FOUNDATION FOR ECONOMIC & INDUSTRIAL RESEARCH

Impact of high energy costs in the chemical industry and policy recommendations

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The judgements on policy issues and the policy recommendations contained in this analysis express the views of the researchers and do not necessarily reflect the opinion of IOBE's members or administration.

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SUMMARY

The present study examines the effects of high energy costs for the chemical industry in Greece and makes policy recommendations for immediate and medium-term actions that will help contain them. The analysis is carried out in view of the need to ensure the competitiveness of the Greek chemical industry in an environment of multiple challenges arising from transition towards climate neutrality and the necessary adaptation of the sector to the new EU strategy for sustainable chemical products.

OVERVIEW OF THE CHEMICAL INDUSTRY IN GREECE

The chemical industry in Greece has been in a development phase in recent years. Domestic chemical production is concentrated in the specialty and consumer chemical categories. The weight of basic chemical production is lower, demonstrating the high dependence on imported chemical raw materials. Prices of chemicals, especially basic chemicals, rose significantly during 2021, driven by stronger demand and rising raw material and energy costs, pushing the industry's turnover to high levels. The chemical industry has a significant contribution to the added value of domestic Manufacturing. Employment in the sector has been increased significantly in recent years and mainly concerns highly specialized jobs. Chemical exports have seen dynamic growth in recent years, while imports, which supply the domestic industry with basic chemicals and products, have also been on the rise. The extroversion of the domestic chemical industry is high and has been increased in recent years, while labor productivity in the industry is higher than the average productivity in Manufacturing, which is reflected in better paying jobs.

THE NEW ENVIRONMENT AND CHALLENGES FOR THE CHEMICAL INDUSTRY

The European Green Deal (EGD) and its framework strategies, such as the Sustainable Chemicals Strategy, pose significant challenges to the chemical industry. Chemicals are present in almost every strategic value chain, and the role of the chemical industry in developing innovative technologies to achieve climate goals is pivotal.

The changes in legislation envisaged in the Sustainable Chemicals Strategy are expected to have a significant impact on the activity of the chemical industry. According to a study by the European Chemical Industry Council (CEFIC), the new legislation is estimated to affect chemicals representing 28% of the industry's turnover. About 8% of this market will likely be replaced, while 2% will be unaffected due to deviations. Additionally, approximately 6% of the market will not face withdrawal pressures and will only be affected by the increased regulatory burden. This means that the changes in the sectoral legislation considered, when taking into account the possible response of businesses, could lead by 2040 to a net reduction in the product/business portfolio (in terms of turnover) of around 12% which is equivalent to 70 billion euros of the total market in 2019. Correspondingly, for the chemical industry in Greece the changes in legislation may have an impact that can reach around 300 million euros.

The chemical industry therefore faces a multiple challenge: achieving climate neutrality in its production processes, contributing materials and products that will allow the reduction of the carbon footprint in other sectors, enhancing the circularity of products and providing solutions for recycling, detoxification and digitization. This is an industrial transformation that requires appropriate planning and significant investments that will lead to ensuring the resilience and competitiveness of the chemical industry in Greece and the EU, so that the sector can effectively contribute to the achievement of the EGD policy objectives.

ANALYSIS OF THE IMPACT ON THE CHEMICAL INDUSTRY FROM THE INCREASE IN ENERGY COST

The chemical industry in Greece uses in its production processes mainly electricity and natural gas and less petroleum, while at the same time it is the largest consumer of natural gas for non-energy use. As a result, the current energy crisis affects it significantly, both directly through energy costs and indirectly

through costs for the purchase of raw chemicals. The unprecedented rise in natural gas and electricity prices from the second half of 2021 has passed on to energy supply tariffs, creating significant pressures on businesses in the sector.

If natural gas import prices remain on average in 2022 at the levels of January 2022 (98.3 euros/MWh), the final prices (without VAT) of natural gas for companies with annual consumption from 100 TJ to 1000 TJ are estimated that they will amount to around 106 euros/MWh, i.e. they will be increased by 163% compared to 2021 and by 450% compared to 2020. The provision of a subsidy to businesses, in the order of 30 euros/MWh, limits the final price to 75 euros/MWh, absorbing only a small part of the increase.

Accordingly, if wholesale electricity prices remain on average in 2022 at the levels of January-February 2022 (241.9 euros/MWh), the final prices (without VAT) of electricity for companies with annual consumptions from 20 GWh to 70 GWh is estimated that they will amount to approximately 259 euros/MWh, i.e. they will be increased by 73.6% compared to 2021 and by 220% compared to 2020. The provision of a subsidy to businesses, of the order of 65 euros/MWh limits the final price to 189 euros/MWh, absorbing again only a small part of the increase.

Individual sectors of the chemicals industry with large direct participation of energy costs in total cost of inputs, such as the production sectors of other inorganic chemicals, industrial gases, dyes, petrochemicals and synthetic fibers, are estimated to have the greatest impact on competitiveness and profitability. However, the production sectors of fertilizers, plastics, plant protection products, paints, auxiliary chemicals for industry and consumer chemicals are also significantly affected indirectly, due to increases in the cost of supplying raw chemical materials, which are closely linked to high energy costs.

Overall for the chemical industry it is estimated that the increase in the cost of energy, without taking into account its impact on the cost of raw materials, causes a price increase of 5.6% if the prices were not subsidized and by 2.5% in the case of the subsidy of prices. Depending on the extent to which demand will be affected, it is estimated that without the energy price subsidy total chemical production in 2022 would be -1.7% to -5.6% lower than the previous year. The energy price subsidy limits the impact on costs and thus on the level of production, which is estimated to be 0.8% to 2.5% lower compared to 2021. From the estimates of the impact on the production of the individual chemical industry sectors it is evident that the impact is greater in sectors where energy costs have a higher participation in production costs.

The losses in the production of the domestic chemical industry will have wider effects on the Greek economy, which result from the interconnection of the sector with the other sectors of economic activity. It is estimated that in the case of non-implementation of the subsidies, and depending on the reaction of the demand, the impact on the GDP can range from €42 million to €140 million, while the impact on employment ranges from 702 to 2,339 jobs. By subsidizing energy prices the impacts are mitigated to €19 million to €63 million and 316 to 1,054 jobs.

In a more unfavorable, but realistic based on the circumstances, scenario, in which the escalation of the war in Ukraine would even cause a cut in gas and oil supplies from Russia, energy prices are expected to rise even more. Depending on the extent to which demand will be affected, it is estimated that without the energy price subsidy total chemical production in 2022 would be -3.4% to -11.2% lower than the previous year. Subsidizing energy prices (or other equivalent intervention) limits the impact on costs and therefore on the level of output, which is estimated to be 1.7% to 5.6% lower compared to 2021. The impact on GDP may vary from €83 million to €278 million, while the impact on employment ranges from 1,397 to 4,658 jobs. By subsidizing energy prices the impacts are mitigated to €42 million

to €138 million and 694 to 2,315 jobs, without taking into account the higher fiscal costs from increased energy price subsidies.

Rising energy prices indirectly but significantly affect the prices of chemicals procured as raw materials or distributed by the domestic chemical industry. The picture of price impacts is different in this case as the increase in the cost of chemical raw materials significantly affects the fertilizer sector with cost and price increases exceeding 100%. A significant impact (32.8%) is also estimated for plastics, while the sectors of petrochemicals, other inorganic chemicals, synthetic fibers and auxiliary chemicals for industry have an impact of 10% to 14% on production costs and prices. Smaller, from 3.2% to 6.9%, is the indirect impact of energy prices in the remaining sectors (industrial gases, dyes, plant protection, paints and consumer chemicals). In the most unfavorable scenario, in which we assume that the already recorded price increases are expanded by 50%, the impact increases even more for fertilizers and plastics, while in the remaining categories it shows smaller changes.

Depending on the demand response, the impact on GDP can range from €125 million to €351 million, while the impact on employment ranges from 2,102 to 5,882 jobs. Furthermore, in the most unfavorable scenario the impact is estimated to be greater, ranging from €169.4 million to €465.5 million and from 2,838 to 7,799 jobs.

From rising raw material costs, the chemical industry could experience total additional production losses ranging from 5% to 14%, with the fertilizer and plastics sectors estimated to be the hardest hit. In the most unfavorable scenario the additional losses for the chemical industry are estimated to be greater and range from 6.8% to 18.7%.

Overall, the prospect of highs pressure on the activity and profitability of firms in the sector will have implications for their ability to invest and meet the challenges of the decade ahead. It is therefore necessary in the short term to limit the effects of high energy costs on the economy and ensure security of energy supply and in the medium term to ensure the supply of energy at affordable prices, without exposure to uncontrollable price fluctuations.

POLICY RECOMMENDATIONS

The effects of the current energy crisis and high energy prices are particularly unfavorable for the enterprises of the domestic chemical industry, as well as for the economy as a whole. Their competitiveness is significantly affected and, given their strong extroversion, their prospects become more uncertain. The measures that have been implemented are obviously necessary and mitigate to some extent the effects of the energy crisis on competitiveness. However, there is a need for the examination and implementation of additional measures, which will help the companies in the sector to deal more effectively with the current crisis, to strengthen their resistance to similar crises in the future, but also to respond to the multiple challenges that are in front of them. It is therefore crucial, within the context and possibilities deriving from the relevant EU directions, to consider interventions with both short-term and medium-term targeting. Examples of such interventions may include the following:

Maintain an adequate level of subsidy for the energy costs of businesses and a differentiated subsidy for energy-intensive businesses. The level of the subsidy should follow the fluctuations of the prices of wholesale electricity and natural gas, as is applied in the current phase. However, it is necessary that energy-intensive enterprises receive a higher subsidy, since, as it was also found in the case of chemical enterprises, the impact on their production costs and competitiveness is disproportionately greater compared to lower energy-intensive enterprises.

Interventions to increase business liquidity. Utilization of the new temporary crisis framework for state aid in the EU, which provides, among other things: a) the possibility of aid up to €400,000 per company

in any form, even with direct aid, b) liquidity support in the form of state guarantees and subsidized loans from banks to all affected businesses and c) aid to offset high energy prices, especially for the most energy-intensive, for the additional costs due to the extraordinary increases in gas and electricity prices. Depending on the country's fiscal capacity, the following state aid measures could be included:

- Tax deduction for those energy-intensive businesses that have an increase in energy costs greater than a predetermined percentage compared to 2019, as can be certified with data to be submitted in a relevant application.
- A government guarantee program for the provision of working capital loans at zero interest to cover the operating costs of companies that are included in the energy affected and certify in a relevant application that they are facing an increase of more than 100% in their energy bills. The State and the banking system have gained relevant experience during the health crisis, which they can use in the case of the energy crisis as well. The granting of these funds will partially offset the blow to the competitiveness of all companies in the chemical industry, whether energy-intensive or those with indirect effects due to the greatly increased cost of raw material procurement.
- State guarantees for the provision of bridge loans to affected businesses.
- Return of the excise tax on electricity and natural gas for companies that export at a percentage corresponding to the value of their exports in turnover.

Additional interventions to reduce energy costs may include**:**

- Reduction of network charges and other fees to the minimum possible level.
- Direct implementation of indirect emission cost offsets for eligible domestic industry sectors.
- Increase the aid intensity from 75% to 100% to offset the cost of indirect emissions and extend the application of the measure to businesses with high electricity intensity that are not eligible according to the existing list of sectors of the European Commission.
- Systematic monitoring and control of wholesale electricity and natural gas markets to avoid abusive practices.
- Subsidizing other energy sources such as LPG for industrial use, which is mostly used by businesses due to the lack of a natural gas network in their area of installation.
- Exemption from excise duty on natural gas when used as a raw material.
- Ensuring the transfer of surpluses, in the form of windfall profits, in electricity prices to businesses and households.
- A national initiative, within the framework of the EU institutions, to moderate the ETS prices – with possible use of the market stability reserve to deal with the excessive prices of emission allowances.

Interventions for greater business participation in the benefits of energy system transformation and the green transition. It is accepted that investments in RES and energy efficiency should be accelerated in order, in addition to climate protection, to reduce dependence on imported fossil fuels and risks to energy security. At the same time, with today's data, these investments will offer affordable wholesale energy prices, ensuring price stability in the future, while the economic activity that will be created during the implementation of the investments will compensate at least part of the losses caused by the energy crisis. In order for industrial enterprises to participate in these benefits, the following should be pursued indicatively:

- Encouraging through institutional interventions (e.g. standardization of contracts, reduction of counterparty risks) direct corporate agreements to purchase electricity from RES through bilateral contracts (PPA's), especially for electricity-intensive enterprises.
- Strengthening/promotion of business investments in self-production of renewable energy in combination with the implementation of the net metering system with:

  - Simplification of the institutional framework (e.g. in parameters such as the installation of the RES station in a different location, real-time consumption limits, increasing the capacity of batteries that can be used, the application of virtual net-metering, etc.).
  - Accelerating the licensing of the installation of photovoltaic systems for businesses, with priority approval from the distribution system operator (DEDDIE).
- Facilitation of the establishment of energy communities by companies, whose RES projects can be directly connected to the high-voltage network, when the medium-voltage network is congested.
- Establishment of energy saving programs for industry.
- Acceleration of investments to strengthen/upgrade electricity networks.
- Reinforcement/promotion of investments linked to the circular economy (e.g. chemical recycling of plastics) which under today's technologies are energy-intensive. More specifically, in addition to subsidizing the initial cost of the investment through the financial tools of the Recovery Fund and NSRF for the period 2021-2027, it is recommended to subsidize the price of energy, indicatively for the first 5 years of operation, according to the fluctuations of wholesale electricity prices energy and natural gas.
- Designing investment support programs, in the framework of the review of the Recovery Plan to integrate the objectives of REPowerEU, to support industrial sectors, including the chemical industry.

Other interventions. Rising costs of energy and other raw materials have led to large price appreciations in construction materials and other related chemicals. As there is no automatic price adjustment, several public projects as well as energy-saving interventions approved by the «Εξοικονομώ» 2021 program are at risk of not being implemented, as their budget does not cover the excessively increased costs. Therefore, it is necessary to systematically monitor the prices and in cases where large deviations from the original budget are found, to carry out at least a partial adjustment of the prices and cover the additional costs. Also, it is considered appropriate to include materials in addition to labor cost in the costs of upgrading buildings that are deducted from the taxable income of individuals who are not included in the «Εξοικονομώ» Program.

Finally, another intervention that could be considered is the temporary reduction of VAT on fertilizers and other agricultural inputs to 0% (it has been implemented by Poland as an anti-inflationary measure), which would mitigate the effects of increased costs on agricultural production.

1 INTRODUCTION

The production of chemicals and products in Greece is an important industrial activity that contributes to the growth of the Greek economy by producing internationally tradable goods with high added value, attracting investment, supporting important sectors of the economy and maintaining and adding specialized jobs to the economy. At the same time, the activities of the chemical industry show strong multiplier effects reflected in the GDP, jobs and public revenues directly and indirectly generated by them, while extroversion, higher labor productivity and better pay levels compared to the average manufacturing business in Greece, classify the chemical industry among the sectors that can serve a new development model for Greece.

The chemical industry in Greece suffered significant losses in the early years of the economic crisis, but managed to recover mainly through the strong growth of its exports, through which it mitigated the effects of the losses in the domestic market. Furthermore, during the health crisis, the importance of the chemical industry for its effective response was highlighted and its individual sectors showed significant growth.

The current economic situation, from the second half of 2021, is characterized by the steep rise in the prices of natural gas, electricity and petroleum products. The war in Ukraine has reignited uncertainty in energy markets, led to further increases in energy costs and inflation, and raised serious concerns about energy security and the cost of high inflation to the economy.

The high cost of energy, if it remains at these levels for a long time, strongly threatens the competitiveness of the companies in the sector and ultimately their sustainability. More vulnerable to the current energy crisis are chemical industries with high energy intensity in production processes. However, the close interconnection of energy costs with the cost of supplying chemical raw materials extends the adverse consequences to industries producing chemical products with lower energy intensity.

The government's decisions to subsidize from January 2022 the increases in gas and electricity charges for businesses and to suspend public utility services charges on business electricity bills are moving in the right direction, providing, temporarily, some relief to businesses as well the chemical industry. The financing of these subsidies from the surplus of the special RES account and from the revenues from the auctions of CO_2 emissions allowances limits the obvious fiscal impact for now. However, in the event that energy prices are not scaled down soon and significantly, the necessary additional financing of subsidies from the state budget entails additional risks for the economy.

The fundamental changes expected to take place in the EU's transition towards climate neutrality in the current and coming decades are likely to frequently put the issues of energy costs and the competitiveness of industry in the EU at the center of attention. In addition, especially for the chemical industry, significant challenges will also be associated with the cost of compliance with the new EU strategy for the sustainability of chemical products. The objectives of the European Green Deal, as well as the new European strategy for sustainable chemicals, make it necessary to transform and adapt the Greek chemical industry, but this cannot be achieved in an environment with significant disadvantages compared to enterprises

in other countries that either they do not face similar compliance costs, or they have significantly lower energy and raw material costs.

In this context, addressing high energy costs and the risk of energy costs remaining at a high level is a critical factor that will support the development perspective and competitiveness of the domestic chemical industry and the sectors supported by it.

The purpose of this study is to analyze the effects of high energy costs for the chemical industry in Greece and to formulate proposals for immediate and medium-term actions that will help to contain them. The analysis is carried out in view of the need to ensure the competitiveness of the Greek chemical industry in an environment of multiple challenges arising from the policy of transition towards climate neutrality and the necessary adaptation of the sector to the new EU strategy for sustainable chemical products.

In particular, the structure of the study is as follows. The **second section** provides an overview of the main dimensions and the contribution of the chemical industry to the Greek economy. The **third section** analyzes the challenges for the chemical industry in the framework of the European Green Deal and the EU Chemicals Strategy, which make it crucial to ensure and strengthen the sector's competitiveness. In the **fourth section**, the effects of the increase in energy costs in the chemical industry are examined and estimates are provided for the impact it may have on the sector and more broadly on the Greek economy. Finally, in the **fifth section**, recommendations are made in the direction of dealing with high energy costs, in the short and medium term, which will contribute to maintaining and further strengthening the contribution of the chemical industry to the Greek economy in the coming years.

2 OVERVIEW OF THE CHEMICAL IINDUSTRY IN GREECE

2.1 Basic categories and value chain of chemicals and products

The chemical industry produces a multitude of chemical substances, but also intermediate and final products, which can be classified into categories according to their chemical elements composition, the stage of the process in which they are produced, or the market segments to which they are directed. The main categories of chemicals and products include **basic chemicals**, **specialty chemicals** and **consumer chemicals.**[1]

Basic chemicals, which are produced in the early stages of the chemical industry's value chain, are a broad class of chemicals and products that are mainly used as inputs in various production value chains, both of the chemical industry itself and of other industries. They include *petrochemicals* and *polymers* (organic chemicals), as well as *basic inorganic chemicals*.

Box 2.1: Categories of basic chemicals

Petrochemicals are chemical substances that are mainly based on oil, natural gas and derivatives of raw materials (feedstocks). They include chemicals such as olefins (ethylene, propylene, etc.) and other monomers, aromatic compounds, alcohols and other intermediates based on these substances.

Basic inorganic chemicals include a variety of materials and products such as industrial gases (hydrogen, nitrogen, oxygen, noble gases, carbon dioxide, etc.), ammonia, fertilizers, nitrogen oxides and other inorganic chemicals such as chlorine and hydrochloric acid, sulphur, sulphates and sulfuric acid and hydroxides of aluminium, sodium and calcium.

Polymers are produced using chemicals from the petrochemical industry. They include intermediate products such as plastics, synthetic rubber and synthetic fibres, which can be molded into a variety of end products such as packaging film, various automotive parts and insulation materials. Basic organic chemicals are a building block of the chemical industry. They are closely related to each other in production processes and form the basis of special chemicals. The organic chemicals sector is high-tech and absorbs most of the chemical industry's Research and Development (R&D) spending.

Specialty chemicals are produced by chemical processes in which basic –mainly organic– chemical substances are used as inputs. As intermediate products, they usually serve specific functions in the production processes of other industries and in several cases are designed to meet the specific needs of users. To a lesser extent, they are also purchased by end consumers. They include products such as agrochemicals (insecticides, herbicides, plant growth regulators, inorganic fungicides, bactericides and seed treatments, rodenticides and other plant protection products), disinfectants, coating paints and varnishes, oil and surface coatings, inks, prepared driers, pigments, etc.

Consumer chemicals are sold directly to end consumers. They include a wide variety of products such as soaps, shampoos, detergents, perfumes, cosmetics, skin care preparations, creams and similar preparations, room fragrance preparations, hair preparations, oral or

[1] In the official statistical classification of branches of economic activity (NACE rev.2), the chemical industry is described as "Manufacture of chemicals and chemical products" (NACE branch 20). The activities included in this branch as well as the assignment of these activities according to the categorization we follow in this study are presented in the appendix of the study. There are, however, some intermediate or final products of other manufacturing industries that can be considered to belong to the products produced by the chemical industry, since their production process involves the further conversion of basic chemicals. One such class of products is that of plates, sheets, films, thin sheets and strips of plastic materials (polypropylene film) (NACE 22.21), the production of which in Greece is closely linked to the development of the petrochemical industry.

