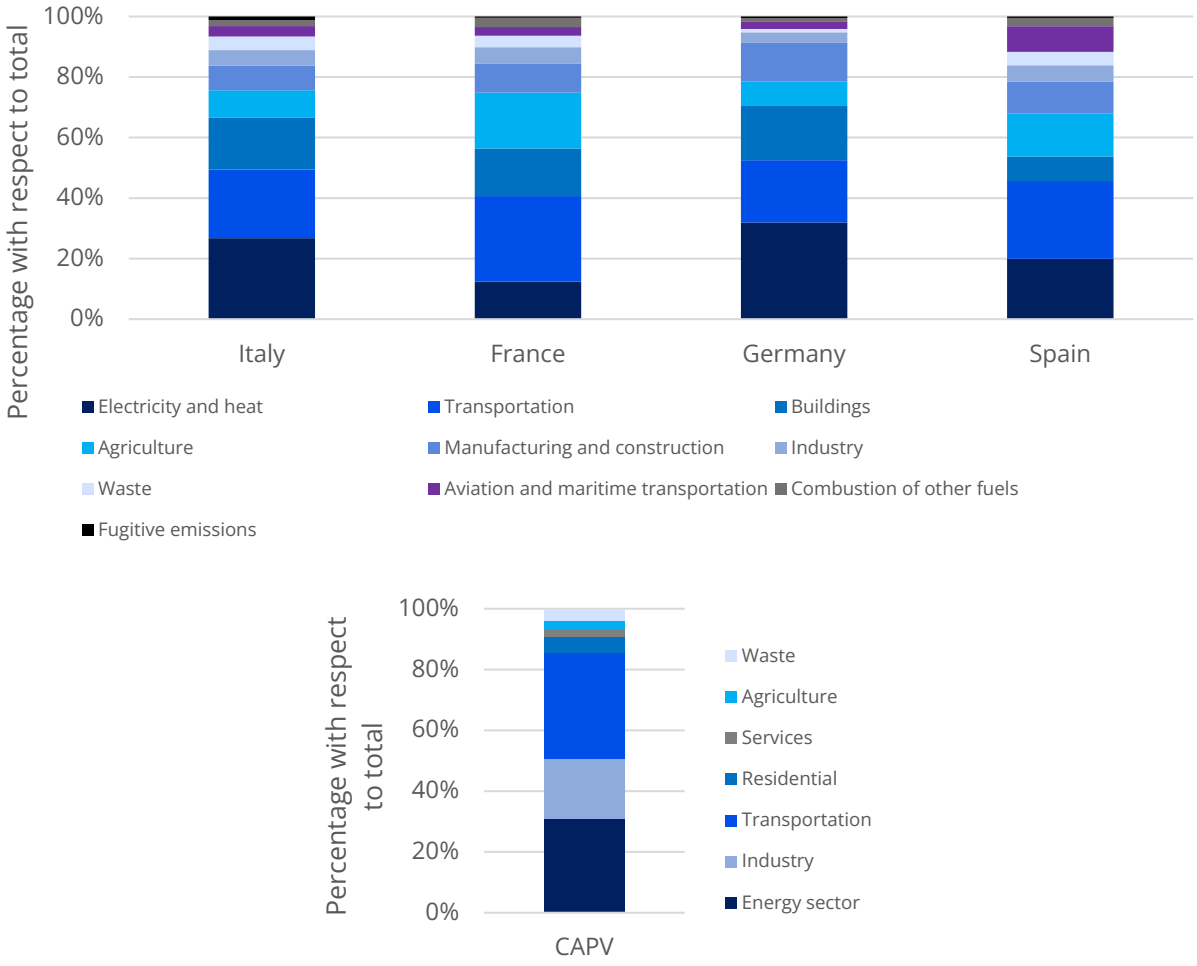
In all European countries, poorer households spend more on electricity as a percentage of total consumption than more affluent households. Thus, the direct impact of higher electricity prices is regressive. Poorer households also spend, on average, more on natural gas (relative to their total consumption) than wealthier households in most countries, with some exceptions such as Bulgaria, Hungary, Lithuania, and Romania (Ari et al., 2022).

The following table shows the sectoral breakdown of GHG emissions in the same territories. In 2020, in absolute terms, Germany (699.22 million tons CO_2 e) doubled Italy's emissions (351.62 million tons CO_2e). Behind was France (325.66 million tons CO_2e) and Spain (281.35 million tons CO_2e). In terms of size, the direct emissions of the ACBC were 16.51 million tons of CO_2e.

As in the case of energy consumption, the origin of GHG emissions differs by country. In the ACBC, electricity, heat generation, transport and industry accounted for 86% of total emissions in 2021. In the rest of the cases, there is a more excellent distribution of these, although it is

true that industry, transport and buildings play an important role in releasing emissions. In Spain and France, emissions from the buildings sector are lower.

Chart 15. Origin of GHG emissions by sector (2020, except ACBC 2021)



Note: combustion of other fuels includes combustion of fuels other than oil, gas and coal.
Source: Prepared by the authors based on Ritchie & Roser (2023) and Department of Economic Development, Sustainability and Environment (2022).

4.1.1. Transportation

According to (Ari et al., 2022) the impact of international crude oil prices on transportation fuels has been more significant than that of coal and natural gas prices on retail electricity and natural gas prices.

Transport can be categorised by the existing means (road, rail, river, sea, air or pipeline) and according to what is being transported (goods or passengers). In the case of inland passenger transport, in 2021, 88.77% of passenger km in Spain were carried by road transport, compared

to 4.4% by rail and 5.56% by air. Maritime transport played a residual role. At the international level, taking the data for 2019, as those for 2021 are incomplete and those for 2020 are not very useful due to all the restrictions on international mobility, 50.75% of passengers used air transport, compared to 47.07% by road, 1.68% by sea and the rest by rail (Transport Studies and Technology Division of the General Secretariat of Transport and Mobility & Ineco, 2022).

Regarding goods moved within the country, 95.75% were moved by road, 2.96% by sea, State Ports, and barely 1.25% by rail. The role of aviation was residual. In foreign transport, the distribution was 78.33% by sea and 20.69% by road, with rail and air transport being residual (Transport Studies and Technology Division of the General Secretariat of Transport and Mobility & Ineco, 2022).

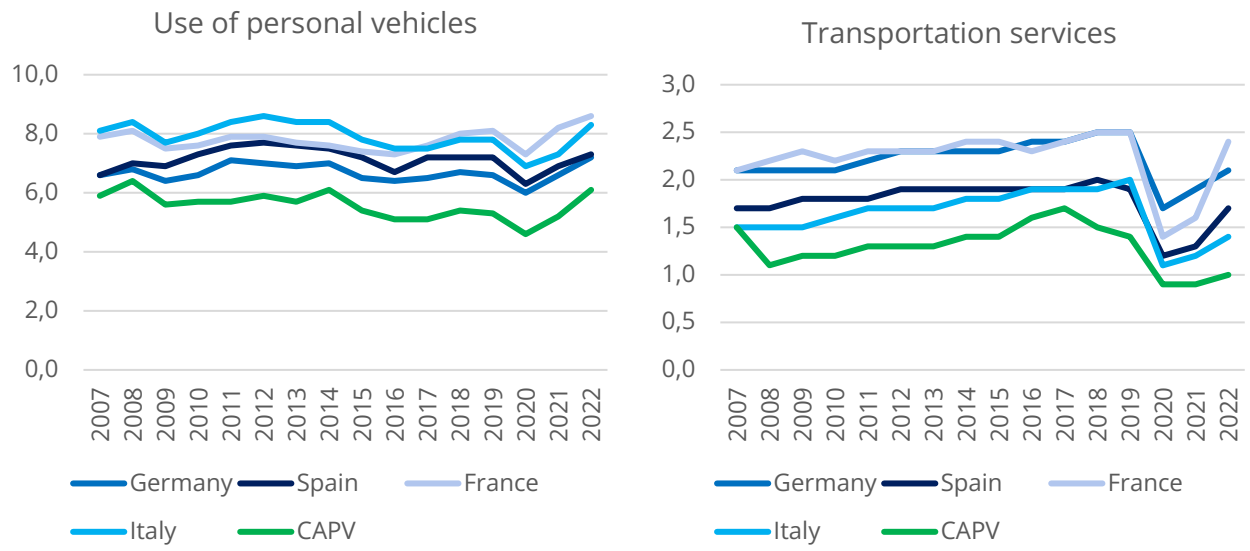
Next, indicators related to passenger transport are presented, starting with household spending on transport, the evolution of own vehicle registrations, accidents on the road and the evolution of the number of passengers in other means of transport such as rail or air.

4.1.1.1. Household spending on transportation

Expenditure on the use of own vehicles (including spare parts and accessories for personal transport equipment, fuel and lubricants for personal transport equipment, maintenance and repair of personal transport equipment, and other personal transport services) shows a slight increase over pre-COVID levels. This may be due to a substitution of means of transport, a lower use of public transport, or an increase in the prices of traditional fuels and/or a possible more significant use of these.

For its part, spending on transport services, which was reduced in 2020 due to the pandemic, to confinements and mobility restrictions and greater use of private vehicles during that period, has not yet recovered the levels at the time of the pandemic. Two cases can be highlighted: that of France, where it has increased to levels prior to the health crisis and that of the ACBC, where it has fallen since 2019 and has practically not increased even though, in the case of Spain and the ACBC, for example, there are programs to reduce the price of public transport.

Chart 16. Household expenditure on transportation as a percentage of disposable income (%)



Source: Prepared by the authors based on Eustat (2023c) y Eurostat (2023c).

According to numerous studies, wealthier households spend more on transportation fuels (as a percentage of total consumption) than less affluent households, reflecting the fact that wealthier households own more vehicles (Ari et al., 2022). It is also true that, in countries such as Spain, the percentage of expenditure on transport is higher in upper-middle income groups and in some groups such as rural households (González-Eguino, et al., 2023).

Fuel expenditure may represent a large share of total consumption for the subset of lower-income households that own a vehicle. The spatial dimension is also relevant. Rural households tend to spend a more significant proportion of their consumption on transportation fuels, presumably to travel longer distances in areas with limited means of public transportation (Ari et al., 2022).

In this conjunction of elements, evaluating the impact of the increase in the prices of automotive fuels (gasoline and diesel) and the mechanisms developed to reduce the impact is not easy[17]. Indeed, in the case of Spain, Cores (2023) indicates for Spain that, in 2022, the consumption of petroleum products reached 57.73 million tons, having increased by 8.1% compared to 2021, but standing 3.5% below 2019. The consumption of liquefied petroleum gases (10.5%), gasoline (9.7%) and gas oils (1.4%) increased.

[17] For more details on the subject, please read (Jiménez et al., 2023).

4.1.1.2. Evolution of vehicle registrations

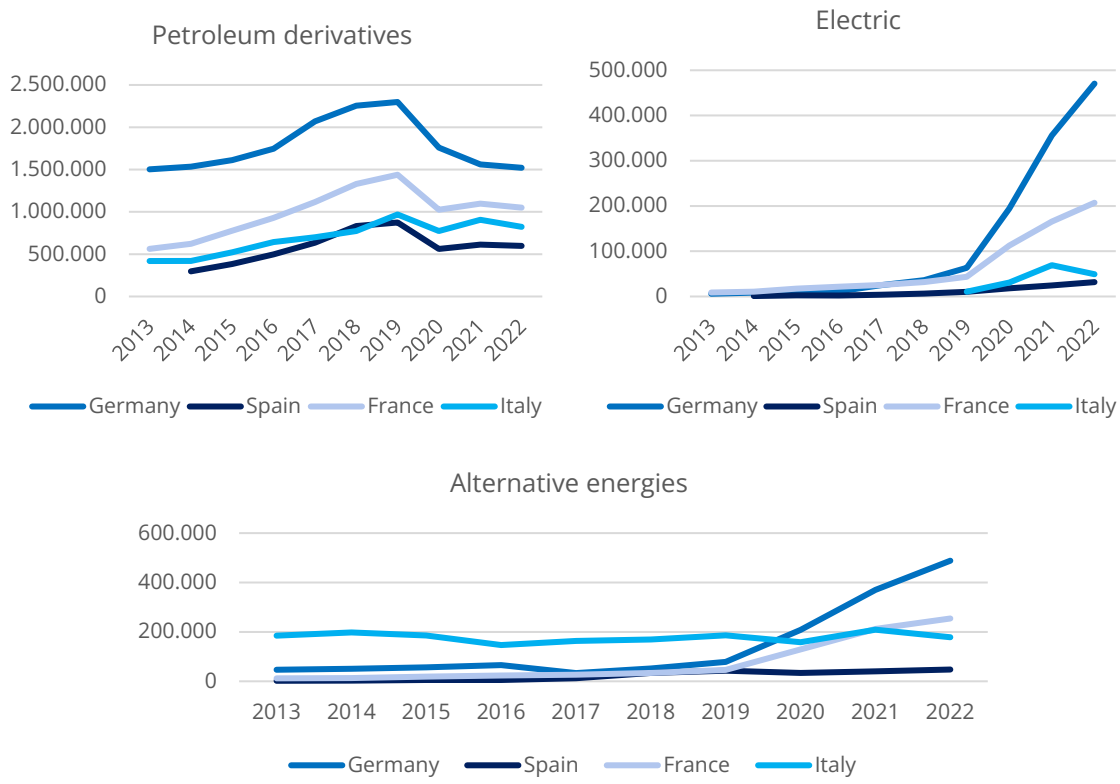
In general, new vehicle registrations have been falling for several years. This is particularly noticeable for vehicles that run on petroleum derivatives, especially diesel, where registrations have dropped below half the peak figures.

In the case of natural gas vehicles, the drop was very striking in 2022, when gas prices peaked. This is detectable in Italy, where the average number of registrations of this type of vehicle was around 30,000 per year, and in 2023, this figure fell to around 10,000 registrations.

For its part, electric vehicle registrations have risen very sharply in recent years, except in Italy, where even in 2022, they fell by 20,000 (from 69,178 new registrations to 49,118).

For alternative energy vehicles, Germany and France saw a take-off in 2019 at a slower pace in France than Germany. In Italy, the evolution is more erratic, although with some stability and a drop in 2022 compared to 2021. The case of Spain is far behind that of its European counterparts, with much lower figures.

Chart 17. Evolution of new vehicle registrations (Number)



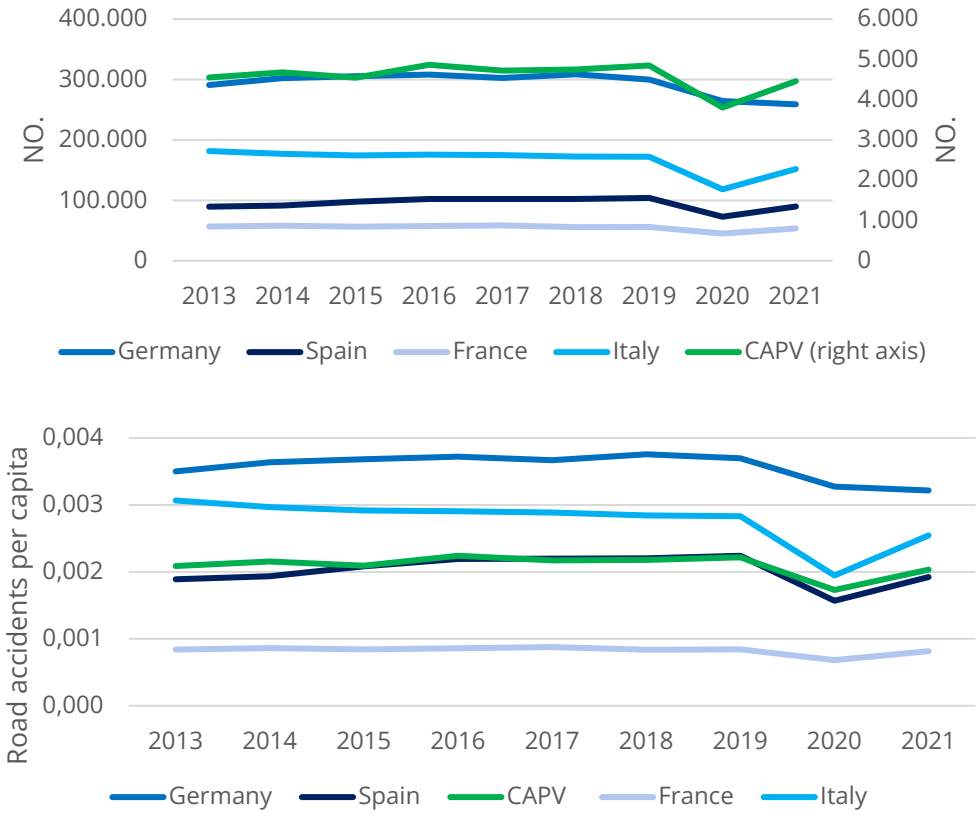
Note: Alternative energies include all types of motive power other than conventional fuels, such as gasoline and diesel. Alternative fuels include electricity, LPG, natural gas (LNG or CNG), alcohols, blends of alcohols with other fuels, hydrogen, biofuels (such as biodiesel), etc. (This list is not exhaustive). Alternative fuels do not include unleaded gasoline, reformulated gasoline or urban diesel (low sulfur).
Source: Prepared by the authors based on Eurostat (2023j).

4.1.1.3. Accidents on the road

One of the variables analysed in the literature on the impact of the energy crisis is the evolution of road accidents, which tend to decrease as energy prices increase. The available data do not show what happened in 2022. After the drastic drop in 2020 due to the economic slowdown, 2021 saw a recovery in road transport activity, especially for passengers. As can be seen, there was an increase in the number of accidents, but still below 2019.

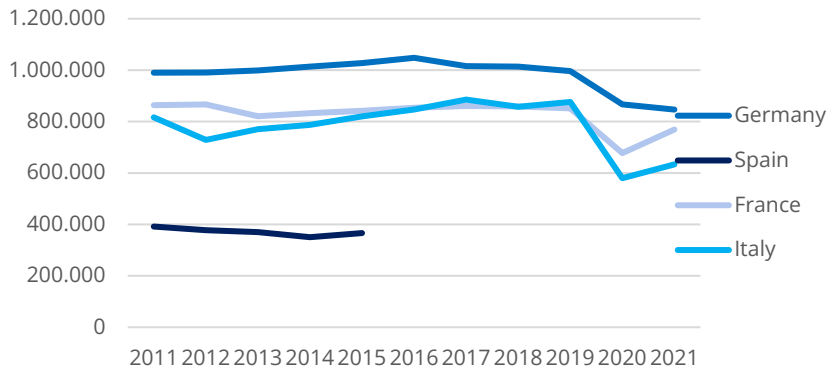
According to data from (Eustat, 2020) in 2019, there were 8,474 accidents in the ACBC. According to (Department of Safety, 2023), in 2022, traffic accidents amounted to 7,642 in the ACBC, which would initially confirm the academic thesis.

Chart 18. Evolution of road accidents and accidents per capita



Source: Prepared by the authors based on Eurostat (2023m)Eurostat (2024a) and Eustat (2024a).

Chart 19. Evolution of passenger-km in road transport

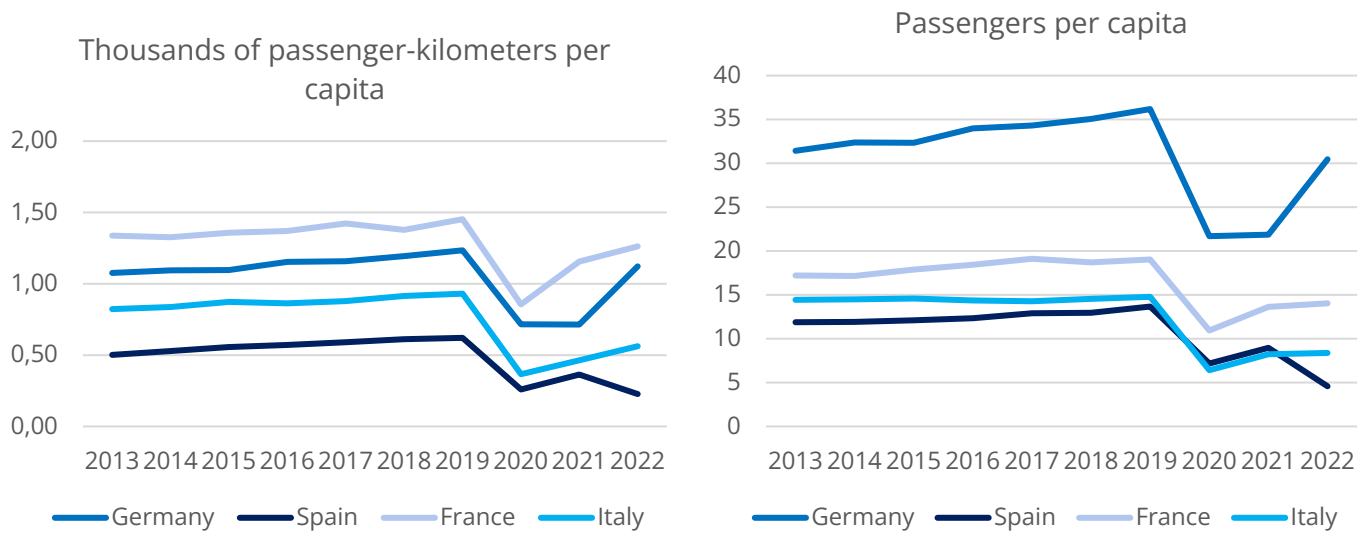


Source: Prepared by the authors based on Eurostat.

4.1.1.4. Evolution of the number of passengers by rail and by aviation

Confinement and subsequent mobility restrictions driven by COVID-19 in 2020 saw a minimal recovery in 2021 of around 25% (except in Germany, where it was virtually zero) and another increase in 2022, except in Spain. However, in no case have pre-pandemic levels in passenger numbers been reached. In the case of rail passenger kilometres, there was a recovery in Germany (57.1%) and France (9.2%).

Chart 20. Evolution of the use of railroads in passenger transportation

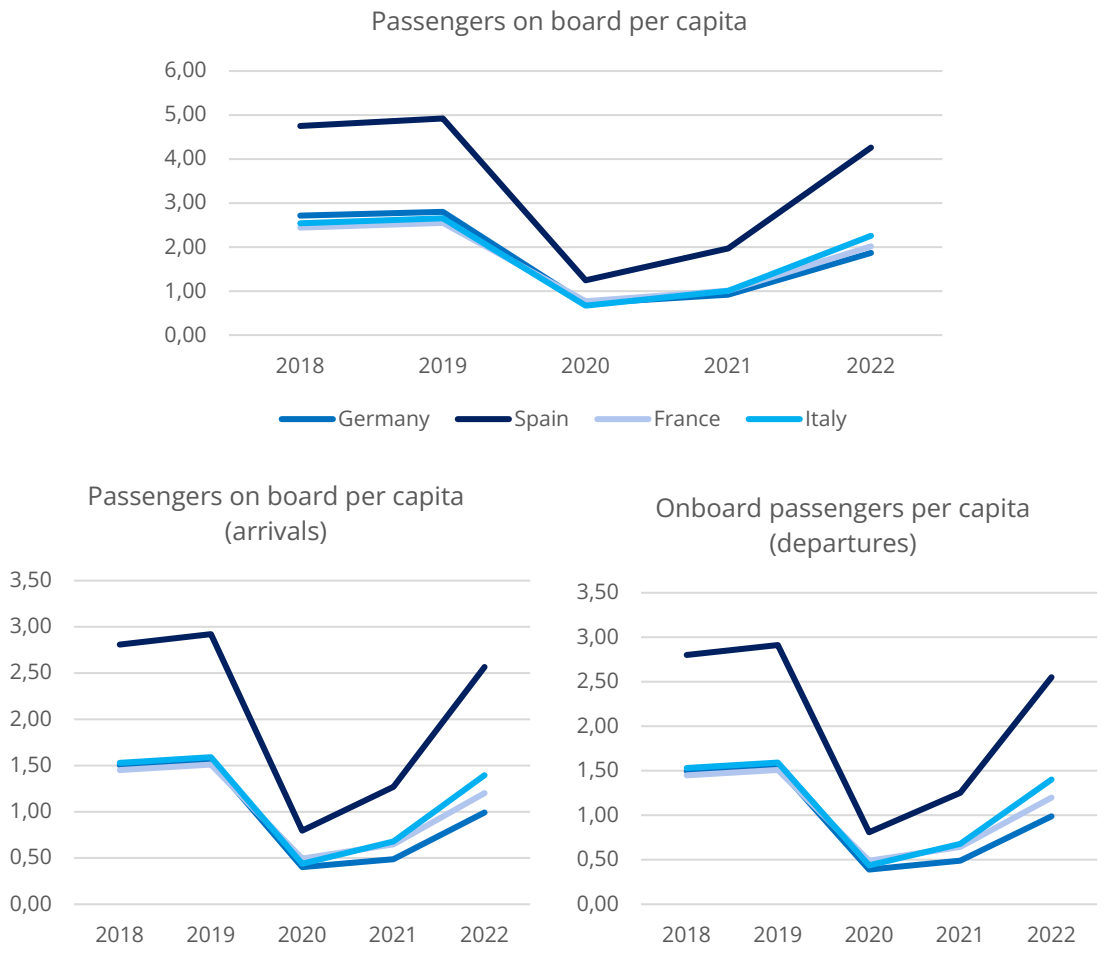


Source: Prepared by the authors based on Eurostat (2023k).

Air travel followed the same pattern as rail. Passenger numbers fell due to the health crisis, however, the total number was still below pre-pandemic levels in 2022, a year with peak energy

prices. Increases in 2021 were lower than in 2022, where passenger numbers on board doubled in Germany, Spain, France and Italy.

Chart 21. Evolution of the number of air transport passengers



Source: Prepared by the authors based on Eurostat (2023a)Eurostat (2024a), Eustat (2024a).

4.1.2. Homes

Energy prices affect the domestic consumer both directly and indirectly (Ari et al., 2022). Thus, an increase in energy prices directly affects household purchasing power through higher prices of energy products (electricity, gas, gasoline, heating oil, etc.) for heating and cooling, cooking and mobility.

Indirectly, a rise in energy prices implies an increase in the production costs of the non-energy sectors and, to the extent that producers of non-energy goods and services adjust their final prices, a further direct reduction in household purchasing power through an increase in the prices of household expenditure items (Ari et al., 2022). On the other hand, if these costs cannot be passed on to the final prices of the goods in question, there will be an indirect impact on

household purchasing power, as producers in the sectors concerned will cut wages or have lower profits to share.

For their part, in advanced economies that are large energy producers (e.g., Canada, Norway, the United Kingdom, and the United States), spillovers through energy producers' wages and profits are also important (Battistini, Di Nino, Dossche, & Kolndrekaj, 2022).

In all European countries, poorer households spend more on electricity as a percentage of total consumption than wealthier households. Thus, the direct impact of higher electricity prices is regressive[18]. In any case, on average Ari et al. (2022) estimated that households saw their costs increase by 7% due to the 2022 energy price increase. Poorer households also spend, on average, more on natural gas (relative to their total consumption) than more affluent households in most countries, with some exceptions such as Bulgaria, Hungary, Lithuania, and Romania (Ari et al., 2022).

As a consequence, it is critical to understand how energy prices are transmitted to households through global supply chains and how they are affected to design effective and equitable policies (Guan et al., 2023)[19]. However, and although not addressed in this paper, the context of the energy crisis and rising prices of other raw materials and food experienced in the same period should not be ignored, which has aggravated the situation of many households and businesses.

Before delving deeper into the households, it is helpful to categorise them, which can be done based on some indicators. In this case, we have selected the environment (rural vs. urban) and the average age and ownership of the dwellings (ownership vs. rental).

In Spain, in 2022, more than half of the population (54.5%) will be located in urban areas, compared to an average of 35-40% in Germany, France and Italy. Likewise, only 13.4% of the population lives in rural areas, in contrast to Germany (20.3%), France (33.6%) and Italy (18.6%). In turn, in Spain, 20.4% and in Italy, 20.1% were below 60% of the median equivalized income in the same year (Eurostat, 2024b). Next, household disposable income, average energy expenditure, consumer confidence and the population at risk of energy poverty are analysed.

[18] As will be explained in section 4.2.1., among the measures to address the impact of rising energy prices on households, there are subsidies for the purchase of energy.

[19] Numerous studies have analyzed the potential impact of the Russia-Ukraine conflict on the energy system, global food supply and the world economy. In terms of household losses, research has focused on rising household energy costs, energy insecurity and poverty caused by the crisis.

Table 4. Average age and ownership status of household dwellings (millions of homes)

	Germany	France	Italy	Spain
0-1945	4,20	4,08	3,15	1,56
1946-1969	5,90	2,73	2,35	1,64
1970-1979	3,32	2,91	2,2	1,43
1980-1989	2,39	2,94	2,1	1,48
1990-1999	2,49	1,86	1,64	1,57
2000-2010	1,69	2,87	1,65	2,08
2011-Present	1,05	1,91	1,58	0,53
Property Regime	Approximately 47% owned	Approximately 60% owned	Approximately 72% owned	Approximately 77% owned

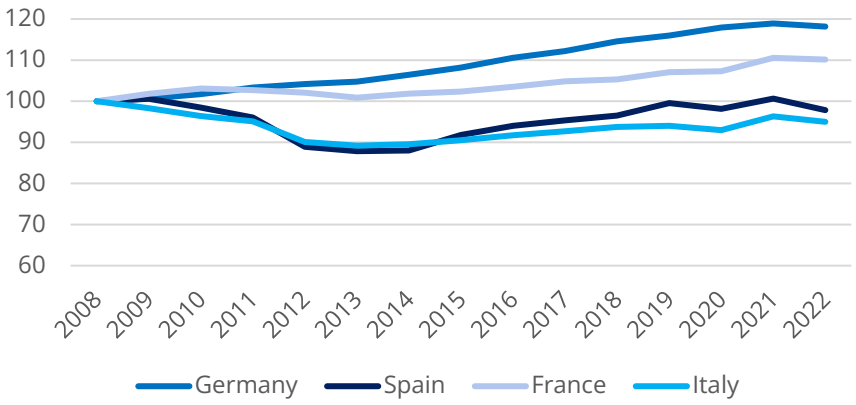
Source: Prepared by the authors based on the European Commission (2024).

As can be concluded from the data in the table on the average age of dwellings, Germany has the most aged housing stock of the four. 75% of the housing stock is older than 1990, compared to 65% and 66% in France and Italy, respectively. Spain has the youngest housing stock, 60% of the total being over 35 years old. In the case of the ACBC, according to Eustat data (2024b), the age of the housing stock is 47.1 years.

4.1.2.1. Household disposable income

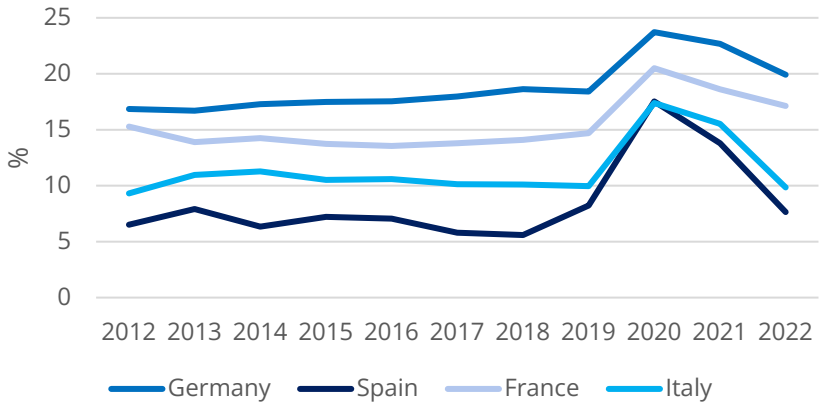
In 2020, household disposable income stagnated, except in Germany. With the improvement in health, household disposable income peaked in 2021, only to contract very slightly in 2022. In parallel, 2020 was accompanied by an increase in household savings, which in Spain and Italy stood at 17.5%, in France at 20.52% and in Germany almost 24% (i.e. almost one euro out of four). As time went by and the economy opened up, the savings rate fell back in all economies, so that in 2022, those territories for which data are available presented a similar level of savings to 2019, despite the increase in disposable income.

Chart 22. Index of the actual evolution of the adjusted gross household disposable income per capita, 2008-2022



Source: Prepared by the authors based on Eurostat (2023f).

Chart 23. Evolution of the Household Savings Rate



Source: Prepared by the authors based on Eurostat (2023g).

This evolution was accompanied by an increase in household indebtedness, which in Germany and France in 2021 was around 5% higher than in 2020, and in 2022 increased again by 4.3% and 5.0%, respectively. Italy's increased indebtedness stood at 3.8% and 3.0% in 2021 and 2022. In Spain, where indebtedness had declined since 2014, it increased by 0.6% in 2021 and remained unchanged in 2022 (+0.0%).

4.1.2.2. Average household energy expenditures

Household energy demand is inelastic in the short run, so price increases imply reductions in household purchasing power (Battistini, Di Nino, Dossche, & Kolndrekaj, 2022), which will be

absorbed through (i) lower consumption of non-energy goods and services, (ii) a reduction in savings or (iii) an increase in income.

Due to the unequal income distribution, higher energy prices could affect households differently. Thus, higher-income households make fewer adjustments in their spending on commodities since energy-sensitive spending represents a smaller percentage of their income. On the other hand, those households with fewer resources[20] spend a more significant percentage of their income on energy. As a result, they are particularly affected when energy prices rise (Battistini, Di Nino, Dossche, & Kolndrekaj, 2022).

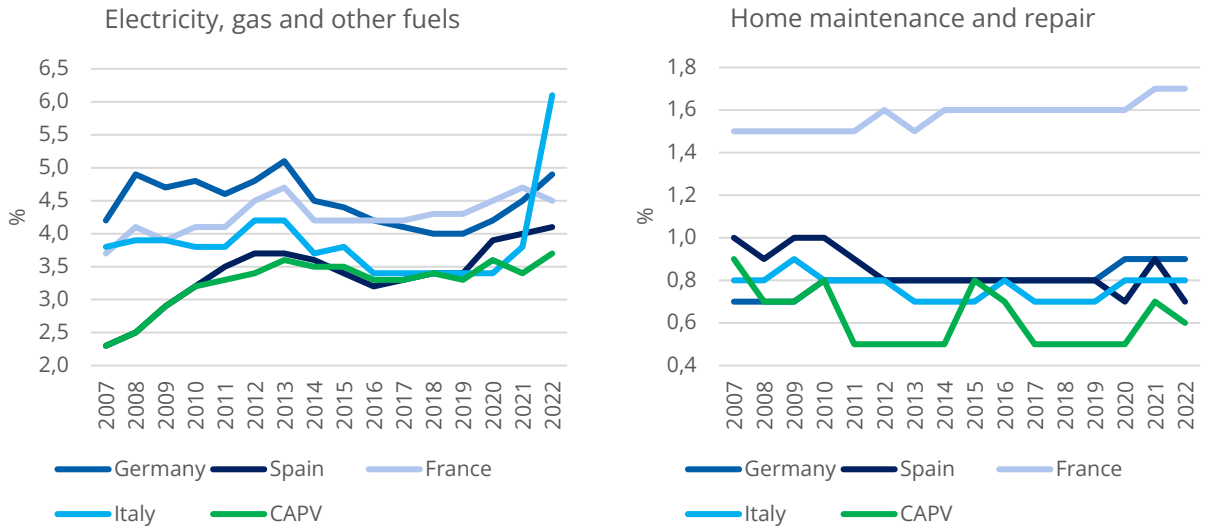
Although energy products only account for about 12% of the household consumption basket, the direct impact on aggregate price growth has been very considerable (Rodriguez Rodriguez, 2022). According to Guan et al. (2023) the recent energy crisis has pushed several economies into recession, causing inflation to rise and putting pressure on the cost of living of households worldwide.

Energy supply disruptions have weighed considerably on actual consumer spending in recent quarters. However, the various components of consumption were affected. The most significant impact was observed primarily on durable goods, to the extent that increased uncertainty due to energy price fluctuations would have pushed households to postpone irreversible purchases of durable goods (Bobasu & Gareis, 2022). This reaction in durable goods consumption in response to rising energy prices could be because households can use their stock of durable goods without an immediate impact on their welfare (Bobasu & Gareis, 2022).

The energy supply disruptions had a negligible negative impact on the consumption of services (i.e., transportation, communications, culture, etc.), meaning that this component increased after the reopening in spring 2022. With the exception of France, the rest of the countries saw an increase in the average expenditure per household on electricity, gas and other fuels. On the contrary, in Spain and the ACBC there was a reduction in spending on home maintenance and repair, which leads to the conclusion that energy saving and efficiency measures may be limited. In the rest of the countries, the level remained stable.

[20] There are wide disparities between countries. In emerging and developing economies, where the share of household budgets devoted to energy and food is already high, rising energy bills increased extreme poverty and slowed progress toward universal access to affordable energy services. Rising energy prices impacted vulnerable households and generated significant economic, social and political stresses, including within advanced economies (IEA, 2023g). In the case of electricity, in low-income countries, the increase in energy costs was lower than the global average because many households still lacked access to electricity. In upper-middle-income and lower-middle-income countries, the impact on electricity costs varied greatly from country to country. In fact, electricity bill changes in most high-income countries were below world levels because their electricity systems were less dependent on fossil fuels and therefore less affected by rising fuel prices.

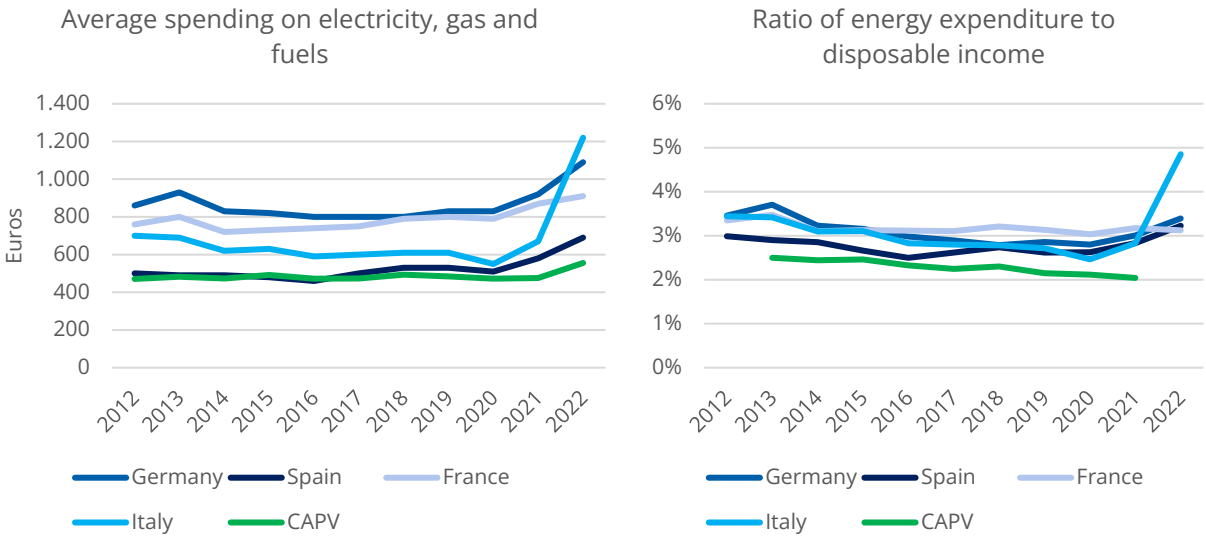
Chart 24. Evolution of average expenditure per household



Source: Prepared by the authors based on Eustat (2023c).

Although the data show that 2021 household energy expenditure increased in all territories, in France and the ACBC, the ratio of energy expenditure to disposable income did not grow. On the contrary, in Germany, Spain, and Italy, since 2020, the weight of energy expenditure in terms of total disposable income has increased. The most notable case is that of Italy.

Chart 25. Evolution of household energy expenditure and the ratio of household energy expenditure to household disposable income per person



Source: Prepared by the authors based on Eurostat (2023f) and Eurostat (2023c).

