



## ***SELECTIVE ELECTROCHEMICAL REDUCTION OF CO<sub>2</sub> TO HIGH VALUE CHEMICALS***

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## **D8.3 MARKET ANALYSIS AND OPPORTUNITIES FOR SELECTCO2 TECHNOLOGY**

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<b>SUMMARY</b>	
<b>Keywords</b>	Chemicals; EU; Ethanol; Ethylene; Carbon Monoxide; Biofuels; Plastics; Market; New Green Deal;
<b>Abstract</b>	<p><i>The goal of this report is to provide an evaluation of the most promising scenarios for SELECTCO2's technologies. To do so the analysis starts with an overview of the European chemical sector in general terms, in order to expose the broader picture of the market in which the products of SELECTCO2 will be inserted. Afterwards the report exposes each final product of SELECTCO2: Carbon monoxide, ethylene, and ethanol. These paragraphs focus on the market analysis of these chemicals providing an exhaustive description about their usage in the different industrial sectors across Europe. The customer analysis describes the trends of products' demand and the main drivers of the main end-sectors where SELECTCO2 may find application. The competitor analysis instead lists the most important producers of each chemical and it also provides a specific focus on their sites with the most recent data available. The last chapter explains the most promising scenario for the chemicals relying on the data provided before and adding few statements based on the previsions for the incoming years.</i></p>
<b>Public abstract for confidential deliverables</b>	

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## MARKET ANALYSIS AND OPPORTUNITIES FOR SELECTCO2 TECHNOLOGY

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## 1. INTRODUCTION

The present document is provided in the context of Deliverable 8.3 “Market analysis and opportunities for SELECTCO2 technology” and is structured in six chapters with a final section dedicated to the conclusions of the work. This analysis provides the economic scenario in which the chemicals, produced through the SELECTCO2’s technology, will end up competing. In order to address this issue, the report employs a “generic-to-specific” approach, the analysis in fact firstly provides a broader picture of the topic, and then it dives gradually into more specific aspects. By using this approach, the reader is provided with enough information to fully understand the challenges and the potentialities of the product. Therefore, the report begins with Chapter 2 in which an exhaustive analysis of the European chemical sector is reported; the section provides the most recent data about this industry, and it also inserts the European industry into a wider prospective considering the world scenario. Afterwards there is a brief overview of the transition undertook by the chemicals sector towards a more sustainable and greener productive process, the goal of this section is to highlight the potentialities for SELECTCO2 products which can meet the new sustainability criteria recently adopted by the industry. The last section of the chapter exposes the commitments of the European Union for a more comprehensive legislation on chemicals, these legislative innovations include a step forward into the promotion of new and less impactful chemicals like those presented in SELECTCO2.

The third chapter is specifically devoted to the three specific products produced via SELECTCO2, namely Ethylene, Ethanol and Carbon Monoxide, for each of which a dedicated section in which are described the market perspectives of the sectors into which they can be applied with specific reference to Europe. The aim is to underline that these chemicals are largely employed by several industrial sectors, therefore it is vital to understand all the possible ramifications of their usage.

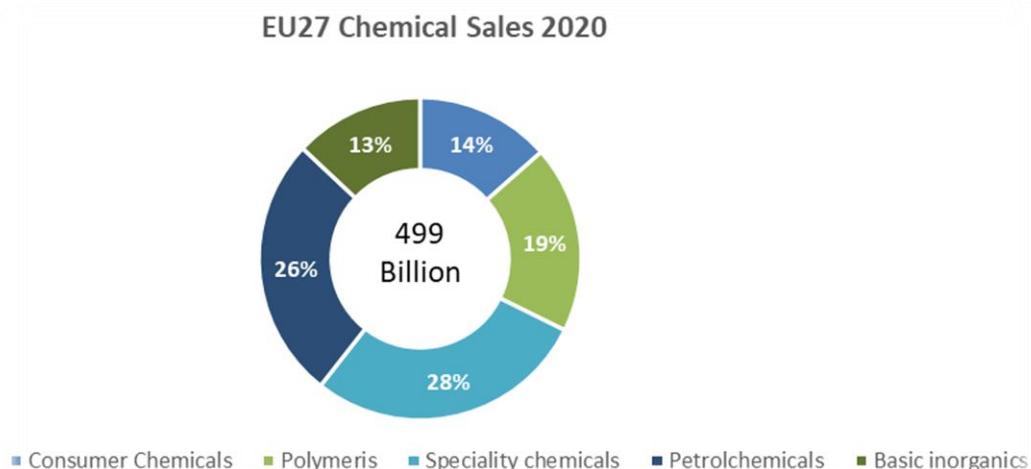
Also, the competitive analysis presented in Chapter 4 is divided by product: for each market this section lists the most prominent actors through tables reporting the most important data, and it is also detailed in order to provide an overview of their facilities and production sites. It is important to underline that all the data provided in the tables represent the data available about the competitors, in terms of production locations and in some cases production processes. This information has been collected through company websites and official and public documents, but they were not always available for all the competitors. Data related to production costs or costs related to the technologies used by each competitor were not available, perhaps on grounds of confidentiality, which this kind of information represents for the market players.

The last chapter is dedicated to the selection of the most promising scenario for SELECTCO2 technology relying on several data and statements present in the previous chapters. Recommendations about the most promising sector (in terms of market trends and sustainability perspectives) are provided.

## 2. OVERVIEW OF THE EUROPEAN CHEMICAL SECTOR

The aim of the present section is to describe the state of the art of the European chemical sector given an overview of the market trends, opportunities and key drivers for future development.

## 2.1. The European chemical sector and its global positioning

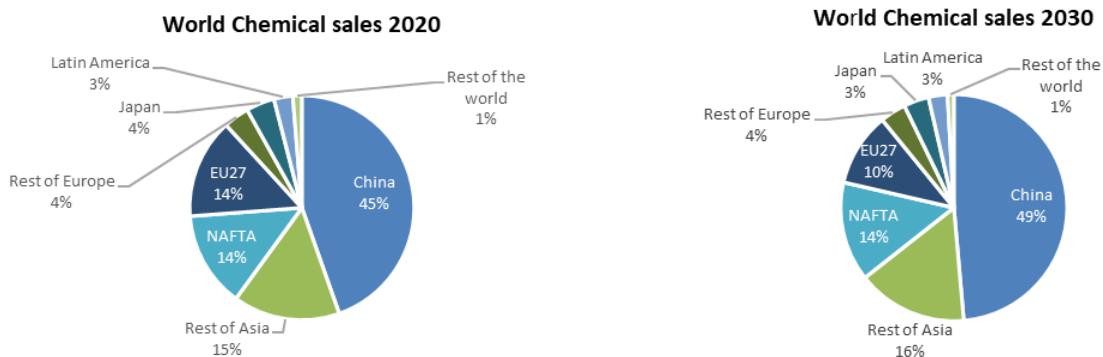


**Figure 1:** EU27 Chemical Sales 2020. Source: RINA-C Elaborations based on CEFIC report 2022: The European Chemical industry Facts and Figures

The chemicals industry is one of the largest economic sectors in the European Union, with an estimated turnover of 940 billion € and a sales value equal to 499 billion € in 2020; it also generates 335.4 billion € in added value, which is the highest rate within the most important manufacturing sectors in Europe. The chemical sector involves about 3.4 million people directly and indirectly employed and boast a higher productivity on average (+67%) if compared to other industries in the manufacturing field: both the labour productivity and the employment rate have increased in the recent 10 years by 1.3% and 1% respectively<sup>1</sup>.

The chemical sector's core position into the European economy has been secured through a large quantity of investments: for example, it is worth mentioning that in 2018, about 49.7 billion € of investments have been sustained, representing the highest level of investment made in the top manufacturing sectors of the continent. The industry's value of sold production has remained constant during the recent decade and this is a positive exception if we compare the chemical sector with other important industrial fields of the EU which have showed a more wavering trend. On the basis of these data the EU can be considered the second-largest producer of chemicals in the world, ranking higher than the NAFTA space (US, Mexico and Canada) and other important regions. Even though the sector has kept its pivotal role into the EU's economy its share in the global market' sales saw a decreasing trend passing from a 24.9% of 2000 to the 14.4% of today. This trend is largely due to the entering of Asian actors in the field of chemical products, China in particular, which has reached the top in both sales and share of the global market thanks to large investments made into the sector; today the chemical sector is worth 3.471 billion € worldwide and China owns the 44,6% of it. Despite China's rise as prominent actor, the market is still far from saturation. The global demand is in fact expected to grow in the next ten years reaching 6.2 trillion € by 2030.

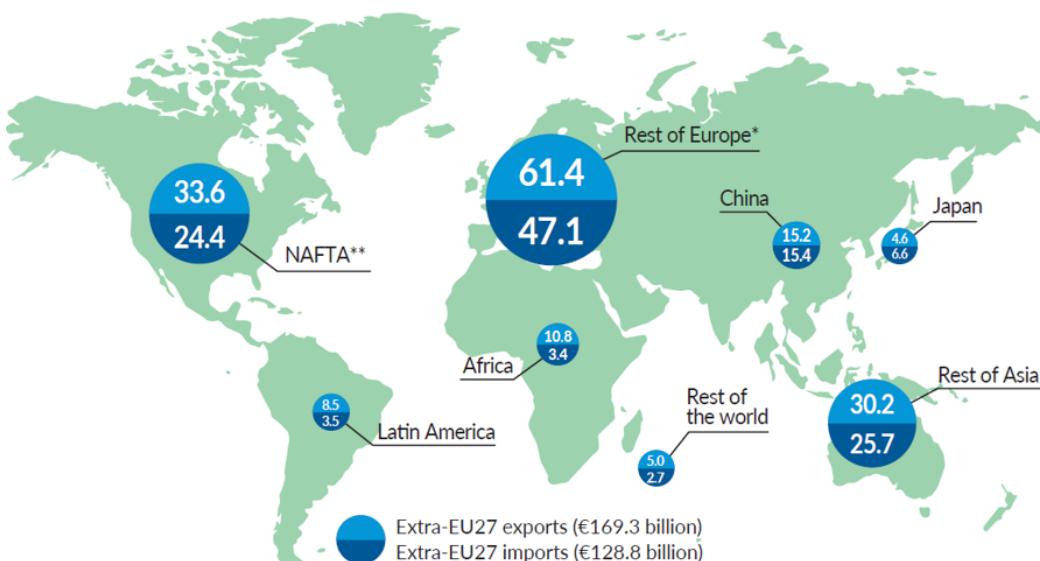
<sup>1</sup> CEFIC, 2020 FACTS & FIGURES of the European chemical industry



**Figure 2:** World Chemical Sales: 2020 vs 2030 projections. Source: RINA-C Elaborations based on CEFIC report 2022: The European Chemical industry Facts and Figures

In this scenario the European market share is projected to further decrease dropping to the 10.5% of the total, but it is worth noticing that, despite this reduction, the total sales in 2030 for the EU are expected to reach a value 651 billion €, which is an important increase compared to the 449 billion € of 2020.

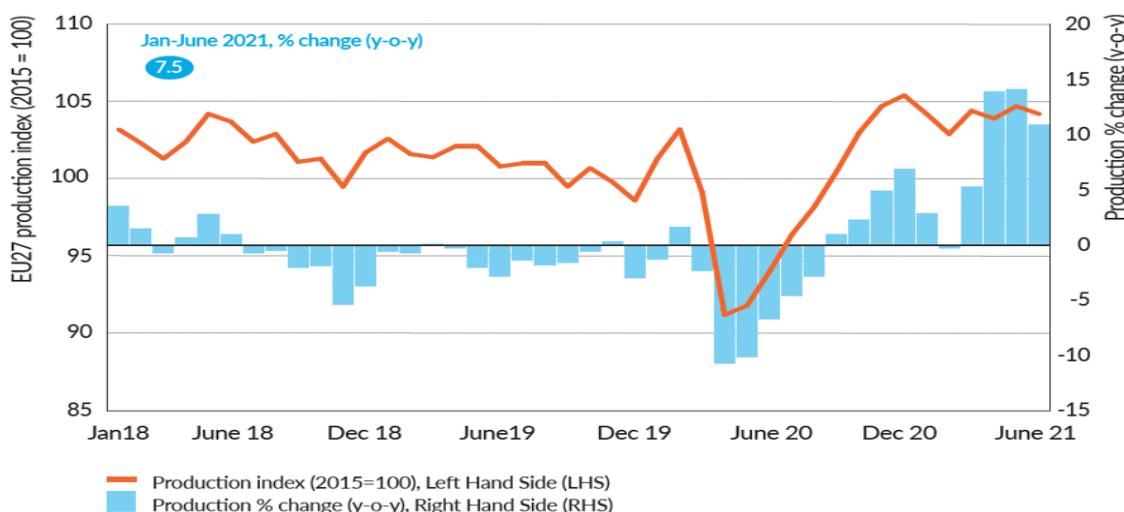
Europe is well inserted in the global market of chemical products and it plays an established role of exporter; in fact the European exports amount to 169.3 billion € while the imports to 128.8 billion € ensuring a positive trade-off for the continent. The trade balance has wavered within 40 and 50 billion € in the recent decade however today has reached its lowest level since 2011 (40.5 billion euro). The European chemical sector's sales to extra EU countries amount to 34% of the total and it also has a trade surplus with wealthy countries like the US and the UK which are respectively its first and second commercial partner. Despite what has been described before concerning the increased importance of China in the sector, it worth noting that the EU has a small trade deficit with this country. Therefore, the European Union does not depend on China but rather the balance of powers in this scenario is symmetric and fruitful for both actors, and China is indeed the third commercial partner for Europe in this sector.



**Figure 3:** EU27 chemicals trade flows with major geographic blocs (2020). Source: RINA-C Elaborations based on CEFIC report 2022: The European Chemical industry Facts and Figures

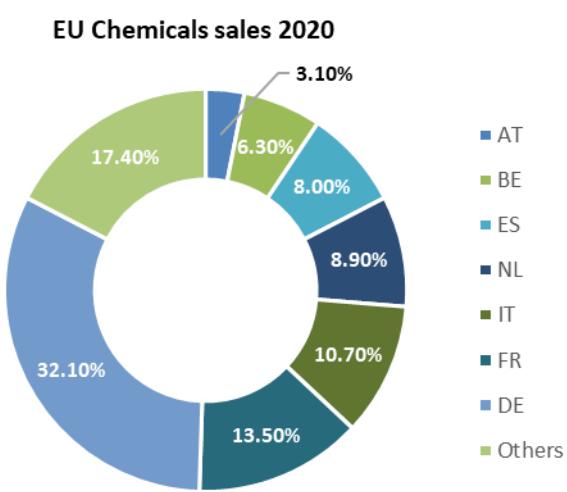
The COVID-19 pandemic has severely affected all the economy's sectors including the chemicals industry; however, this industry showed an impressive level of resilience by bouncing back to pre-pandemic level of production in less than one year (see figure below). Such an accomplishment shows that the chemical sector has a well-established

market with a steady demand, and it also demonstrates that the diversification of the sectors served by chemical products is a key strength element for this field.



