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Chemicals Strategy for Sustainability

The Chemical industry and its contribution to the strategic industrial ecosystems for the Recovery

The Molecule Managers 'Welcome to 2050' report is an open invitation to a joint journey on a plausible path towards a prosperous, more sustainable Europe in 2050 and its successful competitive chemical industry.

"It is impossible to build a better future for Europe without a successful European chemical industry"

We believe that the chemical industry can thrive as it helps Europe define its global advantage in a rapidly changing global landscape by doing things 'the European way'. This means innovating towards circular models, leading on sustainability and being at the forefront of new technologies. It also means integrating more closely with sectors outside the chemical industry and expanding beyond our borders. And being seen by our customers as leading the way.

A journey into the Future of Europe with the European chemical industry: What will Europe and the world look like in 2050? What challenges will we face? How can the European chemical industry contribute?

But we know the challenges ahead are bigger than us and that we will need to work more closely with governments and society to achieve the future we all want. We look forward to the discussions to come.

For Europe to achieve its ambitious goals by 2050 - and to maintain a thriving chemical industry - we face a number of urgent decisions about the prerequisites to a world that is cleaner, healthier and more inclusive, where the transition to climate neutrality has been socially fair and just, and in which Europe maintains its global relevance.

The European chemical industry wants to lead the transition for our industry globally by offering European solutions to global challenges.

Why us?

We serve society with products that people value and that support people's natural desires for better lives, a healthy planet, peace and prosperity. We are a €650 billion industry that produces everything from soaps to solvents and sealants and from biofuels to plastics and vitamins and active ingredients for pharmaceuticals, to name just a few. We also supply downstream industries and value chains from construction to transportation and energy. We produce the raw and high-tech materials on which a modern, resource-efficient society is built. It is impossible to build a better future for Europe without a successful European chemical industry.

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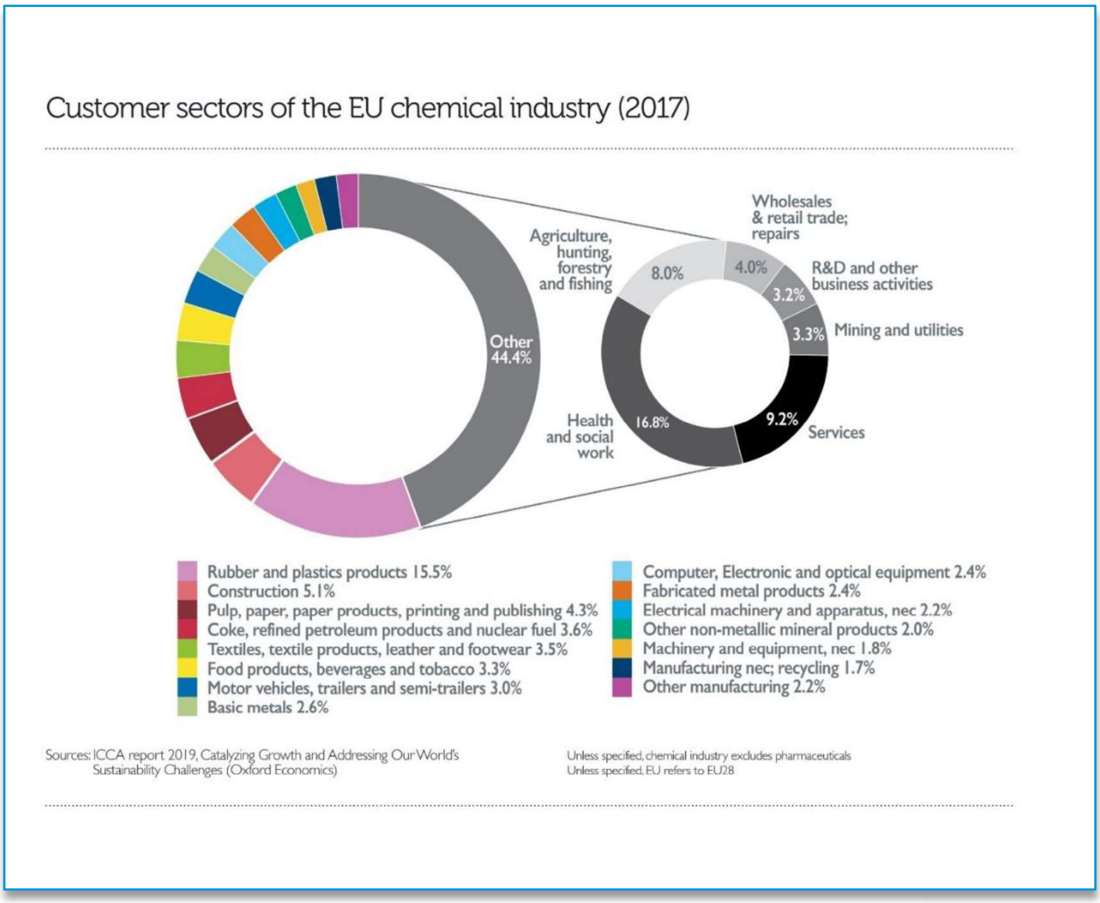


Cefic's 8-point vision for Europe in 2050:

1. The world has become more prosperous and more complex, with a volatile geopolitical environment that brings more economic and political integration within most regions, but more fragmentation between them.
2. Europe has developed its own different but competitive place in the global economy.
3. The European economy has gone circular, recycling all sorts of molecules into new raw materials. The issue of plastic waste in the environment has been tackled.
4. Climate change continues to transform our planet. European society is close to achieving net-zero greenhouse gas emissions while keeping all Europeans citizens and regions on board.
5. Europeans have set the protection of human health and the environment at the centre of an uncompromising political agenda.
6. European industry has become more integrated and collaborative in an EU-wide network of power, fuels, steel, chemicals and waste recycling sectors.
7. Digitalisation has completely changed the way we work, communicate, innovate, produce and consume and brought unprecedented transparency to value chains.
8. The United Nations Sustainable Development Goals and its successors are at the core of European business models and have opened business opportunities as market shares increase for those who provide solutions to these challenges.