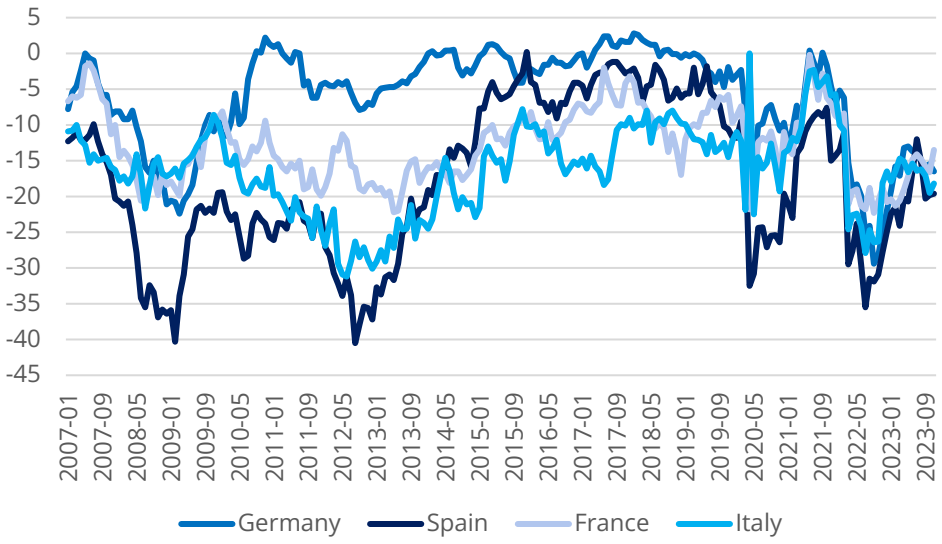
4.1.2.3. Consumer confidence and behaviour

Understanding the impact of a price increase on consumer behaviour is essential. Indeed, according to (Aguayo-Mendoza, Larrea Basterra, Casado-Mansilla, & Borges, 2023) consumers are capable of reducing energy consumption, the question is to know *how, when, where, how much and why energy is consumed throughout the day to know where to propose saving measures*. In addition, any fiscal, geopolitical, environmental, etc. change has consequences on such behaviour and, therefore, on energy consumption[21].

In this sense, the consumer confidence index, which is an indicator that tries to anticipate the behaviour of private consumption and provide information that facilitates its interpretation[22], shows that both the confinements derived from the pandemic and the beginning of the invasion of Ukraine have meant a setback in the confidence of the citizens of the four countries. Confidence fell to record lows during the summer of 2022 when energy prices were at record highs.

Spain is the country with the lowest level of consumer confidence, while Germany is the country with the highest.

Chart 26. Evolution of the adjusted consumer confidence indicator



Source: Prepared by the authors based on Eurostat (2023n).

[21] For more details on this subject, we recommend the reading of (Aguayo-Mendoza, Larrea Basterra, Casado-Mansilla, & Borges, 2023) and WHY Landing page: WHY H2020 Project (why-h2020.eu).

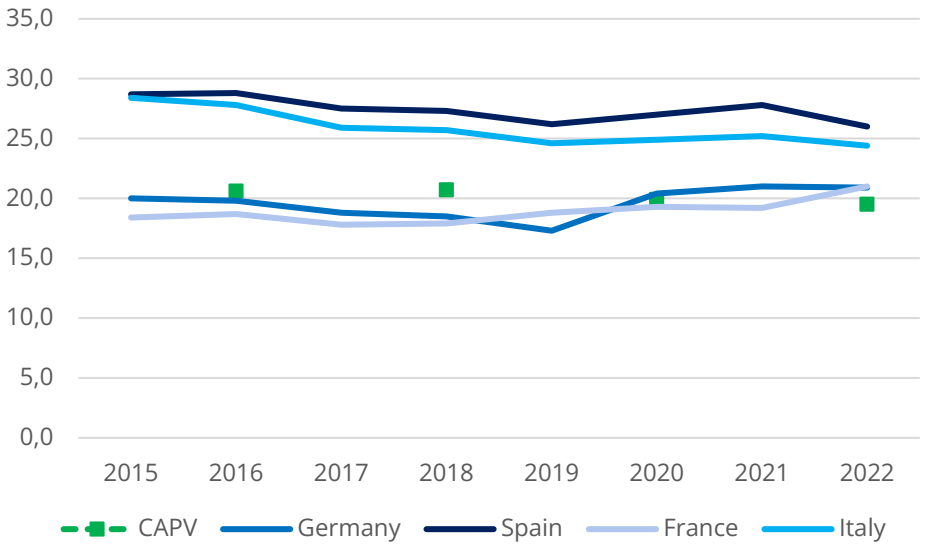
[22] According to the (INE, n.d.), the survey is constructed using the answers to a series of questions on *consumers' perceptions of both recent economic developments (6 months) and potential developments in the immediate future (6 months)*.

4.1.2.4. Population at risk of energy poverty

High energy prices and rising prices of other products and services are pushing the most vulnerable populations into energy poverty and even extreme poverty. Rising energy prices make households more vulnerable to energy poverty, especially during the cold season. People in fuel poverty do not have access to affordable energy services that allow them a decent standard of living, such as heating, cooling, lighting, and energy for appliances (Guan et al., 2023).

The data in the following chart shows that Spain is the territory where the poverty level was the highest in the period considered, with the ACBC being below France and Germany. France is the only country represented where the poverty level increased in 2022.

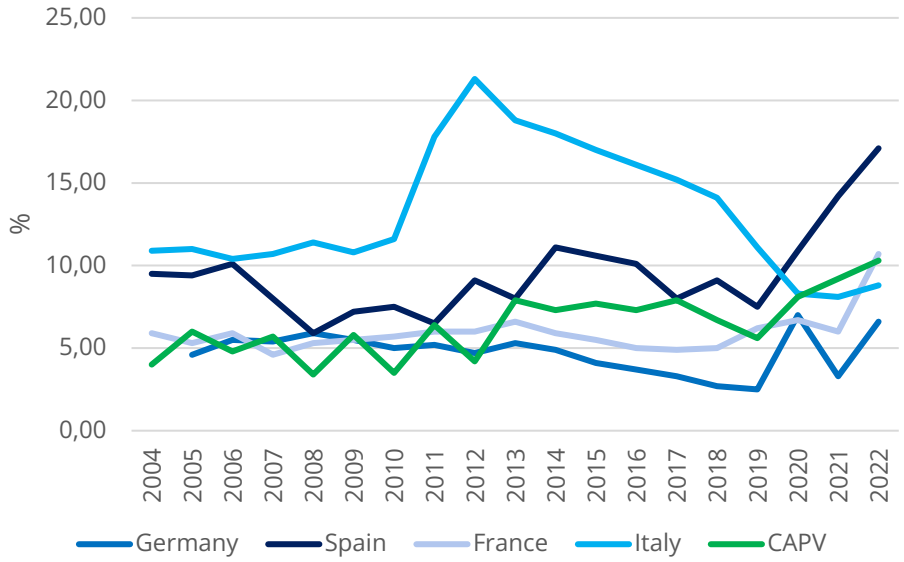
Chart 27. Population at risk of poverty and/or social exclusion (AROPE rate)



Note: The data for the ACBC is not available for all years, only for every two years; therefore, there is no line connecting the points.
Source: Prepared by the authors based on Eustat (2023i).

Although the AROPE rate shows no increase in the population at risk of poverty and/or social exclusion in terms of energy poverty, the following chart shows the evolution of the indicator of inability to keep the home adequately warm. In general, in 2022, there was an increase in the number of households with difficulties in keeping the house at an adequate temperature (which in the case of Spain went from 7.5% in 2020 to 17.1% in 2022, in France from 6.7% to 10.3% in the same period and the ACBC from 8.1% to 10.3%), which can be directly related to the increase in energy prices. In Germany and Italy, on the other hand, values remained relatively stable.

Chart 28. Households with the inability to keep the dwelling adequately warm



Source: Prepared by the authors based on Eurostat (2023e) e INE (2023).

4.1.3. Industry

Industry, categorised according to the codes of the National Classification of Economic Activities (CNAE), is an energy-consuming activity, where some sectors stand out for being energy-intensive compared to others that do not require such high consumption. Generally, the most energy-intensive sectors are those at risk of carbon leakage. These sectors are listed at four CNAE digits at the Community level in the Commission Decision of October 27, 2014, which determines, by Directive 2003/87/EC of the European Parliament and of the Council, the list of sectors and subsectors considered to be exposed to a significant risk of carbon leakage during the period 2015-2019.

These sectors include activities related to the extraction of fossil fuels, oil refining and coking, paper and pulp, wood, cement and glass, iron and steel and chemicals. In this regard, according to Hieminga & van Sante (2022) chemical companies, among others, have been directly affected by the increase in energy prices. The food, hotel, and catering industries were indirectly affected.

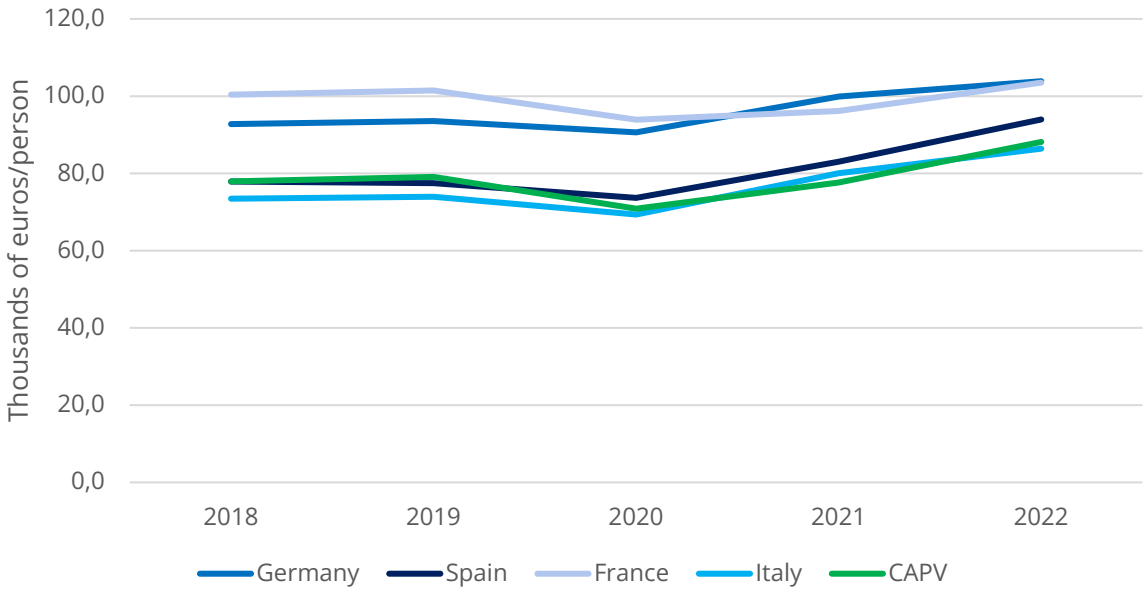
In Europe, some gas-intensive factories had to reduce their production because they could no longer afford to continue operating, while in China, others had their electricity supply completely cut off (IEA, 2023g).

Four variables that may have been affected by the evolution of energy prices are described below: (i) productivity, (ii) energy efficiency, (iii) corporate profitability and (iv) industrial competitiveness, measured as the capacity to pass on the increase in energy prices to the final prices of the products of each sector.

4.1.3.1. Industry labor productivity

In the industrial sphere, productivity, estimated as the quotient between the gross value added of industry and jobs, has been improving for some time in the compared territories. However, Spanish productivity and that of the ACBC remain, together with that of Italy, below that of France and Germany. In 2021 and 2022, industrial labour productivity, as seen in the following chart, responded to the rise in energy prices with an increase to favour industrial competitiveness.

Chart 29. Industrial productivity per person



Source: Prepared by the authors based on Eurostat (2023h), Eustat (2023j), Eurostat (2023i), Eustat (2023l).

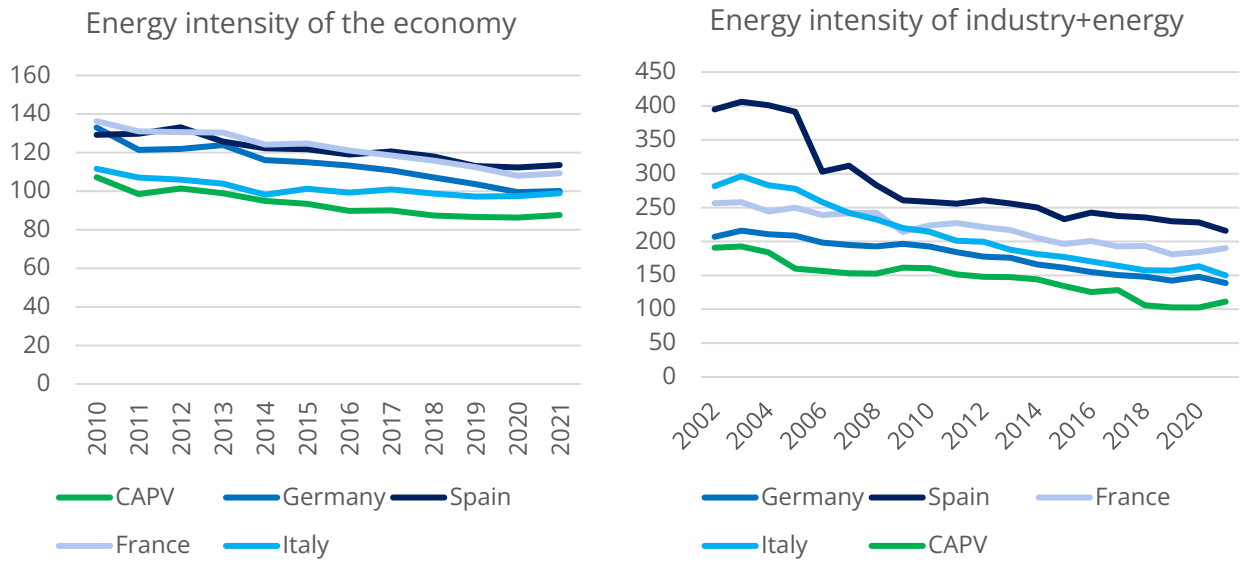
According to estimates made in (Orkestra, 2023) the apparent productivity of labour in the manufacturing sector in Spain was slightly below that of the ACBC and, in recent years, has increased considerably, reaching very similar levels.

4.1.3.2. Energy intensity

The intensity of the economy and industry has improved over the last decades. So has the energy intensity of industry (where energy generation activity is included and measured as the ratio between gross domestic energy consumption and GDP in chained volumes), where it has been seen to be a relevant element in improving competitiveness. In the case of the energy intensity of industry, this worsened in 2021 in Italy and the ACBC. However, in the latter case, a clear improvement is observed in 2022, with a value of 90.8 compared to 111.2 in the previous year and 102.5 in 2020 and 2019.

The energy intensity of the economy and industry in the ACBC was particularly low compared to the rest of the territories.

Chart 30. Evolution of energy intensity



Note: Energy intensity is estimated as the ratio of gross domestic energy consumption to GDP.
Source: Prepared by the authors based on EVE (2023), Eustat (2023k), Eurostat (2023o), Eurostat (2023d), Eustat (2023f).

4.1.3.3. Corporate profitability

According to Bank for the Accounts of Companies Harmonized (BACH) (2023), energy crises have profound implications on companies' financial health and operating performance. These situations often result in higher operating costs, which can reduce profit margins if not passed on to consumers. In addition, the unpredictability of energy prices can hamper companies' ability to forecast costs, leading to uncertainty in investment decisions and strategic planning.

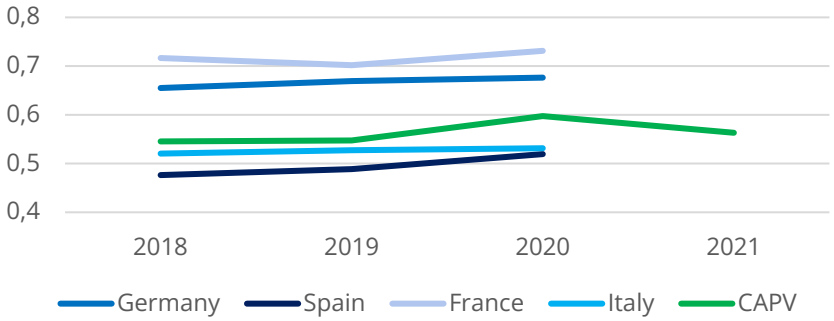
Indeed, the theoretical impact of higher energy prices on the profit margin of large companies would have been considerable. According to Bhimji, Burgering, de Barros Fritz, Beaumont, & Kounis (2022) given the demand and persistence of cost increases, a margin contraction was foreseeable. However, by 2021, energy-intensive companies will have been able to pass on their higher costs to their customers.

(BACH) (2023) conducted an exercise to project the profitability components of corporate balance sheets in 2022. This exercise, which considered the evolution of energy prices and inflation, suggests a stable evolution of corporate profitability. In addition, it highlighted that the extent to which companies can retain a higher share of profits depends primarily on wage dynamics and whether wages ultimately catch up with inflation. This analysis showed an overall negative correlation between energy price increases and corporate profitability indicators over 2011-2021 and a positive correlation between price increases and corporate costs in all countries.

Orkestra (2023) uses, among others, the unit labor cost (ULC) as an indicator of business profitability, which measures the impact of labor costs on company profitability or the

percentage of company income used to hire the labor factor. It is estimated as the quotient between labour cost per employee and labour productivity. When this indicator is reduced, it is positive since workers' productivity offsets the cost per employee and, as a result, makes it possible to maintain competitiveness. The following chart shows its evolution up to 2020, except in the case of the ACBC, where a recovery was observed in 2021 compared to 2020.

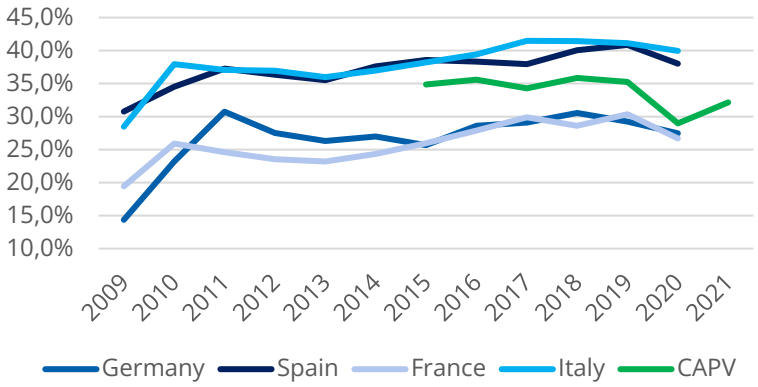
Chart 31. Evolution of unit labour cost in the industry



Source: Prepared by the authors based on Eustat (2023h) y Eurostat (2023b).

To complete the analysis of corporate profitability, the ratio of gross operating surplus to gross value added (GVA) of the sector, in this case, the industrial sector, is used as an indicator. The higher the ratio, the more favourable it is. The gross operating surplus *is generated by operating activities once the labour factor (specifically employees) has been rewarded.* (Orkestra, 2023). It allows us to know the return to capital in total income, although the income of self-employed workers and depreciations are included. As a result of the pandemic, this ratio fell in the industrial sector, having recovered in 2021 for the ACBC.

Chart 32. Evolution of the gross operating surplus/GAV ratio of the industrial sector

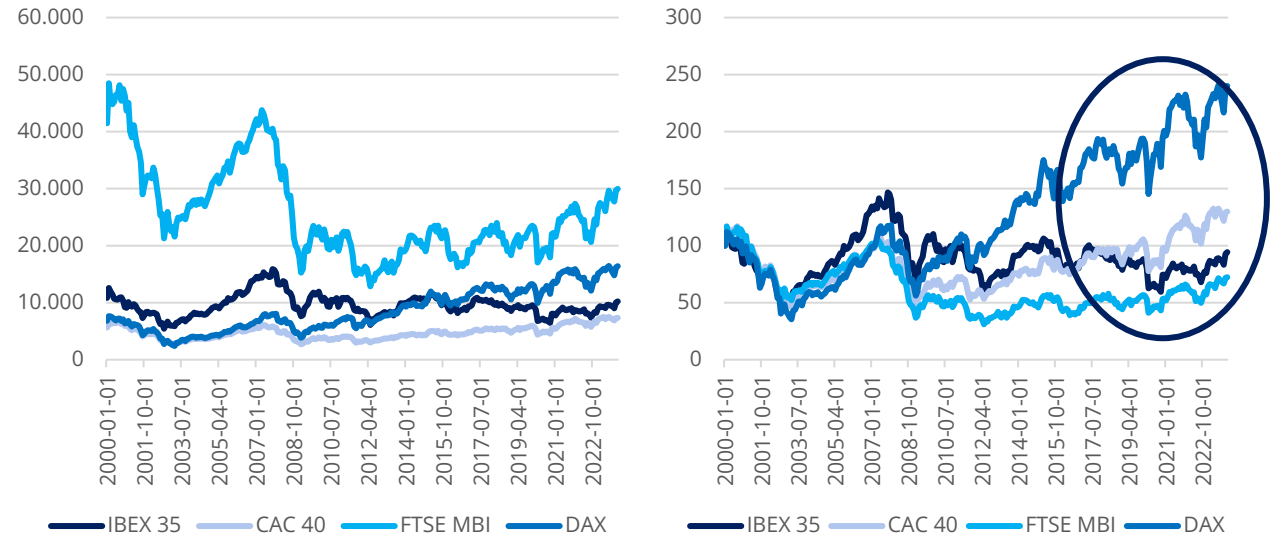


Source: Prepared by the authors based on Eustat (2023h), Eurostat (2023b), Eustat (2023j), Eurostat (2023h).

The share price performance of the leading stock market indexes has shown all kinds of incidences since 2020, but with an underlying upward trend, as seen below. March 2020 and September 2022 saw significant indices decline, with a subsequent recovery. The primary recoveries were seen in November 2020 and, most recently, in November 2023. The four indices have replicated the same patterns of evolution and variability.

It is noteworthy that in the complex context of the last four years and despite rising energy prices, the stock market indexes have performed positively.

Chart 33. Evolution of the share price of the leading stock market indexes and its index



Source: own elaboration based on investing.com.

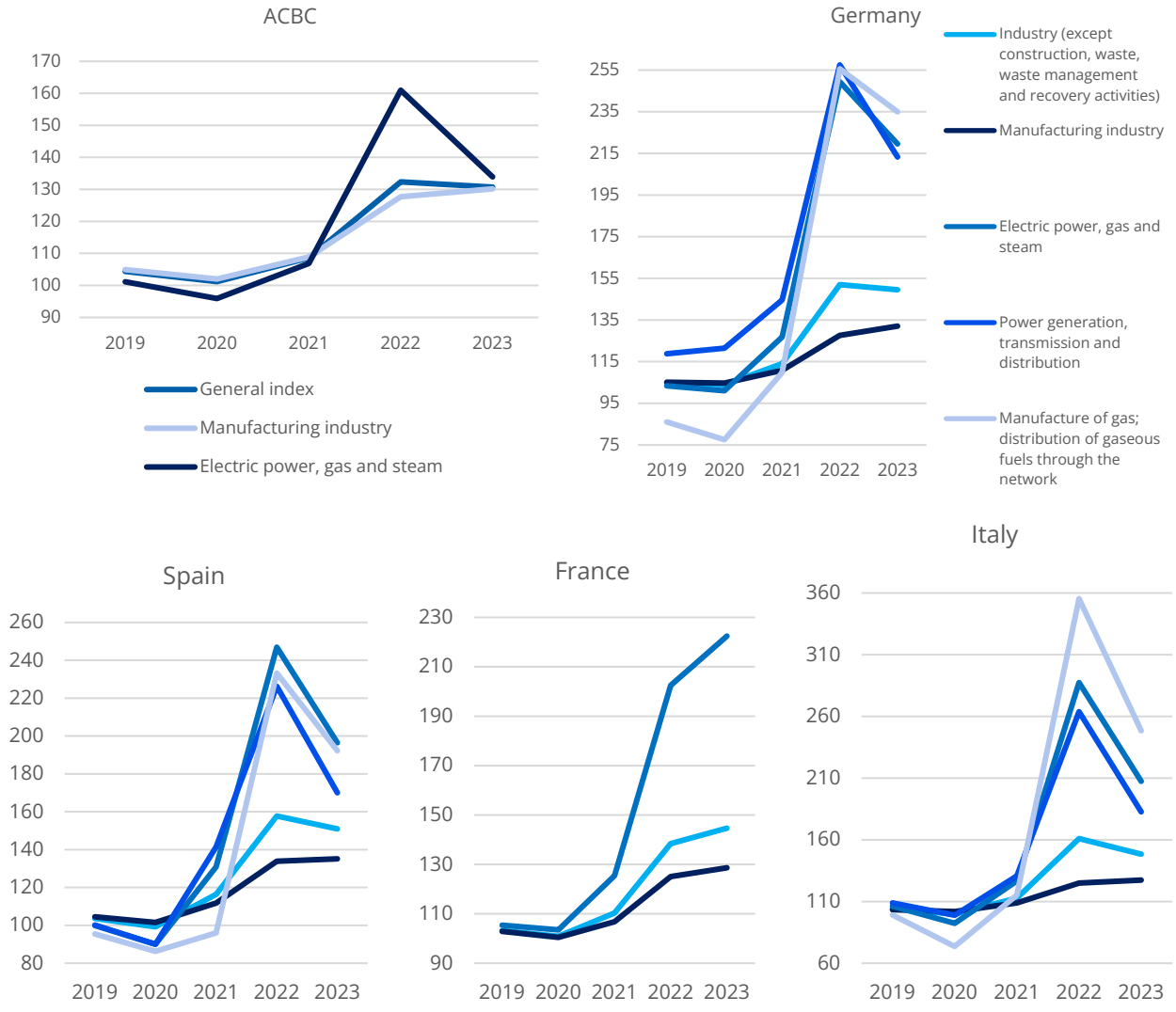
4.1.3.4. Industrial Competitiveness

Energy-intensive companies pass higher energy prices to their customers to a greater or lesser extent, depending on their possibilities[23]. As a result, customers, including households, also face higher costs. As a result, manufacturing energy-intensive products could become unprofitable due to higher energy prices. Producers could eventually reduce production levels, leading to temporary shortages upstream in the supply chain (Hieminga & van Sante, 2022). This high price situation hurts the profitability of companies, more so as they operate in smaller/local markets such as the cement and building materials industry (Hieminga & van Sante, 2022).

[23] For more detail on the relationship of energy prices and industrial competitiveness we recommend reading Álvarez Pelegry, et al. (2016) and Díaz Mendoza, et al. (2016).

As seen below, in all territories in 2021, the price levels of energy products increased. In 2022, this trend continued to reach very high levels. In 2023, prices changed their trend, decreasing to different extents. Notably, in France, prices continued to rise in 2023 due to a combination of factors, including the shutdown of about half of the nuclear reactors (some due to necessity and others due to technical shutdown), the drought and consequent reduced hydro production, and the dependence on imported electricity from Germany, the United Kingdom and Spain (Bettinelli & Longueville, 2023). In addition, during the year, they experienced two price increases of 10% and 15%, respectively, in February and August (Pécout, 2023)[24].

Chart 34. Evolution of the sectoral industrial price index (Base year = 2015)



Note 1: Data for 2023 includes up to October.

[24] These increases affected both domestic and industrial consumers.

Source: Prepared by the authors based on Eustat (2023e) y Eurostat (2023l).

Although, as observed, the price of the products of the different industrial branches increased in 2021, 2022 and 2023[25], with a peak especially in 2022, the increase in energy prices (electricity and gas in general) has been higher than that of the products. In other words, the results show that the companies that make up the different sectors have not been able to pass these increases to the same extent to their customers, so they have had to absorb part of the increase. This has been replicated in all countries, although it is particularly noteworthy for Spain, the ACBC and Italy.

It should be noted that, in this context, countries have adopted price reduction or support schemes for industries to compensate for rising energy costs, for example, reduction of tolls and charges, subsidies, compensation for CO_2 costs, etc., which have mitigated part of the increase in the cost perceived by companies. On the other hand, the weight of energy costs is specific to each production sector. Except in those processes that are very intensive in energy consumption, the relative weight of energy in the value of the final product is low.

In this sense, the results of the following chart[26] show that, despite bearing a high burden in terms of energy consumption, some of the more energy-intensive sectors have been relatively less affected. That is sectors such as coking and oil refining and metallurgy, together with wood, paper and chemicals, have been less affected than others such as vehicle manufacturing, pharmaceuticals, textiles, clothing, leather and footwear.

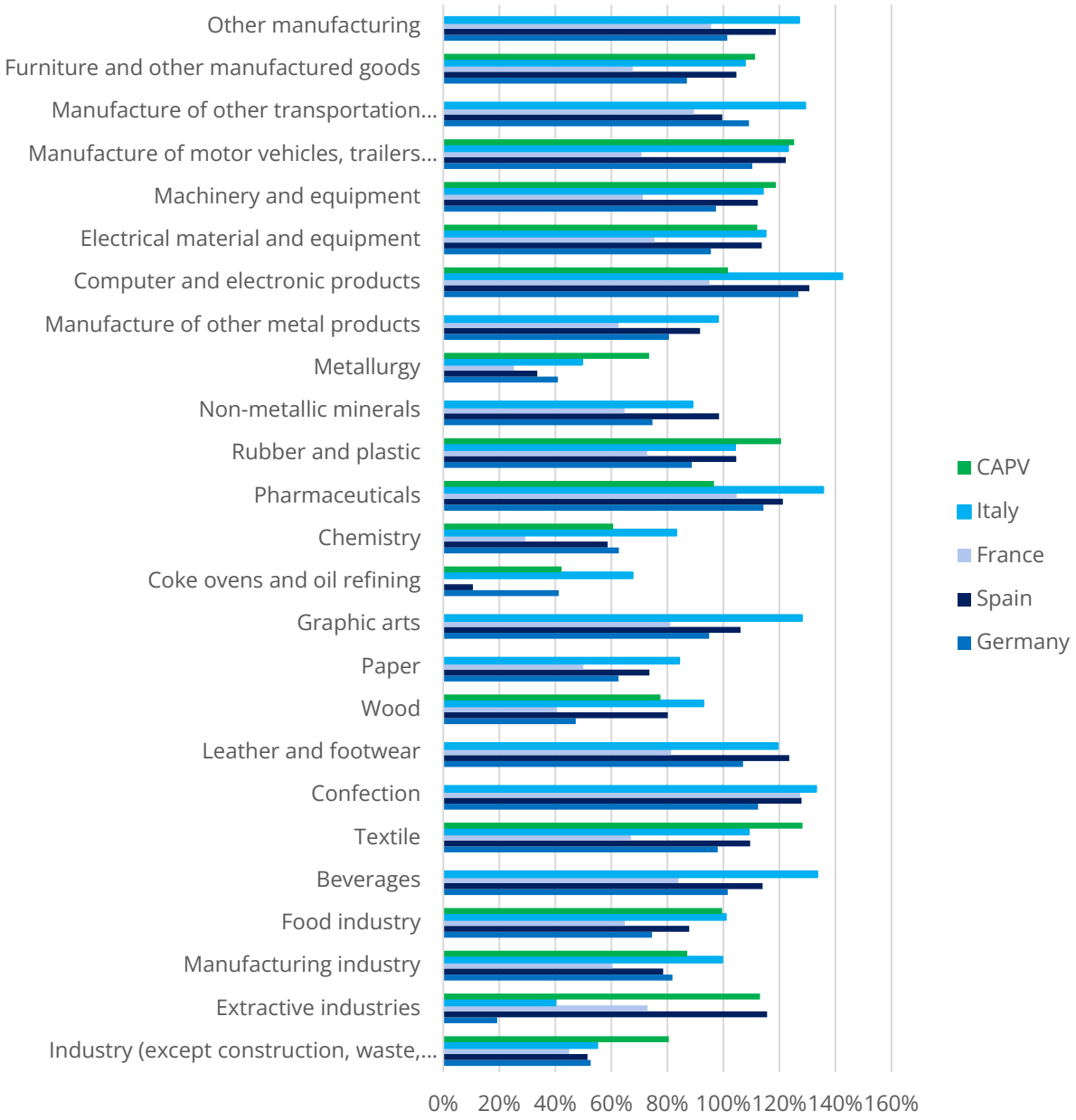
This could be because these sectors have received, as just mentioned, some support in the face of this scenario and/or have been able to develop greater resilience to this type of event than other sectors that have traditionally been less affected. In other words, due to the relevance of energy as a productive factor for their processes, they have more significant experience in risk management. Likewise, there may be issues related to product margin management. It could also be aligned with these energy-intensive sectors' capacity to pass on energy price increases to their final products. In any case, there is no sector where the increase has not been higher than double digits. Considering the level of consumption of specific intensive sectors, this context has placed them in a complex situation.

The conclusions drawn from the following chart align with the inflation data and household indicators' evolution since many of the most severely affected industries are related to final consumer products (food and beverages or clothing and textiles). Likewise, the increase in the price of intermediate products impacts final consumer products.

[25] For further details see Annex IV.

[26] Prepared according to the methodology presented in Día Mendoza, et al. (2016). Crossing energy cost data with product prices can show to what extent the industry has been able to compensate an eventual increase in energy prices with an increase in the prices of its own products.

Chart 35. Comparison of the increase in energy prices over the increase in product prices by industrial sector and territory (2022)



Source: Prepared by the authors based on Eustat (2023e) y Eurostat (2023l).

4.2. Instruments

4.2.1. Regulation/policies adopted in the period 2020-2023 in the energy field

Governments responded to the rise in energy prices with a wide variety of measures[27] fiscal and non-fiscal measures established based on rules and regulatory frameworks[28], which may differ in their temporary or permanent nature, in their amount, in their impact on agents' incomes or product prices, and in their degree of targeting the most vulnerable groups (García-Miralles, 2023).

Most of the measures introduced in high-income countries were non-fiscal measures (although these were also used), such as subsidies, transfers or other regulatory interventions. In many cases, the differences in the approaches adopted were probably due to the existence of more developed transfer and benefit systems in high-income countries, which tend to be better equipped to target support to "at-risk" populations (OECD, 2022).

Indeed, the government's capacity to respond to the crisis differs, as does their capacity to finance measures. For example, Germany and France have placed the burden of their measures on the national budget. However, Spain has shared the cost of the measures among all consumers (for example, the Iberian exception) or has created new taxes that hinder investment and the profitability of companies.

Temporary reductions in indirect taxes were the countries' most common form of tax measure. Reductions in environment-related taxes, especially excise taxes on petroleum products, were the most frequent measures to cushion the impact of higher prices, followed by reductions in VAT on petroleum products and reduction of import duties (OECD, 2022). Direct consumption subsidies (as in the case of Spain with 20 euro cents/litre) or the artificial reduction of regulated tariffs such as gas can also be pointed out.

According to (OECD, 2022) excise taxes were reduced in 73 of the 89 jurisdictions analysed, mainly for petroleum products. VAT reductions on energy products were also a standard policy response, mainly in European countries and most frequently for electricity and natural gas products. Several countries offered additional incentives to save energy. Several European countries also announced plans to tax companies' windfall profits to defray the cost of the measures they introduced.

[27] This section does not quantify either the amounts required to adopt the measures or the resulting economic benefits, given the complexity of such a task, which is not the objective of this work. However, some data that have been explicitly mentioned in the documents reviewed are included in this section.

[28] More details on energy and environmental policy measures or instruments can be found in Goulder & Parry (2008). They distinguish between incentive-based instruments (such as subsidies, emission taxes or trading systems) and direct regulation (including technology mandates or performance standards among others). Similarly, Navarro Arancegui (2024) describes and classifies environmental policies advocated for green growth. In his case he classifies the measures into four major groups: economic incentives, regulation, technology policy and the rest of the measures that address other market failures.

In parallel, the European Council adopted Regulation (EU) 2022/1854 of 6 October 2022 on emergency intervention to deal with high energy prices. This Regulation included in Article 14 the creation of a temporary solidarity contribution to support final energy customers for surplus profits generated by Union companies and permanent establishments operating in the crude oil, natural gas, coal and refining sectors.

Rising fossil fuel prices have generated windfall profits for some energy producers, while others have recorded losses (Ari et al., 2022). Taxing these profits may be an option in some cases, but careful design is key to avoid unintended consequences. Thus, taxes must preserve investment incentives. Specifically, according to the International Monetary Fund study, they should only be applied to profits, allowing producers to recover their operating costs, earn a reasonable return on fixed investments, and retain a share of surplus profits (Ari et al., 2022).

At the Community level, although the Member States have ceded many powers and competencies to the EU, this has not been the case with energy policy in general and the electricity sector in particular. This is due, to a certain extent, to the strategic nature of energy in general and of electricity in particular, to its influence on the well-being of the population, on the economy and the competitiveness of a territory (Ariño Ortiz, del Guayo Castiella, & Robinson, 2020). Indeed, high energy prices impact the most disadvantaged population and industrial competitiveness, especially in the electro-intensive industry.

According to Sgaravatti et al. (2023), the governments of Germany, the United Kingdom, France, Italy, Spain and the Netherlands were, in that order, the ones that designated and allocated the most significant volume of funds, in absolute terms, to protect households and companies from the energy crisis. The most used instruments were reducing energy taxes and VAT, regulating retail prices, transferring to vulnerable groups and creating a windfall profits tax. To a lesser extent, business support was granted, and practically no new regulations or interventions in the wholesale market were implemented.

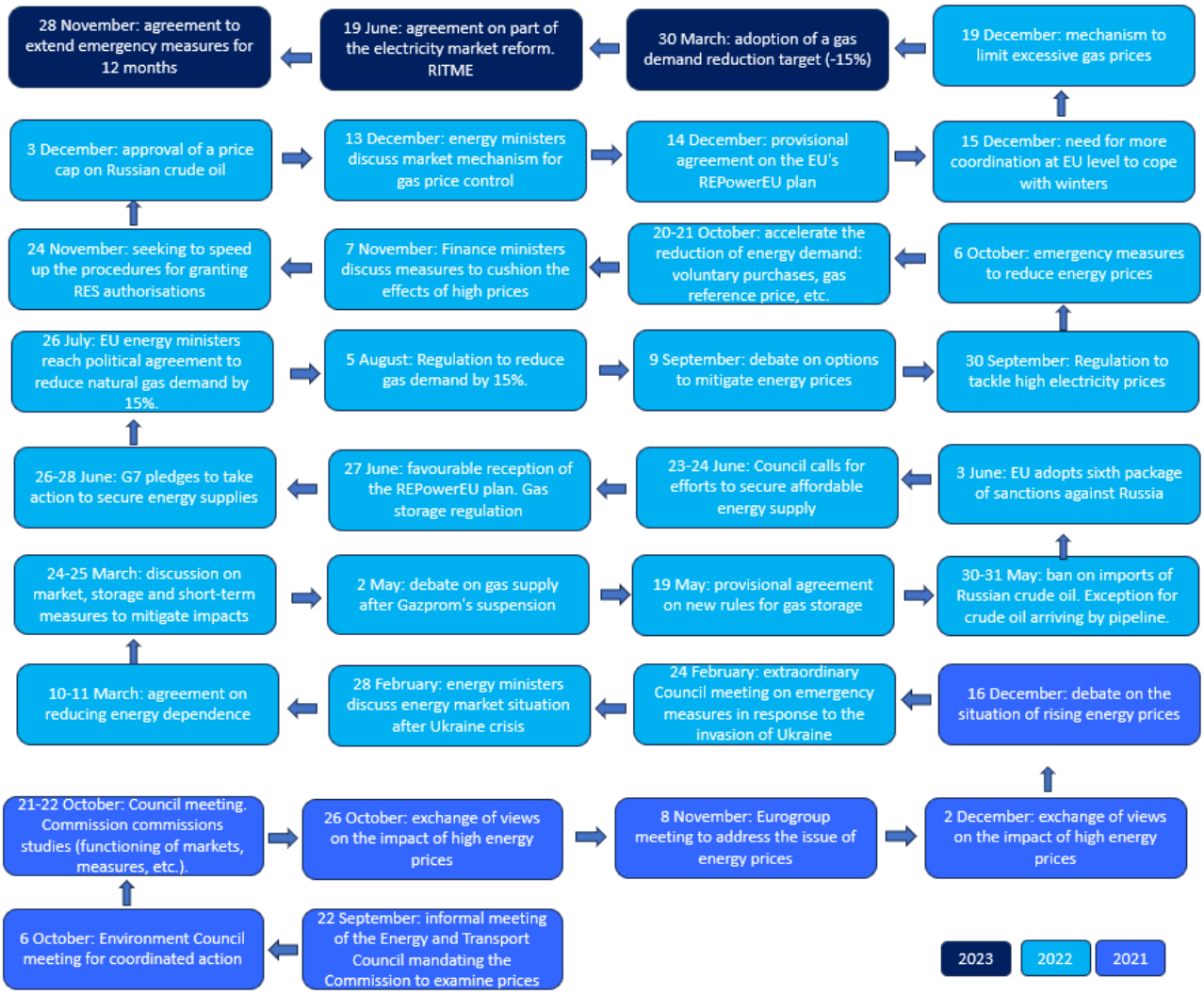
Despite the above, due to the recent energy price crisis, numerous measures have been adopted and promoted at the Community level, given that the problem was not of a state nature but affected all Member States to a greater or lesser extent.

Similarly, measures have also been taken at the national level, some of them stemming from the options put forward at the EU and regional levels. While regional policies can considerably impact consumers, in most EU countries, energy regulation and taxation are set at the national level. Similarly, long-term measures to counteract energy price volatility are paramount (Sgaravatti et al., 2023). The following presents the most relevant ones without categorising them according to any previous classification. In this case, they are presented chronologically and emphasise those measures directly related to energy prices and not necessarily to other measures that may have been adopted to cushion or mitigate the overall impact (e.g., the reduction of VAT on the most basic foodstuffs). However, it is worth mentioning that all the measures adopted are interrelated.