**Figure 4:** EU27 Chemical Industry production. Source: RINA-C Elaborations based on CEFIC report 2022: The European Chemical industry Facts and Figures

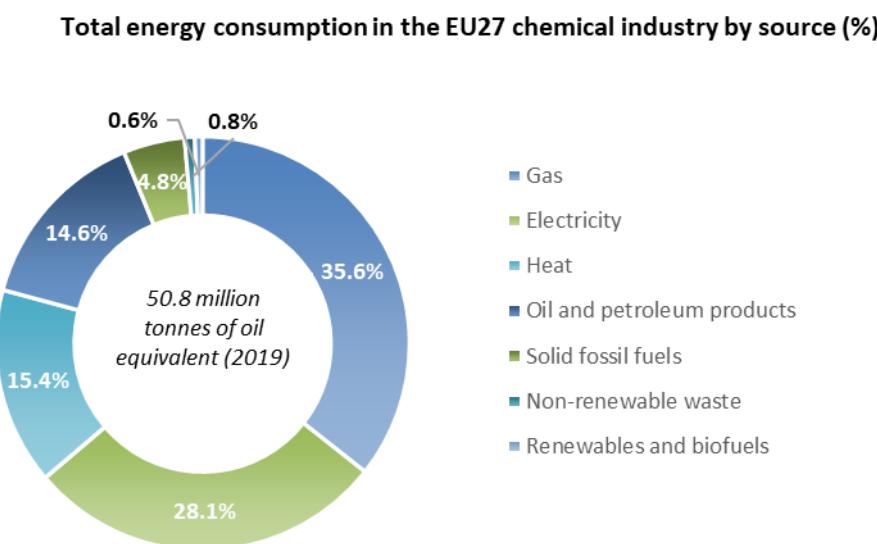
Concerning the internal production of the European Union a few Member States are the most prominent actors of the chemical sector. Germany is the leader in the field accounting for more than 30% of the total European sales, France and Italy are respectively the second and the third most important countries however both hold less than the half of Germany's production. In Italy in particular the chemical sector shows a high presence of small and medium enterprises coherently with the Italian economic model, which highly relies on these kinds of companies. The importance of the SMEs in Italy is demonstrated by their contribution to the national production of chemical products which accounts for the 39% of the total.



**Figure 5:** European Chemical Sales, 2020, by country. Source: RINA-C Elaborations based on CEFIC report 2022: The European Chemical industry Facts and Figures

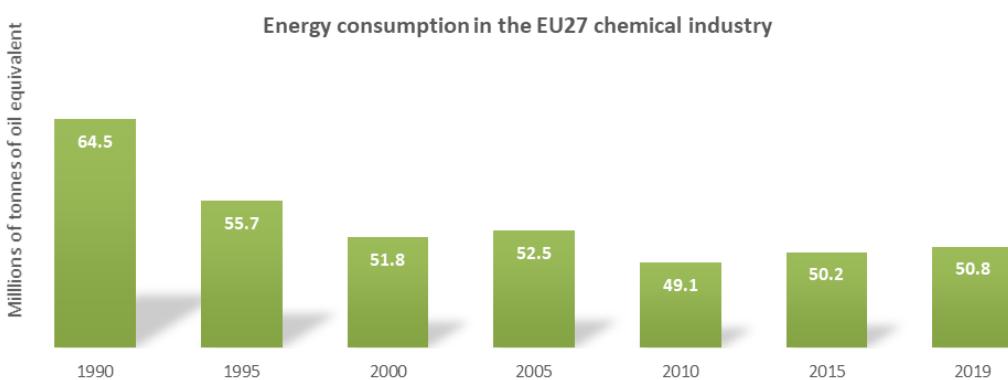
## 2.2 The process towards a more sustainable and safer chemical sector

The European chemical sector consumption is equal to 50.8 million tons of oil equivalent per year, mostly related to the usage of gas (35,6%) and electricity (28,1%) which account for the 2/3 of the total consumption. The remaining amount of energy consumption is composed almost equally by heat (15.4%) and oil and petroleum products (14.6%) with a small percentage coming from solid fossil fuels (4.8%). Such consumption makes the chemical sector one of the most Europe's most energy-intensive and the sector's impact on the environment has raised concerns among Europeans who are increasingly worried about the prospect of an accidental event capable of wrecking the environment in a meaningful way.



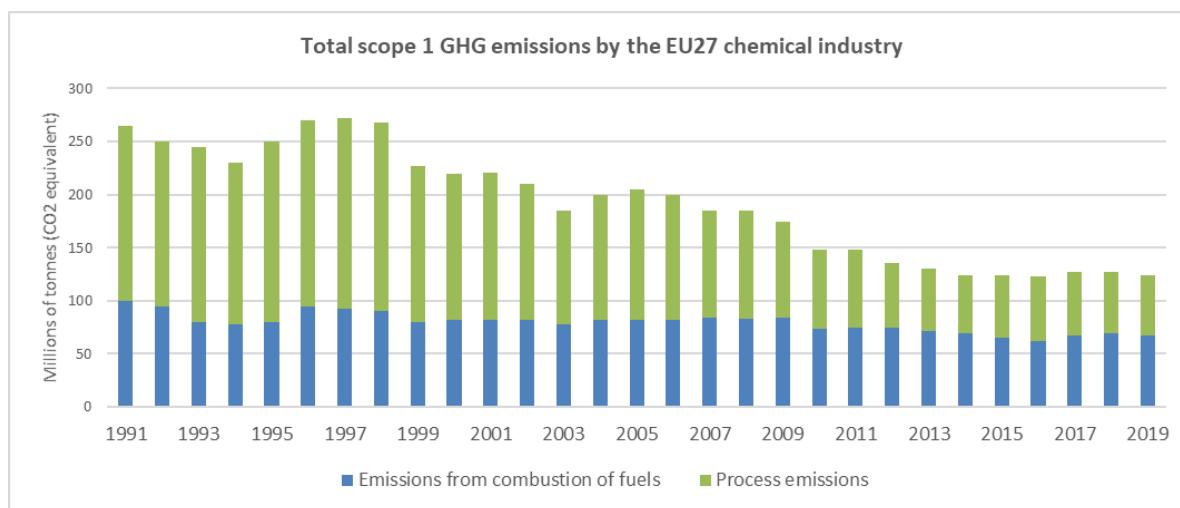
**Figure 6:** Total Consumption in the EU27 chemical Industry by source (%). Source: RINA-C Elaborations based on CEFIC report 2022: The European Chemical industry Facts and Figures

Despite these common worries, the chemicals sector has shown a serious commitment in the assessment of these risks and of the impact of its production: in these years it is employing more sustainable technologies to reduce the energy consumption, and it has adopted some communitarian regulations promoted by the EU aimed at reducing the risks and the dangerousness of the production system. A deep analysis shows a significant drop since 1990 in energy consumption (-21%) due to the reduction in the use of gas (-28%), electricity (-14%), petroleum (-23%) and solid fuels (-64%) compared to thirty years ago, and it has more than doubled the consumption of renewable energies.



**Figure 7:** Energy Consumption in the EU27 Chemical Industry. Source: RINA-C Elaborations based on CEFIC report 2022: The European Chemical industry Facts and Figures.

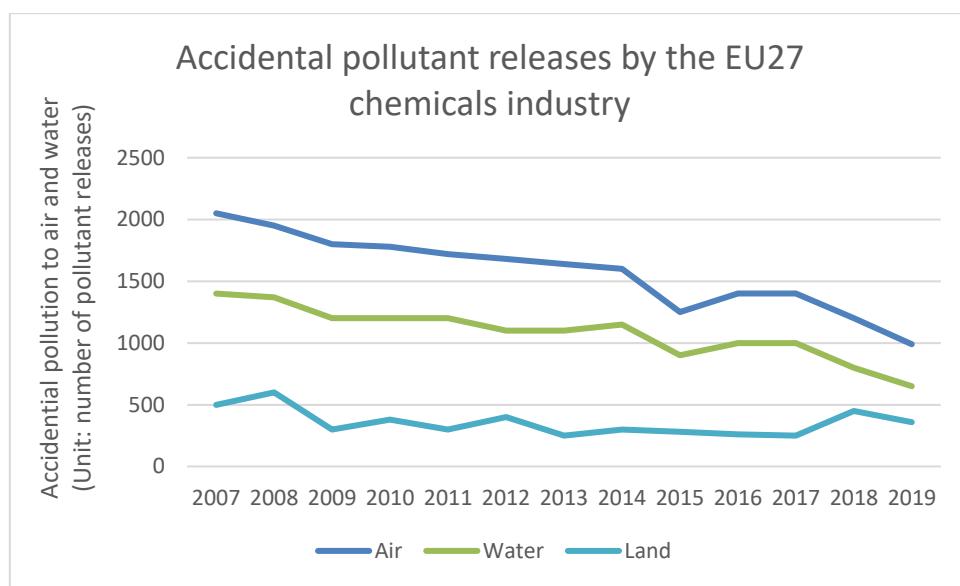
The rationalization and the innovation of the manufacturing process helped the chemical sector become more environmentally sustainable, and this is confirmed by the fact that during the last thirty years the chemical sector's greenhouse gas emissions fell to 125 million tonnes from 275 million in 1990. Combustion of fuels and manufacturing processes, nowadays contribute equally to the total emissions, but in 1990 the ratio was radically different. The process emissions amounted to 175 million tonnes while the ones derived from the combustion of fuels were equal to 100 million of tons; comparing these data to the 2019 it can be seen that the chemical sector tackled its emission reducing drastically the ones coming from the manufacturing process (see figure below). The implementation of new and more sustainable technologies did not affect the production of the sector but rather it helped the chemical industries in reaching new heights.



**Figure 8:** Total Scope 1 GHG Emissions, by the EU27 chemical industry. Source: RINA-C Elaborations based on CEFIC report 2022: The European Chemical industry Facts and Figures

Moreover, the chemical sector has become much safer: comparing the numbers of accidents to ten years ago the drop of such events is estimated to be around 23% while the others manufacturing sectors have reduced them by only the 20%. A clearer pattern can be also retraced considering the reduction of accidental pollutant release into air (-50%), water (-50%), and land (-30%)<sup>2</sup>.

<sup>2</sup>The European Chemical Industry Council, <https://cefic.org/a-pillar-of-the-european-economy/facts-and-figures-of-the-european-chemical-industry/>



**Figure 9:** Accidental pollutant releases by the EU27 chemical industry. Source: RINA-C Elaborations based on CEFIC report 2022: The European Chemical industry Facts and Figures

On the basis of all these considerations, it appears clear that the chemical sector acted decisively in order to become more sustainable, safe and to reverse the general opinion about the risks of this industry.

### 2.3 The future European framework on chemicals: the chemical strategy for sustainability<sup>3</sup>

The European Green deal can be reasonably considered one of the most ambitious and comprehensive plans ever promoted by the European Union. The goal is to make the EU climate neutral by 2050, to achieve this aim the European institutions and the Member States committed towards creating a circular economy scenario, which will help the continent at tackling the emissions. Since the chemical sector is one of the most important industries of the European Union, the Commission identified it as one of the priority areas of intervention; due to its large turnover and its high demand of energy, a sustainable transition of this sector is indeed considered vital to reach the carbon neutrality. The strategy of the Commission is to intervene simultaneously in the production of chemicals and on the communitarian legislative framework of the matter. Concerning the productive process, chemicals are largely used in hundreds of different sectors and industries, therefore an environmentally sustainable economy relies on the employment of chemical products obtained in a sustainable way. The European Union will invest in the sustainability of chemicals' value chain in order to enable the transition from high-impact chemicals to resources efficient ones. The sustainability of chemicals' value chain will also impact the resilience of the continent under different aspects. For instance, during the COVID-19 pandemic the shortages of chemicals occurred to the continent showed the dependency of the European Union on the global market, such scenario severely impacted industries, in particular the pharmaceutical one. The goal of the Commission is to build a more resilient value chain in the chemicals sector ensuring a strategic autonomy of this pivotal industry while preserving and reinforcing its role in the global market. From the legislative standpoint the Commission wants to build a more coherent, predictable and stronger regulatory system in order to protect both the health of the consumers and of the workers exposed to chemicals. Today the communitarian legislative framework is composed of 40 legislative instruments, within these two are worth mentioning: the Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) and the Classification, Labelling and Packaging of hazardous substances (CLP). European

<sup>3</sup> Brussels, 14.10.2020 COM(2020) 667 final COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Chemicals Strategy for Sustainability Towards a Toxic-Free Environment

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legislation is one of the most advanced in the world, however the predictable evolutions of the chemical sectors calls for an enlargement of this framework.

The chemicals strategy for sustainability towards a toxic free environment published by the European Commission in 2020 addresses all these challenges by exposing five areas of intervention all divided in several lines of actions<sup>4</sup>:

#### **1. Innovating for safe and sustainable EU chemicals**

The goal is to finance and promote the use of new chemicals that are safe and sustainable by design. This will allow the European chemical sector to gain competitiveness and so balance the future loss of global market share.

- Promoting safe and sustainable-by-design chemicals;
- Achieving safe products and non-toxic material cycles;
- Greening and digitalizing the production of chemicals;
- Strengthening the EU's open strategic autonomy.

#### **2. Stronger EU legal framework to address pressing environmental and health concerns**

Since the EU's legislation has been effective in addressing the numerous issues connected to the chemical sector, the Commission did not want to jeopardize its structure, but rather the focus is to reinforce REACH and CLP regulations and to make them more comprehensive and predictable.

- Protect consumers, vulnerable groups and workers from the most harmful chemicals;
- Protecting people and the environment from the combination effects of chemicals;
- Towards zero chemical pollution in the environment.

#### **3. Simplifying and consolidating the legal framework**

The comprehensiveness of the EU's legal framework has contributed to its efficiency; however, the next goal of the Commission is to reduce its complexity since the future scenarios of chemical products require a more simplified framework. Such an objective must be achieved without jeopardizing the fruitful structure of the framework in order to ensure a controlled transition towards the new generation of chemicals.

- One substance, one assessment;
- A zero-tolerance approach towards non-compliance;

#### **4. A comprehensive knowledge on chemicals**

The management of the chemical sectors strongly depends on the knowledge of the legislators thus both the EU agencies and the Member States must keep themselves updated to the newest data. In particular certain categories of chemicals that are not produced in high volumes raised some concerns since their small usage reduce the quantity of data available, also the effects of long exposure to some chemicals are still foggy and fragmented. In the prospect of a further developed chemical sector, a more exhaustive and data-based knowledge is necessary in order to properly address the incoming challenges.

- Improved availability of chemical data;
- A strengthened chemical science-policy interface;

#### **5. Setting the example for a global sound management of chemicals**

The European Union plays a prominent role in globally supporting the safety and the sustainability of the chemical sector. The legal framework established in the continent has set a positive standard for all the other global actors, however the threats posed by chemicals to human health and to the environment are still far from the standards required by the international organizations like the UN. Since the projections foresee an important increase of

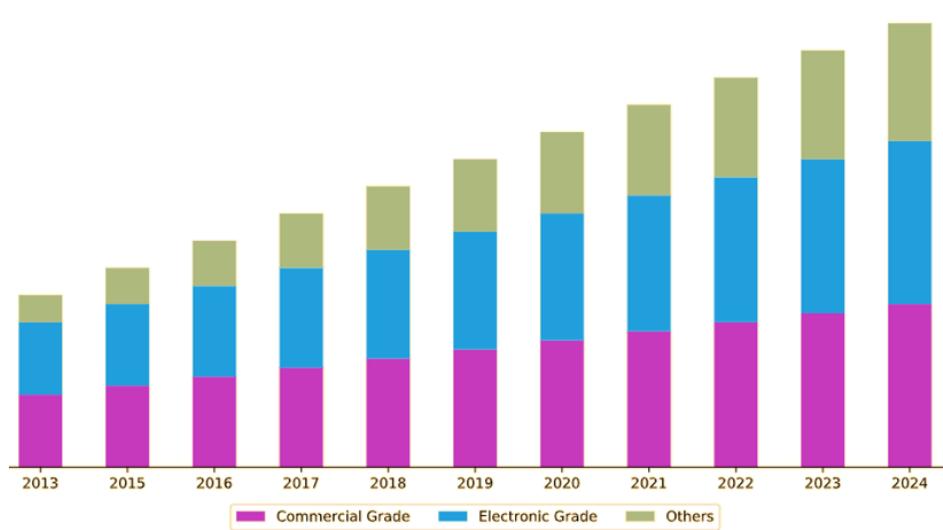
chemicals' sales by 2030, it is vital for the international community to meet the highest possible standards to guarantee the safety and the sustainability of the industry:

- Strengthening international standards;
- Promoting safety and sustainability standards outside the EU.