Chemistry has been an essential part of our world since the dawn of time, providing the biochemical foundation for life itself.

Our industrial fabric, activities and products benefit the well-being of millions of people in Europe and worldwide. In a constant quest for discovery, whether anticipating or responding to societal needs ranging from healthy food for a growing population to caring for an ageing population and providing access to clean water, clean mobility and increased connectivity, chemists have given us medicines, sanitation, fertilisers, paints, insulation material, pesticides and plastics. Chemicals have been instrumental to using natural resources such as water and energy in an efficient way. Today, the European chemical industry is every bit as indispensable to modern life, producing the building blocks and high-tech materials on which modern societies are built. Our molecules and materials are used in every industry, from agriculture to construction, food and beverages, energy, health care, machinery, textiles, hospitals and transportation. We are developing more cradle-to-cradle business models that optimise value throughout multiple lifecycles. The European Union's chemical sector employs 1.2 million highly qualified people directly in 28,000 companies. A recent study from Oxford Economics reports that the chemical sector supports around 19 million jobs across all supply chains. It generates more than €540 billion a year in sales and €170 billion in European value added. We have embraced corporate social responsibility, ethical behavior and the principles of Responsible Care.

We are closely interlinked with many other industrial sectors and value chains in Europe. We are, in fact, the industry of industries. We will evolve as our value chains develop and our changes impact those around us. For that reason, although we believe we need to lead our transition and determine our future ourselves, we are very clear we need to do this in close dialogue with everyone involved.

In recent years, the European chemical industry has increasingly been driven towards high value-added products such as lightweight materials and insulation that improves energy efficiency, sophisticated inks and compounds for 3D printers, coagulants that help recover valuable phosphates from wastewater, better laundry detergents and advanced materials for batteries, solar panels and wind turbine blades. The European chemical industry is also Europe's biggest industrial consumer of electricity, giving us a big stake in the transformation of Europe's energy systems. We have already made big changes. Our greenhouse gas (GHG) emissions have fallen by nearly 61% since 1990, even as production increased by 83.7%. By 2050, based on what we know about technology today, we think we can reduce GHG emissions a further 50% compared to today's levels.

However, this would require an enormous effort by industry and society and the right framework conditions. A 50% reduction in GHG emissions between today and 2050 would represent an 80% reduction from 1990 levels. All technical solutions, including carbon storage and re-using CO2 as a feedstock, will be necessary to reduce our GHG emissions.

We are part of the fabric of progress, sustainably producing the raw and high-tech materials on which a modern, resource-efficient society is built.

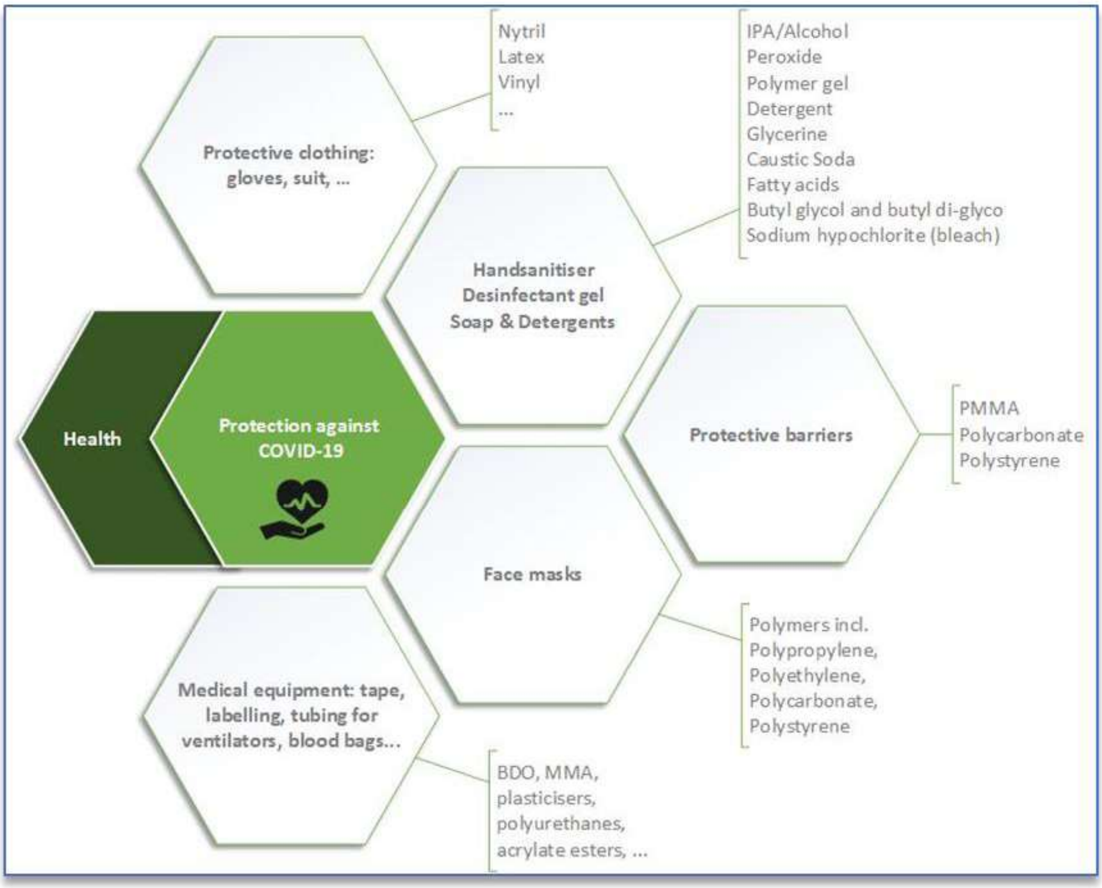
An overview of the value chain links with various industries is provided in the graphic below.