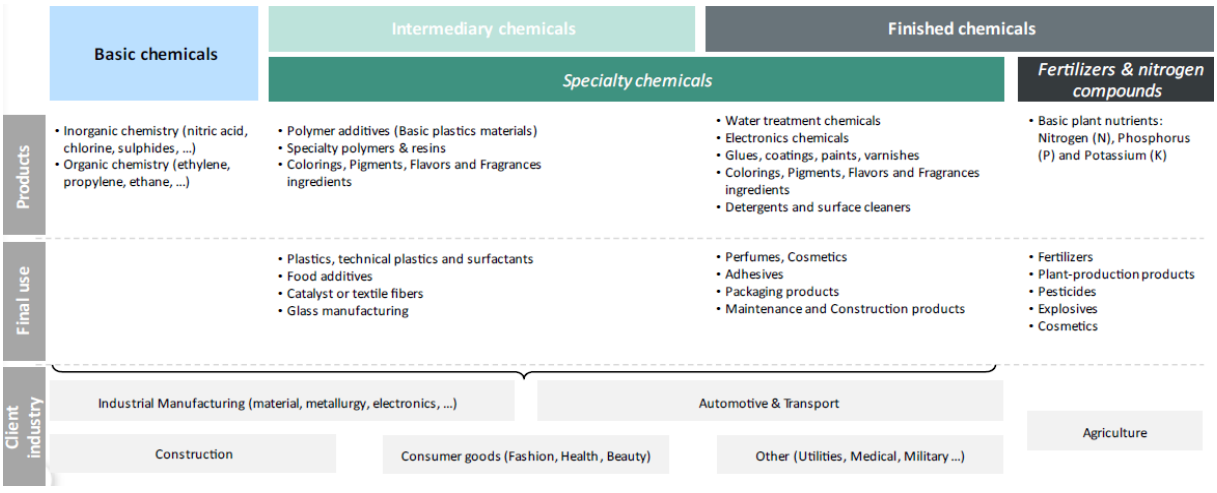
dental hygiene preparations, mano and other care preparations nail polishes, cleaning ointments and powders, etc.

The chemical industry is highly complex. It exhibits strong vertical linkages, mainly in the basic chemicals sector, and a wide dispersion of activities and manufactured products. The concentration in its individual segments varies – a consequence of the different degree of integration, capital needs and energy intensity required by the nature and demand of the chemicals and products produced, as well as the intensity of competition in relevant markets. In addition, chemicals and products are fundamental inputs to other economic activities. They enable the development of activities and products with high value for consumers, they facilitate innovation in a multitude of sectors and they enhance productivity. This relationship is not unambiguous, as the development of these activities feeds back and further strengthens the chemical industry.

The value chain of the chemical industry is diverse and includes many different products that supply a multitude of end applications that are central to the economy (Table 2.1). Thus, with the scope of its production including products such as petrochemicals, fertilizers, synthetic fibers, plastic raw materials, construction chemicals and paints, the chemical industry decisively influences the activity and development of intermediate and final products in a multitude of industries spanning from primary sector, the plastics-rubber industry, the food industry, the textile-clothing industry, the metal industry and construction to technologically more advanced industries such as the pharmaceutical industry, the automotive industry and electronics. The production of consumer chemicals, such as detergents and cosmetics, is an equally important sector of the chemical industry, which complements the range of production activities of the sector.

The most important sectors – buyers of chemicals, in Greece, are the Plastics & Rubber production sectors, Health Services, the Agricultural Sector and the Base Metals production sector, to which approximately 25% of all chemical sales are directed. A considerable part of chemical sales (about 6%) is carried out within the industry, while the largest percentage of chemical products available in Greece are consumer chemical products.

Table 2.1: The chemical industry value chain



Source: CEFIC

2.2 Key figures and trends of the chemical industry in Greece

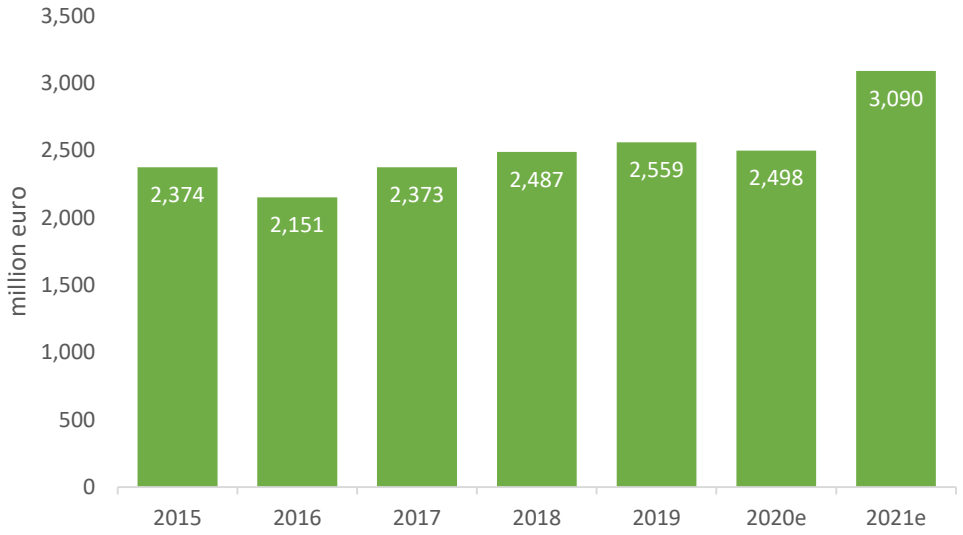
NUMBER OF BUSINESSES

In the chemical industry in Greece, according to the latest available Eurostat data (2020), there are 961 companies employing 12,300 persons –including the self-employed and micro enterprises. The majority of them are engaged into activities related to the production of consumer (45%) and specialty chemicals (34%), while considerably fewer companies are engaged into the production of basic chemicals –mainly basic inorganic substances and polymers. Of all the businesses in the sector, 170 employ more than 10 persons, representing 93% of the sector's turnover. In addition, approximately 1,800 enterprises are active in the wholesale trade of chemical products, employing approximately 7,100 persons.

TURNOVER

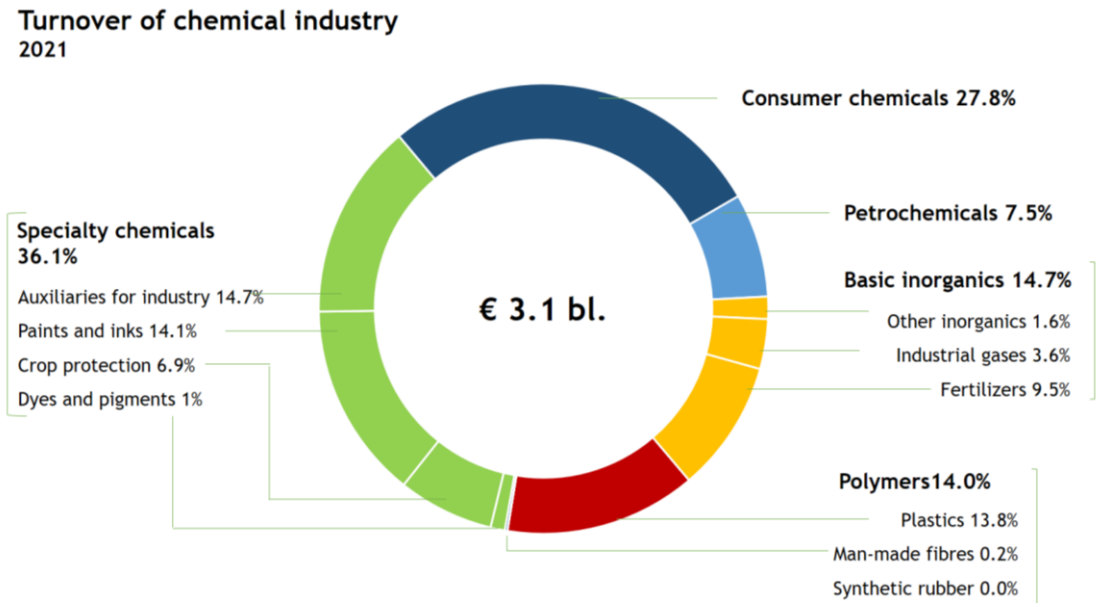
The turnover of businesses in the sector is estimated to have approached €3.1 billion in 2021, marking a significant increase of 24% compared to 2020 (Figure 2.1). The largest part of it is made up of specialty chemicals (€1.1 billion or 36% of the total), while the consumer chemicals production sector is also very important, with €858 million or 28% of the total (Figure 2.2). Basic chemicals account for the remaining 1.06 billion or 36% of total turnover, compared to around 60% in the EU-27, which indicates the high dependence of the chemical industry in Greece on imports of chemical raw materials.

Figure 2.1: Turnover of the chemical industry in Greece, 2015-2021



Source: Eurostat, IOBE estimations (e)

Figure 2.2: Turnover of the chemical industry in Greece by sector, 2021

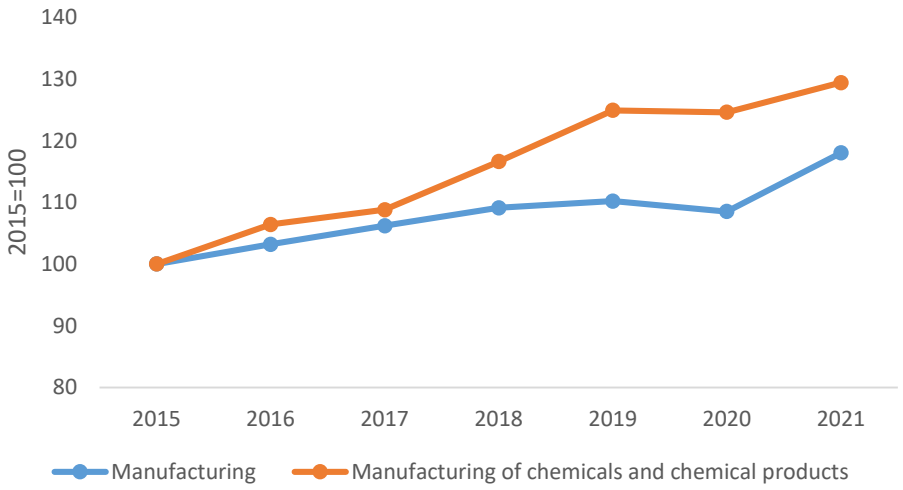


Source: IOBE Analysis

PRODUCTION AND PRICES

Domestic production of chemicals increased by 3.8% in 2021, continuing the upward trend shown by the sector in recent years (Figure 2.3). Chemical production was 29.4% higher in 2021 compared to 2015, with the performance of the chemical industry proved better than domestic Manufacturing. Overall, the crisis of the COVID-19 pandemic did not significantly affect the domestic chemical industry, which in 2020 had marginal losses despite the huge recession of the Greek economy, as the health crisis greatly highlighted the importance of the chemical industry in modern economies and health systems.[2]

Figure 2.3: Index of production of the chemical industry in Greece, 2015-2021



Source: Eurostat, IOBE Analysis

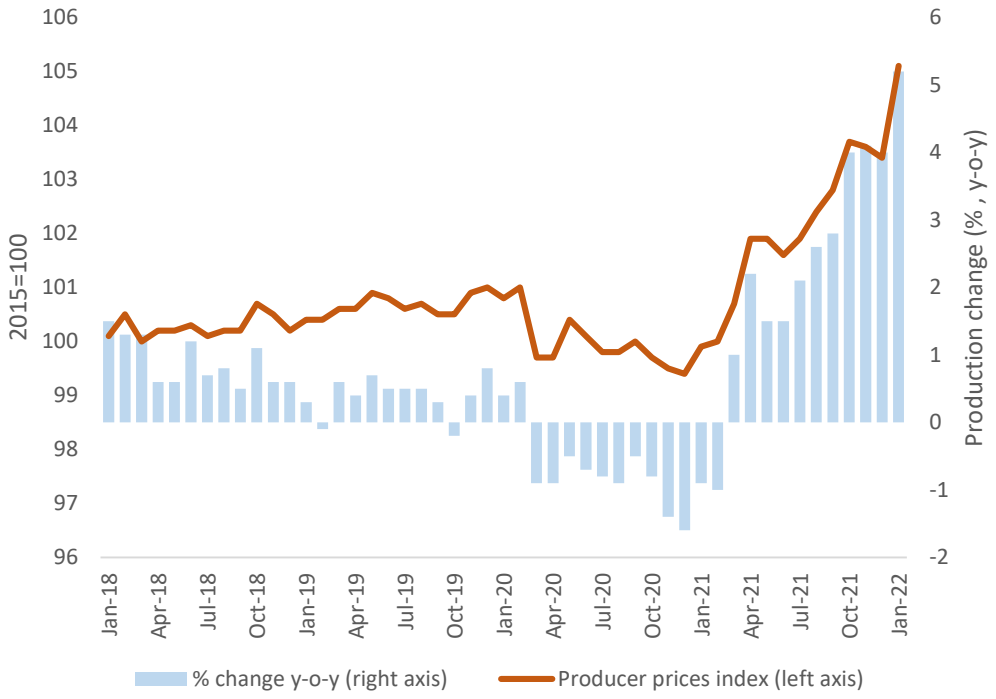
[2]The health sector has as its main supplier the chemical industry in substances such as pharmaceutical ingredients, raw materials for disinfectants, ingredients for detergents and cleaners, as well as ingredients for the production of medical equipment, personal protective equipment for health workers, etc.

After a period of relative stability, producer prices in the chemical industry eased in 2020, adjusting to the decline in demand in individual market segments and the reduction in raw material and energy costs during the first period of the health crisis (Figure 2.4). However, from January 2021 to January 2022 producer prices of chemicals followed an upward trend, increasing by a total of 5.2%, pushing the turnover of the sector to higher levels.

It is worth noting that the evolution of prices in 2021 differs between individual categories of chemicals, with the strongest increases recorded in the categories of basic chemicals (+10.1%) and specialty chemicals directed to other industrial activities (+8.5 %).

The cycle of rising chemical prices is not over. The exogenous disruption in chemical supply due to skyrocketing energy costs will lead to a further rise in chemical prices through 2022, as there is usually a lag between when an exogenous disruption occurs and when the increased costs are passed on to product prices.

Figure 2.4: Produces prices index for the chemical industry in Greece, Jan. 2018 – Jan. 2022



Source: Eurostat, IOBE Analysis

GROSS VALUE ADDED AND OPERATING SURPLUS

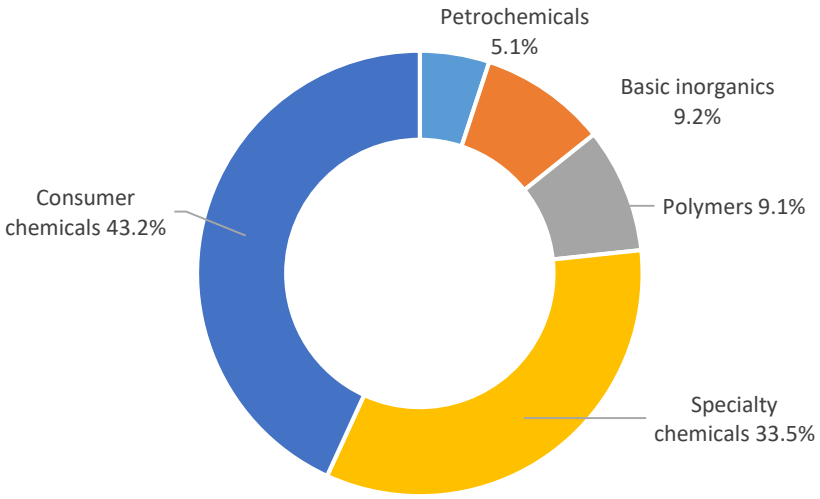
The chemical industry is one of the largest industries of domestic manufacturing. The sector's **gross value added** (GVA) is estimated at €811 million in 2021, representing 6.6% of Manufacturing GVA (Figure 2.5). Compared to 2015, the GVA of the chemical industry grew significantly, but also faster than the total of Manufacturing, as indicated by the increase in its share of Manufacturing GVA.

Figure 2.5: Gross value added of chemical industry in Greece, 2015-2021

Source: Eurostat, IOBE estimations (e)

Approximately ¾ of the GVA of the chemical industry in Greece (€622 million) is estimated to have come in 2021 from specialty and consumer chemicals, while the contribution of the rest of the industry, especially basic petrochemicals, was much smaller (Figure 2.6). This is to be expected due to the relatively small size of production activity in the basic chemicals sector in Greece and the commodity nature of petrochemicals.

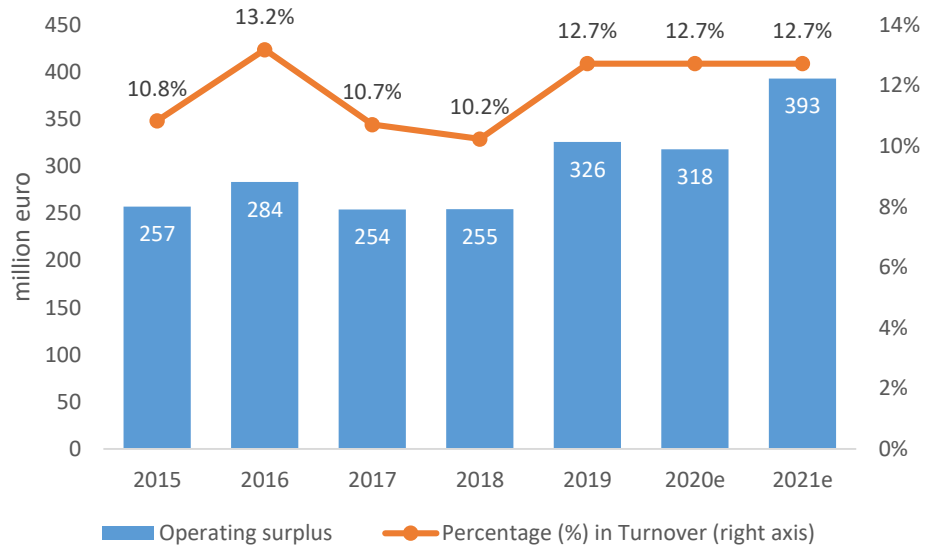
Figure 2.6: Gross value added of chemical industry in Greece by sector, 2021



Source: IOBE estimation

The **operating surplus** is a quantity that expresses the profitability of the sector and is calculated when wages of employees are subtracted from its value added. As we observe in Figure 2.7, the operating surplus of the chemical industry, following the course of value added, is estimated to have approached €400 million in 2021, constituting 12.7% of the sector's turnover.

Figure 2.7: Operating surplus of the chemical in Greece, 2015,2021



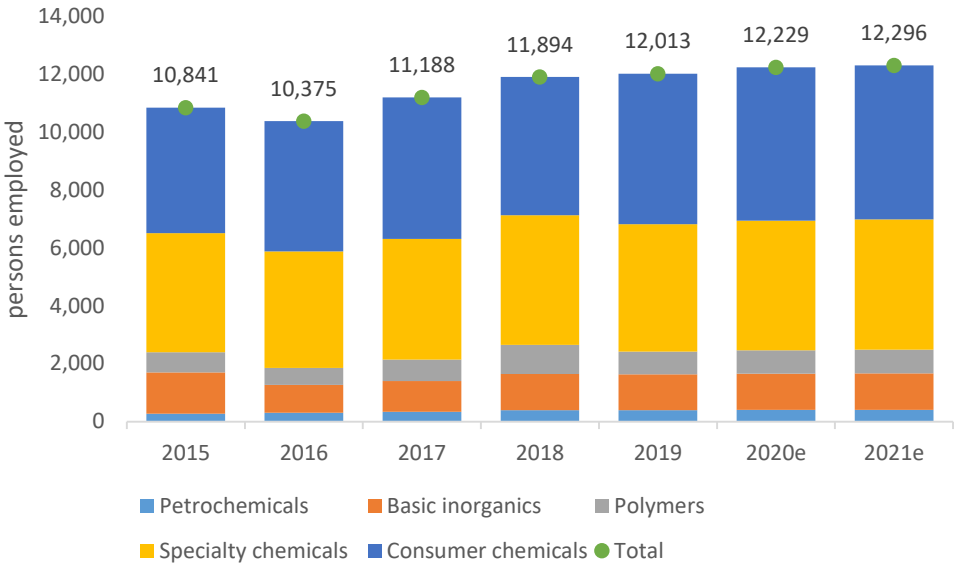
Source: Eurostat and IOBE estimation (e)

About 80% of the industry's operating surplus in 2021 is estimated to come from consumer chemicals (46%) and specialty chemicals (33%). Polymers contribute 11% to the industry's total operating surplus, while petrochemicals and basic inorganic chemicals have a share of 5%, respectively. The share of operating surplus to turnover varies across chemical categories, with consumer chemicals estimated to have the highest percentage in 2021 (21%), petrochemicals, polymers and specialty chemicals around 11% and inorganic chemicals just 5%. The operating surplus to turnover ratio can help in estimating the potential impact from changes on energy and production costs, as will be discussed in the next section.

EMPLOYMENT

In 2021, **employment** in the chemical industry in Greece approached 12,300 jobs, which correspond to 3.6% of total employment in Manufacturing (Figure 2.8). Almost 80% of the labor force in the sector (9,800 persons) are employed in the specialty and consumer chemicals sectors, while the participation of the remaining sectors is smaller. Employment in the sector has recovered in recent years and is 19% higher than in 2016. The majority (~70%) of jobs in the chemical industry are for highly skilled employees and workers.