4.2.1.1. At the community level[29]

Between 2021 and 2023, the EU adopted measures to address high energy and electricity prices in general. The following figure lists the deliberations, meetings, etc., where the issue of rising energy prices has been discussed chronologically.

Figure 3. **Central meetings and agreements at the EU level regarding the crisis caused by the increase in energy prices**



Source: own elaboration.

[29] Part of the information in this section comes from (European Council, 2023).

2021

On September 22, 2021, after a summer of rising energy prices, energy ministers met and asked the Commission to study what was happening. On October 6, the Environment Ministers stressed the need for coordinated action to protect vulnerable households.

A few days later (10/16/2021), the Commission published the Communication "*Tackling rising energy prices: a toolbox for action and support*", which included measures that countries could implement to mitigate the effect of the increase in energy prices occurring since the summer. This Communication included short- and medium-term measures, which are shown in the following table.

Table 5. Communication Measures *a toolbox for action and support*

Deadline	Detail of measurements
Short-term measures	- Emergency support for energy-poverty consumers, e.g., through vouchers or partial bill payments, can be financed from EU Emissions Trading Scheme (EU ETS) revenues. - Authorize temporary deferrals of payment of invoices. - Establish safeguards to avoid supply cuts. - Provide for temporary and selective reductions in tax rates for vulnerable households. - Providing aid to companies or industries by EU state aid rules. - Intensify international energy contacts to ensure market transparency, liquidity and flexibility. - Investigate possible anti-competitive behaviour in the energy market and ask the European Securities and Markets Authority (ESMA) to improve the monitoring of the evolution of the carbon market. - Facilitate wider access to renewable energy purchase agreements and support them with accompanying measures.
Medium-term measures	- Intensify investments in renewables, renovations and energy efficiency, and accelerate renewable energy auctions and permitting processes. - Promote energy storage capacity, including batteries and hydrogen. - Ask European regulators (ACER) to study the advantages and disadvantages of the current electricity market configuration and propose recommendations to the Commission. - Consider revising the security of supply regulations to ensure better use and operation of gas storage in Europe. - Study the possible advantages of the Member States' voluntary joint purchasing of gas reserves. - Create new cross-border regional gas risk groups to analyse risks and advise Member States on formulating national prevention and emergency action plans. - Boost the role of consumers in the energy market, empowering them to choose and switch suppliers, generate their electricity and join energy communities.

Source: Prepared by the authors based on European Commission (2021).

Also, in October (21-22), EU leaders again addressed the issue of energy prices. They invited the Commission to study the functioning of the gas and electricity markets and the EU Emissions Trading Scheme (EU ETS). They called on Member States and the Commission to urgently make the best possible use of the Commission's measures to support the most vulnerable European consumers and businesses. They called on the Commission and the Council to urgently consider medium- and long-term measures for the affordability and security of energy supply.

They instructed the European Investment Bank to accelerate investment in the energy transition.

On October 26, the Council of Energy Ministers addressed rising energy prices and discussed possible medium- and long-term options, such as reform of the wholesale electricity market, voluntary gas pooling schemes and EU-wide storage solutions.

On November 8, the Eurogroup discussed energy prices as part of its deliberations on macroeconomic developments in general. In December (December 2), ministers discussed rising energy prices and possible containment measures at the national and EU levels, and on December 16, the European Council discussed rising energy prices.

2022

As early as 2022, with the Russian invasion of Ukraine on February 24, EU leaders called for emergency energy measures. Four days later, energy ministers discussed the energy market situation during the Ukraine crisis. They initially considered that the EU was not at immediate risk, even disrupting Russian gas supplies. Despite this, the need for contingency measures was raised to secure supply, optimise stock management, improve coordination between member states, and options to limit energy prices' impact on households and industries.

On March 8, the Commission launched the REPowerEU Communication, whose main objective is to reduce dependence on Russian fossil fuels. The REPowerEU Plan was subsequently published on May 18, with three pillars: (i) increased diversification, alternative suppliers; (ii) reduction of energy demand; and (iii) an important part of measures to accelerate the decarbonisation of the economy. All this with the support of EU financial instruments.

On March 10-11, EU leaders agreed to reduce energy dependence and ensure the energy supply's security, considering the situation in Ukraine and the objective of climate neutrality by 2050. They also asked the Commission to present, by the end of March 2022, a plan to ensure the security of supply and affordable energy prices. They also intended to discuss options to address the consequences of rising energy prices for citizens and businesses, especially for vulnerable citizens and SMEs.

On March 24-25, EU leaders discussed measures to mitigate the impact of energy prices and secure energy supply, market-related measures, gas storage and common fuel purchasing, and short-term measures to mitigate the effects on citizens and businesses.

On May 1, Member States agreed on a negotiating mandate for the gas storage proposal. On May 2, the Energy Ministers held an extraordinary session to discuss gas supplies following the suspension of Gazprom's supply. On May 18, the Commission's Communication with the REPowerEU Plan was published, the content of which is explained below.

Table 6. Measures contained in the REPowerEU Plan

Category	Detail of measurements
Energy savings	- Improved long-term energy efficiency measures, including an increase from 9% to 13% of the binding energy efficiency target under the "Target 55" package. - Communication on energy saving in the EU. - Targeted communication campaigns aimed at households and industry. - Use fiscal measures to encourage energy savings, such as reduced VAT rates for energy-efficient heating systems, building insulation, and appliances and products. - Precautionary measures in case of serious supply interruption. - Coordinated demand reduction plan in the EU.
Diversification of supplies and support to international partners	- Diversify supplies (LNG imports and increased pipeline gas deliveries). - Creation of a European Platform for Energy Sourcing - Study legislative measures for the diversification of gas supply over time by Member States. The Platform will also enable joint procurement of renewable hydrogen. - Adoption of the EU External Energy Strategy (same day) for energy diversification and the creation of long-term partnerships with suppliers, including cooperation on hydrogen or other green technologies. Intensification of energy diplomacy. - Collaboration with Ukraine (REPowerUkraine initiative).
Deployment of renewable energies	- Acceleration of renewables in electricity production, industry, buildings and transportation. - The Commission proposes to increase the 2030 headline target for renewable energy from 40% to 45% as part of the "Target 55" package. - A specific EU Solar Energy Strategy to double solar PV capacity by 2025 and install 600 GW by 2030. - Rooftop solar initiative: legal obligation to install solar panels on new public commercial and residential buildings. - Doubling the rate of heat pump deployment and measures to integrate geothermal and solar thermal energy into retrofitted district and community heating systems. - Commission recommendation addresses the slowness and complexity of permitting for large renewable energy projects. - Member States should establish specific zones for renewable energies, with abbreviated and simplified authorisation processes in areas with lower environmental risks. - Making available datasets on environmentally sensitive areas as part of its digital mapping tool for geographic data related to energy, industry and infrastructure. - Target of 10 million tons of domestic renewable hydrogen production and 10 million tons of imports by 2030. - 200 million for hydrogen research. - Biomethane Action Plan. New Biomethane Industrial Alliance and financial incentives to increase production to 35 million cubic meters by 2030 from the Common Agricultural Policy (CAP).
Reduction of fossil fuel consumption in industry and transportation	- Substituting coal, oil, and natural gas in industrial processes. - Energy savings, efficiency, fuel substitution, electrification and increased industry uptake of renewable hydrogen, biogas and biomethane could save up to 35 million cubic meters of natural gas by 2030. - Carbon contracts for differences. - Guidance on power purchase agreements and renewable energy. - A technical advisory mechanism will be established with the European Investment Bank. - The Commission will intensify work on the supply of key raw materials and prepare a legislative proposal. - The Commission will present a package of measures on the greening of freight transport. - It will consider a legislative initiative to increase the percentage of zero-emission vehicles in public and corporate vehicle fleets above a specific size. - The EU Communication on Energy Saving includes numerous recommendations for cities, regions, and national authorities.

Category	Detail of measurements
Intelligent investment	- Additional investment of 210 billion euros by 2027. - To support the REPowerEU Plan: EUR 225 billion in loans under the Recovery and Resilience Mechanism (RRM). - The Commission proposes to increase the financial envelope of the MRR with €20 billion in grants from the sale of EU ETS allowances. - Decarbonization and ecological transition projects with a maximum of 100 billion euros investment in renewable energy, hydrogen, and infrastructure. - An additional EUR 26.9 billion from cohesion funds in voluntary transfers to the MRRF. - 7.5 billion euros from the CAP. - The Commission will double the funding for the 2022 Innovation Fund's large-scale call to around €3 billion. - Limited additional gas infrastructure, estimated at €10 billion of investment, to complement the existing list of projects of common interest (PCI) and fully compensate for the future loss of Russian gas imports.

Source: Prepared by the authors based on European Commission (2022).

On May 19, a proposal for a regulation was presented to ensure that gas storage capacities in the EU would be covered before winter.

At the May 30-31 meeting, EU leaders reached an agreement on the Russian oil ban and priorities for strengthening the EU's energy independence and called for further diversification of supply sources and routes, accelerated development of renewable energies, progress in energy efficiency; and improved interconnection of European gas and electricity grids through investment in infrastructure.

On June 3, the EU adopted the sixth package of sanctions against Russia (European Commission, 2023), which entailed a ban on the purchase of oil and certain petroleum products and their import from Russia. The phase-out of Russian oil would take six and eight months for oil derivatives[30].

On June 23-24, the European Council called for efforts to secure energy supplies at affordable prices. EU leaders considered introducing temporary price caps where appropriate.

On June 27, energy ministers welcomed the REPowerEU plan. The Council adopted the Regulation on Gas Storage (Regulation (EU) 2022/1032 of the European Parliament and of the Council on 29 June 2022, amending Regulations (EU) 2017/1938 and (EC) No. 715/2009 about gas storage), which aimed to ensure that gas storage capacities in the EU would be covered before the winter and shared among member states. The Regulation established that subway gas storage facilities located on the territory of the Member States were to be filled to at least 80% of their capacity before the beginning of the winter of 2022-2023 and to 90% before the

[30] Over the past few months, 11 sanctions packages have been adopted. They contain energy-related issues in addition to the sixth package: the second, fourth, fifth (coal-related), eighth (coal-related and related to the implementation of the G7 oil price cap), ninth (Additional economic measures against the Russian energy and mining sectors), tenth (with import bans on high-income Russian goods: bitumen and related materials such as asphalt; synthetic rubber and carbon blacks), and eleventh (European Commission, 2023). The twelfth sanctions package was adopted in December 2023.

beginning of the following winters. Overall, the Union was to strive to reach a filling level of 85% of the total subway gas storage capacity by 2022.

On June 26-28, G7 leaders[31] pledged to take immediate steps to secure energy supplies and reduce rising prices. They reaffirmed their willingness to relinquish their dependence on Russian energy without compromising climate and environmental goals.

On July 20, the Regulation concerning adopting coordinated measures for gas demand reduction *("Save gas for a safe Winter")* was presented, which seeks to reduce gas demand by 15% between August 1, 2022 and March 31, 2023. In October, each country was to submit its reduction plan. The new regulation would also allow the Commission to declare a "Union alert" on the security of supply and impose a mandatory reduction in gas demand on all Member States. (European Council, 2022). On July 26, Member States committed to **reducing** gas demand by 15% next winter, and on August 5, the Council adopted the Regulation on reducing gas demand by 15%[32].

In September, as the situation did not improve, the ministers discussed options to mitigate energy prices and reviewed progress in winter preparation. On September 14, the Commission proposed an emergency intervention with three tools: a target of reducing overall electricity demand by at least 10% (5% mandatory at peak times), limiting revenues from "infra-marginal" energies, and a solidarity contribution from fossil fuel companies.

On September 30, the Council agreed on a proposal for a Council Regulation on emergency measures to reduce energy prices, which introduced standard measures to reduce energy prices and redistribute surplus revenues from the sector to final customers. They consisted of reducing electricity consumption, limiting the revenues of electricity producers and ensuring a solidarity contribution from fossil fuel companies.

In October, the Council formally adopted a Council Regulation on emergency intervention to deal with high energy prices. This Regulation introduces standard measures to reduce electricity demand, collect surplus revenues from the energy sector, and redistribute them to households and small and medium-sized enterprises.

On October 7, EU leaders discussed measures to reduce energy demand, guarantee supply security, and ensure affordable prices for households and businesses.

On October 18, a new package of emergency measures was proposed to address high gas prices and strengthen security through joint purchasing, solidarity rules, a new benchmark for LNG prices and a temporary price band to avoid extreme market spikes.

On October 20-21, EU leaders reached an energy agreement, stating the need to accelerate and intensify efforts to reduce energy demand, avoid rationing, secure supply, and lower prices.

In the same vein, EU leaders called on the Council and the Commission to urgently come forward with concrete decisions on additional measures, including voluntary joint gas

[31] Canada, France, Germany, Italy, Japan, United Kingdom, United States.

[32] Council Regulation (EU) 2022/1369 of 5 August 2022 on coordinated measures for gas demand reduction ST/11568/2022/INIT.

purchases, a new complementary reference value for gas, a temporary dynamic price range for natural gas transactions, and a temporary EU framework for capping the price of gas in power generation.

This package was completed a month later (November 22) with a proposed gas price ceiling that would be activated under certain conditions. On December 19, the Energy Council approved this item, setting a ceiling of €180/MWh for gas purchases. This mechanism should be applied when the price of gas in the Dutch TTF market exceeds that value for three consecutive days and exceeds by more than 35 euros the reference value of gas in the rest of the world's markets.

On November 7, the Eurogroup discussed energy prices. According to the Commission's estimates, eurozone governments spent around 1.25% of aggregate GDP on energy subsidies that year (approximately EUR 200 billion). They addressed the challenges of effectively managing the balance between reducing inflation and supporting vulnerable households and the international competitiveness of the euro area.

On November 24, the Council agreed on the content of new measures to tackle the energy crisis, including improved solidarity in the event of an actual emergency and gas supply shortages, better coordination of joint gas purchases, and a limitation on the volatility of gas and electricity prices. In parallel, the Council wanted to speed up the procedures for granting authorisations for renewable energy projects. In addition, they introduced a presumption of overriding public interest for renewable energy projects.

On December 13, EU energy ministers discussed a mechanism to protect citizens from excessive gas prices. A provisional agreement on the REPowerEU plan was reached the following day.

On December 15, the European Council declared that greater coordination at the EU level was essential to cope with the coming winters. EU leaders reviewed progress on measures to tackle the energy crisis. They called on the Council to finalise work on proposals for new regulations aimed at strengthening energy solidarity, accelerating the development of renewable energies and establishing a market correction mechanism for gas prices.

This body also stressed the importance of strengthening coordination with a view to future winters. In particular, work should continue on a rapid response for gas demand aggregation and joint purchasing, as well as accelerating discussions with reliable partners to secure long-term supply contracts; efficient filling of gas storage facilities and monitoring of filling trajectories and gas demand reduction targets; and early preparation of contingency plans for winter 2023-2024.

Before the end of the year, on December 19, the Council reached an agreement on the mechanism to limit excessive gas prices (gas cap) and measures to secure and share gas supply in the EU. It accelerated authorisation procedures for renewable energy projects[33].

[33] Council Regulation (EU) 2022/2578 of 22 December 2022 establishing a market correction mechanism to protect Union citizens and the economy from excessively high prices.

2023

On March 30, 2023, the Council formally adopted a 15% gas demand reduction target[34]. It also retained the possibility for the Council to activate a "Union alert" on the security of supply, in which case the gas demand reduction would become mandatory. It came into force on April 1, 2023.

On June 19, the Council agreed on parts of the electricity market reform. It also agreed on a general approach to a Regulation on Integrity and Transparency of the Wholesale Energy Market (RITME)[35]. The proposal aims to support open and fair competition in European wholesale energy markets by prohibiting insider trading and discouraging market manipulation. The proposal is part of a broader EU electricity market configuration reform.

In November 2023, the European Commission sent the Member States a proposal to adjust the timetable for eliminating the provisions of the Temporary Crisis and Transition Framework on State aid in the face of rising energy prices resulting from the Russian invasion of Ukraine. (Smartgridsinfo, 2023). In this line, it proposes to extend until March 31, 2024 the provisions allowing the aforementioned aids to compensate for high energy prices. This applies to compensation for energy-intensive companies, including those subject to safeguards, so that even the necessary support schemes will be allowed to be extended for the next winter energy period.

Issues related to liquidity support and other measures to reduce electricity demand will not be extended and will expire on December 31, 2023. Finally, those issues related to accelerating the transition will not be affected and will remain in effect until December 31, 2025 (Smartgridsinfo, 2023).

At the end of November 2023, the European Commission proposed a 12-month extension to three of the emergency measures introduced in 2022 in response to the energy crisis caused by Russia's invasion of Ukraine and the use as an instrument of geopolitical pressure of its energy resources. These three measures are the well-known *solidarity measures in the gas sector, the Market Correction Mechanism (MCM), and the rules regarding the granting of permits for* renewable *energy projects* (Acosta, 2023). Thus, these mechanisms will remain in place until January 31, 2025 (European Commission, 2023).

4.2.1.2. At the national level

As can be seen below, the measures proposed in Spain have not necessarily been aligned with those proposed at the EU level (for example, the aforementioned temporary solidarity contribution promoted by the EU Council to support end energy customers for surplus profits generated by EU companies and permanent establishments operating in the crude oil, natural

[34] Council Regulation (EU) 2023/706 of 30 March 2023 amending Regulation (EU) 2022/1369 with respect to extending the demand reduction period for gas demand reduction measures and strengthening the reporting and monitoring of their implementation.

[35] Regulation (EU) 1227/2011 of the European Parliament and of the Council of 25 October 2011 on wholesale energy market integrity and transparency Text with EEA relevance.

gas, coal and refinery sectors, or the promotion of the Iberian exception to maintaining marginal markets or promoting long-term contracting).

One important group of measures relates to energy savings and efficiency, another to reducing the bills consumers pay, and a third type covers the rest of the possibilities.

Measures related to energy savings and efficiency

In the field of energy saving and efficiency, for example, Order PCM/466/2022 of May 25, 2022, announcing the Agreement of the Council of Ministers of May 24, 2022, which approves the plan of energy saving and efficiency measures for the General State Administration and the entities of the state institutional public sector, was published in 2022. This includes changes in air conditioning systems, lighting and office equipment, as well as a boost to remote work by encouraging civil servants to telework three days a week if their tasks allow it (Garcia, 2022).

Some of the measures of Order PCM/466/2022 refer to the facilitation of the provision of public services by public employees through different organisational formulas that guarantee attention to citizens. The Plan foresees the reinforcement of the remote work modality and the promotion of public or collective transport and other sustainable mobility measures. Courses will be given to public employees to promote the efficient use of energy in the office and mobility.

For its part, the energy saving and management plan for air conditioning to reduce consumption in the context of the war in Ukraine proposes specific measures such as maintaining the temperature of refrigerated and heated public spaces between 19 and 27 °C, automatic door closures, the windows will be turned off at 10 p.m., and the savings measures adopted will be displayed.

The processing of electricity networks and infrastructures will be expedited, facilitating the injection of renewable gases into the gas pipeline network. The date was also set for the fourth renewables auction, with 3,300 MW for wind and photovoltaic installations.

Another initiative the Council of Ministers approved was the More Energy Security Plan (+SE) to reduce gas consumption, improve energy autonomy, increase the economy's competitiveness and increase energy exports. The Plan includes 73 energy security measures grouped around six significant objectives: savings and efficiency; transformation of the energy system; extension of protection to citizens, especially the vulnerable; fiscal measures; transformation of the industry thanks to renewable energies or hydrogen, and solidarity with the rest of the European countries.

The More Energy Security Plan seeks to offer more excellent protection to neighbourhood communities, increase the power of renewables (promoting self-consumption with 500 million euros), improve the leadership of companies, achieve greater transparency in electricity and gas bills, better tax rebates to adopt solutions for the substitution of fossil fuels, green kit for SMEs, greater flexibility in electricity planning, support for the energy transition value chain, etc. (Council of Ministers, 2022).

In savings and efficiency, awareness campaigns will be carried out, the central Administration's Savings Plan will be extended to the rest of the Administrations, and a program will replace public lighting. SMEs will receive support from the Official Credit Institute (ICO) to implement renewables and savings measures.

Along the same lines of energy savings and efficiency, the Council of Ministers of August 1, 2022, approved a Royal Decree-Law with a Shock Plan for energy savings and management in air conditioning to rapidly reduce energy consumption in administrative, commercial and public buildings, as defined in the Regulation of Thermal Installations in Buildings (RITE). (Council of Ministers, 2022). Similarly, it promotes substituting natural gas for renewable gases by facilitating their injection into the gas pipeline network. (IDAE, 2022).

In the field of transport, on August 2, 2022, Royal Decree-Law 14/2022 of August 1 was published in the Official State Gazette (BOE), on August 1, 2022, on economic sustainability measures in the field of transport, on scholarships and study aids, as well as on energy saving and efficiency measures and measures to reduce energy dependence on natural gas. This was validated on August 25 of the same year.

Measures related to support for consumers in the payment of their bills

Another set of measures is more related to the prices to be paid by consumers, as shown in the table below. Some of these measures may be contrary to the reduction of Russian gas consumption or energy dependence (for example, the direct reduction of fuel prices or the limitation of the TUR for gas).

Table 7. The main measures adopted related to prices to be paid by consumers

Measure	Description
Energy bill reduction	- Reduction of Value Added Tax (VAT) to 5% (calculated *based on* cost + excise tax) until December 31, 2023, for electricity, gas, biomass for heating and wood for firewood. - Reduction of the excise tax on electricity to 0.5% and suspension of the tax on the value of electricity production until December 31, 2023.
Revision of the last resort tariff for natural gas, TUR *vicinal*	- The 15% limit on the maximum increase in the *raw material cost* in its calculation formula is maintained in the revisions of the price of the last resort tariff (TUR) for natural gas in 2023. - New TUR *will* regulate the *gas price* in community boilers to prevent high prices from leading to community indebtedness and an increase in non-payments and supply cuts. - The method for implementing the new tariff will be *calculating* the average consumption of the community of *neighbours* for the last 5 years. On 70% of this consumption, a discount of 40% will be applied, while the remaining 30% will continue to pay for gas at free market prices.
Electricity social bonus discounts	- Since last October and throughout 2023, discounts on the social bonus are set at 65% for vulnerable consumers and 80% for severely vulnerable consumers. - The beneficiaries of this temporary voucher cannot be beneficiaries of the thermal social voucher. - Single persons earning up to 16,800 euros per year, couples earning 19,300 euros or families earning 27,720 euros will be eligible for this new discount in 2023. For 2022, the categories will be €16,212, €18,644 and €26,750, respectively. - The *government has also extended the discounts for the beneficiaries of the current categories of social bonuses. The discount will increase from* 60% to 65% for *vulnerable consumers and* 70% to 80% for the severely vulnerable. Before the current energy crisis broke out, the discounts were 25% and 40%, respectively.

Measure	Description
Thermal social voucher	- The beneficiaries of the electricity social voucher may also be beneficiaries of the social voucher for thermal uses created in 2018. This aid *for heating, domestic hot water, or cooking is paid for* in a single annual payment. *Its* amount depends on the vulnerability and the climate zone *where* the habitual dwelling is located. The minimum amount of aid increased in 2022 from €25 to €40 per year, and the average aid is €375 per year per beneficiary, *which* will be maintained during 2023.
Cap on butane cylinder prices	- The price of the butane cylinder until June 30, 2023, may not exceed 19.55 euros.
Suspension of essential supplies	- Until December 31, 2023, electricity, natural gas and water supplies may not be suspended to those consumers who meet the condition of vulnerable, severely vulnerable or at risk of social exclusion.
20 cents fuel bonus	- The purchase of each *litre of fuel (diesel, gasoline, gas and AdBlue*) is *subsidised* with a minimum of 20 cents for both individuals and professionals, of which 15 cents will be provided by the State and the rest by the oil companies, until June 30, 2023. - 450 million euro fund for direct aid to freight and passenger transport companies, depending on the type of vehicle: 1,250 euros per truck, 900 euros per bus, 500 euros per van and 300 euros per cab, VTC or ambulance. The deadline for the refund of the tax on hydrocarbons will be shortened from three to one month, and the Executive will approve a law that allows carriers to work with a fair price, as the Government has done with farmers and ranchers with the Food Chain Law *(Cinco Días, 2022)*. - In December 2022, the bonus was extended until June 30, 2023*, in two phases: the first phase provides for a discount of 20 cents per litre* of fuel consumed between January 1 and March 31, and the second phase provides for a bonus of 10 euro cents between April 1 and June 30. For fleets driven by gas, a compensation of 27 cents until March and 14 euro cents during the *year's second quarter* is foreseen. *(Ministry of Transport, Mobility and Urban Agenda, 2022).*
Tax measures	- June 2021: reduction of VAT from 21% to 10% on electricity bills. - Deductions in the personal income tax (IRPF) on energy efficiency improvement works in homes throughout 2023. Taxpayers *can* deduct 20% of the amounts spent from the entry into force of Royal Decree Law 19/2021 of October 5 until December 31, 2023, to reduce the demand for heating and cooling of the habitual residence or any other leased. The reduction must be at least 7% of the heating and cooling demand indicators of the energy efficiency certificate of the dwelling. The annual base of this deduction will be 5,000 euros per year. - The deduction may reach 40% if the *work for improving the non-renewable primary energy consumption is* at least 30% in the non-renewable primary energy consumption indicator or the energy rating is improved to obtain the A or B rating. In this case, the maximum annual basis will be 7,500 euros per year. - In corporate income tax (IS), freedom of *amortisation* is allowed for investments in renewable energies, with a maximum investment of 500,000 euros.

Source: own elaboration.

In line with the previous table, García-Miralles (2023) estimated that the set of measures adopted to address the energy crisis and the upturn in inflation would have an approximate budgetary impact of between 34 and 40 billion euros during the 2021-2025 time horizon, which would be concentrated in 2022. The classification of measures differentiated between revenue measures (i.e., reduction of VAT on energy and food and reduction of the excise tax on electricity) and expenditure measures (i.e., fuel subsidies for households and transport professionals, vouchers for vulnerable households or thermal social vouchers)[36].

[36] In his work García-Miralles (2023) analyzed the impact of three measures, using micro-simulation exercises: (i) the reduction of VAT on energy, (ii) the reduction of VAT on food and (iii) the fuel price rebate. The results showed that

The Iberian exception

Another of the measures adopted, with the approval of Brussels, is the Iberian exception. This measure was designed to decouple the wholesale price of electricity in the Iberian market from the wholesale market price of natural gas. Royal Decree-Law introduced it on 10/2022 (and in parallel with Portuguese legislation) for one year.

The Spanish and Portuguese governments aimed to reduce the wholesale price of electricity and energy costs for consumers at a time when natural gas prices were very high and rising. Indeed, while in 2019, wholesale energy costs amounted to approximately €16 billion (37% of the total cost of electricity), in 2022, they exceeded €37 billion (61% of the total cost) (Robinson et al., 2023).

Since the energy component of Spain's regulated retail electricity tariff for more than 10 million consumers was indexed to the wholesale *spot* market, rising wholesale energy prices were causing social and political alarm in 2021 and 2022. Over time, the government reduced taxes and other charges to cushion the impact of high electricity prices for consumers. However, these measures only offset the increase in wholesale gas and electricity market prices to some extent (Robinson et al., 2023).

The Iberian exception was aligned with the Government's view that the price of the marginal electricity market facility needed to meet demand (usually natural gas combined cycle power generation) should not determine the market price for all generators (hydro, renewables and other lower cost and infra-marginal) and against *widely accepted economic principles in academic and technical circles on the design of electricity markets* (Fernandez Gomez, 2022).

The reduction in wholesale electricity market prices of the Iberian exception would be achieved by contributing to fossil generators. These adjusted their offer prices to reflect this contribution or aid, which is based on the difference between a new governmental wholesale gas reference price and the daily price of natural gas in the Iberian Gas Market (MIBGAS) (Robinson et al., 2023).

The Iberian exception sets a cap on the price of gas used in electricity generation. The cap is applied on gas in the wholesale electricity market or pool, in which bids are ranked from cheapest to most expensive, and the price-setter is the last unit that is needed to produce (Alonso Pascual, 2023a).

The Iberian exception fixes the price of gas-fired electricity at 40 euros/MWh. This price increased progressively from the sixth month of application of the measure by 5 euros/MWh per month, something that was planned to be extended to reach 70 euros/MWh in the last month in order to achieve a *gradual and staggered exit* from the measure.

In March 2023, the extension of the Iberian exception was published in the Official State Gazette until December 31, 2023, so it was modified and, as of April, it would not increase at the rate of 5 euros/MWh per month, but by 1.1 euros/MWh, except in August, when it would increase by

while the VAT reductions on electricity and gas and on food would have resulted in higher tax savings relative to total expenditure for low-income households, the fuel rebate would have resulted in higher relative savings for high-income households.

1.2 euros/MWh (Alonso Pascual, 2023a). It should be noted that the Iberian exception has not been applied since February 2023.

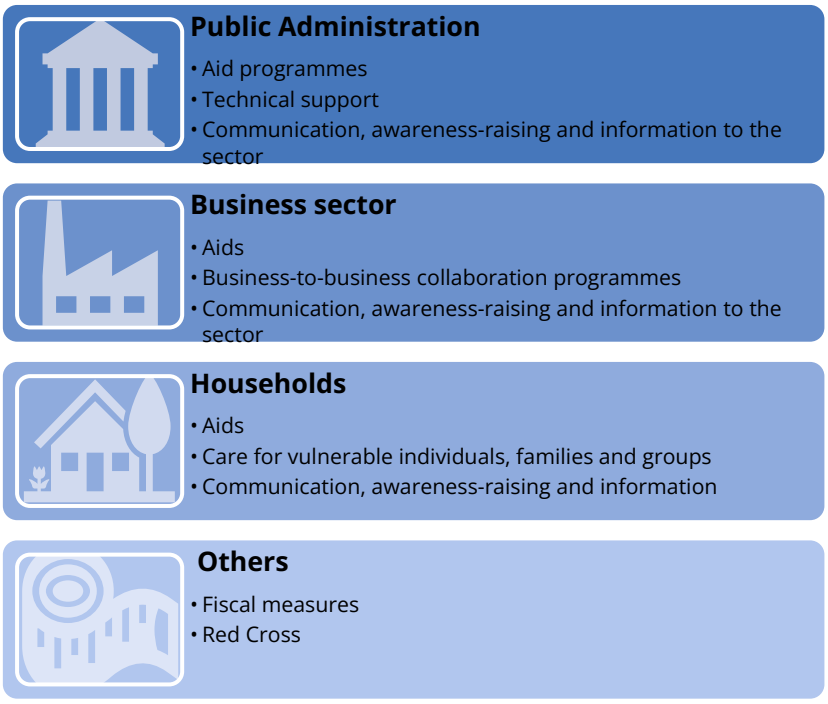
Other measures

Other measures include the promotion of solar roofs, energy communities and self-consumption, and streamlining the processing of renewable energy projects. Support for industry and capacity building for the energy transition will also be increased, with a 1 billion increase in the allocation for PERTE 8 (Strategic Projects for Economic Recovery and Transformation) for Renewable Energies, Renewable Hydrogen and Storage, and a new PERTE for the Decarbonization of Industry will be launched. (La Moncloa, 2022).

4.2.1.3. At the regional level: the ACBC

In the ACBC, the public Administration has also adopted measures within the framework of the Energy Contingency Plan and in the exercise of its competencies. (Department of Economic Development, Sustainability and Environment & Basque Government, 2022).

Figure 4. **Destinations of the Measures of the Energy Contingency Plan**



Source: own elaboration.

The following is a more detailed breakdown of the measures by category.

Table 8. Measures Directed to the Public Administration

Area	Description of measures	Measures implemented
Aid program	- Guazatu energy: to promote refundable advances actions that pursue more sustainable mobility and efficiency in energy consumption and the use of renewable resources in municipal facilities and public buildings. - Grants for studies and audits for energy sustainability of the local public administration. - Sustainable development grants: local actions that promote sustainable development and contribute to climate action. They are articulated through five axes: soil, education for sustainability, circular economy, climate change and natural heritage. - Aid for actions aimed at mitigation, CO_2 absorption and adaptation to reduce the effects of climate change. - Support for local innovation. Aid for innovative projects that promote local climate sustainability through technical and financial support to municipal and county ideas. - Asteklima grants to call citizens to action in the fight against climate change and energy transition. - LEADER 2022 Program. Aid for investments in infrastructure, essential services and renovation of LEADER villages: renewable energies, energy saving, biomass, *district heating*, essential services, refurbishment of population centres, etc. - EREIN 2022 Program. Grants for promoting and developing rural areas, classified G4, G5 and G6, aimed at public entities. They seek to foster social inclusion, poverty reduction and economic development, as well as to promote resource efficiency and improve the quality of life.	- Elaborate and approve "Energy Saving and Efficiency Instruction" for public administration. - Set the air temperature in heated enclosures no higher than 19 ºC and refrigerated enclosures no lower than 27 ºC (RDL 14/2022 on economic sustainability measures). - Take advantage of the roofs of public administration buildings to implement self-consumption photovoltaic installations. - Promote sustainable commuting to the workplace, whether by foot, bicycle or public transportation, for all employees and the public. - Informing, in public buildings and using posters or screens, of the application measures contributing to energy saving.
Technical support	- Udalsarea 2030: to promote local sustainability by developing instruments and tools to support local government. - Advice on the Covenant of Mayors for Climate and Energy. Twenty-five municipalities adhered to the Covenant, and others were in the process of adherence. - Advice in energy communities. - Singular renewable generation projects: EVE offers an advisory service to accompany local administrations considering singular projects using wind, mini-hydro, or photovoltaic resources from conception to start-up. - Incorporation of energy efficiency criteria in the investments to be subsidised in 2023 by the Basque public administrations.	
Communication, awareness and information to the sector	- Measures aimed at training, communication and dissemination through Ihobe and EVE. - Organization of seminars and technical conferences on energy transition and climate change. - Collaboration in European projects (Life, Horizon Europe). - Dissemination through Udalsarea 2030. *ASTEKLIMA Climate and Energy Week to raise awareness and mobilise citizens.*	

Source: Prepared by the authors based on Department of Economic Development, Sustainability and Environment & Basque Government (2022).

Table 9. Measures aimed at companies

Area	Description of measures	Comprehensive measures implemented
Aid program	- Aid program for companies in the industrial sector affected by high natural gas prices. - Support for investments to demonstrate and validate emerging marine renewable energy technologies. For example, experimental tests in the demonstration phase and validation of prototypes at or near the full scale of wave energy harvesting devices, floating wind turbine foundation devices, offshore wind turbines, etc. - Aid for energy efficiency, renewable energies, transportation and efficient mobility investments. Investments for hydrogen consumption in industry and buildings, for the replacement of fossil fuel consumption, in energy efficiency in SMEs in the industrial sector, in vertical boreholes (closed/open circuit) for use by heat pumps, as well as new connections and exchange substations in heat networks and new facilities for the use of waste heat, etc., integrated energy demand management systems, actions in transportation and efficient mobility (vertical mobility, natural gas supply installations, promotion of bicycles) and renovation of energy-efficient equipment in the hospitality sector: hotels, restaurants and cafeterias. - Program to support the modernisation of commercial establishments and certain services related to commercial activity. Renovation, incorporating energy efficiency criteria, of the infrastructure and equipment of the commercial establishment.	- Advice and assistance for the performance of energy audits in SMEs and micro-SMEs. - Accelerate investments in energy efficiency in all sectors: primary, industrial, commercial, tourism, etc. - Take advantage of roofs, decks, tanks, reservoirs, to make a massive development of photovoltaic installations for self-consumption. - Possibility of using the methodology of energy communities formed by companies. - Promote a faster shift towards more sustainable mobility by encouraging the use of public transportation, promoting more sustainable energies, implementing mobility plans for workplaces, and promoting efficient vehicle driving to minimise fuel use. - Possible new aid program for the modernisation of transport fleets. - Develop an awareness and information campaign for the business community in all sectors of activity. - Disseminate the energy saving culture among employees to standardize rational and efficient consumption habits.
Company collaboration programs	- Elaboration and Implementation of Decarbonization Plans in the Industrial Fabric. - Net-Zero Basque Industrial Supercluster. - Guide for the Energy Transition in establishments of the Tourism Sector in the Basque Country.	
Communication, awareness and information to the sector	- Guide for the Energy Transition in establishments of the Tourism Sector in the Basque Country.	

Source: Prepared by the authors based on Department of Economic Development, Sustainability and Environment & Basque Government (2022).

Table 10. Measures aimed at citizens and households

Area	Description of measures	Comprehensive measures implemented
Aid program	- Aid for energy efficiency, renewable energies, transportation and efficient mobility investments. Carrying out vertical boreholes (closed/open circuit), using heat pumps, new connections, and exchanging substations in heat networks and new installations for using residual heat. Carrying out actions in transportation and efficient mobility (energy saving in vertical mobility, natural gas supply installations, promotion of bicycles).	- Replace household appliances for others with energy labelling A. - Disconnect electrical appliances during long absences (vacations). Refrigerator freezers consume up to 30% of the house's energy. - Regulating the heating installations for a more efficient operation. Thermostatic valves should be placed on radiators to avoid overheating rooms and lowering the temperature in unused rooms. - Promote self-consumption photovoltaic installations or participate in energy community projects. - More sustainable mobility management through public transportation or carpooling. - Use LED technology. - Take advantage of natural light and turn off the light in naturally lit areas.
Attention to individuals, families and vulnerable groups	- Reduce gas and electricity consumption and contribute to the decarbonisation of the economy. - Aid aimed at mitigating the impact of higher energy prices on household economies.	
Communication, awareness and information to the sector	- Energy funds in everyday life (Guide for efficient use of the EVE): They include measures aimed at citizens. - Kontsumobide provides adequate information for reading the energy bill.	

Source: Prepared by the authors based on Department of Economic Development, Sustainability and Environment & Basque Government (2022).

Lastly, another type of measure can be mentioned, which is fiscal. On July 28, 2022, the Basque Government and the three Provincial Councils agreed on a battery of measures to face the strong impact that the pandemic and the war in Ukraine were having on the Basque economy, as well as the long consequences that are foreseen. This measure implies a fiscal effort of 250 million Euros.

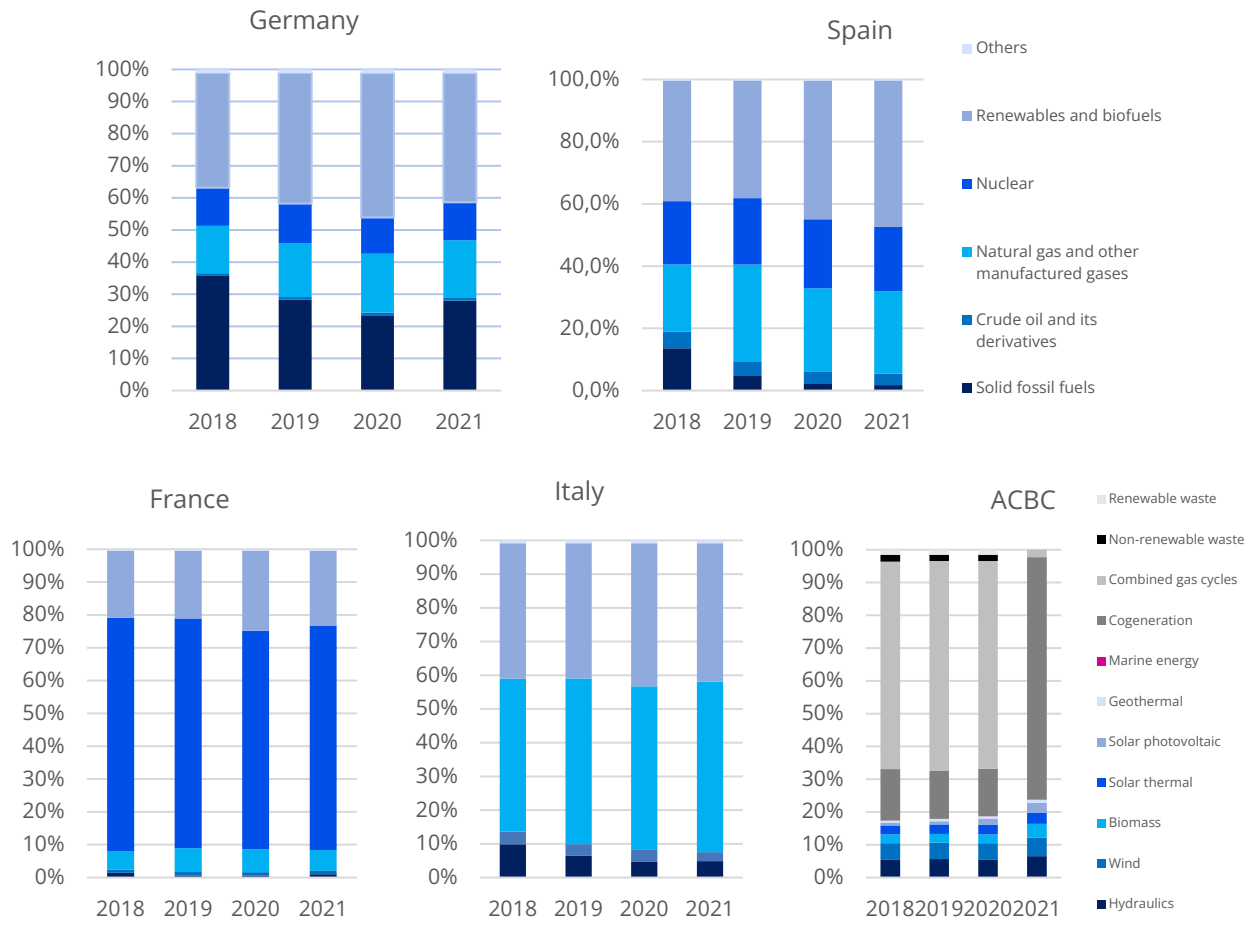
Another noteworthy measure is the direct subsidy to the Red Cross, which reaches one million euros, whose main objectives are (i) to cover part of the costs of electricity, water and gas supplies for families with low income or at risk of social exclusion, (ii) to accompany beneficiaries in raising awareness of the importance of energy saving in households, and to help them better understand the bills and the concepts that appear on them.