Source: Industrial Value Chain – A Bridge towards a Carbon Neutral Europe

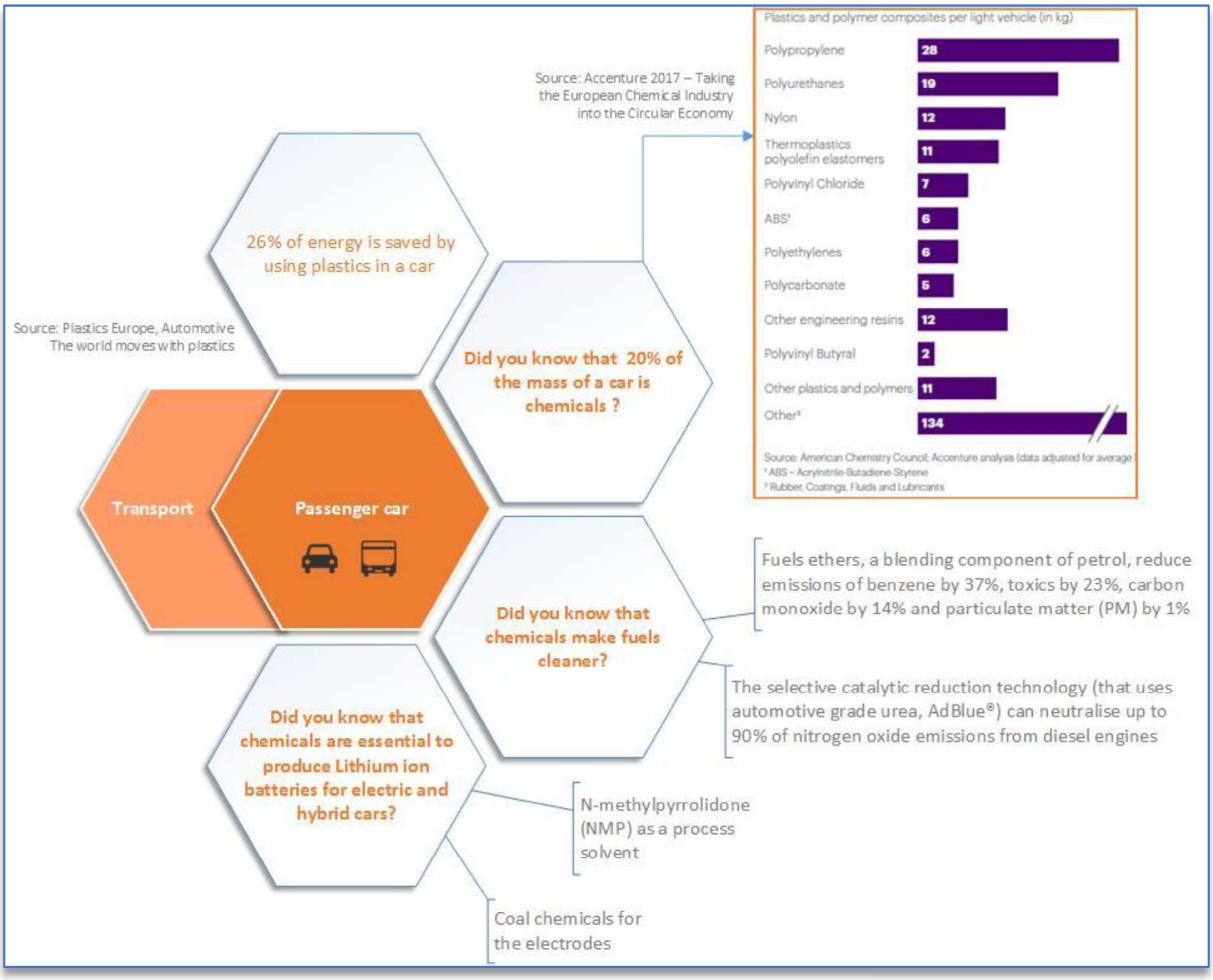
Figure 11: Value chain links of energy intensive industries to other sectors in the economy and other energy intensive industries (red)