Figure 2.8: Employment in the chemical industry in Greece by sector, 2015-2021



Source: Eurostat, IOBE estimation (e)

FOREIGN TRADE

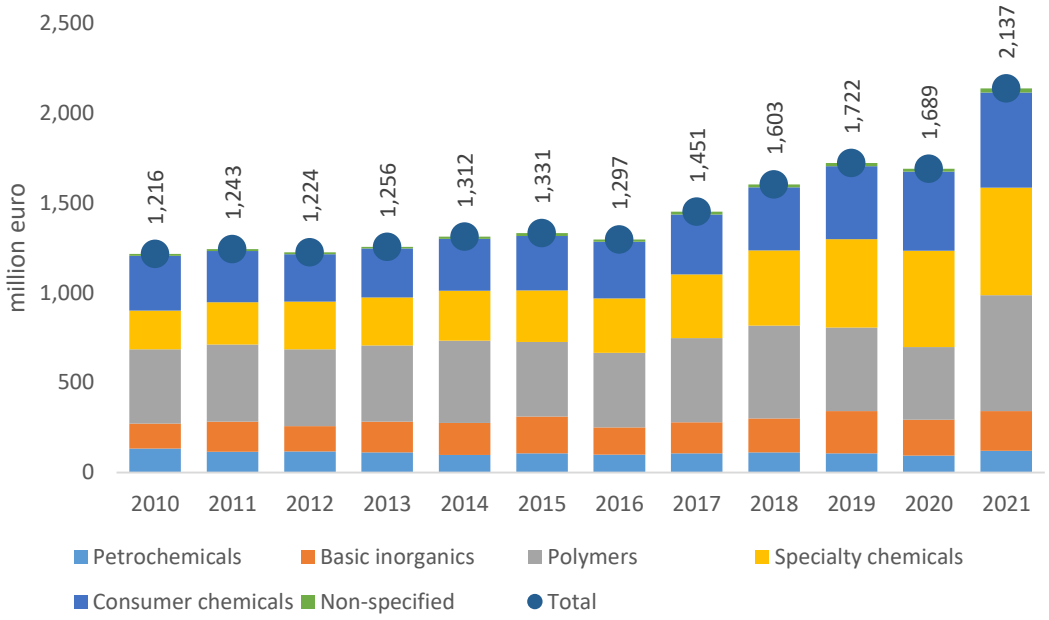
Exports of chemicals reached €2.1 billion in 2021, a significant increase of 27% compared to the previous year[3] (Figure 2.9). Chemical substances and products are one of the most important categories of Greek exports, contributing to 5.4% of their total value in 2021. Polymers and specialty chemicals are the largest categories in Greek chemicals exports, as in 2021 they accounted for 30% and 28% respectively of total chemicals exports. Approximately ¼ of the exports consist of consumer chemicals, followed by basic inorganic chemicals (mainly fertilizers) and petrochemicals, with smaller share.

On the other hand, chemicals imports were set at €5.8 billion in 2021, up 21% over the previous year. In 2021, chemicals imports constituted 9% of total imports in Greece. Petrochemicals and specialty chemicals and polymers constitute the largest categories of chemicals imports in Greece, with shares of 29% and 27% respectively, of all chemicals imports in 2021. Basic chemicals (petrochemicals, basic minerals and polymers) make up a total of 60% of chemicals imports, which is an indication of the dependence of the Greek chemical industry on imported raw chemical materials.

Overall, the trade balance of chemicals and chemical products in Greece is in deficit, with a deficit of €3.6 billion in 2021.

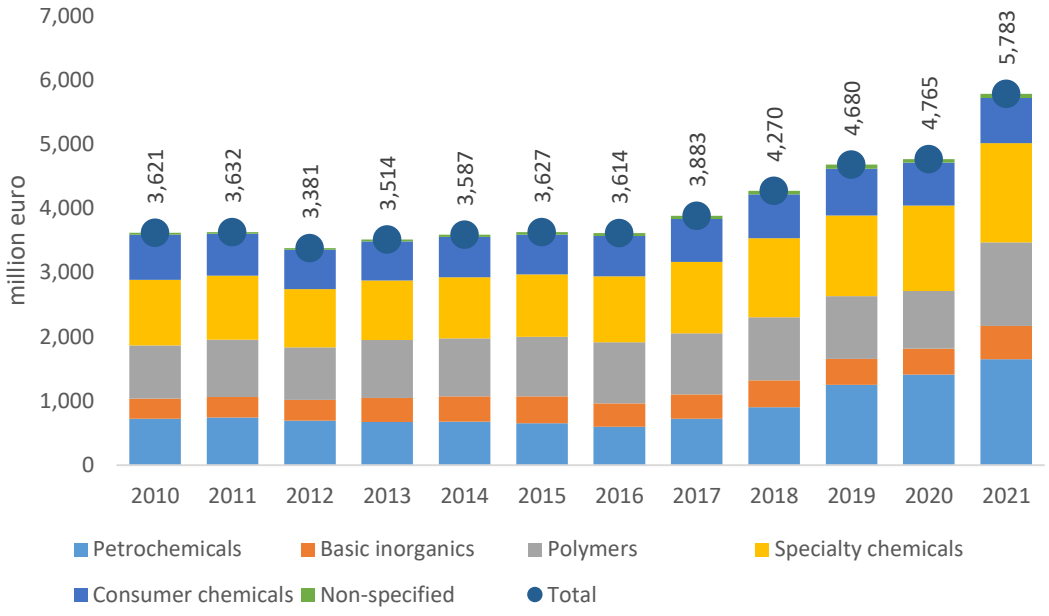
[3] In this section we use the data of the international trade coding CPA 2008, which fully corresponds to the classification of economic activity branches according to NACE. Other product classification systems for foreign trade statistics may give different trade figures for chemicals, as they may include more or fewer chemical products.

Figure 2.9: Exports of chemicals and chemical products, 2010-2021



Source: Eurostat, IOBE Analysis

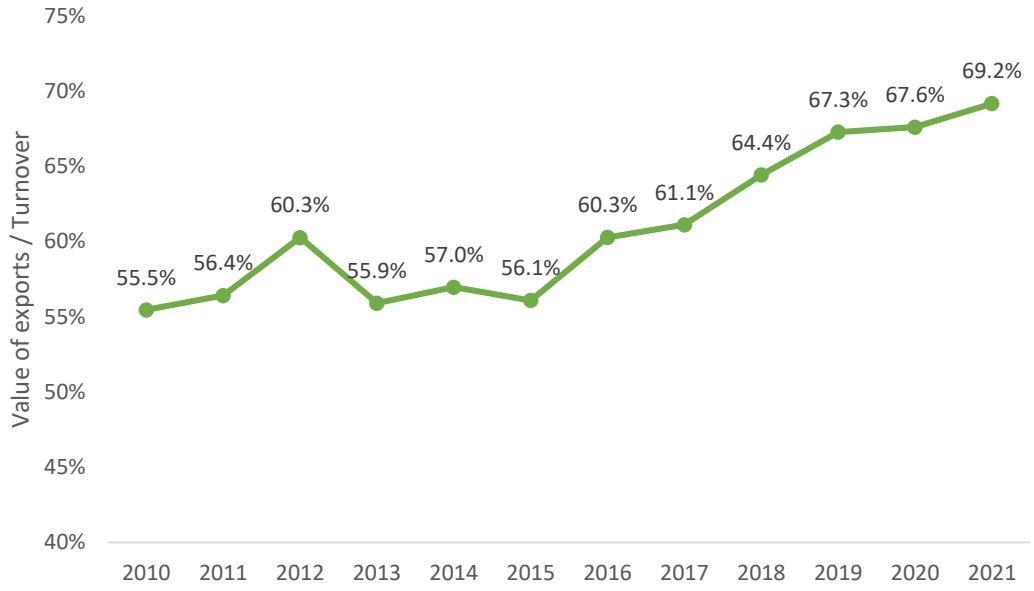
Figure 2.10: Imports of chemicals and chemical products, 2010-2021



Source: Eurostat, IOBE Analysis

The chemical industry's extroversion has increased substantially since 2010, with the industry's extroversion ratio (value of chemicals exports to turnover) reaching 69.2% in 2021 from 55.5% in 2010 (Figure 2.11). The large exposure of the sector's production to foreign markets is in principle positive for the Greek economy. However, it renders ensuring the competitiveness of the domestic chemical industry even more critical, so that its contribution to the economy is maintained and/or increased in the future.

Figure 2.11: Export intensity of the chemical industry in Greece, 2010-2021



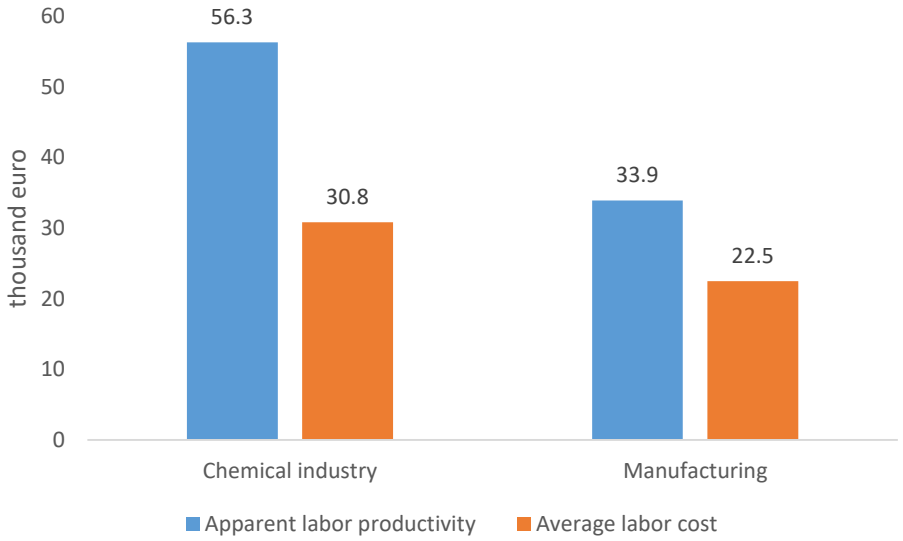
Source: Eurostat, IOBE Analysis

PRODUCTIVITY AND LABOR COST

The chemical industry in Greece has higher labor productivity,[4] but also higher average wages (average labor costs) compared to domestic manufacturing (Figure 2.12). In particular, the value added per employee in the chemical industry was €56.3 thousand in 2019, 66% higher than the Manufacturing average (€30.8 thousand). The difference in labor productivity is reflected in average labor costs, which in the same year were 37% higher in the chemical industry compared to the Manufacturing average. The chemical industry is, therefore, among the branches of domestic Manufacturing with the (relatively) best-paid jobs – jobs that, as mentioned, require a high level of expertise in their majority.

[4]Productivity is generally defined as the ratio between outputs and inputs of a production process. Labor productivity is closely linked to growth, competitiveness and living standards in an economy. Here we use apparent labor productivity, which we calculate as the ratio of gross value added and the number of people employed in the chemical industry.

Figure 2.12: Productivity and labor cost indexes for the chemical industry in Greece, 2019



Source: Eurostat, IOBE Analysis

2.3 Summary

The chemical industry in Greece is in a development phase in recent years. Domestic chemical production is concentrated in the specialty and consumer chemicals categories. The weight of basic chemical production is lower, demonstrating the high dependence on imported chemical raw materials. Prices of chemicals, especially basic chemicals, rose significantly during 2021 driven by stronger demand and rising raw material and energy costs, pushing industry turnover to high levels. The chemical industry has a significant contribution to the value added of domestic Manufacturing. Employment in the sector has increased significantly in recent years and mainly concerns highly specialized jobs. Chemicals exports have seen dynamic growth in recent years, while imports, which supply the domestic industry with basic chemicals and products, have also been on the rise. The extroversion of the domestic chemical industry is high and has strengthened in recent years, while labor productivity in the industry is higher than the average productivity in Manufacturing, which is reflected in better paying jobs.

3 THE NEW ENVIRONMENT AND CHALLENGES FOR THE CHEMICAL INDUSTRY

3.1 Introduction

The chemical industry in Greece faced serious exogenous shocks in previous years, such as the economic and health crisis, but managed to recover and become more competitive and outward-looking. As a producer and supplier of materials for a wide range of industrial and other activities, the chemical industry is significantly affected by the conditions in its operating environment. Factors such as economic changes, energy prices, changes in the regulatory framework, geopolitical uncertainty and technological advances are set to transform the industry in the coming decades.

For the domestic chemical industry the new economic and regulatory environment, as shaped by the acceleration of the EU's path towards climate neutrality, by the new industrial strategy and the EU chemicals strategy, is associated with opportunities but at the same time poses significant challenges. In this section we briefly present some of these challenges, which make ensuring and enhancing the innovation and competitiveness of the chemical industry in Greece and the EU critical factors for its future performance.

3.2 The European Green Deal and the EU's new industrial strategy

The European Green Deal (EGD) presented in December 2019 renewed the European Union's (EU) commitment to tackling climate change and environmental-related challenges. The EGD is a multi-dimensional strategy "*that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use*".[5] The EGD covers all sectors of the economy, in particular transport, energy, agriculture, buildings and industries such as steel, concrete, ICT, textiles and the chemical industry, and is accompanied by an investment plan aimed at immediate financing, the mobilization of investment resources and the practical guidance of public and private entities.[6]

The EU's increased ambition to achieve climate neutrality (zero net emissions) by 2050 is reflected, among other things, in the upward revision of the 2030 interim greenhouse gas emission reduction (GHG) target, the achievement of which is considered critical so that the EU becomes the first region with net zero GHG emissions by 2050. In this context, in December 2020 the European Council approved the European Commission's proposal to revise the target to reduce emissions to at least 55% compared to level in 1990 –against a 40% reduction target that was foreseen before the adoption of the EGD. In July 2021, the European climate law entered into force,[7] which made the targets for reducing emissions first by 2030 and then by 2050 legally binding.[8] Achieving the higher EGD's emission reduction targets requires the major revision of the current EU climate policy instruments, which was carried out in the 'Fit for 55' package of policy proposals announced in July 2021.[9]

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0640&from=EN
[6] https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_24
[7] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32021R1119&from=EN
[8] The European climate law also provides for the determination of a target for the reduction of greenhouse gas emissions for 2040, at the latest within six months after the first global assessment referred to in Article 14 of the Paris Agreement (expected in 2023).
[9] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021DC0550&from=EN

Box 3.1. Fit-for-55

The 'Fit for 55' package of proposals strengthens eight existing pieces of legislation and introduces five new initiatives, across a range of policy and economic sectors: climate, energy and fuels, transport, buildings, land use and forestry, attempting to strike a balance between carbon pricing , objectives, standards and support measures. In summary it envisages: a) the drastic strengthening of the role of carbon pricing in four different ways: reducing the quantity of auctioned emission allowances, expanding into new sectors, with changes in energy taxation and by imposing duties on the embedded carbon emissions on imports of certain products with high emission intensity (CBAM), b) the upward revision of the quantitative targets in the regulations on effort[10] sharing and land use, land use change and forestry, but also in the Directives on Renewable Energy Sources (RES) and energy efficiency[11] and c) stricter CO_2 performance standards for cars and semi-trucks, new infrastructure for alternative fuels and production of more sustainable and cleaner aviation and marine fuels.

It is worth noting that in relation to the chemical industry the Carbon Boundary Adjustment Mechanism (CBAM) has been proposed to be applied to the fertilizer sector and other basic chemical products. The implementation of the CBAM is estimated to have a significant impact on the cost of producing chemical products, as it will be accompanied by the abolition of the allocation of free CO_2 emission allowances to the facilities that produce the products that will be included in the mechanism.[12]

Individual important components of the EGD are the 2030 Biodiversity Strategy, the new EU Industrial Strategy, the Circular Economy Action Plan, the Farm to Fork Strategy for Sustainable Food, the Sustainable Chemicals Strategy, the action plan for a pollution-free Europe, the hydrogen strategy, the European battery alliance, etc. These components are related to the activity of the chemical industry, which is essential for a strong and sustainable European economy of the future, as chemicals are present in almost every strategic value chain, while the chemical industry has a pivotal role for a successful development of innovative technologies in order to achieve climate goals.

For example, the recycling processes of paper, batteries or plastics are basically chemical and contribute to the circular economy. Insulating materials and coatings that lead to energy savings in buildings are products of the chemical industry. Blades in wind turbines contain complex chemical materials, and chemical recycling processes can turn plastic waste back into chemicals. Chemical elements also include electric batteries that extend the range of an electric vehicle. The automotive industry needs lighter plastic parts and electronic chemicals to improve vehicle efficiency. In the Construction sector, materials are needed for smart grids, automatic electrical systems, insulations, smart materials such as nano-materials, coatings and other construction chemicals. In the agricultural sector the demand for bio-pesticides and bio-pesticides will increase. The trade sector will increasingly require innovative packaging materials, inks, sealants and eco-friendly packaging materials that the chemical industry can provide.

Additionally, the chemical industry faces the challenge of becoming climate neutral by 2050 and contributing to the implementation of the EGD. Access to sufficient and competitive low-

[10] The Effort Sharing Regulation establishes binding annual GHG emission targets for Member States for the period 2021-2030 (-40% compared to 2005) for emissions from most sectors not included in the ETS, such as transport, buildings, agriculture and waste.

[11] The proposed targets until 2030 concern a 36% share of RES in final energy consumption and a 36% improvement in energy efficiency (compared to a baseline scenario), against previous targets of 32.5% and 32% respectively.

[12] For more details see IOBE (2022). The impact of the revised European climate policy on the Greek industry and economy, March.

carbon energy, the development of relevant infrastructure, effective protection against the risk of carbon leakage, adequate financing and the exploitation of opportunities related to sustainable materials and products are key conditions to ensuring that the chemical industry will remain competitive during the transition to climate neutrality.

The new **EU industrial strategy,**[13] with the priorities of maintaining the international competitiveness of European industry, ensuring a level playing field in the single market and globally, achieving climate neutrality by 2050 and shaping Europe's digital future, provides an important supporting framework. The strategy sets out the key drivers of Europe's industrial transformation and proposes a comprehensive set of future actions such as:

- Action plan for intellectual property and supporting technological self-reliance.
- Revision of competition rules to be fit for a rapidly changing and digitizing economy that is called to become greener and more circular.
- Integrated measures for the modernization and decarbonization of energy-intensive industries.
- Supporting sustainable and smart mobility industries and promoting energy efficiency.
- Ensuring an adequate and continuous supply of low emission energy at competitive prices.
- Secure supply of critical raw materials, clean hydrogen alliance, green contracts.
- Refocusing on innovation, investment and skills, etc.

Addressing the economic, social and environmental challenges therefore lead to the transformation of the traditional operating model of the chemical industry. In this new phase, which has as its dominant characteristics digitization and the response to the needs of sustainability and the circular economy, changes are required such as improved efficiency in the use of natural resources and raw materials, integration of technology in production processes, development of research activities, improved corporate structures and product offerings and incorporating the principles of sustainable development.

3.3 Strategy for the sustainability of chemical products

The EU Strategy for the Sustainability of Chemicals[14] was announced in October 2020. It is part of the wider framework of the EGD and aims to achieve the goal of zero pollution for a toxic-free environment by stimulating innovation to produce safe and sustainable chemicals products and strengthening the protection of human health and the environment from hazardous chemical products. This strategy sets out specific actions to make chemicals safe and sustainable throughout their life cycle and to ensure that they can deliver all their benefits without burdening the planet, current and future generations. It also foresees various innovation actions as well as investment actions that will support the chemical industry throughout this transition. Enhancing the capacity and innovation of the chemical industry to offer safe and sustainable chemicals is also critical to support the green and digital transition.

13 https://ec.europa.eu/commission/presscorner/api/files/attachment/863067/EU_industrial_strategy_en.pdf.pdf

14 https://eur-lex.europa.eu/legal-content/EL/TXT/HTML/?uri=CELEX:52020DC0667&from=EN

The strategy proposes a concrete roadmap for the transformation of the chemical industry with the aim of attracting investment for safe and sustainable products and production methods. In particular, initiatives to strengthen health and environmental protection include:

- The gradual elimination of the use of the most harmful substances in consumer products, such as toys, childcare products, cosmetics, detergents, materials that come into contact with food and textiles, unless it is proven that their use is essential for society.
- Minimizing and substituting, as far as possible, the presence of substances of concern in all products, with priority given to product categories that affect vulnerable populations and those with the greatest potential for a circular economy.
- Dealing with the combined effects of chemical products with better consideration of the risk to human health and the environment of daily exposure to a wide mixture of chemical products from various sources.
- Ensuring producers' and consumers' access to information on chemical composition and safe use, through the introduction of information requirements under the sustainable products policy initiative.

Stimulating innovation and promoting the competitiveness of the chemicals industry are additional objectives of the EU strategy to seize opportunities and enable the green transition of the chemicals sector and its value chain. This is sought to be achieved mainly based on the following:

- Defining safety and sustainability criteria from the initial design and securing financial support for the marketing and use of safe and sustainable chemical products.
- Ensuring the development and use of safe and sustainable by design substances, materials and products through EU funding and investment instruments and public-private partnerships.
- Strengthening the enforcement of EU rules both at the border and in the single market
- Establish an EU chemicals research and innovation agenda to fill knowledge gaps on the impact of chemicals, promote innovation and move away from animal testing.
- Simplification and consolidation of the EU legal framework — e.g. by establishing the “one substance, one assessment” process, by strengthening the two key principles: “banning non-scheduled substances” and “polluter pays” and introducing targeted amendments to REACH and sectoral legislation (e.g. CLP regulation).

The implementation of a large part of the above legislative and other interventions, according to the indicative schedule of the strategy, is estimated to be completed by 2024.