## 2.4 Focus on the three specific products SELECTCO2 is addressed to: Ethanol, Ethylene and Carbon Monoxide

### FOCUS CARBON MONOXIDE

Carbon monoxide (chemical formula CO) is a colourless, odourless, tasteless, flammable gas which is extremely dangerous for human health. It combines one molecule of carbon (C) and one of oxygen (O) and it is often produced with thermal combustion although there are numerous different ways through which the carbon monoxide can be released. It is widely used in multiple industrial sectors such as metal fabrications, chemicals, steel & metals, pharma & biotechnology and electronics, and in the chemical industry it is employed in the production of inorganic chemicals (metal carbonyls, titanium dioxide), organic chemicals (benzaldehyde and citric acid), and chemical intermediates (toluene and diisocyanatos, used to produce polyurethane). Carbon monoxide in combination with several other gases (hydrogen, nitrogen, methane and carbon dioxide) provides a fuel gas, called syngas, which is used as a substitute for natural gas. It is also used as a reducing agent in metals refining. The global carbon monoxide market is valued at 5705.3 million USD in 2020 is expected to reach 6889.4 million USD by 2026, growing at a Composed Annual Growth Rate (CAGR) of 2.7% during the same span of time. Based on type, the carbon monoxide market can be classified into commercial grade and electronic grade, based on the level of purity: the first one has a purity below the 98% while the electric grade's purity is 99.9%. Commercial grade is projected to be the dominant and fastest growing segment during the forecast period due to the increase in demand for carbon monoxide in end use industries such as chemical and metal.



**Figure 10:** Carbon Monoxide Market Size by product, 2013-2024 (USD Million). Source: Marketintellica

From a geographical point of view, the carbon monoxide market can be divided into North America, Latin America, Asia Pacific, Europe, and Middle East & Africa. North America and Europe are technologically matured regions; thus, they are expected to be the dominant regions of the carbon monoxide market during the forecast period, led by the rapidly developing metal and chemical industries in both areas. The carbon monoxide market in Asia Pacific is foreseen to grow due to the presence of emerging economies such as China, India, and Japan, while, the Middle

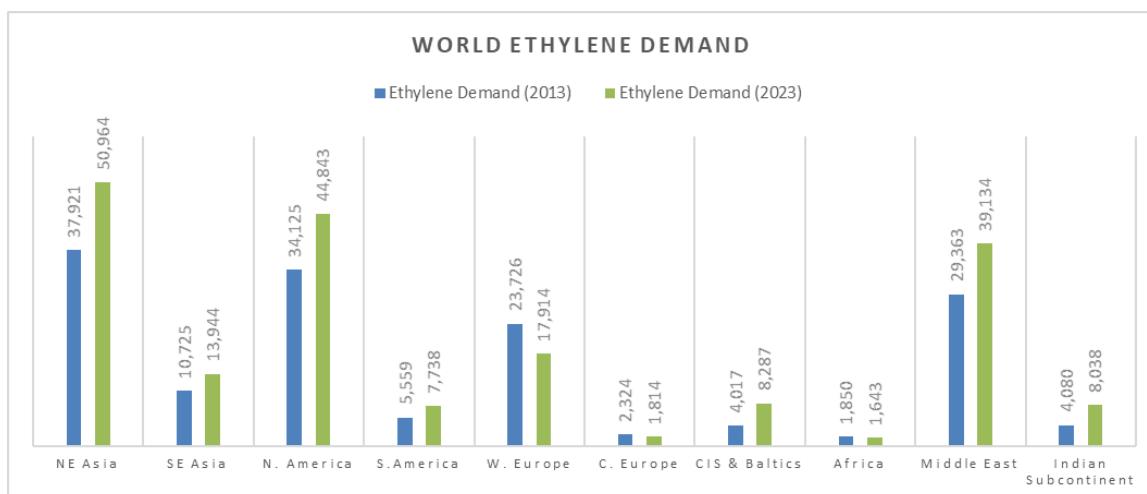
East & Africa is largely not exploited<sup>5</sup>. North America is currently the leader in the CO production, and it is projected to hold that role also in the incoming years fostered by the growth of both the internal and global demand.

## FOCUS ETHYLENE

Ethylene (IUPAC name: ethene) is a hydrocarbon a colourless flammable gas and it is a simple alkene. It is the building block of polyethylene (PE), which is the largest used plastic in the world but represents also a key component to produce other type of plastics such as Polyvinyl Chloride (PVC), polyester (PS) and polyethylene terephthalate (PET). Since plastics are present almost everywhere in our daily life the global demand has grown constantly in these years, led by the demand of emerging economies such those of China and India which are both experiencing an increase in their GDP level, internal consumption and GDP/per capita, and ethylene is benefiting from this growing demand consequently.

In 2020 the global demand reached 367 million tonnes remaining stable in comparison with 2019 despite the COVID19 pandemic<sup>6</sup>. Considering more specifically ethylene it is evident that the demand is following the same pattern, however its most promising markets do not include Europe.

As shown by the graphs below the European demand of Ethylene has decreased since 2013 but the same trend does not apply to the plastics demand, which remained stable<sup>7</sup>. It can be seen an attempt of European countries to move away from ethylene-based plastics in recent years, this pattern is related to the new policies implemented continentally aimed at reducing the use of non-recyclable plastics<sup>8</sup>.



**Figure 11:** World Ethylene Demand. Source: RINA-C Elaborations based on Global-Business-Lead-Olefins

The global production is not dissimilar from the global demand's trends, due to the forecasted increase of plastics use in the future by developing countries who are fostering their internal production. Asia today is the main producer of ethylene followed by North America and Middle East, while, in Europe, the ethylene production has suffered and after the drop caused by the economic crisis in 2008 it never really recovered<sup>9</sup>.

From the European point of view the main ethylene's producers are Germany, the Netherlands, Belgium and France.

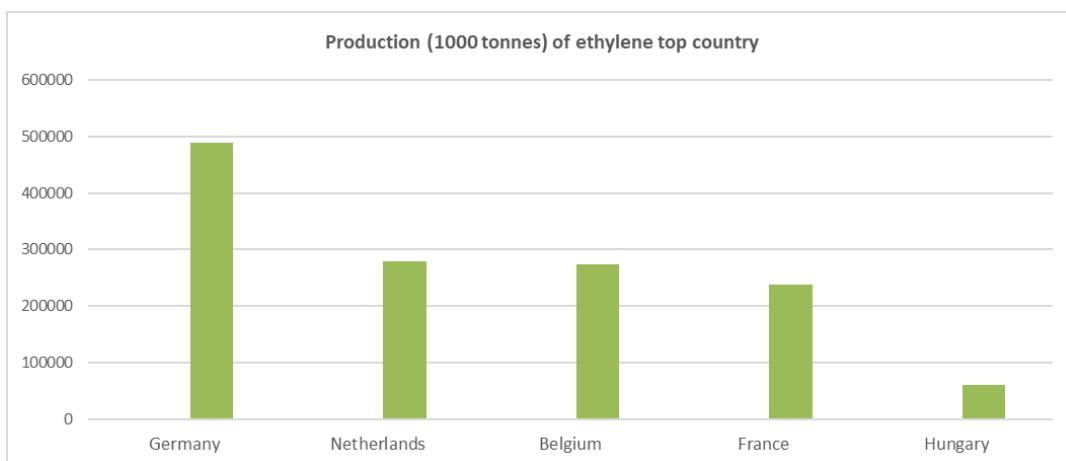
<sup>5</sup> <https://www.transparencymarketresearch.com/carbon-monoxide-market.html>

<sup>6</sup> Plastic Europe

<sup>7</sup> <https://www.climateforesight.eu/global-policy/the-future-of-plastics-is-uncertain/>

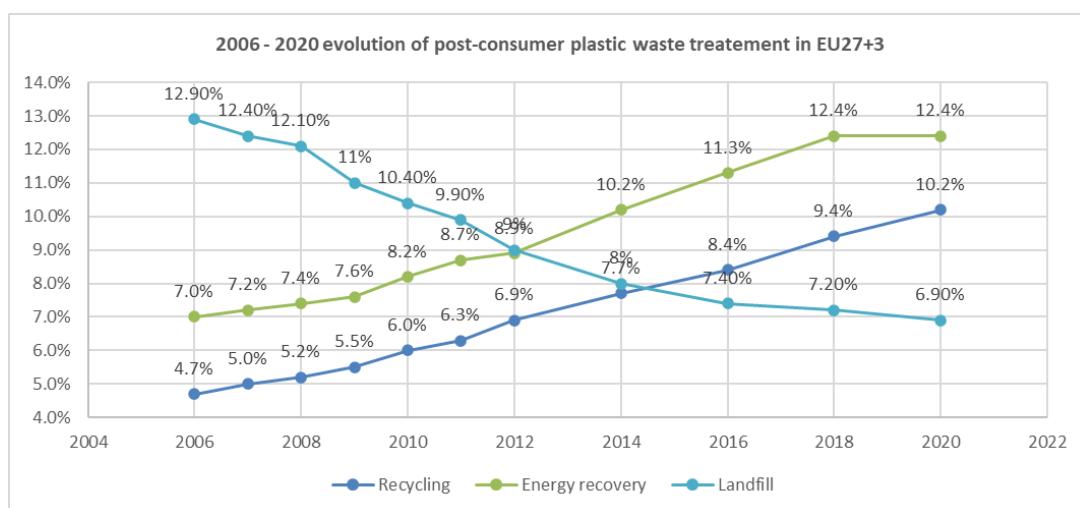
<sup>8</sup> [https://www.researchgate.net/figure/World-Ethylene-Demand-source-Global-Business-Lead-Olefins\\_fig1\\_315685250](https://www.researchgate.net/figure/World-Ethylene-Demand-source-Global-Business-Lead-Olefins_fig1_315685250)

<sup>9</sup> <https://www.petrochemistry.eu/about-petrochemistry/petrochemicals-facts-and-figures/european-market-overview/>



**Figure 12:** Top countries for production of ethylene. Source: RINA-C Elaborations based on NationMaster

Plastics represents one of the most important industries in Europe, ranking 8<sup>th</sup> in terms of industrial value added. It employs 1.5 million people across the continent, and it has an estimated turnover of around 330 billion €. Despite these large volumes, the average of employers for companies is 29, therefore the largest part of this sector is composed of Small and Medium Enterprises (SMEs)<sup>10</sup>. The European commitment towards a more sustainable plastic sector is clearly demonstrated by the statistics presented in the graph below. As it is possible to see the decrease of plastic waste sent to landfill has been steady through the years recording an overall 46.4% reduction since 2006. On the other hand, there is the management of recyclable plastic wastes, which is characterised for a 34.6% by the direct wastes recycle and for another 42% by the employment of these wastes for energy recovering. Both these new practices are fostering the collection of plastic wastes which passed from 24.5 million of tonnes in 2006 to 29.5 million of tonnes in 2020<sup>11</sup>.



**Figure 13:** Evolution of Post-consumer plastic waste treatment in EU27+3 between 2006 and 2020. Source: RINA-C Elaborations based on Plastic Europe data

## FOCUS ETHANOL

Ethanol ( $C_2H_5OH$ ) is a volatile, flammable, colourless liquid which has multiple applications across several industrial sectors and which can be produced in different ways, the most common of those is the fermentation of sugars. Ethanol represents a key element of new and renewable technologies in fuels industry: for instance, it is used as an additive in petrol to create more sustainable fuels (E5; E10; E85; ED95).

<sup>10</sup> Plastic Europe

<sup>11</sup> Plastic Europe

It is also an important element for the food industry since it has a key role in different recipes, specifically in drinks and desserts. The use of ethanol in different industrial sectors is also an important characteristic of ethanol's market, in fact, due to its sustainability, it is widely present in various products such as cosmetics, pharmaceutical, solvents, paints and de-icing fluids.

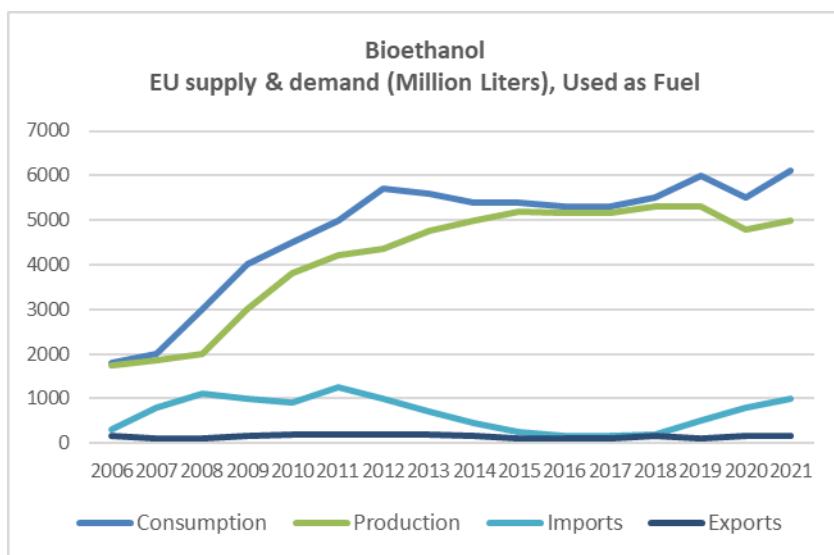
The total European ethanol production in 2020 represented **4.8% of the total global production**, ranking third behind the global market leaders, which are the US and Brazil that together, own the 83% of the global market. The feedstocks most used for ethanol production in Europe are sugar beets (7.45 million MT), corn (6.35 million MT), and wheat (2.64 million MT), followed by triticale (1.04 million MT), rye (520,000 MT) and barley (450,000 million MT). Wheat is predominantly used in Belgium, Germany, France and the UK. Corn was the preferred feedstock in Hungary, where corn is abundantly available, and in the Netherlands, Spain, and the UK, where the majority of corn came from the Ukraine to provide the feedstock for ethanol plants, which are located near seaports. The inland ethanol plants in Spain uses a combination of corn and barley as the feedstock. Sugar beets and their derivatives are used for ethanol production in France, Germany, the UK, the Czech Republic, Belgium and Austria.

**Table 1:** Fuel Ethanol Production, by main producing countries (million liters). Source: RINA-C Elaborations based on US department of agriculture

Year	2014	2015	2016	2017	2018	2019	2020	2021
<b>France</b>	1,018	1,039	987	1,000	1,138	1,299	1,049	1,095
<b>Germany</b>	920	870	882	810	799	676	875	950
<b>Hungary</b>	456	591	633	633	645	689	639	640
<b>Netherlands</b>	519	563	443	532	563	570	538	570
<b>Spain</b>	454	494	328	377	522	547	487	480
<b>Belgium</b>	557	557	570	620	646	620	380	380
<b>Poland</b>	181	214	241	258	259	286	277	285
<b>Austria</b>	230	223	224	235	251	254	241	255
<b>United Kingdom</b>	329	538	658	684	443	190	127	190
<b>Total</b>	<b>5,190</b>	<b>5,165</b>	<b>5,159</b>	<b>5,373</b>	<b>5,497</b>	<b>5,281</b>	<b>4,747</b>	<b>5,000</b>

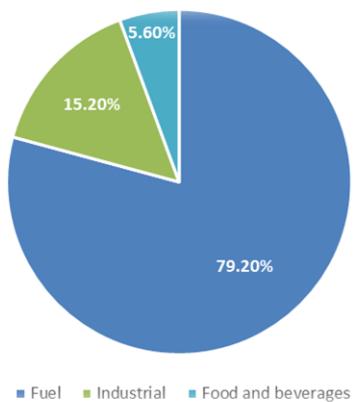
In Europe, there are **57 first-generation ethanol plants** with a total nameplate **capacity of 8.15 billion litres**, which are operated at 58% capacity. There are also 3 lignocellulosic ethanol plants with a total nameplate capacity of 90 million litres. However, these second-generation ethanol plants operate at only 28% capacity. Five other lignocellulosic ethanol plants are under construction in Finland (sawdust, 10 million Litres per year), Italy (biomass, 28 million litres per year), Austria (wood sugars, 30 million litres per year), Romania (wheat straw, 65 million Litres per year) and Bulgaria (corn stover, 50 million Litres per year). All of these plants are expected to be in operation soon. The ethanol **production in the EU in 2020 was 5.47 billion litres**. Due to the COVID-19 pandemic, ethanol consumption in the EU has decreased by 10.1%. However, this number was still slightly lower than the 13.0% decrease in gasoline consumption.<sup>12</sup> An exhaustive recap of the European ethanol market is provided in the figure below.

