The European House
Ambrosetti

The excellence of the plastics supply chain in relaunching manufacturing in ITALY and EUROPE

Executive Summary

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This research report was conducted by the European House – Ambrosetti for M&G Finanziaria, Versalis, Basf Italy, LyondellBasell, Arkema, Artenius, Novamont, Radici Group, Total Petrochemicals & Refining SA/NV, ASSOCOMAPLAST - Associazione Nazionale Costruttori di Macchine e Stampi per Materie Plastiche e Gomma, COREPLA - Consorzio Nazionale per la Raccolta, il Riciclaggio e il Recupero dei Rifiuti di Imballaggi, UNIONPLAST – Federazione Gomma Plastica, Federchimica - PlasticsEurope Italia and PlasticsEurope.

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The contents of this research report are the exclusive responsibility of The European House - Ambrosetti and may not reflect the opinions and points of view of the persons interviewed.

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Foreword

Official historiography pinpoints the origin of plastics in the year 1860, the development of celluloid: in point of fact, this material really developed after the end of World War II with the enormous growth in demand because of the reconstruction and the economic boom in countries that had come out of the conflict.

Ever since then, the entire economy of many industrial sectors has been revolutionised by the existence of these new materials that the plastics industry has gradually made available.

The trend continues without respite throughout the world: the figures are impressive and point to growth rates in the coming years for the sector far higher than those of the economy or industry as a whole, driven by the unrelenting demand for plastics particularly by emerging economies.

This study, in which have taken part not only the producers of raw materials but also all federations of the plastics supply chain in Italy – Federazione Gomma Plastica/Unionplast, Plastica/Unionplast, ASSOCOMAPLAST, Federchimica - PlasticsEurope Italia – shows that the plastics industry is the real backbone of manufacturing in Europe and Italy, not only because of the deep scientific and industrial roots that have characterised the sector to date, but also in terms of prospects.

The plastics industry continues in fact to be characterised by a high level of technological innovation, and is moving forward by developing ever more sustainable and safe products and processes.

The study broaches with clarity also the challenges that the plastics industry faces, particularly in Italy: as it lacks competitive advantages, such as access to raw materials at a low cost, for instance, it must necessarily rely on the technological content of its products to pit itself against the new production realities.

The study moreover shows that the Italian plastics industry is a sector of excellence, with certain positively world-class assets – innovative, high performance products, processing technologies, converting machinery, new "biopolymers," the recycling of plastics, etc. – and as such can and must play a decisive role in helping our country and Europe get out of the crisis.

We are convinced that the simple, concrete proposals contained in The European House - Ambrosetti study, if adopted and implemented, would not only give impetus to the entire plastics sector in Italy, but would also trigger a virtuous process that will have positive repercussions on the entire industrial apparatus and consequently on our economy.

Daniele Ferrari
President, Federchimica - PlasticsEurope Italia

IN BRIEF

Ten most important points of the research report, guidelines and proposals for the country

TEN MOST IMPORTANT POINTS OF THE RESEARCH REPORT

1. PLASTICS ARE PRESENT IN ALL ASPECTS OF DAILY LIFE, AND GLOBAL DEMAND WILL CONTINUE TO GROW.

— We estimate that the global production of plastics will go from the current 235 million tonnes to over 300 million tonnes by 2025, in line with the increase of the population and industrialisation.

2. PLASTICS CONSTITUTE AN INDUSTRIAL SECTOR OF PRIMARY IMPORTANCE, WITH AN INTEGRATED SUPPLY CHAIN STRUCTURALLY CONNECTED TO THE PETROCHEMICAL INDUSTRY.

— In Europe, the sector employs some 1.5 million workers, in over 62,000 companies, and generates a turnover of approximately €300 billion.
— In Italy, it is "worth" approximately 11,000 companies (18% of the EU-27 total) with turnover of approximately €43 billion (14%).

3. THE ITALIAN PLASTICS INDUSTRY HAS A LONG TRADITION AND A CONSOLIDATED COMPETITIVE POSITION.

— Italy ranks third in Europe in terms of number of employees, turnover and added value of the plastics production and converting phases. The country is moreover the second consumption market and number two producer of machinery with world level research and industrial excellence.

4. THE SUPPLY CHAIN CAN MAKE A CONSIDERABLE CONTRIBUTION TO RELAUNCHING MANUFACTURING IN EUROPE, IN LINE WITH THE GOAL OF A 20% SHARE OF GDP BY 2020.

— A 10% increase in the added value of the plastics sector could lead to a 4.4% increase in the added value of European manufacturing.

5. IN ITALY, THE PLASTICS SECTOR IS A GROWTH DRIVER FOR THE ENTIRE COUNTRY.

— For every €100 of GDP generated in the sector, €58 of GDP are generated in other manufacturing activities.
— For every work unit produced in the plastics sector, 0.62 units are generated in other manufacturing activities.
— A 10% improvement in the overall turnover of the Italian plastics supply chain can lead to a 0.6% increase in national GDP (+4.6% in manufacturing) and the creation of more than 40,000 new jobs.

6. THE PLASTICS SECTOR HAS A HIGH INNOVATION RATE AND IS CAPABLE OF MEETING THE CHALLENGES OF MODERN SOCIETIES AND ECONOMIES

— Cutting-edge applications in plastics are found throughout the main industrial sectors: automotive and aerospace, electronics and mechanics, packaging, textile-clothing, healthcare and biomedical, construction materials and renewable energy sources.
— The Italian industry has high-performance innovative products, processing and recycling technologies, and new "biopolymers," which constitute a potential flywheel for getting out of the crisis currently gripping the country.

7. THE "END OF LIFE" OF PLASTICS IS A STRATEGIC PHASE FOR THE REUSE OF PRODUCTS AND ENERGY RECOVERY.

— 51% of plastic waste was recovered in 2011 in Italy for recycling (0.8 million tonnes) or use for energy purposes (0.9 million tonnes).
— In Europe, 1 out of 3 companies in the plastics end-of-life cycle is Italian, with high level competencies.

8. THE ITALIAN PLASTICS INDUSTRY IS FACED WITH CERTAIN STRATEGIC CHALLENGES IN A HIGHLY COMPETITIVE GLOBAL SCENE.

— The transformation of the chemical industry and the consequent impacts on the competitiveness of the plastics supply chain.
— The management of the end-of-life of plastics.
— The definition of a national vision of the conditions for a concrete development of the sector.
— Overcoming the negative perception of public opinion which makes choices difficult.

9. "PLASTICS" SUFFER FROM A WIDESPREAD INFORMATION DEFICIT, WHICH FUELS PREJUDICES AND MAKES CHOICES FOR DEVELOPMENT DIFFICULT.

— In Italy, 43% of the population has misgivings about plastics, compared with 22% in Germany.

10. A CONCRETE VISION FOR THE DEVELOPMENT OF THE PLASTICS SUPPLY CHAIN SHOULD AIM FOR MAINTAINING AND INCREASING THE COMPETITIVENESS OF TRADITIONAL PRODUCTION SECTORS, INCLUDING THOSE "UPSTREAM" AND INVESTING IN KNOWLEDGE-INTENSIVE FRONTIERS.

— Defending the integrated production cycle in terms of the efficiency and competitiveness of European chemical clusters (from raw materials to converting).
— Building on distinctive competencies, including chemistry.
— Boosting integration in research, both within industry and between industry and academia, and in particular, certain cutting-edge sectors.
— Managing the end-of-life as an opportunity.

GUIDELINES AND PROPOSALS FOR THE COUNTRY

GUIDELINE 1: PROMOTE A PROACTIVE INDUSTRIAL POLICY FOR THE DEVELOPMENT OF THE SECTOR AND SAFEGUARDING THE PRESENCE OF THE ENTIRE SUPPLY CHAIN.

- Managing current restraints on development, first and foremost energy and logistics costs and, more generally, existing regulatory and competitive imbalances.
- Implementing (including with the contribution of academia) an a priori system of evaluation of the impact of legislation on the supply chain.
- Substantial incentives for collaboration (including partnerships) between government, research bodies and industry.
- De-fiscalization of R&D investment by companies.
- Orientation of research (and focusing of investments) on applications with high potential in traditional fields of application and emerging niches.
- Recognizing plastics as a macro-sector within national statistical studies unquestionably sends a message—including on a political level—of its importance.

GUIDELINE 2: PROMOTE A WIDESPREAD PUBLIC INFORMATION CAMPAIGN ON THE PROPER USE OF PLASTICS AND "RECYCLING" CULTURE".

- Launching an awareness campaign (including in collaboration with industry and academia) about the real value and positive contribution - also in terms of sustainability - of plastics for society throughout the entire life cycle and their correct utilization.
- Stimulating recycling of plastic waste with specially-designed initiatives, including adapting and implementing the best practices found in Europe today.

PROPOSAL 1: USING A PUBLIC/PRIVATE SECTOR MODEL, INCLUDING FOR FINANCING, CREATE A LARGE-SCALE NATIONAL CLUSTER OF EXCELLENCE IN PLASTICS, INCLUDING SYSTEMS OF PRODUCTION AND ENERGY SELF-SUFFICIENCY (RETURN TO THE INTEGRATED CYCLE).

- Safeguard the entire plastics supply chain throughout all its phases.
- Foster orientation of research in selected strategic areas and integration with industry.
- Focus on areas of development connected to the nation's clusters of industrial specialisation and "Made in Italy" driving sectors.
- Develop a network of existing areas of excellence in academia and other primary research centres in the country (avoiding duplication).
- Create a further element of attractiveness on an international level for new talent and cutting-edge industrial competencies.

PROPOSAL 2: PROMOTE A POSITIONING STRATEGY FOR ITALY THROUGH EXPLOITATION OF THE ENTIRE PLASTICS LIFE CYCLE FROM THE STANDPOINT OF ECONOMIC-COMPETITIVE OPPORTUNITIES.

- Create uniform efficiency (including through specific legislation) throughout the entire waste collection cycle.
- Introduce a ban on disposing of plastic waste in landfills.
- Promote the modernisation (revamping) of waste disposal plants (incinerators) using cutting-edge technologies, by drawing up a simplified regulatory framework and developing de-fiscalisation measures.
- Replicate the best practices existing in Italy today for waste-to-energy in non-recyclable plastics in coal thermoelectric power stations.

Executive Summary

1. Plastic is an essential material for today's and tomorrow's society and industry

1. Plastics are one of the primary entirely man-made materials not found in nature, although they are comprised of organic substances. Plastics are made, in fact, of raw materials that include petroleum[1] (by-products of its refining process), natural gas, carbon, common salt and other natural products.

2. There are many diversified sectors and modes of application. Today, plastics are present in **all aspects of daily life**, from transport to construction, telecommunications, consumer goods, food products and healthcare.

3. Starting in the 1950s[2], worldwide production of plastics showed an average annual growth rate of 8.7%, increasing nearly nine-fold since the 1970s, compared with a 4.5 times growth in aluminium and 2.5 times in steel. These differences can be traced to research-related developments, the discovery of new applications and innovative materials, and the gradual substitution of other materials (i.e. metal, glass, etc.).

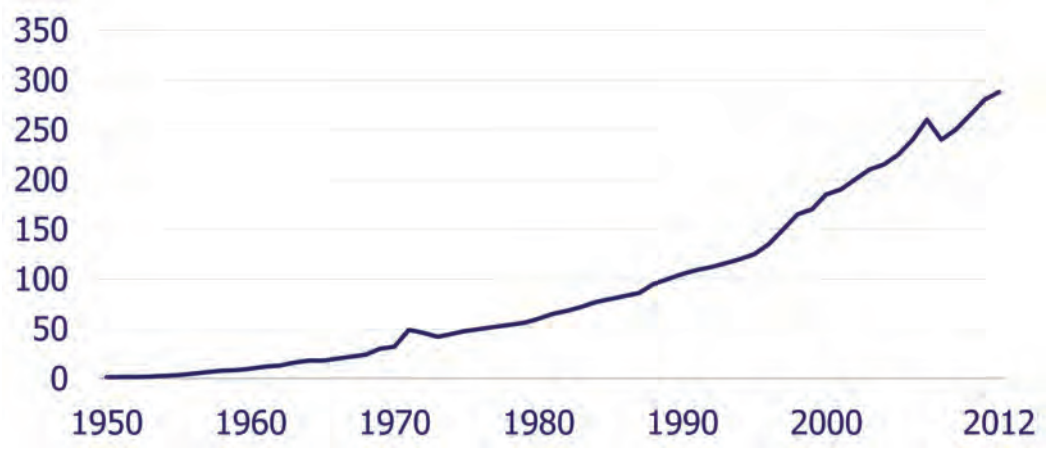


Figure 1. World production of plastics (million tonnes), 1950-2012

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

4. The demand and production of plastics are uniformly divided between the main macrogeographical areas, with a **growing role of the emerging economies**.

[1] About 4% of the world's petroleum is used to produce plastics.

[2] In Italy, thanks to the research carried out by Giulio Natta, the production of isotactic polypropylene began in 1957 at the Montecatini company.

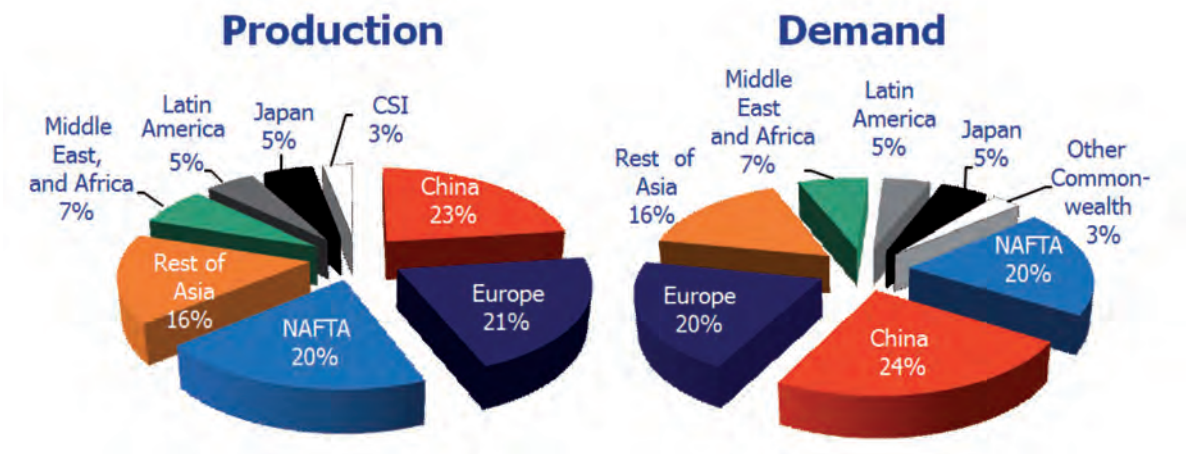


Figure2. Global production and demand of plastics by geographical area (percentage of total), 2012

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

5. In the future, the increase in worldwide demand for plastics will continue at a high rate as the economy and population also grow. According to our simulation, by 2025:

- Global production of plastics will exceed the threshold of **300 million tonnes** to meet growing demand.

- Demand in Africa, Latin America, the Middle East and China will grow by **54%** (from 101 to 156 million tonnes), exceeding that in Europe and the United States (110 million tonnes)[3].

6. Plastics could provide a substantial contribution to the sustainability of **major global challenges** connected with an increase in population, climatic-environmental changes and growing scarcity of natural resources. A recent study conducted on a European-wide scale[4] estimated that substituting plastics with other materials in their main applications would increase packaging weight by nearly four times compared with plastics, a 60% increase in the volume of waste produced, a 57% increase in electricity consumption throughout the entire life cycle and between 78 and 170 million tonnes of additional greenhouse gas emissions.

[3] It is estimated that per capita growth in Europe will increase by 8.1% and by 15.9% in the United States. Source: The European House-Ambrosetti data elaboration, 2013.

[4] Denkstatt GmbH, "The impact of plastic packaging on life cycle energy consumption and greenhouse gas emissions in Europe", 2010. The study involved EU-27 countries plus Norway and Switzerland.

2. Our vision for the future of this sector and guidelines for strengthening the plastics supply chain in Italy and Europe

7. The four main phases of the supply chain — production of primary raw materials, plastics converting, production of rubber and plastics machinery and post-consumption phase — are **closely interrelated**: it must be considered as a whole — including by policy-makers — and not as separate sectors. The plastics industry is also **structurally tied** "up-stream" **to the petrochemical industry**, fundamental to guaranteeing the supply of raw materials.[5]

8. To stimulate growth, especially in the current juncture, Italy and Europe must make a significant manufacturing component the centre of its industrial policies and within this component, the plastics supply chain is a **key element**. A successful vision for the development of the European plastics supply chain must aim at:

i. Maintaining and increasing the competitiveness of traditional production sectors, including those up-stream, through:
   - Defending the integrated production cycle in terms of the efficiency and competitiveness of European chemical clusters (from raw materials to processing).
   - Building on distinctive competencies, including chemistry.
   - Boosting integration in research, both within industry and between industry and academia.

ii. Investing in knowledge-intensive frontiers (integrating traditional sectors with emerging niches), for example, composite materials, "green chemistry" (bioplastics, etc.) and repolymerisation techniques.

9. Italy has a tradition and competitive positioning with examples of **industrial and research excellence** including on a worldwide level; these must be preserved and built upon through incisive choices in order to:

i. Create critical mass (approximately 82% of plastics companies in Italy have fewer than 20 employees: medium-to-large size companies account for 6.2% of the total, compared with an average of 22% in Germany).

ii. Create a major push for innovation, including in conjunction with leading "Made in Italy" sectors.

iii. Build localising factors to maintain the existing industrial base and attract new companies.

iv. Handle the product end-of-life cycle as an **opportunity** (as is the case, for example, in Germany and many countries in northern Europe).

[5] Monomers derived from petroleum refining used in plastics production, which are used, in turn, in processing.

10. To concretise this vision, action must be taken **simultaneously** on two fundamental aspects which could even be considered basic pre-conditions.

- **Industrial policy choices**.
- **Information** and promoting public **awareness**.

Guideline 1:

Promote a proactive industrial policy for the development of the sector and safeguarding the presence of the entire supply chain.

Given the international economic context and the specific needs of the country's supply chain, the **conditions of the national context** ("ecosystem") favourable to the development of existing companies on the basis of competitive standards and the attraction/growth of new companies must be guaranteed. This calls for focused and synergic industrial policy choices, **from the standpoint of an integrated supply chain**, around key issues, the most important being:

- Managing current restraints on development, first and foremost energy and logistics costs and, more generally, existing regulatory and competitive imbalances.
- Implementing (including with the contribution of academia) an *a priori* system of evaluation of the impact of legislation on the supply chain.
- Substantial incentives for collaboration (including partnerships) between government, research bodies and industry.
- De-fiscalisation of R&D investment by companies.
- Orientation of research (and focusing of investments) on applications with high potential in traditional fields of application and emerging niches.

Last but not least, recognising plastics as a macro-sector within national statistical studies unquestionably sends a message—including at the political level—of its importance.

Guideline 2:

Promote a widespread public information campaign on proper use of plastics and "recycling culture".

Today, "plastic" products must contend with the effects within European public opinion of informational ignorance that feeds preconceptions and improper behaviour. In Italy, these preconceptions have reached **singular highs** that render development choices more complex and penalise the nation. This situation must be overcome by taking action to educate the population, as is done in the most successful situations in other countries. Important in this effort would be:

— Launching an awareness campaign, including in collaboration with industry and academia, about the real value and positive contribution—including in terms of sustainability—of plastics for society throughout the entire life cycle and their correct utilisation.

— Stimulating recycling of plastic waste with specially-designed initiatives, including adapting and implementing the best practices found in Europe today.

3. Two proposals for Italy as a point of departure

11. Our proposals for the plastics supply chain in Italy are centred on two key themes:

— The creation of a **national cluster of excellence in plastics** focused on selected areas of strategic development capable of stimulating the industry and research.

— Take advantage of the opportunities offered by the entire plastics cycle, starting from end-of-life.

Proposal 1: Innovation and critical mass

Using a public/private sector model, including for financing, create a large-scale national cluster of excellence in plastics, including systems of production and energy self-sufficiency (return to the integrated cycle).

This proposal responds to the strategic needs to:

— Safeguard the entire plastics supply chain throughout all its phases.

— Foster orientation of research in selected strategic areas and integration with industry.

— Focus on areas of development connected to the nation's clusters of industrial specialisation and "Made in Italy" driving sectors.