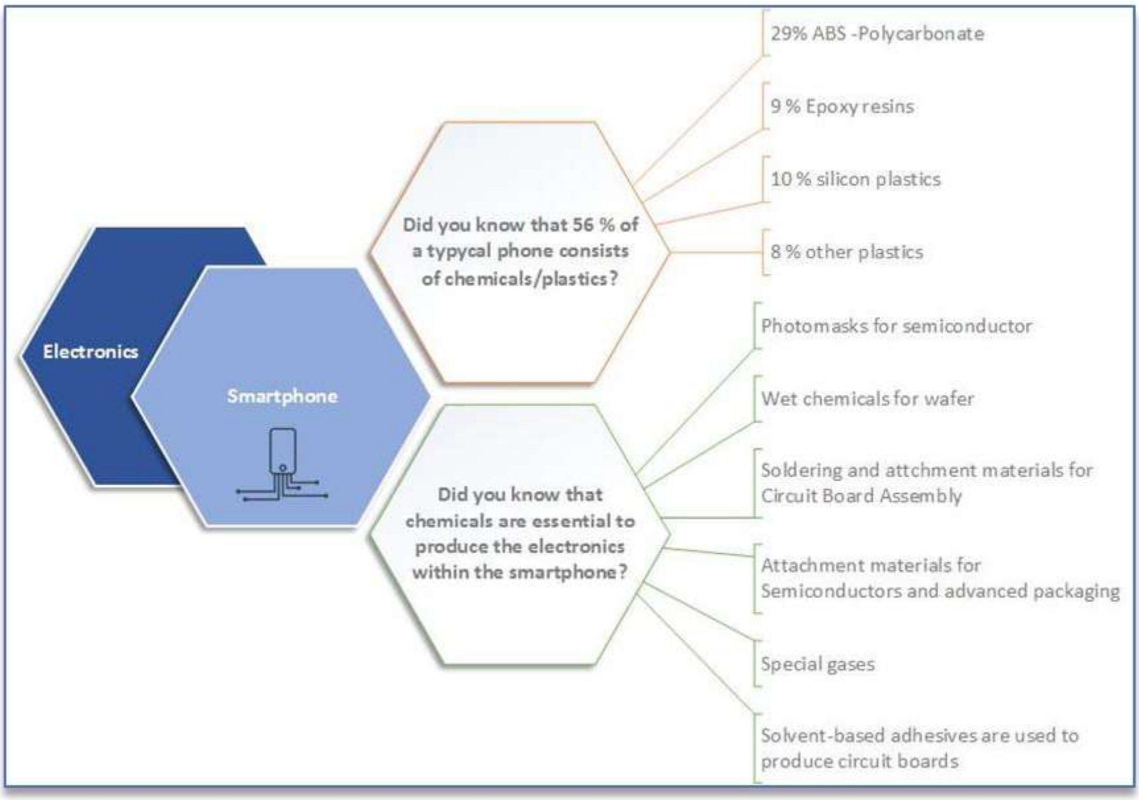
In addition, some examples of various applications of chemicals in daily life have been worked out in more detail to illustrate an few chemical molecules that are essential to our daily lives.