<sup>12</sup> Hoang, T.-D.; Nghiem, N. Recent Developments and Current Status of Commercial Production of Fuel Ethanol. Fermentation 2021, 7, 314. <https://doi.org/10.3390/fermentation7040314>.



**Figure 14:** Bioethanol – EU supply and demand (in million liters), used as fuel. Source: RINA-C Elaborations based on US department of agriculture.

France is the leading **producer** of ethanol in Europe, accounting for 32% of the European ethanol production, slightly more than Germany which ranks second. Two thirds of French output are used in the biofuel market (bioethanol) while the remaining third goes to more classic applications (drinks, perfume, pharmaceuticals, and other industries). Germany, from its side, is the leading country for ethanol consumption in the continent right above the UK and France. Almost the **80% of the ethanol produced in Europe is destined to the fuels sector** in which it plays a pivotal role as additive to the E5 and E10 biofuel. The remaining part is used in the industrial sector and in the food and beverage industry<sup>13</sup> (see the graph below).

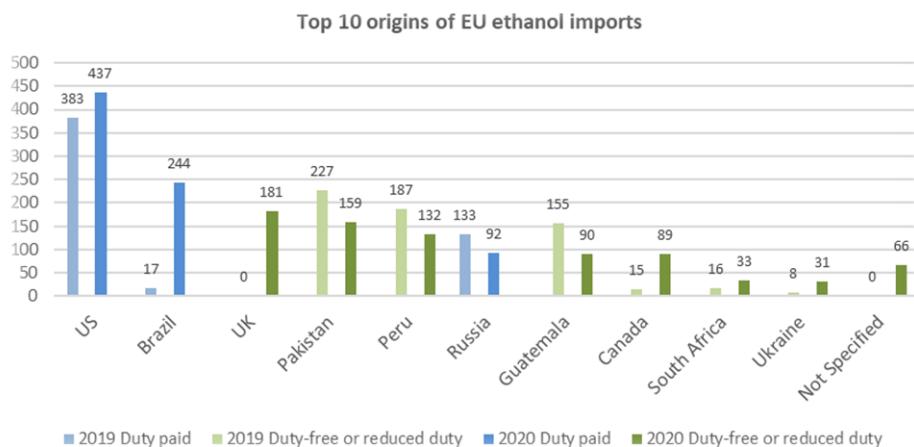


**Figure 15:** Ethanol sectors of destination (%)- Source: RINA-C Elaborations based on EPure infographics

**Production** has been estimated to have recovered in **2021 (5000 million litres)** with an anticipated increase in demand. However, to what extent production will rebound alongside consumption will depend on the competition from third country imports. Anticipating increased competition from U.S. and Brazilian exports in the expanding UK market, French production is not expected to rebound to production levels achieved in 2019. Additionally, Belgian production is also not expected to return to 2019 levels because of the 20 expectations of continued high prices for grains. In Germany, production is forecast to improve based on an expected large increase in domestic consumption and an increase in production capacity. Total EU ethanol production capacity, for fuel, industry and food uses, is

<sup>13</sup> Epure infographic

estimated at roughly 10 billion litres in 2021, with nearly 8.2 billion litres of capacity allocated for fuel ethanol (bioethanol)<sup>14</sup>.



**Figure 16:** TOP 10 Countries in terms of origins of EU ethanol imports. Source: RINA-C Elaborations based on EPure infographics

### 3. MAIN END SECTORS FOR SELECTCO2 TECHNOLOGY APPLICATION

The ultimate goal of the SELECTCO2 project is to take advantage of the increasingly lower power costs derived from renewable electricity and use this to create a process where the consumption of CO<sub>2</sub> is made to produce three specific high value products: CO, ethanol and ethylene.

In particular, the following are examples of other chemicals for other industrial markets, which it is possible to reach thanks to the chemical industry's well-established processes used on the abovementioned three specific products:

- Through CO production it is possible to generate hydrocarbons (via Fisher-Tropsch) which may be applied into the fuel sector; polyurethane (produced with CO via phosgene) which finds application in a wide range of sectors from the construction sector in the form of heat-insulating panels, in the heating and cooling sector inserted directly in the body of heat exchanger or in the fridge structures, and reductant employed in the steel industry.
- Ethanol through its production it is possible to generate antiseptics and other substances useful in the medical sector, fuel (via fuel cell or combustion) and solvents which find application in paints, consumer goods etc.
- Ethylene allows to produce products for the plastic sector (PE, PVC, PET etc), surfactants (via ethylene oxide) which find various applications, for example in detergents, emulsifiers, inks, paints; anti-freeze to be applied in the engine, fuel and automotive sectors.

So, it is possible to say that SELECTCO2 technologies will allow these products to have a substantial impact on the chemical markets and mitigate CO<sub>2</sub> emissions. In particular this commitment to the climate change mitigation will be directly transferred to the final consumer because, as just illustrated at a high level, the chemicals produced via SELECTCO2 will be further converted to plastics, cosmetics, pharmaceuticals, detergents, antiseptics, recreational drinks etc.

In light of all these considerations, it is possible to say that SELECTCO2 technologies may be applied to all the key sectors composing the chemical sector: Commodity chemicals, specialty chemicals, pharmaceuticals, agrochemicals and consumer products, which may be considered as customer sectors, for the SELECTCO2 technology.

<sup>14</sup> Required Report: Required - Public Distribution Date: June 22, 2021 Report Number: E42021-0053 Report Name: Biofuels Annual Country: European Union Post: The Hague Report Category: Biofuels (US Department of agriculture/GAIN Global agriculture information network)

It is important to underline that commodity chemicals includes petrochemical and polymers sector, and this is the reason why commodity chemicals and specialty chemicals will be described in the following section summarizing their market trends. Considering **Figure 1**, in fact, these two categories represent together 73.5% of the European chemical sales. The aim of these sections is to provide information about the situation of the market to which the SELECTCO2 technologies may play an important role in terms of products produced in a more sustainable way thanks to the green production of their mother-products.

## COMMODITY CHEMICALS

Commodity chemicals are categorized based on their chemical compositions. They represent a great part of the chemicals industry, and they comprise polymers, plastics, synthetic fibers and petrochemicals<sup>15</sup>. As shown in **Figure 1**, petrochemicals and polymers (which includes plastic as main contributing sub-sector) together represent almost 45% of the European chemicals sales in 2020.

Petrochemical end markets in 2022 were subject to demand shocks. Consumer packaged goods, which represent the main sub-market of petrochemical sector, during pandemic showed a great increase due to the home and e-commerce consumption and for the drastically increase demand for personal hygiene and cleaning products, which boosted in turn also a greater demand for packaging<sup>16</sup>.

The global petrochemical market is estimated to reach 860.8 USD billion by 2028, and it is expected to further grow at a CAGR of 6.4% from 2021 to 2028. The market is being driven by the always increasing demand for specialty chemicals and plastic manufacturing and to be subjected of the increasing demand from end-use industries such as construction, industrial, textile, medical pharmaceuticals, consumer good automotive and electronics. In 2020, ethylene became the dominant product segment representing more than 40.7% of the total revenues obtained by the petrochemical sector. It is the most utilized element in the production of many derivatives such as ethylene oxide, polyethylene etc<sup>17</sup>.

Petrochemicals are also responsible for the production of sustainable solutions to energy savings and comfort, such as for example, insulation, durable lightweight and resistant composites, etc. Moreover, it is important to highlight those petrochemicals are an important starting point of almost all chemicals value chains<sup>18</sup>. Also, plastic is part of the commodity chemicals. The European plastics industry is the 8<sup>th</sup> most important industry in Europe in terms of value-added contribution<sup>19</sup>. In the two figures below the global and European plastic production from 2016 to 2020 is provided.

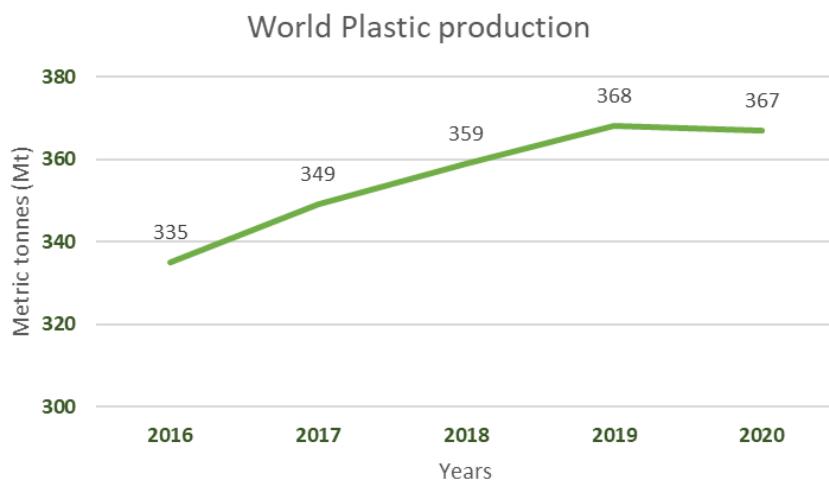
<sup>15</sup> <https://www.predictiveanalyticstoday.com/what-is-chemical-industry/>

<sup>16</sup> McKinsey&Co, (2021), "Petrochemicals 2020: A year of resilience and the road to recovery".

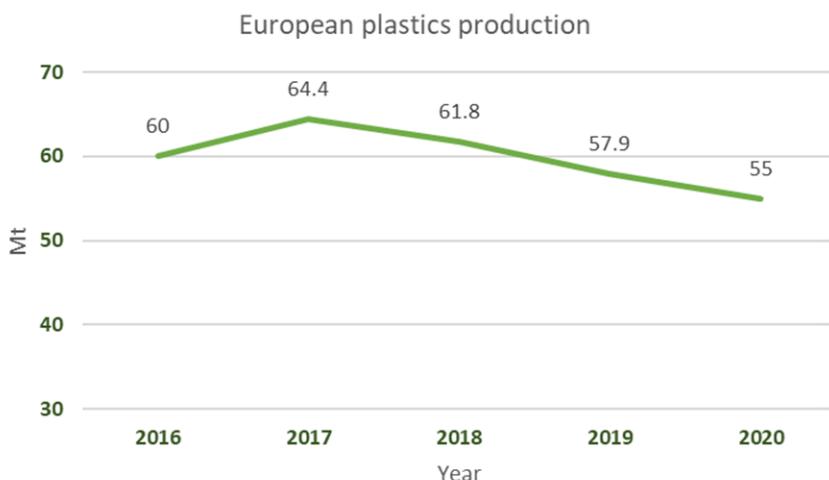
<sup>17</sup> Reportlinker, (2021), "Petrochemicals Market Size, Share & Trends Analysis Report By Product, By Region And Segment Forecasts, 2021 – 2028"

<sup>18</sup> Petrochemicals Europe, (2019), "Situation and Outlook for the European Petrochemical industry".

<sup>19</sup> Plastics Europe (2021) "Plastics – the Facts 2021".

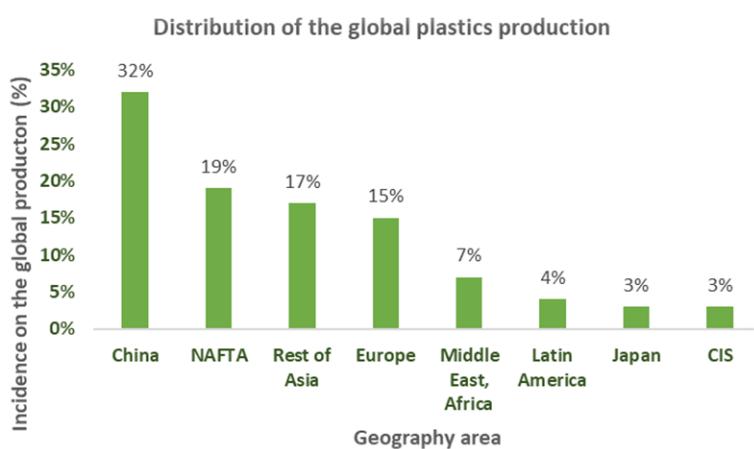


**Figure 17:** World Plastic Production. Source: RINA-C Elaborations based on PlasticsEurope

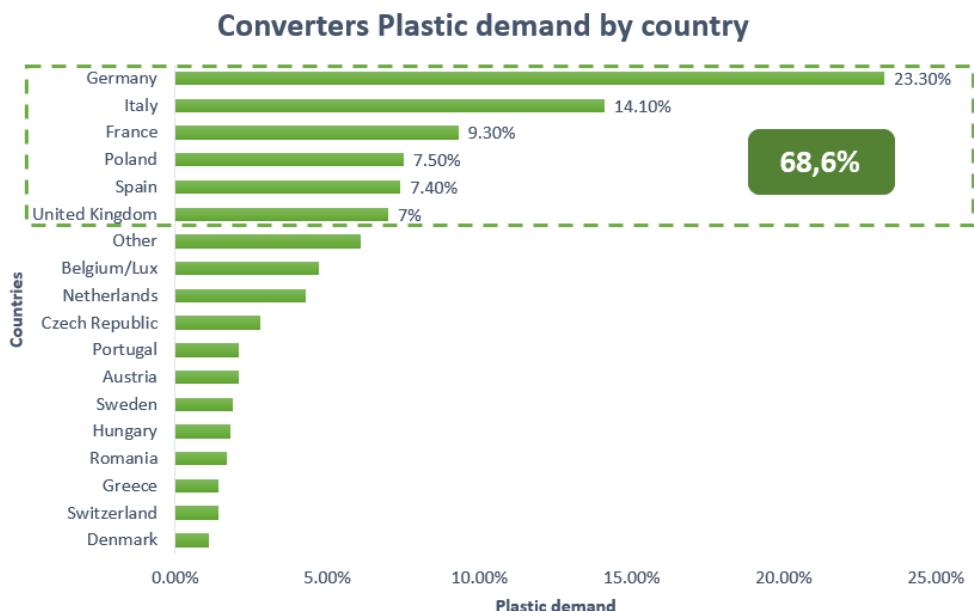


**Figure 18:** European plastic production. Source: RINA-C Elaborations based on Plastic Europe

Europe represents about 15% of the world plastic production, and the fourth geographic area after China, NAFTA countries and Rest of Asia (see **Figure 19**).