— Develop a network of existing areas of excellence in academia and other primary research centres in the country (avoiding duplication).

— Create a further element of attractiveness on an international level for new talent and cutting-edge industrial competencies.

Proposal 2: Second life for plastic

Promote a positioning strategy for Italy through exploitation of the entire plastics life cycle from the standpoint of economic-competitive opportunities.

The motivation behind this proposal is to meet the double goal of:

- Capitalising on the competencies already available in Italy today (industry, technologies, know-how) while developing a major supply chain, including from the standpoint of internationalisation.
- Obtaining significant economic, social and environmental benefits.

To do this, concerted action must be taken on a number of levels:

- Create uniform efficiency (including through specific legislation) throughout the entire waste collection cycle.
- Introduce a ban on disposing of plastic waste in landfills.
- Promote the modernisation (revamping) of waste disposal plants (incinerators) using cutting-edge technologies, by drawing up a simplified regulatory framework and developing de-fiscalisation measures.
- Replicate the best practices existing in Italy today for waste-to-energy in non-recyclable plastics in coal thermoelectric power stations.

4. Potential impacts of a strengthened plastic supply chain for Italy and Europe

12. Significant strengthening of the plastics supply chain could result in **widespread benefits on a number of levels**: economic and industrial development, innovation, attractiveness and quality of life. We have quantified the impacts in terms of:

- Contribution to the overall growth of the European manufacturing sector.
- Increase in employment and GDP generated by the plastics supply chain in Italy.

13. Over the last decade, the European Union has entered a phase of structural change involving significant processes of de-industrialisation. The economic crisis has intensified this trend. The European Commission is currently oriented towards focusing future development of the EU-27 on **growth in the manufacturing sector** with a goal of a 20% share of GDP by 2020.

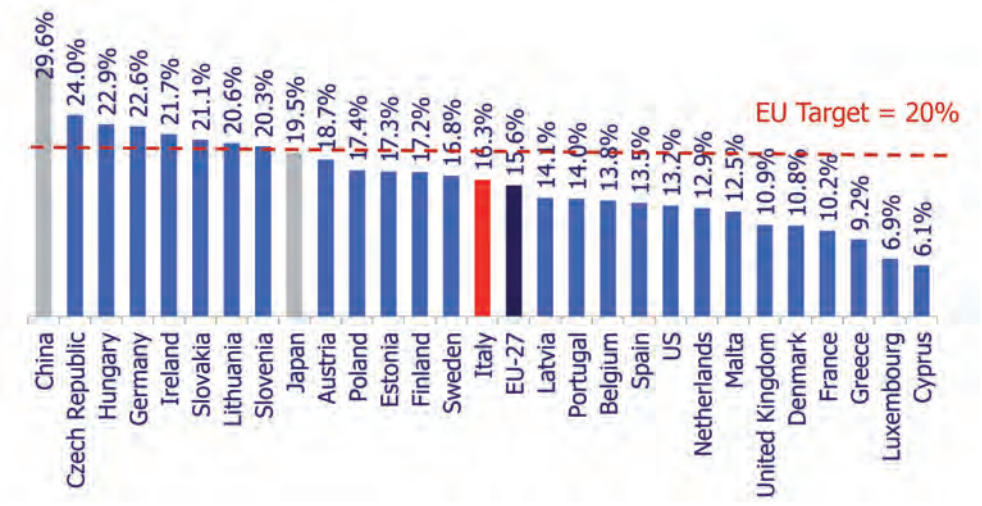


Figure 3. Share of added value of manufacturing in GDP in the EU-27 and in certain global economies, 2011
Source: The European House-Ambrosetti re-elaboration of Eurostat data, 2013

14. The plastics supply chain can contribute substantially to meeting this objective. On the basis of the multiple regression analysis model we have developed that takes into consideration (for the twenty-year period 1992-2012) a number of manufacturing sectors, we have estimated the activation coefficient on the growth rate of added value for this area, all else being equal:

- Plastics is one of the industrial sectors providing the greatest contribution to manufacturing.
- An increase of 10% in added value in the plastics sector could result in a **4.4% increase in the added value of European manufacturing**.

15. In Italy, on the basis of analyses of ISTAT matrices of sectorial interdependence (input-output matrices)[6], the plastics supply chain is **strongly interrelated to other manufacturing activities**:

- For every 100 euros of GDP produced in the plastics sector, 58 euros of GDP are generated in other manufacturing activities.
- For each work unit in the plastics sector, 0.62 are generated in other manufacturing activities.

16. On the basis of the sector's economic and employment activation coefficients, a 10% improvement in overall turnover in the Italian plastics supply chain (+€4.3 billion) could translate into a **0.6% increase in national GDP** (+4.6% in the manufacturing sector) and the creation of **over 40,000 new jobs**.

[6] Different methods and techniques exist for estimating the impacts produced by an industrial sector or area. In our analysis, we used the forecasting method involving direct and indirect impacts and spin-offs on the plastics sector which utilises sector input-output matrices to forecast the effects on the national economy following an increase in GDP and annual work units (AWUs) in the plastics sector.

5. Competitive international positioning of the Italian and European plastics supply chain

17. Plastics is an industrial sector of **primary importance**:

- In Europe, this supply chain employs approximately 1.5 million people in over 62,000 companies with a turnover of about €300 billion.
- In Italy, it is "worth" about 11,000 companies (18% of the EU-27 total), 160,000 employees (11%) and a turnover of €43 billion (14%).

	Companies		Turnover (bln. €)		Employees ('000)	
	UE-27	Italy	UE-27	Italy	UE-27	Italy
Production	2,636	360	89	7	167	13
Converting	54,915	9,410	194	31	1,171	129
Machinery	3,700	900	17	4	100	13.5
Recycling	1,000	300	2	0.5	30	2
Total	62,251	10,970	302	43	1,468	158
		18%		14%		11%

Figure 4. Details of the plastics supply chain in the EU-27 and Italy

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope, EUROMAP, Plastics Recyclers Europe, ASSOCOMAPLAST and ASSORIMAP data, 2013

18. In Italy, this sector has **significant tradition and positioning**:

- It is the second country in Europe, after Germany, with the highest consumption of plastic products.
- The Italian **plastics machinery** industry is nr. 3 in the world in terms of turnover after China and Germany, fourth in terms of export value and third by trade balance.
- Italy is one of the countries at the forefront of innovation, including in emerging sectors such as bio-based plastics and bioplastics.
- In Europe, one plastics recycling company out of three is Italian, with state-of-the-art competencies in terms of competition.

19. Within Italy, this supply chain faces a number of **strategic challenges**:

- Transformation of the chemical industry and resulting impacts on the competitiveness of the plastics supply chain.
- Management of the end-of-life cycle for plastic products.
- Lack of a national perspective on the preconditions for concrete development of the sector.

— Particularly disadvantageous competitive gaps, such as logistics and energy costs which are significantly higher than in other countries, both in Europe and elsewhere.[7]

— The negative perception of public opinion,[8] fed by faulty information that complicates decision-making.

20. These aspects are part of a highly competitive international context that is undergoing change, including the emergence of a number of potentially disruptive factors ("game changers"), such as:

— *The competitive advantage of the U.S. in terms of energy after the discovery of shale gas and shale oil deposits*.[9]

— The growth of **China** on the global scene of plastics production (surpassing Europe in 2010) and plastics machinery.

— The development of the plastics processing sector in **India**[10], above all thanks to the development of manufacturing sectors using these products, such as the automotive industry.

— "Downstream" integration of the supply chain in **oil** and natural gas **producing countries** through external growth channels and massive downstream investment (processing).

— The potential role of **Brazil** (and other Latin American countries) in the production of biofuels and bio-based plastics.

21. The taking effect on January 1, 2014 of the new classification in EC regulations (**General Scheme of Preferences - GSP**) which will cancel or significantly reduce duties on merchandise imported into Europe by a number of emerging countries (specifically East Asian and African)[11] could create significant potential competitive imbalances disadvantageous to the Italian and European chemical-plastics industry. Within this context, a further aspect for consideration are the consumer safety and environmental regulations governing EU-27 chemical companies, such as the measures requested to European firms by the **REACH regulation** on chemical substances and by the **Machinery Directive** related to safety of machineries used in the workplace.

[7] The average impact of electricity costs on turnover is 6% for plastics manufacturing companies and is double this (about 12%) for companies that recycle and sort plastic waste. In Italy, the cost of electricity for industrial use is traditionally 30% higher than the European average. In the last two years, this gap has widened further (especially due to tariffs, the duties set by the Agenzia per l'Energia Elettrica e il Gas and by the Agenzia delle Dogane, which have risen by 116% since 2011) – Source: Federchimica 2012

[8] A survey conducted in six key European markets (Italy, Germany, Spain, France, Poland and the United Kingdom) showed that in Italy 43% of the population has misgivings about plastics, while in Germany—which is very active in terms of social-environmental communications—the share of the population with a negative perception of plastics is quite low (22%).

[9] Shale gas is methane gas produced by unconventional deposits of partially diagenised clay, the result of anaerobic decomposition of organic material contained in the clay. Shale oil is petroleum obtained from new drilling techniques which break up the clay and make it possible to extract the crude oil even found in pores of impermeable rock. The reservoirs of oil shale and bituminous clay are concentrated predominantly in the U.S., with the rest distributed among Brazil, Australia and China.

[10] By 2015 it is expected that the output volume in plastics manufacturing will grow from the current 9 million to 18 million tonnes, with an increase in the labour force from 4 to 7 million.

[11] Starting in 2014 a new tariff system (with preferential duties) to promote European imports from developing economies will take effect. The GSP calls for the abatement of customs duties on a number of product categories chosen by evaluating the potential of the exporting country and the European reference market. There are three potential configurations: 1) Standard GSP (covering 6,350 products) that calls for a reduction in export duties for a number of products classified as "sensitive" (capable of distorting the internal market) and the complete cancellation of duties classified as "non-sensitive"; 2) GSP+ (covering 6,400 products) that calls for the cancellation of duties on sensitive products when the customs duty is comprised of specific, ad valorem duties and the complete cancellation of duties classified as "non-sensitive"; 3) EBA (Everything But Arms) that calls for the cancellation of import duties on both "sensitive" and "non-sensitive" products, with the exception of arms.

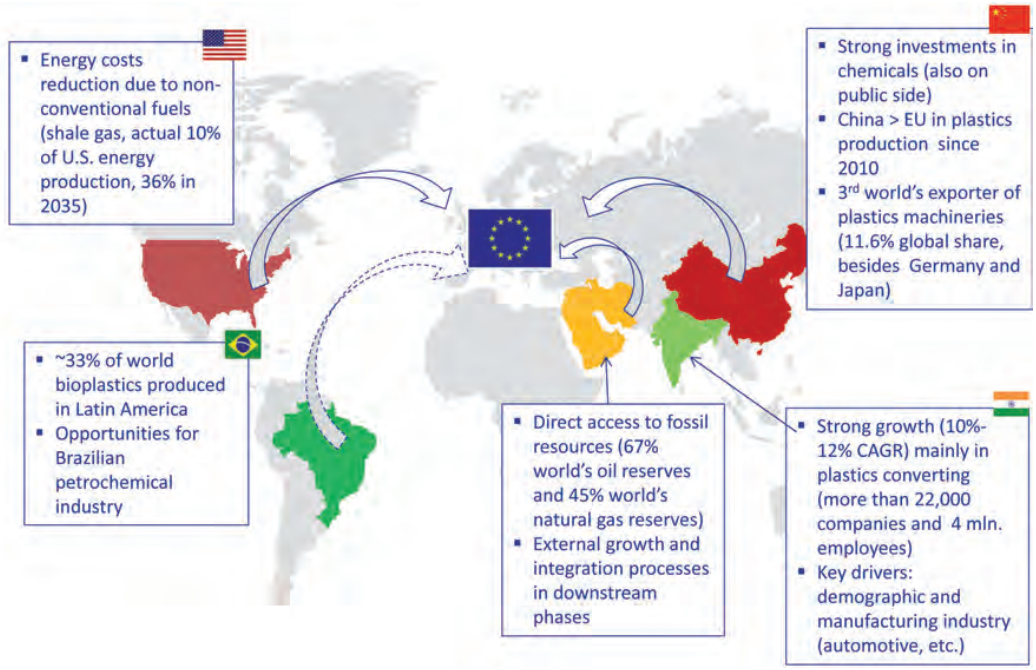


Figure 5. The global geopolitical scene for plastics and the threats to Europe

Source: The European House - Ambrosetti elaboration based on different sources, 2013

Note: CAGR - Compound Annual Growth rate

6. Contribution of the plastics supply chain to the Italian economy

22. Utilising sectoral interdependence matrices (see section 4), we analysed the impact of the plastics sector on the national economy on a number of levels:

- **Direct impacts**, those directly correlated to the sector analysed and relative to the effects produced on the plastics sector production chain itself;
- **Indirect impacts** generated through the production chain comprised of suppliers of goods and services of activities directly linked to the plastics sector;
- **Spin-off effects** generated through expenditure and consumption that are the result of direct and indirect impacts.

23. Analysis was carried out for the plastics sector as identified by ISTAT and for which it provides the following databases:

- Manufacture of products in rubber and plastic;
- Manufacture of chemical products.

Adding to these the contribution of other sectors in the plastics supply chain (machinery, disposal sector, etc.) not currently broken down in input-output tables, even higher values would be obtained.

24. For every euro generated in the plastics sector, the direct and indirect impact and spin-offs on the national economy is € 2.38, of which € 1.13 are "retained" within the sector itself, while € 1.25 are generated indirectly and as spin-offs: 45% in manufacturing, 14% for commerce, 11% for transport and 9% for real estate, research and services to companies.

Therefore, through cross-industry relations (indirect impact) and the increase in demand (spin-off effect) a € 100 increase in GDP in the plastics sector generates **an increase of € 238 in GDP for the Italian economy**.

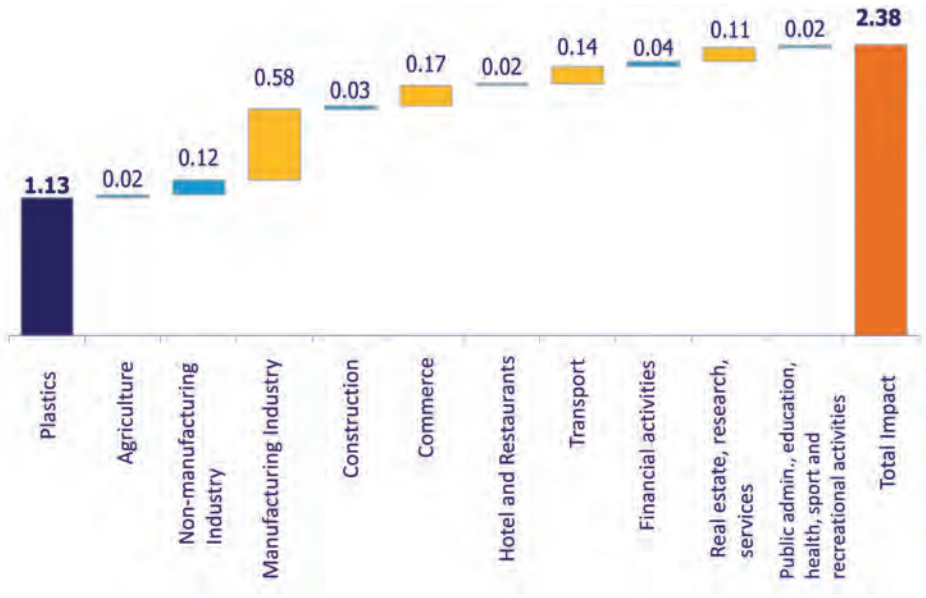


Figure 6. Breakdown of the impact of an increase in GDP in the plastics sector on the overall GDP of the economy as a whole

Source: The European House - Ambrosetti data elaboration, 2013

25. In terms of the multipliers for plastics on employment (annual work unit – AWU), **each unit increment in the plastics sector results in an increase in annual work units in the economy as a whole of 2.74 AWUs**. Of these, 1.10 units are "retained" within the sector itself, while 1.64 AWUs are generated indirectly and as spin-offs: 38% in manufacturing, 18.5% for commerce, 12% for transport and 9% for real estate, research and services to companies.

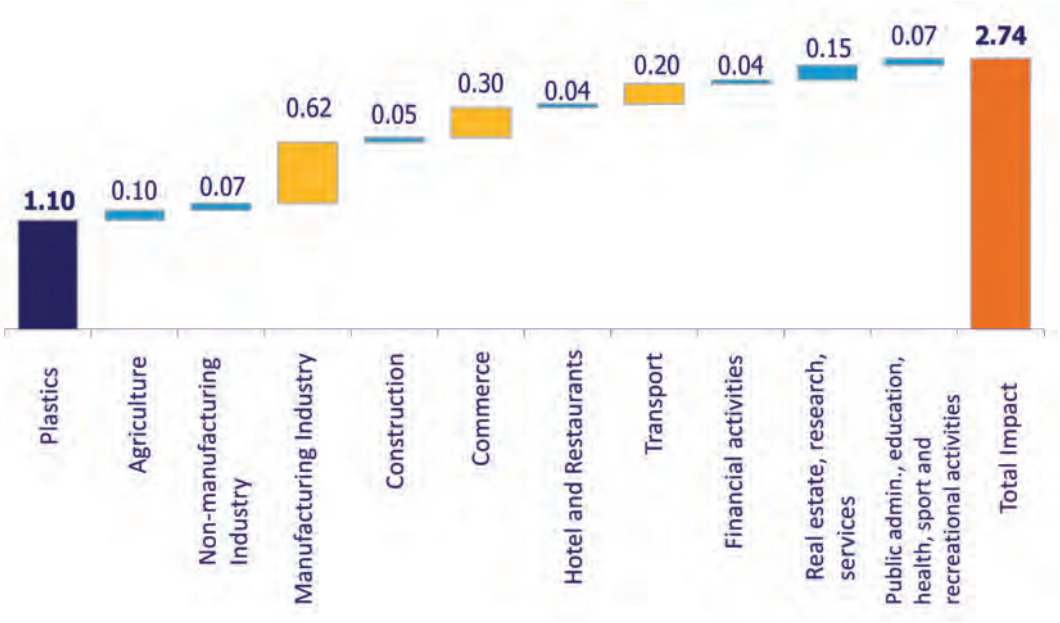


Figure 7. Breakdown of the impact of an increase in Annual Work Unit (AWU) created in the plastics sector on the total AWUs in the economy as a whole

Source: The European House - Ambrosetti data elaboration, 2013

7. Innovation in the plastics sector

26. The plastics sector traditionally has a **high level of innovation**, with major investment in research and development and spill-over into new applications relevant to a number of industrial sectors.

27. The directions taken by research are focused, on the one hand, on improving the properties of plastics to provide enhanced response to modern-day needs for security, low environmental impact, durability, practicality and light weight, biocompatibility and reuse; and, on the other hand, significant opportunities for innovation are provided by modern technologies in machinery to apply to manufacturing of finished products.

28. Cutting-edge applications in plastics are found **throughout the main industrial sectors** with widespread new functions and benefits:

- **Automotive and aerospace**: higher safety standards and enhanced performance (40%-50% lighter in weight compared with alternative materials in a car of medium-power and fuel savings of 750 litres for every 150,000 km travelled).
- **Electronics and mechanics**: meeting the goals of energy savings and lightweight components to create light and flexible flat screens; creation of new polymers for batteries and sensors; high-level opportunities for future development of the 3D printing technology thanks to the use of plastics.

- **Packaging**: new functions in innovation, practicality and safety for food and beverages ("functional packaging").
- **Textiles and clothing**: creation of new fabrics using innovative fibres, recycled plastic and polymer memory fibres ("intelligent textiles") to improve human performance and provide new technical functions.
- **Healthcare and biomedical**: creation of biocompatible prosthesis increasingly less invasive for patient health.
- **Construction**: optimisation of building thermal insulation to save energy, together with the durability, light weight and lower maintenance costs of plastic products.
- **Renewable energy sources**: substitution of traditional materials with plastics to produce components for solar collectors, wind blades and polymer membrane fuel cells (under development).

29. In the future, **composite materials** and **bioplastics**[12] will be two further important sectors: the former thanks, above all, to the development of key sectors such as aerospace and renewable energy sources and the latter to biodegradable/compostable bioplastics (product innovation) as well as non-biodegradable bioplastics (process innovation).