Health protection

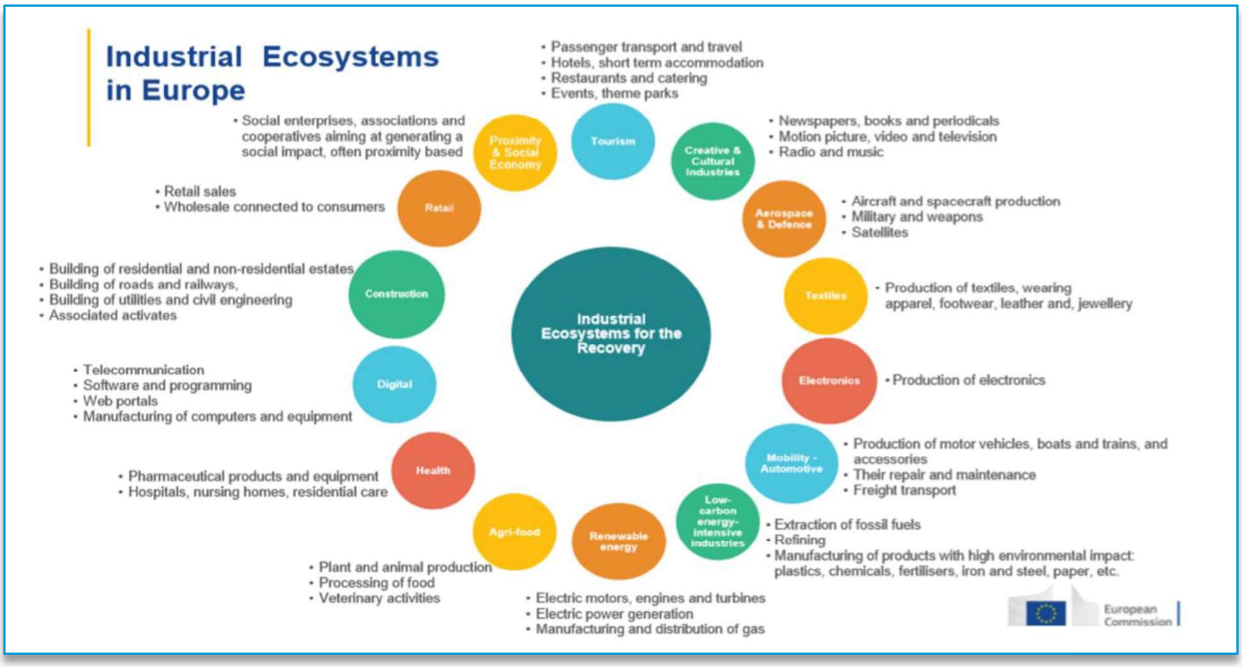


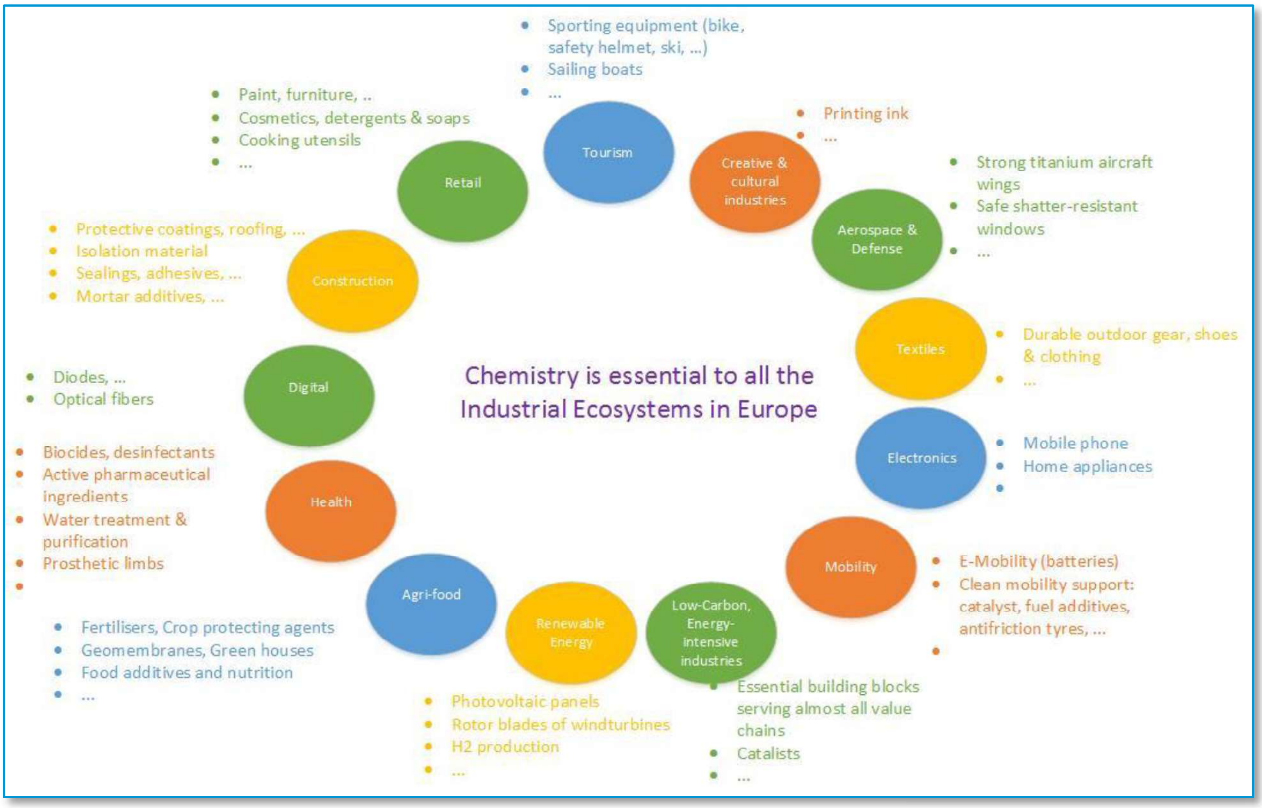
High-tech materials for our modern life





Finally, we welcome the approach taken by Commissioner Breton to adopt the new Industrial Strategy, basing it on the **European industrial ecosystems** and actors are in agreement that the Recovery Plan should be organised around these ecosystems. **Chemical processes and products are present** in every imaginable Industrial Ecosystem in Europe today **as illustrated in the overview and interactive table below.**





Chemicals segments	Link for further reading	Relevant EU Industrial Eco-system and more detail
Hydrocarbon and oxygenated solvents are used to dissolve other substances and are essential in the manufacturing and/or cleaning process of many everyday applications and items. They are key products in the fields of transport, health, paintings and coatings, agriculture and food etc. Hydrocarbon solvents are molecules containing only hydrogen and carbon atoms. Oxygenated solvents contain hydrogen, carbon and oxygen atoms. Most solvents are manufactured from crude oil.	Read more (Solvents Family)	Agriculture and food Transport Health Coatings and paintings Cleaning/household products Cosmetics Textiles
Aromatics derive their name from their distinctive aromatic or perfumed smell. The main substances in this group, benzene, toluene and the xylenes, are basic chemicals used as starting materials for a wide range of consumer products. Almost all aromatics come from crude oil. Everyday items made with the help of aromatics can be found in the home, workplace and supermarket. Products made using aromatics can reduce energy consumption and so have a positive impact on the environment. For example, lightweight plastic components in vehicles and aircraft, and insulating foams in houses and offices are made with the help of aromatics.	read more Aromatics in everyday life	Textiles Pharmaceuticals Electronics Paints Car manufacturing Construction materials Sports equipment
Biocides are our principle defences against pests and other organisms which threaten our health, our food, our environment and the places in which we live and work. Biocides have numerous applications that provide benefits to all of us, ranging from keeping drinking water clean to making products longer-lasting. They ensure the protection of humans and animals from	Read more about biocides	Agri-food Construction Retail Health