4.2.2. Technologies

4.2.2.1. Evolution of installed electric power by technology

Although this indicator has been studied in the literature as an element of change in the face of an energy crisis, the changes promoted are seen in the longer term. This is due to the time required to undertake the relevant administrative procedures and the necessary investments. However, in Germany and Spain, the weight of solid fossil fuels has fallen, and the weight of renewables and biofuels has increased.

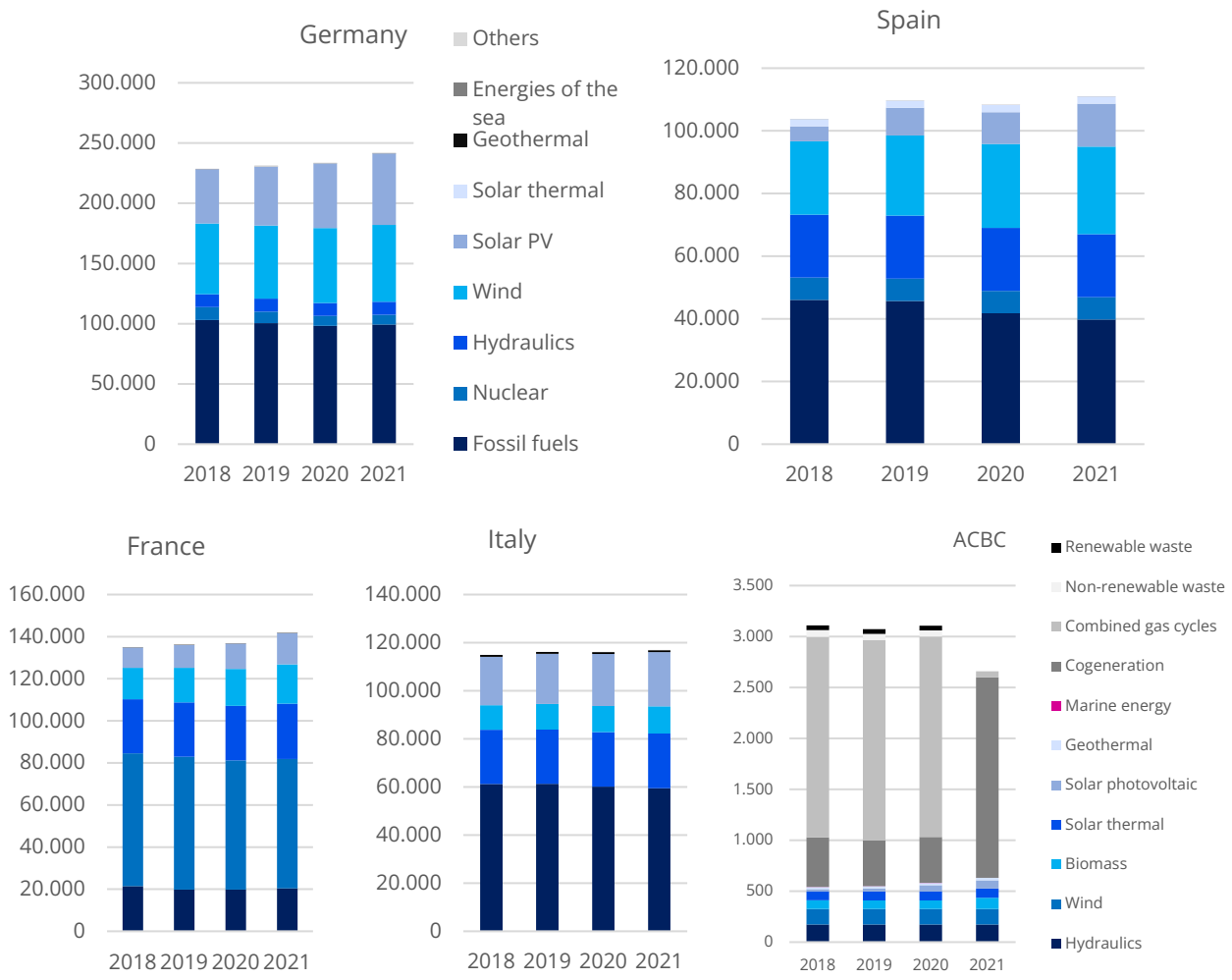
Chart 36. **Evolution of the Electricity *Mix***



Note: The categorisation of the ACBC is its own; for the four countries, the one next to the chart for Spain applies.
Source: Prepared by the authors based on EU Commission (2023) and Red Eléctrica de España.

The previous set of charts shows the power *mix*, while the following one shows the evolution of power. A slight increase in power is observed in Germany and France, while there has been a significant reduction in the ACBC. In some cases, a fall in conventional power with fossil fuels is observed, as in Germany or Spain, as well as an increase in renewable energies (for example, solar in Italy or wind power in Germany and France). However, most of the changes are small and progressive over time.

Chart 37. **Evolution of electric power (MW)**



Source: Prepared by the authors based on EU Commission (2023) and Red Eléctrica de España.

4.2.2.2. Innovation in energy

To make progress in decarbonising energy, investing in innovation (e.g., in storage, CO_2 capture, marine energy, etc.) is necessary. As can be seen, the evolution of investments in energy R&D is not similar in the territories under study. France is the country with the highest levels of investment in recent years, with a significant increase in 2022 amid the energy crisis. In that year, it reached 1.31 euros per 1,000 units of GDP.

Germany also maintains a significant investment volume, below France, although it accounted for just 0.38 euros per 1,000 of GDP in 2022. For Italy and Spain, data for 2022 are not available. Italy in 2019 and 2020 maintained its level of investment. In Spain, investments were well below the other countries, with around 100 million in investments in 2019 and 2020. In 2021, there was a boost to $730 million.

Table 11. Total R&D investment in millions of US$ (2022 prices and exchange rates)

Germany	2019	2020	2021	2022	France	2019	2020	2021	2022
Energy efficiency	240,6	227,4	231,9	192,4	Energy efficiency	230,3	335,4	267,3	415,5
Fossil fuels	22,8	36,1	36,4	47,4	Fossil fuels	44,6	55,5	58,3	64,2
Renewable energies	285,9	276,8	307,7	258,1	Renewable energies	203	214,1	224,2	306,5
Nuclear (fusion and fission)	254,4	257,6	153,6	160,8	Nuclear (fusion and fission)	849,2	835,6	1.042,4	962
Hydrogen and fuel cells	52,7	68,7	173	323,1	Hydrogen and fuel cells	61,1	74,1	83,3	1.611,2
Other energy technologies and storage	149,5	130,4	140,9	118,9	Other energy technologies and storage	80,9	93,7	151,4	109,7
Other cross-cutting technologies	61,9	56,1	96	127,1	Other cross-cutting technologies	129,1	155,3	148,7	179
Not Assigned	269,1	361,4	362	335,3	Not Assigned				
Total	1.336,9	1.414,5	1.501,5	1.563,1	Total	1.598,2	1.763,7	1.975,6	3.648,1
Italy	2019	2020	2021	2022	Spain	2019	2020	2021	2022
Energy efficiency	118,2	109,6			Energy efficiency	24,7	7,3	213,7	
Fossil fuels	120,6	87,5			Fossil fuels	3	1,4	9,3	
Renewable energies	111,5	108			Renewable energies	60,1	52,3	95,5	
Nuclear (fusion and fission)	91,5	105,3			Nuclear (fusion and fission)	1,6	8,8	120,9	
Hydrogen and fuel cells	10,7	22,5			Hydrogen and fuel cells	11,7	9,6	152	
Other energy technologies and storage	45,4	58			Other energy technologies and storage	12,6	14,1	85,8	
Other cross-cutting technologies	66,8	71,8			Other cross-cutting technologies	0,3			
Not assigned					Not Assigned	1,1	0,6	53,4	
Total	564,7	562,7			Total	115,1	94,1	730,6	

Note: Investment in energy efficiency does not refer to R&D but to investment in efforts made throughout the production, transformation and consumption chain of all products, either to offer more services with the same energy input or the same services with less energy input.
Source: Prepared by the authors based on IEA (2023c).

In all cases, the weight of government investment can be noted, which accounted for around 90% of the total in Germany and Spain. In Italy, it accounted for around 55%, and in France, the boost of private investment in 2022 should be mentioned, which rose from 12% in 2021 to 44% of the total.

The following table shows the data on R&D expenditures in areas related to energy in the economy of the Basque Country, where the weight of this area has been maintained in recent years. It could be highlighted the weight that these expenditures have in the primary sector and how it has increased in the machinery manufacturing sector in 2021 and 2022, having gone from 6 million euros of R&D expenditures in energy in 2018 to 25 million in 2022 (0.20 euros of R&D in energy-related topics per 1,000 of GDP and 16.05 euros per 1,000 of GDP in total).

Table 12. Internal R&D expenditure in the business sector and IPSFL in the ACBC by branch of activity and percentage concerning the total

Millions of euros	2018	2019	2020	2021	2022
Total R&D expenditure	1.080	1.130	1.143	1.275	1.385
Total R&D expenditures in production, distribution and rational use of energy	130	135	126	163	178
Percentage of total R&D expenditure on production, distribution and rational energy use concerning the total.	12,0 %	11,9 %	11,0 %	12,8 %	12,8 %
Sectoral distribution of total R&D expenditures on production, distribution and rational use of energy					
Agriculture and fishing, extractive industries, energy, and construction	15,9 %	10,9 %	14,4 %	14,6 %	14,3 %
Chemicals, petroleum refining, rubber and plastics	2,1%	2,1%	3,3%	4,2%	1,8%
Essential industry and metal products	5,1%	3,9%	4,6%	2,5%	4,5%
Machinery	4,4%	7,3%	6,2%	12,4 %	13,8 %
Electrical, electronic and precision equipment	10,6 %	9,9%	11,0 %	11,6 %	11,4 %
Transport equipment	3,5%	2,9%	3,1%	2,1%	2,7%
Other manufacturing	0,4%	0,4%	0,1%	0,3%	0,3%
R&D activities	43,4 %	50,6 %	45,9 %	41,5 %	38,8 %
Other services	14,7 %	12,0 %	11,5 %	10,7 %	12,3 %

Note: IPSFL= Private Non-Profit Institution.
Source: Prepared by the authors based on Eustat (2023b).

4.2.2.3. Energy investments and prospects

Recovery from the COVID-19 pandemic and the response to the global energy crisis have driven global investment in clean energy and a slower increase in fossil fuel subsidies. (IEA, 2023h). Increases have occurred in virtually all categories (such as power grids and electrification, energy efficiency, and renewables). Renewables, led by solar and electric vehicles, lead the projected increase in clean energy investment in 2023 globally (IEA, 2023h).

However, at this point, it is worth highlighting the support granted by governments, which, due to the energy crisis, more than ever, has been primarily oriented towards energy affordability measures for the consumer. Under this heading are included all measures aimed at helping consumers and businesses withstand the high energy prices resulting from the global energy crisis. This category includes the measures already mentioned, enacted at the EU level and by governments in response to the international price spike that materialised in the fourth quarter of 2021 and was further exacerbated by Russia's invasion of Ukraine. In the following table, the clean energy investment support category captures all public spending directly supporting increased levels of clean energy investment.

Table 13. Breakdown of public energy expenditure in 2021 (%)

Category	Spain	France	Germany	Italy
Total expenditure (billions of US$)	89,39	149,73	339,01	175,9
Consumer support for energy affordability	42,6	56,9	72,6	36,7
Support for investment in clean energy				
Efficient and low-carbon transportation	22,9	12,5	11,2	27,2
Energy efficiency in buildings and industry	13,4	19	9,7	25,6
Low carbon electricity	6,7	1,7	0,4	8,2
Fuel and technology innovation	3,8	9,3	5	2,8
Electrical networks	10,2	0,1		2,8
Citizen-centered transitions	0,5			
General		0,6	0,2	0,2

Source: Prepared by the authors based on IEA (2023d).

At this point, it is worth highlighting the following chart, where public funds allocated to energy affordability are shown in grey, and those dedicated to investment in clean energy are shown in different colours. According to data from (IEA, 2023d) the resources allocated to energy affordability accounted for the most significant volume in 2021, with a total of US$ 2,243.16 billion.

Chart 38. Public expenditure on energy by category 2021

Source: IEA (2023d).

The literature analyses the impact of energy crises on the energy and electricity *mix*. However, given that the variation in the *mix* is slight in the short term (as seen for electricity), some of the prospects for future investments are presented below.

Many of these forecasts were made before the crisis and are primarily framed within the current energy transition process towards decarbonisation and the penetration of renewable sources. However, forecasts for investments in regasification capacity and electricity interconnection have been proposed due to the energy crisis to guarantee energy security, detailed in section 4.3.3.4.

Table 14. Investment prospects in the energy sector

Country	Investment prospects
Germany	Installed onshore wind power capacity is expected to increase by 7 GW annually from 2023 to 2030. As for photovoltaic power, the government forecasts an installed solar PV capacity of 18.4 GW annually from 2023 to 2030. Other targets set for 2030 include offshore wind power (30 GW by 2030 versus 8 GW today), electric heat pumps (6 million in 2030 versus 1.5 million today), electric cars (15 million in 2030 versus 1 million today) or recharging points (1 million in 2030 versus 80,000 in early 2023) and electrolyser capacities to produce (green) hydrogen of the order of 10 GW by 2030.
ACBC	Basque hydrogen corridor Synthetic fuels plant and a process for the recovery of urban wastes Wind farms: Labraza (40 MW) and Azazeta (40 MW) and forecasts for an additional 383 MW Solar photovoltaic: 3 initiatives of photovoltaic panels, one of 40 MW in the Laminoria quarry and two others of 50 MW each in the northeast of Vitoria. In addition, energy communities are being developed (promoted by municipalities and others).
France	France 2030 is a national investment plan endowed with €34 billion (€30 billion in grants and the rest in financing plans) to be deployed over 5 years. In 2022, €3.5 billion was allocated. France 2030 is composed of 10 objectives, including: - 8 billion to develop small nuclear reactors (1 billion), green hydrogen projects (1.9 billion) and decarbonise industry (5.6 billion). - 4 billion for transportation, to produce nearly two million electric and hybrid vehicles and low-carbon aircraft. Additional provisions were unveiled in February 2022: - Construction of six new EPR 2 nuclear reactors, representing 25 GW. The lifetime of the reactors has been extended to more than 50 years. - Investments in renewables for 1 billion euros. Renewable energy capacity will increase tenfold by 2050 to 100 GW. 40 GW will come from offshore wind farms. - Reducing energy consumption by 40% through building renovation.
Spain	Planned investment in 2021-2030: 294 billion euros, 40% in renewable energies, 29% in energy savings and efficiency, 18% in networks, 12% in electrification and 1% in others. In electricity, it is expected to more than double wind power capacity (from 26,754 MW in 2020 to 62,044 MW in 2030), a sevenfold increase in solar power capacity (from 11,004 MW in 2020 to 76,387 MW in 2030), double solar thermal power capacity (from 2,300 MW to 4,800 MW), and reach 18,543 MW of storage (from 6,413 MW in 2020).
Italy	Electricity production capacity from renewables would have to be 20 GW higher than planned to reach 115 GW in 2030 (including renewable electricity to produce hydrogen). Overall, renewables must account for at least 70% of electricity generation. Increased electrification would require a higher deployment of heat pumps (+10% compared to forecasts); about 7.3 million EVs, i.e. 20% of the car fleet in 2030 (1 million more cars compared to previous forecasts); and 43% of electricity in industrial consumption (compared to 38% forecast in the NECP). There is also a need to invest in networks (electricity, gas, hydrogen, etc.) and their adaptation to climate change.

Source: Prepared by the authors based on IEA (2023a), Government of Spain (2023), Deutsche Bank Research (2023), IEA (2023e).

The above forecasts must be framed at the EU level in the different announcements of the European Commission (the REPowerEU Plan, the Net-Zero Industry Act, etc.) where different objectives are included, among them: (i) increase of the EU renewable target to 45% by 2030 (of the entire energy matrix, not only electricity), (ii) acceleration of the permitting process and 225.225 billion in grid loans, (iii) nine European countries have committed to increasing offshore wind capacity to over 120 GW by 2030 and to over 300 GW by 2050).

4.2.2.4. *Energy Transition Index* (ETI)

The ETI is a synthetic indicator that includes a set of variables grouped into two sub-indices: "*System Performance*" and "*Transition Readiness*". The global average score of the indicator has increased by 10% since 2014, but in the last three years, the growth has been marginal. Only 41 countries have made steady progress over the past decade (World Economic Forum & Accenture, 2023).

Of the countries analysed (in this case, the indicator is not available for the ACBC), Spain is the one which has made the most progress in terms of energy transition and has also done so over the last few years.

Table 15. Energy transition index 2023

Indicator	Germany	France	Italy	Spain
System performance	64,6	73,3	63,9	65,1
Equity	67,9	67,9	60,7	63,9
Security	66,4	74,6	70,3	61
Sustainability	59,5	77,4	60,7	70,5
Preparing for transition	71,9	66,5	55,6	64,7
Regulation and political commitment	91,1	86,5	79,5	83,4
Infrastructure	62,6	60,5	51,6	66,9
Education and human capital	71,3	52	42,5	59,6
Innovation	51,8	48,5	39,3	36
Financing and investment	72,9	72	53,9	67,1
Energy transition index (2023)	67,5	70,6	60,6	65
Position (2023)	11 of 120	7 of 120	38 of 120	16 of 120
Energy transition index (2014)	63,7	64,2	54,3	56
Position (2014)	6 of 120	5 of 120	40 of 120	29 of 120

Source: Prepared by the authors based on World Economic Forum (2023).

There are other indicators related to energy transition preparedness, such as the one developed by (REA, 2023), which assesses the readiness of selected electricity markets for the

energy transition from the perspective of private investors in flexibility services and technologies that support deployment and decarbonisation. In this case, France is positioned ahead of Germany, Spain and Italy. The latter three countries are in an intermediate position compared to France, which is at a higher level.

4.3. Sustainability

4.3.1. Environment

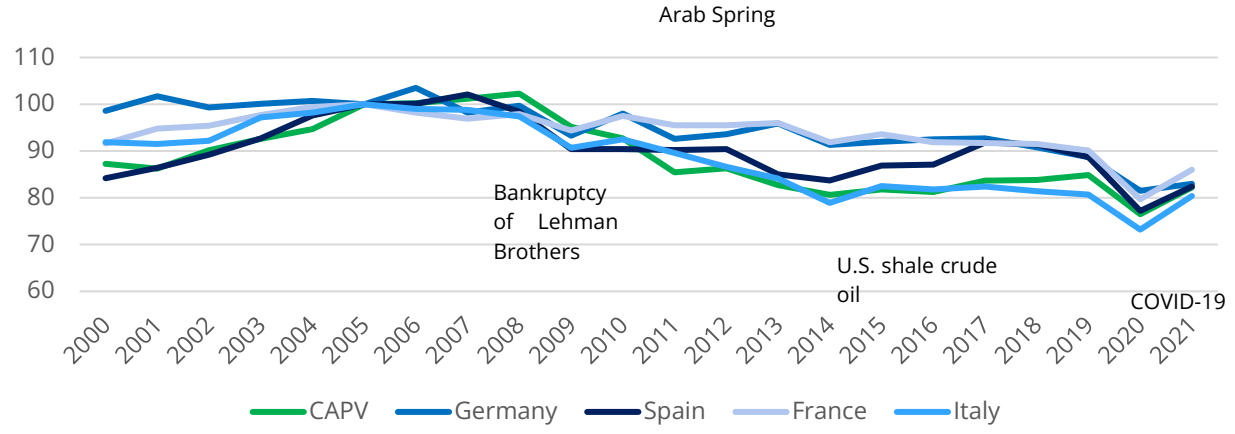
4.3.1.1. Power consumption

The data presented below show the impact of the health crisis on the drop in final energy consumption in the absence of greater detail.

As can be seen in the chart below, primary energy consumption in the countries under study has been declining since 2006-2008. The last notable drop occurred due to confinements during 2020, and although in 2021, the level of consumption recovered, there is a downward trend. However, higher energy prices do not always lead to reduced consumption. On the contrary, they could lead to a further increase (Battistini, Di Nino, Dossche, & Kolndrekaj, 2022).

This is because the economic impact of an oil price change caused by an unanticipated shock to global aggregate demand will be very different from that of an oil price increase caused by an unanticipated shortfall in oil production. Therefore, the extent to which oil price increases are due to different types of shocks must be understood before formulating answers (Battistini, Di Nino, Dossche, & Kolndrekaj, 2022).

Chart 39. Index of the evolution of primary energy consumption



Source: Prepared by the authors based on Eustat.

Globally, the regions most affected by the fall in energy consumption during the pandemic were the most dependent and those with the highest share of previous consumption, such as North America, with a drop in primary energy consumption of 8%, and Europe, with 7.8%. In Asia, it

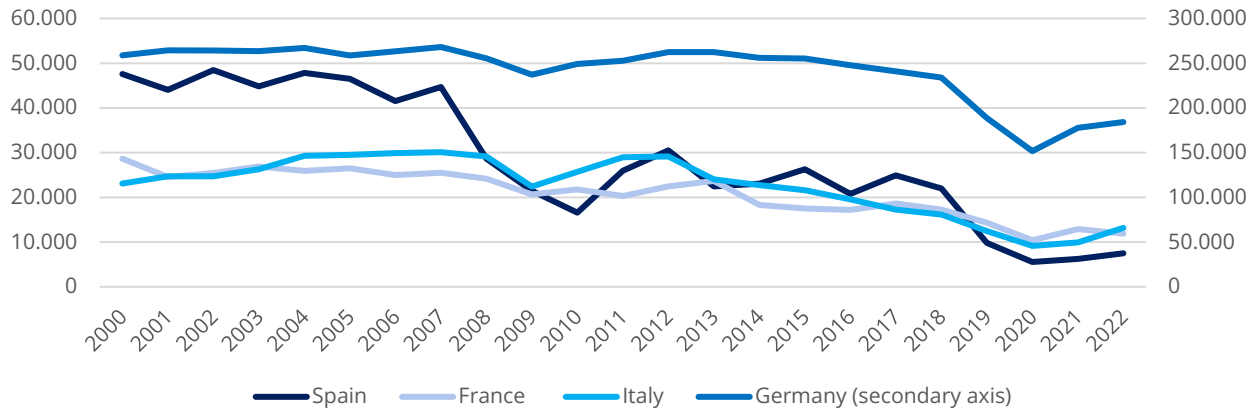
was only 1.6%, due to the 2% increase in China due to the recovery of production activity in the second half of 2020. Consumption also fell 7.8% in Central and South America and 3.1% in the Middle East (Morales, 2021).

During the pandemic, crude oil consumption in the United States fell by 2.3 million barrels per day in 2020 (compared to a regular consumption of 22.4 million barrels), in the EU by 1.5 million barrels and in India by 440,000. As a result, refinery activity fell by 8.3%, its lowest level since 1985. Oil consumption declined in China as private car travel was curtailed. Air travel also plummeted, with only one in four domestic flights scheduled. As a result, there was a drop in energy demand compared to April 2021, which, for oil, was expected in April 2022 to be 9% (Seurat, 2022).

For its part, and as a result of the Russian invasion of Ukraine, demand for natural gas plunged by 10% in the first nine months of 2022 compared to the previous year, motivated, among other reasons, by government plans and the reduction in industrial production associated with the crisis that was being experienced. In Spain, cumulative demand for fuel fell by 22% between August 2022 and January 2023, compared to a historical average of the last five years. In more than a year, Europe reduced its dependence on Russian fossil fuels (Hernandez & Garcia, 2023).

The case of coal is very remarkable, where it can be observed how, in all cases (less striking in Italy), after the fall in 2020, there was a rebound in its consumption in 2021 and 2022. European partners bought, in 2022, an additional 22 million tons of coal to generate energy.

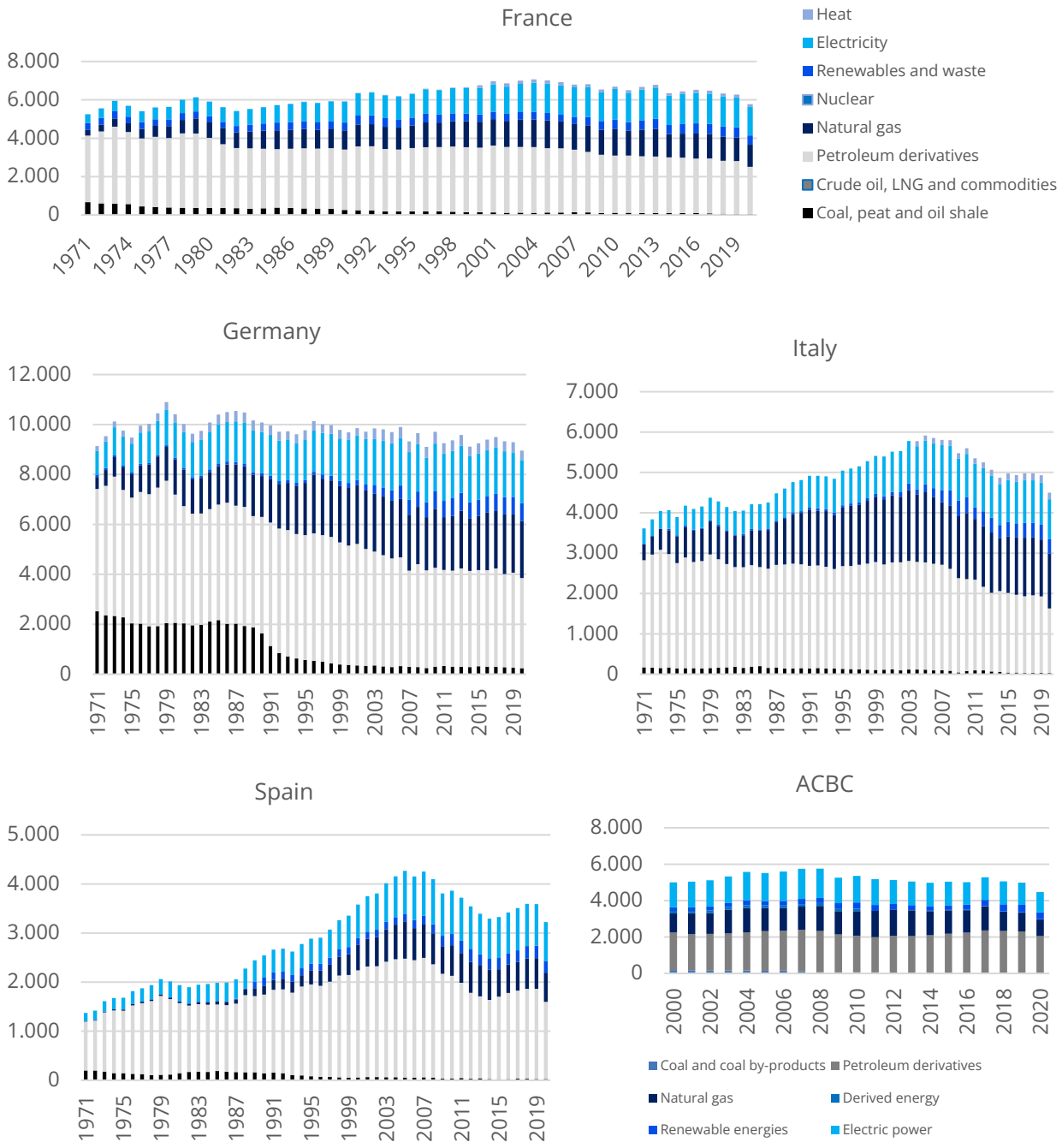
Chart 40. Evolution of domestic coal consumption (thousands of tons)



Note: Coal consumption in the case of the ACBC is residual. It barely represents 0.37% of final energy consumption.
Source: Prepared by the authors based on Eurostat.

The evolution of final energy consumption by source is shown below, where, once again, the drop in total consumption is observed, generally from conventional sources and fossil fuels.

Chart 41. Evolution of final energy consumption by source and territory (data in petajoules-PJ, except for the BAC, which are kilotons of oil equivalent (ktoe)



Source: Prepared by the authors based on IEA and Eustat.

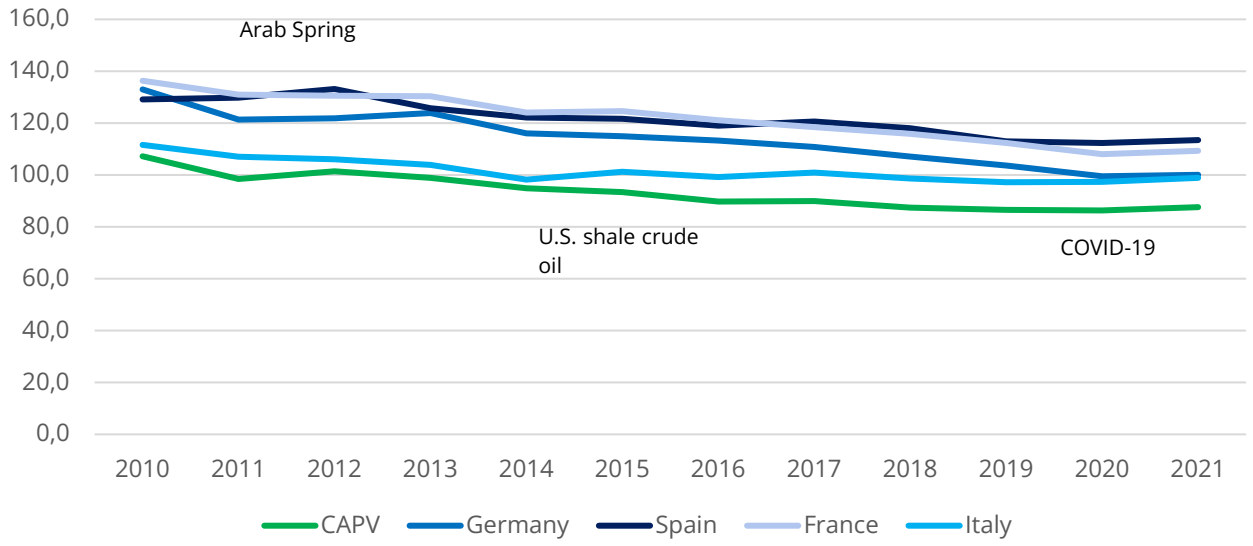
4.3.1.2. Energy intensity

Rising energy prices have often been the main consequence of changes in energy consumption. Moreover, energy costs, prices and taxation can influence the decarbonisation of the

economy[37] (Ariño Ortiz, del Guayo Castiella, & Robinson, 2020). These increases can induce both a reduction in consumption and greater efficiency in energy use.

As can be seen below, energy intensity is improving in the countries under study, especially in the ACBC and Italy; however, as information is only available up to 2021, it is not possible to observe whether the measures to reduce energy consumption related to efficiency have had the desired impact.

Chart 42. Evolution of energy intensity



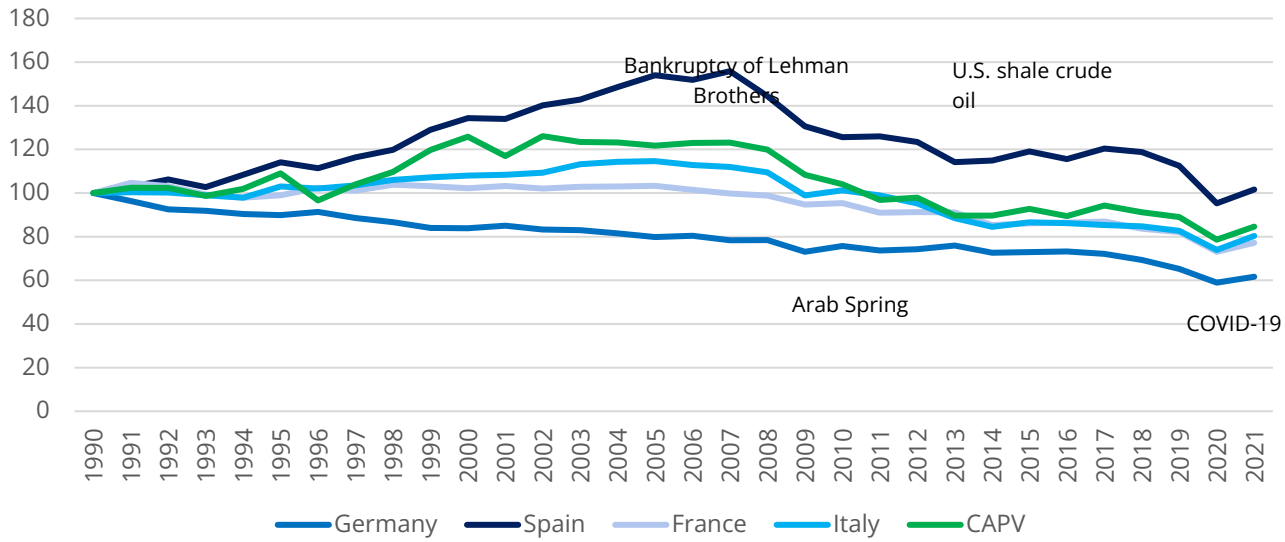
Note: Energy intensity is estimated as the ratio of gross domestic energy consumption to GDP.
Source: Prepared by the authors based on Eustat (2023g).

4.3.1.3. GHG emissions

As with energy consumption, greenhouse gas emissions have followed a downward trend, especially since 2008. In 2020, the drop was remarkable due to the restrictions implemented, but in 2021 the level of emissions recovered, albeit to lower levels than in previous years, confirming the aforementioned trend.

[37] For example, part of the traditionally high electricity prices in Spain is due to taxes and charges that finance policies to promote renewable energies, among others, and which can represent around half of the price for a domestic consumer. This may have made electricity (increasingly renewable) less competitive with fossil fuels in end markets, particularly for transport and heating, thus discouraging decarbonization via electrification (Ariño Ortiz, del Guayo Castiella, & Robinson, 2020).

Chart 43. Evolution of the GHG emissions index by country. Base year 1990=100%.

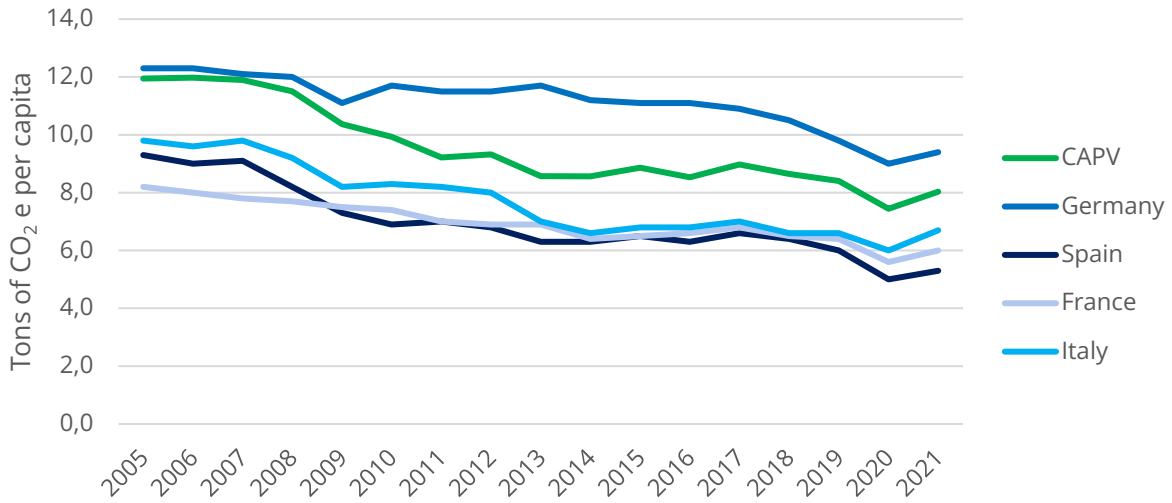


Source: Prepared by the authors based on Eustat (2023d).

The recovery of emissions in 2021, in the particular case of Spain, was determined by an increase in emissions associated with transportation and electricity generation (the increase in renewable production could not offset the latter). On the industrial side, emissions associated with metallurgy and non-metallic minerals increased. To a lesser extent, emissions from the commercial and residential sectors increased (Ministry for Ecological Transition and the Demographic Challenge, 2023).

The following chart shows the GHG emissions per capita of the territories under study.

Chart 44. Evolution of per capita GHG emissions by country. 2005-2021

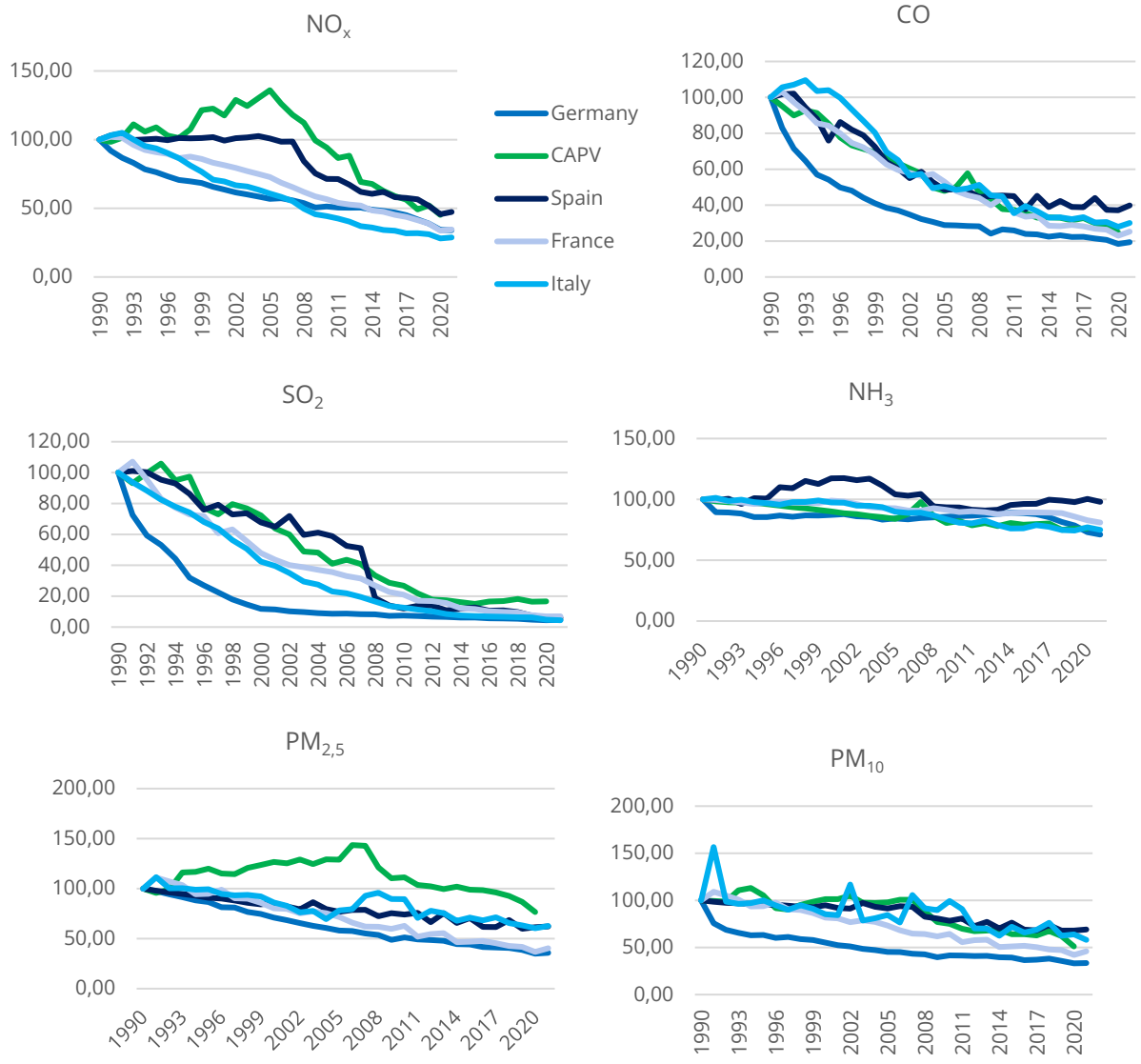


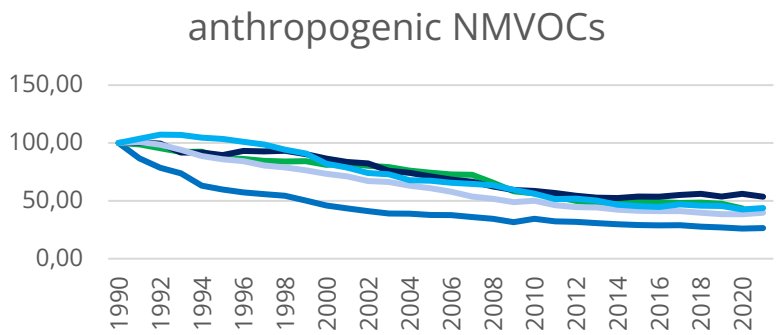
Source: Prepared by the authors based on Eustat (2023d).