- It is estimated that the global industry of composite materials will reach 27.4 billion dollars by 2016, with an annual average growth rate of +5.3%.
- In 2011, global production of bioplastics was 1.2 million tonnes, compared with an expected increase of 5.8 million tonnes in 2016. With 18.5% of the total volume, Europe, today, is the nr. 3 producer of bioplastics worldwide, behind Asia (34.6%) and Latin America (32.8%).

All the main reference markets in Europe (Germany, France, UK and Spain) have earmarked significant investment to boost their competitiveness in terms of industrial production and research.

For Italy, bioplastics is one of the areas of greatest research intensity, with competitive positioning at international level.

The projects and initiatives being studied by the European Union indicate further potential for the plastics sector, especially in terms of "green" applications. If, on the one hand, the close integration between production of biodegradable bioplastics and development of organic recycling (collected and recycled together with organic products) today represents a limit to their efficient spread on a large scale, on the other hand it opens up wide opportunities for the future, especially in a country such as Italy where the quality of the plastics recycling process is comparable to the average standards in the most advanced countries. In addition to contributing to improving the **disposal of organic waste**, if effectively inserted into an integrated cycle, bioplastics could generate a new market.

[12] This refers to composite materials (especially advanced, high-performance materials obtained from the combination of polymeric resins with fibres, such as carbon and glass) and bioplastics, i.e., plastics derived completely or in part from biological and "renewable" raw materials instead of fossils (carbon, crude oil and natural gas).

8. End-of-life cycle of plastics

30. By **"end-of-life"** is meant those processes carried out at the end of the useful life of a plastic product to give that product a second life. This can occur through:

- **Recycling** and therefore generation of a new product;
- Energy **recovery** from burning waste.

31. End-of-life management is—and will be in the future—of **growing strategic importance**:

- By 2015 a 30% increase in mechanical recycling is expected (from 5.3 to 6.9 million tonnes).[13]
- Disposal and incineration with energy recovery will remain the primary solutions in waste management.

32. In Italy, 3.3 million tonnes of municipal plastic waste were produced in 2011, due to a correlated growth in consumption; **50.9% (1.7 million tonnes)** were collected and recycled (0.8 million tonnes) or used for energy purposes (0.9 million tonnes).

33. The players involved in the end-of-life cycle are:

- **Consumers**: as "producers" of waste, they must be made more fully aware of collection (the starting point for the recycling and recovery supply chain).
- **Business**: which takes part in the **generation** of plastic scrap and waste, in the **collection** of waste and in the **recycling and recovery** of plastic waste.
- **Government**: makes transfers (including monetary) along the supply chain and plans specific agreements/conventions to foster waste recycling.
- **Consortiums**: expert players who act as coordinators of the supply chain by monitoring the situation and providing relevant guidelines.[14]

34. The plastics second life supply chain offers major development potential in Italy:

- A significant share of plastic waste is still disposed of in landfills (1.6 million tonnes, 49.1% of plastic waste collected in the country).
- There are significant **discrepancies** in the collection of plastic waste (ranging from 19.4 kg per capita in northern Italy to 8.9 kg per capita in southern regions) which represent important margins for potential improvement.
- The transformation of plastic waste through **waste-to-energy**[15] – also as a result of public misinformation—is little used: examples from central-northern Europe demonstrate that it is possible to activate successful mechanisms for the co-combustion of waste through modern plants which guarantee that emissions into the atmosphere are contained.

[13] Source: European Commission, Green Paper "A European Strategy for Plastic Waste in the Environment", Brussels, March 2013.

[14] For example, the *Consorzio Nazionale per la Raccolta, il Riciclaggio ed il Recupero degli Imballaggi in Plastica* – COREPLA.

[15] Plastic waste can be processed through waste-to-energy processes because plastic is an excellent fuel, superior on average to diesel oil and can be burned mixed with municipal solid waste (MSW).

— Italy is a net exporter of **plastic** waste and this not only generates costs to the economy but also makes it more difficult to support the development of the national waste disposal supply chain, to the benefit of operators in other markets.

35. Upgrading the entire plastics second life cycle in Italy could improve the **national context** in support of the **spread of "end-of-life" awareness** that could create synergies (together with plastics manufacturing, processing and machinery-producing industries) with the competencies Italy has in developing waste collection, recovery and recycling models. This would make it possible to give **plastics recycling and recovery a central role in waste management**. Italy should be looking to the **successful experiences** promoted for some time in central-northern European countries which have achieved major results in recycling/energy recovery including meeting the goal of "zero plastics to landfill" (for example, in Germany between 2004 – the year the law prohibiting disposal of plastic waste to landfill came into effect – and 2011, the share of plastic destined for energy recovery rose from 38% to 56%, while that subject to mechanical recycling rose from 37% to 42%).

PART I

THE FUTURE OF THE PLASTICS SUPPLY CHAIN IN ITALY AND EUROPE

1. Plastic is an essential material for today's and tomorrow's society and industry

KEY MESSAGES OF THE CHAPTER

— **Plastics are present in all aspects of daily life**. There are many diversified sectors and modes of application: from transport to construction, telecommunications to basic commodities, food to healthcare, with a growing replacement process with regard to other materials.

— The production of plastics worldwide has grown **at sustainable rates** since the 1950s (average rate of 8.7%), with only two interruptions, namely during the oil crisis of the 1970s and the economic and financial crisis of 2008. World plastics production has grown by nearly 9 times since the 1970s, compared with 4.5 times for aluminium and 2.5 times for steel.

— The production of plastics tends to be uniformly divided between the main macrogeographical areas. **Europe is the world's number two producer** (21% of the total), after China.

— Worldwide demand for and production of plastics will continue to grow at a high rate as the economy and population also grow. A simulation we conducted on the development of the *per capita* demand for plastics in relation to *per capita* GDP in the 2012-2025 timeframe shows that by 2025, global production should go from the current 235 million tonnes to over 300 million tonnes to meet the growing demand, with the emerging economies playing a driving role: demand in Africa, Latin America, the Middle East and China will increase by 54%, compared with 21% in Europe and the U.S.

— The plastics sector will be able to meet **the current and future needs of our society**, responding to the main challenges, including sustainability, that will emerge in the coming years owing to the mega trends that are taking shape at global level, including: the population explosion and socio-demographic changes, climate and environmental change, the risk of a potential energy crisis and the exponential acceleration of technological development.

Origins, production process and areas of application

1. Plastics are one of the primary entirely man-made materials not found in nature, although they are comprised of organic substances. Plastics are made in fact of raw materials that include petroleum (by-products of its refining process), natural gas, carbon, common salt and other products. Many plastics were originally made with vegetable resins, such as cellulose (from cotton), oils (from the seeds of certain plants), and starch and carbon derivatives. Today, most plastics are made from **petrochemicals** (approximately 4% of the oil used at global level). From the chemical viewpoint, plastics are artificial materials with macromolecular structures,[1] which under certain conditions of temperature and pressure, can undergo permanent variations.

2. Plastics have many **advantageous characteristics** compared to metal and non-metal materials: they are easy to process, economical, and easy to colour; they can be used for acoustic, thermal, electrical and mechanical insulation; they are resistant to corrosion and chemical inertia, as well as waterproof and resistant to attacks by mildew, fungi and bacteria. There are three main categories of plastics:

- **Thermoplastics:** plastics which become malleable under heat and can be modelled or shaped into finished objects, and then made rigid by cooling. This process can be repeated several times depending on the quality of the plastics.
- **Thermosets:** thermosetting plastics are a group of resins that after an initial moulding phase when heated, are hardened by the three-dimensional cross linking effect; they are formed in the moulding phase by the combined effect of heat and pressure, and once hardened, have a resistance comparable to that of certain metals.
- **Elastomers:** these are synthetic or natural polymers with a characteristic elasticity that, with the application of force, can be stretched up to 10 times their initial length. This is made possible by their particular molecular structure, composed of monomers linked together to form long chains which, when stretched, return immediately to their initial state once the external force has ceased to be exerted on the polymer.

3. The industrial processes used to obtain plastics consist of two phases:

- Process for treating petroleum derivatives (*cracking*) by which the long chains of the hydrocarbon molecules of petroleum are broken, and each of them is fractioned into far smaller molecules (known as monomers), which are then reunited and connected in long chains.
- Process for polymerisation and the creation of polymers, each of which has different properties, structures and dimensions, depending on the different types of basic monomers.

  Chemical and/or biotechnological processes by which renewable raw materials (i.e. vegetable oils, lignocellulosic waste, starch) are converted into monomers.

[1] Plastics are formed by polymers, long chains of atoms. There are natural polymers such as cellulose, silk or wool.

The most widely used polymers are derived primarily from a few basic petrochemical products, particularly: **ethylene, propylene, butadiene, benzene, oluene, m-xylene** and **p-xylene** and **styrene.**

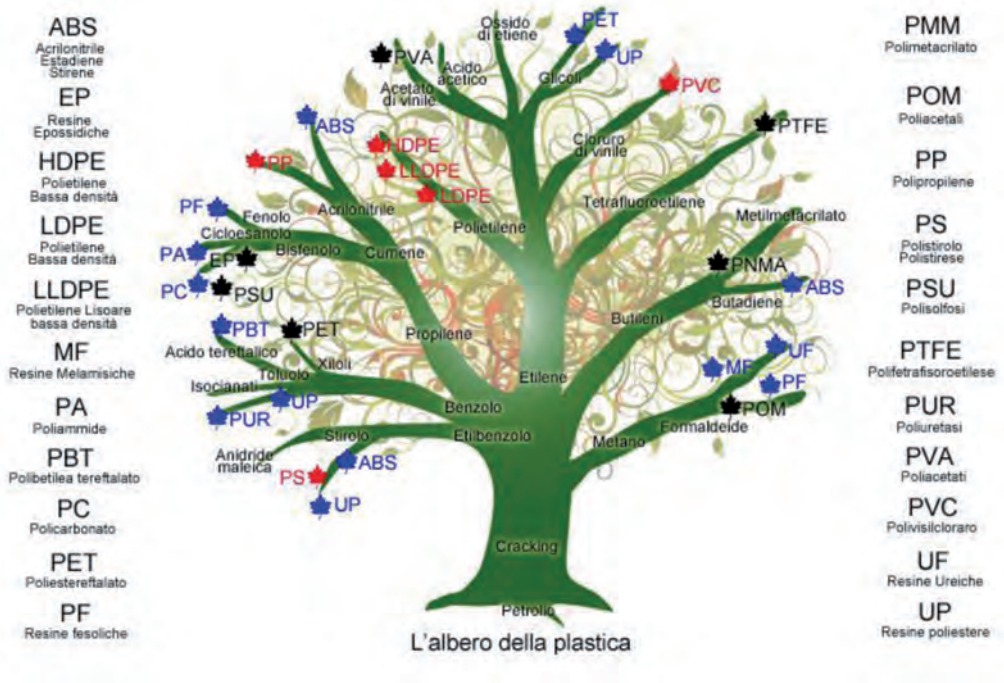


Figure 1. Tree of plastics derived from petroleum

4. There are many diversified sectors and modes of application. Today, plastics are present in **all aspects of daily life**, from transport to construction, telecommunications, consumer goods, food products and healthcare.

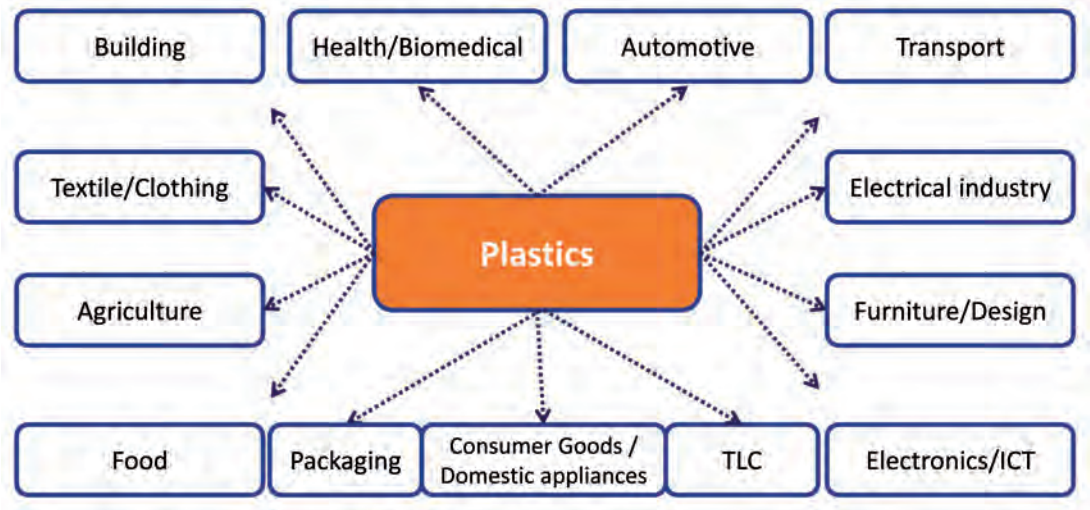


Figure 2. Sectors in which plastics are used: some examples

Source: The European House – Ambrosetti re-elaboration, 2013

Growth in the production of plastics, yesterday and today

5. Starting in the 1950s[2], worldwide production of plastics showed an average annual growth rate of 8.7%, with only two interruptions, namely during the oil crisis of the 1970s and the economic and financial crisis of 2008.

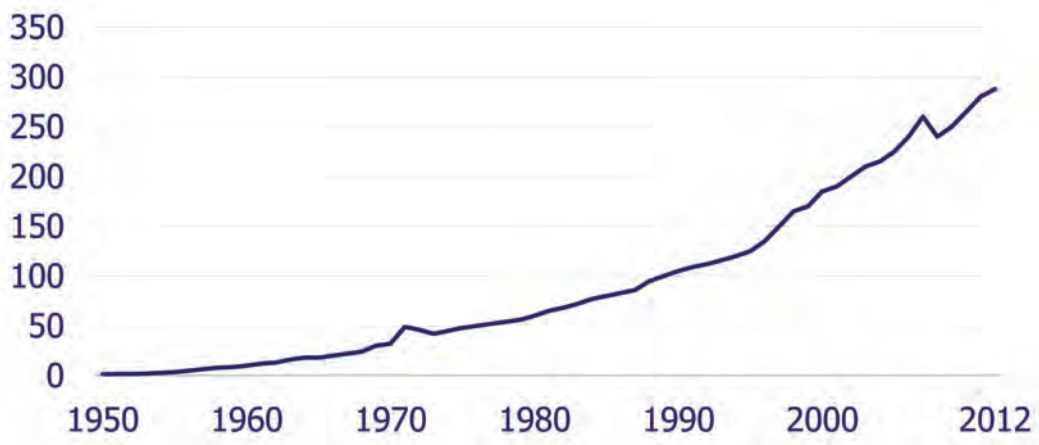


Figure 3. World plastics production (million tonnes)
Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

A comparison with the world production of other materials shows that plastics production **has grown by nearly 9 times** since the 1970s, compared with 4.5 times for aluminium and 2.5 times for steel. These differences in growth rates can be traced to research-related developments, the discovery of new applications and innovative materials, and **the gradual substitution of other materials** (i.e. metals, glass, etc.).

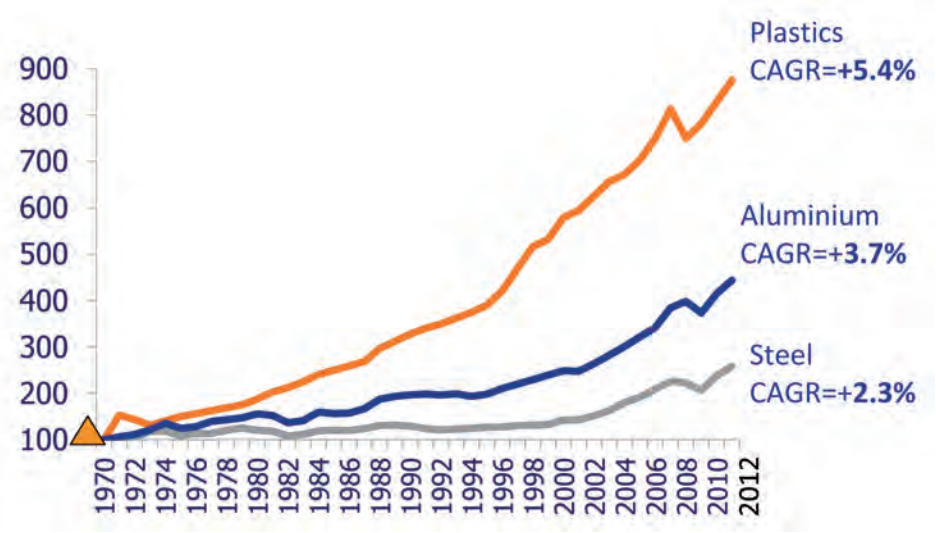


Figure 4. World production of plastics, aluminium and steel (index number; 1970 = 100), 1970-2011
Source: The European House - Ambrosetti re-elaboration of PlasticsEurope Market Research Group, World Steel Association and World Aluminium data, 2013

[2] In Italy, thanks to the studies of Giulio Natta, production of isotactic polypropylene started at Montecatini in 1957.

6. The production of plastics is uniformly divided between the main macrogeographical areas, with a **growing role of the emerging economies**, first and foremost China, with 23% of production. Production of plastics in Europe and North America (NAFTA) amounts to 41%.

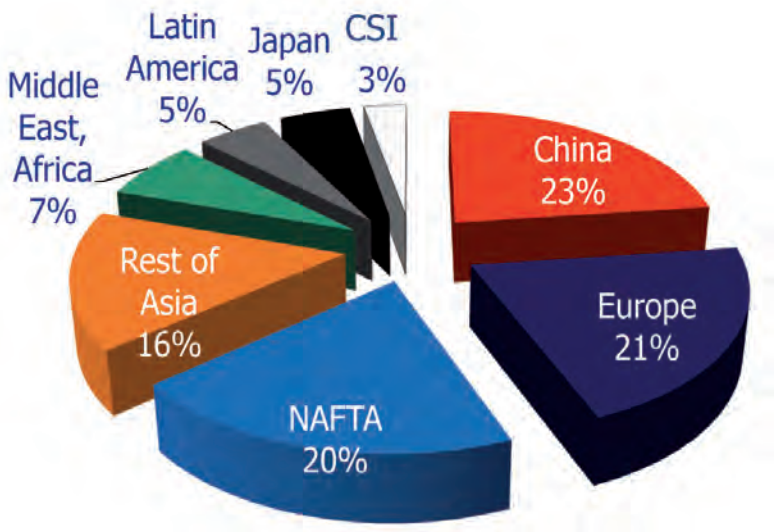


Figure 5. World production of plastics per geographic area (percentages of the total) 2012

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

Note: NAFTA = Mexico, USA and Canada

7. The world demand for plastics reflects the consumption patterns of the industrialised economies on the one hand, and the gradual growth of China and emerging countries on the other. Here once again, China "consumes' more plastics than Europe or North America as a whole.

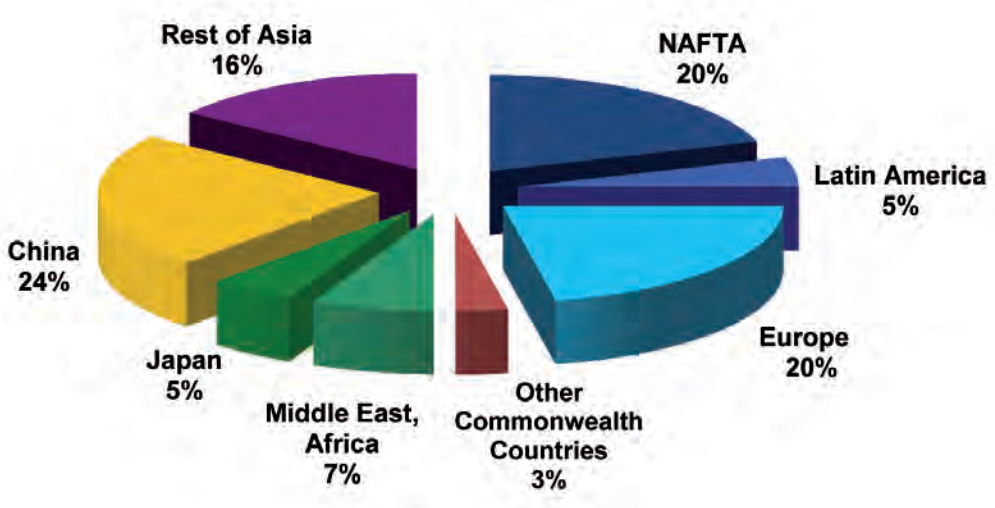


Figure 6. World demand for plastics per geographic area (in percentage) 2012

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

Impacts of demographic and economic development on the consumption and production of plastics

8. The various ways in which world production is absorbed can be gauged also from the growth in per capita consumption of plastics. For example, China has tripled its *per capita* consumption of plastics since the 1980s.