harmful organisms (by disinfection or pest control), but also contribute to a more sustainable use of a large variety of products (by preservation).		
Fine chemicals are mostly used in the production of pharmaceuticals, but are also key to the agrochemical industry, food and domestic products. Soda ash is used in a wide variety of applications and industries. Amongst many others, the major uses of soda ash are in glass, detergents, chemicals. **Sodium bicarbonate** is extensively used in human food products and domestic uses: baking soda, effervescent drinks, toothpaste, fruit cleaning, personal hygiene, etc. and in pharmaceutical applications: effervescent tablets, hemodialysis etc.	Read more about fine chemicals Read more about the fine chemical soda ash & sodium bicarbonate	Agri-Food Health Retail
Food & Feed Chemistry is an integral part of our food, with a variety of chemical substances commonly added to food to perform a necessary technological function. **Ammonium sulphate** is widely used in agriculture as a key ingredient in fertilisers because of its environmental performance: it improves the availability of Sulphur and Nitrogen – key nutrients for plant growth. Besides fertilisers, ammonium sulphate is used in food, bread and bakery as an acidity regulator, and in pharmaceuticals. **Vitamin E** is used in a wide variety of	Read more about: • Vitamin E • raw materials for the fermentation industry • Gelatine • Inorganic feed phosphates • Phosphates	Agri-food: additives & gelatine & inorganic feed phosphates Creative and cultural industries Health: Vitamin E & Vitamin C & penicillin & Gelatine (also as pharmaceutical & for sports) Retail

applications in human and animal nutrition & health. It is a strong antioxidant; it prevents the propagation of lipid peroxidation, protects proteins and DNA from oxidative damage. Studies found positive associations between vitamin E intake and reduced risk for cardiovascular disease **Carbohydrates** such as the sugar glucose (derived from corn and cereals), are the main raw materials for the fermentation industry. These agricultural feedstocks are critical for the manufacture of essential products like penicillin, vitamins, amino acids, citric acid and lactic acid. • Vitamin C plays a key role in boosting the human immune system and acts as a powerful antioxidant, reducing the damage caused by free radicals. • Penicillin is an effective antibiotic and the starting material for a variety of semi-synthetic anti-infective agents. **Phosphates** are used in food processing to achieve a wide range of effects like buffering capacity, sequestering agent, anti-cracking agent, shelf life improvement, water binding, mineral enrichment, etc. They are used as functional food additives in the following several food categories: e.g. bakery products, meat and poultry products, seafood products, processed cheese, dairy products, potato products, soups and sauces, starch-based products, powdered foodstuffs, beverages, soda and juice products, drinking water.		

Pigments, dyes, fillers & catalysts Pigments are used for colouring paint, ink, plastic, fabric, cosmetics, food, and other materials. A distinction is usually made between a pigment, which is insoluble in its vehicle (resulting in a suspension), and a dye, which either is itself a liquid or is soluble in its vehicle (resulting in a solution). **Synthetic Amorphous Silica (SAS)** is used in cosmetics (e.g., as abrasion additive in toothpastes, thickener in pastes, formulation aid in creams), pharmaceuticals (e.g., as free-flow additive, carrier, or retardant agent) and food (as E 551 e.g. to introduce free-flow properties into powder or seasonings). It is also used in industrial applications as a reinforcement agent (e.g., in rubber ("Green Tyre") and silicones), as matting agent or rheological additive (e.g. in paints, lacquers, and varnishes), to prevent plastic films from sticking, and in thermal insulations. Colloidal silica is widely used in coatings, ink receptive papers, metal casting, refractory products, catalysts, and as a filter aid in food production, where it is removed completely at the end of the process. Silica gel is in addition used as a desiccant or in chromatography. **Catalysts** are substances that increase the rate of a chemical reaction. They are widely used today for emissions reduction for volatile organic compounds, SO2, NOX. They are crucial to reduce future environmental burdens, achieve lower limits, make products greener and more sustainable and to reduce CO2 emissions or to address future energy challenges.	Read more about • Synthetic Amorphous Silica • Catalysts	Agri-food Health Mobility Retail

Specialty Aluminas are synthetic products with inherent thermal, electrical and/or chemical properties like superior hardness, mechanical strength and resistance to wear, to high temperatures and to corrosion. This makes of Specialty Aluminas key components in a broad range of applications like flame retardants, ceramic and refractory materials and products, bonded and coated abrasives, pressure blasting and wear resistant floorings and tiles.		
Plastics Additives such as flame retardants, plasticisers, anti-oxidants, heat and light stabilisers are added to plastic to enhance its durability, safety and/or performance. **Plasticisers** make things soft and flexible. They are used in cables, cladding, roofing, flooring, tubes and hoses, toys, medical applications, personal care and cosmetics, inks and waxes, food packaging, film and sheet, coated fabrics and vehicles. **Stabilisers** are added to PVC to allow its processing and to improve its resistance especially in outdoor applications (stabilisers). They are used in pipes and fittings, window profiles, films, flexible PVC, wires and cables, medical appliances, consumer goods, coatings and flooring Antioxidants and UV light stabilisers are organic additives that enhance the performance, safety and durability of finished products. They are used in drinking water pipes for instance. **Flame retardants** are essential for the safety of products and applications such as electrics, electronics, construction, textiles and transport	Read more on plasticisers, stabilisers, Light stabilisers and anti-oxidants Flame retardants	Agri-food (packaging) Construction Digital Electronics Health Mobility Textiles
Resins are solid or highly viscous	Read more about resins	Agri-Food: packaging, food