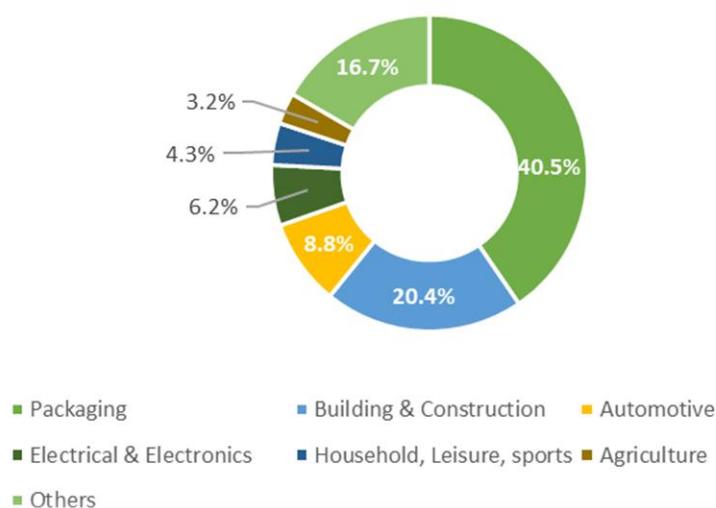


**Figure 19:** Distribution of the global plastics production (year 2020). Source: RINA-C Elaborations based on Plastic Europe



**Figure 20:** Converters Plastic demand by country. Source: RINA-C Elaborations based on Plastic Europe

As it possible to observe from **Figure 20**, Germany is the main country, accounting for 23.30% of the European plastic demand, followed by Italy corresponding to the 14.10%, France (9.30%), Poland (7.50%), Spain (7.40%) and United Kingdom (7%). This first six countries account for almost the 70% of the total European plastic demand.



**Figure 21:** EU27+3 converters plastics demand by segments 2020. Source: RINA-C Elaborations based on Plastic Europe

Packaging and building and construction are the main demand end-sectors representing respectively 40.5% and 20.4% of the total plastic demand, followed by the Automotive sector representing the 16.7%. In 2020, almost 10.2 million tonnes of postconsumer plastic waste were collected and sent to recycling facilities inside and outside Europe. In 2021, plastic producers planned significant investments in chemical recycling technologies – ramping up from EUR 2.6 billion in 2025 to EUR 7.2 billion in 2030<sup>20</sup>.

## SPECIALTY CHEMICALS<sup>21</sup>

<sup>20</sup> Plastic Europe 2021, "Plastics - the Facts 2021",

<sup>21</sup> IHS Markit, (2021) <https://ihsmarkit.com/research-analysis/specialty-chemicals-forecast-to-grow-in-2021.html>

Specialty chemicals are products sold for their performances, with an adjusted<sup>22</sup> global market value, in 2020, closer to 546 billion dollars.

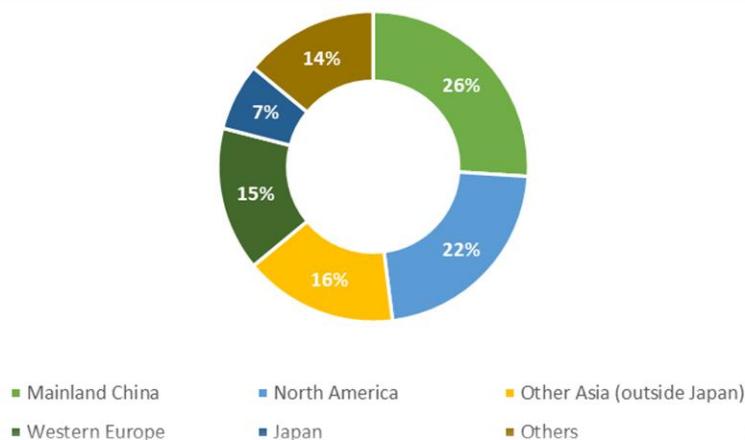


Figure 22: Main geographical area in terms of specialty chemicals consumption, in 2020. Source: RINA-C Elaborations based on HIS Markit data

Mainland China is the most consuming market of specialty chemicals, while Western Europe is fourth representing the 15% of the total specialty chemicals consumption. Specialty polymers, electronic chemicals, industrial and institutional cleaners, surfactants, and flavor and fragrances are the most sold specialty chemicals in 2020, representing 37% of the total specialty chemicals sales of the year (see figure below).

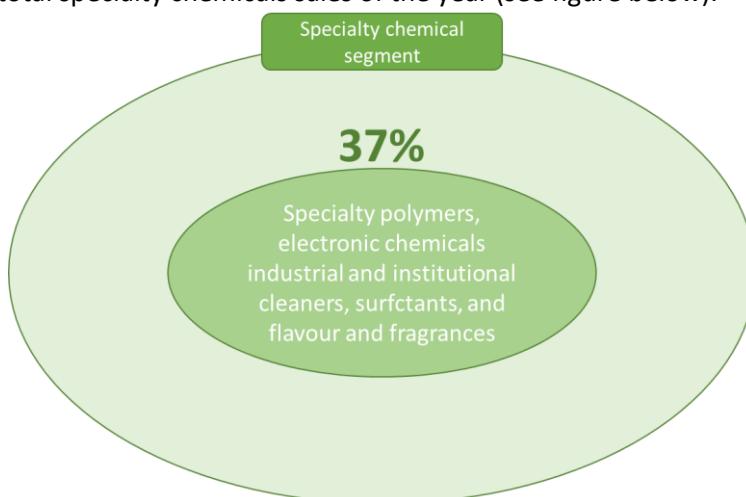


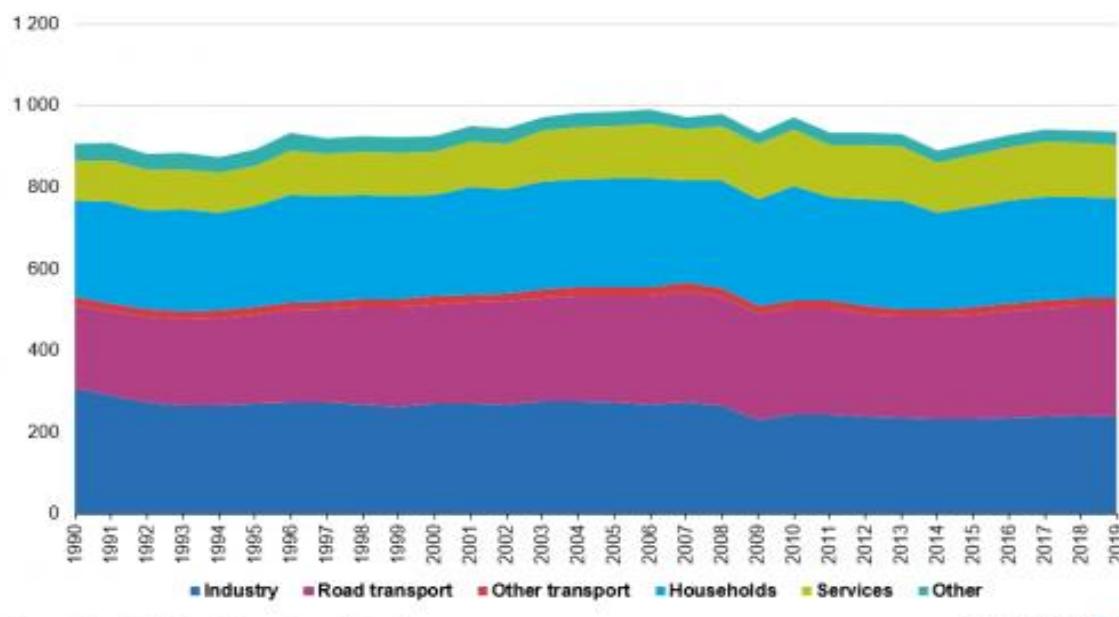
Figure 23: Main specialty chemical segment components. Source: RINA-C Elaborations based on HIS Markit data

The fastest growing segment is electronic chemicals followed by specialty polymers, nutraceutical ingredients and cosmetics/personal care chemicals. The global specialty chemicals market value saw a decline of about 2.5% due to the COVID-19 pandemic, but it is estimated to be returned in the growing path already in 2021, and it is projected to grow at a CAGR of 3.5% reaching a market value of about 750 billion dollars by 2026.

Starting from the summary of the main end uses of the three products analysed in this document, it is not possible to not mention the fuel sector, which as it has been possible to observe in the paragraph dedicated to the focus of ethylene, represents the greatest end sector for ethylene application (see Figure 14).

<sup>22</sup> This category includes 28 specialty chemicals segments which are characterized by an overlapping nature, so HIS Markit (which is the source of this data) provided an adjustment of the market value assumption, avoiding double counting, providing the market value reported.

When talking about fuel, the obvious link has to be done with the transport sector, which as a consequence, represents the most important ethanol end user. The transport sector is today the most energy-intensive sector in Europe accounting for 31% of the total energy consumption (see Figure 28)<sup>23</sup>. As the graph below shows the usage of energy by the transports industry has remained constant in the last two decades.



Source: Eurostat (online data code: nrg\_bal\_c)

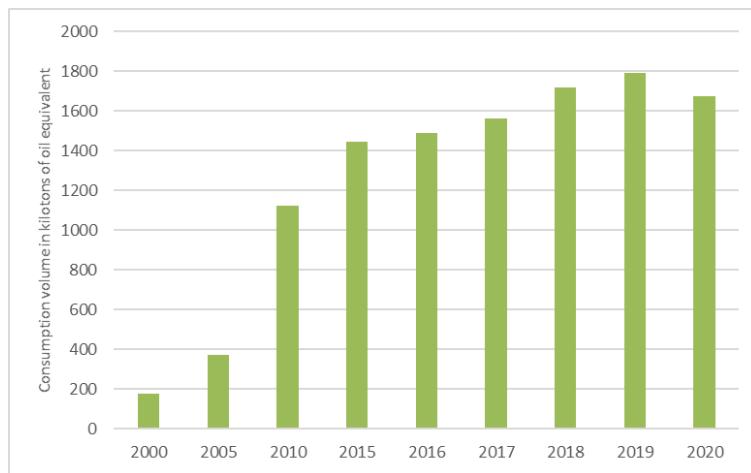
eurostat

**Figure 22:** Final Energy consumption by sector, EU, 1990-2019. Source: RINA-C Elaborations based on Eurostat

In the context of today's decarbonization strategy the role of fuel has also changed with an always increasing tendency to become more sustainable in order to mitigate the environmental impacts, and here, in this context, is biofuels. In 2020, global biofuel production levels reached 1,677 thousand barrels of oil equivalent per day, showing a great increase if compared to the 187 thousand barrels of oil equivalent per day that was produced in 2000. This growth relies on the increasing commitment in policies that encourage the use and production of biofuels due to the perception that it could provide energy security and reduce greenhouse gas emissions in relevant sectors. Biofuels can be beneficial due to its limited environmental impacts in comparison to fossil fuels as well as its consumption of waste materials that would normally be discarded. Blending mandates, sustainability criteria, fuel quality standards, and import tariffs have impacted the biofuel market. The global biofuels market is expected to reach a market value of 153.8 billion U.S. dollars by 2024.

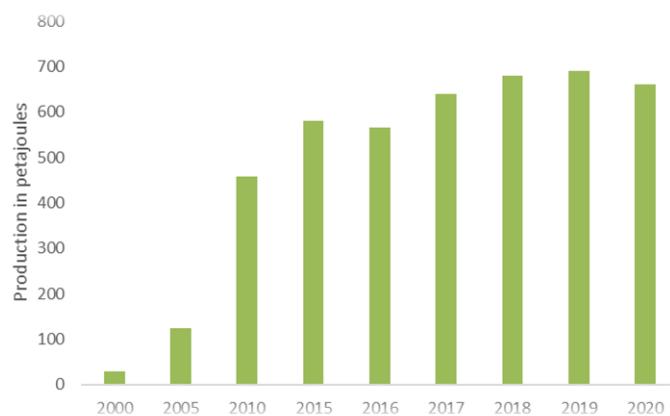
<sup>23</sup>

[https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Final\\_energy\\_consumption\\_by\\_sector,\\_EU-27,\\_2018\\_\(%25\\_of\\_total,\\_based\\_on\\_tonnes\\_of\\_oil\\_equivalent\).png](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Final_energy_consumption_by_sector,_EU-27,_2018_(%25_of_total,_based_on_tonnes_of_oil_equivalent).png)



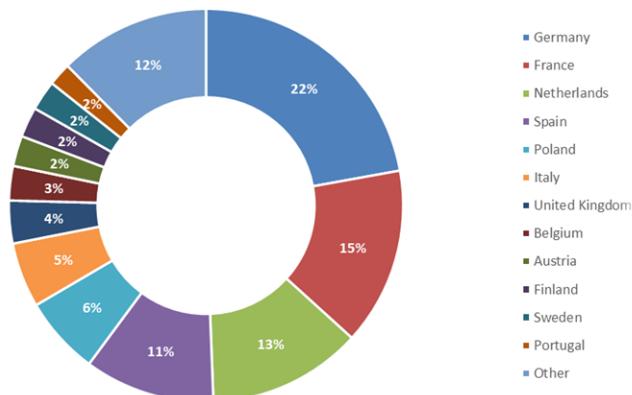
**Figure 24:** Biofuel production worldwide from 2000 to 2020. Source: RINA-C Elaborations based on Statista

Biofuel production in Europe amounted to approximately 660 petajoules in 2020, showing a decrease by about 4.4% if compared to the previous year. Analyzing the period between 2000 and 2020 the European biofuel production increased by 631 petajoules, reaching a peak in 2019 at nearly 691 petajoules (see figure below).



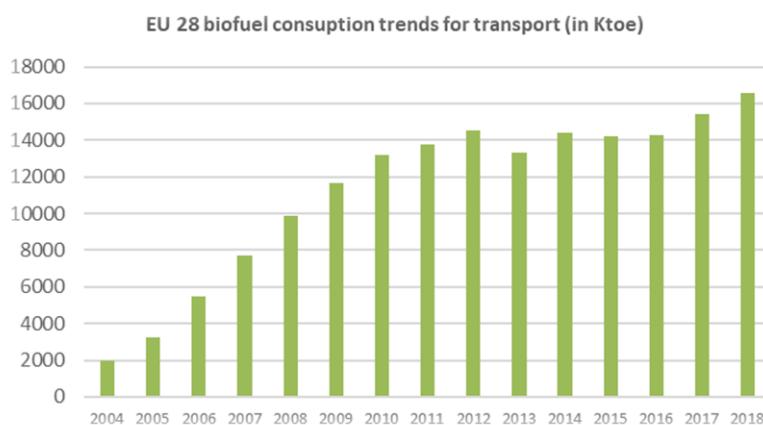
**Figure 25:** Biofuel production in Europe and CIS from 2000 to 2020. Source: RINA-C Elaborations based on Statista

In the figure below, the biofuel production in Europe by leading countries in 2020 is provided. The first biofuel producer is Germany, which represents the 22% of the total biofuel production, followed by France (15%) and Netherlands (13%).



**Figure 26:** Biofuel production in Europe, in 2002 by leading countries. Source: RINA-C Elaborations based on Statista

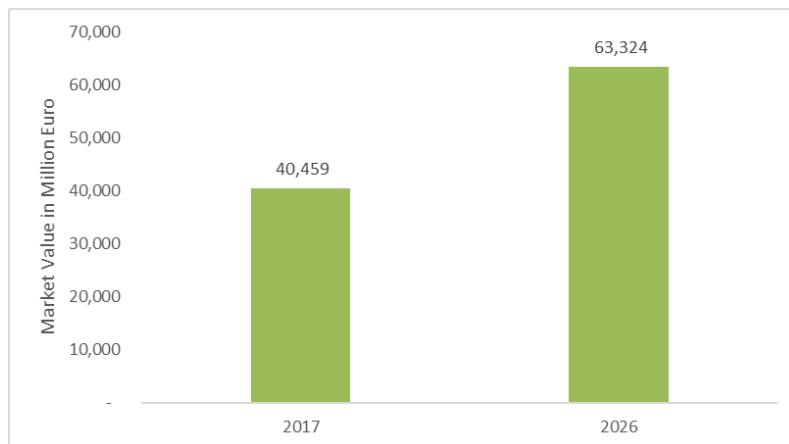
As the graph below shows the European consumption of biofuels followed the same increasing path of the production figures, showing a rapid growth since early 2000s and today biofuels are the most used alternative energy source employed by the transportation sectors. Biofuels have been used to substitute older sources of energies which were too polluting and environmentally dangerous, however the transports industry are still underusing renewable energy sources (see Figure 29) therefore it is likely to see an increase in the next years.