The changes in chemicals legislation foreseen in the strategy are estimated to have a significant impact on the activity of the chemical industry. According to a study by the European Chemical Industry Council (CEFIC),[15] the new legislation is estimated to affect chemicals representing 28% of the industry's turnover. About 8% of this market will likely be replaced, while 2% will be unaffected due to deviations. Additionally, approximately 6% of the market will not face withdrawal pressures and will only be affected by the increased regulatory burden. This means that the changes in the sectoral legislation considered, when taking into account the possible response of businesses, could lead by 2040 to a **net reduction**

[15] Economic Analysis of the Impacts of the Chemicals Strategy for Sustainability, December 2021

in the product/business portfolio (in terms of turnover) of around 12% which is equivalent to 70 billion euros of the total market in 2019. **Correspondingly, for the chemical industry in Greece the changes in legislation may have an impact that can reach 300 million euros.**

The analysis also showed that 74% of the products that will be affected are professional or consumer products. The downstream sectors that could be most affected are the following:

- Polymer preparations and compounds, paper and board products, inks and toners, which can be used for food contact materials
- Paints and coatings
- Cleaning products
- Adhesives and sealants
- Cosmetics and personal care products
- Lubricants
- Biocides and plant protection products

Impacts in these areas will affect the EU's ability to strengthen its strategic autonomy and value chains for chemicals that have key uses in the health sector and/or are essential for achieving the circular and climate-neutral economy.

The companies that participated in the CEFIC survey state that under conditions (economic and technical feasibility, reaction of their customers, etc.) they could replace and/or reform 1/3 of the affected substances (in terms of turnover). But adaptation time and in some cases a long period of time is required to research and develop alternative solutions that can be made available on the market.

3.4 Summary

The European Green Deal (EGD) and the strategies that frame it, such as the Sustainable Chemicals Strategy, pose significant challenges to the chemical industry. Chemicals are present in almost every strategic value chain, and the role of the chemical industry in developing innovative technologies to achieve climate goals is pivotal. The chemical industry therefore faces a multiple challenge: achieving climate neutrality in its production processes, contributing materials and products that will allow the reduction of the carbon footprint in other sectors, enhancing the circularity of products and providing solutions for recycling, detoxification and digitization. This is an industrial transformation that requires appropriate planning and significant investments that will lead to ensuring the resilience and competitiveness of the chemical industry in Greece and the EU, so that the sector can effectively contribute to the achievement of the EGD policy objectives.

4 ANALYSIS OF THE IMPACT ON THE CHEMICAL INDUSTRY FROM THE INCREASE IN ENERGY COST

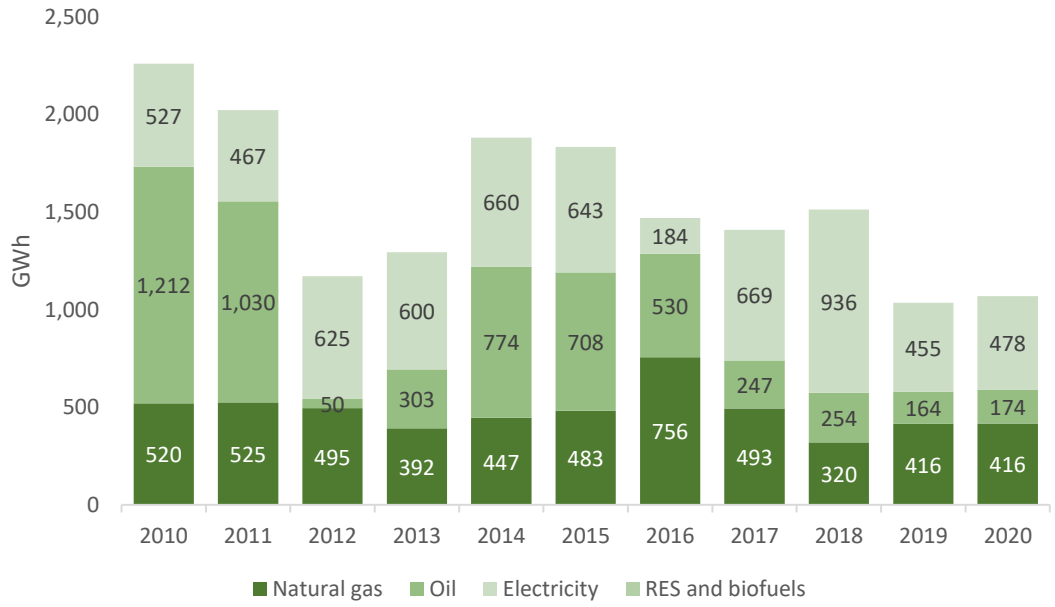
4.1 Energy consumption in the chemical industry

In 2020, energy consumption by the chemical industry[16] in Greece reached 1,067 GWh (Figure 4.1). This amount corresponds to approximately 4% of the total energy consumption from industry in Greece in the same year and is 53% lower compared to 2010. Energy consumption in the domestic chemical industry has therefore been significantly reduced, partly due to the improvement in its energy efficiency.

Most of the total energy consumption of the chemical industry (478 GWh or 45% of the total) was covered by electricity in 2020 (Figure 4.2). The chemical industry also consumes significant amounts of natural gas (416 GWh in 2020 or 39% of total energy consumption) and petroleum products (174 GWh or 16% of total energy consumption). About half (51%) of the consumption of petroleum products is LPG for industrial use.

Therefore, the current energy crisis, with the steep rise in the prices of natural gas, electricity and petroleum products, is (also) affecting the chemical industry significantly.

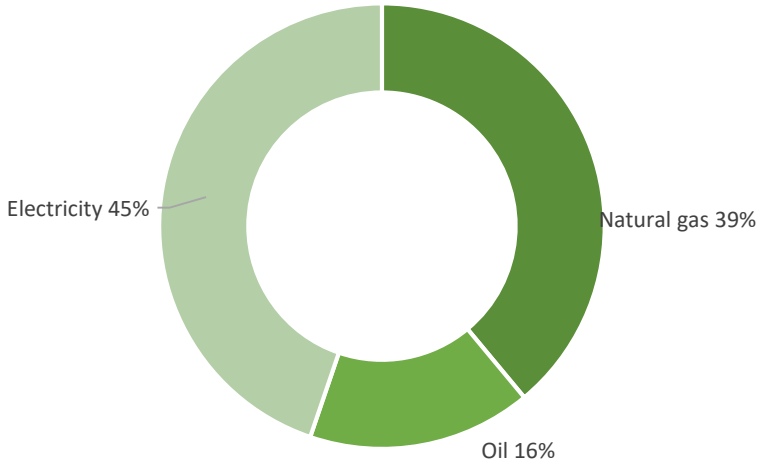
Figure 4.1: Final energy consumption by energy source in the chemicals and petrochemicals industry in Greece, 2010-2020



Source: Eurostat

[16] The pharmaceutical industry is also included.

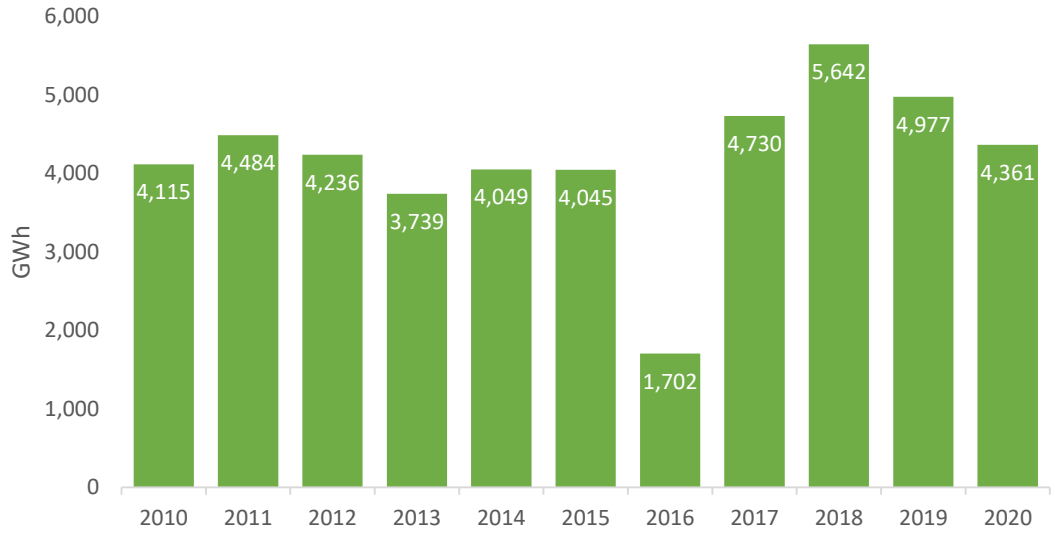
Figure 4.2: Final energy consumption in the chemicals and petrochemicals industry in Greece by energy source (%), 2020



Source: Eurostat

In addition, the chemical and petrochemical industry in Greece is a large consumer of natural gas for non-energy uses (e.g. fertilizer production), to a multiple extent than energy uses. In 2020, the consumption of natural gas by the chemical and petrochemical industry for non-energy uses reached 4,361 GWh, i.e. it was four times higher compared to energy uses (Figure 4.3). This is a second, extremely important, route through which the chemical industry is affected by high energy costs, as **natural gas is one of the key raw materials for the production of basic chemicals**.

Figure 4.3: Natural gas consumption for non-energy uses in chemicals and petrochemicals industry in Greece, 2010-2020



Source: Eurostat

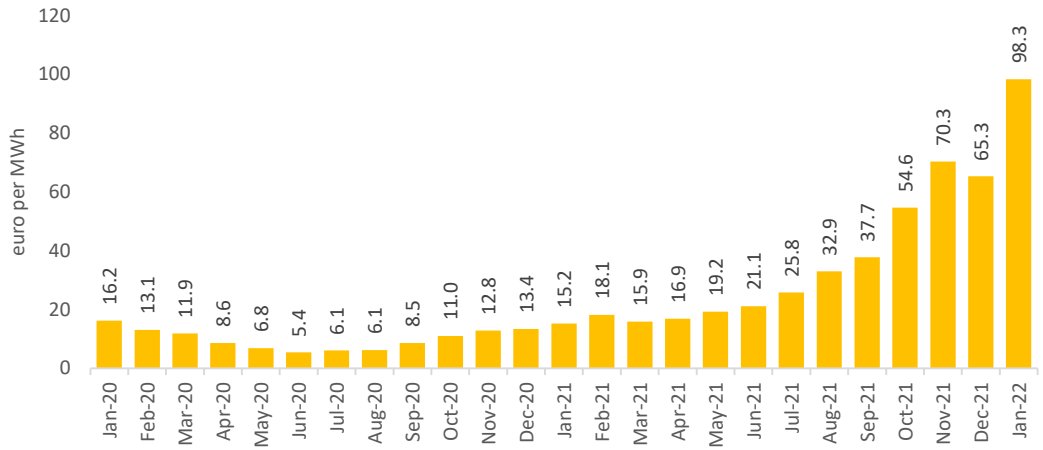
4.2 Evolution of natural gas and electricity prices

WHOLESALE PRICES

After a period of particularly low international gas prices, reflecting weak global demand due to the COVID-19 pandemic, since mid-2021 natural gas prices have followed a strong upward trend, reaching unprecedented levels (Figure 4.4). The average natural gas import price in Greece increased from 16.2 euros/MWh in January 2020 to 98.3 euros/MWh in January 2022, an increase of 505%.[17] In Europe, natural gas prices, as set out in the Dutch TTF market, were even higher than the import prices of natural gas in Greece.[18] However, such price increases did not occur in markets outside Europe, which differentiates the effects on European economies and on the competitiveness of European businesses.

The increase in natural gas prices is attributed to several factors, such as low European gas inventories due to lower than expected supply volumes from Russia, geopolitical tensions and a lack of investment in relevant infrastructure. The fighting in Ukraine that began in late February 2022 has exacerbated the problem of high energy prices, as Europe's dependence on Russian gas exports has come to the fore. This dependence raises serious energy security issues in the short to medium term, which increases uncertainty and makes it difficult to de-escalate energy prices in Europe.

Figure 4.4: Weighted-average import price of natural gas (€/MWh)

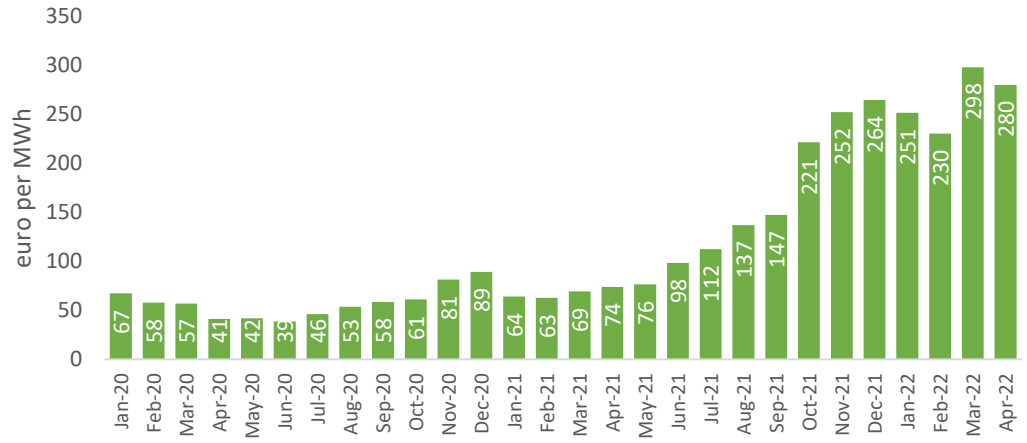


Source: RAE

The rise in natural gas supply prices has affected wholesale electricity prices on the Greek energy exchange, which recorded an equally steep rise. Between January 2020 and April 2022 wholesale electricity prices, including the surcharges for balancing and other ancillary services, increased by 316% –from €67.3/MWh to €280/MWh (Figure 4.5). The increase in the price of CO_2 emission allowances has also contributed to the rise in electricity prices –from 24 euros/tCO_2 in January 2020 to 92 euros/tCO_2 in February 2022– but their effect on electricity prices is smaller compared to effect from the increase in natural gas prices (Figure 4.7).

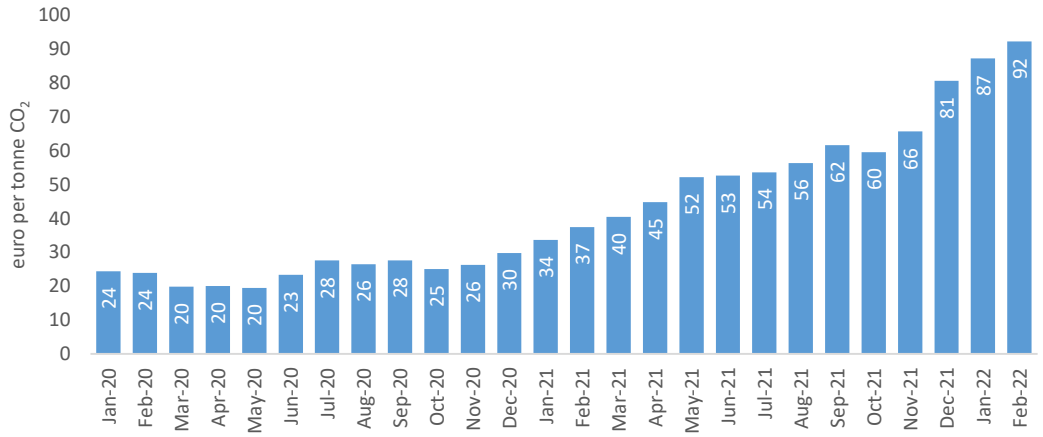
[17] Meanwhile, during the first phase of the health crisis, the average import price of natural gas in Greece had fallen to 5.4 to 8.6 euros/MWh, recording historically low levels.
[18] Tsafos Nikos, The anatomy of an energy crisis, Dianeosis, February 2022 (in Greek).

Figure 4.5: Weighted-average wholesale price of electricity in the Greek interconnected system



Source: ADMIE and Energywatch (for the average price in April). Balancing and other ancillary services costs are included.

Figure 4.6: Average price of CO_2 emission allowances(EUA units)



Source: EEX – Emission spot primary market auction report 2018- until Jan. 2022.

RETAIL PRICES FOR BUSINESSES

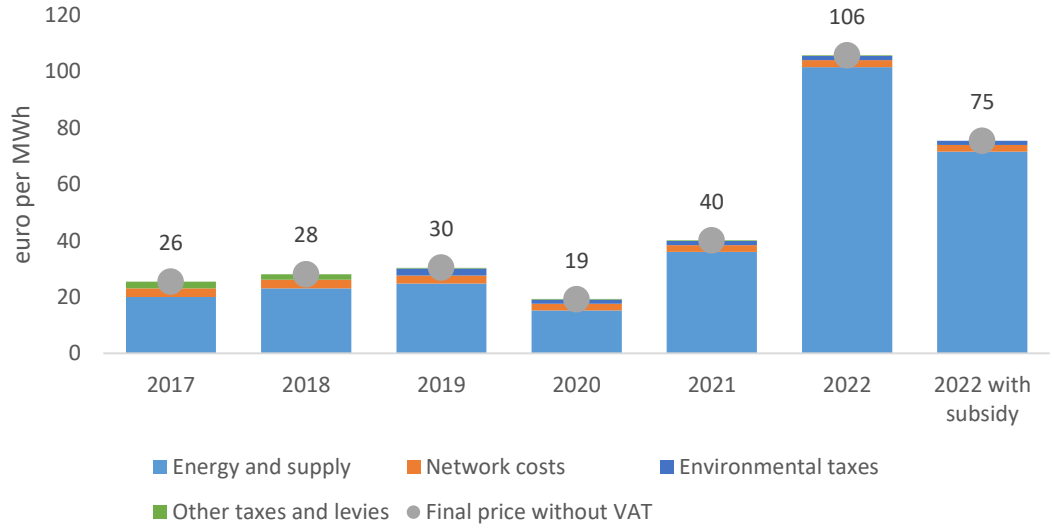
Natural gas import prices and wholesale electricity prices form the basis of retail energy prices for businesses and households. Final retail energy prices include the cost of supply from the wholesale markets, the retail margins of suppliers, charges for the transmission and distribution networks and taxes and levies borne by final consumers.

According to Eurostat data for Greece, the average price of natural gas (without VAT) for annual business consumptions from 100 TJ to 1000 TJ ranged in the period 2017-2019 between 26-30 euros/MWh. The cost of energy supply made up about 80% of the final price, while distribution network charges and taxes made up the remaining 20%. The decline in international prices has led to a decrease in natural gas prices in the domestic market to 19 euros/MWh in 2020, while according to our estimates, in 2021 prices doubled to an average of 40 euros/MWh, since natural gas price hikes started in the second half of 2021, so businesses have yet to see the full impact on their financial results. At the same time, the weight of natural gas supply costs on the final price has increased to 90% and correspondingly

the weight of distribution network charges and taxation has decreased. This also limits the effect of price reduction interventions that would target these tariff components.

As long as the import prices of natural gas remain on average in 2022 at the levels of January 2022 (98.3 euros/MWh), the final prices (without VAT) of natural gas for businesses in the examined consumption category are estimated to amount to approximately 106 euros/MWh, i.e. they will **be increased by 163% compared to 2021 and by 450% compared to 2020**. The provision of a subsidy to businesses, in the order of 30 euros/MWh, limits the final price to 75 euros/MWh , absorbing only a small part of the increase.

Figure 4.7: Average retail natural gas price for yearly consumption from 100 TJ to 1000 TJ (band I4)

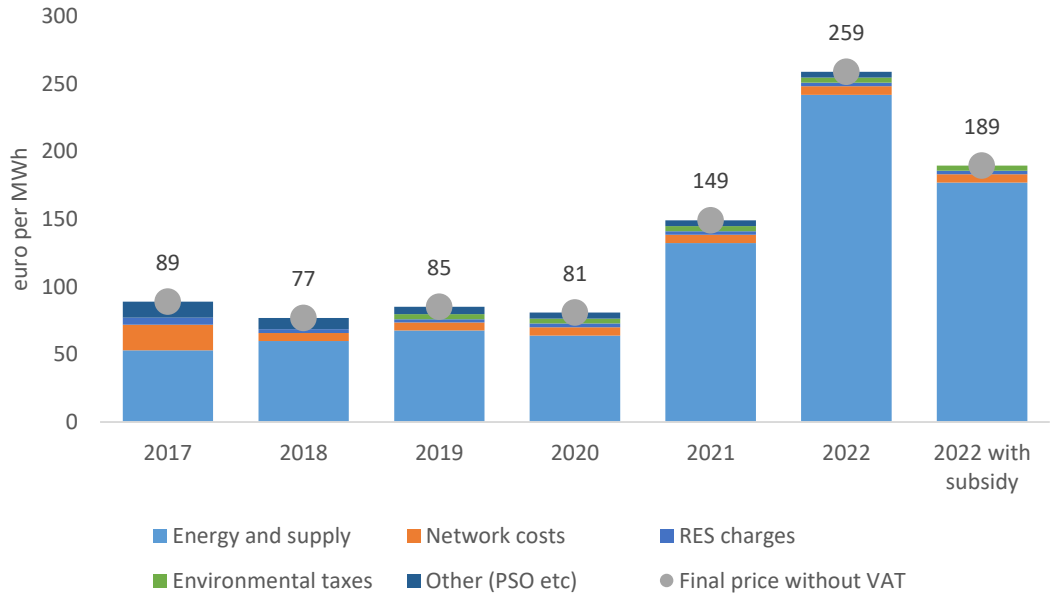


Source: Eurostat. IOBE estimations (under the assumption of average natural gas import price of 100 euro/MWh throughout 2022)

Accordingly, the average price of electricity (without VAT) for annual business consumptions from 20 GWh to 70 GWh ranged between 77-89 euros/MWh in the period 2017-2020. After 2017 the cost of supplying energy made up about 80% of the final price, network charges 8% and taxes and levies the remaining 12%. According to our estimates in 2021 prices increased by 83% and reached an average of 149 euros/MWh. Wholesale electricity price increases started in the second half of 2021, so businesses have yet to see the full impact on their financial results. At the same time, the weight of energy supply costs on the final price has increased to 89%, as the weight of distribution network charges and taxation has decreased accordingly. If wholesale electricity prices remain on average in 2022 at the levels of January-February 2022 (241.9 euros/MWh), the final prices (without VAT) of electricity for businesses in the specific consumption category are estimated to rise to approximately 259 euros/MWh, i.e. **they will be increased by 73.6% compared to 2021 and by 220% compared to 2020**. The provision of a subsidy to businesses, in the order of 65 euros/MWh[19], limits the final price to 189 euros/MWh, absorbing only a small part of the increase.