substances which are typically convertible into polymers. They can be either plant-derived or synthetic in origin. Enabling and improving the performance of a multitude of other raw materials, resins help products perform in the way they are supposed to. Resins can be applied to coatings & inks, adhesives & sealants, rubber & plastics modification, road construction **Polyester powder coatings** are used in industrial applications for both decorative and protective uses on profiles for buildings, agricultural machinery, white goods such as fridges, garden and leisure-equipment and many other applications. **UV/EB acrylate resins** have the unique property of instantaneously polymerising under ultra-violet radiation (UV) when mixed with an adequate photoinitiator or when treated with a beam of high energy electrons (electron beam, EB). UV/EB curable resins are mainly used as solventless binders in inks, varnishes, adhesives and decorative and protective coatings and paints. They can be applied on almost any substrate – paper, wood, plastics, glass and metal. **UP/VE resins** are the key building blocks in creating lightweight and durable composite materials, used in sectors such as construction and transport.	Read more about UP/VE resins	additive Creative and cultural industries Retail: coatings & inks; adhesives & sealants; rubber mofication Construction: adhesives & sealants, flooring, other Mobility Renewable energy: wind turbines Tourism: pleasure boats
Melamine is a vital raw material in the	Melamine	Construction

production of wood-based panels, laminates, coating resins, moulding compounds and many other products. In laminates melamine adds properties like heat, water, chemical resistance and antibacterial properties to the end product. In wood adhesives melamine reduces the release of free formaldehyde and improves the water resistance of the boards. As coatings they provide chemical, water and scratch resistant properties.		Retail Textiles
Formaldehyde-based resins are excellent adhesive and low-cost materials that play an integral role in many construction and furniture applications including the production of particle board and wood panels. Some types of formaldehyde-based resins also have excellent heat and chemical resistance which make them essential in the production of certain types of automobile and aeroplane parts. Formaldehyde is also used as an intermediate to produce other chemicals, many of which play an important role in the production of coatings and plastics such as polyurethanes. Because formaldehyde has excellent antibacterial properties, a small percentage of manufactured formaldehyde can be found in healthcare applications such as vaccines and disinfectants.	Read more about Formaldehyde	Aerospace & Defence Construction Mobility Health Textiles
Silicones are high-performance oligomers or polymers that can take a variety of physical forms, ranging from solids to water-thin liquids and semi-viscous pastes, greases and oils. Silicones display a host of unique properties that can lubricate, seal, bond, release, defoam, encapsulate, insulate, waterproof and coat.	Learn more Uses & benefits	Construction Digital Health Renewable energy Retail: cooking utensils Transport

Oleochemicals Oleochemicals are used as raw materials or intermediates in a variety of products such as personal care products, paints and coatings, paper recycling, plastics, printing, rubber production, soaps & detergents, waxes, animal feed, electronics, food, healthcare, industrial lubricants, leather, metalworking and mining. Whilst oleochemicals have their own specific applications, they are also derivatised into surfactants.	Read more	Agri-food: animal feed & food Creative and cultural industries Construction: metalworking Electronics Health Retail: Personal care; paint and coatings; soaps & detergents; leather Mobility: rubber
Surfactants can mobilise and combine materials - typically water, oils, fats and solvents - that otherwise would not mix due to their incompatible molecular properties. They are used for all kinds of cleaning and detergent formulations for the home or workplace, in personal care products, cosmetics and pharmaceuticals. They also serve a diverse range of important industrial applications & processes (Metal, Pulp and paper, Plastics, Leather, Fibres & textiles, Mining Oil, Food, Paints, inks and coatings, Construction and Petroleum products).	Read more	Agri-food Construction Creative and cultural industries Health Retail: Home care & Personal care Textiles
Chlorine chemistry is necessary for the manufacture of a multitude of vital products, including plastics (especially PVC and polyurethane), solvents, medical products and fire protection. Here are some key uses: -many IT applications from PVC cables with chlorinated alkane plasticisers and fire retardants to computer chips made of silicon chloride; even neodymium trichloride enriched data cables that lie deep beneath the sea!	Read more	Digital & Electronics Construction Health Agri-food Renewable energy Mobility - Textiles

-PVC and polycarbonate add support, structure and style to modern buildings, and protective safety bike helmets are made of polycarbonate -Sterile, heat-resistant and oxygen permeable PVC blood bags are essential during hospital operations and prosthetic limbs are also made of PVC. polyurethane is used in 'balloon pumps' that can be placed directly in the heart to help it squeeze more blood. -PVC packaging helps transport our medicines to us to help treat illness and wrap food to keep it fresh from farm to store to our tables. Even common table salt is a chlor-alkali chemical (sodium chloride) which we use to make hundreds of other products (or to flavour our food!) -Made from layers of polyester, wind turbine blades are held together by epichlorohydrin (EPI) derived from chlorine. Alternatively, the blades can be made from polyurethane, which, when it is made into a foam also helps insulate our homes and make them more energy efficient. Polyurethane is also found in flexible foams for furniture padding and comfortable seating in vehicles. -Hydrochloric acid helps to purify the silicon in solar panels which captures the energy from the sun. -Polyurethane kept the Solar Impulse cabin and battery compartments well insulated from the large variations in temperature (-40 to +40°C) as the plane made its historic journey.		Aerospace and defense
Chlorinated solvents have a variety of uses, including the manufacture of tearproof aramid fibres for bulletproof	Read more	Aerospace and defence Construction