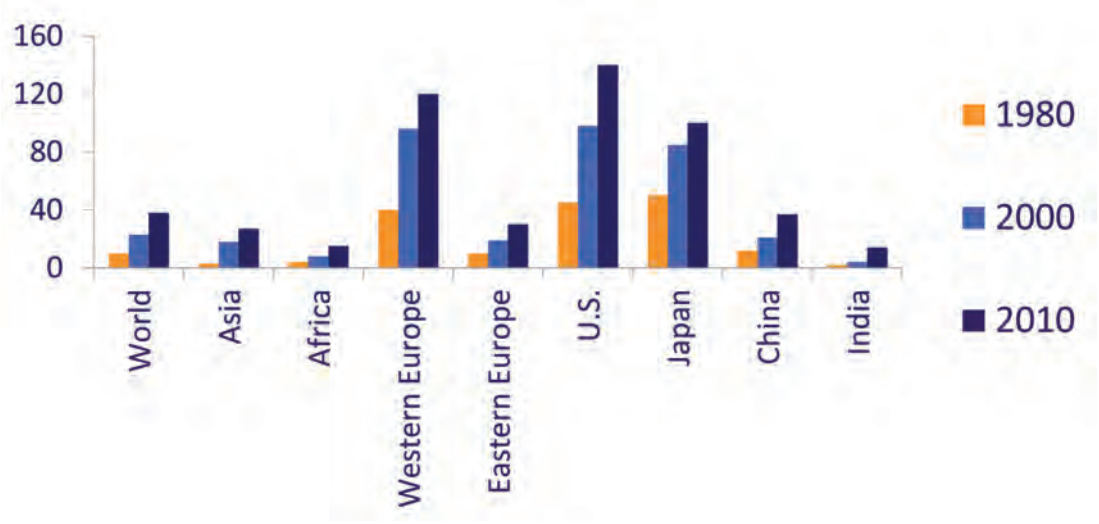


Figure 7. Growth in per capita consumption of plastics per macrogeographic area (kg/inhabitant), 1980-2010
Source: The European House - Ambrosetti re-elaboration of National Institute of Technology data, 2013

9. Worldwide demand for and production of plastics will **continue to grow at a sustained rate** as the per capita GDP and population also grow. We conducted a simulation on the development of the *per capita* demand for plastics in relation to *per capita* GDP in 4 continental blocs (Africa, Europe, Latin America and the Middle East) and 5 countries (China, Italy, Germany, Japan and the U.S.) in the 2012-2025 timeframe:

- Today, the 4 continental areas, plus China, Japan and the U.S., account for **more than 90%** of the world consumption of plastics.
- In **2025**, world production of plastics is expected to go from the current 235 million tonnes (PlasticsEurope data, excluding 45 million tonnes of other plastics) to over 300 million tonnes to satisfy the growing demand.
- By 2025, the demand of emerging countries (in Africa, Latin America, the Middle East plus China) will increase by **54%**, from 101 to 156 tonnes, compared with a **21%** increase in Europe and the United States (from 91 to 110 million tonnes).[3]

[3] *Per capita* consumption is expected to go up by 8.1% and 15.9% in Europe and the U.S. respectively. Source: The European House – Ambrosetti elaboration, 2013.

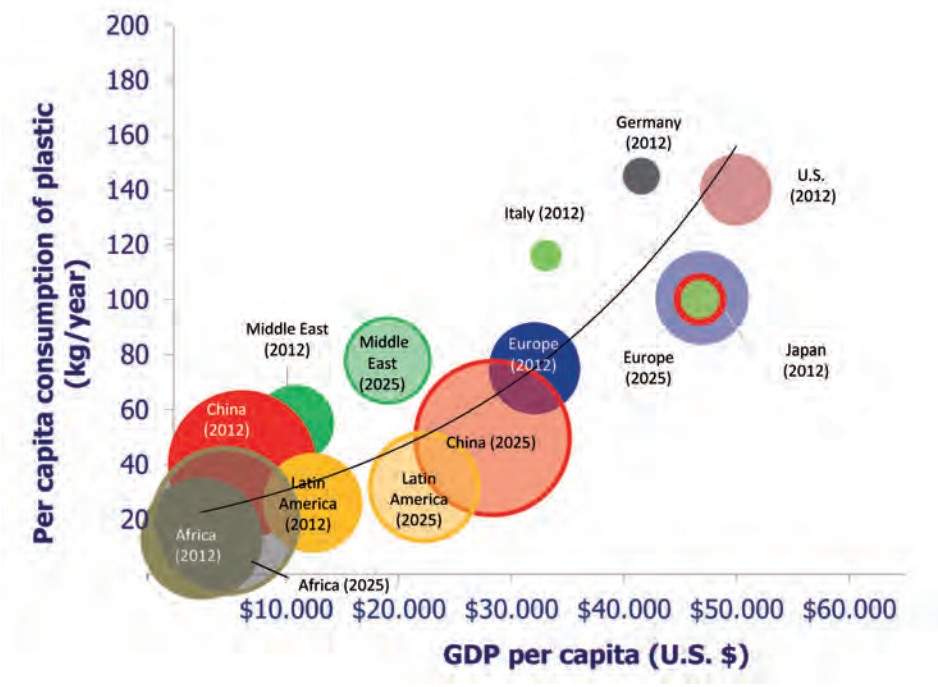


Figure 8. Growth in per capita consumption of plastics (kg/year) in the light of the per capita GDP growth rate ($), 2012-2025

Source: The European House – re-elaboration of PlasticsEurope, IMF and FAO data, 2013

Note: The sizes of the balls indicate the total population of the geographic area considered.

	2012	2025	fluctuation %
U.S.	140	162	+15.8%
Europe	93	103	+10.8%
Middle East	55	81	+46.8%
Japan	100	102	+2.0%
China	40	50	+26.1%
Africa	13	20	+55.0%
Latin America	26	33	+25.4%
Italy	116	132	+13.7%
Germany	145	151	+4.2%

Figure 9. Growth in per capita consumption of plastics (kg/year) in light of the growth rate in per capita GDP ($), 2012-2025

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope, IMF and FAO data, 2013

10. One of the main elements used for the production of plastics is a by-product from the *cracking* of petroleum, **ethylene**. The aim of our analysis is to understand the production scenarios brought about by the significant increase in the worldwide consumption of plastics:

— Today, more than **90%** of ethylene production worldwide is used to make plastics.

— Europe produces approximately **23%** of the world's ethylene,[4] even if the larger plants are concentrated primarily in Asia and the U.S. More specifically, five of the main ethylene producing plants in the world are in North America, with a production capacity exceeding 10 million tonnes per year (or about 30% of the North American production).

— The production capacity in the world is gradually relocating to the Middle East and China, even though the U.S. and Canada have made major plans to boost production.

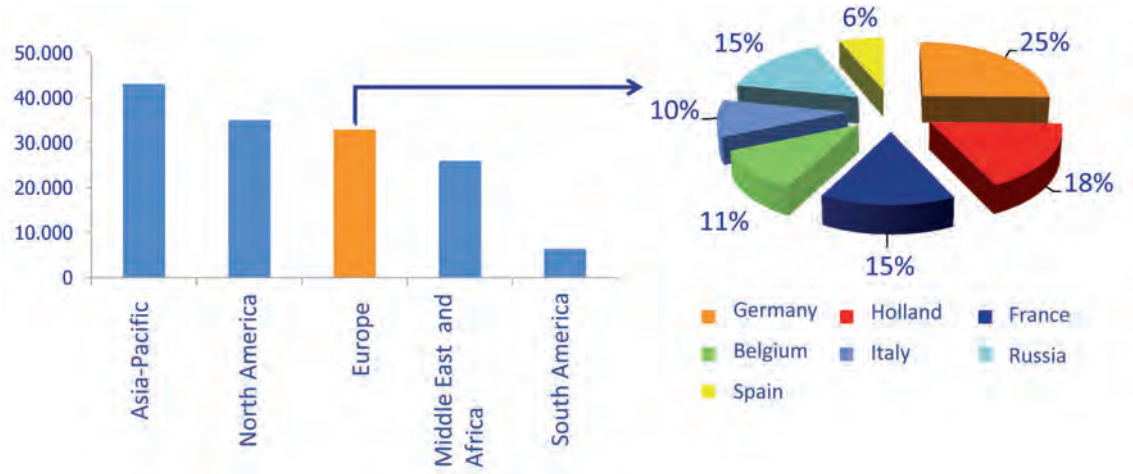


Figure 10. World ethylene production (in million tonnes) and distribution in Europe (in percentage), 2012

Source: The European House - Ambrosetti re-elaboration of Oil & Gas Journal data, 2013

Figure 11. World production of ethylene (million tonnes), 2013

Source: The European House - Ambrosetti re-elaboration of Oil & Gas Journal data, 2013

[4] Including Russia.

— To sustain the production of plastics in 2025, some 190 million tonnes of ethylene will be needed worldwide, compared with 140 million tonnes at present. The increase in production capacity will be concentrated primarily in:

  - The **Middle East** (+89%), thanks to the significant availability of raw materials and the will to activate an integrated cycle on petrochemical products.

  - The **U.S.** and **Canada** (+30%), thanks to the recent discoveries in shale gas deposits and renewed competitiveness on international markets thanks to the depreciation of the dollar.

  - **China** (+45%), due to the need to meet internal demand for by-products from the *cracking* of petroleum.

Global megatrends in the near future and the contribution of plastics to sustainability

11. The plastics sector will be able to meet the current and future needs of our society, responding to the main challenges of the coming decades relating to the mega trends that are taking shape at global level[5]:

— the population explosion and socio-demographic changes;

— climate and environmental change;

— the risk of a potential energy crisis;

— the growing globalisation of the markets;

— the exponential acceleration of technological development;

— the challenges in health and medicine (prevention of diseases and longevity).

12. The increase in the demand for basic inputs for the production of plastics is justified by the scope of the areas of application and the afore-cited mega trends in the medium and long term: plastics constitute a driver for technological innovation to improve the quality of life, thanks to their use in new applications and innovative products, which entail the development of new technologies and new production processes, and the introduction of new materials on the market. Plastics today provide the **best solutions** for innovative applications in some of the sectors with more intensive investments in R&D.

[5] Cf. inter alia, R. Hammond, "The World in 2030," Editions Yago, 2007.

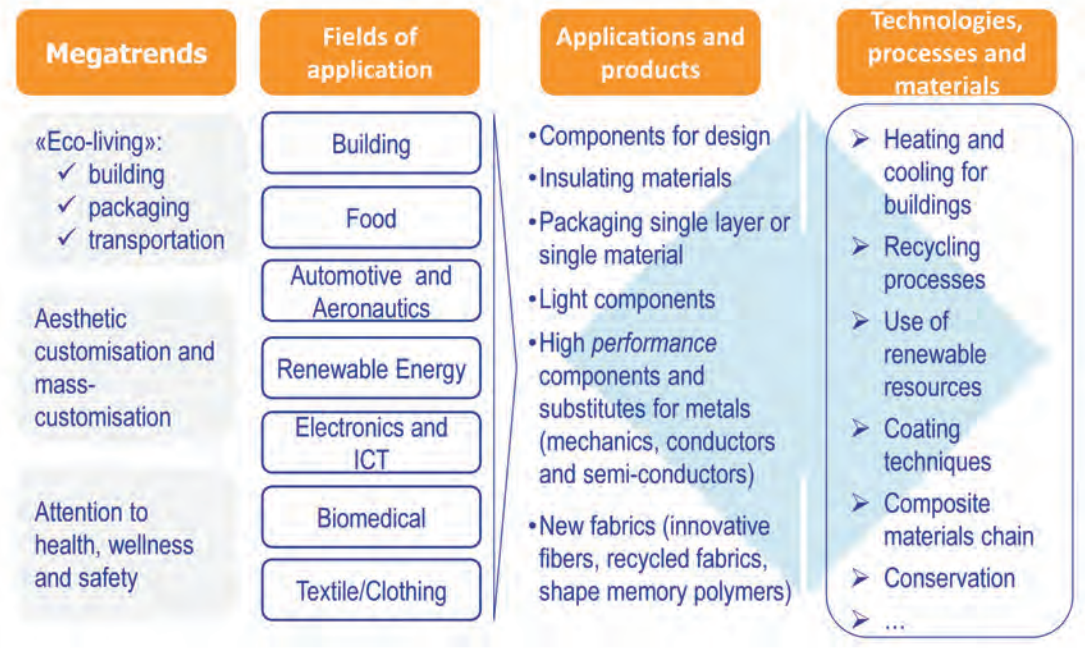


Figure 12. Impacts on mega trends on fields of application and the plastics industry (applications/products, technologies, processes, materials): an interpretative table

Source: The European House - Ambrosetti elaboration from various sources, 2013

To cite a few examples (for a more in-depth treatment, cf. Chapter 7):

- Applications in the ***automotive*** and ***aerospace*** sectors help obtain high safety standards in motor vehicles and better performance levels in aircraft (carbon fibre reinforced polymers).
- Applications in the **biomedical industry** already make it possible to produce to increasingly less invasive biocompatible prostheses and will continue to do so.
- The use of PET in the **food industry** has revolutionised the way we conceive of the useful life of products. Now, *packaging* is the best solution for preserving the nutritional and qualitative properties of foodstuffs, including as regards access to food in various parts of the world.
- In **construction**, new polymer-based material can help optimise the thermal insulation of buildings and thus conserve energy.
- The **textile-clothing sector** is already experimenting with new fabrics using innovative fibres, fabrics made of recycled plastic fibre and shape memory polymers (known as intelligent fabrics).

Energy and environmental advantages of using plastics

13. The positive properties of plastics moreover make them **difficult to replace** with other materials with the same overall cost-benefit balance. A recent study conducted on a European scale,[6] assessed the potential impacts of a substitution in the main applications (*packaging*, finished products, etc), in terms of weight, energy consumption and greenhouse gas emissions during the entire life cycle of the product. According to the study, the replacement of plastics with alternative materials in Europe (including irreplaceable plastics):

- Would increase the weight of packaging **by nearly 4 times** compared with the use of plastic packaging (with an accompanying increase of ca. **60% in the volume of waste produced**).

- Energy consumption during the entire life cycle would increase by ca. 2,140 GJ per year, and greenhouse gas (GHG) emissions would go up by 110 million tonnes of CO_2 equivalents per year. Any replacement of plastics used today, even if possible, would cause an **annual increase in energy consumption of 57%** (1,500 – 3,300 GJ per year) during the entire life cycle.

- **Greenhouse gas emissions would go up by 78-170 million tonnes (+61%).** In other words, the energy savings obtained from the use of plastics on the market today amounts to 2,400 GJ per year.

In addition, the greenhouse gas emissions avoided through the use of plastics are equivalent to the GHG emissions produced by a country like Belgium in one year (year 2000 data) and to 39% of the target imposed on the EU-15 by the Kyoto Protocol with reference to the reduction of GHG emissions in the atmosphere.[7]

[6] Denkstatt GmbH, *"The impact of plastic packaging on life cycle energy consumption and greenhouse gas emissions in Europe"*, 2010. The analyses carried out pertain to the EU-27 Member States plus Norway and Switzerland.

[7] The energy savings attributed to the use of plastics varies depending on the application, with packaging accounting for greater such savings; the use of recycled plastics in packaging is estimated to reduce CO_2 emissions from the entire life cycle of the product by 27%.

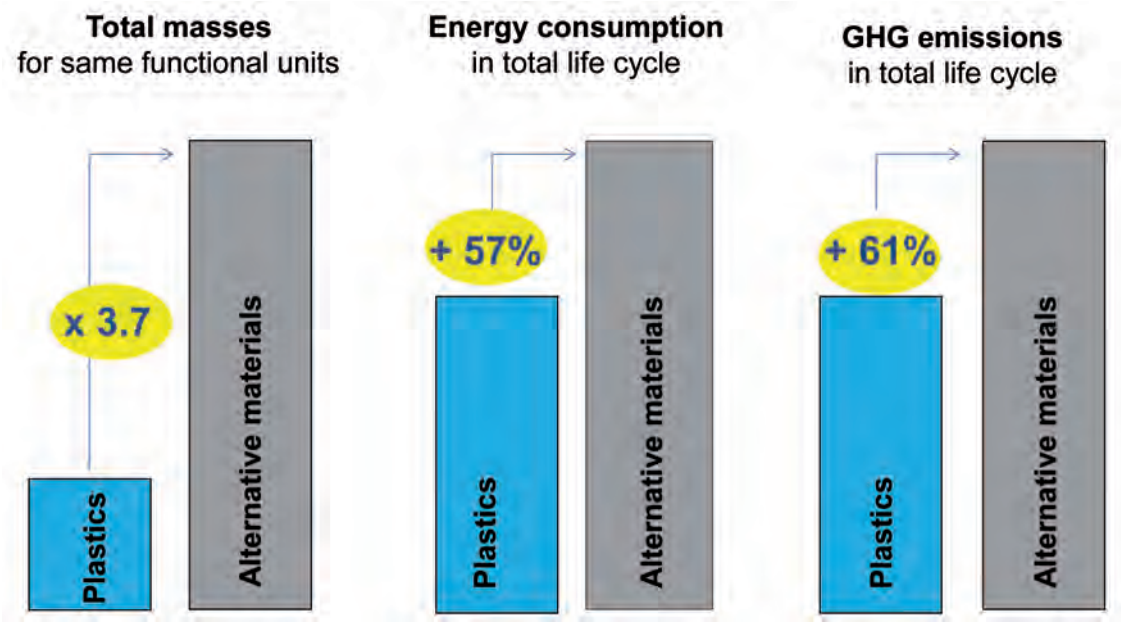


Figure 13. Assessment of a hypotetical replacement of plastics with alternative products in Europe (EU-27 + Norway and Switzerland) in terms of weight, energy consumption and environmental impact

Source: Denkstatt GmbH, "The impact of plastics on life cycle energy consumption and greenhouse gas emissions in Europe", 2011

2. Our vision for the future of this sector and guidelines for strengthening the plastics supply chain in Italy and Europe

KEY MESSAGES OF THE CHAPTER

— The four main phases of the supply chain — production of primary raw materials, processing of plastics, production of rubber and plastic machinery and post-consumption phase — are **closely interrelated**: it must be considered as a whole — including by policy-makers — and not as separate sectors. The plastics industry is also structurally tied "up-stream" **to the petrochemical industry**, fundamental to guaranteeing the supply of raw materials.

— Italy has a tradition and competitive positioning (**18% of the companies, 14% of the turnover and 11% of the employees** of the entire European chain supply), with industrial and research excellence, including on a world level.

— The national plastics supply chain has certain priority strategic requirements:

- Create critical mass by creating **large industrial clusters**.
- Create a major push for innovation (including in conjunction with leading "Made in Italy" sectors), capitalising on distinctive competencies.
- Build **localising factors** to maintain the existing industrial base and attract new companies.
- Handle the product end-of-life cycle as an **opportunity**, in the light of high-level national competencies already available (companies and technology).

— A **concrete vision** for the development of the plastics supply chain must focus on maintaining and increasing the competitiveness of traditional production sectors, including upstream from the plastics supply chain, by taking action in two key areas, namely to:

- Promote a (proactive) industrial policy for the **development of the sector and safeguarding the presence of the entire supply chain**.
- Promote a **widespread public information campaign** on proper use of plastics and "recycling culture".

The plastics supply chain is a key component of manufacturing and the economy for Italy and Europe

1. The plastics industry is an **integrated supply chain** that comprises the:

- **Production of primary plastic raw materials:** companies that produce polymers, the raw materials for subsequent processing phases of plastics.
- **Processing of plastics:** this segment comprises processing companies (converters) which use various processes[1] to obtain semi-finished or finished products from plastics.
- **Production of rubber and plastic machinery:** this segment, which is part of the broader instrumental mechanics sector, consists of companies that make machinery, auxiliary equipment and moulds for processing plastics.
- **Post-consumption phase:** comprises all operators who deal with the management of what is known as the end-of-life of plastics, or companies that recycle and regenerate plastics (including pre-consumption), by reintroducing scrap, rejects or remnants of regenerated or recycled plastics in the production cycle.