[19]The larger subsidy announced for April 2022 (€130/MWh) was intended to limit the impact of the higher wholesale prices experienced in March 2022 and does not significantly change the estimate for the final price after

Figure 4.8: Average retail electricity price for yearly consumption from 20 to 70 GWh



Source: Eurostat. IOBE estimates (assuming an average wholesale electricity price of 242 euro/MWh in 2022)

LPG PRICES

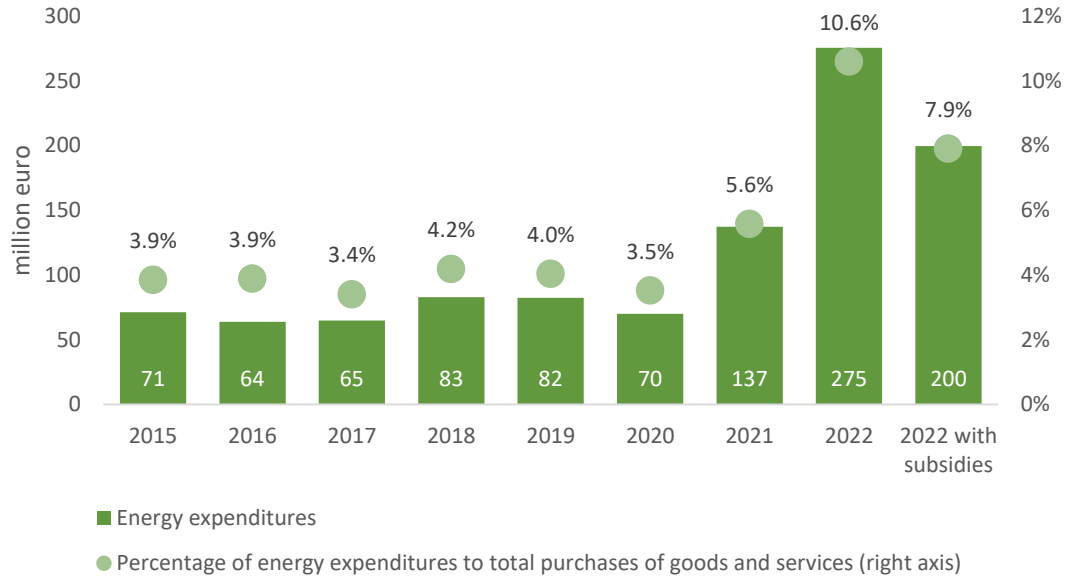
The chemical industry consumes significant quantities of petroleum products (mainly Liquefied Petroleum Gas – LPG), which are mostly used by companies due to the absence of a natural gas network in their location. Therefore their total energy costs are also affected by fluctuations in LPG prices. Indicatively, refinery prices for LPG destined for industry increased from around €670 per metric ton in January 2020 to €1,088 per metric ton in March 2022, an increase of 62% that further burdens the chemical's industry energy costs.

4.3 Energy costs and impact of increasing energy costs in the chemical industry

The total expenditure on the purchase of energy (natural gas, electricity and petroleum products) by the companies of the chemical industry is estimated for 2020 at 70 million euros, corresponding to 3.5% of total purchases of goods and services (cost of production excluding the compensation to factors of production or cost of inputs) (Figure 4.9). The increase in energy prices from the second half of 2021 onwards is estimated to have caused the chemical industry's energy expenditure to double in 2021 (increase by 96%), increasing its share in total expenditure to 5.6%. Assuming that energy prices do not decelerate this year, energy expenditure (for the same level of chemical industry activity as in 2021) is estimated to rise further to €275 million in 2022, or 10.6% of total production costs, in the event that the increased costs were not subsidized. With the subsidies, the total expenditure for purchasing energy is contained to 200 million euros or 7.9% of the total cost of inputs. That is, **compared to 2020, it is estimated that it will be 184% higher**.

the subsidy we have assumed. Similarly, a subsidy of 120 euros/MWh was announced for May, while from July onwards, with a new intervention, the prospect is that the compensation received by power producers other than natural gas plants will be limited to their production costs plus a reasonable profit so that the "windfall" profits of these units are directly captured and returned to consumers, with a continuation of the subsidy regime aimed at absorbing 70%-80% of the increase in electricity prices.

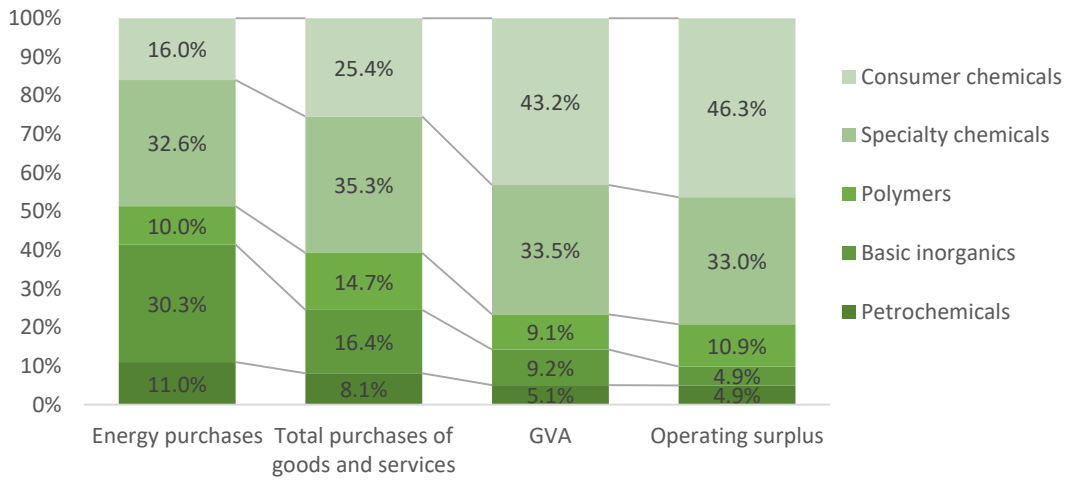
Figure 4.9: Energy expenditures of the chemical industry in Greece, 2015-2022est.



Source: Eurostat. IOBE estimation. For the estimation of energy expenditure in 2021 and 2022, the weighted average change in electricity and natural gas prices presented in the previous section and an energy mix ratio of 70% electricity and 30% natural gas have been assumed.

It should be noted that the largest part of the total energy expenditure of the chemical industry in 2021 is estimated to have been collected by the categories of specialty chemicals (32.6%) and basic inorganic chemicals (30.3%) (Figure 4.10). Consumer chemicals represented 16% of total energy expenditure, petrochemicals 11% and polymers the remaining 10%.

Figure 4.10: Energy expenditure per chemicals category (%), 2021



Source: IOBE estimation

The distribution of the corresponding expenditure for total purchases of goods and services, for GVA and for operating surplus differs between chemical categories, suggesting that the impact of changes in energy costs is also not uniform across the individual sectors of the chemical industry.

In this context, the energy costs compared to the total costs for the purchase of goods and services in each category of chemical products highlight the different impact that increased energy costs may have on the individual sectors of the chemical industry (Table 4.1).

According to our estimates, the biggest impact on production costs is for chemical companies active in the fields of **other inorganic chemicals** (production of chlorine, sulfur, etc.), where the share of energy costs in the total costs increases (without considering energy price subsidies) from 15.9% in 2020 to 40.2% of total input costs in 2022, i.e. an increase of 24.3 percentage points. With subsidies included, the share of energy expenditure again more than doubles, reaching 32.8%.

Of a similar magnitude is the estimated impact of chemical companies operating in the **industrial gases** sector, where the share of energy costs in total costs increases (excluding energy price subsidies) from 14% in 2020 to 35.4% of total input costs in 2022, i.e. an increase of 21.3 percentage points. Including subsidies, the share of energy expenditure again more than doubles, reaching 28.4%.

Table 4.1: Energy expenditure as a percentage of total purchases of goods and services in the chemical industry in Greece by chemical category

Chemicals category	2020	2021	2022	2022 Με επιδότηση	Δ2022-2020
1. Petrochemicals	6.4%	9.4%	17.2%	13.1%	*10.8%*
2. Basic Inorganics					
Other inorganics	15.9%	25.1%	40.2%	32.8%	*24.3%*
Industrial gases	14.0%	21.4%	35.4%	28.4%	*21.3%*
Fertilizers	3.6%	4.6%	8.9%	6.6%	*5.3%*
3. Polymers					
Plastics	2.5%	3.3%	6.5%	4.8%	*3.9%*
Synthetic fibers	6.3%	9.9%	18.1%	13.8%	*11.8%*
4. Specialty chemicals					
Dyes & pigments	12.8%	20.1%	33.6%	26.8%	*20.8%*
Plant protection	1.0%	1.8%	3.6%	2.7%	*2.6%*
Paints & inks	3.2%	5.1%	9.7%	7.2%	*6.5%*
Auxiliaries for industry	2.9%	4.6%	8.8%	6.5%	*5.9%*
5. Consumer chemicals	2.1%	3.7%	7.1%	5.2%	*5.0%*
CHEMICALS & CHEMICAL PRODUCTS	3.5%	5.6%	10.6%	7.9%	*7.1%*

Source: IOBE estimations

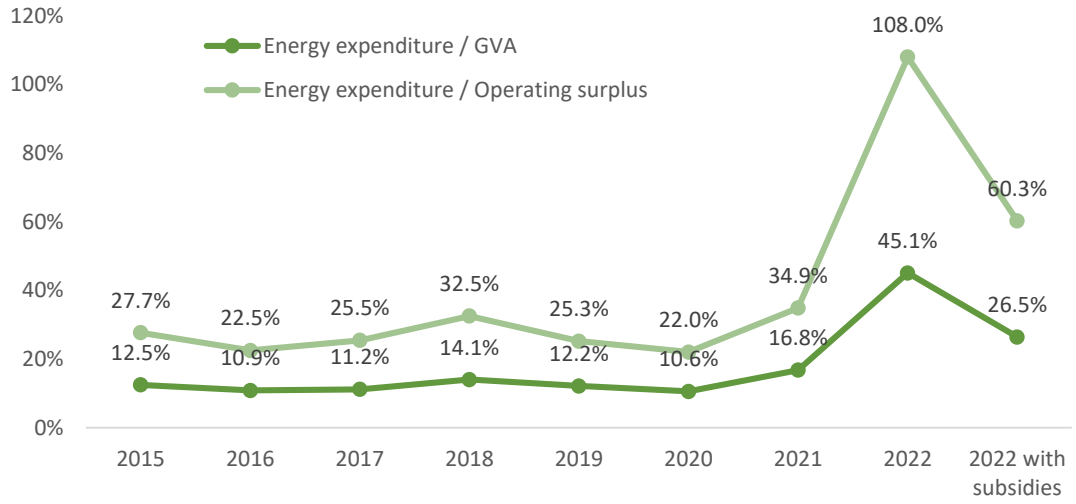
Chemical companies active in the **production of pigments** also have a significant impact on costs, in which the share of energy costs in the total cost (without taking into account energy price subsidies) increases from 12.8% in 2020 to 33.6% of total input costs in 2022, i.e. an increase of 20.8 percentage points. With subsidies included, the share of energy expenditure again more than doubles, reaching 26.8%.

For chemical companies active in the **petrochemical** and **synthetic fiber sectors**, the share of energy costs in total costs increases (excluding energy price subsidies) from 6.4% and 6.3%

respectively in 2020 to 17, 2% and 18.1% respectively of total input costs in 2022, and to 13.1% and 13.8% respectively with subsidies included.

In the remaining chemical categories (fertilizers,[20] plastics, crop protection, paints, auxiliary chemicals for industry and consumer chemicals), the participation of energy costs in the total input costs is comparatively smaller (in 2020 it ranged from 1% to 3.6%), but nearly doubles in 2022 even with energy price subsidies factored in. However, in some of these production activities there is also non-energy use of natural gas, while the **cost of supplying chemical raw materials**, which is affected by the cost of energy, has a significantly greater participation.[21] As a result **the effects of energy costs in these sectors of the chemical industry are indirect but equally important as in the production activities of the chemical industry which are more energy intensive.[22]**

Figure 4.11: Indicators of shares of energy expenditure in GVA and in the operating surplus of the chemical industry in Greece, 2015-2022est.



Source: Eurostat. IOBE estimations

Comparing energy costs with value added and operating surplus (which equals gross profit and part of the value added) of the chemical industry indicates the impact on its profitability and ultimately its ability to absorb increased energy costs without a significant increase in prices for its products and without degrading its competitiveness. Overall energy expenditure without the energy price subsidy is estimated to constitute 45.1% of the sector's value added

[20]The process of producing chemically synthesized inorganic fertilizers is highly electricity intensive and therefore significantly affected by increases in energy costs. The official data we present for this sector may have gaps and underestimate the impact of the increase in energy costs, as only one company in Greece is active in the chemical fertilizer production sector. The remaining companies in the sector produce fertilizers after importing and processing/mixing the required raw materials. Therefore, the increase in energy costs affects them indirectly, but significantly.

[21]For example, in the case of nitrogen fertilizer production, the supply of natural gas constitutes approximately 80% of the production costs and the increase in natural gas prices has led to interruption of production in facilities located in European countries.

[22]Between January 2021 and January 2022, import prices of basic chemicals and products had already increased by 16%. Increases are expected to continue as the full energy costs have not yet been incorporated into chemical prices.

in 2022 from 10.6% to 14.1% in the period before 2021 (Figure 4.11). But even with energy price subsidies, the impact is significant, as it is estimated that energy costs will constitute 26.5% of the sector's value added.[23] Similarly, energy expenditure without subsidies is estimated to rise to 108% of the operating surplus in 2022, while with subsidies it reaches 60.3% of the operating surplus, up from 22% to 32.5% compared to the period before 2021. This estimate suggests **the prospect of a drastic reduction in the profitability of the sector, with consequences in terms of its ability to invest and respond to the challenges it is going to face in the current decade.**

The ability of chemical companies to respond to the pressures posed by high energy costs varies according to chemicals subsector. Based on the impact on value added, the sectors that produce petrochemicals, basic inorganic chemicals, industrial gases, dyes and fertilizers are estimated to be under the greatest pressure. In these specific sectors, the increased expenditure on energy is a multiple of the value added, therefore the only possible reaction in the short term is a significant increase in the prices of chemical products, which, however, will have an impact on demand, profitability and erode the competitiveness of chemical companies (Table 4.2). But also in other sectors of the chemical industry, the impact is calculable, especially if we take into account the relationship between energy costs and the cost of procuring chemical raw materials, which is not reflected in these estimates.

Table 4.2: Energy expenditure as a percentage of the GVA of the chemical industry in Greece by chemical category

Chemicals category	2020	2021	2022	2022 with subsidy	Δ2022-2020
1. Petrochemicals	30.2%	44.2%	283.0%	80.3%	*252.8%*
2. Basic Inorganics					
Other inorganics	86.5%	136.2%	-267.3%*	518.6%	*-353.8%*
Industrial gases	42.8%	65.4%	4,442.8%	135.1%	*4400.0%*
Fertilizers	23.6%	30.8%	111.7%	52.0%	*88.1%*
3. Polymers					
Plastics	12.7%	16.8%	45.1%	26.4%	*32.4%*
Synthetic fibers	30.1%	47.5%	322.1%	87.9%	*292.0%*
4. Specialty chemicals					
Dyes & pigments	43.7%	58.9%	945.8%	116.9%	*902.1%*
Plant protection	4.3%	7.7%	17.4%	11.6%	*13.1%*
Paints & inks	7.7%	12.3%	30.3%	19.0%	*22.6%*
Auxiliaries for industry	11.7%	18.5%	51.2%	29.4%	*39.5%*
5. Consumer chemicals	3.8%	6.7%	14.9%	10.0%	*11.1%*
CHEMICALS & CHEMICAL PRODUCTS	10.6%	16.8%	45.1%	26.5%	*34.5%*

Source: IOBE estimations. * Negative values indicate that higher energy costs lead to negative GVA.

Maintaining energy price subsidies throughout 2022 may limit the impact on profitability of high energy costs in individual chemical industry sectors such as consumer chemicals, crop protection products, industrial auxiliaries, paints and plastics, which, however, are under pressure from increases in raw materials (Table 4.3). **Businesses in the manufacturing, basic**

[23] Energy costs also limit value added since they increase input costs.

inorganic chemicals and industrial gases sectors even with subsidized energy prices face disproportionately high costs compared to their operating surplus, while **petrochemicals, dyes, synthetic fibers and fertilizers** companies will also have smaller leeway and will receive strong pressures.

Table 4.3: Additional energy expenditure as a percentage of the operating surplus of the chemical industry in Greece by chemical category

Chemicals category	Additional energy expenditure 2022-2020 (million euros)			
	No subsidy	% operating surplus (2021)	With subsidy	% operating surplus (2021)
1. Petrochemicals	28.1	112%	8.2	33%
2. Basic Inorganics				
Other inorganics	18.3	717%	5.6	219%
Industrial gases	26.8	361%	8.2	110%
Fertilizers	17.0	144%	5.3	45%
3. Polymers				
Plastics	18.3	41%	5.5	12%
Synthetic fibers	0.7	158%	0.2	48%
4. Specialty chemicals				
Dyes & pigments	7.8	223%	2.4	68%
Plant protection	4.7	27%	1.5	9%
Paints & inks	24.4	39%	7.4	12%
Auxiliaries for industry	24.1	65%	7.4	20%
5. Consumer chemicals	35.1	20%	10.6	6%
CHEMICALS & CHEMICAL PRODUCTS	205.4	52%	62.3	16%

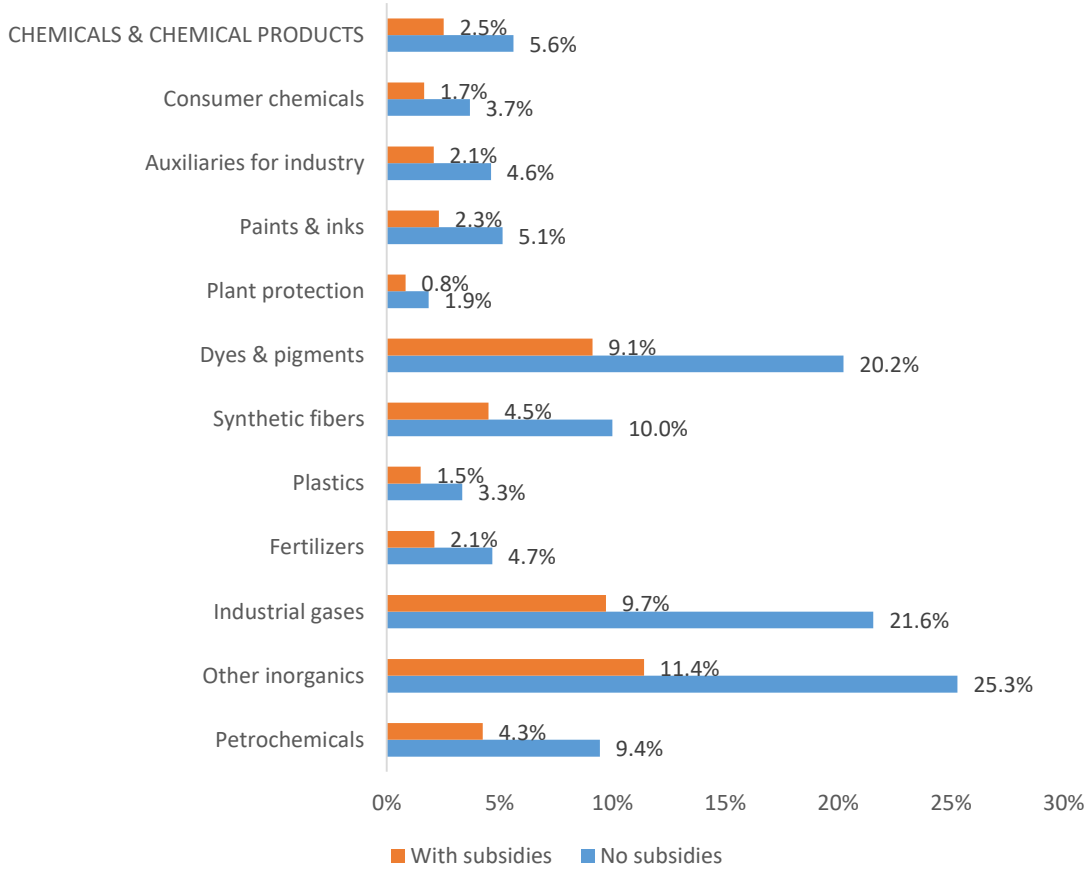
Source: IOBE estimations

ENERGY COST IMPACT ON PRICES AND PRODUCTION IN THE CHEMICAL INDUSTRY

The previous analysis indicates that the sharp increase in energy costs cannot be absorbed by the companies in the sector and subsequently it will be passed on to the prices of chemical products.[24] Price increases is estimated to be higher in the energy-intensive sectors where the share of energy expenditure is a large proportion of the total cost. Overall for the chemical industry it is estimated that the increase in energy cost, **without considering its impact on the cost of raw materials**, causes a price increase of 5.6%, which is reduced to 2.5% when prices are subsidized (Figure 4.12).