vests and as adhesives to construct and renovate houses. They help in the development of pharmaceuticals (preparation of antibiotics, asthma inhalers and cholesterol treatments). They are vital to dry-cleaners to get our clothes ready for your big day, can be used for cleaning printed circuit boards in all kind of electronic devices and help decaffeinate unroasted coffee beans and tea leaves and feature in the extraction of natural substances such as fats and oils, hop oil, flavours and pharmaceutically active natural compounds.		Health Textiles Electronics Agri-food
Caustic soda is key in producing pain medications like aspirin. It is also used to make clean paper and packaging to transport our foods. Sodium-based preservatives from caustic soda help to keep our food fresher for longer Energy-saving LED light bulbs are made using caustic soda-treated metals	Read more	Health Agri-food Renewable energy
Potassium hydroxide regulates the acidity of soils to ensure that crops have the best possible conditions to grow in. It is also important in fuel cells and batteries as it helps to conduct the electricity and can also help to de-ice planes as they wait to take-off.	Read more	Agri-food - Mobility - Aerospace and defence -
Hydrofluoric acid is the key chemical to manufacture silicon based semi-conductor devices. Its ability to attack silicon oxide and transform it into soluble compounds is the basis of multiple applications in cleaning and etching processes. Hydrofluoric acid is also used to produce		Electronics Agri-food Health

crop protection agents, as well as being a catalyst in the production of detergents. **Florine compounds such as sodium fluoride and sodium monofluorophosphate** are essential components of toothpaste formulations, and are similarly important in helping to prevent dental caries The final stage of the crystal glass manufacturing process is to pass it slowly through a bath containing a mixture of hydrofluoric acid and sulphuric acid. Aqueous hydrofluoric acid solutions are the only acids capable of dissolving the raw material, silica, in an acceptable time. It is this final acid treatment which gives crystal glass the sparkling finish for which it is revered throughout the world.		
Sulphuric acid is crucial to manufacture superphosphate, which ensures that soil has a sufficiently high phosphorous content (phosphorus is an essential nutrient for plants). Highly diluted sulphuric acid is an EU approved food additive: as acidifying agent it can be used, for example, for pH adjustment to inhibit growth of bacteria and microbes. Ultra-pure sulphuric acid is a critical cleaning agent in the manufacture of semiconductor chips Sulphuric acid serves as the electrolyte in lead-acid storage batteries.		Agri-food Electronics Mobility
Fuel ethers, including MTBE, bio-MTBE, bio-ETBE, TAME, bio-TAME and TAEE, are key components for the production of high-octane fuels. They are the clean and efficient replacement for compounds, such as for instance toxic lead, that pose a proven risk to health and the environment. Whether manufactured	Read more	Transport

from traditional hydrocarbons or renewable biomass, fuel ethers are more energy dense than alcohols. Therefore, they increase petrol's performance, while reducing the emissions of air pollutants and CO2 across their life cycle.		
Acrylonitrile is a chemical intermediate used to produce acrylic fibres, ABS (acrylonitrile-butadiene-styrene), SAN (styrene-acrylonitrile), acrylamide, adiponitrile and NBR (nitrile-butadiene-rubber). Acrylonitirle is key to produce carbon fibres used in aircraft, defense and aerospace industries as well as wind turbine blades' manufacturing.	Read more	Aerospace and defense Wind turbines
Propylene oxide is used as a monomer in polymer production and as an intermediate in the synthesis of other substances. It is also used as a chemical intermediate for the manufacture of polyols used in polyurethane foam, propylene glycol ethers, butanediol and related products for speciality resins and solvents, propylene glycols.	Read more Read more on propylene glycols	Paints & coatings Construction, Transport Food Pharmaceuticals Cosmetics
Methacrylates are used as building blocks to make a wide range of polymers. These polymers are then used as raw materials or components in the manufacture or formulations or objects that we use in our everyday life, especially when stability, durability, hardness and scratch resistance are needed. Methyl methacrylate (MMA) is used to produce a pure homopolymer (poly-methyl methacrylate or acrylic glas – PMMA) like the protective glass shields in shops.	Read more on Methacrylates Read more on PMMA	Transport Construction Furniture and design Electronics & Energy Health
Coal chemicals are chemicals derived from coal tar distillation. The main product (approx. 50 %) of the tar refinery is the	Read more	Transport Construction

distillation residue “coal tar pitch”. The distillates are crude naphtalene and technical fractions (aromatic oils). The major single compounds are naphthalene (~10 %), phenanthrene (~4,5 %) and anthracene (~1,3 %). They are mainly used for: • Electrode binders for aluminium and electro-steel production • Refractory materials • Aromatic oils for the production of carbon black • Wood impregnating oils • Chemicals for the production of dyes, inks, pesticides, plasticisers, solvents and coatings.		Food packaging Printing and coatings
Ethylene oxide is a chemical intermediate required for the manufacture of many important products and downstream markets. The major use of ethylene oxide in Europe is as a chemical intermediate in the manufacture of ethylene oxide derivatives such as surfactants, ethanolamines, glycol ethers, polyether polyols and other ethylene oxide derivatives. These ethylene oxide derivatives play a vital role in applications such as tensile formulations, paints and varnishes and many kind of polyurethane formulations. The main use of ethylene oxide is as a starting raw material in the manufacture of ethylene glycols. The largest homologue Mono Ethylene Glycol is used as a chemical intermediate in the manufacture of polyesters (Polyethylene Terephthalate PET). PET can be converted into fibres and fabrics or used as a plastic for film and packaging applications such as PET bottles. PET is one of the plastics with the highest growth rates due to good physical properties and good recyclability.	Read more	Food packaging Construction Paints & coatings