2. All four phases of the supply chain are **closely interrelated:** it must be considered as a whole — including by policy-makers — and not as separate sectors. The plastics industry is also **structurally tied** "up-stream" **to the petrochemical industry**, fundamental to guaranteeing the supply of raw materials (monomers derived from petroleum refining and used to make plastics, which are in turn used in the converting processes).

[1] The plastics converting processes are: extrusion, injection, compression moulding, injection moulding, thermoforming, rotational moulding and calandering.

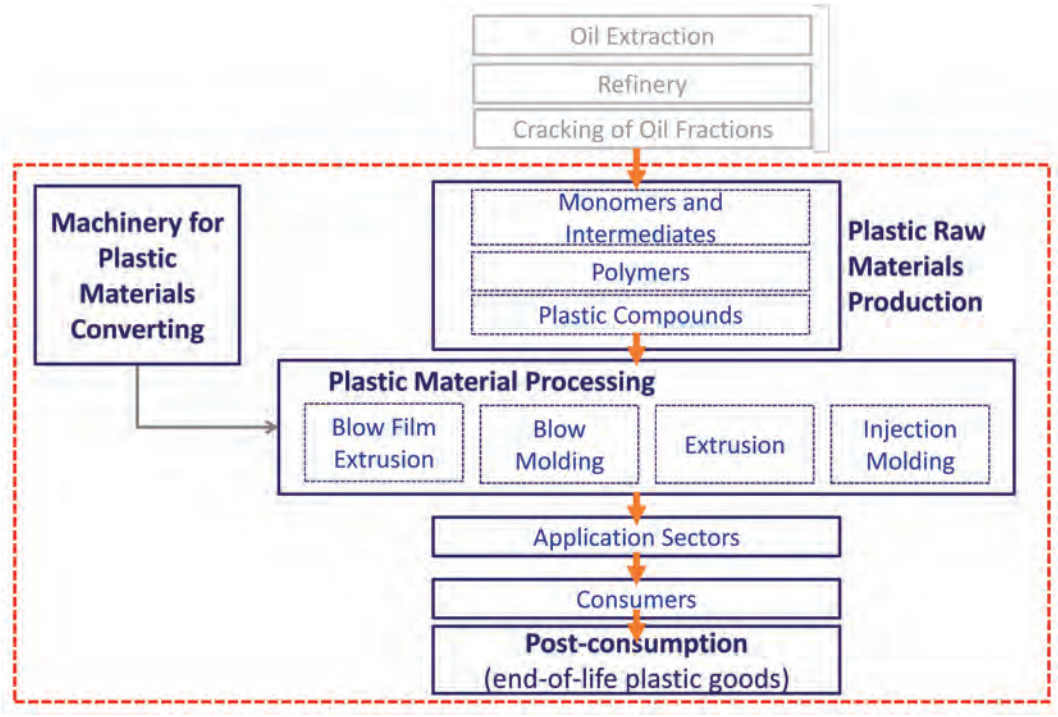


Figure 1. Structure of the plastics supply chain

Source: The European House – Ambrosetti elaboration, 2013

3. In Europe, the sector employs some 1.5 million workers, in over 62,000 companies, and generates a turnover of approximately €300 billion.

	Companies		Turnover (bln. €)		Employees ('000)	
	UE-27	Italy	UE-27	Italy	UE-27	Italy
Production	2,636	360	89	7	167	13
Converting	54,915	9,410	194	31	1,171	129
Machinery	3,700	900	17	4	100	13.5
Recycling	1,000	300	2	0.5	30	2
Total	62,251	10,970	302	43	1,468	158
		18%		14%		11%

Figure 2. Details of the plastics supply chain in the EU-27 and Italy

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope, EUROMAP, Plastics Recyclers Europe, ASSOCOMAPLAST and ASSORIMAP data, 2013

4. The European plastics industry has registered **export growth** (+6.3% and +5.2% on average per year between 2005 and 2011 for production and converting respectively), with a **constant trade surplus** (€20 billion in 2011, 61% attributable to the production of plastics).

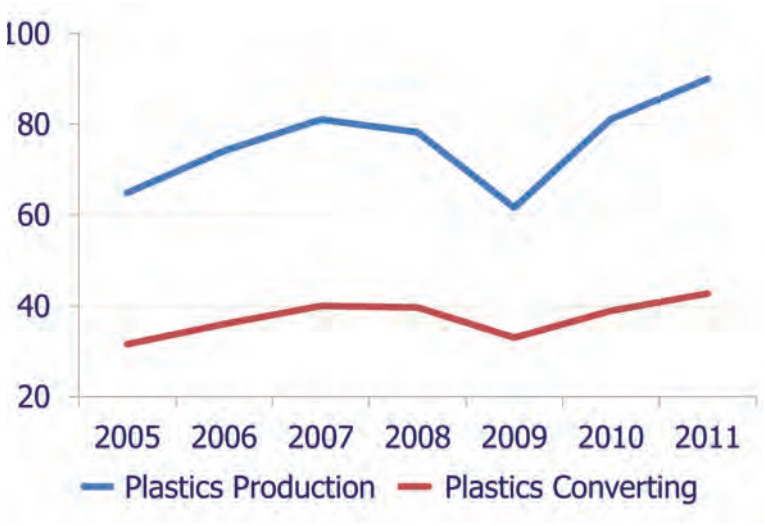


Figure 3. Details of plastics production and plastics converting in the EU-27 (in billion euro), 2005-2011
Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

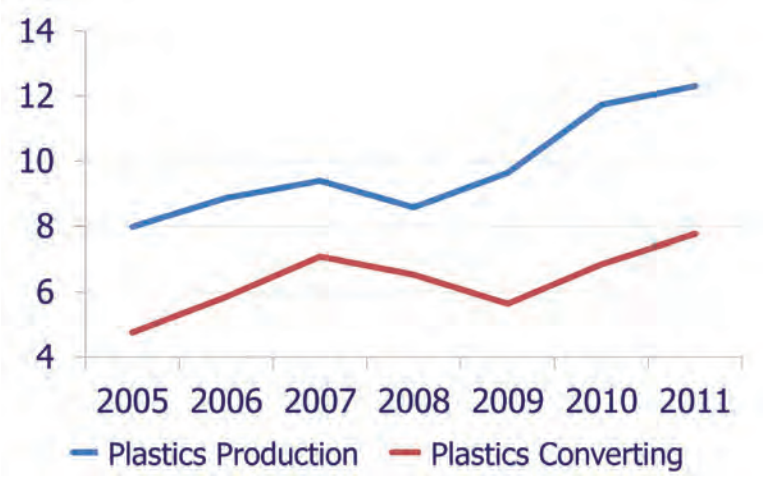


Figure 4. Details of the trade balance of plastics production and plastics converting in the EU-27 (in billion euro), 2005-2011
Source: The European House - Ambrosetti re-elaboration of PlasticsEurope, data 2013

5. The plastics supply chain is **significantly developed** in Italy, "worth" about 11,000 companies (18% of the EU-27 total), nearly 160,000 employees (11%) and a turnover of approximately €34 billion.

Exports of plastics and machinery manufacturing have returned to growth since 2009, and the balance of trade has remained positive. The only exception is the production of plastics (- €3.5 billion in 2012), in as much as our country, the consumption of plastic raw materials (6.8 million tonnes) peculiarly exceeds production (4.3 million tonnes).

	Plastics production	Plastics converting	Plastics machinery	Plastics waste recycling	
Companies	360	9,410	900	300	~11,000
Employees	13,000	129,000	13,500	2,000	158,000
Turnover (bn €)	7.1	31.0	4.0	0.5	~43 bn €
Export (bn €)	5.7	12.2	2.6	n.d.	
Trade balance (bn €)	-3.8	5.9	1.9	n.d.	

Figure 5. Characteristics of the plastics supply chain in Italy

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope, ASSOCOMAPLAST and ASSORIMAP data, 2013

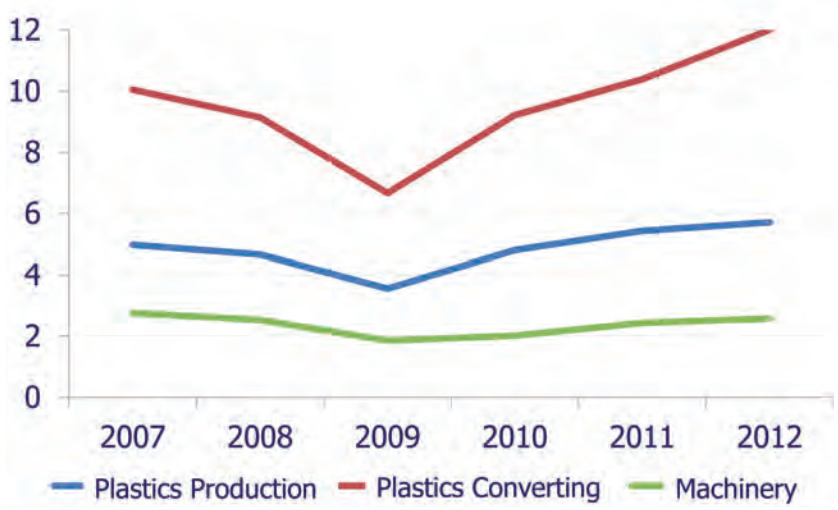


Figure 6. Details of plastics production and plastics converting exports in Italy (in billion euro), 2007-2011

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope and Istat – Coweb data, 2013

6. With reference to Europe as a whole, Italy accounts for **18% of the companies, 14% of the turnover and 11% of employment**, reaching significant levels within the individual phases as well; for instance:

- Italy is the second country in Europe, after Germany, for **consumption** of plastic products.
- Italy generates nearly one fourth of the turnover of the machinery industry for plastics, and is **second only to Germany**.
- In Europe, one plastics recycling company out of three is Italian.

	Companies	Turnover (billions €)	Employees ('000)
Production	14%	8%	8%
Converting	17%	16%	11%
Machinery	24%	24%	14%
Recycling	30%	25%	7%
Total	18%	14%	11%

Figure 7. Weight of the Italian plastics supply chain in the EU-27 (in percentage)

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope, ASSOCOMAPLAST and ASSORIMAP data, 2013

Our vision for the future of the Italian (and European) plastics supply chain

7. To return to growth at the current historical moment of the economic crisis, Italy (and Europe) must focus on a significant manufacturing component in their industrial policies, and the plastics supply chain is a **key mainstay** of that component.

8. Italy has a tradition and competitive positioning with indubitable excellence and areas – particularly upstream – that require punctual measures.

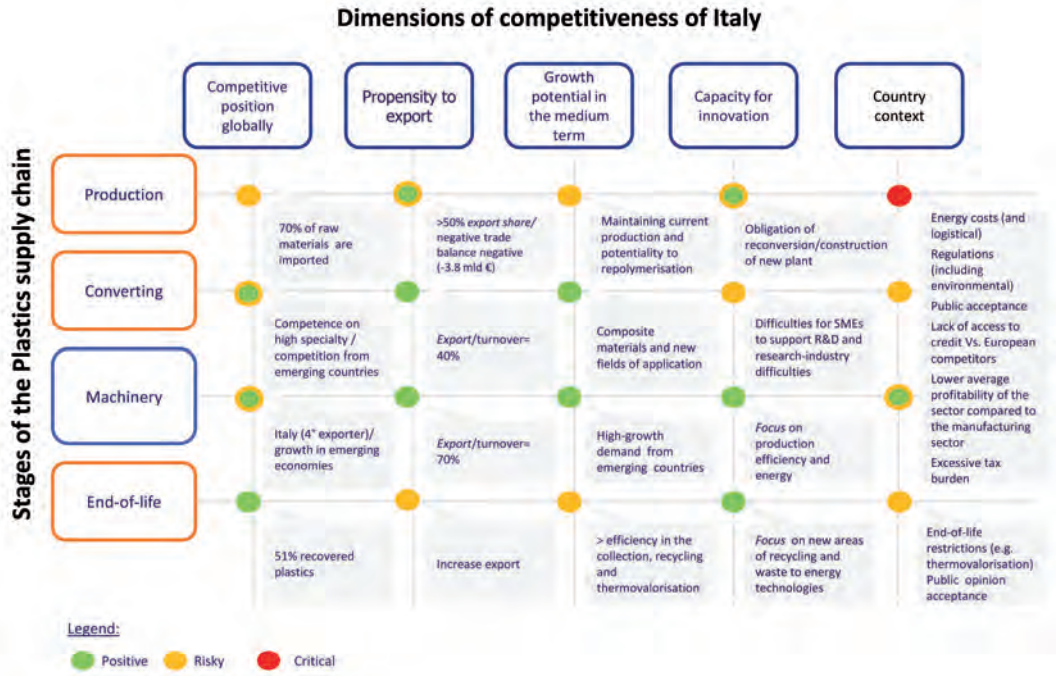


Figure 8. Competencies and risk factors of the plastics supply chain in Italy

Source: The European House - Ambrosetti re-elaboration of various sources, 2013

9. The supply chain has certain **priority strategic requirements**:

i. Create **critical mass** through large industrial clusters (approximately 82% of plastics companies in Italy have fewer than 20 employees: medium-to-large size companies account for 6.2% of the total, compared with an average of 22% in Germany).

ii. Create a major push for innovation (including in conjunction with leading *"Made in Italy"* sectors), capitalising on **distinctive competencies**.

iii. Build **localising factors** to maintain the existing industrial base and attract new companies.

iv. Handle the product **end-of-life cycle as an opportunity**, in the light of the increase in the volume of plastic waste generated (and collected) for recycling and recovery, and the development of sorted collection of the Organic Fraction of Municipal solid Waste (OFMSW) which opens up important new application outlets for compostable plastics.

10. A comparison of Italy with two important competitors in the plastics supply chain – one consolidated (**Germany**), the other emerging (**China**) – shows that:

— The entire German plastics supply chain benefits from the presence of **large petrochemical clusters**, from the leadership in **trade** on a global level (including in the plastic waste and machinery) and from **investments in R&D**, promoted by cooperation between heavy industry, the universities and the research sector. There is moreover a **strong industrial vision** on the part of the government, geared to protecting the chemicals and plastics sector.

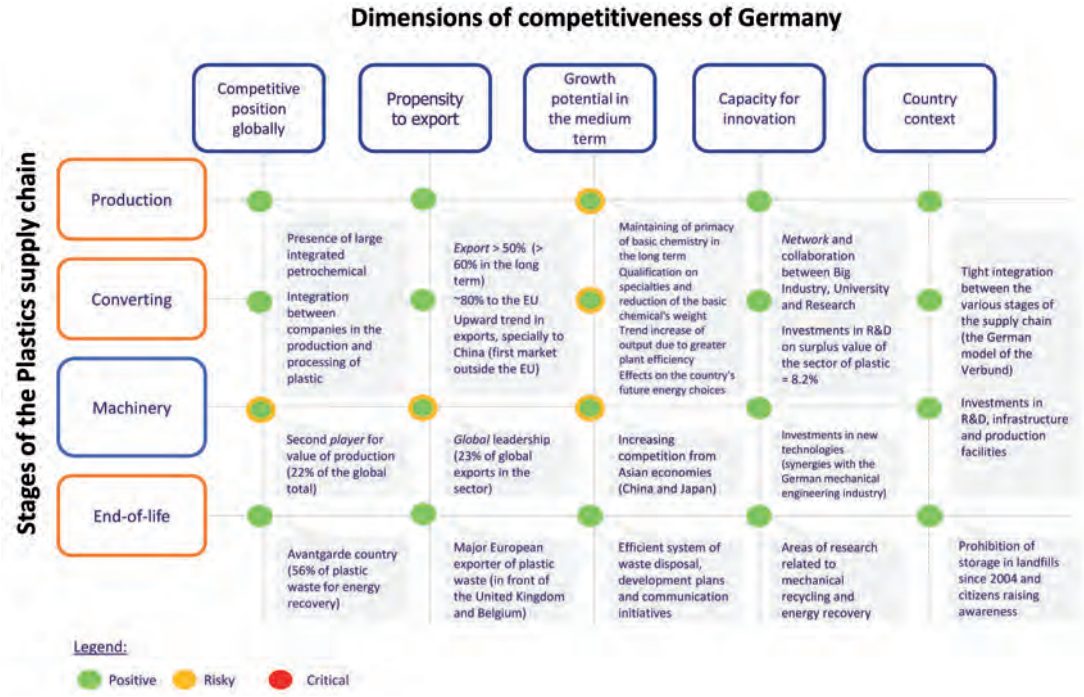


Figure 9. Competencies and risk factors of the plastics supply chain in Germany

Source: The European House - Ambrosetti elaboration from various sources, 2013

— The Chinese plastics industry, against a background characterised by national policies to support manufacturing and investments (in production as well as in technology and innovation) carried out by local operators and external multinationals in the chemical and petrochemical sectors, is distinguished by **strong growth in the production and consumption** of plastics, plus a significant export performance. The plastics sector operates in what is **not yet a fully regulated framework** and with **quality and safety standards that are not in line** with the best international practices (with competitive asymmetries).

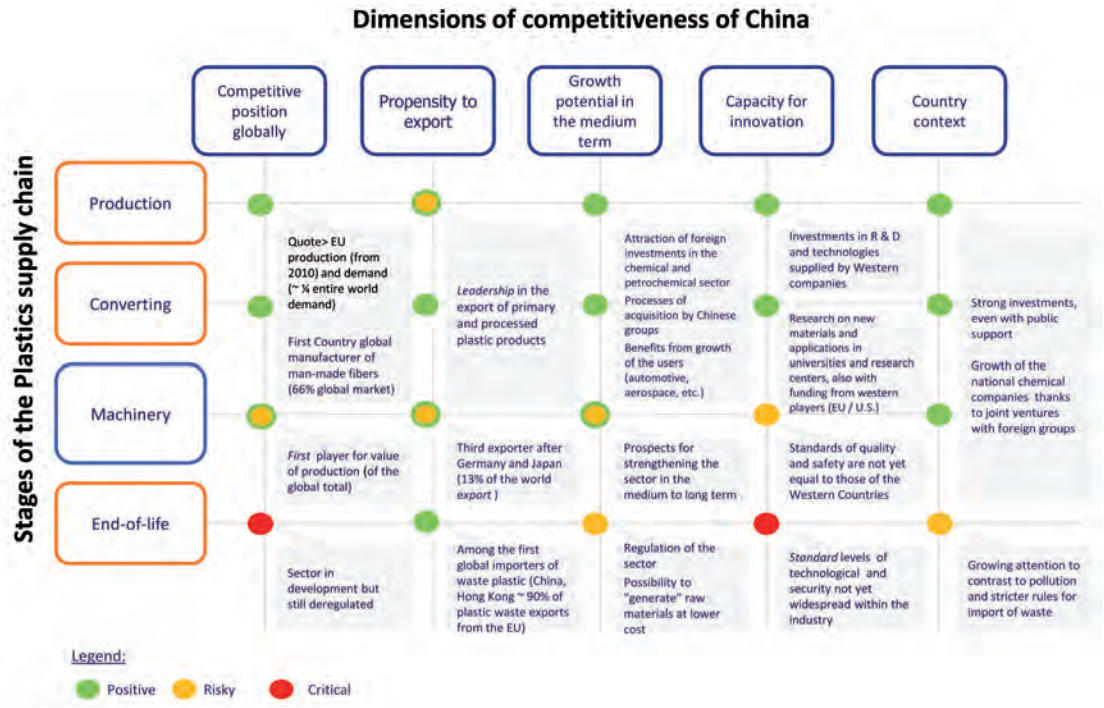


Figure 10. Competencies and risk factors of the plastics supply chain in China

Source: The European House - Ambrosetti elaboration from various sources, 2013

In light of the afore-outlined scene, a concrete vision for the development of the plastics supply chain must focus on:

I. Maintaining and increasing the competitiveness of traditional production sectors, including those upstream of the plastics supply chain, by:

- Defending the current distinctive competencies in chemistry.
- Safeguarding the integrated production cycle for the efficiency and competitiveness of European chemical clusters (from raw materials to processing).
- Strengthening the integration of research between industrial operators as well as between industry and universities.

II. Investing in areas with higher innovation and knowledge content (integrating traditional sectors with emerging niches), such as, for instance, composites, "green chemistry" (bioplastics, etc.), and repolymerisation technologies.