**Figure 27:** EU28 Biofuel consumption trends for transport (in ktoe). Source: RINA-C Elaborations based on EUrObserv'ER 2019

The European market of biofuels is projected to reach a market value of 63.2 Million € by 2026 growing at a CAGR of 5.18% up from 45.2 billion U.S. dollars in 2017<sup>24</sup>.

<sup>24</sup> Inkwood Research; (2019), "Europe biofuels & biodiesel market"



**Figure 28:** Market size of biofuels and biodiesel in Europe in 2017, with a forecast for 2026. Source: RINA-C Elaborations based on Statista

At the end of this overview about the main end-markets for the technology application, it is worth mentioning the benefits that the technology may bring to society at different levels from final consumers of the products to the industrial end-users, so the industrial player who will choose to employ the technology inside their production processes, by identify other important needs for them and how the technology meets these needs. The key information are summarized in the chart below:

Other important needs of the end users	How the technology answers to them
To feel part of the process of mitigation of the climate change	The chemicals deriving from SELECTCO2 technology will be converted in final products used by the end user. A good communication during marketing phase may directly engage the customers into the climate change mitigation process
The final end users need to be sure to use safe products for their health	Using SELECTCO2 technology without a non-fossil-based source of carbon will assure the customers of the lack of potential hazardous elements in the product
Distance from the industrial centre	The SELECTCO2 Technology is scalable so usable also for those who are not so near the centres of supply of chemicals

#### 4. COMPETITIVE ANALYSIS

The electrochemical reduction of CO<sub>2</sub> is not the only attempt to convert the chemical sectors into a more sustainable industry. The H<sub>2</sub> power-to-chemical process is another raising an approach which employs hydrogen as key energy sources. The production of hydrogen is nowadays a mature technology and through the electrocatalytic methods it produces energy, which can be used to eliminate the emission generated from the combustion of petrochemical sources. However, one of the important differences between electrochemical CO<sub>2</sub> reduction and H<sub>2</sub> power-to-chemical is that the first one requires a single step to produce renewably sourced hydrocarbons<sup>25</sup>. The data concerning the employment of these two technologies across Europe are not available, so it is impossible to clearly define how big is the market share of each approach. However, the chemical sector will surely convert its production in a more sustainable way in the future, therefore the prospective for SELECTCO2's technology is positive regardless. Below in this section are listed the most important producers of ethanol, ethylene, and carbon monoxide in Europe, it is worth noticing that most of these competitors are multinational companies with sites spread across the entire continent and, sometimes, even globally.

<sup>25</sup> Towards an accelerated decarbonization of chemical industry by electrolysis Magda H. Barecka Cambridge Centre for Advanced Research and Education in Singapore, CARES Ltd. 1 CREATE Way, CREATE Tower #05-05, 138602 Singapore

## ETHANOL

**Table 2:** Competitors factsheet: European ethanol plants. Source: RINA-C Elaborations based on IEthanol and ePure information and companies' websites.

Company	Description
<b>Kraul &amp; Wilkening u. Stelling GmbH</b>  <b>Kraul &amp; Wilkening u. Stelling GmbH, Lohweg 39 / D-30559 Hannover</b> e-mail: <a href="mailto:info@kwst.com">info@kwst.com</a> Website: <a href="https://kwst.com/">https://kwst.com/</a>	The family company Kraul & Wilkening u. Stelling GmbH has been producing and purifying alcohol of the highest quality for over 160 years. The company owns 5 distillation plants which operate for 330 days out of the year. The plants produce highly purified neutral alcohol from grain, sugar beets and sugar cane reaching a capacity of over 80,000 m <sup>3</sup> per year. Today KWST is one of the largest Ethanol producers in Germany. Its main customers range from the spirit and cosmetics industry to companies from the chemical and pharmaceutical industry as well as paint, foil and plastics producers. They supply ethanol of agricultural origin for a various range of applications.
<b>INEOS</b>  <b>Ineos Herne, Shamrockstraße 88, Herne 44623, Germany</b> Website: <a href="https://www.ineos.com/">https://www.ineos.com/</a> Site: <a href="https://www.ineos.com/sites/herne/">https://www.ineos.com/sites/herne/</a> Contacts: INEOS Solvents Germany GmbH Römerstraße 733, 47443 Moers, Germany T: 0049 2841 490 E: <a href="mailto:info.solvents@ineos.com">info.solvents@ineos.com</a>	INEOS is a multinational company with 61bln € of turnover, 26,000 employees and 194 sites spread in 29 countries around the globe. The section INEOS solvents is the branch, which works on ethanol in the Herne site. The plant comprises 16 hectares and it produces 229 KT of synthetic Ethanol employing 135 people. The first ethanol plant started production in 1959. INEOS synthetic ethanol can be blended with a variety of denaturants to meet specific customer requirements. Herne site also produces DEE, a high-quality C2 derivate. In addition, IPA and peroxides are produced in Herne as well. The products are in line with EN ISO 9001 and 14001 as well as Kosher Certificates. INEOS products are present in disinfectants and defrosters, in perfumes, deodorants and after shaves, but also in inks, tires and gloves. They are also used as pharmaceutical extractants and many applications more.
<b>Caviro Extra SpA</b>  <b>Via Convertite, 8 48018 Faenza (RA) Italy</b> E-mail: <a href="mailto:caviroextra@caviroextra.it">caviroextra@caviroextra.it</a> Website: <a href="https://caviroextra.it/en/business-unit/extra-alcoli#edoardo_pasquali">https://caviroextra.it/en/business-unit/extra-alcoli#edoardo_pasquali</a>	Caviro is the largest producer of wine in Italy, it had a turnover of 390 million € in 2021 with a net profit of 8.7 million €. In order to implement a virtuous cycle of circular economy the Caviro group financed a spin-off named Caviro Extra focused on sustainability. The goal is to make Caviro's industrial process entirely green through the best available technologies. Caviro Extra, thanks to its Alcohols Division, has the largest production capacity for ethyl alcohol in Italy which amounts to 90 million of liters in Faenza's plant. With its products, all of agricultural origin, it responds to the needs of all sectors of ethyl alcohol use - pharmaceutical, food, cosmetics, industrial - and at the same time, through the development of advanced bioethanol used to produce energy, it offers a natural alternative fuel for bio-stoves and bio-fireplaces.
<b>Stock Baltic Distillery</b>  <b>GARTENWEG 1. 18334 DETTMANNSDORF</b> Website: <a href="https://www.baltic-distillery.de/">https://www.baltic-distillery.de/</a>	Stock Spirits Group acquired and founded Baltic Distillery GmbH on 26 July 2012. The distillery at Brennerei Dettmannsdorf, near Rostock in North Eastern Germany, originated in 1900, when three farming estates joined forces to found a potato flake factory and distillery. A new state-of-the-art plant commenced production in 2005, including a grain storage unit, a heating house for steam generation, a carbonic acid recovery building, an ethanol store with capacity to hold 1 million litres, production hall and office building. The distillery's production capacity of 20 million litres of ethanol per annum supplies the manufacturing plants in Poland and the Czech Republic, ensuring control over the supply of our primary raw material to the highest quality standards.
<b>Teresos</b>  Address: <a href="#">Moussy-le-Vieux, France</a>	Tereos is a multinational company funded in France in 1932, today it has 3200 employees and its sales revenues amount to 4.3 billion €, the 20% share of the revenues derives from ethanol market which is the second most profitable sector for the company. Tereos has been active in the alcohol market for almost 100 years. It possesses unique know-how and experience that positions it as a major player in the sectors of traditional alcohol and ethanol, both in Europe and in Brazil. Tereos produces the 43% of French ethanol. Considering that France is the leader in this sector within the European countries this reinforce further

<p><b>Website:</b> <a href="https://tereos.com/">https://tereos.com/</a></p>	<p>Tereos's role as a leader into the ethanol market. Tereos's five factories spread across France produced 1684 million tonnes of ethanol during 2021. The plants are located in Artenay (Loiret), Origny-Sainte-Benoite (Aisne), Lillers (Pas-de-Calais), Morains (Marne) and Nesle (Somme).</p>
<p><b>Cristal Union</b></p>  <p><b>Address:</b> Villette-sur-Aube, France  <a href="https://www.cristal-union.fr/en/">https://www.cristal-union.fr/en/</a></p> <p><b>83, Avenue de la Grande Armée</b>  <b>75116 Paris</b></p>	<p>Cristal Union was founded in 2000 as a result of the merger of three sugar-producing agricultural cooperatives and one distillery and has remained loyal to its founding cooperative values. Today the company has 9000 cooperative members, which are represented by 120 elected members across 8 divisions, each with its own Divisional Council. Each of these bodies is represented by three elected members who sit on the Cristal Union Board of Directors. The Council validates strategic directives in collaboration with the General Manager and their management team. Cristal Union is the second largest producer of ethanol in France with an estimated production of 4 million gallons of bioethanol. The factories are all located in northern France, more specifically in Goyard, Dislaub and Arcis-Sur-Aube.</p>
<p><b>Silcompa SpA</b></p>  <p><b>Address:</b> Via Fosdondo, 71/A          42015 Correggio (RE) – Italy  <b>E-mail:</b> <a href="mailto:info@silcompa.it">info@silcompa.it</a>  <b>Website:</b> <a href="https://www.silcompa.it/">https://www.silcompa.it/</a></p>	<p>Silcompa was founded in 1925 as a winery for the production of local wines. In 1962, the company expanded its businesses by purchasing a distillery, where they began the production of ethyl alcohol from wine materials. In 1979, the company started dedicating itself exclusively to the production and distribution of ethanol of agricultural origin. In 1990 began the construction of the current plant with the creation of modern facilities for the direct production of ethyl alcohol. Today the company moves over 200,000 m³ of ethanol per year producing it in the facility of Correggio (RE) which is 40,000 m² big. It has customers in 30 countries all around the globe.</p>
<p><b>CROPENERGIES</b></p>  <p><b>CropEnergies AG</b>  <b>Phone:</b> +49 621 71 41 90-00  <b>Fax:</b> +49 621 71 41 90-04  <b>E-Mail:</b> <a href="mailto:info@cropenergies.de">info@cropenergies.de</a></p>	<p>Founded in Mannheim in 2006, the member of the Südzucker Group is the leading European producer of renewable ethanol. With a production capacity of 1.3 million m³ of ethanol per year, CropEnergies produces neutral alcohol as well as technical alcohol (ethanol) for a wide range of applications at locations in Germany, Belgium, the UK, and France. CropEnergies expects revenues in a range of EUR 1,020 to EUR 1,070 (previously expected: EUR 970 to EUR 1,010, previous year: EUR 833) million for the full financial year (2021). With four modern production sites in Germany, Belgium, United Kingdom and France, as well as two tank storage facilities in Amsterdam and Rotterdam, CropEnergies has created an efficient production and distribution network in Europe. At the Zeitz location, CropEnergies Bioethanol GmbH operates an ethanol plant with a capacity of about 400,000 m³ of ethanol, of which 60,000 m³ is high-purity neutral alcohol, more than 350,000 tonnes of protein feed and 100,000 tonnes of liquefied CO₂ per year. In Wanze, Belgium, the CropEnergies subsidiary BioWanze SA operates a next-generation ethanol plant with a production capacity of 300,000 m³ of ethanol per year making Wanze's facility the Belgium's largest ethanol plant. The activities of the plant located in Ryssen Alcohols (FR) is divided in two areas: In addition to the dehydration (drying) of raw alcohol for the fuel sector (capacity: 100,000 m³ per year), Ryssen Alcohols is a specialist in the purification (rectification) of raw alcohol for traditional and technical applications. The high-quality products are flexibly adapted to the wishes of customers in the beverage and cosmetics industries as well as the pharmaceutical and chemical industries. In this field Ryssen Alcohols has a capacity of up to 90,000 m³ of ethanol per year. In Wilton, United Kingdom, the CropEnergies subsidiary Ensus UK Ltd operates one of the largest ethanol plants in Europe. The plant has an annual production capacity of 400,000 m³ of ethanol and 350,000 tonnes of DDGS (Distillers' Dried Grains with Solubles).</p>
 <p><b>VERBIO Vereinigte BioEnergie AG</b>  <b>Ritterstraße 23</b>  <b>04109 Leipzig</b>  <b>Germany</b></p>	<p>Based in the town of Zörbig in the German region of Saxony-Anhalt, VERBIO is a leading independent bio-energy manufacturer in Europe. It has about 800 employees producing biodiesel, bioethanol and biomethane on an industrial scale at a number of sites in Germany and abroad. Every year, VERBIO's plants produce around 660,000 tonnes of biodiesel, 260,000 tonnes of bioethanol, and 900 gigawatt-hours of biomethane. VERBIO manufactures biofertilizer and animal feed for agricultural use as well as high value raw materials for the pharmaceutical, cosmetic and foodstuff industry. The plants are located</p>

<b>Tel.: +49 (0) 341 308530-0</b> <b>Fax: +49 (0) 341 308530-999</b>	<p>respectively in Zörbig and Schwedt with a capacity of 125 and 230 million liters per year</p>
<p><b>Pannonia Bio</b></p>  <p><b>Pannonia Bio Zrt.</b>  <b>H-1051 Budapest</b>  <b>Zrínyi u. 16. I/1</b>  <b>Hungary</b></p>	<p>Pannonia Bio operates a biorefinery in Tolna County, Hungary. The plant uses state of the art production processes and is a nursery for development of new bio-based technologies. From its beginnings as a bioethanol producer in 2012, the refinery has almost tripled in size and developed into a multiproduct facility. The biorefinery is the largest single site bioethanol plant in Europe, one of the most efficient refineries in the world and has a mission to mitigate climate change, it processes over a million tons of grain to produce over 500 million liters of bioethanol, hundreds of thousands of tons of protein-rich animal feed and more than 10,000 tons of corn oil each year. The refinery creates a substantial market for locally produced feed corn, making the plant a key operator in the Hungarian maize market. The company continuously seeks opportunities to strengthen local partner relations, contributing more than 500 million euros (over 156,556m HUF) to Hungary's GDP and supporting over 5,000 jobs, mostly in rural communities. Pannonia Bio is a subsidiary of ClonBio Group Limited (ClonBio), an Irish agribusiness headquartered in Dublin, Ireland.</p>

## Ethylene

**Table 3:** European Ethylene Crackers, by market share in terms of annual capacity. Source: RINA-C Elaborations based on Petrochemicals Europe

Company	Site	Capacity Kt ethylene/year (2019)	Total annual capacity per company	Market Share
Dow	Terneuzen (Benelux)	565	3065	12%
	Terneuzen (Benelux)	580		
	Terneuzen (Benelux)	680		
	Boehlen (Germany)	565		
	Tarragona (Spain)	675		
Ineos Olefins	K-Worringen (Germany)	946	2206	9%
	Rafnes (Norway)	560		
	Grangemouth (UK)	700		
LyondellBasell	Berre (Aubette) (France)	470	1910	8%
	Munchmunster (Germany)	400		
	Wesseling (Germany)	305		
	Wesseling (Germany)	735		
BASF	Antwerp (Benelux)	1080	1700	7%
	Ludwigshafen (Germany)	220		
	Ludwigshafen (Germany)	400		
Versalis	Dunkerque France)	380	1840	7%
	Brindisi (Italy)	440		
	Priolo (Italy)	530		
	Porto Marghera (Italy)	490		
Repsol	Sines (Portugal)	410	1214	5%
	Puertollano (Spain)	102		
	Tarragona (Spain)	702		
<b>Sabic Europe</b>	Geleen (Benelux)	1310	1310	5%
Shell	Moerdijk (Benelux)	910	1220	5%
	Wesseling (Germany)	310		
<b>TOA</b>	Antwerp (Benelux)	550	1160	5%

	Antwerp (Benelux)	610		
ExxonMobil	NDG (France)	425	1195	5%
	Fife (UK)	770		
Borealis	Porvoo (Finland)	400	1025	4%
	Stenungsund (Sweden)	625		
BP	Gelsenkirchen (Germany)	1073	1073	4%
MOL	Tiszaújváros (Hungary)	380	905	4%
	Tiszaújváros (Hungary)	300		
	Bratislava (Slovakia)	225		
OMV	Schwechat (Austria)	500	950	4%
	Burghausen (Germany)	450		
Naphtachimie	Lavera (France)	740	740	3%
PKN Orlen	Plock (Poland)	700	700	3%
Sabic UK	Wilton (UK)	786	786	3%
Petkim	Aliaga (Turkey)	588	588	2%
Total	Gonfreville (France)	525	525	2%
Unipetrol	Litvinov (CZ Rep.)	544	544	2%
A.P. Feyzin	Feyzin (France)	250	250	1%
Klesch	Heide (Germany)	110	110	0%
<b>Total</b>		<b>25016</b>		<b>100%</b>

On the basis of the data provided in the table above, table below summarize the key companies in terms of market share."