[24] The impact on prices has been estimated under the assumption that the pass-through elasticity of costs is equal to unity, i.e. a 10% increase in production costs causes a 10% increase in the final price of a product.

Figure 4.12: Estimated price change by chemical category 2021/2022



Source: IOBE estimations

The increase in the prices of chemical products due to the increase in energy expenditure has an impact on the demand and ultimately on the output of the domestic chemical industry. Depending on the extent to which demand will be affected,[25] it is estimated that without the energy price subsidy total chemical output in 2022 would be from -1.7% to -5.6% lower than the previous year. The energy price subsidy limits the impact on costs and thus on the level of output, which is estimated to be 0.8% to 2.5% lower compared to 2021. From the estimates of the impact on the production of the individual chemical sectors it is evident that the impact is greater in sectors where energy costs have a higher participation in production costs (Table 4.4).

[25]The final effect on demand and output depends on the price elasticity of demand for each product. As the elasticities for each product are not known, estimates were made using two plausible values for the elasticities (low value: 0.3 and high value: 1.0) to give a range of possible effects. These values for the elasticities suggest that an average increase in prices of 10% leads to an average fall in output of 3% and 10% respectively.

Table 4.4: Estimation of the impact of energy costs on output by chemical category

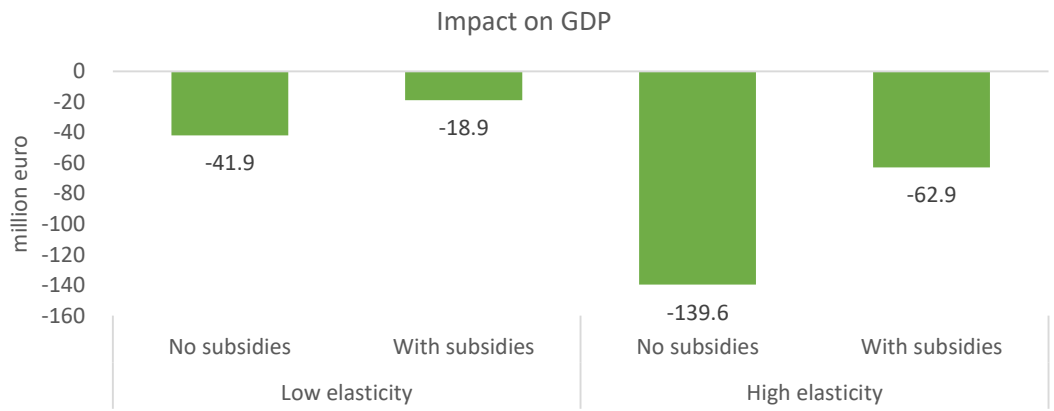
Chemicals category	Low elasticity		High elasticity	
	No subsidy	With subsidy	No subsidy	With subsidy
1. Petrochemicals	-2.8%	-1.3%	-9.4%	-4.3%
2. Basic Inorganics				
Other inorganics	-7.6%	-3.4%	-25.3%	-11.4%
Industrial gases	-6.5%	-2.9%	-21.6%	-9.7%
Fertilizers	-1.4%	-0.6%	-4.7%	-2.1%
3. Polymers				
Plastics	-1.0%	-0.5%	-3.3%	-1.5%
Synthetic fibers	-3.0%	-1.4%	-10.0%	-4.5%
4. Specialty chemicals				
Dyes & pigments	-6.1%	-2.7%	-20.2%	-9.1%
Plant protection	-0.6%	-0.3%	-1.9%	-0.8%
Paints & inks	-1.5%	-0.7%	-5.1%	-2.3%
Auxiliaries for industry	-1.4%	-0.6%	-4.6%	-2.1%
5. Consumer chemicals	-1.1%	-0.5%	-3.7%	-1.7%
CHEMICALS & CHEMICAL PRODUCTS	**-1.7%**	**-0.8%**	**-5.6%**	**-2.5%**

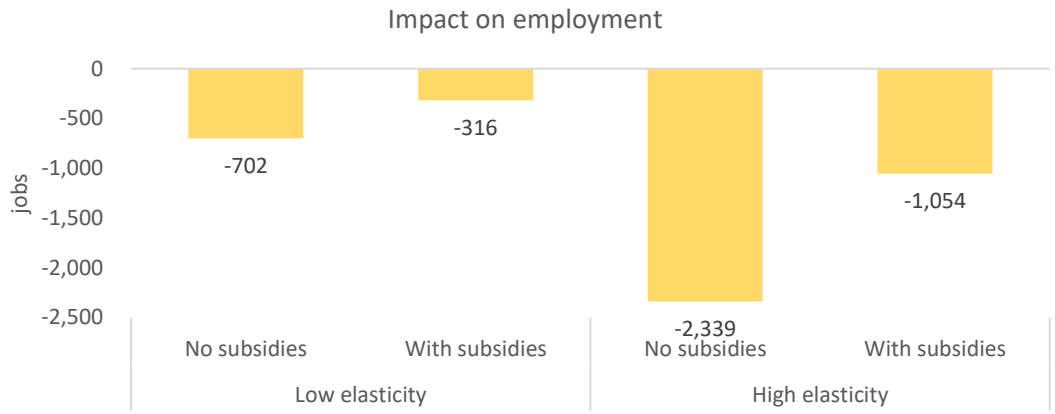
Source: IOBE estimations. Low elasticity: 0,3. High elasticity: 1,0.

IMPACT ON THE ECONOMY

The losses in the production of the domestic chemical industry will have wider effects on the Greek economy, which result from the interconnection of the sector with the rest of the economic activity sectors. Using an input-output model for the Greek economy, we estimated that in the case of non-implementation of the subsidies, and depending on the reaction of demand, the impact on GDP could range from €42 million to €140 million, while the impact on employment is ranging from 702 to 2,339 jobs. By subsidizing energy prices the impacts are mitigated to €19 million to €63 million and 316 to 1,054 jobs.

Figure 4.13: Estimation of the impact of energy costs on GDP and employment





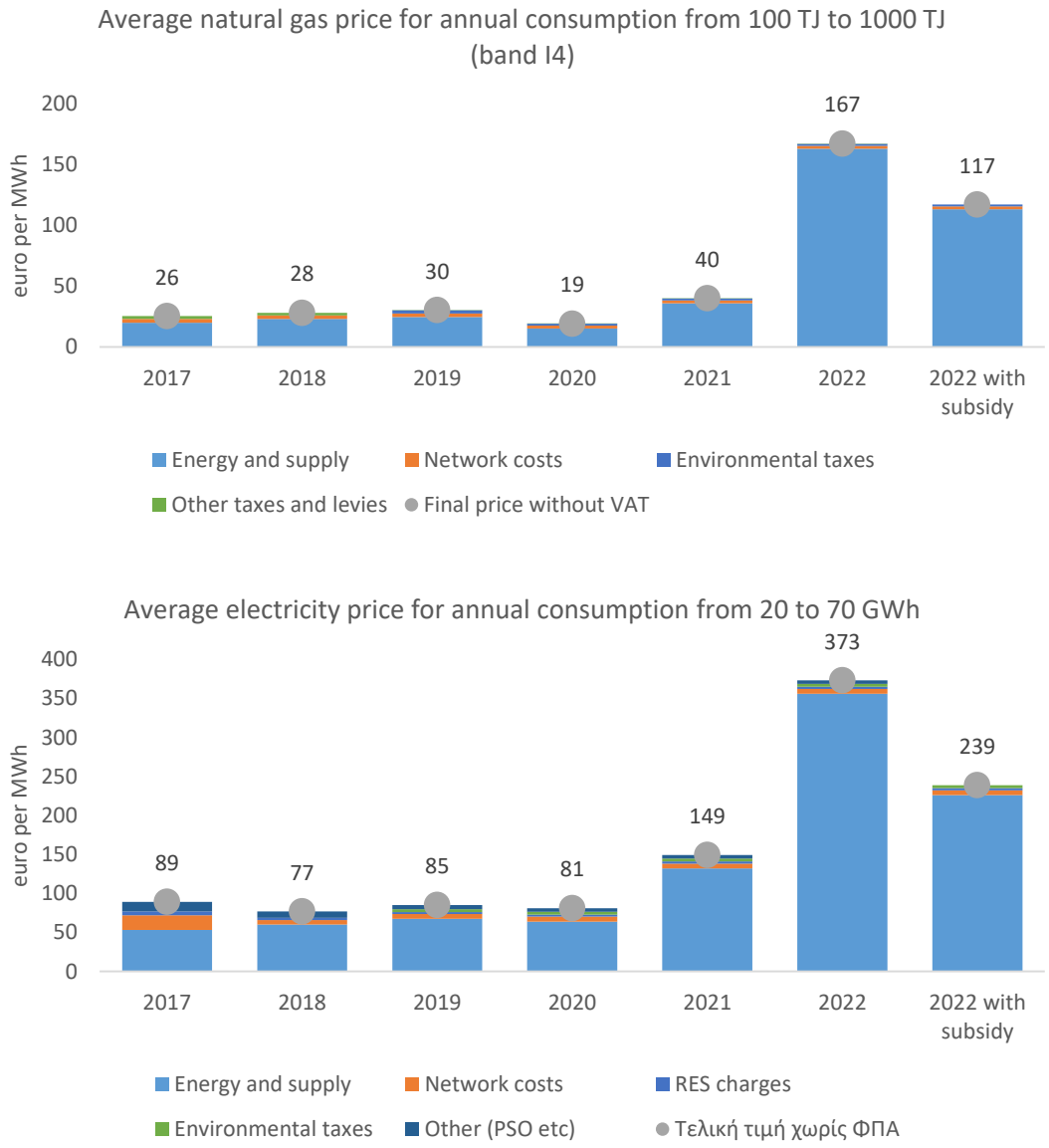
Source: IOBE estimations. Low elasticity: 0.3. High elasticity: 1.0.

4.4 Energy prices, energy costs and impact of rising energy costs in the chemical industry in a worst-case scenario

In a more unfavorable, but realistic based on current circumstances, scenario, in which the escalation of the war in Ukraine even causes a cut in gas and oil supplies from Russia, energy prices are expected to rise even more. In such an worst-case scenario we assume that natural gas import prices will rise on average in 2022 to 160 euros/MWh, while final prices (without VAT) of natural gas for businesses are estimated to rise to around 167 euros/MWh, **that is, they will be increased by 317% compared to 2021 and by 771% compared to 2020**. The provision of a subsidy to businesses, of the order of 50 euros/MWh, limits the final price to 117 euros/MWh, absorbing only a small part of the increase (Figure 4.14).

Accordingly, wholesale electricity prices, following the rise in natural gas prices, are assumed to rise to 356 euros/MWh on average in 2022. Final prices (without VAT) of electricity for businesses are estimated to be around 373 euros/MWh, **i.e. they will be increased by 150% compared to 2021 and by 361% compared to 2020**. The provision of subsidy to companies, of the order of 130 euros/MWh limits the final price to 238.6 euros/MWh, absorbing again only a small part of the increase.

Figure 4.14: Average price of natural gas and electricity in the worst-case scenario



Source: IOBE estimations

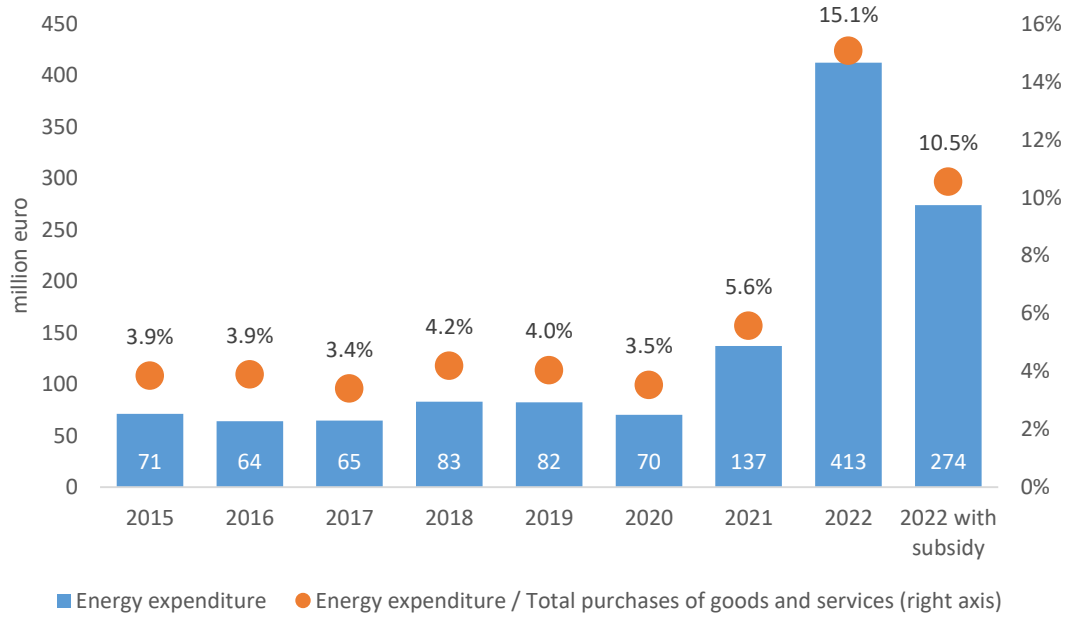
Energy costs[26] are estimated to rise further to €413 million in 2022, or 15.1% of total production costs, if the increased costs were not subsidized[27] (Figure 4.15). With the subsidies, the total cost of buying energy is estimated at 274 million euros or 10.5% of the total cost of inputs. That is, **compared to 2020, it is estimated that it will be 291% higher**.

In the worst-case scenario energy expenditure without the energy price subsidy is estimated to constitute 87% of the sector's added value in 2022 from 10.6% to 14.1% in the period before 2021 (Figure 4.16). But even with energy price subsidies the impact is significant, as it is estimated that energy costs will make up 40.3% of the sector's value added. Similarly, energy spending without subsidies is estimated to jump to 350% of the operating surplus in 2022, while with subsidies it reaches 106.8% of the operating surplus, up from 22% to 32.5%

[26] For the same level of chemical industry activity as it had in 2021.
[27] Data for individual chemical categories are presented in the Appendix.

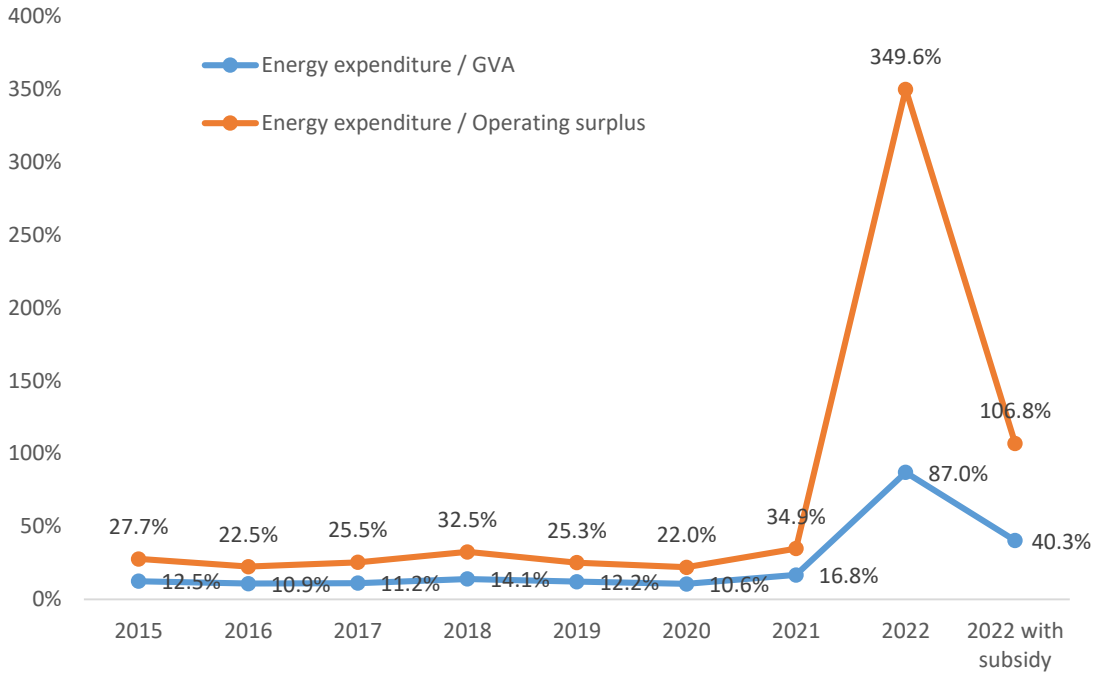
compared to the pre-2021 period. This estimate still suggests a more unfavorable outlook for the sector in the coming years.

Figure 4.15: Energy costs in the chemical industry in the worst-case scenario



Source: IOBE estimations

Figure 4.16: Indicators of shares of energy expenditure in GVA and in the operating surplus of the chemical industry in Greece in the worst-case scenario

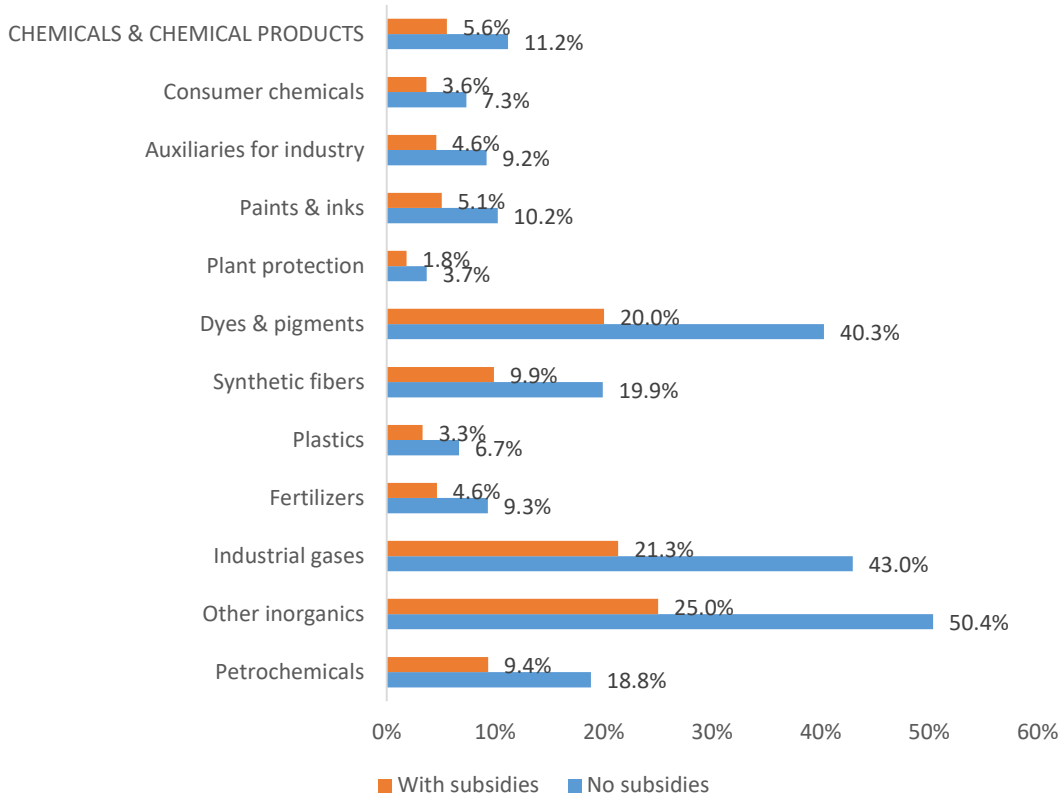


Source: IOBE estimations

ENERGY COST IMPACT ON PRICES AND PRODUCTION IN THE WORST SCENARIO

In the worst-case scenario, it is estimated the increase in energy costs, **without taking into account its impact on the cost of raw materials**, causes an increase in chemicals prices by 11.2% if the prices were not subsidized and by 5.6 % in the case of the price subsidy (Figure 4.17).

Figure 4.17: Price change by chemical category in the worst-case scenario (2021/2022)



Source: IOBE estimations

Additionally, depending on the extent to which demand will be affected,[28] it is estimated that without the energy price subsidy total chemical production in 2022 would be from -3.4% to -11.2% lower than in the previous year.[29] The energy price subsidy limits the impact on costs and therefore on the level of production, which is estimated to be 1.7% to 5.6% lower compared to 2021. The impact on the individual sectors of the chemical industry varies depending on the participation of energy costs to total production costs (Table 4.5).

[28]The final effect on demand and output depends on the price elasticity of demand for each product. As the elasticities for each product are not known, estimates were made using two values for the elasticities (lowest value: 0.3 and highest value: 1.0) to give a range of possible effects.

[29]We assume that no exogenous demand disturbance or other change in factors affecting demand occurs.