4.3.1.4. Pollutant emissions

As in the case of GHG emissions, in 2020, most of the pollutant emissions were reduced, but in 2021, they increased again, following a decreasing or relatively stable path as in the case of NH_3 and SO_2.

Chart 45. Evolution of the rate of emissions of different pollutants by country. Base year 1990=100%.





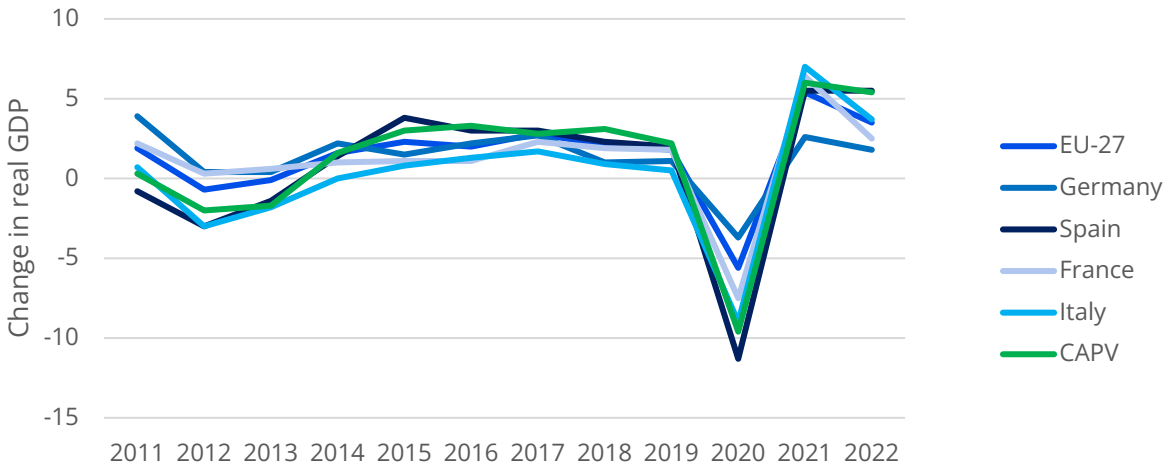
Source: Prepared by the authors based on Eustat and Eurostat.

4.3.2. Economy

4.3.2.1. GDP

After the fall in 2020, in 2021, when the restrictions imposed due to the health crisis began to ease, GDP (or aggregate demand) recovered. However, in 2022, there was a slight contraction, less pronounced in the case of the ACBC, Spain and Germany than in France or Italy.

Chart 46. Evolution of real GDP



Source: Prepared by the authors based on Eustat and Eurostat.

4.3.2.2. Inflation

Inflation, as a general growth in the level of consumer prices in an economy, is one of the economic variables where the effects of the energy crisis have been first glimpsed due to the direct impact of the price of energy on it (Rodríguez Rodríguez, 2022) and the indirect impact on the production costs of other goods and services caused by the aforementioned price

increase. Inflation can be caused by variations in the supply and demand of products (which will be discussed below), which can be gradual over time or more or less abrupt.

As already presented in the section on energy prices, as a result of the confinements due to the health crisis, there was a reduction in energy prices, even though inflation, measured in terms of the consumer price index (CPI), remained at favourable levels. It was in the prices of energy products and in the prices of some of the services most affected by the restrictions that the principal price reductions were observed.

According to (Fernandez, 2021) Since many services could not be purchased during the months of confinement, there were no associated prices, so INE attributed estimated prices to them to calculate the general inflation rate. Once the stricter confinement ended, activities resumed, and the inflation rate for services declined from what was previously assigned by the INE. As a result, the average annual inflation rate for 2020 was -0.3%, as in 2009 (Statista, 2023).

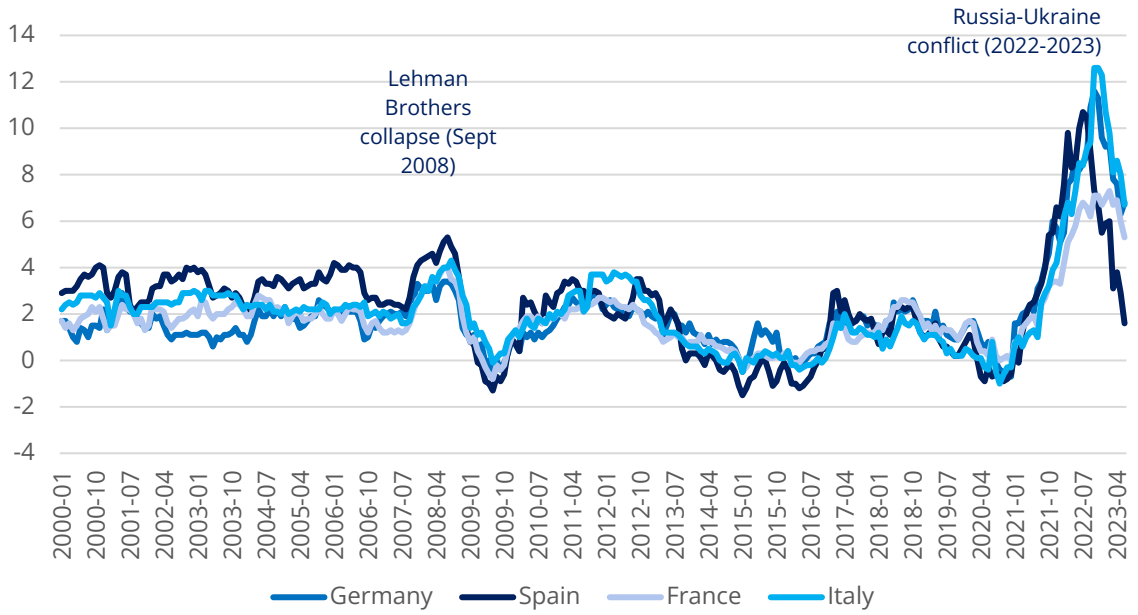
This negative result was due to the sharp drop in the prices of energy products. The fall in oil prices caused a reduction in the inflation rate of energy products by as much as -9.8%, subtracting one percentage point from the overall inflation rate. The COVID-19 crisis, therefore, generated an immediate deflationary impact on energy products (Fernandez, 2021).

The recovery was quite asymmetric once the tightening phase of 2020-2021 was over (except in the case of China, which lasted until 2022). Social distancing continued to limit demand and activity in high-touch service sectors, and spending shifted to goods consumption, which was a substantial sectoral shock. Similarly, manufacturing output was affected by labour supply shocks and temporary factory closures (most notably in China), as well as strains in commodity and food commodity markets.

The combination of these factors resulted in mismatches between supply and demand (bottlenecks), exacerbated by the nature of global supply chains, where a disruption in one part of the chain translated into a cascading effect up and down the chain. Also, adjustments due to demand and supply shocks were not made in a linear fashion[38].

[38] This situation is known as the whiplash effect.

Chart 47. Evolution of inflation



Source: Prepared by the authors based on Eurostat.

As a result of the global and common nature of the pandemic, all alternative suppliers in the same industry or sector faced similar constraints. In these atypical circumstances, large and sudden increases in demand or drops in supply were difficult to resolve quickly, smoothly or gradually, resulting in delays in production and sales processes along the supply chain and changes in relative prices. However, from the point of view of inflation, relative price variations associated with bottlenecks had to be of a conjunctural rather than permanent nature[39].

On the demand side, however, the pandemic generated an increase in the relative demand for goods, partly due to the loss of service-related consumption opportunities and partly reflecting the increase in demand for some goods induced by the pandemic shock (e.g., office, gym and home entertainment equipment).

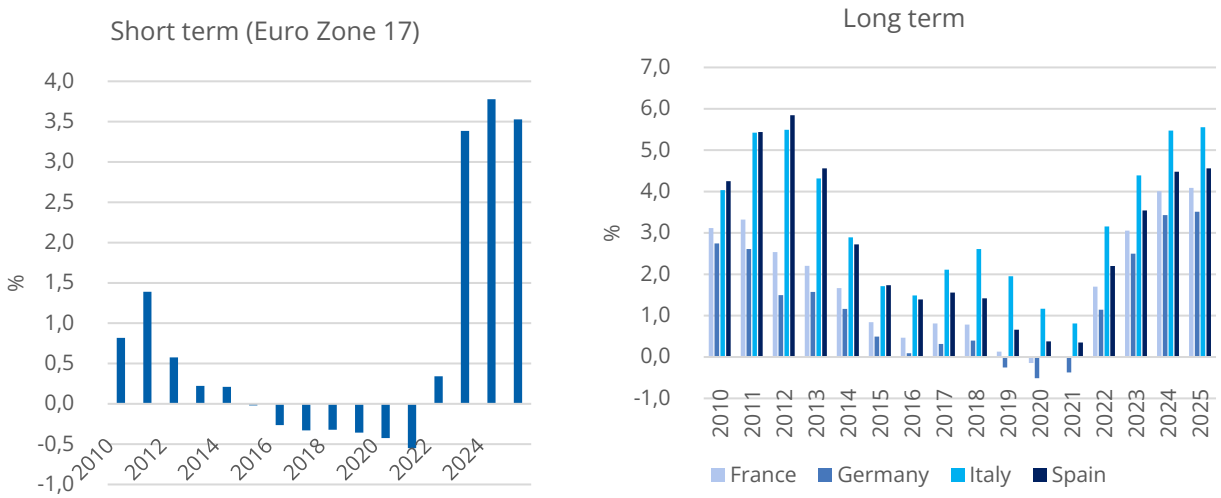
The increase in inflation, caused by higher energy prices and others[40], had an impact on financial markets and asset allocation. As a result, central banks around the world took action and will continue to do so until high inflation is brought under control.

[39] In particular, an increase in the relative price of a scarce item will eventually induce the creation of new supply, while cooling demand. Moreover, if the supply disruption is caused by a time-limited loss of productive capacity (such as a factory closure), the recovery of supply capacity when the temporary disruption has been reversed will put downward pressure on prices.

[40] Because the sudden reactivation of the economy after the pandemic led to a temporary increase in demand, there was a lack of short-term responsiveness, which became a drag on the economy and a threat to growth and inflation. Also, supply, which is much more rigid in the short term than demand generated bottlenecks that affected part of the

One of the main monetary policy tools to address inflation is interest rates. For example, higher interest rates pull down consumer incomes, which could translate into lower spending on travel and driving, limiting oil demand. In turn, higher interest rates also increase manufacturers' costs, so the data suggest that a slowdown in the sector may be underway. The yield curve is expected to remain under surveillance, even though the markets have already discounted possible hikes (Seurat, 2022). In any case, past interest rate hikes continue to be passed on to financing conditions, increasingly dampening demand, thus contributing to lower inflation.

Chart 48. Recent evolution of short-term and long-term interbank market interest rates



Source: Prepared by the authors based on OECD (2023).

The U.S. Federal Reserve[41] and others warned in summer 2023 that more hikes could be on the horizon to combat high inflation.

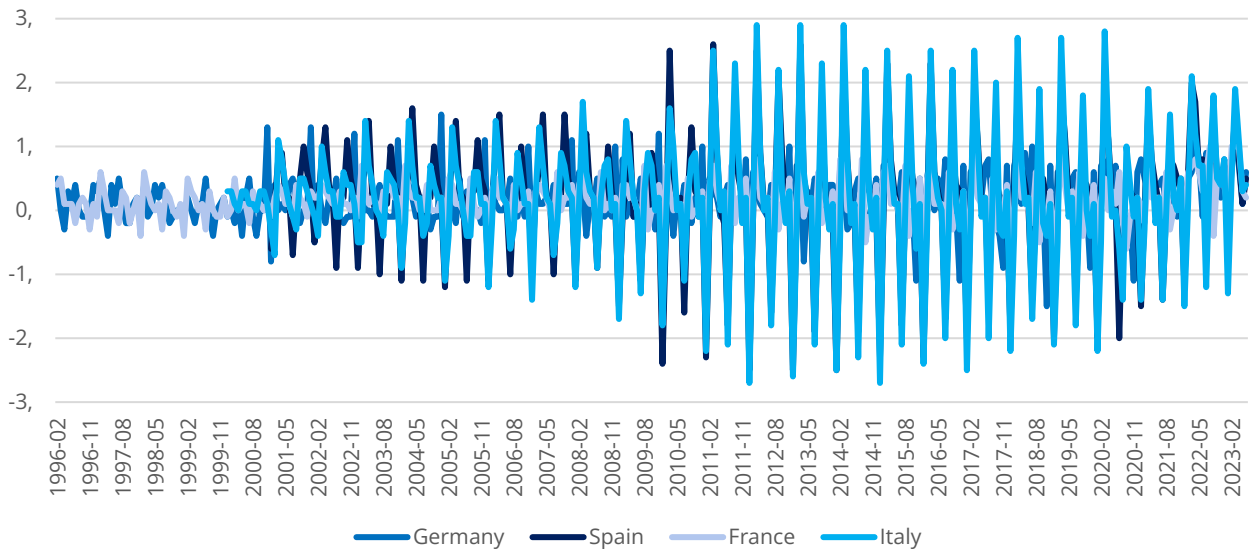
The following chart shows core inflation, another indicator of inflation trends, which presents the changes in prices in the short and medium term in processed foods, clothing, restaurants,

supply chain and global production (e.g. due to shortages of chips for transporting goods). The ECB's Governing Council has been looking for inflation to return to its medium-term target of 2%, so its future decisions should aim to keep its policy rates at sufficient levels for as long as necessary.

[41] On July 27, 2023, the Federal Reserve raised its policy rate for the eleventh time in 17 months as part of its efforts to curb inflation. However, it offered few clues as to whether or not it would raise rates again. This latest hike raised the Fed's benchmark short-term interest rate from around 5.1% to 5.3%, its highest level since 2001. Together with the previous hikes, this move by the Fed could lead to further increases in the cost of mortgages, auto loans, credit cards, and business loans (Rugaber, 2023).

communications, leisure and culture. In addition to showing the increase in the cost of living, it facilitates the measurement of the results of a country's monetary policy (and the actions taken to improve it) since it does not include transitory factors that would make the estimates imprecise. In this case, even evolution is observed between territories, where, in fact, since 2020, a slight reduction in variability can be observed concerning the previous decade.

Chart 49. Evolution of core inflation



Note: The calculation of core inflation does not include the most volatile products, i.e., those that are more susceptible to a change in their "value", such as unprocessed food (fruit or vegetables), energy (gas, electricity, etc.) and fuel.
Source: Prepared by the authors based on Eurostat.

4.3.2.3. Employment

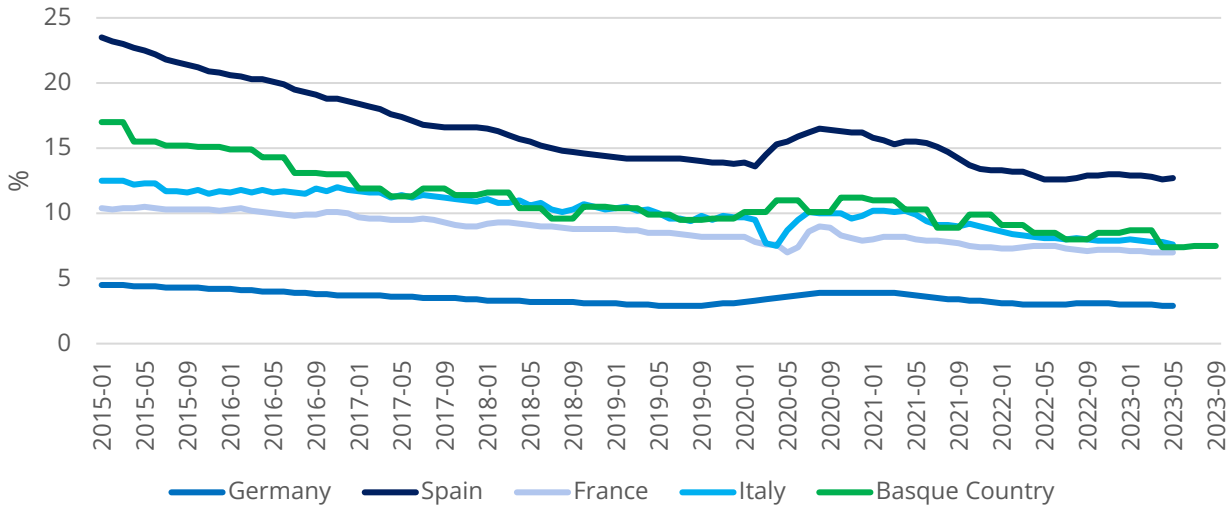
An energy crisis can have an impact on employment in two ways. On the one hand, it influences labour requirements, and on the other hand, it can impact wages.

About employment needs, an analysis of the November 1973 to March 1974 energy crisis in the United States found that the industries most directly affected were the gas stations and automobile manufacturing industries (Early, 1974).

In Europe and the current context of the energy crisis, the economic sectors with the most significant energy dependence were the most affected due to increased production costs. These include mining, chemicals, metallurgy and fertilisers. Other sectors, such as food and hospitality, were also indirectly affected due to their dependence on products whose costs increased.

However, according to (European Commission, 2022), the labour market at the end of 2022 had remained resilient despite the reduction in production, and a decrease in new hiring intentions was observed. In the following chart, the aforementioned evolution in terms of the unemployment level can be observed.

Chart 50. Evolution of monthly unemployment



Source: Prepared by the authors based on Eustat and Eurostat.

On the other hand, there is the repercussion in terms of wages. Thus, as just presented, one of the direct consequences of the energy crisis has been the increase in inflation to levels that had not been reached for decades. This has resulted in wage hikes[42] (Moreno, M., 2023).

However, the current energy crisis differs from previous ones in several respects. First, compared to the 1970s, EU economies have become less energy dependent (due to greater energy efficiency), so the shock will affect the economy to a lesser extent than in the 1970s.

Second, the response of nominal wages to rising energy prices declined over time. In specific environments, inflation is no longer used in wage settings. This, together with expectations that the crisis would be temporary and monetary policy efforts to reduce inflation and keep inflation expectations well anchored, sought to limit demands for wage increases.

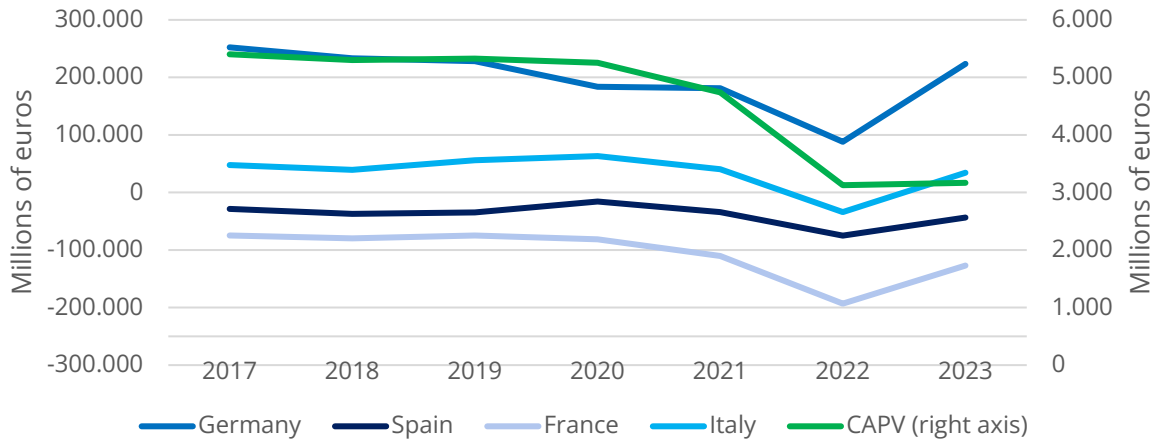
4.3.2.4. Balance of trade

Dependence on foreign energy in a context of high energy prices has led to an increase in the trade deficit due to the higher cost of energy products (with a direct impact on activities such as refining), but also due to its repercussions on the cost of other products that use energy as a raw material in their processes (for example, in metallurgy, chemistry or glass and cement manufacturing).

For net energy importers (such as the euro area), energy prices show a stable negative correlation with the terms of trade, interpreted as the quantity of imported goods that an economy can buy per unit of exported goods (Battistini, Di Nino, Dossche, & Kolndrekaj, 2022).

[42] As will be presented below, despite wage increases, there has been an increase in the cost of living, which has led to a loss of purchasing power for families (European Commission, 2022).

Chart 51. Evolution of the trade balance (EXP-IMP)



Source: Prepared by the authors based on Eustat and Eurostat.

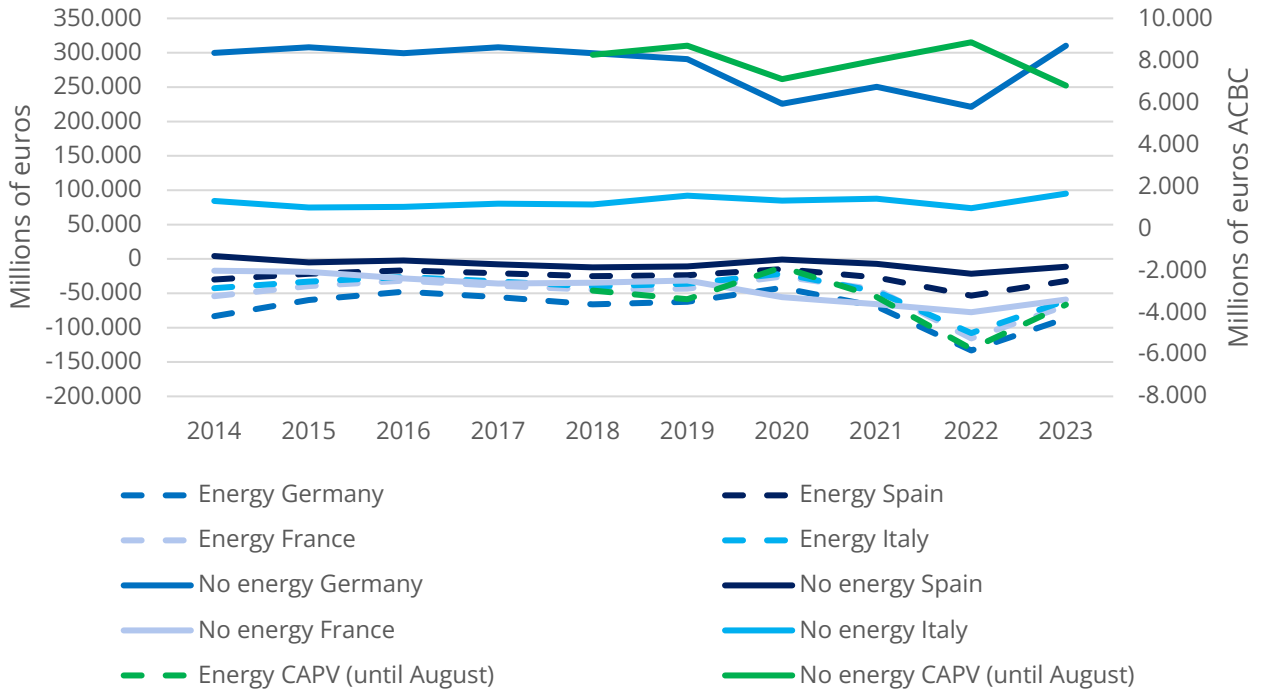
The exporting economy of Germany can be highlighted, as opposed to economies such as the Spanish economy, which is in deficit, and the Basque economy, which maintains positive balances in international trade[43]. However, the latter shows deficit balances in the energy sector when the international non-energy trade balance is disaggregated from the energy balance. There was no deficit balance in the energy area in the period of the 2020 confinements, when crude oil prices were at a minimum, and, on the contrary, there were deficit balances in 2022 when the price of crude oil rose and reached very high levels, close to historical maximums.

The volatility of the energy trade balance is mainly due to fluctuating energy prices. In contrast, the quantities of energy imports and exports vary much less over time and are more easily predictable.

Due to the relevant share of energy products in total trade, the total trade balance follows a similar pattern as the trade balance of energy products, but at a different level (Eurostat, 2022). In all cases, the energy trade balance is negative. The non-energy trade balance is positive in Germany, Italy and the ACBC.

[43] This section includes imports and exports from the rest of the world, not those produced in the context of the Autonomous Communities.

Chart 52. Evolution of the energy and non-energy trade balance (EXP-IMP)



Source: Prepared by the authors based on Eustat and Eurostat.

4.3.3. Security Energy

The International Energy Agency (IEA) was founded in 1973 in response to that year's oil crisis. Its activity was initially focused on the security of crude oil supply from an accessibility and availability point of view (IEA, 2011). Although its conception of energy security has evolved, in the development of the Model of Short-Term Energy Security (MOSES[44]), only some related indicators will be presented here, following the framework of analysis extracted from the literature review[45].

[44] MOSES is a tool based on a set of quantitative indicators that measures two aspects of energy security in IEA countries: (i) the risks of energy supply disruptions and (ii) the resilience of a national energy system to cope with such disruptions.

MOSES integrates approximately 30 indicators, analyzes the vulnerabilities of primary energy sources and how they affect the security of secondary fuels. It includes external factors related to imported energy, as well as internal factors related to domestic energy production, transformation and distribution.

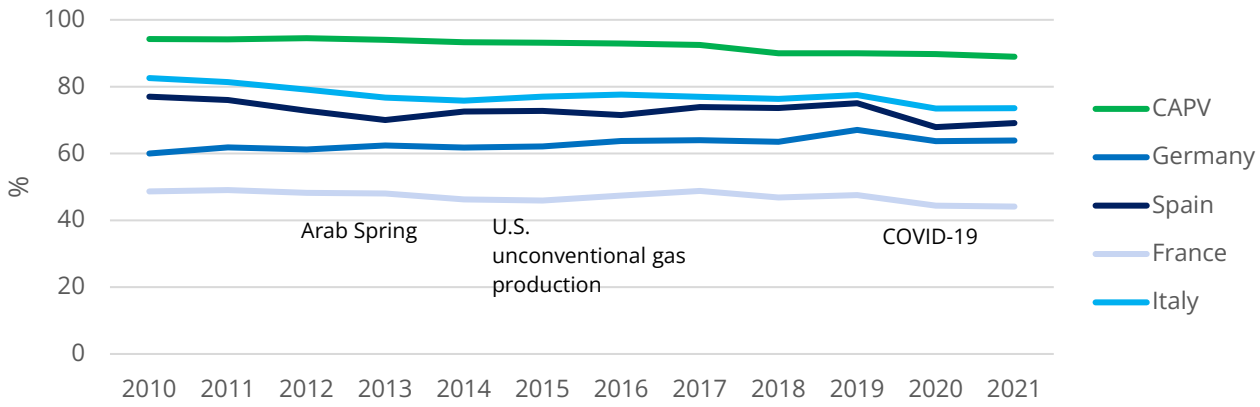
[45] For more detail on theoretical frameworks to address energy security, we recommend Larrea Basterra, et al. (2019), where the framework based on international relations, the MOSES, that of the U.S. Chamber of Commerce and the so-called four As (*availability, accessibility, affordability, and acceptability*) are presented.

4.3.3.1. Energy dependence and energy production

Energy dependence, estimated as the ratio between net imports and gross available energy[46], indicates the dependence on the exterior to cover energy needs. In parallel, it represents the capacity of a territory to meet its needs from its own resources.

The following chart shows the high dependence of the ACBC (89%) and Spain (69%), although this has been significantly reduced in recent years. It can also be seen that France's dependence on foreign sources to cover its energy needs has been below 50% for at least a decade. The measures taken by the EU to reduce energy consumption and promote renewables to deal with the energy crisis and the impact of the war in Ukraine should result in a reduction of energy dependence in all territories.

Chart 53. Evolution of energy dependence



Source: Prepared by the authors based on Eustat (2023a).

Likewise, as it seems to be observed, none of the events that, in the case of energy prices, had an influence (not even the increase in energy prices) have a clear impact on the evolution of this ratio[47].

Table 16. Evolution of oil and other liquid fuels consumption (millions of b/d)

	2018	2019	2020	2021	2022	2023
OECD	47,73	47,77	42,05	44,77	45,65	45,76
No OECD	52,32	53,15	49,57	52,86	54,29	56,21

Note: OECD = Organisation for Economic Co-operation and Development.

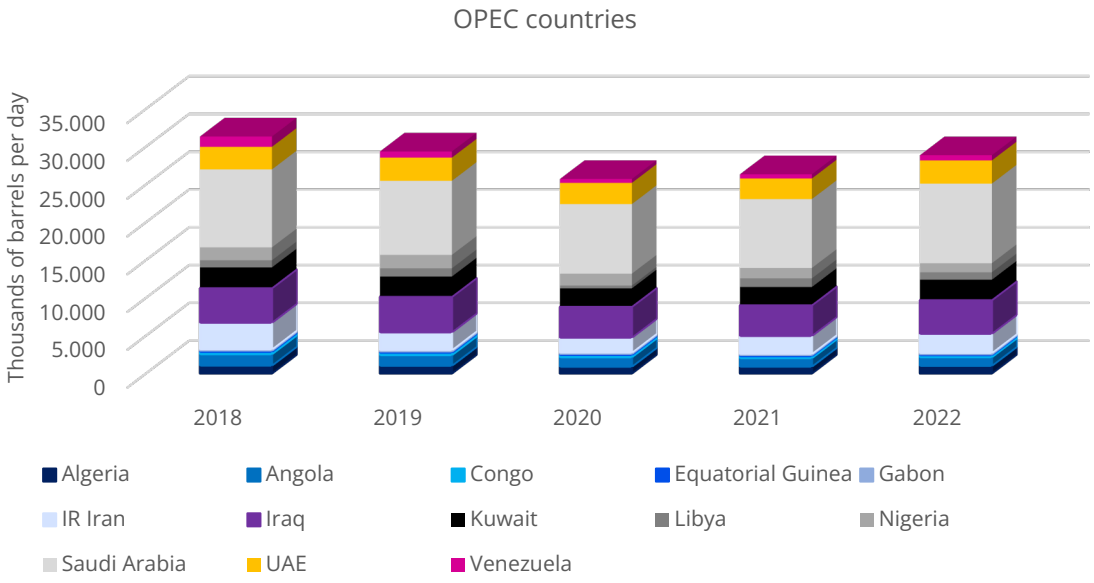
[46] Primary energy consumption.

[47] However, what did happen was that, in 2023, Spain imported more Russian gas than ever before, multiplying its dependence by six compared to 2018. Russia became Spain's third largest gas supplier (from the Palace, 2023).

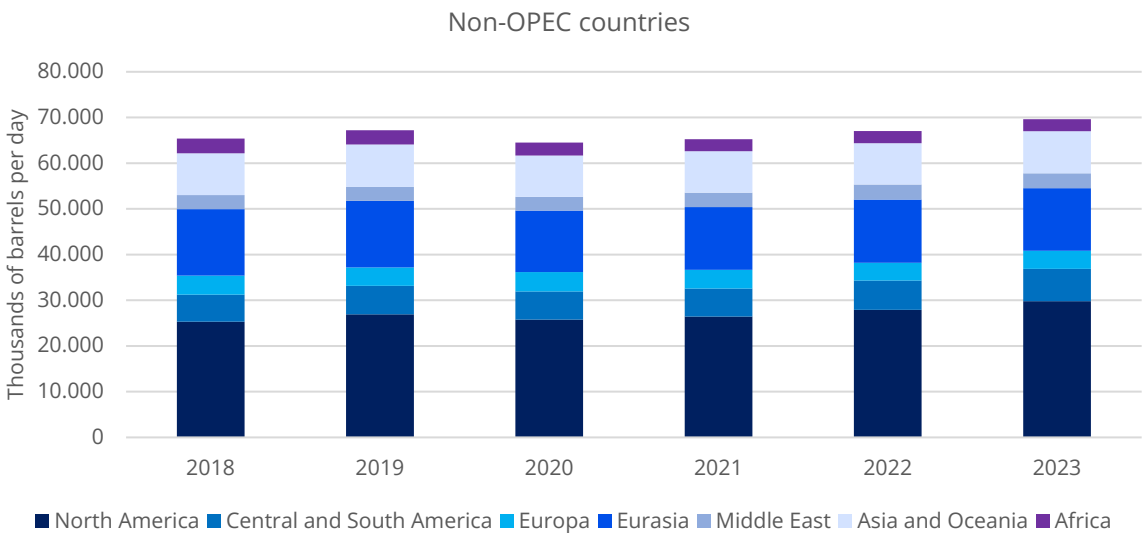
Source: Prepared by the authors based on (Energy Information Administration, 2024).

Much of the foreign dependence in the countries analysed is due to crude oil, where, as can be seen in the table above, non-OECD countries have increased their demand in recent years, placing it above the demand of OECD countries. The group comprises the Organization of the Petroleum Exporting Countries and its allies, including Russia (OPEC+), which pumps around 40% of the world's crude and has cut oil production since 2018. The annual figures do not show the cuts that members Saudi Arabia and Russia, the world's largest oil exporters, made to push up prices[48].

Chart 54. Evolution of world crude oil production



[48] An action that only briefly boosted the market.



Source: Prepared by the authors based on Organization of the Petroleum Exporting Countries (2023) and Energy Information Administration (2024).

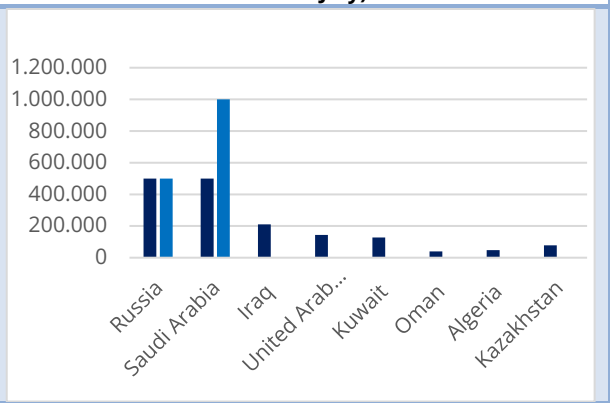
An OPEC+ agreement to limit supply through 2024 and bring total announced production cuts to more than five million barrels per day (b/d), or about 5% of global oil production, was tabled in April 2023 (Reuters, 2023b). This announcement deepened the production cuts introduced in November 2022 and helped lift prices by around US$9 per barrel to over US$87 per barrel in the following days. However, these cuts fail to lift oil prices due to (i) significant concerns about weak demand, (ii) higher interest rates, and (iii) rising US production.

Indeed, data from China raised fears that the economic recovery following the coronavirus blockades in the world's second-largest oil consumer was losing steam. "*The economic recovery in China following the lifting of the coronavirus restrictions has been notably slower than expected, even though China's oil demand data proved robust*" (Ategi, 2023).

Finally, faster-than-expected growth in US production has also contributed to oil price pessimism. The U.S. Energy Information Administration projects that the country's crude oil production will rise by 720,000 b/d to 12.61 million b/d this year, up from a previously forecast increase of 640,000 b/d (Reuters, 2023c).

Saudi Arabia announced Monday, July 3, 2023, that it would extend its oil production cut by 1 million barrels per day to boost prices, while Russia announced it would reduce exports by 500,000 barrels per day in August (Hurtado, 2023).

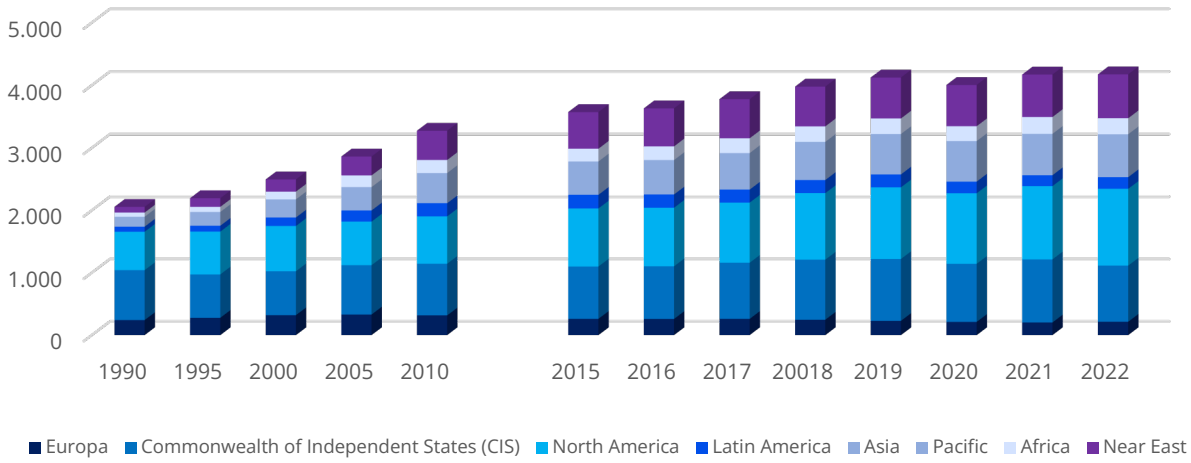
Table 17. Most recent OPEC production cuts (2023)

Country	Reduction April (barrels of oil)[49]	Reduction July (barrels of oil)	Reductions in barrels of oil (left column-April, right column-July)
Russia	500.000	500.000	
Saudi Arabia	500.000	1.000.000	
Iraq	211.000		
United Arab Emirates	144.000		
Kuwait	128.000		
Oman	40.000		
Algeria	48.000		
Kazakhstan	78.000		

Source: Prepared by the authors based on Reuters (2023b).

Regarding gas production, the evolution has been increasing, and a drop was barely observed in 2020. In 2021, production was already established ahead of 2019, and in 2022, it increased again.

Chart 55. Evolution of world natural gas production (bcm) and international trade in 2021



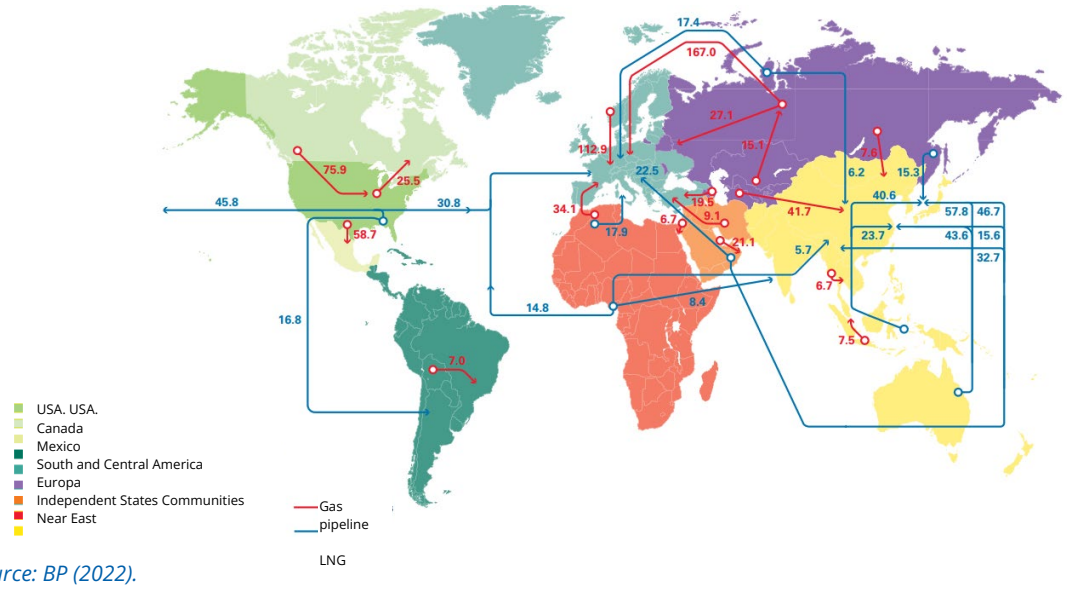
Source: Prepared by the authors based on Enerdata (2023).

[49] (Reuters, 2023b).