**Table 4:** Competitor's factsheet: European ethylene plants. Source: RINA-C Elaborations based on information and companies' websites, reports, and statements.

Company	Description
<b>DOW</b>  <b>Dow Europe GmbH</b> Bachtobelstrasse 3 8810 Horgen   Switzerland <a href="https://www.dow.com/en-us.html">https://www.dow.com/en-us.html</a>	Dow is an American multinational company with an estimate net sale of 38,542 million dollars. It operates in 31 countries where are located 106 operative sites. In Europe the company owns five plants in which it produces a total of 3065 Kt of ethylene per year (2019). Plastics are Dow's core business since they account for almost the half of the company sales and the European plants are pivotal to supply the costumers in the continent. The ethylene' production levels make Dow one of the most important actors in Europe which is especially active in the established sectors of ethylene application such as packaging and building. Recently Dow has signed an agreement with the Swiss company Gunvor Group, Gunvor will supply cracker-ready feedstock to Dow in Europe beginning in 2021, which will be used to produce circular plastics for customers.
<b>BASF</b>  We create chemistry <a href="https://www.bASF.com/global/en.html">https://www.bASF.com/global/en.html</a> General inquiries: Phone: +49 621 60-0, email: <a href="mailto:global.info@basf.com">global.info@basf.com</a> Media Relations:	BASF (Badische Anilin- und Soda Fabrik) is a German company located in Renania, BASF is a multinational with companies in 90 countries around the world. Europe is its most important market since it accounts for 24,233 million € of sales over a grand total of 54,149 million € on a global scale. BASF is a leading company in chemical sector, and it has a very diversified sales structure, in fact the most important sales' segment is the Surface Technologies one which accounts for the 28% of total sales. The other sectors are Materials (18%), Chemicals (14%), Industrial Solutions (13%), Agricultural Solutions (13%) and Nutrition & Care (10%). The Verbund system is one of BASF's great strengths. It adds value by using the resources efficiently. The Production Verbund intelligently links production units

<p><b>Jens Fey, phone: +49 621 60-99123</b>  <b>Sustainability Relations:</b>  <b>Thorsten Pinkepank, phone: +49 621 60-41976</b>  <b>Investor Relations:</b>  <b>Dr. Stefanie Wettberg, phone: +49 621 60-48002</b></p>	<p>and their energy supply so that, for example, the waste heat of one plant provides energy to others. Furthermore, one facility's by-products can serve as feedstocks elsewhere. This not only saves raw materials and energy, it also avoids emissions, lowers logistics costs and leverages synergies. The Verbund site in Ludwigshafen, Germany, is the world's largest chemical complex owned by a single company that was developed as an integrated network. This was where the Verbund principle was originally established and continuously optimized. BASF is also planning to start the expansion of ethylene oxide plant in Atwerp (Belgium) in 2021.</p>
<p><b>INEOS</b></p>  <p><b>Marco Amici</b>  <b>Sr Business Development Manager</b>  <b>INEOS Olefins &amp; Polymers Europe</b></p> <p>T: +41 79 208 5756  E: marco.amici@ineos.com</p> <p><b>INEOS Europe AG</b>  <b>3 Avenue des Uttins</b>  <b>1180 Rolle</b>  <b>Switzerland</b></p> <p><b>Bamble and Rafnes site</b>  <b>Asdalstrand 291</b>  <b>Stathelle</b>  <b>3960</b>  <b>Norway</b>  <b>+47 35 57 70 00</b></p> <p><b>K-Worringen site</b>  <b>Koeln, Germany</b>  <b>Alte Strasse 201</b></p> <p><b>Koeln</b>  <b>DE-50769</b>  <b>Germany</b></p>	<p>INEOS is a multinational company with 61bln € of turnover, 26000 employees and 194 sites spread in 29 countries around the globe. INEOS O&amp;P is Europe's number one producer of ethylene, which is today's primary petrochemical component, used in over half of all finished petrochemicals and plastics. INEOS has the capacity to produce over 3 million tons of ethylene per year from state-of-the-art plants in France, UK, Germany and Norway - using oil and gas-based feedstocks. In Norway there is the Bamble and Rafnes site, it is home to the INEOS Rafnes cracker, principally producing ethylene which is integrated to the Bamble LDPE asset which specialises in pharma, coating, film, moulding and wire and cable applications. INEOS' Grangemouth facility is a fully integrated refining and petrochemical complex, comprising three businesses: INEOS O&amp;P UK, INEOS FPS and Petroineos (a refinery Joint Venture) At the heart of the O&amp;P UK business is the ethylene cracker, KG. The cracker produces feedstock for the two co-located polymer plants, Innovene 4 (polyethylene) and PP3 (polypropylene); as well as for the synthetic ethanol plant. Ethylene not consumed on site is also exported via a network of underground pipelines to the Northeast and Northwest of England for conversion into a wider range of (petro)chemicals or for onward export. The K-Worringen facility is located in Cologne (Germany); INEOS in Cologne is the largest chemical company and the third largest industrial employer in Cologne. With almost 2,500 employees in four business divisions, INEOS in Cologne is one of the largest locations of the INEOS Group. At the Cologne site, this is used to produce raw materials that serve the chemical industry as basic building blocks for the manufacture of plastics, rubber and fibres. They are also used in solvents and detergents, paints, fertilisers and pesticides, as well as in cosmetics and pharmaceuticals.</p>
<p><b>LyondellBasell</b></p>  <p><b>Delftselein 27E</b>  <b>3013 AA Rotterdam</b>  <b>Netherlands</b>  <b>Telephone</b>  <b>+31 10 275 5500</b>  <b>Fax</b>  <b>+31 10 275 5589</b></p>	<p>LyondellBasell is one of the largest plastics, chemicals and refining companies in the world. It sells products into more than 100 countries and is the world's largest producer of polypropylene compounds and the largest licensor of polyolefin technologies. The company has production sites in 24 countries, and it sells to more than 100. In 2020 the total amount of sales was 27,753 million € which certifies a decrease of 7 million € compared with 2019 and a more consistent decrement considering 2018 (39 million €). LyondellBasell is the fifth largest producer of ethylene in Europe with an ethylene capacity of 1.9 million tons per year. The petrochemical cluster in Berre (France) employs 1378 people and has an economic impact estimated in 369 million \$ in 2016, the site in Münchsmünster is smaller since it has 382 people employed an economic impact worth 125 million \$. The last plant is in Germany, more specifically in Wesseling. Here there are employed 2,550 employees producing 613 million \$ worth of economic impact.</p>
<p><b>Versalis</b></p>	<p>Versalis is Eni's chemical company operating globally in the basic and intermediate chemical sectors, plastics, rubbers and renewable sources chemistry. It focuses on development of an integrated technological platform in line with its strategy.</p>

 <p><b>Versalis S.p.A.</b> Registered offices <b>Piazza Boldrini, 1 – 20097 San Donato Milanese (MI) Italy</b> Tel. +39 02 520.1 <a href="mailto:info@versalis.eni.com">info@versalis.eni.com</a></p>	<p>With a total production of around 8 million tons in 2019, Versalis markets and works towards developing chemical products in its five business areas:</p> <ul style="list-style-type: none"> <li>Intermediates</li> <li>Polyethylene</li> <li>Styrenics</li> <li>Elastomers</li> <li>Biotech</li> </ul> <p>Versalis employs 5,350 people around the world and has 14 active plants, 9 of which are located in Italy and all the production sites are in Europe but one. The plant in Brindisi is one of the largest and most energy-efficient steam-cracking plants in Europe, integrated with on-site production of polyethylene and butadiene. The polyethylene unit produces two families of products (LLDPE and HDPE) for applications such as food packaging, agriculture (drip-feed irrigation) and pharmaceuticals, using technology that ensures low costs and top quality. Roughly €25 million is being invested in installing a new ground-level smokeless flare at the Versalis plant, supplied by a leading global constructor of installations of this type. The new flare will function in parallel with the existing torch to mitigate environmental impact both visually and in terms of emissions.</p>
 <p><b>SABIC</b>  <b>Address: PO Box 5151, 6135 PD Sittard, The Netherlands</b> <b>Tel: +31 467 222 222</b> <b>Fax: +31 467 220 000</b></p>	<p>SABIC (SAudi Basic Industries Corporation) is a diversified manufacturing company, active in chemicals and intermediates, industrial polymers, fertilizers and metals. It is the largest public company in Saudi Arabia since the Saudi government still owns 70% of its shares. SABIC is also the largest listed company in the Middle East. SABIC is currently the second largest global ethylene glycol producer and is expected to top the list after the introduction of new projects. SABIC is the third largest polyethylene manufacturer, the fourth largest polyolefins manufacturer, and the fourth largest polypropylene manufacturer. SABIC is also the world's largest producer of mono-ethylene glycol, MTBE, granular urea, polycarbonate, polyphenylene and polyether imide. The production of chemicals has slightly grown in 2020 moving from 37.0 million tonnes to 37.7. SABIC in Europe is headquartered in Sittard, Netherlands, and employs nearly 6,000 people. SABIC in Europe has a European-wide network of sales offices and logistic hubs, as well as five large production sites in Europe: at Geleen, Bergen, Zoom (the Netherlands), Teesside (United Kingdom), Gelsenkirchen (Germany), and Cartagena (Spain).</p>

## Carbon monoxide

**Table 5:** Competitors factsheet: European carbon monoxide producers, main players. Source: RINA-C Elaborations based on information and companies' websites, reports, and statements

Company	Description
	<p>Linde is a multinational company based in Germany since 1871. Today it is the leading player in European industrial gasses production. Its sales amount to 24 billion € in 2020 and it employs 75,000 people globally. Despite its European heritage Linde's main market is Americas where sales amount to 12 billion \$, this segment represents almost half of the company's total sales. The other key regions for Linde are EMEA (Europe, Middle East, Africa) with a total of 8 billion \$ and the Asia/Pacific area, which is worth 6 billion \$ in sales. In 2018 Linde merged with Praxair, another key player in world industry of gasses. Even though the European Commission raised concerns about the outcome of the merge on the competitiveness of the sector, the companies committed to some key actions to avoid a monopolistic scenario. These commitments made the merge acceptable for the Commission thus the acquisition of Praxair</p>

	<p>proceeded as scheduled. The merger has made Linde the global leader in the sector of industrial gasses with an important diversification in the business model. The company produces different gasses (atmospheric, rare and process gasses) and is also active in the engineering of gasses' factory and more.</p>
	<p>A world leader in gases, technologies and services for Industry and Health, Air Liquide is present in 78 countries with approximately 64,500 employees and serves more than 3.8 million customers and patients. Air Liquide's revenue amounted to more than 20 billion euros in 2020. Air Liquide is listed on the Euronext Paris stock exchange. The Gas &amp; Services is the key segment of company's market since it accounts for 19,6565 million € revenues, the other segments are global market and technologies ((579 million €) and Engineering &amp; Construction (250 million €). The most prominent market for the company is the American continent, which accounts for the 40% of the total revenues derived from gas, Europe ranks second (35%) and Asia &amp; Pacific area is third with the 22% share.</p>
	<p>Air products was founded in 1940 in Detroit (US). Today it is one of the largest companies' active in industrial gasses production. It has more than 20,000 people employed worldwide, a total sales estimated around 10.3 billion \$ and more than 750 facilities around the globe. The main market for Air products is the North America with a 41% market share, followed by Europe (26%), China (18%) and Asia (11%).</p>

## 5. SELECTION OF THE MOST PROMISING SCENARIOS FOR TECHNOLOGY APPLICATION

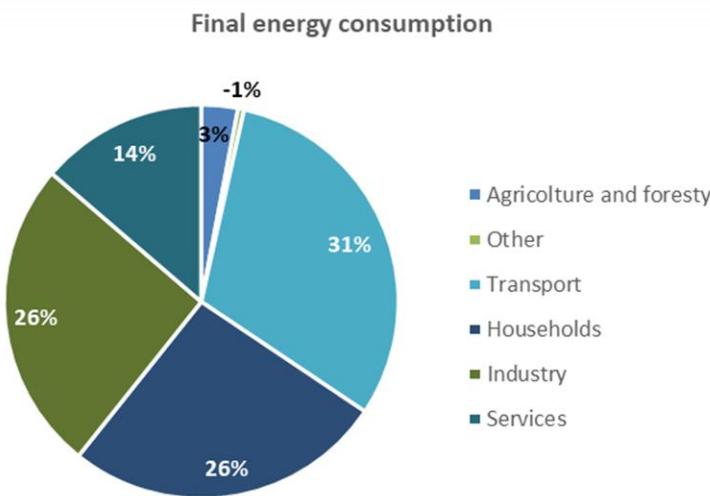
The European Union in 2019 has presented the Green Deal aimed at reducing the carbon footprint of the continent accordingly to the commitments made internationally concerning climate change. In order to achieve this goal the European Commission has decided to tackle the issue from different sides, promoting several policies all aimed at reducing the greenhouse gas emissions (GHG). From an economic point of view the Deal is a unique chance for many industrial sectors to change their business models and their production processes in a more sustainable way. This opens a lot of fruitful scenarios for new technology to meet these challenges. In fact the Commission has heavily financed research and new innovations to expand the market of sustainable technologies<sup>26</sup>. According to the Commission data the EU's long-term budget for the next seven years will provide support to the green transition. 30% of programmes under the €2 trillion 2021-2027 Multiannual Financial Framework and NextGenerationEU are dedicated to supporting climate action; 37% of the €723.8 billion (in current prices) Recovery and Resilience Facility, which will finance Member States' national recovery programmes under NextGenerationEU, is allocated to climate action<sup>27</sup>. The Commission has set the target for a complete climate neutrality by 2050<sup>28</sup>, considering a smaller span of time the Commission has committed the EU towards a reduction of at least 50% of GHG by 2030<sup>29</sup>. Biofuels will play a pivotal role in enhancing the transition since transportation is the sectors that contributes more to the European emissions accounting for more than 30% share of continental energy consumption.