Table 4.5: Estimation of the impact of energy costs on output by chemical category

Chemicals category	Low elasticity		High elasticity	
	No subsidy	With subsidy	No subsidy	With subsidy
1. Petrochemicals	-5.6%	-2.8%	-18.8%	-9.4%
2. Basic Inorganics	0.0%	0.0%	0.0%	0.0%
Other inorganics	-15.1%	-7.5%	-50.4%	-25.0%
Industrial gases	-12.9%	-6.4%	-43.0%	-21.3%
Fertilizers	-2.8%	-1.4%	-9.3%	-4.6%
3. Polymers	0.0%	0.0%	0.0%	0.0%
Plastics	-2.0%	-1.0%	-6.7%	-3.3%
Synthetic fibers	-6.0%	-3.0%	-19.9%	-9.9%
4. Specialty chemicals	0.0%	0.0%	0.0%	0.0%
Dyes & pigments	-12.1%	-6.0%	-40.3%	-20.0%
Plant protection	-1.1%	-0.6%	-3.7%	-1.8%
Paints & inks	-3.1%	-1.5%	-10.2%	-5.1%
Auxiliaries for industry	-2.8%	-1.4%	-9.2%	-4.6%
5. Consumer chemicals	-2.2%	-1.1%	-7.3%	-3.6%
CHEMICALS & CHEMICAL PRODUCTS	**-3.4%**	**-1.7%**	**-11.2%**	**-5.6%**

Source: IOBE estimations

IMPACT ON THE ECONOMY

As previously mentioned, the losses in the output of the domestic chemical industry will have wider effects on the Greek economy, which arise from the interconnection of the sector with other sectors of economic activity. Specifically, in the worst-case scenario, it is estimated that with no subsidies, and depending on the reaction of demand, the impact on GDP can range from €83 million to €278 million, while the impact on employment ranges from 1,397 to 4,658 jobs.[30] By subsidizing energy prices the impacts are mitigated to €42 million to €138 million and 694 to 2,315 jobs. However, these estimations do not take into account the higher fiscal costs from increased energy price subsidies (Figure 4.18).

[30] Estimates based on the IOBE input-output model.

Figure 4.18: Estimated impact on GDP and employment in the worst-case scenario

Source: IOBE estimations. Low elasticity: 0.3. High elasticity: 1.0.

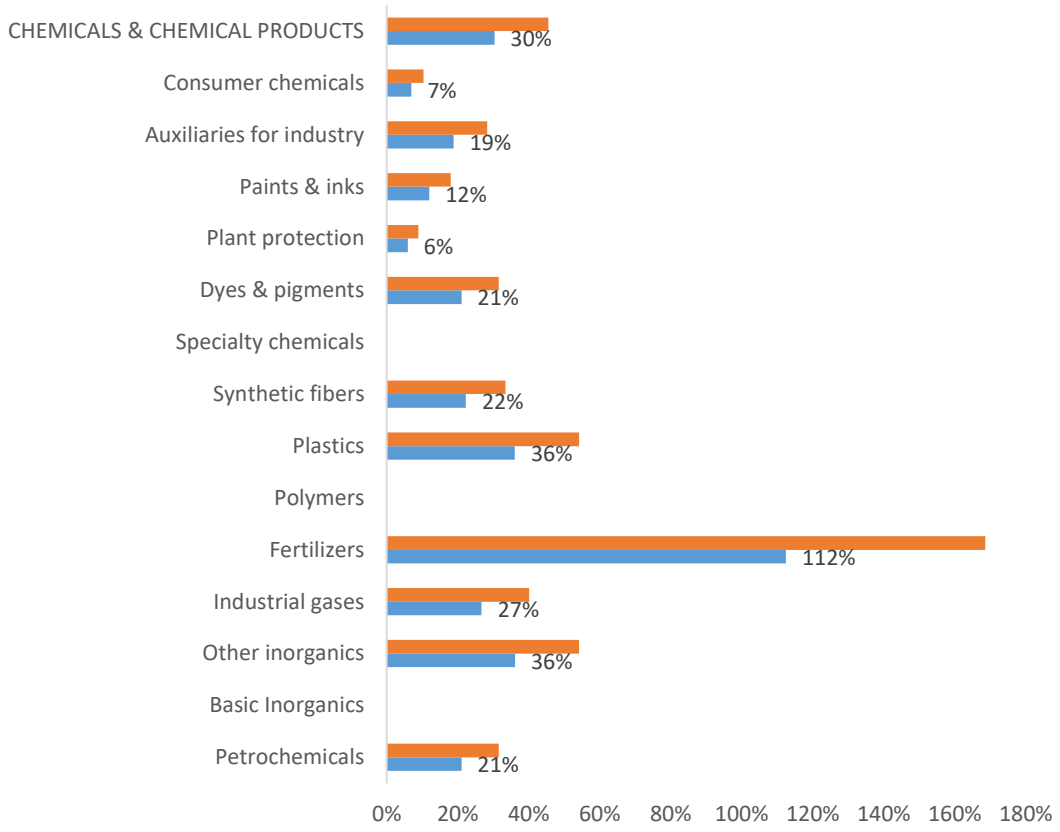
4.5 Indirect impact of high energy prices on the cost of chemical raw materials

Rising energy prices indirectly but significantly affect the prices of chemicals procured as raw materials or distributed by the domestic chemical industry. As detailed data on the prices of chemicals and products and their participation in domestic production costs were not available, we approximated the indirect effects of high energy costs on production costs using data on the evolution of producer prices by sector of the EU chemical industry -27 for the period from January 2021 to February 2022. The specific price changes are due both to the increase in the cost of energy and to the increase in the cost of other inputs (which are mainly affected by the cost of energy), thus giving a representative picture of the impact of high energy prices on the chemical industry.

At an overall level, the prices of chemical substances and products in the EU-27 increased by 30% during this period (Figure 4.19). The biggest price increase (112%) was recorded in fertilizers, which directly use natural gas as a raw material. High increases (36%) were recorded in the prices of plastics and inorganic chemicals. Between 19% and 27% were the

price increases in the categories of dyes, synthetic fibers, petrochemicals and auxiliary chemicals for industry. Finally, plant protection products, consumer chemicals and paints show milder increases. These changes represent a significant increase in the industry's cost base and are due to skyrocketing energy prices.

Figure 4.19: Change in producer prices in the EU-27 by chemical category (Jan. 2021 – Feb. 2022)



Source: Eurostat

If from the above price changes per chemical category, the part of the change related to the additional energy costs of the domestic chemical industry, as calculated in previous parts of the study (without subsidies), is subtracted, an estimate is obtained for the increase in production costs and prices that is not due to increased energy costs. In this case, price impacts differ. For example, the fertilizer sector is affected significantly more by the increase in the cost of chemical raw materials, with cost and price increases exceeding 100%. A significant impact (32.8%) is also estimated for plastics, while petrochemicals, other inorganic chemicals, synthetic fibers and auxiliary chemicals for industry have an impact from 10% to 14% on production costs and prices. Smaller, from 3.2% to 6.9%, is the indirect effect of energy prices in the remaining sectors (industrial gases, dyes, plant protection, paints and consumer chemicals). In the worst-case scenario, in which we assume that the already recorded price increases are expanded by 50%, the impact increases even more for fertilizers and plastics, while in the remaining categories it shows smaller changes.

From rising raw material costs, the chemical industry could experience total additional production losses[31] ranging from 5% to 14%, with the fertilizer and plastics sectors estimated to be the hardest hit. In the worst-case scenario the losses for the chemical industry are estimated to be greater and range from 6.8% to 18.7%.

Table 4.6: Estimation of price and output change by chemical category

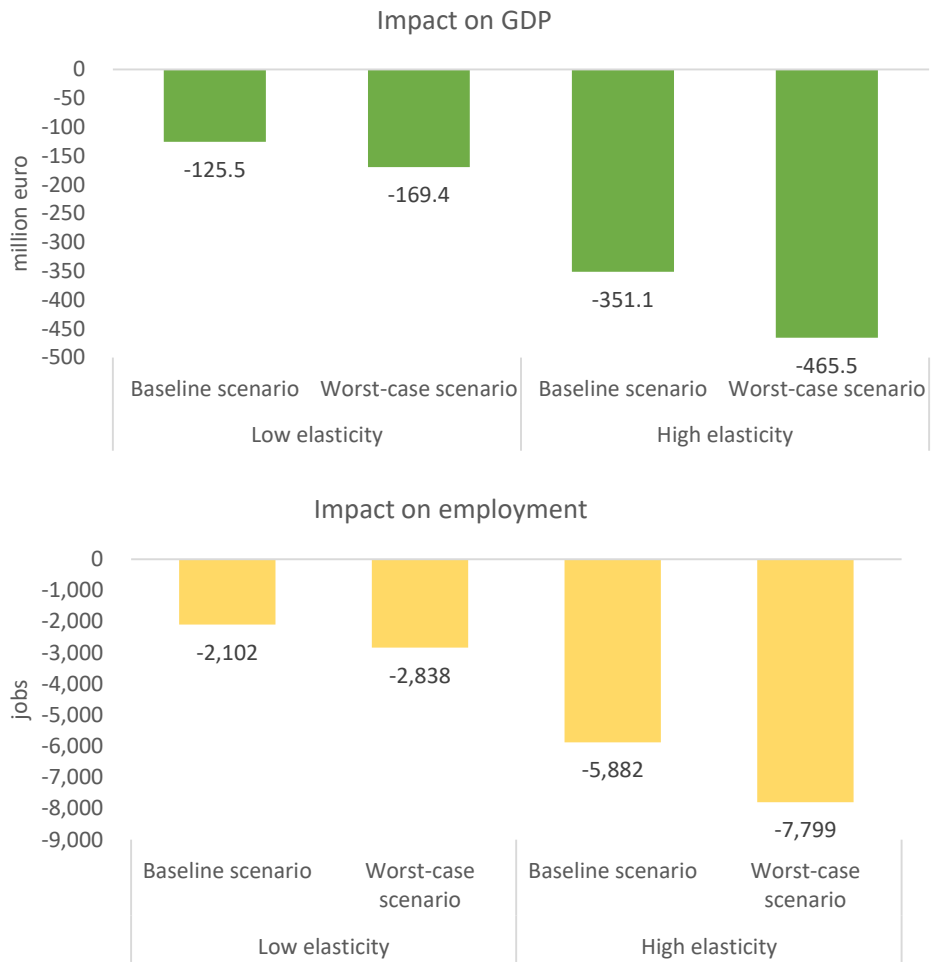
Chemical category	Price change		Output change			
	Baseline scenario	Adverse scenario	Baseline scenario	Adverse scenario	Baseline scenario	Adverse scenario
			Low elasticity		High elasticity	
1. Petrochemicals	11.6%	12.8%	-3.5%	-3.8%	-11.6%	-12.8%
2. Basic Inorganics						
Other inorganics	10.8%	3.8%	-3.3%	-1.1%	-10.8%	-3.8%
Industrial gases	5.2%	0.0%	-1.6%	0.0%	-5.2%	0.0%
Fertilizers	107.7%	159.3%	-21.5%	-31.9%	-43.1%	-63.7%
3. Polymers						
Plastics	32.8%	47.5%	-9.8%	-14.2%	-32.8%	-47.5%
Synthetic fibers	12.3%	13.5%	-3.7%	-4.1%	-12.3%	-13.5%
4. Specialty chemicals						
Dyes & pigments	0.8%	0.0%	-0.2%	0.0%	-0.8%	0.0%
Plant protection	4.1%	5.2%	-1.2%	-1.6%	-4.1%	-5.2%
Paints & inks	6.9%	7.8%	-2.1%	-2.3%	-6.9%	-7.8%
Auxiliaries for industry	14.2%	19.1%	-4.3%	-5.7%	-14.2%	-19.1%
5. Consumer chemicals	3.2%	3.0%	-1.0%	-0.9%	-3.2%	-3.0%
CHEMICALS & CHEMICAL PRODUCTS			**-5.0%**	**-6.8%**	**-14.1%**	**-18.7%**

Source: IOBE estimations. Assumptions: Low elasticity equals 0.3 and high elasticity equals 1.0. For the fertilizers the elasticities are 0.2 (low) and 0.4 (high).

These losses in the output of the domestic chemical industry will have wider additional effects on the Greek economy. Depending on the demand response, the impact on GDP can range from €125 million to €351 million, while the impact on employment ranges from 2,102 to 5,882 jobs (Figure 4.20). Furthermore, in the most unfavorable scenario the impact is estimated to be greater, ranging from €169.4 million to €465.5 million and from 2,838 to 7,799 jobs.

[31] These estimates refer to additional losses, beyond those due to the increase in energy expenditure.

Figure 4.20: Assessment of the impact on GDP and employment from the increase in the cost of chemical raw materials



Source: IOBE estimations. Low elasticity: 0.3. High elasticity: 1.0.

4.6 Summary

The chemical industry in Greece uses in its production processes mainly electricity and natural gas and less petroleum, while at the same time it is the largest consumer of natural gas for non-energy use. As a result the current energy crisis affects it significantly, both directly through energy costs and indirectly through costs for the purchase of raw chemicals. The unprecedented rise in natural gas and electricity prices from the second half of 2021 has been passed on to energy supply tariffs, creating significant pressures on businesses in the sector. Individual sectors with a large direct participation of energy costs in the total cost of inputs, such as other inorganic chemicals, industrial gases, dyes, petrochemicals, synthetic fibers, are estimated to have the greatest impact on their competitiveness and profitability. However, the production sectors of fertilizers, plastics, plant protection products, paints, auxiliary chemicals for industry and consumer chemicals are also significantly affected indirectly, due to increases in the cost of supplying chemical raw materials, which are closely linked to high energy costs. Overall, the prospect of strong pressure on the profitability of businesses in the sector will have implications for their ability to invest and meet the challenges of the decade

ahead. It is therefore necessary in the short term to limit the effects of high energy costs on the economy and ensure security of energy supply and in the medium term to ensure the supply of energy at affordable prices, without exposure to uncontrollable price fluctuations.

5 POLICY RECOMMENDATIONS TO ADDRESS HIGH ENERGY COSTS

5.1 The European Commission's toolbox of measures to deal with high energy costs

In October 2021, when the issue of high energy costs had started to intensify and some EU Member States had already announced national measures to moderate energy price increases, the European Commission in its Communication[32] provided guidance on appropriate measures that can to be received by the Member States. The purpose of this toolbox of measures was to address in a coordinated manner the short-term needs to reduce energy costs for households and businesses in the EU, as well as medium-term measures to strengthen the resilience of the economy against future shocks, without creating problems in the EU's internal energy market or barriers to the green transition.

In the short-term national measures, the toolbox includes measures such as extraordinary income support for households, state aid to businesses and targeted tax reductions, while in the medium term, it includes support for investments in renewable energy sources and energy efficiency, consideration of measures for energy storage and natural gas supply security and the assessment of the current design of the EU electricity market.

More specifically, the immediate measures to protect households and businesses include the following:

- Providing emergency income support to households affected by energy poverty, for example through vouchers or partial bill payments. These measures can be supported by revenues from the EU ETS.
- Possibility of temporary postponements in bill payments.
- Implement safeguards to avoid network disconnections.
- Temporary, targeted reductions in tax rates for vulnerable households.
- Providing aid to businesses or industries under EU state aid rules.
- Intensification of the EU's international contacts in the energy sector in order to ensure the transparency, liquidity and flexibility of global markets.
- Investigating possible anti-competitive behavior in the energy market while calling on the European Securities and Markets Authority (ESMA) to further strengthen the monitoring of developments in the CO_2 emission rights market.[33]
- Facilitating wider access to electricity purchase agreements from renewable sources and supporting them through accompanying measures.

Medium-term measures for a resilient and CO_2-free energy system in the EU include:

- Accelerating investments in renewable energy, renovations and energy efficiency, and speeding up both renewable energy auctions and licensing processes.
- Developing energy storage capacity, including batteries and hydrogen, to support an increase in the share of renewable energy sources.

[32] European Commission. COM(2021) 660 final 13.10.2021.

[33] The investigation into the CO2 emission rights market was completed on 28 March 2022. No major problems were identified, but recommendations were made to improve market transparency and monitoring see https://www.esma.europa.eu/press-news/esma-news/esma-publishes-its-final-report-eu-carbon-market.

- Request the European regulatory bodies (ACER) to study the benefits and drawbacks of the current electricity market design and submit recommendations to the Commission where appropriate.
- Examining the need to revise the Security of Supply Regulation to improve the use and operation of natural gas storage in Europe.
- Investigating the potential benefits of voluntary joint gas supply by Member States.
- Creation of new gas risk analysis teams at cross-border regional level to analyze risks and advise Member States on the development of their national preventive action plans and emergency plans.
- Strengthening the role of consumers in the energy market, enabling them to choose and switch suppliers, generate their own electricity and participate in energy communities.

The toolkit continues to be an important framework for action at national level. However, developments triggered by Russia's invasion of Ukraine have created a new reality for EU member states' energy markets and energy security, making it imperative to wean themselves off Russian gas. In this context, the European Commission with its new communication in March 2022 presented emergency measures for energy prices and natural gas storage and provided additional guidance to Member States specifying, among others, how Member States can redistribute to consumers the revenues arising from high profits of the energy sector and from the trading of emission allowances.

These measures include:[34]

- Measures to moderate retail prices and support highly exposed businesses. The Commission provides guidance to help Member States set up price regulation systems, which could be accompanied by incentives for energy efficiency and energy saving to reduce energy bills.
- A new temporary State aid crisis framework to provide aid to businesses affected by the crisis, in particular those facing high energy costs (with targeted amendments to the ETS state aid guidelines after consultation). For example, Member States will be able to offer temporary support to businesses facing liquidity needs due to the current high energy prices, regardless of their size, based on the rescue and restructuring guidelines. To finance such emergency measures, Member States may consider taking temporary windfall tax measures.
- Submit by April 2022 a legislative proposal that would require underground gas storage facilities across the EU to be at least 90% full by 1 October each year.
- Examining the implementation of emergency measures, e.g. establishment of temporary price limits, in order to limit the possibility of influencing electricity prices by natural gas prices.
- Evaluation of options to optimize electricity market design, taking into account the final report of the Agency for the Cooperation of EU Energy Regulators (ACER) and other contributions on the benefits and drawbacks of alternative pricing mechanisms, with the aim of electricity to remain affordable, without disrupting supply and to further invest in the green transition.

[34]Further specification of the measures was expected by the European Commission in May 2022.

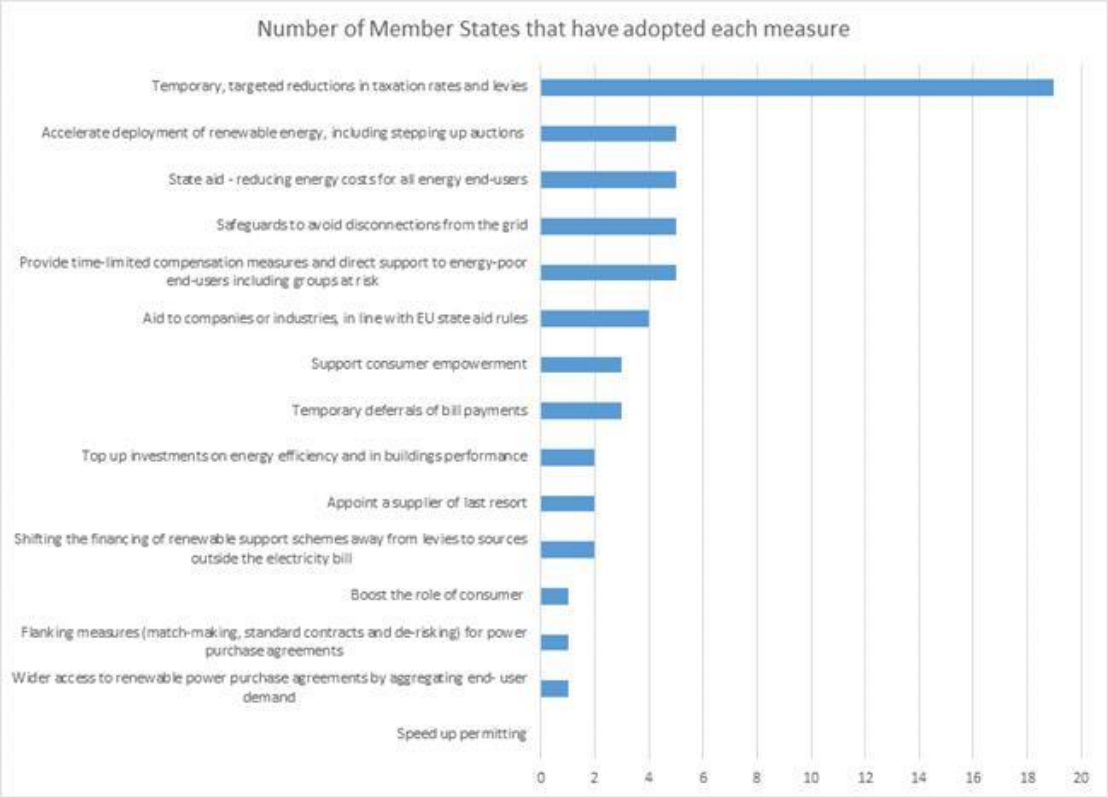
- Development of the REPowerEU plan, which will increase the resilience of the energy system at EU level based on two pillars:
    - the diversification of natural gas supply, by increasing imports of liquefied natural gas (LNG) and pipeline imports from suppliers outside Russia, and by increasing the volume of production and imports of biomethane and renewable hydrogen.
    - faster reduction of fossil fuel use in homes, buildings and industry, as well as in the electricity system, by enhancing energy efficiency, increasing RES and electrification, and addressing infrastructure bottlenecks.

Therefore, the European Commission provides EU Member States with a framework of potential measures, which can mitigate in the short and medium term the economic impact of high energy costs and the risks of the EU's high dependence on energy resources coming from Russia, without disturbing to a significant extent the conditions of competition in the single energy market and the path towards the green transition.

5.2 Policies to mitigate increases in energy costs in EU Member States

The energy price toolkit has helped Member States mitigate the impact of high prices on consumers, according to European Commission figures. Most Member States have chosen to implement temporary targeted reductions in taxes and fees, provide compensation and direct support to energy-poor end-users including groups of users at risk (including providing guarantees to avoid disconnection from the grid), reduce energy costs for all energy end-users in line with EU state aid rules and accelerating RES deployment (including accelerating RES auctions) (Figure 5.1). Other measures such as the temporary deferral of bill payments and support for consumer empowerment and role, the transfer of financing of the RES support scheme from sources other than the electricity bill and the designation of a supplier of last resort, were adopted by fewer Member States.