In addition to global production, it is essential to understand the trade flows of natural gas and LNG since they represent the main dependencies. However, data for 2021 are presented below in the absence of more recent updates.

In 2021, economic recovery was started, and the global gas market increased by 4% and the LNG market by 6% (Alvarez Pelegry, 2022). The US played an important role by increasing its exports, part of which was acquired by Europe, reducing dependence on Russia.

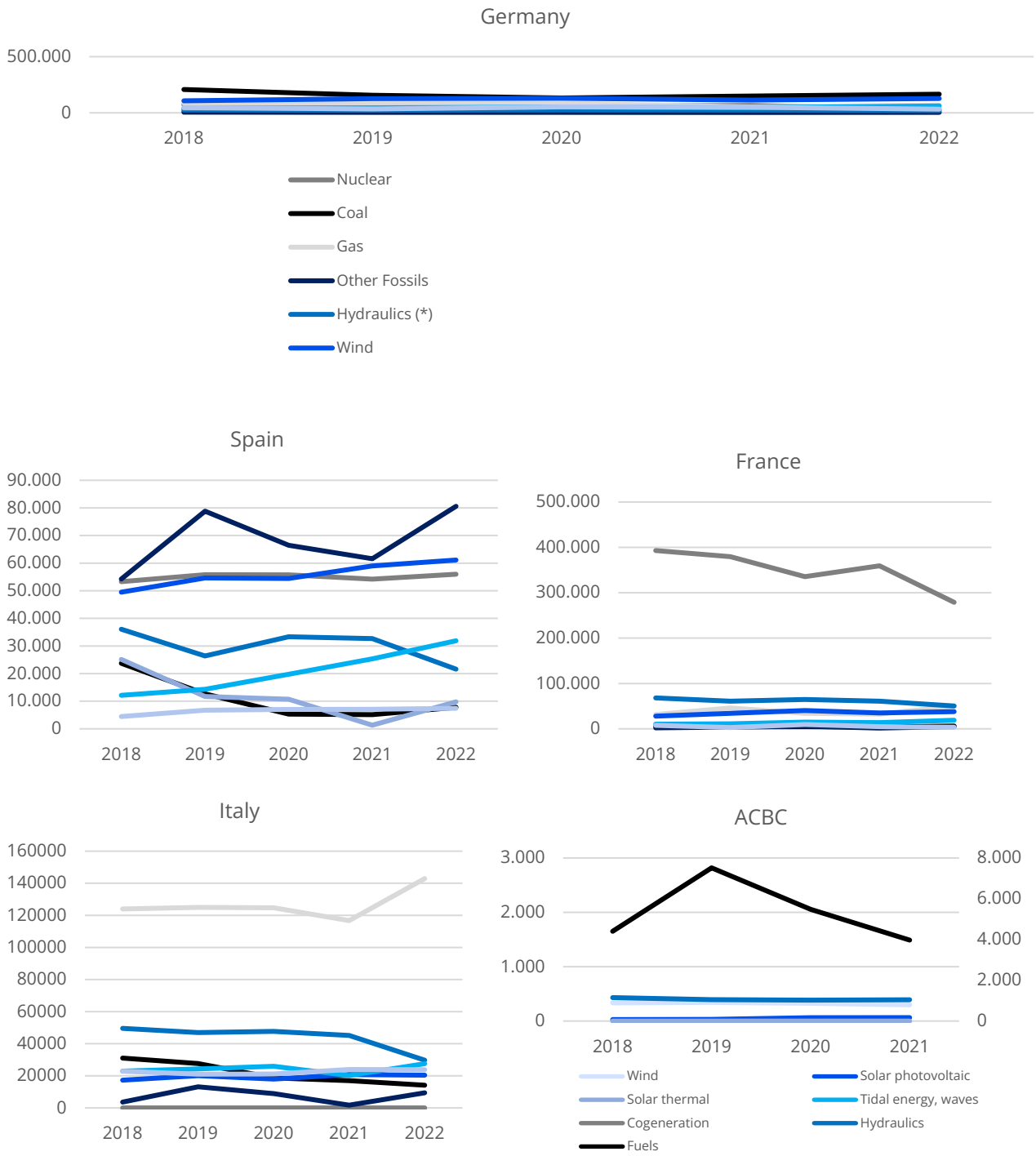
Map 1. Main trade movements of natural gas and LNG (2021).



Source: BP (2022).

The situation is different in the case of electricity since all the countries analysed have their generation facilities, so dependence on foreign sources is much lower.

Chart 56. Electricity production evolution (GWh)



*Note: Fuels include fossil and other renewables. * includes pumping installations.*
Source: Prepared by the authors, based on the Spanish Nuclear Industry Forum and Third Vice-Presidency of the Government & Ministry for Ecological Transition and the Demographic Challenge (2022).

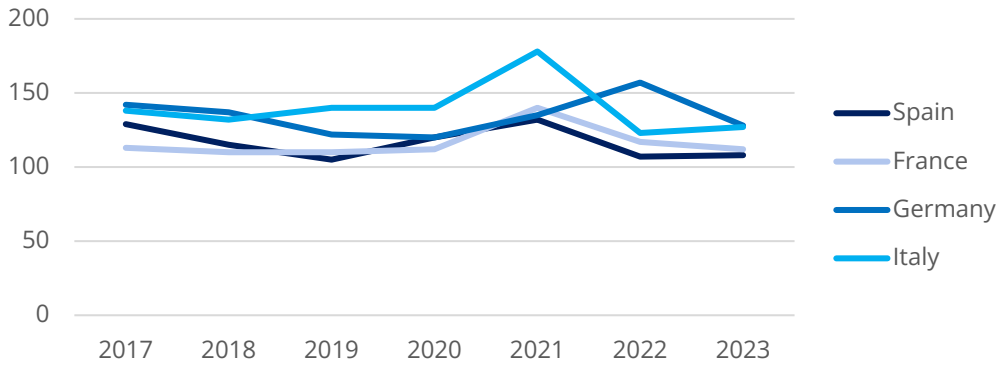
However, the International Energy Agency (IEA) acknowledged in its February 2023 report on the 2023 electricity market that the use of gas to generate electricity in Spain increased by

around 25% in 2022, even though domestic demand fell by 2.6%. This, he points out, could be due to the collateral effects of the "Iberian exception" (gas cap), which promoted an increase in exports to France (IEA, 2023b).

4.3.3.2. Crude oil and gas inventories

Due to high external dependence, countries have crude oil inventories, which have fallen by more than 1% per month since August 2020. In fact, in July 2021, OECD industry crude oil inventories or *stocks* were around 4% below their five-year average (Nagle & Temaj, 2021). Spain remains among the countries with the lowest inventories. However, there is no change in the trend due to the international context.

Chart 57. Evolution of crude oil inventories (in days of net imports)

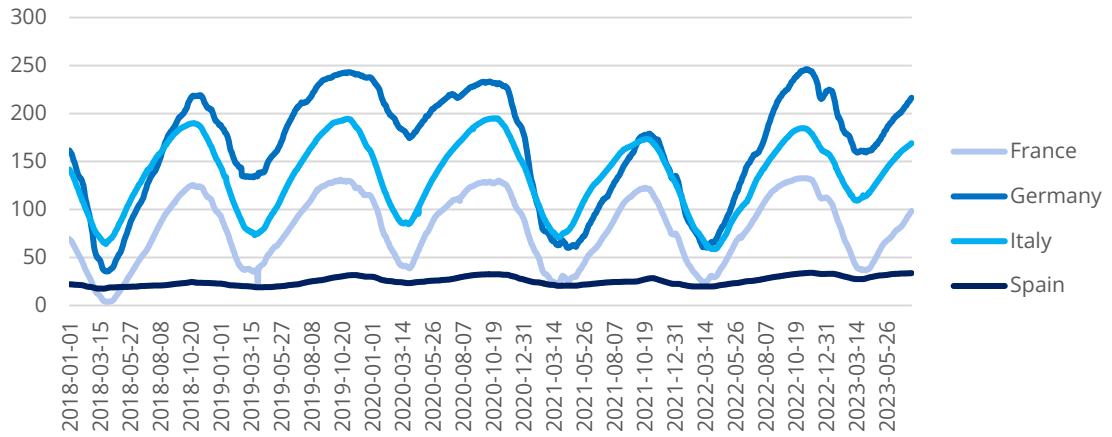


Source: Prepared by the authors based on IEA (2023f).

Regarding natural gas, the outbreak of the Russia-Ukraine conflict led to a drop in supply, which, together with the sanctions imposed on Russia, prompted EU countries to reduce their dependence on Russian gas imports and increase the level of gas inventories. This reduction in dependence was achieved by increasing imports of pipeline gas from Norway, North Africa, and Azerbaijan, as well as LNG from the United States, Qatar, and Nigeria. Since the start of the war in Ukraine, gas consumption has fallen by 11% in the EU as a whole (Alonso, López, Santabárbara, & Suárez-Varela, 2022).

The EU proposal that gas storage reaches 80% of its capacity before the winter of 2022/2023 and up to 90% before the following winter periods was quickly implemented so that by September 2022, EU storage facilities were already 80% full on average. In October 2022, the filling level reached 90%. In March 2023, after the cold season, the filling level was around 55%, above the same month in 2022 (26%). (European Council & Council of the European Union, 2023) and with a rapid filling rate. In July 2023, Spain's gas reserves stood at 98.7% (Alonso Pascual, 2023). (Alonso Pascual, 2023b) and in October 2023, the combined EU reserves exceeded 95% of storage capacity (Flores, 2023).

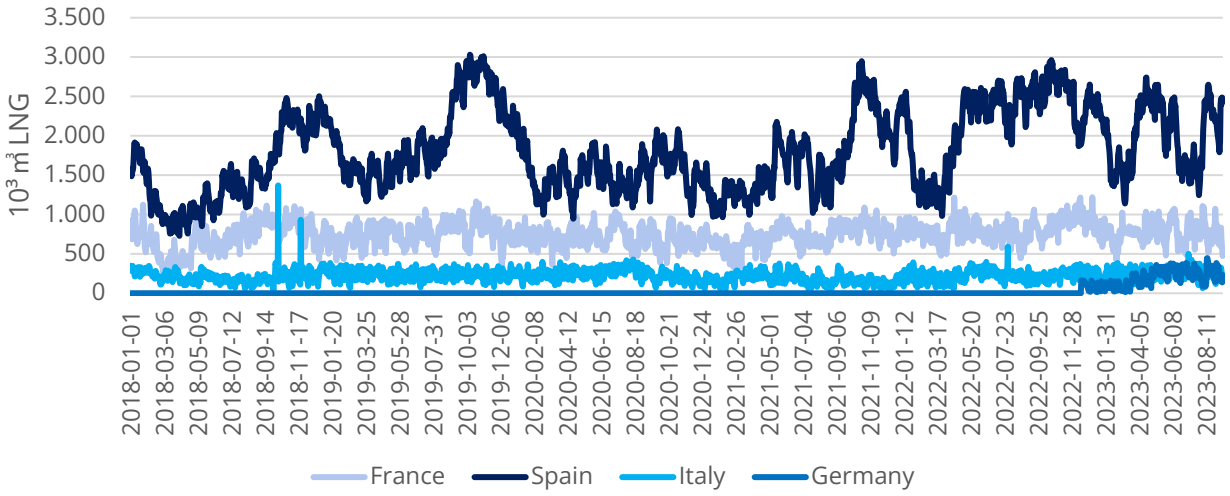
Chart 58. Evolution of subway natural gas inventories (TWh)



Source: Prepared by the authors based on GIE Aggregated gas storage inventory (2023).

In the case of Spain, it is observed that it has a lower level of subway natural gas storage due to the weight that LNG has in the national energy system and where it stands out concerning other countries.

Chart 59. Evolution of LNG inventories (thousands of m³)



Source: Prepared by the authors based on GIE & ALSI (2023).

4.3.3.3. Diversification of energy import sources

To improve supply security, diversification of raw material origins is encouraged so that the greater the diversification, the lower the risk of supply chain disruptions. The following table shows the percentage data of the leading crude oil origins in the studied countries.

Table 18. Origin of crude oil imports by country (%)

Spain					Italy				
	2018	2019	2020	2021		2018	2019	2020	2021
Nigeria	16,9	19	23,8	20,1	Azerbaijan	11,7	13	15,2	19,9
Libya	9,61	12,1	3,99	10,9	Iraq	8,96	12,5	9,51	12,8
Algeria	2	2,41	2,63	4,75	Saudi Arabia	7,24	5,45	7,16	8,84
Mexico	11,9	11,4	12	11	Russia	13	14,3	14	12,6
USA	1,96	3,59	6,41	7,92	United Kingdom	0,53	0,45	2,36	2,61
Saudi Arabia	11,8	12	9,42	6,68	Norway	1,03	0,86	1,17	2,15
Iraq	6,5	7,37	5,58	5,88	USA	2,62	2,97	8,16	4,95
Kazakhstan	6,19	6,89	6,94	5,7	Libya	16,7	18,7	4,41	17,8
Russia	2,04	2,25	2,44	4,9	Nigeria	2,5	3,76	3,56	5,59
Brazil	6,88	2,98	6,54	4,03	Kazakhstan	19,3	19,3	24,5	3,02
Angola	4,4	3,58	3,19	0,98	Iran	6,01			
Others	19,82	16,43	17,06	17,16	Others	10,41	8,71	9,97	9,74
France					Germany				
	2018	2019	2020	2021		2018	2019	2020	2021
Nigeria	12,5	15,2	12,5	15,8	Russia	40,5	33,5	32,4	32,2
Algeria	11,2	11,5	10,9	12,1	Libya	0,72	1,52	3,8	11,1
Libya	11,8	6,4	4,12	11,6	Norway	11,7	11,5	5,35	7,24
USA	3,33	8,94	14,9	16	United Kingdom	8,88	16	12,8	6,91
Kazakhstan	15,8	15,8	15,2	11,7	Netherlands	7,1	6,7	6,06	6,62
Saudi Arabia	15,6	16,4	13,1	7,4	Kazakhstan	0,3	0,6	0,62	11,9
Iraq	2,19	4,19	2,35	5,87	US	2,55	2,72	17,2	6,13
Norway	5,01	4,95	6,51	5,98	Iraq		2,6	2,05	3,31
United Kingdom	4,03	3,02	4,91	4,46	Nigeria	8,48	8,39	7,72	3,87
Russia	3,2	3,94	3,55		Chad			1,2	3,16
Others	15,34	9,66	11,96	9,09	Others	19,77	16,5	10,8	7,56

Source: Prepared by the authors based on OEC (n.d.).

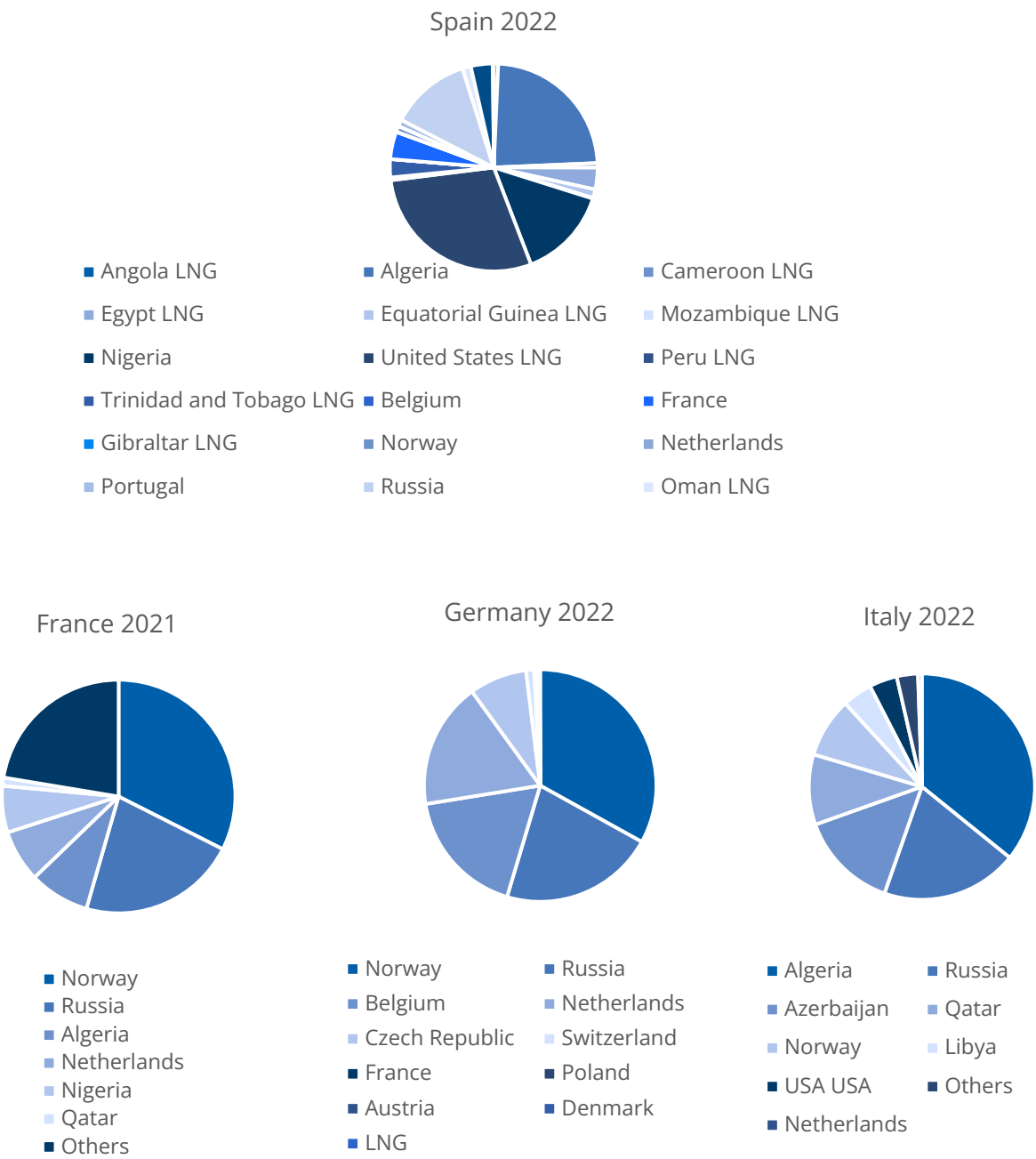
As can be seen, the concentration is moderate. France has the lowest Herfindahl e Hirschman index[50] (HHI), between 1,100 and 1,200. It is followed by Spain, slightly above the level, between 1,100 and 1,300. Italy is next with an HHI between 1,200 and 1,400. In 2020, it dropped, and in 2021, even more, achieving a level of 1,576, mainly due to a drop in imports from Russia, which went from representing 40.5% in 2018 to 32.2% in 2021. According to Destatis & Statistisches

[50] This index assesses the level of concentration in the industry. It is estimated as the sum of the squared sum of the market shares of the agents. The value is between 0 and 10,000. The higher the index, the higher the level of concentration and the greater the market power of the companies.

Bundesamt (2023), in January 2023, German crude oil imports from Russia were just 3,500 tons compared to around 1.3 million tons the previous month or 2.9 million tons in March 2020 (the peak between January 2020 and January 2023).

In the case of natural gas, in 2022, Spain imported around 30% of its gas from the USA in the form of LNG. Some 24% came from Algeria, 14% from Nigeria and 13% from Russia, despite the conflict and the fact that it started in the first quarter of the year.

Chart 60. Origin of natural gas imports



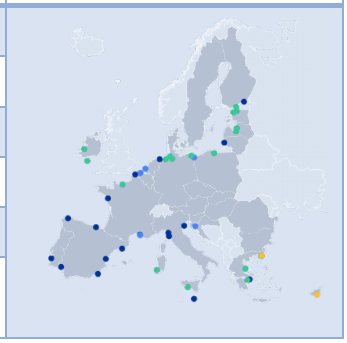
Source: own elaboration based on CORES, Statista and others.

In comparison with other territories, it can be seen that there is a leading group of large suppliers, represented by three or four countries, and then another more diversified group with less weight. Spain has the lowest concentration of gas suppliers for the year available, with a HHI of 1,810, compared to 2,203 in France, 2,250 in Germany and 2,084 in Italy. With these values, it can be said that in none of the cases is an excessive concentration in one supplier.

4.3.3.4. Regasification and Electricity Interconnection Capacity

The search for new origins (to replace Russian gas) has boosted LNG trade in Europe. As can be seen, the LNG storage capacity in Spain is higher than that of other European countries. The latter represents about a quarter of the total capacity in Europe and about 40% of the EU-27 regasification capacity.

Table 19. Annual regasification capacity. Large-scale LNG import terminals by country (bcm(N) / year)

Territory	Operations	Under construction	Planned	
France	33		4	
Germany			31	
Italy	16		18	
Spain	67*			
EU-27	169	17	101	
Europa	264	22	110	

Note: The operating capacity value for Spain includes the Gijón terminal, which has been operational since August 2023 and is not marked on the map.
Source: modified from GIE, G. I. E. (2023) and map of Council of Europe and Council of the European Union (2022).

Since the beginning of the Russian invasion of Ukraine, Germany has put into operation floating *storage and regasification units* (FSRU) (The Guardian, 2022; Habibic, 2023) to solve the problems of dependence on Russian gas and reduce consumption. In France, the authorities approved the project for a floating LNG terminal in Le Havre (GRT Gaz, n.d.). Also, in Italy, an FSRU unit at the Tuscan port of Piombino was put into operation in March 2023, with a capacity of 2 bcm this year and about five bcm by 2024 (Reuters, 2023a). In Spain, where there was non-operational regasification capacity, in the summer of 2023, the Gijón terminal (El Musel) became operational and received the first LNG carrier (EFE, 2023).

Regarding electricity, the following table shows the exchange capacity available in recent years in the interconnections of the Iberian Peninsula with France and Portugal. In any case, it can be pointed out that Spain, in 2023, still does not meet the 15% interconnection targets established in the Community regulations for each country (in fact, it barely reaches 5%, including that of Portugal and France) (Martos Villar, 2023). The objective is to increase the interconnection capacity with France from the current 2,800 MW to 5,000 MW (Redeia, 2023).

Table 20. Interconnection capacity (MW)

Year	FR▶ES	EN▶FR	PT▶EN	EN▶PT
2018	2.568	2.185	3.096	2.221
2019	2.201	2.246	3.276	2.635
2020	2.639	2.460	2.960	2.977
2021	2.878	2.392	3.020	3.751
2022	2.828	2.298	2.992	3.679
2023	2.566	2.136	3.100	3.576

Source: Prepared by the authors based on IESOE (2023).

5. Conclusions

The energy crisis led to increased energy prices in general and their volatility above normal levels

The price level of different energy sources and their volatility began to increase in 2021 with the beginning of the gradual economic reopening after the COVID-19 pandemic. Subsequently, they were exacerbated by rising tensions due to the start of the Russia-Ukraine war.

2022 became an atypical year if one analyses past developments, with gas prices increasing by 400% on average in European markets (TTF and UK), which was sometimes higher, and electricity, which in European wholesale markets more than doubled already in summer 2021 and remained above €100/MWh (reaching levels of between €440 and €543/MWh in summer 2022).

Oil prices also rose above US$ 100 per barrel (but below the historic highs of 2008), except in the case of US crude oil, following the particularly depressed prices experienced in the spring of 2020, which in the case of West Texas became negative. For its part, the price of coal, which had already risen in 2021, reached levels above US$ 400/Mt in 2022.

The increase in electricity and coal prices was a consequence of the increase in gas prices, in the first case because gas is the source of energy supply for electricity generation and in the second because, given the increase in gas prices, coal entered the energy *mix* as a substitute for gas.

As a result of the increased use of coal to offset rising gas prices, allowance prices were not oblivious to the situation in international energy and regional electricity markets and increased. In fact, after almost a decade of gradually increasing prices from €10 to €40 per ton of CO_2, in 2021-2023, prices remained in the range of €60-100.

In electricity, the level of the energy component increased in all countries and for all consumers, industrial and domestic, and of different consumption levels or bands. The increase was most notable in 2022 when gas prices and emission allowances were higher.

The increase in gas prices had different impacts on electricity prices and volatility

The increase in electricity prices was reflected in increased market volatility. It was a consequence of the increase in gas prices, which also impacted the rise in inflation, which in turn was affected by the tensions in the raw materials and food commodities markets.

This was due to the impact of natural gas on electricity prices (although it also depends on the generation *mix*). In the wholesale market, natural gas is the technology that usually sets the marginal price. Therefore, an increase in gas prices means an increase in the price of electricity in that market. In the case of Spain, given that consumers under the Voluntary Price for Small Consumers (PVPC) are directly exposed to the wholesale price, they were greatly affected by the increase in the price of natural gas.

Also, the increase in electricity prices was reflected in a slow increase in consumption caused by the increased industrial activity that followed the pandemic.

The complex context resulting from the health and subsequent energy crises affected the economic situation in some areas

The energy crisis has damaged the recovery of the struggling European economy. The data show that, while the evolution of GDP improved compared to 2020 in a very striking way, in 2022, GDP fell again in the countries under study. Indeed, the drop in GDP resulting from the health crisis recovered quickly in 2021 to levels above 2019. The impact of the energy crisis in 2022 was negligible. The 2022 GDP level remained very slightly above the 2019 GDP level.

Regarding unemployment, whose level increased due to the pandemic, it can be said that it was not significantly affected by the energy crisis since its reduction was maintained, albeit discreetly.

However, it is possible to point out the increase to levels not seen in more than two decades and, in many cases, up to double-digit inflation. An increase began in 2021, but in 2022 reached the maximum in more than 20 years. France kept inflation at single-digit levels, reaching 6.7%. However, core inflation remained less volatile than in 2010-2020. As a result, central banks acted to contain inflation and the loss of citizens' purchasing power. As a result, they addressed interest rate hikes.

The trade balance (exports-imports) of energy products worsened in 2021 and 2022 reached its minimum, being negative in all territories. However, a slight change in trend is observed in 2023. Regarding the trade balance of non-energy products, Germany, Italy, and the ACBC maintained a positive balance during this period.

Governments developed a wide range of measures in response to rising energy prices to limit the impact of these increases on the economy

Governments responded to the rise in energy prices with a wide variety of fiscal measures (adaptation of tax figures, reduction of tax rates or introduction of taxes on companies' extraordinary profits to defray the cost of the measures introduced by governments) and non-fiscal measures (granting of subsidies, discounts and others on energy bills, promotion of energy saving and efficiency measures).

The EU developed different initiatives and packages of measures over 2021-2024 (Communication *a toolbox for action and support* or the REPowerEU Communication) and opened the possibility of adopting others at the Member State level (such as the Iberian exception).

At the global level, most of the measures introduced in high-income countries were non-fiscal measures, such as subsidies, transfers or other regulatory interventions. In contrast, fiscal measures were more frequent in low- and middle-income countries.

However, temporary reductions in indirect taxes (e.g., the reduction of VAT from 21% to 10% on electricity bills in Spain) were a common form of fiscal measure, along with other reductions in direct taxes (such as reductions in income and corporate taxes for energy efficiency investments). In Spain, reductions in environment-related taxes, especially excise taxes on petroleum products, were the most frequent measures to cushion the impact of higher prices, followed by reductions in VAT on petroleum products and reductions in import duties.

In another sphere of action, governments were not unaware of the impact of price increases on agents and, therefore, directed public funds to address the associated challenges. Thus, the governments of Germany, Spain, France and Italy devoted the largest share of public spending on energy-to-energy accessibility/affordability (which accounted for 30-60% of the total, depending on each case), sustainable mobility and energy efficiency.

The energy crisis led to a deterioration in the quality of life of part of the population due to increased energy poverty in European households

Households were directly and indirectly affected by the increase in energy prices. Directly due to the impact they suffered from an increase in energy expenditure relative to disposable income. Indirectly, they suffered the increase in the prices of goods and services whose productive process was also affected by the increase in energy prices (for example, the increase in the price of a car, in which a part of the increase in the price of energy suffered by the steel sector is passed on).

Indeed, in the case of households, a reduction in disposable income is observed after the slight increase in 2021. In addition, the generalised drop in household savings in 2021 and 2022 can be indicated. In both cases, it is impossible to establish a direct link with the increase in energy prices since there was also, in parallel, the gradual exit from the health crisis, which had imposed restrictions that pushed up savings (closures of leisure establishments, restrictions on mobility, etc.).

In any case, the complex environment pushed consumer confidence down in 2022, a fall that, in the case of Spain, was the most drastic of the territories analysed. In 2020, at the height of the pandemic, confidence had declined, but to a lesser extent than in the year of the start of the Russia-Ukraine war.

Except for France, in Germany, Spain, Italy, and the ACBC, the weight of energy expenditure (electricity, gas, and other sources) as a percentage of total disposable income has increased since 2020. In Italy, this percentage more than doubled. In absolute terms, household energy expenditure increased in all countries in 2021 and 2022 compared to 2020.

In this context, although there was a very slight fall in the population at risk of poverty or social exclusion (except in France), there was a general increase, although more contained in Italy, in the number of households unable to keep their homes adequately warm. Furthermore, in Spain and the ACBC, spending was reduced on the upkeep and repair of housing; therefore, it is understood that in domestic energy saving and efficiency measures.

Passenger transportation has slowed down its recovery

Passenger transportation was greatly affected by the health crisis, which, as mentioned above, led to the implementation of restrictive measures on local, regional, national and international mobility.

In this area, it should be noted that, despite the progressive reopening, spending on transportation services did not recover to pre-pandemic levels in 2021 and 2022. However, although the price levels of automotive fuels in those years remained high, there was an

increase in spending on using own vehicles. Nevertheless, it also failed to reach the levels before the health crisis and in the consumption of automotive fuels.

Overall, the number of passenger kilometres by road declined, which could partly explain the reduction in road accidents per capita. Similarly, rail and air use recovery was contained in 2021 and 2022. In fact, in neither case in 2022 was the 2019 level reached. Again, the difficulty would be in separating the effects of the pandemic from the impact of the energy crisis on the speed of recovery.

The transition to more sustainable mobility through alternative energy vehicles is still underway

Although up from pre-pandemic levels, the evolution of passenger transport activity was contained in overall terms, including the use of public transport.

Along these lines, a reduction in vehicle registrations is observed. In the case of alternative energy vehicles, gas vehicles saw their demand contract more in 2022, at peak natural gas prices, than other alternative energy vehicles. Moreover, this drop occurred particularly in Italy, where these types of vehicles were more relevant.

Meanwhile, electric vehicle registrations continued upward, except in Italy, where demand was also subdued.

The light and shade of the impact on industrial profitability

Studies show a positive correlation between the increase in energy prices and the business costs of the recent energy crisis. At the same time, other analyses have highlighted the negative correlation between price increases and profitability indicators. In 2022, many European companies with high gas consumption reduced production due to rising gas prices.

However, the main stock market indexes analysed, with significant swings and falls (in spring 2020 and throughout 2022) in 2020-2023, showed a clear upward trend.

In any case, the industry responded with an increase in labour productivity and a continuation of the improvement in energy intensity in recent years, both for the economy and the industrial and energy sector in particular.

A more detailed analysis shows that the price of energy generally increased above the prices of industrial products in the different sectors. In this situation, despite bearing a high burden in terms of energy consumption, some of the more energy-intensive sectors were relatively less affected. That is, sectors such as coking and oil refining and metallurgy, together with wood, paper and chemicals, were less affected than others such as vehicle manufacturing, pharmaceuticals, textiles, clothing, leather and footwear. In the face of eventualities such as the one that occurred, adequate risk management in the purchase of energy could be behind this situation, together with the experience that these energy-intensive sectors have in terms of energy saving and efficiency.

Overall, all sectors passed on the increase in energy prices to their respective consumers, but to different extents. In any case, the final impact increased overall inflation and reduced household disposable income.

There is an apparent quest to reduce dependence on foreign energy sources, but it requires significant investments and trade agreements

The current geopolitical context is introducing changes in international relations in an environment where France is the territory with the lowest dependence on foreign energy (around 50% in 2021) of the countries analysed, and the ACBC is the most dependent (89% in 2021).

Among the measures adopted to combat the crisis at the EU level are others that, to a certain extent, hamper the security of supply, such as the sanctions against Russia. Indeed, Russia was a major supplier of fossil fuels to the EU, mainly to Germany. On the other hand, there are the successive decisions by crude oil-producing countries to cut their production, adding tension to a scenario in which countries were emerging from the health crisis and more significant amounts of energy were needed than in 2020, along with increases in demand from other countries that were hitherto consuming less (non-OECD countries). However, it should not be forgotten that around two-thirds of world crude oil production comes from non-OPEC countries.

In the case of gas, the situation was different, given that there was an increase in production. In this case, part of the problem was the aforementioned sanctions against Russia.

Germany increased its crude inventories in response to the events, but the rest of the countries reduced them slightly. There has been a move towards diversification of origins, where much progress has been made, but a structure is still maintained in which there are four major suppliers and a set of other small suppliers. Geographies change depending on the countries of destination and the international relations maintained by each country. In any case, suppliers' concentration indexes show significant diversification; therefore, the risk of a country unilaterally adopting a measure that further disturbs the context is lower.

In all cases, there is great interest in advancing electricity and gas interconnections and in the availability of regasification facilities to diversify the origins of natural gas. In the case of Spain, for example, the El Musel regasification plant came into operation. In Germany, a floating regasification plant was inaugurated at the end of 2022 to import liquefied natural gas while construction is undertaken on onshore regasification plants.

The impact of the crisis on the environment goes hand in hand with a reduction in energy consumption, mainly through a reduction in energy consumption

Primary energy consumption has been on a declining path for several decades in all the countries under study. During the health crisis, the fall was more significant, leading to an increase in consumption in 2021 compared to 2020, but with a decreasing trend. However, the energy crisis did, to some extent, drive the increase in coal consumption, especially in Germany.

While energy spending increased, energy intensity continued its downward trend in 2021. Indeed, the economy's energy intensity improved with the crisis, which went hand in hand with an increase in energy prices and the interest in reducing the energy bill. Likewise, with lower energy consumption and despite the increase in coal consumption in some cases, further progress was made in decarbonisation and reducing the emission of various pollutants.

Different economic agents developed measures to reduce the impact of the increase in energy prices

Just as governments acted, the various economic agents developed measures or continued to make progress on some measures aimed at reducing the impact of rising energy prices. However, it is not possible to conclude that there is a direct relationship between the evolution of investment in technological development and R&D and the increase in energy prices.

Diversification of origins, having alternative facilities, investing in renewable energies, etc., are common elements in all the countries under analysis. This was something that was being worked on and has now been accentuated. Progress continued to be made in the energy transition, which could result in less vulnerability to this type of crisis.

However, despite the evolution of the electricity generation *mix* in recent years, no element can be highlighted as relevant in 2021-2022. The evolution towards renewables, an essential element to reduce dependence on third countries and to cushion the impact of the increase in the prices of energy sources such as crude oil and its derivatives, or the price of gas, as has happened, has been maintained.

The periods required for their development and the ambitious targets for decarbonisation raise doubts as to whether this crisis will have accelerated the commitments for the penetration of renewable sources or whether the deadlines established in the committed targets will continue to be met. There are numerous investment plans in energy and energy R&D in all countries. Spain is the country with the lowest planned contribution.

The four countries under study are well positioned regarding the energy transition index and have improved overall assessment (France, Germany, Spain and Italy, in order). In any case, it should be noted that only Italy, and to a much greater extent Spain, have made progress in the last period.

There are many areas in which an energy crisis impacts and all the territories analysed have been affected to a greater or lesser extent, in some areas or others

The literature review shows the broad scope of the impact of an energy crisis, and the analysis carried out here corroborates the above statement. Thus, energy crises, understood as unusual increases in energy prices or their volatility, can have important repercussions in various areas such as the economy in general, particularly in the different energy-consuming sectors; in national security and the environment, as well as in other issues such as the development or promotion of new technologies or measures by governments.

Due to this amplitude and the short span between the health and energy crises, the recovery of the former has been disrupted and, to some extent, postponed. However, there are parameters in which it has continued to evolve positively. In addition, there are times when it is challenging to determine questions such as whether the recovery that has not occurred after the pandemic is due to the subsequent energy crisis or simply has not affected it as might have been expected.

Limited up-to-date information hampers a complete analysis of the crisis

In line with the above, although this study attempts to analyse the impact of the crisis holistically, the results presented show the impact of the health crisis. However, in some cases, it has been limited in detecting the impact of energy prices on the main trends in many variables. This is due to the lag in their collection, handling and dissemination and the fact that the energy crisis emerged amid the economic reopening phase after the health crisis.

In general, it is price-related variables (such as energy prices, industrial prices or inflation) along with macroeconomic variables that are the most up-to-date.

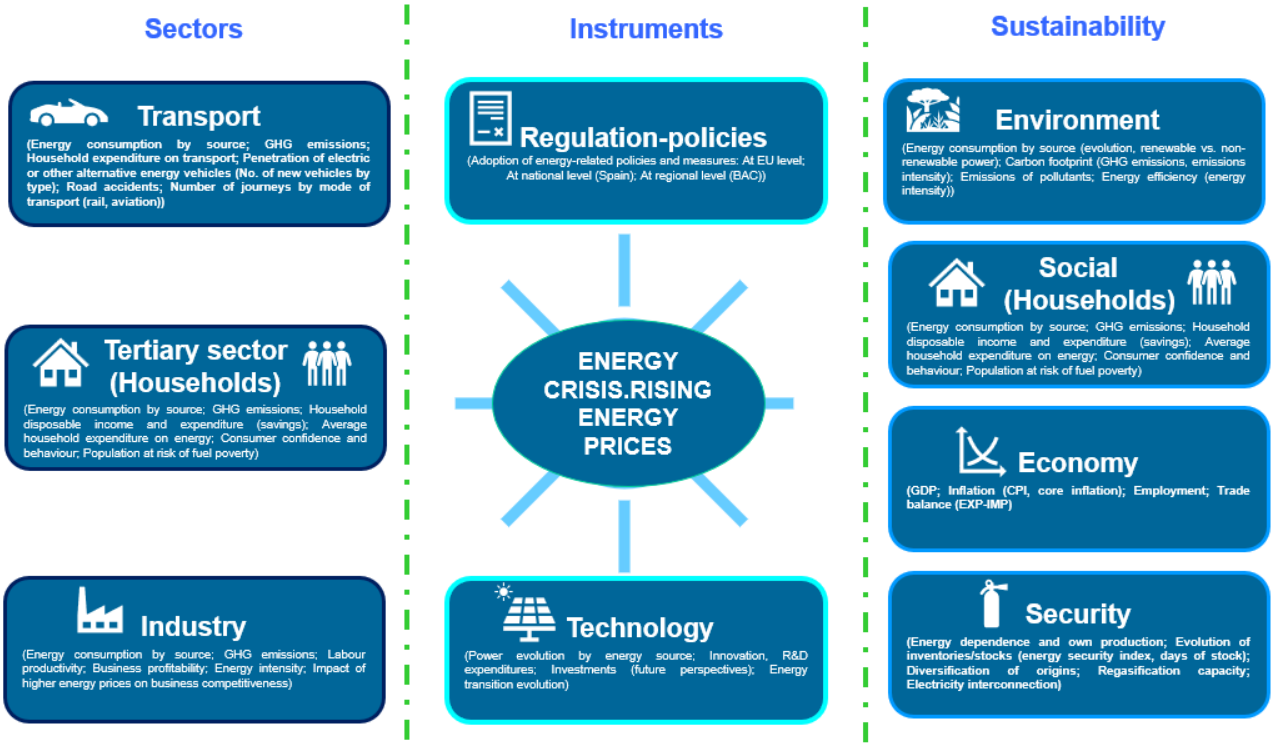
It is necessary to develop an analysis framework to organise these impacts and monitor the follow-up of the variables under analysis

Different elements can be analysed in this situation, depending on where the focus is placed (economic aspects, impact on households, development of regulations, impact on business competitiveness, etc.). However, it is helpful to have an organised framework of analysis that presents all these options, especially when deciding on the measures to reduce or cushion the impact. This is due to the interrelationship between the different elements of an economy and the existence of direct, indirect and induced impacts (for example, higher energy prices induce an increase in household energy expenditure, an increase in inflation, a possible increase in interest rates to contain inflation, the development of government measures to encourage payment of the energy bill or investment in energy efficiency improvements).

In this sense, the following figure shows the approach taken in this report, which includes the variables that have been analysed. This framework can be expanded, especially if we wish to focus on a specific area, for example, if we wish to analyse the impact of the crisis on households by their economic level or if we wish to compare the (policy-regulatory) measures proposed in each country.

In addition, it is recommended that the indicators be monitored and tracked as the different data sources are updated since only in this way will it be possible to have a complete picture of the effects of energy price increases.

Figure 5. Framework of analysis of this work



Source: own elaboration.

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Annex I Literature review

To develop the analysis model used in this work, a literature review of academic and non-academic references on the impact of energy crises was carried out to detect the main parameters that are usually analysed in this type of study. This review has also monitored the methodology used to calculate the impact of crises.