III. Promoting a hybridisation of plastics production processes in which our country excels with leading *"Made in Italy" sectors*.

IV. Consolidating the positioning in the management of the end-of-life cycle of plastics.

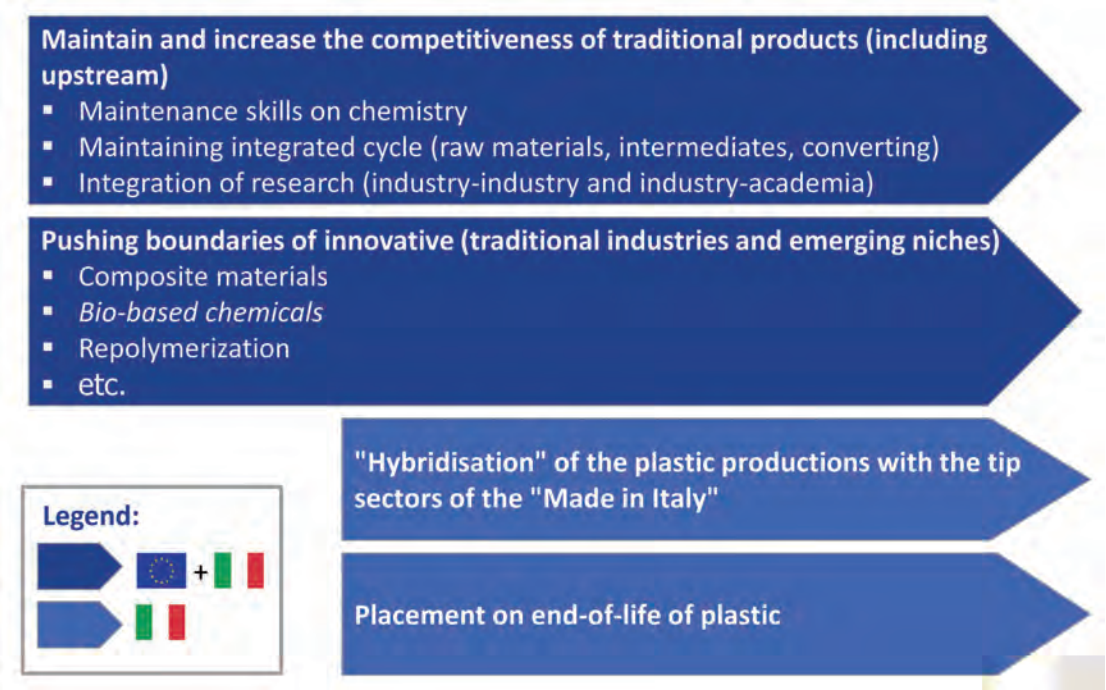


Figure 11. Our vision for the future of the plastics supply chain

Source: The European House – Ambrosetti eloaboration, 2013

Guidelines for strengthening the chain in Italy (and Europe)

11. To concretise the aforementioned vision, action must be taken **simultaneously** on two fundamental aspects that can be considered as "hygienic" pre-conditions:

- **industrial policy choices;**
- the **cultural** dimension for promoting public awareness and appropriate behaviour.

Guideline 1:

Promote a (proactive) national industrial policy for the development of the sector and safeguarding the presence of the entire supply chain, by:

- Managing current constraints to development, first and foremost energy costs and logistics, and more generally existing legislative and competitive asymmetries.
- Proceeding to a systematic ex-ante assessment of the impact of legislation on the supply chain, including with the contribution of the universities.
- Inducing cooperation (including in partnerships) between institutions, research and industry.
- Removing taxation from corporate investments in research and development.
- Promoting the direction of research (and focusing investments) on high-potential applications in traditional fields and emerging niches.
- Recognising plastics as a macro-sector in the national statistics (including as a "political" message of its importance).[2]

12. At the international level, the experience of certain countries at the vanguard show how determined **political will** and **cooperation between government and industry** make it possible to define specific strategies for strong development in the sector:

- Germany has launched a strategy for 2030 to safeguard **basic chemicals production**, which is vital for the success of the entire manufacturing industry.
- The United Kingdom has made specialisation in **composites** one of its national priorities.

[2] The various plastics supply chains are currently included in the broader macro-sectors of ISTAT (e.g. polymer production falls under "basic chemicals production;" machinery for plastics is included under machinery, etc.), making it difficult to retrieve data and information.

— France has created a **national competitiveness cluster** on plastics engineering (Plastipolis) which brings together the competencies of the Rhone-Alps and Franche-Comté in chemistry and innovative materials.

The German 2030 strategy for the competitiveness of the basic chemicals production

The basic chemicals production in Germany is the foundation of the chemical production industry as a whole and for the creation of added value for the entire manufacturing supply chain. Thanks to the **integrated cycle**, and to the close connection between production and processing, the country can continue to count on the availability of basic chemicals at national level.

Today, basic chemicals account for 37% of the German overall chemicals production. In the next 20 years, the sector is expected to:

— register moderate growth of 1.8% per year on average;

— shift gradually towards specialties (CAGR +2.2%[3]), which will go from 43% to 47% of the total;

— maintain a relevant weight in the basic chemicals production phase (CAGR from +1.3%, to 34% of total chemicals production).

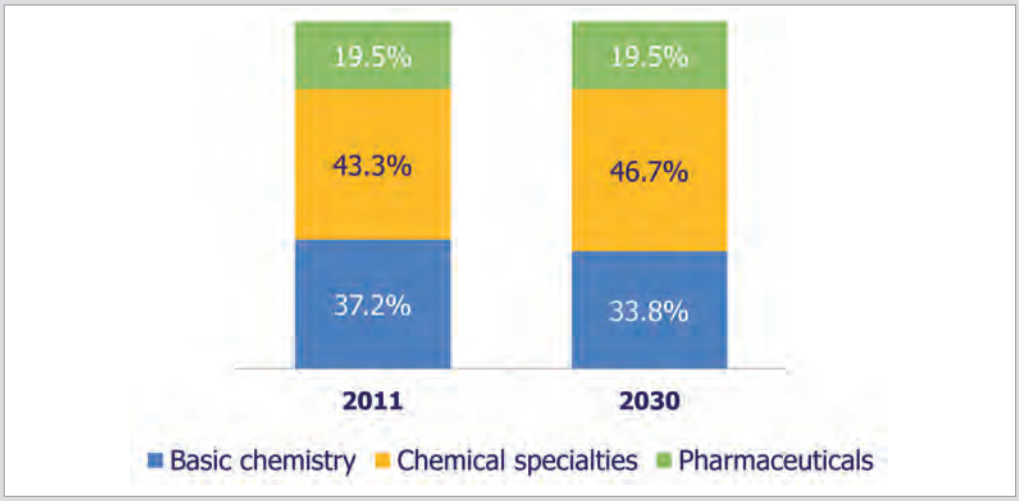


Figure 12. Breakdown of the German chemicals production between 2011 and 2030 (in percentage)
Source: The European House - Ambrosetti re-elaboration of data provided by the Verband der Chemischen Industrie e.V. (VCI) - Prognos, 2012

Future demand for basic chemicals in Germany and Western Europe will in large measure reflect the expected growth in the chemical sector and the main industries for such products.

In light of these future developments, the German Association of the Chemical Industry (VCI) has

[3] An average annual growth rate of 2.5% for polymers and technopolymers is expected during the period 2011-2030. Source: VCI – Prognos, 2012.

put forward a **joint, long-term (2030) action plan for the competitiveness of the chemical industry.**[4] To safeguard the competitive production sites in the basic chemicals industry and to preserve efficiency due to the high level of specialisation in both basic chemicals and specialities, there are plans for:

- Considerable investments in the industrial plants (like the *crackers*)[5] and in infrastructure and facilities.
- Actions to create a favourable climate in the country (as well as in public opinion) for the industry, including the supply of energy and raw materials under sure and competitive conditions.
- Measures to support the sustainable production of basic chemicals.

UK Composite Strategy

In the light of future development in the composites sector, in November 2009, the British government launched the *UK Composites Strategy* which provides for:

- Strengthening the **public-private network** through the *Composite Skills Alliance* to align the competencies, technologies and needs of the supply chain.
- The *National Composites Centre* (created in Bristol in 2011[6]), a **centre of excellence** for basic research, the coordination of the network of regional composites centres and support for cooperation with national universities; the centre also provides support for training for the development of specialised skills as well as production structures on the industrial scale and rapid production processes.
- Commencement of operations, as of the end of 2012, of the *Composites Leadership Forum* , which promotes **cooperation among the stakeholders** (government, industry and research[7]) to survey the national skills on composites, understand the needs of the market, identify opportunities and challenges and define a joint national action plan. The industrial sectors with which cooperation schemes are already underway include in particular aerospace, the automotive industry, public transport and construction.

Plastipolis: national competitiveness cluster in France

The *Pôle Plasturgie Rhône-Alpes et Franche-Comté* – Plastipolis was established in 2005 as a **national competitiveness cluster** under a partnership between the French regions with a strong presence of the chemical and innovative materials sector (cf. also the “Plastics Vallée” cluster of plastic industries, in Chapter 3).

[4] Cf. Verband der Chemischen Industry e.V (VCI), *“Basic chemicals production 2030”*, October 2012.

[5] The closing of plants could lead to the discontinuance of production of downstream products, causing a “domino effect” in other production chains based on petrochemical derivatives and damaging client industries.

[6] The investment for the construction of the new centre amounted to £25 million, co-financed by the European Regional Development Fund (ERDF), the South West Regional Development Agency, and the Department for Business, Innovation and Skills (BIS). The founding members include the multinationals AugustaWestland, Airbus, Cytec (now Umeco), GKN Aerospace, Rolls Royce and Vestas.

[7] Members of the Composite Leadership Forum: Department of Business, Innovation and Skills (BIS) for the government, Composites UK for industry, the Composites Skills Alliance on the skills front, the National Composites Centre (NCC), the Centre of Innovative Manufacturing in Composites, the Technology Strategy Board (TSB) and the Engineering and Physical Sciences Research Council (EPSRC) on the technology front, and the Knowledge Transfer Network for the materials.

The cluster comprises **a third of the French plastics engineering industry:** over 33,000 workers and more than 1,000 companies (20% of the sector in France), generating a turnover of €8 billion. The cluster has 380 members, of which 230 companies (90% SMEs). The mission of Plastipolis is to:

- Promote the development of the plastics engineering sector in France and identify new applications through technological innovation.
- Provide SMEs in the sector with projects geared to innovation.
- Develop the sharing of industrial and academic skills through a network of companies and universities and the creation of new partnerships.

The cluster has 2,400 employees, with:

- 80 projects financed at the national level (since 2005);
- participation in more than 15 European projects;
- promotion of 40 international missions (2008-2011);
- the presence of 45 centres of excellence based in the two regions of the cluster.[8]

Activities in the polymers sector range from new materials for complex systems to eco-compatibility/recyclability, from bio-based and biodegradable material, to high-added value processes. The key markets with which cooperation schemes are already under way include: transport, healthcare, food, construction, energy, and fast moving consumer goods.

13. Upstream, in a EU context (endowed with common reference legislation for Europe as a whole), there is a **penalising national regulatory framework** for the development of the Italian chemical industry, which discourages not only new investments by external operators but also the injection of new capital by companies that are already present (with the risk of divestiture of investments in progress at times).

14. The many restrictions in the legislative and administrative-bureaucratic structure which the Italian chemical industry is faced which can be gauged from a comparison with other European markets,[9] with reference to:

- **Duration of permits:** 5 years in Italy for the Integrated Environmental Permit required by companies that are subject to the *Integrated Pollution Prevention and Control* (IPPC Directive[10]) for the operation of plants, compared with 10 years in The Netherlands and the entire useful life in France.[11]

[8] Including the National Institute of Applied Sciences (INSA) in Lyon, Compositec, French National Centre for Scientific Research (CNRS), Training Centre for Plastics Engineering in Grenoble and Leonardo Da Vinci School of Engineering (ESIVL). Source: Plastipolis - *Pôle Plasturgie Rhône-Alpes et Franche-Comté*, 2013.

[9] Source: Federchimica, December 2012.

[10] The IPPC Directive has been replaced by the *Industrial Emissions Directive* (IED).

[11] In addition, every ten years, the company must provide an environmental balance on the basis of which the competent authority may impose subsequent requirements.

- **Issuance of permits:** 14-21 months on average in Italy compared to 1 to 12 months in Belgium and Austria.
- **Emission Limit Values (ELV) in the permits:** More restrictive in Italy than abroad (Germany,[12] France and Belgium).
- **Requirements for the reclamation of polluted chemical sites:**[13] today, less than 1% of the polluted areas in Italy has been officially declared reclaimed and "restored for legitimate use" (or at the free disposal of companies). In general, there are more stringent restrictions for reclamation operations than abroad, also because of the high number of reference parameters (234, of which 94 are required; the rest for information in Italy, compared to fewer than 20 in the United Kingdom, Austria, Belgium and Germany, and fewer than 40 in other European countries).

  This situation is an obstacle to activities in progress and to the development of new investment projects for the establishment of activities in the areas concerned.

15. In addition to the difficulties to take a foothold on global markets, such asymmetries entail uncertainty, added costs and a **clear disparity on the competitiveness front as well** for our chemical industry, ultimately impacting the very appeal of the Italian system.

16. The Italian competitive context is characterised by higher **energy and logistics costs** than the European average, which constitute a burden for the manufacturing industry and the chemical sector: for example, the cost of electricity accounts for 6% of the overheads of plastics manufacturing companies and for 12% of plastic waste sorting and recycling companies.

[12] For example, in Germany, the emission limit for certain processes and relative emissions in the atmosphere corresponds to the highest level in the range to be reached within 4 years, and a more restrictive limit to be reached within 8 years. In the case of the existing plants which were adequate for the preceding BAT, the new limits and adjustment schedule are conveniently regulated in time, taking into account the actual situation of the plant, with time frames of up to 8 years. Source: Federchimica, December 2012.

[13] More than 800,000 hectares on land and approximately 340,000 hectares at sea.

Guideline 2:

Promote a widespread public information campaign on proper use of plastics and **"recycling culture"**.

- Launching an awareness campaign, including in collaboration with industry and academia, about the real value and positive contribution—including in terms of sustainability—of plastics for society throughout the entire life cycle and their correct utilisation.
- Stimulating recycling of plastic waste with specially-designed initiatives, including adapting and implementing the best practices found in Europe today.

17. Compared with the situation in other countries, our country is characterised by a widespread lack of information concerning plastics: lack of information and public awareness raising (cf. Chapter 5 for discussion in greater depth). A communication campaign at national and/or European level to raise public awareness about the proper value of plastics should:

- Amount to the **widest range of actions** among the public, assuming the form of **"progress advertising"** for instance, with extensive involvement on the part of the competent ministries in Italy, and the competent directorates general at EU level. The recent European awareness raising campaign about the pollution of marine waters with plastic waste is being conducted in this sense, for instance[14].
- Involve actively the **industrial components** (sector associations and individual operators in the plastics supply chain) and **research/universities**, deploying all forces systematically to achieve a common objective.
- Appeal to **greater awareness issues** among public opinion in the light of in-depth reports, such as the conservation of natural resources, reduction of CO_2, etc., thereby helping to eradicate certain **prejudices and erroneous convictions** deeply rooted in the general consensus.

[14] Cf. Directive 2008/56/EC (Marine Strategy Framework Directive) geared to achieving a satisfactory environmental status for all marine waters in the EU by 2020. In 2010, the EU Commission laid down the criteria that the Member States have to adopt to assess the ecological status of their marine waters pursuant to this framework directive.

18. **Educating citizens** about the right way to relate to plastics, especially regarding the **waste disposal and reuse**, is one of the key points for attention, both in Europe and in Italy.[15] Some examples from abroad show how it is possible to take effective measures, often at "zero cost," and to obtain benefits for society and for industry itself.

Some good international practices for the development of a domestic plastics recycling culture

- **Germany:** the country has planned (and is currently busy with) the installation of **recycling bins** to increase the recycling of plastics such as PET bottles for beverages by the family (discounts for returning waste, equal to €0.25 per returned bottle, paid at the collection centres which are generally situated in supermarkets), with sorted waste collection to enter into force by 2015.
- **United Kingdom:** today, more than 50% of plastic bottles are recycled, 65% of local entities are interested in collection, and some 55,000 tonnes of plastic packaging are recovered every year. Citizens have become aware through initiatives such as the **Recycle Week** (in its 10th edition in 2013): managed by a non-profit organisation funded by the government, it conducts campaigns on television and advertising, runs a dedicated website, and appeals to *social networks*.
- **France:** launched a campaign in 1971 entitled ***"Vacances Propres"*** ("Clean Holidays") to prevent littering in bathing and tourist areas (providing bags and bins for sorted collection) and to educate citizens. The non-profit association came into being thanks to the joint effort of the packaging industry and fast moving consumer goods. Some results obtained in terms of waste prevention and networking attest to the initiative's success:
  - 20,000 bins installed in France since 2007;
  - 50,000 tonnes of waste collected in 2012 (2.5 million bags sold);
  - participation by more than 1,000 local authorities;
  - 7,400 posters put up in a single summer;
  - extensive knowledge of the campaign among the public (7 out of 10 people).

[15] A virtuous example was provided in Italy by the *Consorzio Nazionale per la Raccolta, il Riciclaggio ed il Recupero degli Imballaggi in Plastica* (COREPLA) [National Consortium for the Collection, Recycling and Recovery of Plastic Packaging]

— **U.S.**: campaign conducted in 2012 by the non-profit association GreenBlue's Sustainable Packaging Coalition (SPC) and the American Chemistry Council to disseminate the **"How2recycle" label for *packaging*.** The aim was to make it easier for consumers to understand the correct procedures for the disposal of packaging: Thanks to a summary graphic that is easy to read, the label indicates which parts (box/container, wrap, bag, etc.) and packaging materials of the product (paper, plastic, etc.) can be recycled.[16]

Figure 13. Examples of labels from the "How2recycle" project applied on plastic bags and packages in the U.S.

Source: www.how2recycle.info, 2013

[16] cf. www.how2recycle.info

3. Two proposals for Italy as a starting point

KEY MESSAGES OF THE CHAPTER

Our proposals for the plastics supply chain in Italy are focused on two key themes:

1) Using a public/private sector model, including for financing, create a **large-scale national cluster of excellence in plastics** to:

- Safeguard the entire plastics supply chain throughout all its phases, including systems of production and energy self-sufficiency (return to the integrated cycle).
- Foster orientation of research in selected strategic areas and integration with industry.
- Focus on areas of development connected to the country clusters of industrial specialisation and “Made in Italy” driving sectors.
- Develop a network of existing areas of excellence in academia and other primary research centres in the country (avoiding duplication).
- Create a further element of attractiveness on an international level for new talents and cutting-edge industrial competencies.

2) Promote a positioning strategy for Italy throughout **the entire plastics life cycle** from the standpoint of economic-competitive opportunities with ad hoc measures to:

- Create uniform efficiency (including through specific legislation) throughout the entire waste collection cycle.
- Introduce a ban on the disposal of plastic waste in landfills.
- Promote the modernisation (revamping) of waste disposal plants (incinerators) using cutting-edge technologies, by drawing up a simplified regulatory framework and developing de-fiscalisation measures.
- Replicate the best practices existing in Italy today for waste-to-energy in coal thermoelectric power stations (for non-recyclable plastics).

1. Assuming that the "hygiene factors" at the centre of the guideline set out in Chapter 2 are addressed as a matter of priority, and taking action on the strong and weak points that characterise the plastics supply chain in Italy (cf. Chapter 5 infra), a number of proposals for action have been put forward capable of having a structural impact on the industry, with effects in the short and medium term.

2. The proposals for the country are centred on two key themes:

— Create of a national cluster of excellence in plastics focused on selected areas of strategic development capable of stimulating the industry and research.

— Take advantage of the opportunities offered by the entire plastics cycle, starting from end-of-life.

3. The method that has led to the identification of these measures is **strategic in nature:** the aim is to tackle the problem of strengthening the national plastics supply chain by taking action in its four main phases (plastic raw materials production, plastics converting, machinery and post-consumption phase) so as to obtain **systemic effects for the European manufacturing sector and for the Italian economy** (cf. Chapter 4).