Figure 5.1: Measures to deal with high energy prices in the EU Member States (until 16.02.2022)



Source: European Commission

Finally, important measures such as (a) additional strengthening of investments in energy efficiency of buildings and (b) greater access to bilateral energy supply contracts (PPA's) by concentrating end-users demand and taking measures such as the standardization of contracts to reduce the counterparty risk between energy suppliers and consumers, had a very limited application. However, that do not mean that there is no planning and preparation for their subsequent adoption at an appropriate time by more Member States.

In a different categorization, Table 5.1 presents the national policies to protect consumers from rising energy prices in European countries. The measures that have been implemented by the majority of countries are the reduction of energy taxes, including VAT, as well as resource transfers to consumer groups in addition to or as an alternative to retail price regulation. Regulating wholesale prices, taxing electricity producers' windfall profits and supporting businesses were implemented by fewer countries.

Table 5.1: National policies to shield consumers from rising energy prices

	Reduced energy tax / VAT	Retail price regulation	Wholesale price regulation	Transfers to vulnerable groups	Mandate to state-owned firms	Windfall profits tax / regulation	Business support	Other
Austria	√			√		√	√	
Belgium	√	√		√				
Bulgaria		√					√	
Croatia	√			√				
Cyprus	√			√	√			
Czech Republic	√	√		√			√	
Denmark	√			√				
Estonia	√	√		√			√	
France	√		√	√	√	√		
Germany	√			√		√		√
Greece				√			√	
Hungary		√						
Ireland	√			√				√
Italy	√			√		√	√	
Latvia	√			√				
Lithuania		√		√				√
Luxemburg				√				
Netherlands	√			√				
Norway				√				
Poland	√	√		√				
Portugal	√		√		√			
Romania	√	√		√		√		
Spain	√	√	√	√		√		
Sweden	√			√				√
UK		√		√			√	√

Source: Sgaravatti, G., S. Tagliapietra, G. Zachmann (2021) 'National policies to shield consumers from rising energy prices', Bruegel Datasets, first published 4 November, available at https://www.bruegel.org/publications/datasets/national-policies-to-shield-consumers-from-rising-energy-prices/

In Greece a subsidy on electricity bills was announced for the majority of Greek households and small businesses, from September 2021 until the end of the year. In mid-October the subsidy was extended and it was readjusted after January 2022. For other businesses initially only a suspension of payment of PSO charges on electricity bills (until March 2022) was implemented. In January 2022 businesses were given a subsidy of €65/MWh, regardless of size, sector and voltage level. For business consumers, the unit price of the subsidy doubled from €65/MWh in March to €130/MWh in April. Natural gas has been subsidized from January 2022 for both households and businesses at €20/MWh and €30/MWh respectively. From February 2022 the natural gas price subsidy for businesses was set at €20/MWh. The price subsidies are financed by the Energy Transition Fund, to which a large part (74.9%) of the national revenues of the Emissions Trading System is directed, as well as by transferring resources from the RES support account (ELAPE), which has shown large surplus due to high electricity prices in the wholesale market. Therefore, so far the subsidies do not have a direct impact on the state budget.

In addition, with regard to securing the energy supply in the event of an interruption of the flow of natural gas from Russia, the following have been decided: a) the evaluation of the addition of a floating LNG tank in Revythusa, b) the examination of the possibility of maintaining strategic natural gas reserves in underground Italy's warehouses, c) the calculation of the additional LNG cargoes needed in the event of a natural gas flow interruption from Russia and the close monitoring of the availability of natural gas cargoes in the markets, d) the operation of gas-oil power plants, for those units that is possible and e) planning for lignite mining to ensure the uninterrupted operation of available power plants.

As the energy crisis affects all the EU member states, although with different intensity, **joint action at the EU level** is required in addition to national measures. In this context, the Greek government has proposed to EU institutions measures such as: a) the creation of a "European Solidarity Mechanism for the Energy Crisis", b) the implementation of a price cap and a daily fluctuation limit on the TTF natural gas market in the Netherlands, which will be benchmarked against the historically highest gas price before the crisis, c) setting prices as a contingency measure in the event of announcements regarding pipeline gas flows from Russia, d) capping the gross margin on the wholesale electricity market, e) for a certain period of time, to allow transactions only with physical delivery of natural gas and f) the strengthening of liquidity in the US, EU and Asian natural gas markets.

In May 2022, the Greek government announced the strengthening of electricity price subsidies for May and June and the continuation of natural gas subsidies (20 euros per thermal MWh for the entire monthly consumption). From July 2022 and with a time horizon of up to one year, the implementation of a horizontal discount mechanism on electricity tariffs was announced, in order to stabilize the retail price, as well as the introduction of a mechanism to absorb producers' windfall profits in the wholesale market. At the same time, the subsidy in the retail market will be adjusted so that prices remain on average stable at a level slightly higher than that prevailing before the crisis. The cost will be covered by the State Budget, the resources of the Energy Transition Fund, combined with **a mechanism to absorb the producers' windfall profits in the wholesale electricity market**. The package of interventions is intended to absorb 70%-80% of the increase in the price of the kilowatt hour for households and businesses. For professional consumers, the unit price of the subsidy is set at 120 euros/MWh in May for total consumption, with an additional subsidy of 50 euros/MWh total consumption for small and medium-sized enterprises with a power supply of up to 35kVA.

5.3 The REPowerEU plan

On 18 May 2022, the European Commission presented the REPowerEU[35] plan, to address the global energy market disruptions caused by Russia's invasion of Ukraine. REPowerEU is a plan to save energy, produce clean energy, diversify the EU's energy supply and wean itself off Russian fossil fuels, supported by financial and legal measures to build the new energy infrastructure and systems that Europe needs.

The short-term measures of the plan include among others: a) Common purchases of natural gas, liquefied natural gas (LNG) and hydrogen through an EU energy platform, b) New energy partnerships with reliable suppliers, c) Rapid development of solar and wind energy projects

[35] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52022DC0230&from=EN

combined with the development of renewable hydrogen to save about 50 billion cubic meters (bcm) from natural gas imports, d) Action plan to increase biomethane production to save 17 bcm from natural gas imports, e) Approval of the first of hydrogen projects at the EU level by the summer, f) A European Commission's Communication for the EU energy savings with recommendations on ways citizens and businesses can save around 13 bcm from natural gas imports, g) Replenishment of natural gas reserves to 80% of the storage capacity by November 1st 2022, h) EU coordination plans to reduce demand in case of natural gas supply disruptions.

At the same time, the medium-term measures to be completed before 2027 concern the following: a) New REPowerEU national plans under the amended Recovery and Resilience Fund, with the aim of supporting investments and reforms amounting to €300 billion,[36] b) Strengthening industry for GHG emissions reduction investments under the Innovation Fund, c) New legislation and recommendations for faster licensing in the RES sector and guidance for Power Purchase Agreements (PPAs), d) Investments for an integrated and adapted natural gas infrastructure network and of electricity, e) Increase the EU-wide energy saving targets from 9% to 13% for 2030, f) Increase the EU's RES target from 40% to 45% for 2030 with a comprehensive "Solar Strategy" for doubling the capacity from solar farms by 2025 and installing 600 GW by 2050, g) Modern hydrogen regulatory framework and a program for accelerating the use of hydrogen by building 17.5 GW of electrolytic cells by 2025 with the aim of supplying EU industry with domestic production of 10 million tons of renewable hydrogen.

In the framework of REPowerEU, a documented proposal for revising the Recovery Plan can be submitted to the European Commission, with which additional emphasis will be placed on actions that will support investments and reforms to strengthen the green transition and in particular on the following:

- Improvement of the energy infrastructure to immediately strengthen the security of oil and natural gas supply and support the diversification of energy supply sources.
- Enhancing energy efficiency in buildings, getting rid of CO_2 emissions, increasing the production and use of biomethane and renewable or mineral-free hydrogen and increasing the share of RES.
- Tackling energy transport bottlenecks and supporting zero-emission transport and its infrastructure.
- Support the above objectives through the rapid specialization of the workforce in green skills.

For Greece, the indicative financing to address the energy crisis under REPowerEU includes a) up to 7.5 billion euros in loans from amounts not requested by member states from the Recovery Fund, b) 1 billion euros in subsidies from the EU ETS emission allowances auctions and c) amounts that Greece has already claimed and is entitled to for the programming period 2021-2027 from other EU funds such as 1.53 billion euros from the new NSRF and 348 million euro from the Common Agricultural Policy (CAP).

[36]Member States can use the remaining loans of the Recovery and Resilience Mechanism (currently €225 billion) as well as its new grants financed by the auctioning of ETS emission allowances that are included in the market stability reserve and amount to 20 billion euros. Other REPowerEU funding sources include: Cohesion Policy Funds, European Agricultural Fund for Rural Development, Connecting Europe Facility, Innovation Fund, National and EU funding to support REPowerEU objectives, National fiscal measures, Private investment, European Investment Bank.

5.4 Policy Recommendations

The effects of the current energy crisis and high energy prices are particularly unfavorable for the enterprises of the chemical industry in Greece, as well as for the economy as a whole. Their competitiveness is significantly affected and, given their strong extroversion, their prospects become more uncertain. The measures that have been implemented are obviously necessary and mitigate to some extent the effects of the energy crisis on competitiveness. However, there is a need for the examination and implementation of additional measures, which will help the companies in the sector to deal more effectively with the current crisis, to strengthen their resistance to similar crises in the future, but also to respond to the multiple challenges that are in front of them. It is therefore crucial, within the context and possibilities deriving from the relevant EU directions, to consider interventions with both short-term and medium-term targeting. Examples of such interventions may include the following:

Maintaining an adequate level of subsidy for the energy costs of businesses and a differentiated subsidy for highly energy-intensive businesses.[37] The level of the subsidy should follow the fluctuations of the prices of wholesale electricity and natural gas, as is applied in the current phase. However, it is necessary that energy-intensive enterprises receive a higher subsidy, since, as was also found in the case of chemical enterprises, the impact on their production costs and competitiveness is disproportionately greater compared to lower energy-intensive enterprises.

Interventions to strengthen business liquidity. Making use of the new temporary crisis framework for state aid in the EU,[38] which allows aid to be granted to businesses affected by the crisis, especially those facing high energy costs, for example by offering temporary support to businesses facing liquidity needs due to current of high energy prices, regardless of their size. The framework provides, among other things: a) the possibility of aid of up to €400,000 per company in any form, even with direct aid, b) liquidity support in the form of state guarantees and subsidized loans from banks to all affected companies and c) aid to compensate for high energy prices, especially for the most energy-intensive, for the additional costs due to the extraordinary increases in the prices of natural gas and electricity.[39] Depending on the country's fiscal capacity, the following state aid measures could be included:

- Tax deduction for those energy-intensive businesses that have an increase in energy costs greater than a predetermined percentage compared to 2019, as can be certified with data to be submitted in a relevant application.
- A government guarantee program for the provision of working capital loans at zero interest to cover the operating costs of businesses that are included based on Activity

[37] The current system of subsidies does not directly affect the operation of the relevant markets and the EU energy market. The possible application of extraordinary measures with a direct subsidy on the price of natural gas or the application of price ceilings per power generation technology, so that the wholesale price of electricity is not burdened disproportionately, will entail the interruption of the current subsidization system provided that it will have an equivalent effect on prices.

[38] https://ec.europa.eu/commission/presscorner/detail/el/statement_22_1949

[39] According to the decision "Support can be granted in any form, including direct grants. The total aid per beneficiary cannot exceed 30% of the eligible costs, with a maximum of 2 million euros at a given time. When the business incurs operating losses, further support may be needed to ensure the continuation of an economic activity. To this end, Member States may grant aid exceeding these ceilings, up to EUR 25 million for energy-intensive users and up to EUR 50 million for companies active in specific sectors, such as the production of aluminum and other metals, glass fibers, paper pulp, fertilizers or hydrogen and many basic chemicals".

Number Codes in the energy affected and certify in a relevant application that they are facing an increase of more than 100% in their energy bills. The State and the banking system have gained relevant experience during the health crisis, which they can use in the case of the energy crisis. The granting of these funds will partially offset the blow to the competitiveness of all companies in the chemical industry, whether energy-intensive or those with indirect effects due to the greatly increased cost of raw material procurement.

- State guarantees for the provision of bridge loans to affected businesses.
- Return of the excise tax on electricity and natural gas for companies that export at a percentage corresponding to the value of their exports in turnover.

Additional interventions to reduce energy costs may include:

- Reduction of network charges and other fees to the minimum possible level.
- Direct implementation of indirect emission cost offsets for eligible domestic industry sectors.
- Increase the aid intensity from 75% to 100% to offset the cost of indirect emissions and extend the application of the measure to businesses with high electricity intensity that are not eligible according to the existing list of sectors of the European Commission.
- Systematic monitoring and control of wholesale electricity and natural gas markets to avoid abusive practices.
- Subsidizing other energy sources such as LPG for industrial use, which is mostly used by businesses due to the lack of a natural gas network in their area of installation.
- Exemption from VAT on natural gas when used as a raw material.
- Ensuring the transfer of surpluses in the form of windfalls in electricity prices to businesses and households.
- A national initiative, within the EU institutions, to ensure that ETS prices moderate – with possible use of the market stability reserve to deal with excessive emission allowance prices.

Interventions for greater business participation in the benefits of energy system transformation and the green transition. It is accepted that investments in RES and energy efficiency should be accelerated in order, in addition to climate protection, to reduce dependence on imported fossil fuels and risks to energy security. At the same time, with today's data, these investments will offer affordable wholesale energy prices, ensuring price stability in the future, while the economic activity that will be created during the implementation of the investments will compensate at least part of the losses caused by the energy crisis. In order for industrial companies to participate in these benefits, the following should be pursued indicatively:

- Encouraging through institutional interventions (e.g. standardization of contracts, reduction of counterparty risks) direct corporate agreements to purchase electricity from RES through bilateral contracts (PPA's), especially for electricity-intensive enterprises.
- Strengthening/promotion of business investments in self-production of renewable energy in combination with the implementation of the net metering system with:

  - Simplification of the institutional framework (e.g. in parameters such as the installation of the RES station in a different location, real-time consumption limits, increasing the capacity of batteries that can be used, the application of virtual net-metering, etc.).
  - Accelerating the licensing of the installation of photovoltaic systems for businesses, with priority approval from the distribution system operator (DEDDIE).
- Facilitation of the establishment of energy communities by companies, whose RES projects can be directly connected to the high-voltage network, when the medium-voltage network is congested.
- Establishment of energy saving programs for industry.
- Acceleration of investments to strengthen/upgrade electricity networks.
- Reinforcement/promotion of investments linked to the circular economy (e.g. chemical recycling of plastics) which under today's technologies are energy-intensive. More specifically, in addition to subsidizing the initial cost of the investment through the financial tools of the Recovery Fund and NSRF for the period 2021-2027, it is recommended to subsidize the price of energy, indicatively for the first 5 years of operation, according to the fluctuations of wholesale electricity prices energy and natural gas.
- **Designing investment support programs**, in the framework of the review of the Recovery Plan to integrate the objectives of REPowerEU, to support industrial sectors, including the chemical industry.

Other interventions. Rising costs of energy and other raw materials have led to large price appreciations in construction materials and other related chemicals. As there is no automatic price adjustment, several public projects as well as energy-saving interventions approved by the «Εξοικονομώ» 2021 program are at risk of not being implemented, as their budget does not cover the excessively increased costs. Therefore, it is necessary to systematically monitor the prices and in cases where large deviations from the original budget are found, to carry out at least a partial adjustment of the prices and cover the additional costs. Also, it is considered appropriate to include materials in addition to labor cost in the costs of upgrading buildings that are deducted from the taxable income of individuals who are not included in the «Εξοικονομώ» Program.

Finally, another intervention that could be considered is the temporary reduction of VAT on fertilizers and other agricultural inputs to 0% (it has been implemented by Poland as an anti-inflationary measure), which would mitigate the effects of increased costs on agricultural production.

6 APPENDIX

Table 6.1: Statistical classification of chemical industry subsectors

C20 - Manufacture of chemicals and chemical products
C201 - Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms
C2011 - Manufacture of industrial gases
C2012 - Manufacture of dyes and pigments
C2013 - Manufacture of other inorganic basic chemicals
C2014 - Manufacture of other organic basic chemicals
C2015 - Manufacture of fertilisers and nitrogen compounds
C2016 - Manufacture of plastics in primary forms
C2017 - Manufacture of synthetic rubber in primary forms
C202 - Manufacture of pesticides and other agrochemical products
C2020 - Manufacture of pesticides and other agrochemical products
C203 - Manufacture of paints, varnishes and similar coatings, printing ink and mastics
C2030 - Manufacture of paints, varnishes and similar coatings, printing ink and mastics
C204 - Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
C2041 - Manufacture of soap and detergents, cleaning and polishing preparations
C2042 - Manufacture of perfumes and toilet preparations
C205 - Manufacture of other chemical products
C2051 - Manufacture of explosives
C2052 - Manufacture of glues
C2053 - Manufacture of essential oils
C2059 - Manufacture of other chemical products n.e.c.
C206 - Manufacture of man-made fibres
C2060 - Manufacture of man-made fibres

Table 6.2: Assignment of chemical categories and subsectors according to NACE rev2 statistical classification

Sector	NACE rev2
Petrochemicals	20.14
Basic inorganics	20.11 - 20.13 - 20.15
Polymers	20.16 - 20.17 - 20.6
Specialty chemicals	20.2 - 20.3 - 20.5 - 20.12
Consumer chemicals	20.4

Table 6.3: Energy expenditure as a percentage of total purchases of goods and services in the chemical industry in Greece by chemical category in the worst case scenario

Chemicals category	2020	2021	2022	2022 with subsidy	Δ2022-2020
1. Petrochemicals	6.4%	9.4%	23.7%	17.1%	*17.3%*
2. Basic Inorganics					
Other inorganics	15.9%	25.1%	50.2%	40.1%	*34.3%*
Industrial gases	14.0%	21.4%	45.0%	35.2%	*31.0%*
Fertilizers	3.6%	4.6%	12.8%	8.9%	*9.2%*
3. Polymers					
Plastics	2.5%	3.3%	9.4%	6.4%	*6.9%*
Synthetic fibers	6.3%	9.9%	24.9%	18.0%	*18.6%*
4. Specialty chemicals					
Dyes & pigments	12.8%	20.1%	43.1%	33.4%	*30.3%*
Plant protection	1.0%	1.8%	5.3%	3.6%	*4.3%*
Paints & inks	3.2%	5.1%	13.9%	9.7%	*10.7%*
Auxiliaries for industry	2.9%	4.6%	12.6%	8.8%	*9.7%*
5. Consumer chemicals	2.1%	3.7%	10.2%	7.0%	*8.1%*
CHEMICALS & CHEMICAL PRODUCTS	3.5%	5.6%	15.1%	10.5%	11.6%

Source: IOBE estimations

Table 6.4: Energy expenditure as a percentage of the GVA of the chemical industry in Greece by chemical category in the worst-case scenario

Chemicals category	2020	2021	2022	2022 with subsidy	Δ2022-2020
1. Petrochemicals	30.2%	44.2%	-1,038.3%,	157.5%	*-1,068.5%*
2. Basic Inorganics					
Other inorganics	86.5%	136.2%	-171.8%	-761.0%	*-258.3%*
Industrial gases	42.8%	65.4%	-315.2%	374.2%	*-358.0%*
Fertilizers	23.6%	30.8%	376.7%	88.6%	*353.1%*
3. Polymers					
Plastics	12.7%	16.8%	87.1%	40.3%	*74.4%*
Synthetic fibers	30.1%	47.5%	-800.1%	179.8%	*-830.2%*
4. Specialty chemicals					
Dyes & pigments	43.7%	58.9%	-382.2%	285.0%	*-425.9%*
Plant protection	4.3%	7.7%	28.5%	16.6%	*24.2%*
Paints & inks	7.7%	12.3%	53.5%	28.0%	*45.8%*
Auxiliaries for industry	11.7%	18.5%	102.8%	45.3%	*91.1%*
5. Consumer chemicals	3.8%	6.7%	24.1%	14.3%	*20.3%*
CHEMICALS & CHEMICAL PRODUCTS	10.6%	16.8%	87.0%	40.3%	*76.4%*

Source: IOBE estimates. *Negative values indicate that higher energy costs lead to negative GVA.

Table 6.5: Additional energy costs as a percentage of the operating surplus of the chemical industry in Greece by chemical category in the worst-case scenario

Chemicals category	Additional energy expenditure 2022-2020 (million euro)			
	No subsidy	% operating surplus (2021)	With subsidy	% operating surplus (2021)
1. Petrochemicals	46.2	184%	18.0	33%
2. Basic Inorganics				
Other inorganics	30.6	1.199%	12.3	219%
Industrial gases	44.8	604%	18.0	110%
Fertilizers	28.7	243%	11.7	45%
3. Polymers				
Plastics	30.4	68%	12.1	12%
Synthetic fibers	1.2	265%	0.5	48%
4. Specialty chemicals				
Dyes & pigments	13.0	374%	5.2	68%
Plant protection	8.0	46%	3.3	9%
Paints & inks	40.7	65%	16.2	12%
Auxiliaries for industry	40.4	108%	16.2	20%
5. Consumer chemicals	58.4	33%	23.3	6%
CHEMICALS & CHEMICAL PRODUCTS	342.4	87%	136.8	16%

Source: IOBE estimations