<sup>26</sup> European Commission "Support Mechanisms 2021-2027" – Eco-Innovation Action Plan - [https://ec.europa.eu/environment/ecoap/about-action-plan/union-funding-programmes\\_en](https://ec.europa.eu/environment/ecoap/about-action-plan/union-funding-programmes_en)

<sup>27</sup> European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions Brussels, 14 July 2021

<sup>28</sup> The European Green Deal

<sup>29</sup> The European Green Deal



**Figure 29:** Biofuels by application. Source: RINA-C Elaborations based on EUROSTAT

Despite such a large amount of energy consumption the transportations, industry is one of the least sustainable above compared to the other sectors. In 2020 the 22.1%<sup>30</sup> of EU's energy consumption derived from renewable sources, however the transportation only used the 6.8% of this energy<sup>31</sup> relying heavily on fossil fuels. Above all, the renewable resources available in this sector biofuels are the most used one. Biofuels like bioethanol are the most used renewable energy sources by road, aviation, and waterborne transport, therefore their role in the green transition of this industry will be pivotal. In order to achieve EU's environmental goals, the percentage of renewable resources must increase, according to the Commission the transportation sector is expected to reach 28% of renewable energy sources by 2030. Such a decrease in fossil based usage would mean a GHG reduction of over 13%. Due to this scenario the European demand of Biofuels will increase in the next years, considering specifically ethanol in the fuel industry, its demand is expected to grow by 10% in 2022 due to two main factors: first the EU's commitment towards a more sustainable economy and secondly towards the reduction of COVID19's impact on economy. Such a demand will not be met only by the European production, which it is projected to increase only by the 4%.<sup>32</sup> Therefore, the European Union will have to rely more heavily on imports. As previously stated in the Ethanol section, the US and Brazil are the most important commercial partners for this industry, however the EU has clearly set a path towards a more resilient and autonomous chemical sector, therefore the Union will try to foster the internal production of ethanol rather than increase its dependency from these countries. In June 2019, the EU and Mercosur reached a political agreement. The two parties are still currently performing a legal revision of the agreed text in preparation for the final, official version of the agreement. However, several EU member states, such as France and the Netherlands, have announced that they will not support ratification due to Amazon rainforest degradation. Without support from the member states, the EC cannot sign the agreement with Mercosur. While no official text is available, the EC published a document summarizing negotiations results. For ethanol, if adopted, the EU would agree to allow 450,000 MT (570.15 million litres) duty free for chemical uses, as well as 200,000 MT (253.4 million litres) for all uses, including fuel, with an in-quota rate of one third of the MFN (most favoured nation) rate.<sup>33</sup>

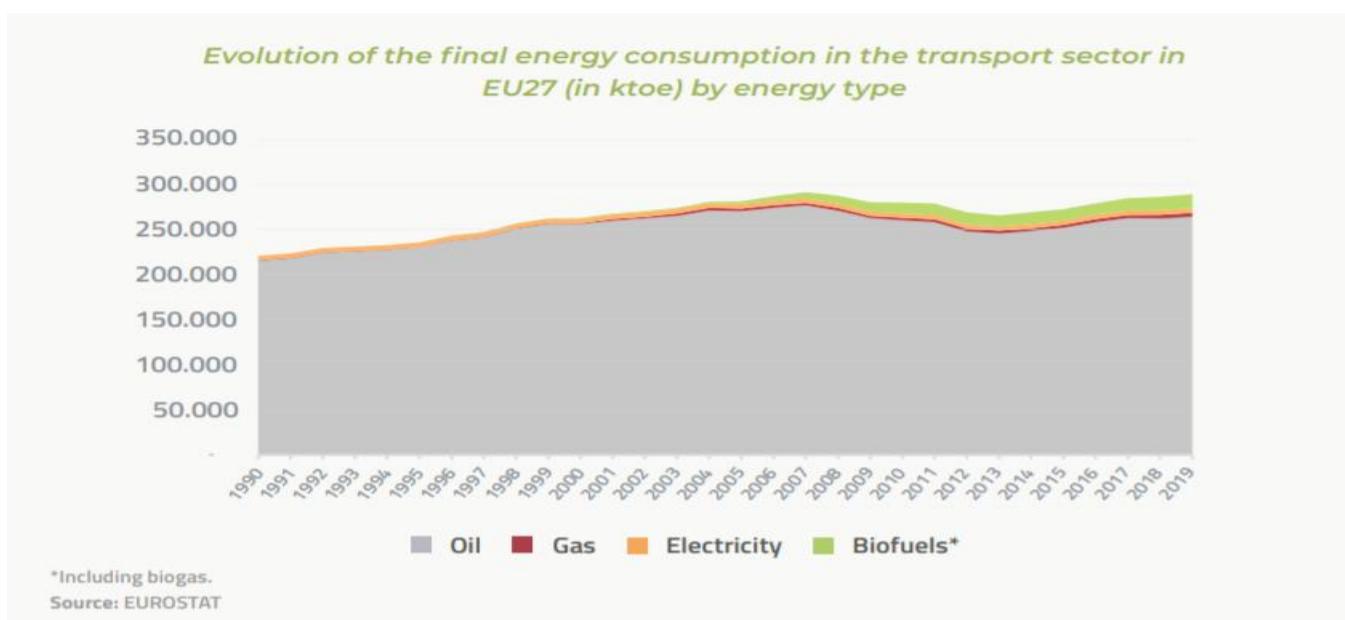
<sup>30</sup>

[https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable\\_energy\\_statistics&oldid=551416#Share\\_of\\_renewable\\_energy\\_more\\_than\\_doubled\\_between\\_2004\\_and\\_2020](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics&oldid=551416#Share_of_renewable_energy_more_than_doubled_between_2004_and_2020)

<sup>31</sup> Policy Brief: Biofuels for transport Bioenergy Europe Statistical Report 2021

<sup>32</sup> <https://www.spglobal.com/platts/en/market-insights/latest-news/agriculture/010422-commodities-2022-european-biofuel-mandates-to-structurally-shift-ethanol-demand-higher#:~:text=European%20fuel%20ethanol%20demand%20in,2020%2C%20according%20to%20Platts%20Analytics>.

<sup>33</sup> Required Report: Required - Public Distribution Date: June 22, 2021 Report Number: E42021-0053 Report Name: Biofuels Annual Country: European Union Post: The Hague Report Category: Biofuels (US Department of agriculture/GAIN Global agriculture information network)



**Figure 30:** Evolution of the final energy consumption in the transport sector in EU27 (in ktoe) by energy type. Source: EUROSTAT

However, a point is worth mentioning: the member states are gradually implementing the National Plans in order to meet the EU criteria for 2050 targets therefore the demand of biofuels in each of these countries will depend on the policies proposed. Before analysing the national markets, it is also worth noticing that the usage of ethanol is not equally spread across the continent. As it was mentioned before the Ethanol can be used as an additive in petroleum, it substitutes gasoline in the blend, and its concentration varies from 5% to 10%. With a percentage of 5% the biofuel is labelled as E5 while a 10% concentration is named E10. Dividing the states accordingly with the use of E5 or E10 it can be noted that E10 is currently available in 14 Member States: Belgium, Bulgaria, Denmark, Germany, Estonia, France, Latvia, Lithuania, Luxembourg, Hungary, the Netherlands, Romania, Slovakia and Finland while E5 is available everywhere in the continent and it owns the larger market share (75%). The market share for E10 in each of the states' where it is available is shown by the figure<sup>34</sup> below:



**Figure 31:** E10 Market Share by country. Source: RINA-C Elaborations based on EPure infographics

To provide a broader picture of the national policies concerning renewable energies in transportation sector the following table recaps all the commitments undertaken by each member states. As the table shows<sup>35</sup> the European Union's goal of reducing the GHG in this area will be achieved through a consistent increase in renewable energies applied in transports. Each state has set its own target therefore the scenario varies on national basis. Austria for instance has foreseen the lowest increase (+4,2%) while Finland is the most ambitious country with an expected

<sup>34</sup> <https://www.epure.org/wp-content/uploads/2021/01/201104-DEF-REP-Overview-of-biofuels-policies-and-markets-across-the-EU-Nov.-2020.pdf>

<sup>35</sup> <https://www.epure.org/wp-content/uploads/2021/01/201104-DEF-REP-Overview-of-biofuels-policies-and-markets-across-the-EU-Nov.-2020.pdf>

increase of 30,1%. However, the average increase amounts to 12,35% which will constitute a significant driver for the internal demand of ethanol in the EU.

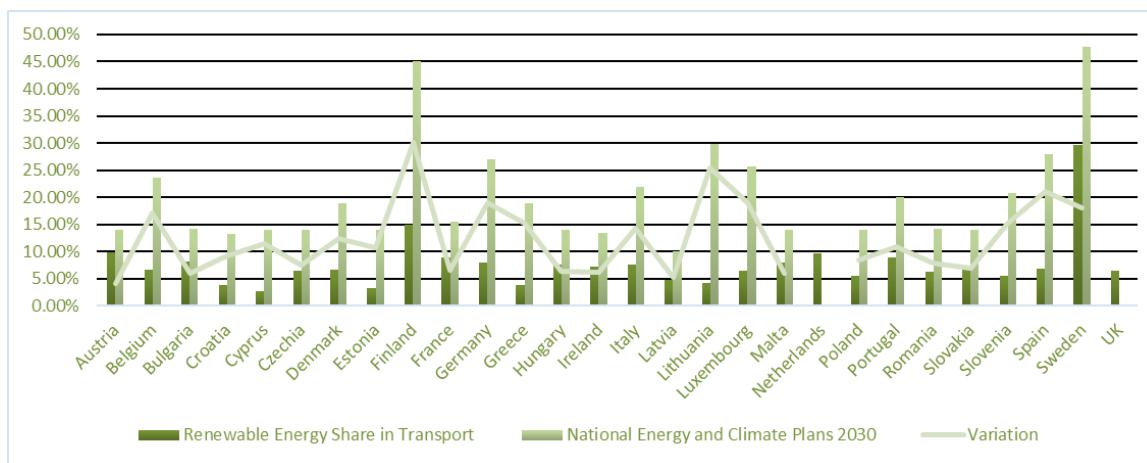


Figure 32: European GHG reduction plan

Despite the common perception bioethanol is not entirely sustainable, even though the biofuels are decisively less pollutant than fossil fuels the cost of producing ethanol still has important consequences on the environment. Ethanol is produced in different ways, but the most common ones use sugar beets, corn and wheat. All these productions have a high index of Indirect Land Use Change (ILUC) meaning that they increase deforestation and intensive agriculture and consequently GHG emissions. In order to address this issue EU has proposed an amendment to the Renewable Energies Directive (RED) in order to rule out gradually the more impactful practices. The goal is to cap the usage of these technologies while promoting new and more sustainable process to produce ethanol. The table below shows the intention of the Commission which is still discussing the topic with other European institutions.

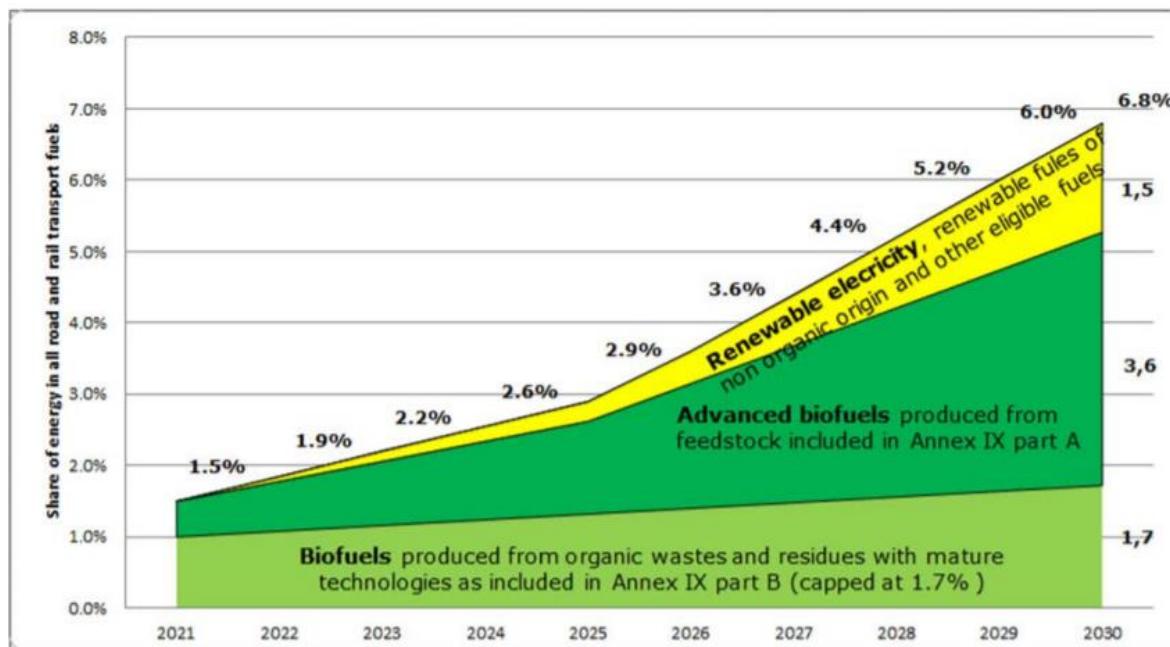


Figure 33: Share of energy in all road and rail transport fuels Source: European Commission The way towards RED II – State of affairs on biofuel related aspects

In conclusion the commitment of the EU towards a more sustainable economic model leads to new opportunities in terms of start-ups and business development, especially into the sectors that can contribute more to this transition. Biofuels is certainly a promising scenario for a technology like SELECTCO2, the demand for sustainable

fuels is destined to increase in the incoming years but the offer will unlikely meet the market expectations. Therefore, a new player with an innovative proposal like SELECTCO2 will probably have good chances to find new costumers. Also, it is worth noticing that the EU is demanding a more sustainable productions of biofuels, thus the technology developed by SELECTCO2 will likely have a competitive advantage due to its low impact on the environment. The European market is still fragmented due to the prominent role played by the member states in the environmental policy, however all the member states have agreed in playing their part to reach EU's goals, as it has been showed previously everywhere in the continent the commitment towards a more sustainable transport sector is considered pivotal to reduce GHG emissions. The usage of biofuels will indeed vary on national basis but the prospective is to see an increase everywhere in Europe. Despite the fact that new sustainable energy sources are entering into the transportation market biofuels such as E5 and E10 are the most used, therefore SELECTCO2 could rely on an established market share with a consolidated network of customers and suppliers. This will constitute a competitive advantage compared with different energy sources that are still building such network and relations across the continent.

## 6. CONCLUSIONS

The analysis made in the context of this research shows how various and interconnected the chemical industry is both at a global and European level. Chemicals are part of our daily life, therefore it is impossible to picture a world without these products. In addition, the demand is increasingly driven by new emerging markets such as China and Asia in general. However certain regions are changing their chemical sectors and with them the legislation: Europe, specifically, is moving toward a more sustainable economy and this can't be made without tackling the serious concerns that chemicals raise environmentally wise.

Overall, products made by SELECTCO2 technology will surely have great opportunities among their end-sectors thanks to the favourable projected trends foreseen for each of them. However, focusing on ethanol market, it is important to underline that among its wide possibilities of application, the fuel sector is the biggest one and it is projected to maintain its leading role also in the upcoming years considering the fact that, together with the other sectors, it is going to increase its commitment in becoming more environmentally sustainable. The biofuel sector, in fact, will play a decisive role into the transition of the transportation industry: the usage of these fuels has increased decisively in the recent years and the policies mentioned before are going to further push the European demand. Bioethanol is the most used biofuel in Europe therefore it will experience a growth in both demand and production, however as previously stated, there are raising concerns about the production of bioethanol due to its impact on the environment. Therefore, a sustainable production of ethanol like the SELECTCO2 one will surely be seen more favourably compared with traditional bioethanol productions.

Furthermore, all the products, produced through an innovative sustainable technology such the one SELECTCO2 represents, may boast of an undisputable advantage compared to other chemicals, being safer and more sustainable providing all the consequently benefits for both the society and the environment, fitting perfectly to the European green transition strategy, and contributing to the transition also of all the other end markets where these materials will find application.