Proposal 1: Innovation and critical mass

Using a public/private sector model, including for financing, create a large-scale national cluster of excellence in plastics, to:

- Safeguard the entire plastics supply chain throughout all its phases, including systems of production and energy self-sufficiency (return to the integrated cycle).
- Foster orientation of research in selected strategic areas and integration with industry.
- Focus on areas of development connected to the country clusters of industrial specialisation and "Made in Italy" driving sectors.
- Develop a network of existing areas of excellence in academia and other primary research centres in the country (avoiding duplication).
- Create a further element of attractiveness on an international level for new talents and cutting-edge industrial competencies.

Rationale

4. The country is today faced with three strategic requirements, namely to:

- **Maintain the integrated cycle in Italy**, boosting productivity (from petrochemicals to converting) for the competitiveness of the chemicals-plastics industry, also on the example of what is taking place in central northern countries. This could be achieved through scope optimisation and a radical increase in efficiency of existing production assets. For example, by 2030 in Germany, the chemical industry is expected to increase production in the plants by 40% from 2011 levels, compared with a 15% increase in the consumption of raw materials and 8% in energy consumption.

- **Increase the critical mass of the industry**, exceeding the medium-small dimensions entailed particularly by the converting segment, where a very high number of companies is operating, unlike production, where the activity requires sizeable investments in polymerisation plants.

- **Stimulate innovation and research.**

5. The vertical integration of the plastics industry with the **petrochemical** industry has emerged as a **key element** for the competitiveness of the entire supply chain – for companies that produce plastics (which depend on the petrochemical industry for the raw material (monomers) and for those that convert plastics:

- In a far more pronounced manner than in Italy, the chemical industry in **Germany** continue to have strong integration between the different phases, from upstream to downstream of the supply chain (cf. Chapter 2).

- The German case shows strong integration between the petrochemical sites and companies that produce basic chemicals or specialities. The BASF Group, for instance, has 6 sites with integrated production (***Verbund***) at global level, one of which near the company's headquarters in Ludwigshafen[1].

[1] The second integrated production site of the BASF Group in Europe is in Antwerp, Belgium. BASF, 2013.

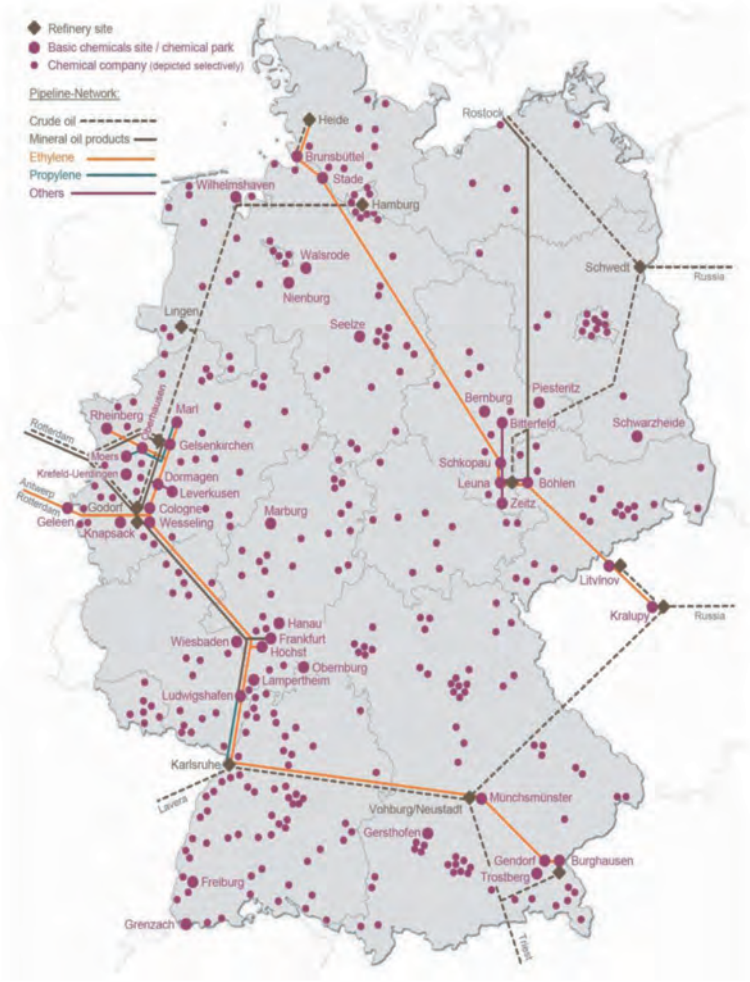


Figure 1. Integration of the chemical industry in Germany

Source: Verband der Chemischen Industrie e.V., "Basic chemicals production 2030", October 2012

6. A key element of competitiveness, especially in a context where Italy could not compete through price levers and production volumes, is represented by the level and quality of R&D. The creation of specific competence centres in partnership between companies and universities can constitute a significant **"location factor"** to encourage companies not to divest from Italy (or to move there), in the direction of the development of **specialised, high level products** and **strengthened roots in territory.**

7. A comparison with Italy's main competitors in the plastics industry reveals that the most developed supply chains, in terms of employees and generated turnover, are also the ones which **invest the most in R&D:** for instance, in Europe, France and Germany can count on R&D investments to have an impact on the added value of the plastics sector[2] of 4.5% and 8% respectively, in the face of high volumes of employees and turnover.

[2] The OECD aggregate considered refers to the rubber and plastics products.

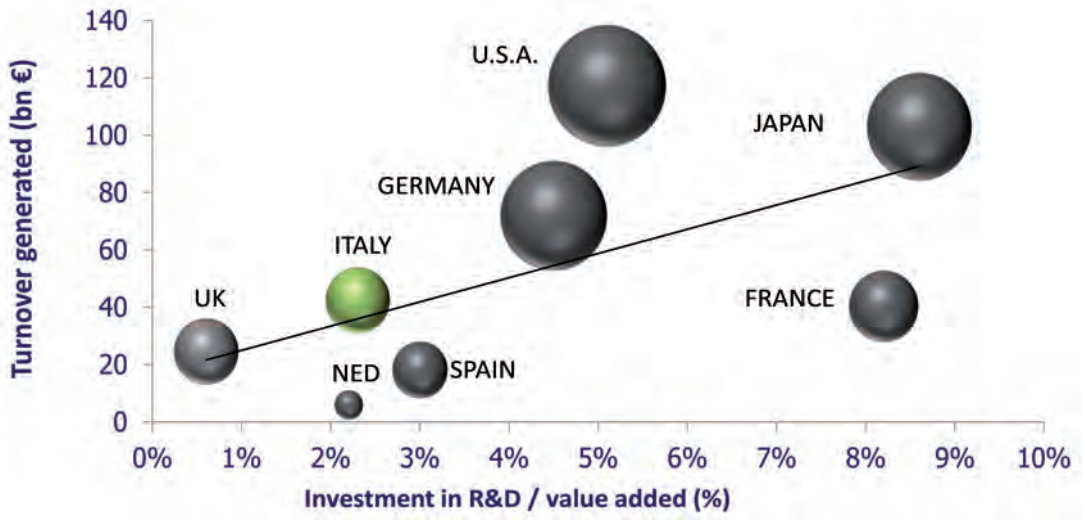


Figure 2. Turnover (in billion euro), size (employees) and investments in R&D in the plastics sector, 2011

Source: The European House - Ambrosetti re-elaboration of Eurostat and OECD data, 2013.
Note: the size of the balls indicate employment in the sector in absolute values

8. An analysis of the relation between the presence of **large** plastics companies and the relevance of investments in R&D sheds further light in this respect: in a context dominated by a manufacturing base consisting of large companies, innovation is driven by the latter:

- In Italy, where companies with more than 250 employees account for only **0.7% of the plastics sector** (compared with 3.6% in Germany and 2.3% in France), investments in R&D are estimated at **2.3% of the added value.**
- The difference for our country is also pronounced with reference to the EU-27 average (5.8%).

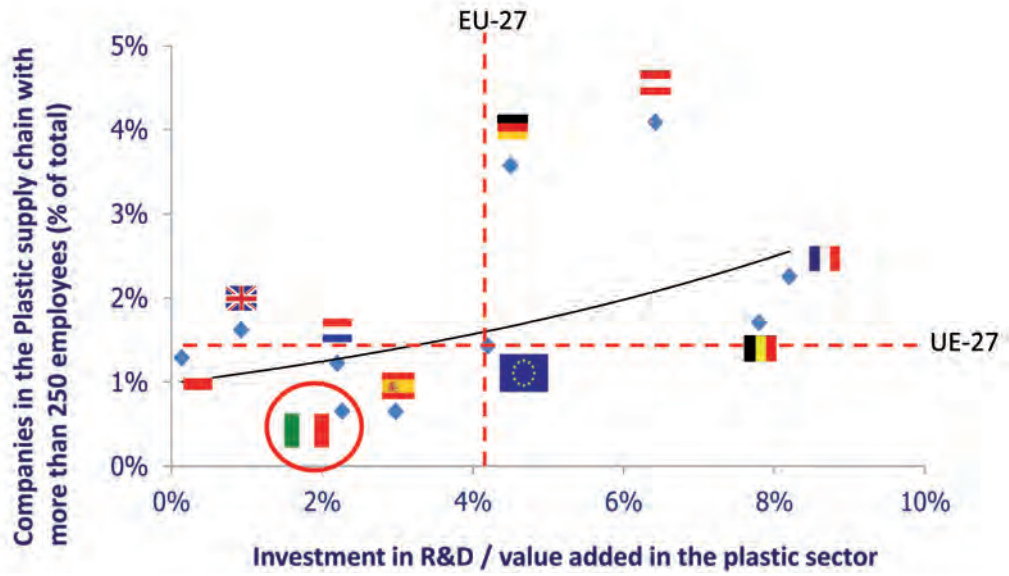


Figure 3. Relation between plastics companies with more than 250 employees (percentage of the total) and investments in R&D (percentage of the added value of the sector)

Source: The European House - Ambrosetti re-elaboration of OECD data, 2013

9. The concurrent presence of a well-established network of SMEs, the private sector's difficulty to invest in research and development in the current crisis, and the gradual concentration of significant R&D centres, fuels a need to adopt policy measures to **pre-competitive research** conducive to growing integration with industry (basic and applied research). Pre-competitive industrial research is aimed at producing new knowledge and to creating networks:

— It is constantly conducted directly by the centre and/or other research organisations and companies in Italy and abroad.

— It is based on public financing (national and European) with access on a competitive basis.

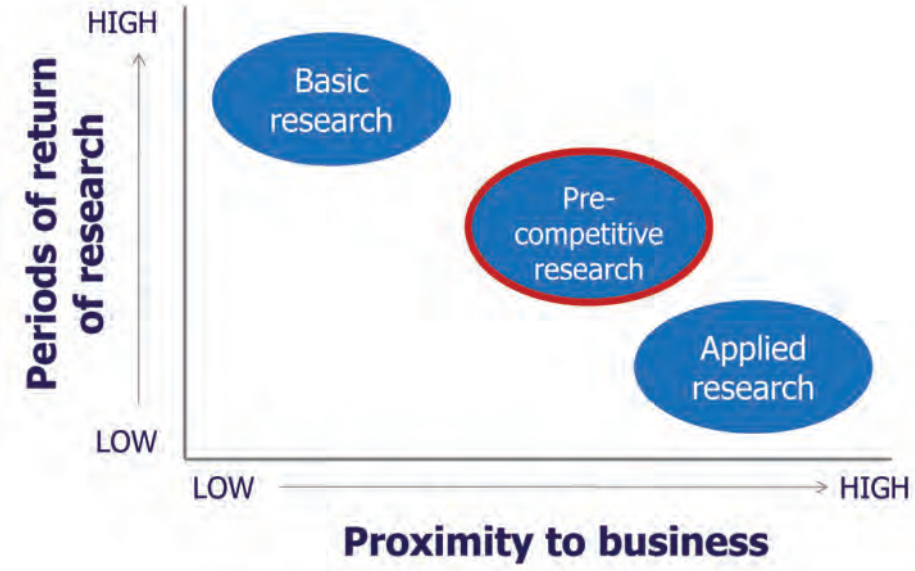


Figure 4. Types of industrial research: Research return times and proximity to companies
Source: The European House – Ambrosetti elaboration, 2013

10. The creation of a large scientific and industrial cluster for research on plastics and cutting-edge applications and technologies for plastics could help strengthen the supply chain by:

— Attracting **larger-sized industries** (including in adjacent sectors, e.g. aerospace, electronics, nanotech, biotech, etc.) already established in our country, but also inducing potential **new external investors** to enter in the Italian market in the production/converting phases.

— **Systematising existing skills and areas of specialisation** in certain production niches, in synergy with new research branches in the development phase in industry and academia[3] (for example, drawing inspiration from the model adopted by the Italian Institute

[3] By way of example: The Department of Chemistry, Materials and Chemical Engineering of Milan Polytechnic, the Institute of Polymer Chemistry and Technology of the NRC, the National Nanotechnology Laboratory of INFM of the University of Lecce (academic research); the Tortona Protoplast Consortium (Alessandria), MaTech Point Friuli Venezia Giulia at the AREA Science Park and the Pordenone Technology Cluster, the European Centre for the Development of Plastic Applications in Zingonia (Bergamo) (industrial research).

of Technolog[4] (IIT)).

— Developing and patenting new materials, processing technologies and processes and semi-finished and final products to be **placed on the market**, through the various sectors that use plastics.

— Promoting a progressive re-orientation of the national production portfolio (including reconverting plants for different and more innovative types of production).

11. Some large (not only European) countries have recognised the importance of adopting integrated strategies for the plastics sector and have proceeded to:

— Make huge investments.

— Promote cooperation between institutions, research centre and private industry, including through partnerships.

— Direct innovation towards segments with greater potential for development.

12. In general, clusters that have adopted an integrated model have hit on a **winning solution** to sustain industrial development. For example, **Malaysia** has made sizeable investments in the petrochemical sector:

— Versalis (Eni Group) recently entered a joint venture with the Malaysian state-owned company Petronas – market leader in chemicals in Asia – to develop the elastomer business.

— Signed in 2012, the agreement provides for the development and joint management of a **production site** for elastomers in Pengerang (Johor) near the Petronas integrated development centre and refinery and for the production and marketing of synthetic rubber with Versalis technology and know-how.

[4] Headquartered in Genoa, the ITT boasts 30,000 m² of floor space, 12 advanced research laboratories and 1141 employees: researchers from abroad account for 42% of the staff, of whom 24% are foreign nationals and the remaining 18% Italians working abroad who have returned to their country of origin. The Institute can moreover boast nearly 3,000 publications and 99 inventions, which have led to 151 patents. As regards technology transfer, the IIT operates through a network of private organisations and academic institutions with a multidisciplinary approach. The Multidisciplinary Research Network (RRM) consists of 10 external research units located throughout Italy; the centres are near academic and scientific centres of excellence and are manned by their own research staff and cutting-edge equipment. Each research units develops part of the scientific programme of the IIT and the research goals are examined annually by a Scientific Technical Committee. Moreover, the IIT provides economic support and active cooperation by making its laboratories and staff available, and signs five-year agreements with the various units of the network. Source: Italian Institute of Technology (IIT) Foundation, 2013.

Integrated clusters: Biopolis, the global reference centre for biotech in Singapore

Designed in 2001 and inaugurated at the end of 2003 in Singapore with a public investment to the tune of $19.7 billion, Biopolis, "the city of biomedical sciences" set out to become the **biomedical research centre of reference in the world**.

Singapore's decision to invest in the biotech industry is a direct consequence of the crisis in the electronics industry, the sector on which the island had built its economic development as of the 1980s. To tackle rampant unemployment and to reflate the economy, the government of Singapore found a solution to attract private capital, particularly by promising incentives, tax relief and subsidies to companies (multinationals, but also SMEs) that would establish their research centres in Biopolis.

With a workforce of 4,300 researchers from all over the world, today the centre plays host to:

- **Local and international universities**, such as the National University of Singapore, Singapore Polytechnic, Institute of Technical Education, National University Hospital, Singapore Science Park, ESSEC Business School, INSEAD Business School.
- **Multinationals from the sector**, such as Abbott, GSK, PharmaLogicals, Novartis, Merlion, MSD, S*Bio, Takeda, Invitrogen and CellResearch Corporation – which generate a turnover of $21 billion.

In addition to Biopolis, the area is also home to **Fusionopolis**, a district dedicated to the media and to *information technology*, and many other functional structures to imbue life into the neighbourhood (residential units, shopping centres, restaurants, services for the tertiary sector, schools, sports facilities, etc).

Figure 5. The map of Biopolis and Fusionopolis in Singapore
*Singapore: Agency for Science, Technology and Research (A*STAR), 2013*

Integrated clusters: Plastics Vallée in France

The Plastics Vallée is located in Oyonnax (Ain district), in the Rhone-Alps region, in south-eastern France. This district today boasts:

- 662 companies;
- 12,000 employees (133 employees in the plastics sector per 1,000 inhabitants);
- €2 billion in turnover.

The various participants in the cluster are cooperating **to turn it into the district of reference in plastics in Europe** by:

- Creating ideal conditions for scientific research at university level in connection with industry.
- Operating as a scientific research laboratory.
- Providing scientific support and monitoring for the companies in the district.
- Providing constant stimulation for scientific research.

Integrated clusters: the Imperial West+ project in London

The project (currently in the implementation phase) to create a new science and innovation cluster on nearly 10 hectares in the centre of London was launched by **Imperial College in September 2009.**

It is the largest science-based development plan for the London university system since the 1960s.[5] The new Imperial West+ centre will produce an expected value between £500 million and £1 billion per year and help establish London as a place of reference for high-level training and scientific cooperation between world class universities and innovative companies.

The overall investment in 2025 will amount to £3 billion, and plans for the Research and Translation Hub include:

- funding to the tune of **£150 million**, £90 million from the private sector, £35 million from the public sector (through the Research Partnership Investment Fund) and £25 million from Imperial College;
- the establishment of 50 companies and structures for research in fields such as advanced materials and biotechnology;
- recruitment of 1,000 researchers and engineers.

[5] For example, University College London (UCL), another world-class university, has invested £1 billion for its own development in UCL Stratford, is involved in Tech City, the cluster of technology companies in the east of London supported by the government. Many other scientific projects are in progress in the city, including the medical research centre of the Francis Crick Institute (£600 million) through the partnership between UCL, Imperial College and King's College London.

Figure 6. Imperial West + project in London

Source: Imperial College London, 2013

Proposal 2:

Second life for plastics

Promote a positioning strategy for Italy through exploitation of the entire plastics life cycle from the standpoint of economic-competitive opportunities:

- Create uniform efficiency (including through specific legislation) throughout the entire waste collection cycle.
- Introduce a ban on disposing of plastic waste to landfill.
- Promote the modernisation (revamping)[6] of waste disposal plants (incinerators)[7] using cutting-edge technologies, by drawing up a simplified regulatory framework and developing de-fiscalisation measures.
- Replicate the best practices existing in Italy today for waste-to-energy in non-recyclable plastics in coal thermoelectric power stations.

[6] Revamping is an operation used to overhaul and restructure industrial plants in order to extend their useful life cycle in the production process, thereby exceeding the design and technological limits of the past and integrating the original project with up-to-date and cutting-edge solutions.

[7] There were 45 incineration plants for urban waste, dry fraction and secondary solid fuel in Italy in 2012. Most were situated in the North (68% of the total); only 9 and 8 plants are operational in the Centre and the South respectively.

Rationale

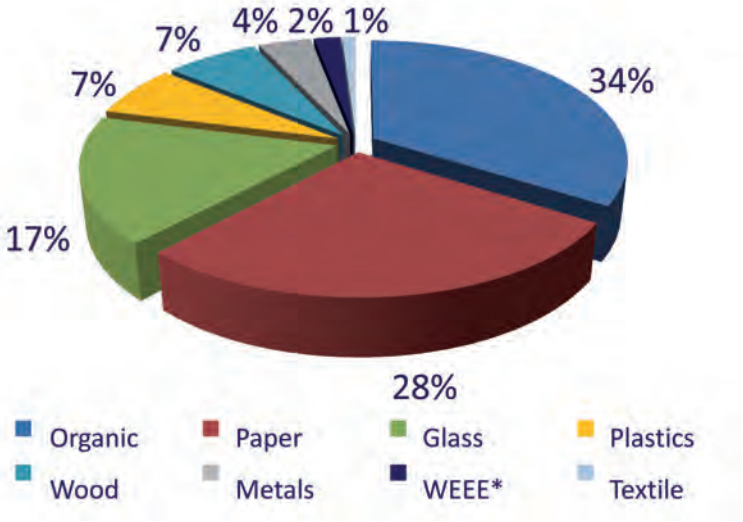
13. Regarding second life plastics, Italy:

- Holds a **potentially strong position** in Europe.
- Can turn the end-of-life "problem" (owing to legislative, technological and - far from least - cultural restrictions) into **a concrete opportunity** for the entire plastics supply chain, with significant repercussions for production, the environment and employment.