The following table lists the 95 bibliographic references detected on the subject, including information on the authors, year of publication, title, details of the publication and the elements under analysis. Some references include academic articles, reports from international institutions and organisations, web pages, etc.

Table 21. Literature review

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Tihansky, D.P.	Impact of the energy crisis on traffic accidents	1974	Transp Res. Vol. 8	Analyses the relationship between road accidents and energy scarcity. Econometric Model.	Road accidents
Walters, E.A. and Wewerka, E. M.	An Overview of the Energy Crisis	1975	Journal of chemical education. Volume 52, No. 5	Substitution of energy sources, energy savings, technological development. Descriptive.	Changes in the energy *mix*, energy savings and technologies
Brownstein, A.M.	Trends in petrochemical technology. The impact of the crisis.	1976	Petroleum Publishing Company	Summary of a book on petrochemicals that is limited to detailing its different chapters.	
Neveu, A.J.	The 1973-74 Energy Crisis: Impact on Travel	1977	The 1973-74 Energy Crisis: Impact on Travel	List of habits before the 1973 crisis, and effects during the crisis on people's behavior in relation to transportation.	Changes in people's transportation behaviour

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Sears, D.O.; Tyler, T.R.; Citrin, J. and Kinder, D.R.	Political System Support and Public Response to the Energy Crisis	1978	American Journal of Political Science, Vol. 22, No. 1 (Feb. 1978), pp. 56-82.	Analyses the impact of the support system on citizen behaviour in the 1974 energy crisis. Uses data from a survey of Los Angeles residents and examines three hypotheses: (1) that diffuse support promotes conformity to the government "line" during a crisis; (2) that long-standing symbolic loyalties, rather than the impact of the crisis on the individual's personal life, determine conformity to the government "line," and (3) that behavioural conformity to official policy is determined more by situational conditions than by underlying political attitudes. Behavior, in the form of reduced energy consumption, was controlled by situational constraints.	People's behavior and energy savings
Pendse, D.R.	Energy Crisis and Its Impact on Energy Consumers in Third World: II	1980	Economic and Political Weekly, Vol. 15, No. 4	Energy consumption, substitution of energy sources, penetration of renewables.	Energy consumption, energy mix
Pendse, D.R.	Energy Crisis and Its Impact on Energy Consumers in Third World: I	1980	Economic and Political Weekly, Vol. 15, No. 3 (Jan. 19, 1980), pp. 107-109+111-116	There are differences between countries depending on their gas, coal, and oil reserves, per capita consumption, energy consumption, and lifestyle changes.	Energy consumption, gas, coal and oil reserves, citizen's behaviour
Becker, L.J. and Seligman, C.	Welcome to the energy crisis	1981	Journal of social issues volume 37, No. 2, 1981	Summary of three articles on measures to combat the energy crisis regarding the political, psycho-social and methodological scope of the policies.	Energy policy
Committee on Social Development and World Peace	Reflections on the Energy Crisis	1981	United States Catholic Conference	Moral dimension of energy policy. Moral principles. Commitment. Oil and natural gas, coal, nuclear fission, solar energy, energy distribution, and control. Systemic evil. Conservation.	Energy policy

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Hamilton, J.	Oil and the Macroeconomy since World War II	1983	Journal of Political Economy, April 1983, 228-248	The major recessions since World War II have been preceded by 3-4-year periods of high oil prices. However, this does not mean that high oil prices cause recessions.	Energy prices
Huntignton, H.G.	Oil Prices and Inflation	1985	Annual Review of Energy, vol 10, 1985	Interaction between inflation and oil prices.	Inflation, energy prices
Contributions to economic analysis	Macroeconomic impacts of energy shocks: A summary of the key results.	1987	Volume 163, Pages 1-123	Different scenarios associated with varying shocks of energy in the economy. Reduction in oil prices, increase in domestic energy prices, two oil price hikes each of a different magnitude. Measures to combat shocks arising from oil price increases. Section on energy dependence. Effects on elements of GDP and the open economy (imports and exports).	Energy prices, GDP, international trade, countermeasures and energy dependence
Donatos, G.S. and Mergos, G.J.	Energy demand in Greece. The impact of the two energy crises	1989	Energy Economics. Volume 11, Issue 2, April 1989, Pages 147-152	It examines the two crises 73/74-78/79 to see if they have played a significant role in the country's energy demand structure. Finally, conclusions and policy implications are presented. Econometric Model	Energy *mix*
Watanabe, C.	Trends in the substitution of production factors to technology - empirical analysis of the inducing impact of the energy crisis on Japanese industrial technology	1991	New Energy and Industrial Technology Development Organization, Sunshine 60, Higashi-Ikebukuro, Toshima-ku, Tokyo 170, Japan	Examines trends in the substitution of factors of production (labour, capital, materials, and energy) for technology (namely, cumulative R&D investment) in the Japanese manufacturing industry during the 1970s-80s and shows that this substitution is a response to the dramatic rise in energy prices following the energy crises. Econometric model.	Employment, technology, R&D, energy prices
Douglas, R.B.	On the macroeconomic effects of energy price shocks	1991	June 1991, Pages 145-162	Doubts exist about the direct relationship between energy price increases and economic recessions. This article discusses other possible relationships, such as the monetary policy that is deployed.	Energy prices, monetary policy

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Hamilton, J.	This is What Happened to the Oil Price Macroeconomy Relationship	1996	Journal of Monetary Economics, vol 38, No. 2, October, October, 215-220	When looking at the net increase in oil prices over the year, the most recent past data is consistent with the historical correlation between oil shocks and recessions.	Energy prices, macroeconomic impact
Hooker, M.A.	What Happened to the Oil Price Macroeconomy Relationship?	1996	Journal of Monetary Economics, 38, 195-213.	Oil prices are not behind most macroeconomic variables, such as the unemployment rate, real GDP, aggregate employment and industrial production, in quarterly data from 1973 to the present.	Energy prices, employment, GDP, industrial production, etc.
Huntignton, H.G.	Oil Prices and the U.S. Economic Activity	1998	IAEE - The Energy Journal, Vol. 19, No. 4 (1998), pp. 107-132	Effects on consumer prices, impact on energy prices, growth, output and aggregate demand.	Energy prices, production, aggregate demand
Brown, S.P.A. and Yücel, M.K.	Oil Prices and the U.S.	1999	Economic review (Federal Reserve Bank of Dallas)	Study of economic policies and their effects on economic activity. Based on the U.S. autoregressive model.	Energy prices and economic policy
Lynch, M.C.	Oil scarcity, Oil crises, and alternative energies- don't be fooled again	1999	Applied Energy	Price projections, oil supply, OPEC and non-OPEC, OPEC market power, energy vulnerability, the impact of the crisis, probability of the crisis, and alternatives.	Energy prices, energy supply, vulnerability, response measures
Brown, S.P.A.; Stephen, P.A. and Mine, K. Y	Energy Prices and Aggregate Economic Activity: An Interpretative Survey	2002	Quarterly Review of Economics and Finance 42(2): 193-208.	The data relate fluctuations in energy prices to fluctuations in aggregate economic activity. However, the exact channels through which oil price shocks affect economic activity are only partially known.	Energy prices, economic activity
CBO	The Economic Effects of Recent Increases in Energy Prices	2006	Congress of the US. Congressional Budget office. July 2006.	Analysis of oil and natural gas demand. Changes in oil use by region. Oil price expectations. Effects on inflation and GDP. Effects on households. Household energy expenditures as a percentage of disposable income. Real household spending. Personal savings.	Energy prices, energy demand, inflation, GDP, household spending on energy, savings, corporate profits, consumer confidence,

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
				Corporate profits. External balance. CPI. Consumer confidence. Effects of energy shocks. Exports. Monetary policy. Energy consumption.	international trade. monetary policy
Consumer Energy Alliance	The Impact of High Energy Prices on Key Consumer Sectors of the U.S. Economy	2008	Consumer Energy Alliance	Energy prices, airline consumption, changes in domestic flights, exchange rates and competitiveness, and energy consumption by sector are the main topics.	Energy prices, energy consumption, energy consumption in aviation, competitiveness
Chevalier, J.M. and Geoffron, P.	The New Energy Crisis. Climate, Economics and Geopolitics	2009	Palgrave Macmillan	Geopolitics of Energy: Economics and inequality, scarcity and prices, oil and gas exporting countries, importers, dependence, companies, global market, third shock.	Geopolitics, energy prices, energy dependence, producers
PwC (PricewaterhouseCoopers S.L.)	Estudios de Impacto Económico. Cómo valorar la repercusión y el retorno de iniciativas e inversiones públicas	2012	Monografía	Direct impact: Corresponds to the production (gross value added) and employment generated. Indirect impact: Corresponds to the production and employment generated in the sectors that indirectly benefit from investments and spending. Induced impact: Corresponds to the production and employment generated by the sectors' employees' consumption of goods and services that benefit, directly or indirectly, from the investments and expenditures. Measure economic, social, fiscal and environmental impacts.	GVA, employment, economic, social, fiscal and environmental impact
Liu, M.F.M. and Pistorius, T.	Coping with the energy crisis: Impact assessment and potentials of non-traditional renewable energy in rural Kyrgyzstan.	2012	Energy Policy. 44(2012)130-139	The excerpts from interviews conducted by the authors are from a population in an energy crisis for years. In the rural environment of a poor country, cuts in supply, poverty, change of energy source, reduction of consumption with awareness, as well as investment in renewables that indirectly improve the	Energy poverty, change in the energy source, reduction of consumption

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
				health of the population and have environmental benefits.	
Gronwald, M.	Oil and the U.S. Macroeconomy: A Reinvestigation Using Rolling Impulse Responses	2012	The Energy Journal, 33(4): 143-159.	Analysis of significant increases in oil prices. The impact of these increases at the macro level is visible in the long term.	Energy prices, macroeconomic impact
Brown, S.P.A. and Huntington, H.G.	Assessing the U.S. oil security premium	2013	Energy Economics. Volume 38, July 2013, Pages 118-127.	Energy dependence. Effects on oil prices in the U.S. Associated externalities.	Energy prices, energy dependence, energy externalities, energy prices, externalities
Shah, B.; Essrani, S.D.; Shah, N. and Raha, N.	The impact of energy crisis in the textile sector	2013	Journal of Emerging Issues in Economics, Finance and Banking (JEIEFB)An Online International Monthly Journal (ISSN: 2306 367X) Volume:1 No. 5 May 2013	This paper analyses the impact of the energy crisis in Pakistan from 2005 to 2010. It covers two periods: pre-crisis 2005-2006 and post-crisis 2007-2010. It basically deals with the evolution of the business indicators ROA, ROE, NPM, DER, Financial expenses as a percentage of sales, liquidity analysis, dividends, and earnings per share.	ROA, ROE NPM, DER, liquidity, dividends, earnings per share
Arocena, P.; Díaz Mendoza, A.C.	Los costes de la energía en la industria del País Vasco	2014	Boletín de Estudios Económicos, Vol. LXIX, 212, agosto, pp. 357-375.	This paper analyses the evolution of energy costs in the Basque industry from 2000 to 2009. For this purpose, the weight that energy costs represent over production costs is quantified. It also analyses the variation of energy expenditure in relation to the added value of industrial production and breaks it down into three parts: the effect of the relative change in prices, the change in the intensity of energy use, and the change in productivity.	Energy costs, GVA, industrial production, industrial production, etc.

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Dagoumas, A. and Kitsios, F.	Assessing the impact of the economic crisis on energy poverty in Greece	2014	Sustainable Cities and Society 13 (2014) 267-278.	Analyses the impact of the economic crisis on energy poverty.	Energy poverty
Grossman, P.Z.	Energy shocks, crises and the policy process: A review of theory and application.	2014	Energy Policy. Volume 77, February 2015, Pages 56-69.	Concept of crisis from an academic point of view, as well as different definitions of what an energy crisis is. Policy-making process in shocks and crises. Two cases of policy response to energy crises. USA 1992 Energy Policy Act + Energiewende Germany.	Policy or response measures
Coyle, E.D. and Simmon, R.A.	Understanding the Global Energy Crisis	2014	Purdue University Press	Policy of the different world players in the energy field: EU, China, Russia, USA.	Energy policy
Arocena Garro, P. and Díaz Mendoza, A.C.	La evolución de los costes energéticos y su efecto en la competitividad de la industria española	2015	Economía Industrial (396), 151-162	The main objective of this paper is to analyse the energy costs of the Spanish manufacturing sector and provide a picture of the relative position of the Spanish industry's energy costs and their evolution over the last decade.	Energy expenditure, competitiveness
Álvarez, E.; Larrea, M.; Díaz A.C.; Kamp, B.	¿Afectan los costes de energía a la competitividad de la industria?	2016	Economía Industrial. Volumen 401	Brief reflection on how energy prices and an increase in energy prices affect the competitiveness of energy-intensive industries.	Energy prices, competitiveness
Díaz A.C., Larrea M., Kamp, B. Álvarez, E.	Precios de la energía y competitividad industrial	2016	Orkestra	Analysis of the impact of energy prices and an increase in energy prices on the competitiveness of energy-intensive industries.	Energy prices, competitiveness
Huntington, H.G.	The Historical "Roots" of U.S. Energy Price Shocks: Supplemental Results	2016	MPRA - Munich Personal RePEc Archive	Different oil shocks in the U.S. Analyzes events: crash of '29, World War II, before and after. Econometric models and statistical tests.	Energy prices

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Costa-Campi, M.T.; Trujillo-Baute, E.; Batalla, J.; del Río, P.; Duch, N.; García-Quevedo, J.; Mir, P. and Costa, O.	Economic analysis of the impact of electricity regulation - Electricity Regulation Report	2017	Innoenergy	Economic analysis of the regulation of electricity markets using econometric models. Three models: retail price model; transfer model (where the impacts of the liberalisation of the retail market and the penetration of renewables on consumers' and producers' incomes are analysed, which is assessed through an analysis of the wholesale market); growth model (analyses the effect of the costs of promoting renewable energies and the grid costs on electricity consumption and economic growth).	Electricity regulation, energy prices, renewables, consumer income,
Erker, S., Stangl, R. and Stoeglehner, G.	Resilience in the light of energy crises. Part I: A framework to conceptualise regional energy resilience.	2017	Journal of cleaner production. Volume 164, 15 October 2017, Pages 420-433.	It determines resilience in relation to an irreversible and long-term decline in fossil energy supply while choosing a gradual and deductive approach to dealing with this term, called RERA.	Power supply
Erker, S., Stangl, R. and Stoeglehner, G.	Resilience in the light of energy crises. Part II: Application of the regional energy resilience assessment.	2017		First, it examines the energy sectors and services affected by fossil energy constraints and their need for improvements (fact-level assessment). Second, it examines attitudes and risk sensitivity in relation to energy crises to reveal community awareness and acceptance of needed improvement measures (value-level assessment). Third, both levels are compared to identify key aspects for planning a resilient energy system. Finally, policy implications on integrating resilience thinking into energy system development efforts will be derived.	Energy consumers, consumer behaviour, energy efficiency, technological change

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Audin, M.	Dealing with energy crises: Working and living arrangements in peri-urban France.	2018	Transport Policy. 65(3) DOI: 10.1016/j.tranpol.2016.09.008.	The aim is to show how households living in peri-urban areas in France adapt their housing and commuting costs to the context of the energy and economic crisis and what this reveals about the possibility of changing lifestyles. The article is based on a study conducted in 2012-2013 when oil prices peaked. It examines the daily lives of individuals to gain some appreciation of the developments in the context of household vulnerability. It deals with different factors such as household and transportation.	Consumer behaviour, household energy expenditure
Junejo, I. and Khoso, J.R.	Impact of electricity crisis on Industrial growth in Pakistan: A multiple regression analysis approach.	2018	International Journal of Academic Research in Business and Social Sciences. 8(9), 851-862.	Studies the impact of the electricity crisis on industrial growth in Pakistan. Generation capacity, demand, deficit and surplus. The growth pattern of industrial *output* and electricity consumption. Agricultural, industrial and service growth. Econometric model.	Energy consumption, industrial production
Larrea Basterra, M.; Rebollo Garay, G.	Precios de la energía y competitividad industrial. Alemania y Francia	2019	Cuadernos Orkestra. Instituto Vasco de Competitividad-Fundación Deusto	The study analyses the electricity and gas price situation in France and Germany. Although the study focuses on energy prices borne by industry, it also provides residential customer prices.	Energy prices, industrial competitiveness,
Wu, J.; Sexton, S. and Zilberman, D.	Energy price shocks, household location patterns and housing crises: Theory and implications.	2019	Energy Economics. Volume 80, May 2019, Pages 691-706.	Evolution of housing stock and urban form. It focuses on describing the characteristics of the housing market that make it vulnerable to unexpected increases in gas prices. It focuses on the 2007-2008 crisis and its effects. He also discusses energy prices. Section 3 formalises his theory of the housing market's collapse in a model. In Section 4, he simulates the housing market impacts of gas price shocks by parameterising the model presented in Section 3. Section 5 concludes by discussing the	Gas prices, housing stock

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
				implications of this analysis for policies related to housing, energy, and the environment.	
Ali, A.; Rahutb, D.B. and Imtiaz, M.	Effects of Pakistan's energy crisis on farm households	2019	Utilities Policy	Energy demand/supply. Energy production by fuel type. Econometric model.	Energy demand and supply by energy type
Ariño Ortiz, G.; del Guayo Castiella, I.; Robinson, D.	La transición energética en el sector eléctrico. Líneas de evolución del sistema, de las empresas, de la regulación y de los mercados	2020	Publicaciones Universidad de Deusto, ISBN 978-84-1325-093-9	Security of supply. Reference is made to prices as an element that may discourage decarbonisation. Reference is made to the impact of carbon leakage. Reference is also made to the effect on investment and innovation. Reference is made to the importance of electricity prices for the competitiveness of territories and the population's welfare. The price level can influence the electricity producers themselves. Thus, reduced prices can displace the less efficient generators, i.e. the more expensive ones.	Energy prices, security of supply, investment and innovation, technological change
Latif, K.; Raza, M.Y.; Chaudhary, G.M. and Arshad, A.	Analysis of Energy Crisis, Energy Security and Potential of Renewable Energy: Evidence from Pakistan	2020	Journal of Accounting and Finance in Emerging Economies. Volume 6: Issue 1	Impact on energy security, development of renewable energies.	Energy security, energy *mix*
Rodrigue, J.P.	Potential Impacts of High Energy Prices on Transportation	2020	The Geography of Transport Systems. New York: Routledge, 456 pages. ISBN 978-0-367-36463-2	Effect of inflation due to higher fuel prices on different transportation dimensions: use (speed, carpooling, etc.), means of transportation...	Energy prices, inflation, transportation
Rodríguez-Fernández, L.; Fernández Carvajal, A.B.	Evolution of European Union's energy security in gas supply during Russia-Ukraine	2020	Energy Strategy Reviews	Energy security index. Energy security. Geopolitics. Dependence. Connectivity. Multivariate analysis.	Energy security, dependence, geopolitics

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
and Ruiz-Gómez, L.M.	gas crises (2006-2009)				
Halkos, G.E. and Gkampoura, E.C.	Evaluating the effect of economic crisis on energy poverty in Europe	2021	Renewable and Sustainable Energy Reviews	Energy poverty. Energy Consumption. Different ways of measuring energy poverty. Econometric model. Model variables include Gini coefficient, GDP, unemployment, poverty risk, urban population, and electricity prices.	Energy consumption, energy poverty, GDP, unemployment, at-risk-of-poverty, energy prices, urban population
Rodríguez Rodríguez, D.	Los precios de la energía y la inflación: Las medidas regulatorias y sus efectos	2022	ICE. Nov-Dic 2022. N. º 929. Monográfico. El proceso inflacionario en España y el área del euro: un análisis económico.	Inflation, regulation, prices of +G4 substitute energy products, the price index of the special group of energy products (0451 Electricity, 0453 Liquid fuels, 0452 Gas 0722 Fuels and lubricants), average expenditure per household on gas/electricity/hydrocarbons, level of energy consumption, impact derived from measures taken on price signals (e.g. to reduce consumption of oil derivatives, on inframarginal generators, reduction of rents associated with revenues from non-emitted CO_2).	Inflation, regulation, energy prices, household energy expenditures, response measures.
Authers, J.	A tale of two oil shocks: Ukraine and Yom Kippur	2022	Bloomberg LP	Inflation, derived impact on interest rates.	Inflation, interest rates
Loewen, B.	Coal, green growth and crises: Exploring three European Union policy responses to regional energy transitions.	2022	Energy Research & Social Science 93 (2022) 102849	Energy crises are analyzed as turning points that promote changes and progress in the energy transition. The article starts from the premise that the price crisis has driven the energy transition and, in particular, the policies needed for it. However, it focuses mainly on regional development issues, analysing social, environmental and political issues.	Energy prices, technology change, energy efficiency

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Oknoprime	Crise énergétique: quelles conséquences sur le marché de la rénovation?	2022	Plateforme des professonels de la menuiserie	Inflation and consumption reduction are indirectly proposed. Household appliances are to be changed, and investments in energy rehabilitation of buildings and solar panels are to be made. The government is adopting other measures, such as an energy check for the poorest households and aid programs for energy rehabilitation. The industry is investing in renewables.	Household energy consumption, inflation, technological change, countermeasures
IEA	Crise Énergétique Mondiale	2022		Rising energy prices have accelerated inflation, pushing families into precarious situations, forcing some factories to limit or even stop production, and slowing growth. Vulnerability is due to the high dependence on Russia for gas supplies.	Energy prices, inflation, energy dependence, household energy consumption, competitiveness, etc.
KPMG	Crisis energética y sector industrial	2022	KPMG	The energy crisis and its effects on the industrial sector. Comparison of industry's weight with other European countries. Measures adopted to combat the energy crisis and context.	Competitiveness, countermeasures
Rico, A.	Efectos de la crisis energética	2022	EY	Origin of the crisis. Transition from COVID-19 prices to price increases. Role of the CFO in the Company.	Energy prices, inflation
IEA	Crisis energética mundial	2022	IEA	Energy crisis: mediums taken, release of reserves, increase in the life of nuclear and coal plants, and investments in LNG.	Response measures
Chaney, E.	Ukraine's War: The Economic Impacts	2022	Montaigne Institute	Effects of sanctions in Russia. Stagflation. Similarity in shock with the 1973 crisis.	Stagflation (inflation, GDP)
JP Morgan	What are the impacts of rising energy prices?	2022		Possible consequences. CPI breakdown.	Inflation
Statistics Norway	Economic consequences of high electricity prices and	2022	Statistics Norway	The situation in Norway regarding subsidies given to energy: increases/decreases, how the impact changes	Energy prices, energy consumption of households

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
	electricity subsidy scheme			between different housing types, etc.	
Núñez Navarro, M.	La crisis energética en el proceso de transición energético europeo. Impacto y planes futuros	2022	Cuadernos de Energía, Jornada anual del Comité Español del Consejo Mundial de la Energía. N.º 71	Effects on imports, exports, gas and oil prices	Energy prices, international trade
Club Español de la Energía	Energy and Climate Futures: Europe after the energy crisis. Cronograma de la crisis	2022	Cuadernos de Energía, Jornada anual del Comité Español del Consejo Mundial de la Energía. N.º 71	Rising energy prices are driving energy efficiency and the adoption of energy-saving measures. Reducing dependence on certain suppliers (in this case, Russia), developing new renewable energy projects, and promoting innovation and collaboration are also on the agenda.	Energy prices, energy saving, energy dependency, technological change, innovation
Sancha, J.L.	Balance económico de 200 días de aplicación del tope al precio del gas. Artículo interesante donde nos habla de la medida del tope del gas y sus verdaderos efectos	2022	Cuadernos de Energía, Jornada anual del Comité Español del Consejo Mundial de la Energía. N.º 71	Development of mechanisms to respond to and protect against price increases: the gas price cap mechanism for the Iberian Peninsula.	Energy prices, response measures
OECD	Special Feature: Policy responses to rising energy prices	2022	Tax Policy Reforms 2022. OECD and selected partner economies. OECD	Chapter of the report Tax Policy Reforms 2022 summarizes the measures taken by OECD member countries in response to the crisis caused by rising energy prices.	Response measures
Robinson, D.	Crisis Energéticas Actuales y Transición Energética - Agenda Pública	2022	El País	Energy crisis. Energy trilemma. Redesign of energy markets. Role of governments in the energy transition.	Energy transition, regulation

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Xua, J.; Akhtarb, M.; Harisc, M.; Muhammadd, S.; Abbane, O.J. and Taghizadeh-Hesary, F.	Energy crisis, firm profitability, and productivity: An emerging economy perspective	2022	Energy Strategy Reviews	The situation in Pakistan in the face of energy crises. The effects of energy crises in developing countries on business development. Econometric model.	Competitiveness,
Bednář, O.; Čečrdlová, A.; Kadeřábková, B. and Řežábek, P.	Energy Prices Impact on Inflationary Spiral	2022	Energies - MDPI	Correlation between energy prices and inflation. Econometric model.	Energy prices, inflation
Economist Intelligence	The EIU Update Energy crisis will erode Europe's competitiveness in 2023	2022	Economist Intelligence	Alternatives to supply. Main *driver* of energy prices in 2024 Aggregate Demand. Competitiveness of the EU with respect to third states/regions. Effects on debt, energy transition, and the effect of restrictive monetary policies on companies.	Energy prices, energy transition, monetary policy, competitiveness, debt
Battistini, N.; Di Nino, V.; Dossche, M. and Kolndrekaj, A.	Energy prices and private consumption: what are the channels?	2022	ECB - Economic Bulletin - Issue 3/2022	Energy prices. Effects on inflation, trade, consumption and savings. Compares different crises.	Energy prices, inflation, trade, consumption, saving
Ari, A.; Arregui, N.; Black, S.; Celasun, O.; Iakova, D.; Mineshima, A.; Mylonas, V.; Parry, I.; Teodoru, I. and Zhunussova, K.	Surging Energy Prices in Europe in the Aftermath of the War: How to Support the Vulnerable and Speed up the Transition Away from Fossil Fuels	2022	IMF - Working Papers	Energy crisis: impact on the fight against climate change, on the mix, on households. State policies.	Climate change, technological change, energy transition
Torres, R.; and Fernández, M.J.	Perspectivas de la economía española tras la crisis energética	2022	FUNCAS - Cuadernos de Información Económica, N.º 291 (noviembre-diciembre 2022)	Economic variables (PMI, household disposable income, GDP, demand, etc.). Fiscal and monetary policies. Foreign economy. Labor market. Consumption. Investment.	PMI, household disposable income, GDP, fiscal and monetary policy, employment, consumption, investment, investment, etc.

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Office for National Statistics	Energy prices and their effect on households	2022	Office for National Statistics	Effect on households in the United Kingdom. Energy prices. Gas and electricity.	Energy prices, energy consumption of households
Michálek, O.	How will the high energy prices affect household consumption?	2022	Czech National Bank	Situation of the Czech Republic. How they consume energy and price elasticity.	Energy prices, price elasticity, energy consumption, price elasticity, energy consumption
Riksbank	High energy prices -how will other consumer prices be affected?	2022	Riksbank	Inflation, Monetary Policies, Energy Prices. Sweden.	Energy prices, inflation, monetary policies, monetary policies
Hieminga, G. and van Sante, M.	The sectors most affected by soaring energy prices	2022	ING Think	The effects of energy prices on different sectors of the economy (aviation, shipping, chemicals, food, rubber, etc.)	Energy prices, energy consumption
Maneejuk, P. and Yamaka, W.	Nexus between energy price shocks and the G7 financial development	2022	The 5th International Conference on Electrical Engineering and Green Energy, CEEGE 2022,8-11 June, Berlin, Germany	Relationship between energy prices and financial market performance. Analyses the causal relationship between three energy shocks (coal, oil and natural gas) and advanced stock markets, i.e. G7 countries. Econometric model and statistical tests.	Energy prices, financial and stock markets
García Cuadrado, R.	Análisis del Impacto de la Crisis Energética en la Consecución del ODS 7 en España	2022	Universidad Politécnica de Madrid	Impact on inflation and the most disadvantaged households. Slowdown of the transition. Pre-war factors in Ukraine: "The energy sector during COVID-19 and the subsequent international energy crisis".	Inflation, energy transition
Duan,W.; Khurshid, A.; Nazir, N.; Khan, K. and Cantemir Calin, A.	From gray to green: Energy crises and the role of CPEC	2022	Renewable Energy	Pakistan. Continuing energy crisis, demand > supply. Econometric model.	Energy consumption

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Raza, F.; Tamoor, M.; Miran, S.; Arif, W.; Kiren, T.; Amjad, W.; Hussain, M.I. and Lee, G.H.	The Socio-Economic Impact of Using Photovoltaic (PV) Energy for High-Efficiency Irrigation Systems: A Case Study	2022	Energies - MDPI	Pakistan. Change in irrigation systems from diesel to high efficiency.	Technological change
Choi, D.G. and Murali, K.	The impact of heterogeneity in consumer characteristics on the design of optimal time-of-use tariffs	2022	Energy	The game theory model sheds light on the optimal pricing problem from the utility's perspective when its consumers vary their electricity consumption scheduling preferences, as well as their willingness or flexibility to change consumption in response to the pricing incentives offered by the utility	Energy prices, countermeasures changes in consumer behaviour
ABN-AMRO	How are companies coping with higher energy costs	2022	Sustainaweekly. Group Economics | Financial Markets & Sustainability Research	Corporate margins, consumer confidence, Eurozone savings, Green Bonds, ESG.	Competitiveness, consumer confidence, savings
Álvarez Ondina, P. and Ibañez de Aldecoa Fuster, J.	Rising energy prices and their impact on the manufacturing industry: which sectors are being hit the hardest?	2022	CaixaBank Research	Energy consumption by households and business sectors. Type of energy most used in industry.	Household and business energy consumption
EY and Fundación Naturgy	Impacto de la situación actual sobre los mercados de gas y sus implicaciones en la transición energética de la UE y España	2022	Impacto de la situación actual sobre los mercados de gas y sus implicaciones en la transición energética de la UE y España	EU gas imports, EU gas infrastructure, the gas market in Europe, prices, supply, storage facilities, actions and measures to alleviate the current situation, the Spanish market, prices, electricity generation from gas and electricity, energy transition, and domestic demand.	Energy prices, international energy trade, energy consumption, technology, energy prices, international energy trade, energy consumption, technology

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Eichhammer, W.	Assessing the impact of high energy prices on the economic potentials for energy savings in the EU	2022	Fraunhofer ISI	Energy price projections. Price developments. Energy price breakdown.	Energy prices
Calthrop, E.	Energy crisis makes public banks even more important	2022	European Investment Bank	Power generation. High fossil fuel prices will accelerate the transition. Batteries. Heating electrification. Green hydrogen. There is a risk of disorderly transition.	Energy prices, power generation, technology, energy transition
Banco de España	Informe de Estabilidad Financiera Primavera 2022	2022	Banco de España	GDP, Inflation, Credit rate to the private sector, and different economies. Profitability. Stock market returns. Asset prices. Housing prices, home sales and purchases, credit evolution. Interest rates. Debt as a percentage of GDP. Impact of sanctions on imports, exports and GDP. Public debt vis-à-vis other states, public financing needs, current account balance, credit volume, cost of bank financing, money market rates, corporate ratios, dividends. Risk indicator, GDP output gap, cryptocurrencies, volume of cryptocurrency transactions in Europe.	GDP, inflation, profitability, interest rates, interest rates, government debt, competitiveness
Market Observatory for Energy. DG Energy.	Quarterly report. On European electricity markets.	2022	Quarterly report. On European electricity markets. Volume 15.	Demand-side factors, GDP, electricity consumption, heating, electric vehicles. Supply-side factors, coal and gas prices, emission allowance prices. Prices at European level. Price futures. Lignite generation. Switching from coal to gas. Cross-border flows. Nuclear power in France. Evolution of the electricity mix in the United Kingdom. Situation in Spain and Portugal. Retail electricity market. Wholesale markets by region.	Energy prices, energy consumption, GDP,

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Market Observatory for Energy. DG Energy.	Quarterly report. On European gas markets.	2022	Quarterly report. On European gas markets. Volume 15, issue 3, covering third quarter of 2022.	Consumption, gas imports, gas pipelines from Russia, liquefied natural gas, storage, hydrogen, gas policies and infrastructure. Wholesale markets. Commodities, LNG and international gas markets. European market, LNG in Europe. Price development. Pipeline pricing. EU hubs. Retail prices. Developments in the retail market.	Energy prices, energy supply, energy policy, technology, and investment.
Fasting, M.	Norway's Energy Windfall	2022	Civita	This paper presents the situation in Norway: citizens' response to rising prices in the form of protests and demands for subsidies, transition to renewable energy, electricity market integration, and gas production.	Energy prices, energy transition, regulation
Torres, R. and Fernández, M.J.	El conflicto en Ucrania y la economía española	2022	Funcas - Cuadernos de Información Económica, N.º 287 (marzo-abril 2022)	Effects on inflation and GDP growth of the war in Ukraine. It also deals with Russian strategic resources. Conclusions on the geopolitical level.	Inflation, GDP,
J.P. Morgan Asset Management	Décryptage des mécanismes économiques de la crise énergétique en Europe	2022		Key elements for gas security are the degree of dependence on Russian gas, the gas-dependent electricity mix, and storage capacity. The first increase in fossil fuel consumption and its long-term effect, the development of renewables, and the impact of energy prices on households and consumers in general.	Energy prices, energy *mix*, energy consumption, energy security, storage capacity, technology, household energy consumption
Gouvernement	Plan de Sobriété énergétique	2022	Dossier de presse 6 octobre 2022 Une mobilisation générale	Energy savings to reduce dependence on fossil fuels.	Energy dependence, energy savings
Navarrete, M.	Enquête CPME : quel est l'impact de la crise	2022	Compta Oline	Analyzes the case of SMEs and highlights the difficulties of cash flow, cash financing and	Energy prices, inflation, competitiveness,

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
	énergétique sur les TPE-PME ?			investment. Rising energy prices lead to higher inflation.	financing and investment
Arengi, M.	L'impact de la crise de l'énergie sur les entreprises	2022	Business Cool	Changes in the way of working of companies that promote teleworking, and even close one day a week to save. On the other hand, employees complain that it increases energy costs in their homes.	Household energy expenditures, changes in work behaviour
Caradisiac	La crise énergétique actuelle peut-elle tuer la voiture électrique?	2022	Midi Pile	Potential impact on the development and penetration of electric vehicles.	Technology, energy transition
Fouquet, C.	Les entreprises françaises redoutent l´impact croissant de la crise énergétique	2022	Les Echos	Inflation, corporate financial difficulties.	Inflation, competitiveness
Belaïd, F.; Al-Sarihi, A. and Al-Mestneer, R.	Balancing climate mitigation and energy security goals amid converging global energy crises: The role of green investments.	2023	Renewable Energy 205 (2023) 534-542	Inflation, deteriorating living standards and slow economic growth. Crossroads of energy transition, climate policy and green investment paradigms, energy security and sustained economic growth. Substitution of gas for coal and increased GHG emissions. Impact on household and industrial consumers' bills, energy poverty, paralysis of industrial activity, pressure or opportunity to improve other countries' oil and gas production and fill gaps not covered by Russia (Qatar), progress in energy transition (new investment programs and promotion of renewables).	Inflation, energy and climate policy, energy security, investment, technology, competitiveness, household energy expenditures, energy poverty, energy transition
Eurelectric	Power prices, causes, consequences and solutions	2023	Eurelectric	Prices €/MWh broken down. Measures to be taken by the EU. Government action and the effects on the energy market.	Energy prices, response measures
Escribano, G.	Geopolítica de las renovables y nuevas	2023	Fundación Naturgy	The geopolitical panorama of renewable energies, dependence, the WEF index of	Energy geopolitics,

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
	geografías de la energía			success in the energy transition, and relationships between different regions are discussed.	technology, energy transition
Yan, G. and Bian, W.	The impact of relative energy prices on industrial energy consumption in China: a consideration of inflation costs	2023	Economic Research-Ekonomska Istraživanja	Energy prices in China and impact on the industrial sector. Econometric analysis	Energy prices, competitiveness
Patiño, M.A.	Rebelión histórica de todas las patronales contra la reforma eléctrica del Gobierno español	2023	Expansión	Employers' criticism of the Spanish Government's electricity reform. They reject the price interventionism proposed by the Government, establishing fixed prices for nuclear or hydroelectric plants or tenders directed by the regulator to establish long-term supply contracts.	Energy prices, response measures
IEA	Electricity Market Report2023	2023	IEA	Electricity demand. Increase, decrease, etc., in electricity consumption in the EU. Electricity demand in India and the USA. Generation from gas and coal. Supply, wholesale electricity prices, carbon pricing. Outlook in different regions of the world: Asia Pacific, America, Europe, Eurasia, Middle East, Africa.	Energy and carbon prices, energy consumption, energy *mix*
IRENA	Global landscape of renewable energy finance 2023	2023	IRENA	The energy crisis drives investment in renewable, sustainable, and affordable energy sources. Investment needs for the 1.5 °C scenario. CP/LP. Annual investment in renewable energy 2015-2022. Electricity capacity. Investment in renewables vs. fossil fuels globally and by region. Fossil fuel subsidies by region. Renewable energy financing. Investment by type of renewable energy. Investment per capita.	Technological change, investment, financing

Authors	Title	Year	Magazine/web	Factors to be analysed	Study variables
Frilingou, N.; Xexakis, G.; Koasidis, K.; Nikas, A.; Campagnolo, L.; Delpiazzo, E.; Chiodi, A.; Gargiulo, M.; McWilliams, B.; Koutsellis, T. and Doukas, H.	Navigating through an energy crisis: Challenges and progress towards electricity decarbonisation, reliability, and affordability in Italy.	2023	Energy Research & Social Science 96 (2023) 102934	The war in Ukraine has spurred investment in gas infrastructure to reduce dependence on Russian gas. Rising energy prices, inflation, and the security of supply are issues.	Energy prices, inflation, technological change, energy dependence
Delépine, J.	La crise de l'énergie va-t-elle tuer l'industrie européenne?	2023	Alternatives Économiques	Inflation and deindustrialization.	Inflation, industrial activity

Source: own elaboration.

Annex II Potential variables under study

Table 22. Parameters studied in the reviewed bibliography on the impact of energy crises

Areas of analysis	Parameters to be evaluated
Sectors	
Transportation	✓ Energy consumption by source and means of transport ✓ GHG and pollutant emissions by mode of transportation ✓ Penetration of electric vehicles (No. of new vehicles by type, evolution of the vehicle fleet using transport). ✓ Road accidents ✓ Number of trips using transport (No. of passengers vs. freight) ✓ Transportation networks (kilometres of highways, high-speed networks) ✓ Investment volume
Tertiary Sector (Households - social sustainability)	✓ Household disposable income and expenditures (savings, energy expenditures, etc.) ✓ GDP per capita ✓ Energy consumption by source and use (heating, transportation, etc.) ✓ GHG and pollutant emissions ✓ Consumer confidence ✓ Households in poverty and fuel poverty ✓ The evolution of housing stock and household equipment, as well as investment in household energy efficiency (measured through expenditure on home maintenance and repair). ✓ Change in household behavior
Industry	✓ Energy consumption by source and use (sectoral approach, cost of energy in relation to total cost of production) ✓ GHG and pollutant emissions ✓ Labor productivity ✓ Corporate profitability (corporate margins and profits, gross operating surplus, CLU, ROE, ROA, dividends, indebtedness, stock market indexes, etc.) ✓ Energy intensity ✓ Impact of rising energy prices on business competitiveness ✓ Substitution of productive factors ✓ Energy R&D, energy efficiency
Instruments	
Regulation-policies	✓ Adoption of policies ✓ Types of response measures: energy, fiscal, monetary, etc.
Technology	✓ Innovation, R&D expenditures ✓ Power evolution by energy source ✓ Future prospects ✓ Investments
Sustainability	

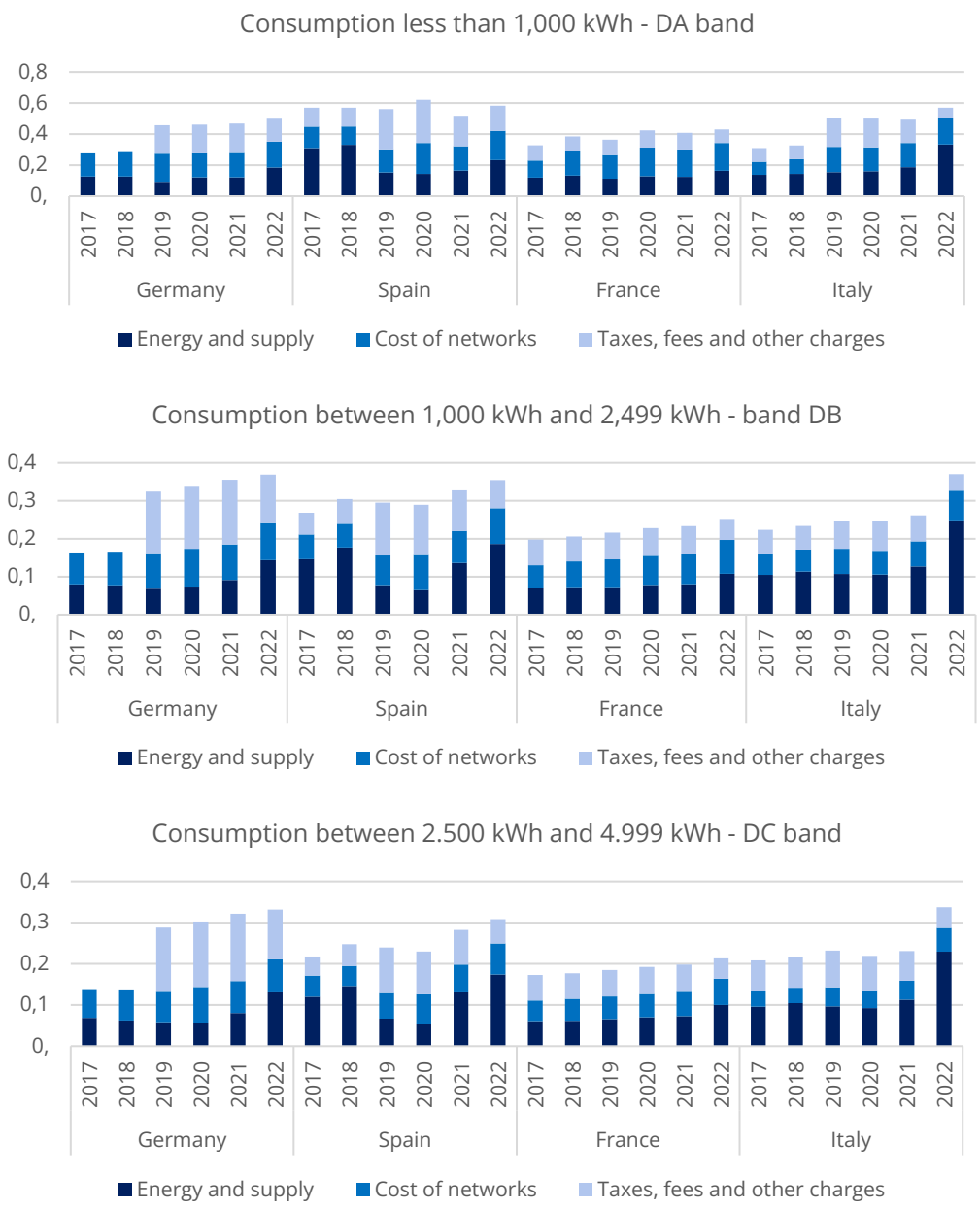
Areas of analysis	Parameters to be evaluated
Environment 	✓ Energy consumption by source (evolution, renewable vs. non-renewable power) ✓ Carbon footprint (GHG emissions, emissions intensity) ✓ Pollutant emissions ✓ Energy transition (World Economic Forum) ✓ Energy efficiency (energy intensity) ✓ Investments in new technologies/clean technologies (natural gas, LNG, nuclear, etc.)
Economy 	✓ GDP ✓ Inflation (CPI, IPRI, core inflation) ✓ Employment ✓ Interest rates ✓ Foreign exchange markets (exchange rates) ✓ Taxation ✓ Financial markets ✓ Green bonds ✓ Trade balance (EXP-IMP) ✓ Public debt, household debt and corporate debt
Security 	✓ Energy dependence (renewable vs. non-renewable) ✓ In-house production ✓ Reserves evolution (*energy security index*, days of *stock*) ✓ Diversification of origins ✓ Regasification capacity ✓ Electrical interconnection

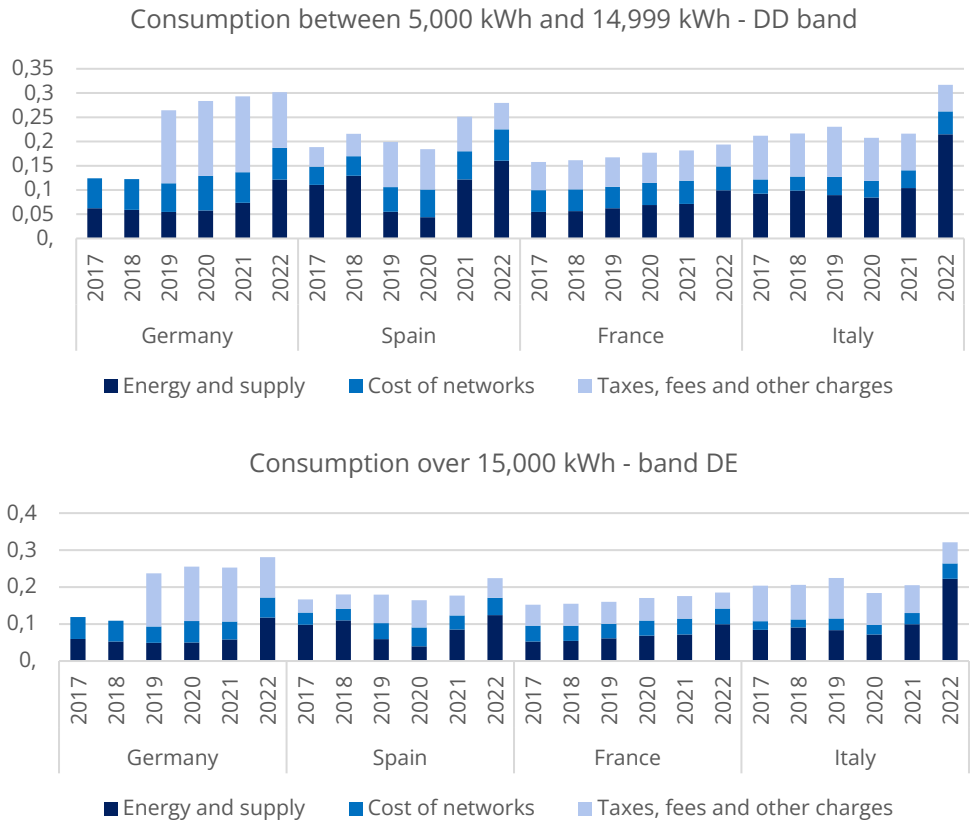
Note 1: Indicators related to regulation and policies are included in this case in section 4.
Note 2: the social element of the sustainability section is analysed at the household sector level to avoid possible repetition of indicators.
Source: own elaboration.

Annex III Electricity prices for the rest of the consumption bands

Household consumers

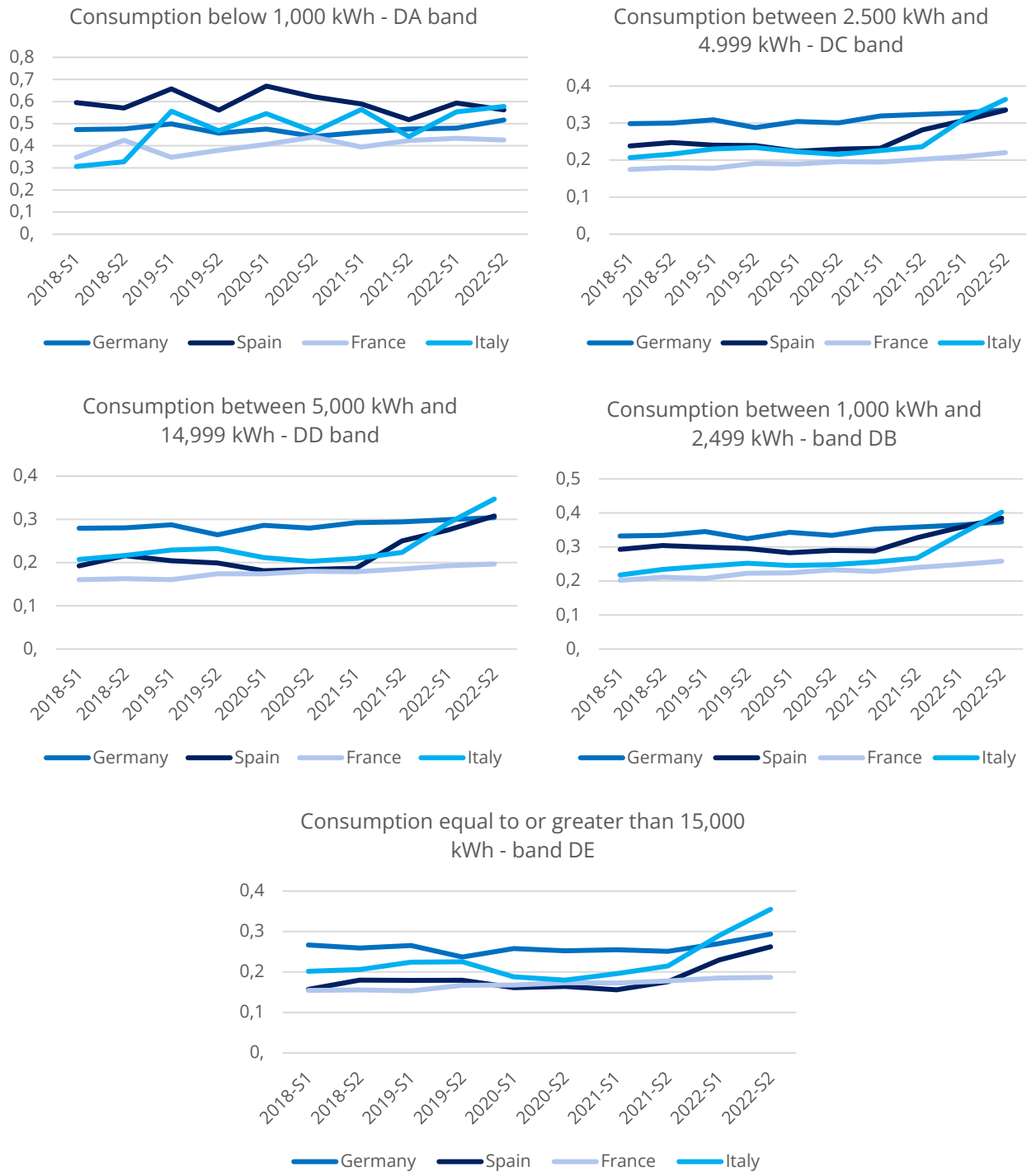
Chart 61. Evolution of electricity prices for households by component (€/kWh)





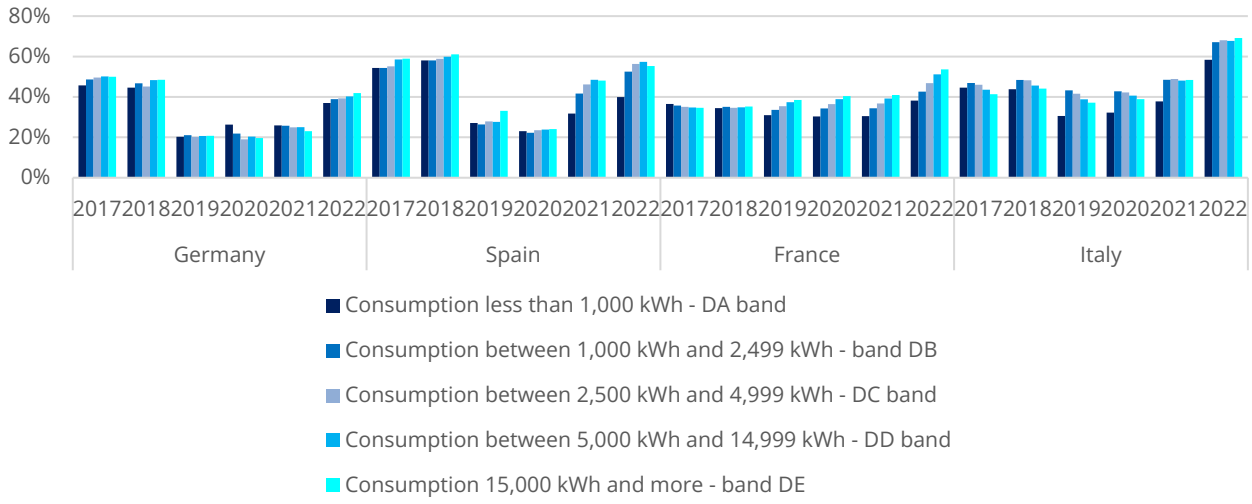
Source: Prepared by the authors based on Eurostat.

Chart 62. Evolution of electricity prices for households by country (€/kWh)



Source: Prepared by the authors based on Eurostat.

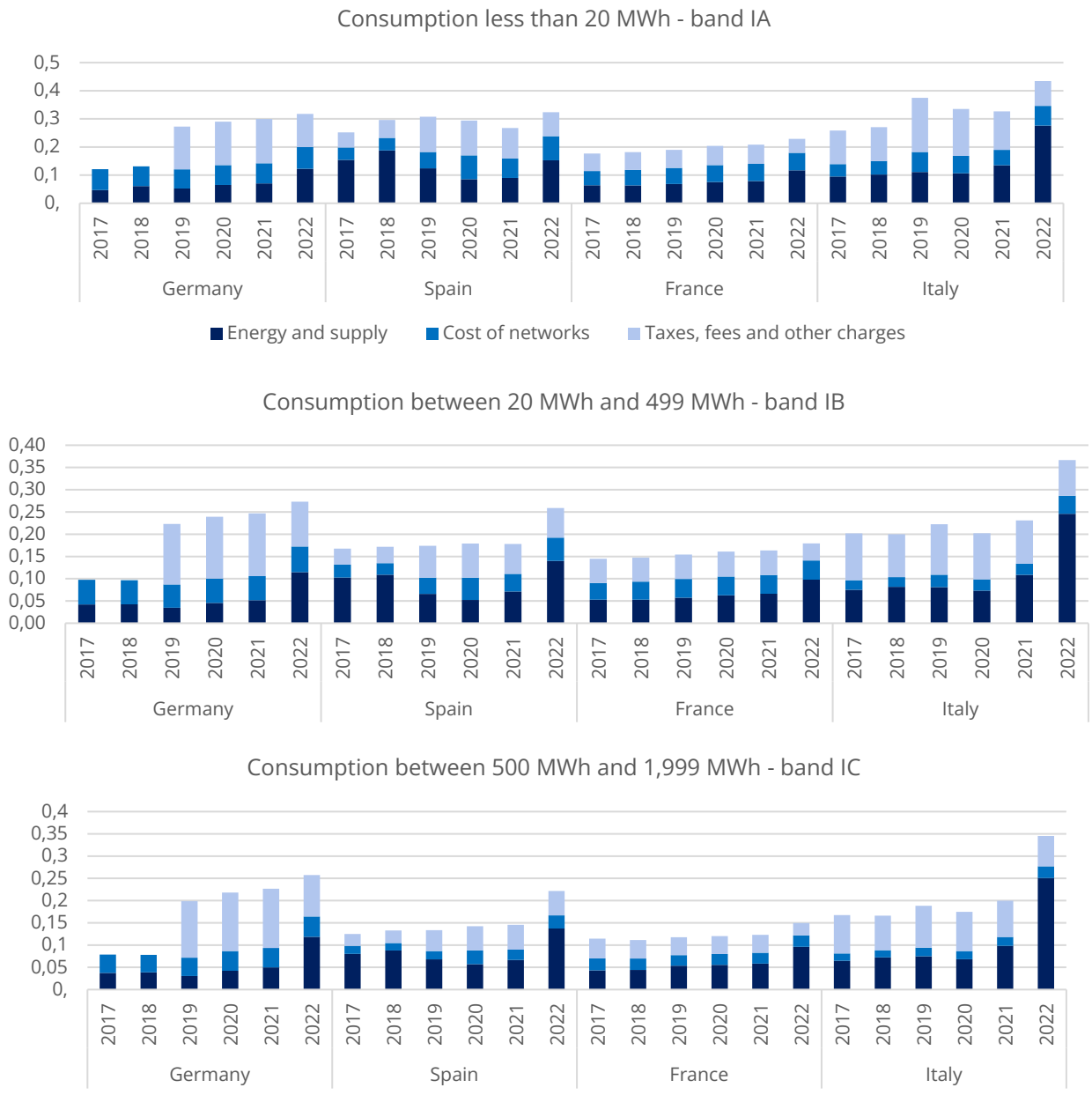
Chart 63. Evolution of the weight of the energy component in the price of electricity for households

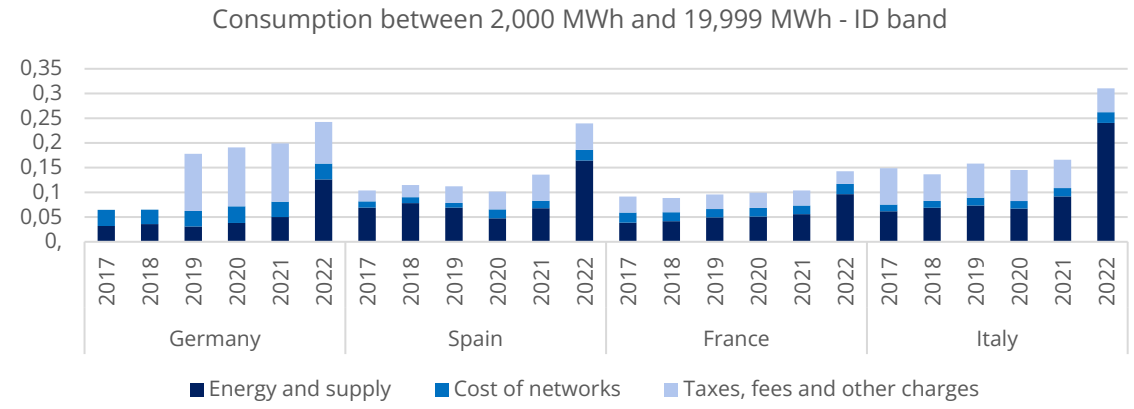


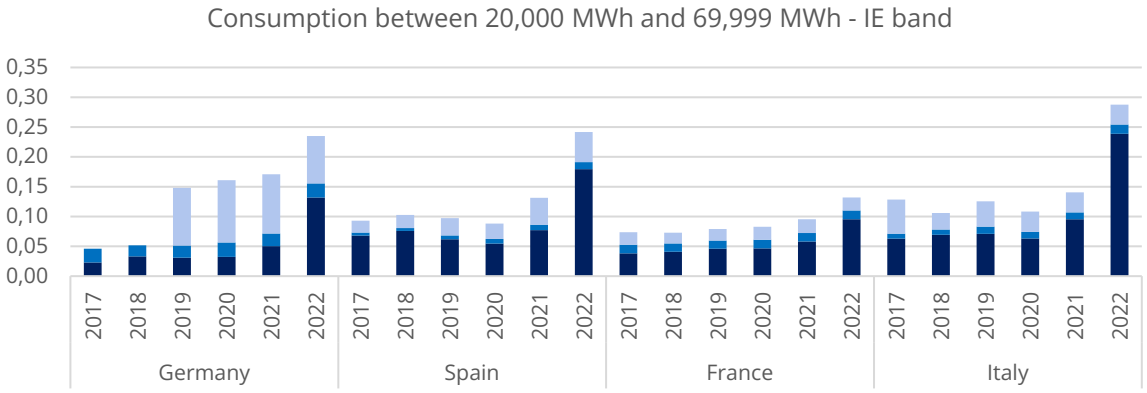
Source: Prepared by the authors based on Eurostat.

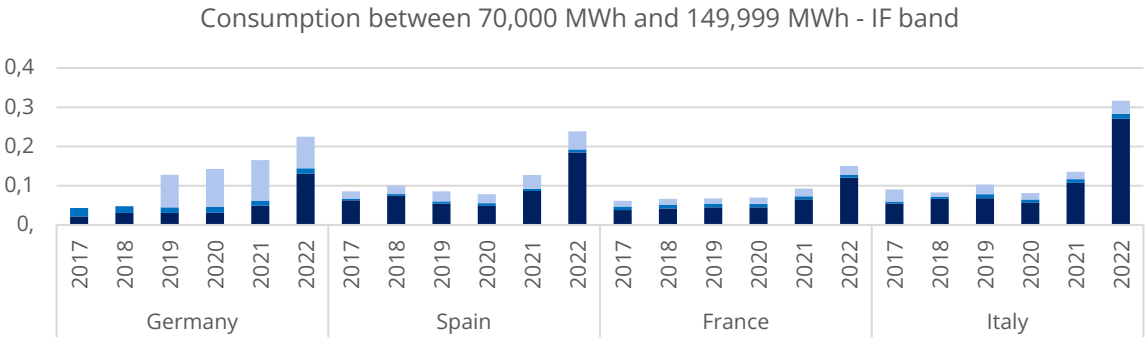
Non-domestic consumers

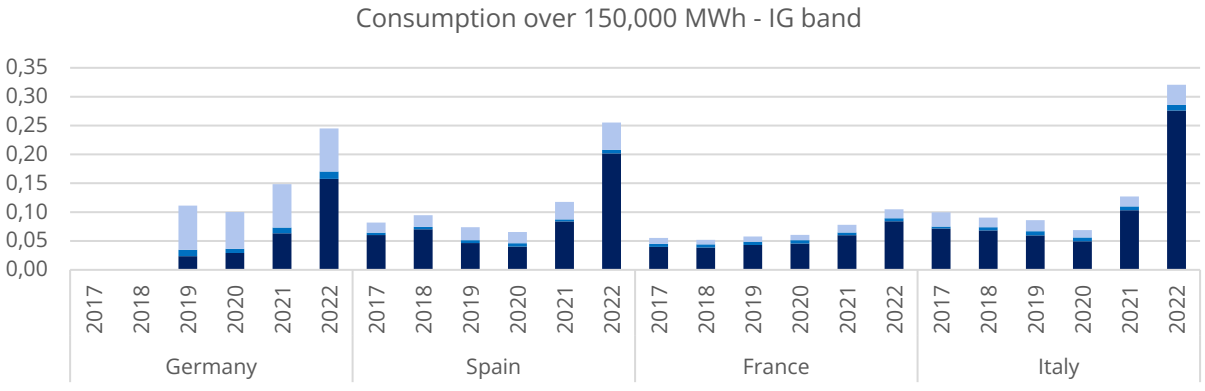
Chart 64. Electricity price evolution for non-domestic consumers by component (€/kWh)





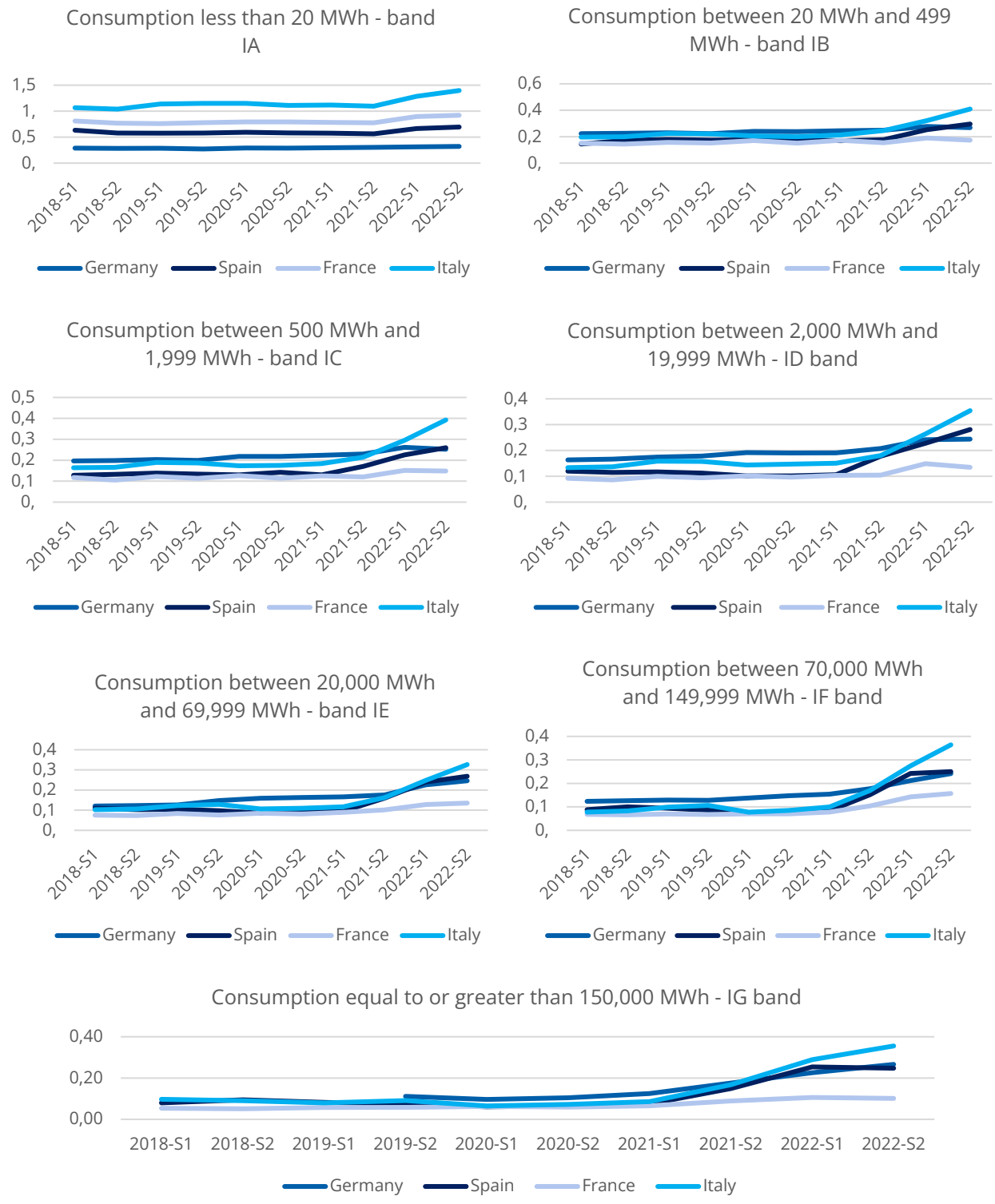






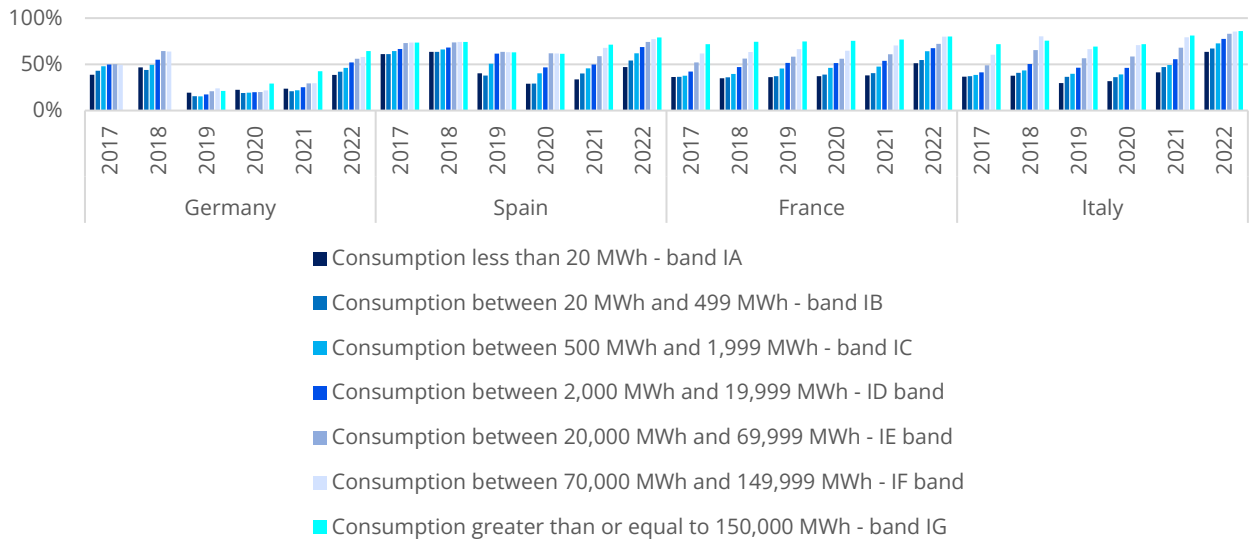
Source: Prepared by the authors based on Eurostat.

Chart 65. Electricity price evolution for non-domestic consumers by country (€/kWh)



Source: Prepared by the authors based on Eurostat.

Chart 66. Evolution of the weight of the energy component in the price of electricity for non-household consumers



Source: Prepared by the authors based on Eurostat.

Annex IV Evolution of the price of energy with respect to the evolution of the price of products by sector in the Basque Autonomous Community

Table 23. Evolution of the price of energy in relation to the evolution of the price of products by sector in the ACBC

Sector	2019	2020	2021	2022	2023
General index	0,1%	-10,5%	19,0%	80,5%	48,4%
Extractive industries	-0,4%	-15,9%	22,0%	113,1%	55,6%
Manufacturing industry	-0,4%	-11,2%	18,7%	87,1%	49,0%
Food, beverages, tobacco	1,4%	-13,6%	20,2%	99,5%	46,7%
Textile, apparel, leather and footwear	-1,5%	-18,1%	25,8%	128,3%	74,7%
Wood, paper and graphic arts	-2,5%	-12,7%	19,2%	77,5%	30,9%
Coke ovens and oil refining	-7,8%	3,4%	15,8%	42,2%	34,4%
Pharmaceuticals	-4,3%	-17,0%	15,0%	96,6%	49,9%
Chemical industry	-4,4%	-16,8%	10,4%	60,6%	30,3%
Rubber and plastics	5,8%	-8,5%	29,2%	120,6%	60,2%
Metallurgy and metal products	1,7%	-11,2%	14,1%	73,5%	39,1%
Computer and electronic products	3,2%	-12,4%	15,0%	101,7%	59,6%
Electrical material and equipment	1,3%	-13,5%	20,5%	112,1%	67,5%
Transport equipment	-0,3%	-16,2%	22,4%	125,3%	73,2%
Machinery and equipment	-2,7%	-13,1%	23,6%	118,8%	68,3%
Furniture and other manufactured goods	-0,9%	-14,6%	19,5%	111,3%	60,7%
Electric power, gas and steam	3,3%	-5,5%	20,9%	48,4%	44,8%

Note: Data for 2023 includes up to October.
Source: Prepared by the authors based on (Eustat, 2023e).

Table 24. Evolution of the price of energy in relation to the evolution of the price of products by sector in Germany

Sector	2019	2020	2021	2022	2023
Industry (except construction, waste, waste management and recovery activities)	-0,7%	-4,0%	9,3%	52,6%	37,1%
Extractive industries	1,0%	6,2%	5,0%	19,3%	19,8%
Manufacturing industry	-1,1%	-4,7%	12,5%	81,8%	55,2%
Food industry	-3,0%	-8,0%	12,5%	74,5%	41,1%
Beverages	-2,2%	-7,3%	14,5%	101,6%	65,3%
Tobacco	-3,1%	-10,8%	8,7%	92,5%	62,0%
Textile	1,7%	-2,7%	18,3%	98,0%	66,1%
Confection	0,1%	-4,5%	18,3%	112,4%	79,3%
Leather and footwear	-1,4%	-5,8%	17,2%	107,0%	70,9%
Wood	-1,9%	-4,8%	-4,2%	47,3%	40,8%
Paper	-1,7%	-2,5%	13,4%	62,6%	44,6%
Graphic arts	3,3%	0,1%	25,3%	94,9%	59,6%
Coke ovens and oil refining	-3,3%	8,5%	6,6%	41,2%	39,4%
Chemistry	-0,4%	-2,0%	10,1%	62,7%	44,8%
Pharmaceuticals	1,0%	-4,2%	17,8%	114,3%	81,1%
Rubber and plastic	1,4%	-2,6%	15,0%	88,7%	62,4%
Non-metallic minerals	-3,8%	-9,6%	9,5%	74,7%	34,4%
Metallurgy	-3,3%	-3,8%	-4,3%	40,9%	33,6%
Manufacture of other metal products	-1,6%	-5,8%	11,5%	80,6%	53,4%
Computer and electronic products	6,3%	3,4%	29,4%	126,8%	92,5%
Electrical material and equipment	-0,3%	-5,1%	15,3%	95,6%	61,9%
Machinery and equipment	-1,0%	-6,1%	14,9%	97,4%	63,0%
Manufacture of motor vehicles, trailers and semi-trailers	1,0%	-3,8%	18,9%	110,4%	77,5%
Manufacture of other transportation equipment	-0,3%	-5,2%	16,8%	109,2%	78,8%
Furniture and other manufactured goods	-1,9%	-7,2%	12,6%	87,0%	53,8%
Other manufacturing	-1,3%	-6,9%	14,7%	101,4%	68,6%
Electric power, gas and steam	0,6%	-1,2%	-1,7%	-7,0%	-6,6%
Power generation, transmission and distribution	-12,4%	-17,8%	-13,8%	-9,9%	-3,9%
Manufacture of gas; distribution of gaseous fuels through the network	20,9%	28,7%	13,6%	-9,3%	-12,8%

Note: Data for 2023 includes up to October.
Source: Prepared by the authors based on (Eurostat, 2023l).

Table 25. Evolution of the price of energy with respect to the evolution of the price of products by sector in Spain

Sector	2019	2020	2021	2022	2023
Industry (except construction, waste, waste management and recovery activities)	0,8%	-8,7%	11,1%	51,5%	28,5%
Extractive industries	3,8%	-11,1%	25,7%	115,6%	64,4%
Manufacturing industry	0,0%	-10,7%	15,6%	78,5%	43,5%
Food industry	3,9%	-11,2%	19,2%	87,8%	37,8%
Beverages	-1,3%	-14,9%	21,6%	114,0%	57,3%
Tobacco	-1,5%	-15,9%	19,1%	118,8%	76,9%
Textile	4,1%	-9,6%	26,5%	109,6%	64,5%
Confection	3,9%	-10,1%	27,5%	127,9%	80,5%
Leather and footwear	1,6%	-12,6%	24,1%	123,5%	76,0%
Wood	-0,5%	-13,9%	16,2%	80,2%	40,4%
Paper	-0,9%	-12,4%	15,3%	73,6%	41,9%
Graphic arts	-1,0%	-14,1%	22,0%	106,1%	60,6%
Coke ovens and oil refining	-8,7%	7,8%	6,6%	10,6%	7,8%
Chemistry	0,6%	-9,2%	7,1%	58,7%	39,7%
Pharmaceuticals	0,7%	-13,2%	22,4%	121,3%	75,4%
Rubber and plastic	3,2%	-10,3%	21,6%	104,6%	62,9%
Non-metallic minerals	1,5%	-12,5%	22,7%	98,5%	45,0%
Metallurgy	-7,2%	-15,4%	-9,5%	33,6%	21,0%
Manufacture of other metal products	0,2%	-12,8%	16,2%	91,7%	52,7%
Computer and electronic products	4,1%	-10,2%	27,5%	130,7%	84,7%
Electrical material and equipment	4,1%	-10,2%	25,0%	113,7%	67,3%
Machinery and equipment	1,4%	-12,7%	22,7%	112,3%	65,1%
Manufacture of motor vehicles, trailers and semi-trailers	2,8%	-11,6%	24,8%	122,3%	74,4%
Manufacture of other transportation equipment	-7,4%	-19,8%	11,5%	99,6%	55,8%
Furniture and other manufactured goods	0,4%	-13,7%	19,3%	104,6%	60,6%
Other manufacturing	2,3%	-13,2%	22,8%	118,7%	72,0%
Electric power, gas and steam	4,6%	0,7%	-1,2%	-3,2%	-1,3%
Power generation, transmission and distribution	4,4%	0,6%	-8,6%	5,6%	14,0%
Manufacture of gas; distribution of gaseous fuels through the network	9,4%	5,0%	34,7%	2,4%	0,9%

Note: Data for 2023 includes up to October.
Source: Prepared by the authors based on (Eurostat, 2023l).

Table 26. Evolution of the price of energy with respect to the evolution of the price of products by sector in France.

Sector	2019	2020	2021	2022	2023
Industry (except construction, waste, waste management and recovery activities)	4,5%	-1,8%	11,9%	44,9%	45,3%
Extractive industries	4,7%	-2,5%	16,9%	72,9%	61,9%
Manufacturing industry	4,8%	-1,3%	15,6%	60,5%	63,4%
Food industry	6,5%	-2,7%	18,4%	64,8%	55,8%
Beverages	4,0%	-3,0%	19,1%	84,0%	78,7%
Tobacco					
Textile	1,7%	-4,4%	13,9%	67,0%	57,3%
Confection	19,3%	13,0%	40,8%	127,4%	130,5%
Leather and footwear	4,4%	-6,3%	14,7%	81,3%	75,1%
Wood	1,6%	-5,9%	3,6%	40,6%	47,5%
Paper	3,2%	-1,0%	15,3%	50,0%	58,0%
Graphic arts	9,7%	0,8%	24,7%	81,0%	73,7%
Coke ovens and oil refining	-10,4%	28,8%	3,3%	-8,7%	17,0%
Chemistry	5,0%	5,0%	9,1%	29,3%	53,2%
Pharmaceuticals	13,9%	5,2%	29,4%	104,8%	110,1%
Rubber and plastic	6,7%	0,1%	19,0%	72,8%	74,3%
Non-metallic minerals	3,3%	-5,7%	15,3%	64,8%	53,8%
Metallurgy	3,0%	-1,5%	0,1%	25,2%	44,1%
Manufacture of other metal products	4,2%	-4,8%	12,8%	62,6%	66,5%
Computer and electronic products	9,5%	0,3%	24,0%	95,1%	96,7%
Electrical material and equipment	6,8%	-2,0%	17,9%	75,4%	72,1%
Machinery and equipment	3,5%	-5,8%	14,7%	71,3%	69,6%
Manufacture of motor vehicles, trailers and semi-trailers	6,3%	-4,8%	14,1%	70,8%	63,0%
Manufacture of other transportation equipment	6,2%	-3,3%	19,3%	89,5%	97,3%
Furniture and other manufactured goods	4,7%	-4,4%	14,1%	67,6%	65,3%
Other manufacturing	8,2%	-0,3%	23,8%	95,6%	97,9%
Electric power, gas and steam	2,4%	-4,2%	-1,6%	-0,9%	-5,5%

Note: Data for 2023 includes up to October.
Source: Prepared by the authors based on (Eurostat, 2023l).

Table 27. Evolution of the price of energy with respect to the evolution of the price of products by sector in Italy

Sector	2019	2020	2021	2022	2023
Industry (except construction, waste, waste management and recovery activities)	1,7%	-8,4%	8,3%	55,0%	28,5%
Extractive industries	26,1%	29,4%	40,1%	40,1%	101,4%
Manufacturing industry	2,6%	-10,3%	12,2%	99,6%	49,6%
Food industry	3,6%	-11,8%	13,8%	100,9%	44,4%
Beverages	4,8%	-9,2%	21,2%	133,5%	68,0%
Tobacco					
Textile	1,5%	-12,5%	14,5%	109,1%	53,5%
Tailoring	4,4%	-9,8%	20,2%	133,1%	66,9%
Leather and footwear	4,5%	-11,7%	14,3%	119,4%	54,6%
Wood	2,1%	-12,0%	7,8%	92,9%	46,1%
Paper	2,8%	-10,2%	13,3%	84,2%	41,7%
Graphic arts	6,8%	-8,5%	19,8%	128,1%	62,2%
Coke ovens and oil refining	-1,9%	3,5%	9,5%	67,6%	34,0%
Chemistry	1,9%	-11,1%	9,7%	83,2%	41,4%
Pharmaceuticals	3,1%	-11,9%	16,3%	135,6%	78,0%
Rubber and plastic	4,7%	-9,3%	14,2%	104,2%	52,0%
Non-metallic minerals	2,5%	-12,8%	13,7%	89,0%	30,7%
Metallurgy	-1,4%	-12,4%	-10,4%	49,6%	29,5%
Manufacture of other metal products	1,8%	-12,4%	10,7%	98,1%	47,3%
Computer and electronic products	5,1%	-9,7%	20,6%	142,5%	80,7%
Electrical material and equipment	5,3%	-9,5%	15,2%	115,1%	56,7%
Machinery and equipment	2,2%	-12,3%	15,0%	114,1%	55,7%
Manufacture of motor vehicles, trailers and semi-trailers	3,8%	-11,2%	15,5%	123,1%	66,3%
Manufacture of other transportation equipment	4,4%	-10,2%	17,4%	129,2%	67,6%
Furniture and other manufactured goods	2,3%	-12,6%	12,0%	107,7%	50,8%
Other manufacturing	5,0%	-10,5%	17,9%	127,1%	65,5%
Electric power, gas and steam	0,0%	-1,0%	-3,6%	-13,2%	-8,1%
Power generation, transmission and distribution	-2,6%	-7,6%	-6,6%	-5,4%	4,4%
Manufacture of gas; distribution of gaseous fuels through the network	7,0%	24,2%	6,0%	-29,8%	-23,3%

Note: Data for 2023 includes up to October.
Source: Prepared by the authors based on (Eurostat, 2023l).

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