14. The collection of plastic waste could be the subject of targeted actions at the legislative and/or voluntary level that are helping **align the various areas of the country.** For example:

- 62% of the sorted plastic collection in the country is concentrated in the North, 16% in the Centre and 22% in the South, with clear disparities in per capita terms: 19.4 kg of waste collected per inhabitant in the northern regions, and 8.9 kg/inhabitant in the South, with a national average of 14.3 kg/inhabitant in 2012.
- The proportion of Italian municipalities that have proceeded to the sorted collection of plastics is uneven: nearly all municipalities in the North (99.1%), and an improved proportion in the South (88.2%) with an average of 94.6% for the country as a whole.

15. According to recent ISPRA estimates, approximately 7% of the overall volume of waste for recycling in Italy consists of plastics (more than one third consists of organic waste).



*WEEE = Waste from Electrical and Electronic Equipment

Figure 7. Estimates (in percentage) of the quantity of urban waste recycled in Italy, 2011

Source: The European House - Ambrosetti re-elaboration of ISPRA data, 2013

16. A key move to boost the recovery rate of waste materials is the introduction of the **ban on landfilling plastic waste** (cf. the campaign of the European plastics industry *"Zero Plastics to Landfill by 2020"* in Chapter 8).

Experience in certain regions in Northern Europe have shown how it is possible to achieve this objective in **a short time:**

— Countries with a disposal rate of less than 5% such as Germany, The Netherlands, Sweden, Sweden, Denmark, Belgium and Austria reach plastic waste recovery percentages (including recycling) between 80% and 100%.

— The measures taken, including the ban on disposal, have actually led to a reduction in the levels of fuel waste disposal in landfills.

Ban on landfilling waste: the case of the countries in Central-Northern Europe

Plastic waste has not been broached specifically by EU legislation to date. Only Directive 94/62/EC on packaging has set a specific recycling target for plastic packaging. Conversely, the Framework Directive on Waste (2008/98/EC) has set a general recycling goal for domestic waste that applies also to plastic waste, and has established a waste hierarchy (prevention, preparation for reuse, recycling, recovery, including for energy purposes, and disposal).

Nevertheless, waste management practices differ between the Member States with regard to the legislative requirements. It has been estimated that full implementation of the EU legislation on waste would lead to:

- savings of €72 billion per year;
- an increase in annual revenues in the EU of €42 billion in the waste management and recycling sector;
- more than 400,000 new jobs by 2020.[8]

The strategic options provided in the EU's Green Paper on plastic waste of March 2013 include the gradual phasing out or ban on landfilling plastic waste (ca. 10 million tonnes per year).

Seven EU countries, plus Norway and Switzerland, have **anticipated the provisions adopted by the European Union** and have banned the landfilling of plastic waste through internal legislation or initiatives to promote waste recovery.

The **Netherlands** has played a pioneering role in this initiative, introducing the first measures to stem the flow of plastic waste to landfill in 1996. The problem remains topical today, as 80% of waste intended to landfilling come from countries (including Italy) which have not adhered to any of these initiatives yet.

[8] Source, European Commission, BIO Intelligence Service, "Plastic Waste in the Environment," Final Report, November 2010.

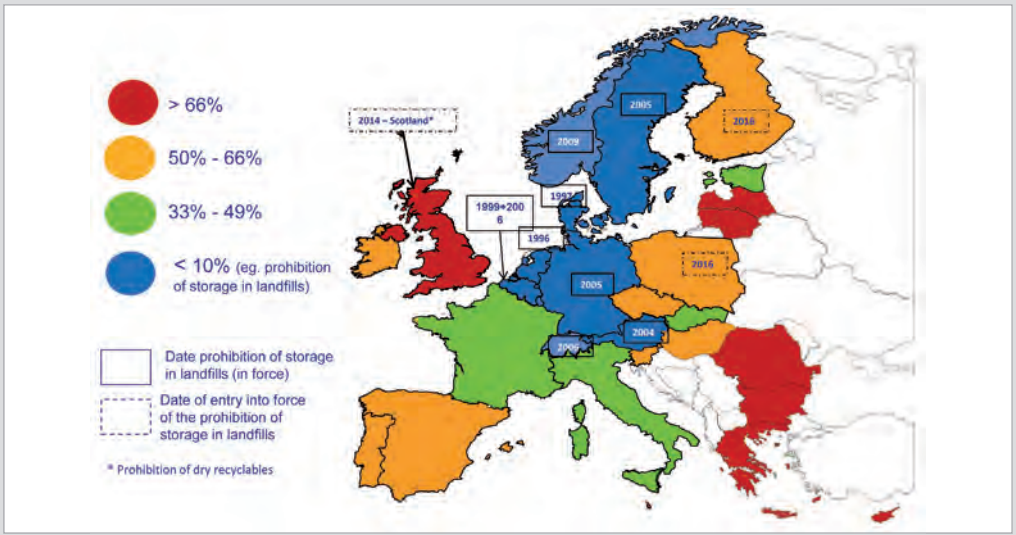


Figure 8. Destination of landfilling plastic waste in Europe (in percentage)

Source: PlasticsEurope, 2011

A case study for plastic waste management is Germany:

- In 2001, the Federal government enacted legislation that bans the landfilling of plastic waste, which came into force in 2004.
- Following the measure adopted by the German government, **landfilling went from 41% to 1% of all waste in less than 10 years.**
- Improvements have been registered not only in the **mechanical recycling** of plastic waste (from **36% to 42%** of the collected total), but above all **energy recovery** (from **14% to 56%** of the collected total).

These policy measures, combined with a public awareness campaign and an open dialogue between industry and environmental associations have catapulted Germany to the top of the most "virtuous" countries in Europe in the second life cycle of plastics.

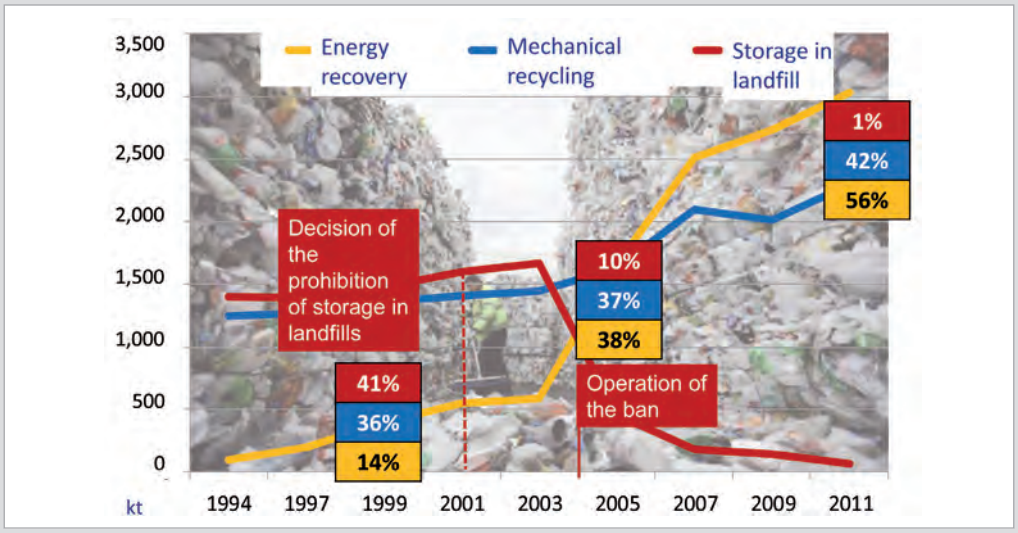


Figure 9. Destination of plastic waste in Germany. Effect of the landfilling ban (in '000 tonnes and percentage breakdown), 1994-2011

Source: The European House - Ambrosetti re-elaboration of data from Consultic, Produktion, Verarbeitung und Verwertung von Kunststoffen in Deutschland, 2011

17. New technologies make it possible to improve the waste-to-energy from plastics. Non-recyclable plastics can be earmarked for recovery at:

- **waste-to-energy plants;**
- **cement plants**, replacing fossil carbon in *clinker* production processes.[9]

These operations require a financial contribution to gain access to the user plants and entail costs for the proper preparation of the material.[10]

In Europe, a reference model of coal and urban waste co-firing on this front is provided by the reconversion of the **Fusina power station** in Veneto. The process followed in that plant could be replicated in other parts of the country and "exported" abroad.

An Italian best practice: recycling fuel co-firing in the coal-fired Fusina plant

The "Andrea Palladio" thermoelectric power station dates from the 1960s and has been subject to a technological improvement programme (installed capacity of 1,136 MW).[11] The new plant was launched in 2008 thanks to public-private sector cooperation by and between Enel, Vertias, Ecoprogetto, the Municipality of Venice, the Province of Venice and the Region of Veneto.

The tonnage of recycled fuel[12] used in co-firing with coal has gone up from 27,000 in 2006 to 58,400 in 2012: the aim is to recover 210,000 tonnes of recycled fuel in 3 years (70,000 /year).

The results obtained are particularly impressive:

- Coal and recycled fuel co-firing, together with an efficient sorted collection system in the territory, have led to substantial revision in the use of landfills in the Province of Venice **(reduction of landfilled waste by ca. 4%).**
- The Fusina plant has reached the production efficiency target (70,000 tonnes of recycled fuel sufficient to supply electric power to 35,000 households).

[9] For example, between 40% and 50% of materials used by the six cement plants in Switzerland for the production of replacement fuels come from waste. In recent years, in addition to replacement fuels, these companies have used more than 300,000 tonnes of alternative raw materials from waste, thereby conserving natural raw materials. Source: Ufficio Federale dell'Ambiente – UFAM, 2013.

[10] The option of using refuse from duly prepared plastic packaging waste selection processes (in 2011, 218,000 tonnes out of the 657,000 tonnes collected) should be verified in relation to the scarce quantity of alternative fuels authorised in cement plants, while the launch in waste-to-energy plants has to cope with the energy efficiency of that type of plants. Source: COREPLA, 2012.

[11] Tests are moreover under way on the first industrial sized hydrogen plant in the world (12 MW) to generate electricity.

[12] Recycled fuel is obtained from the treatment of residual urban waste through the phases of grinding, biodrying and mechanical separation of inert materials and metals. The process makes it possible to process waste into a high heating value fuel thanks to the effective loss of water inside the biocells and the separation of materials that have a negative influence on a subsequent combustion.

Environmental standards are high:

- Atmospheric emissions below the limits set by national and European legislation and EAMS certification.
- Savings of 936 kg of CO_2 per every tonne of recycled fuel burnt.
- 99.7% less particulate matter produced by firing in the power station.

Recycled fuel and plastic waste co-firing in coal-fired thermoelectric power stations can therefore be a very attractive option, one that can be replicated with significant results in all situations where a coal-fired power station is available, the feasibility of which will be explored where local conditions so permit or warrant.

4. Potential impacts of a strengthened plastics supply chain for Italy and Europe

KEY MESSAGES OF THE CHAPTER

— The plastics industry can **contribute substantially to the recovery of manufacturing,** in line with the Commission's target of 20% of GDP by 2020 (compared with 15.6% at present).

— Our analyses, based on regression coefficients and on a model for estimating the variation in the added value of the manufacturing sector, show that plastics ranks among the industrial sectors providing the greatest contribution to manufacturing: an increase of 10% in added value in the plastics sector could result in a **4.4% increase in the added value of the overall manufacturing sector** at European level.

— In Italy, on the basis of an analysis of matrices of sectorial interdependence shows a €100 increase in GDP in the national plastics supply chain generates **€ 238 of GDP in the national economy,** and that every work unit created in the plastics sector leads to **2.74 subsequent work units.**

— A 10% improvement in overall turnover in the Italian plastics supply chain (+ €4.3 billion) could translate into a **0.6% increase in national GDP (+4.6% in the manufacturing sector)** and the creation of **40,000 new jobs.**

1. The concrete activation of the guidelines and proposals for action suggested could strengthen substantially the plastics supply chain in Italy first and foremost, with benefits expanding to Europe as well. We have quantified the impacts in terms of:

— contribution to the overall growth of the European manufacturing sector;

— increase in employment and GDP generated by the Italian plastics supply chain.

Contribution of the plastics supply chain to relaunching European manufacturing

2. In the last decade, the European Union has entered a structural change phase in which the de-industrialisation processes have intensified:

— The EU-27 is the area with the most pronounced drop in terms of share of the added value of manufacturing in GDP (-2.9%), exceeding China (-2.5%), the U.S. (-2.7%) and Japan (- 1.9%).

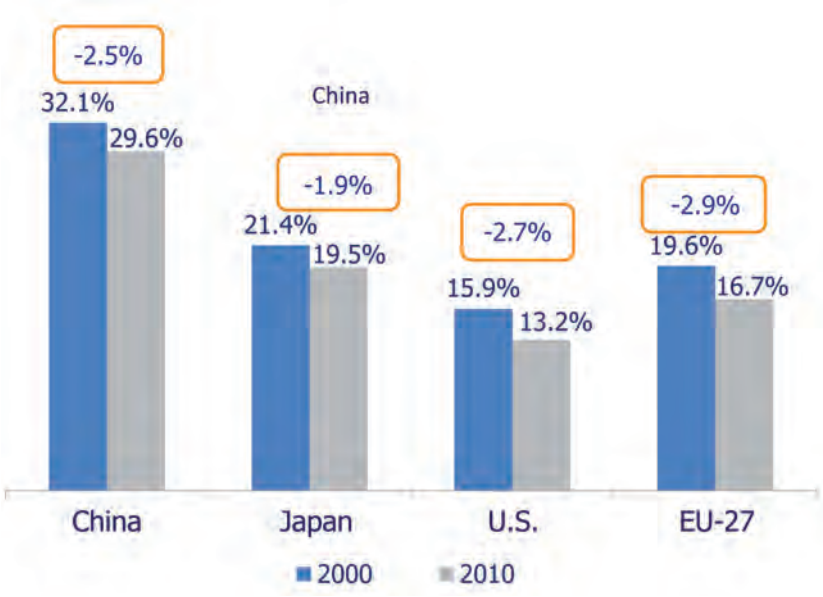


Figure 1. Share of added value of manufacturing in the overall added value

Source: The European House - Ambrosetti re-elaboration of World Bank data, 2013

3. Few Member States today have a ratio between the added value of the manufacturing sector and GDP exceeding 20%:

— None of the EU-15 countries, with the exception of **Germany**, belongs to that group.

— The loss of added value of the manufacturing sector was generalised between 2000 and

2010 (between - 9% in Malta and 0.5% in Poland)[1].

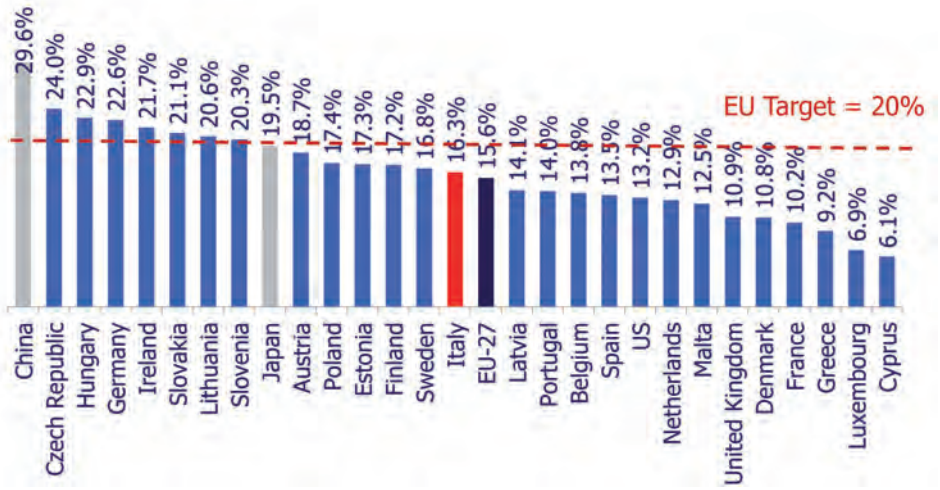


Figure 2. Share of added value of manufacturing in GDP in the EU-27 and in certain global economies, 2011

Source: The European House - Ambrosetti re-elaboration of Eurostat data, 2013

4. The economic crisis has aggravated this trend. Industrial production has slowed down drastically since the start of the recession:

- The decline registered in 2009 has not yet been recovered.
- Between 2008 and 2009, industrial production dropped by 12.8% in the EU-27.
- Whereas this result is relatively positive with regard to Japan (-21.0%), the same cannot be said with reference to the U.S., where the recovery has been slow but steady since 2009.

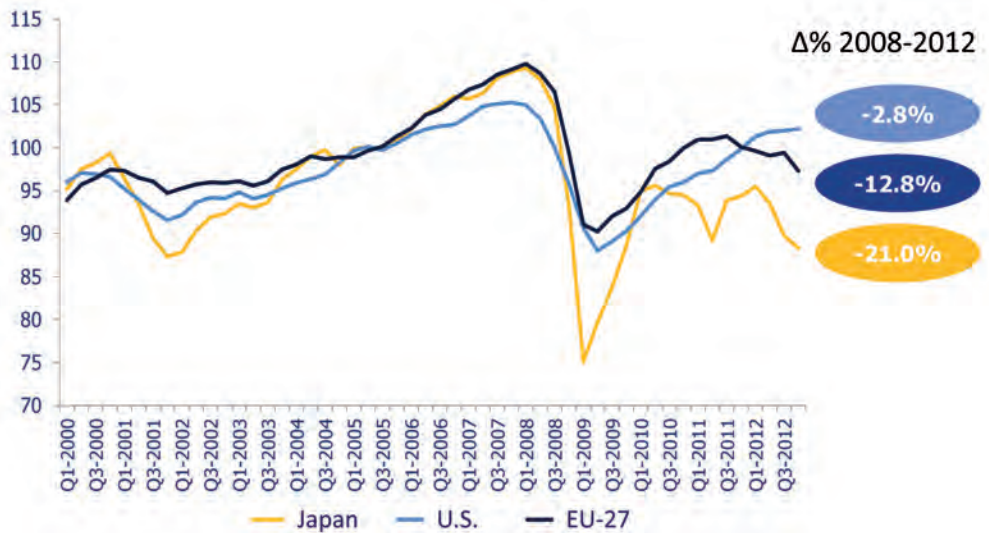


Figure 3. Industrial production index: comparison between Japan, the U.S. and the EU-27 (2005=100, not including construction), 1st quarter 2000 – 3rd quarter 2012

Source: The European House - Ambrosetti re-elaboration of OECD data, 2013

[1] Romania is the only EU Member State to have registered a gain since 2000 (from 15% to 22% of GDP).

5. The new EU industrial policy is geared to laying the foundations for the future development of the EU-27 **on growth in manufacturing** and on attaining a **20% share of GDP** by 2020. According to the latest declarations, the European Commission is now in favour of turning the EU-27 into an area favourable to industry, provided there is a single European industry policy (instead of 27 national industrial policies) endowed with:

- adequate instruments;
- greater coherence of other policies;
- a decisive drive for innovation (for example, basic "enabling technologies" – nanotechnologies, micro- and nano-electronics, advanced materials, biotechnologies, clean vehicles, sustainable construction, intelligent networks and aerospace)[2].

6. The plastics supply chain can make a substantial contribution towards achieving the EU's objectives. We have estimated **the contribution to the growth in added value of the manufacturing sector:**

- We have estimated the **activation coefficient** on the growth rate of added value in the sector by developing a multiple regression analysis model.
- In an initial phase, the analysis was conducted taking into account a considerable number of sectors:
  - chemicals, excluding rubber-plastics and the pharmaceutical sector; [3]
  - pharmaceuticals;
  - rubber – plastics;
  - textiles (yarns and textile fibres);
  - wood – furniture;
  - basic metals (primary processing of iron and steel, processing of precious metals, iron-steel casting and casting of non-ferrous metals);
  - iron and steel (production and processing of iron and steel);
  - other non-metal materials (production and processing of glass, porcelain, ceramics, clay, cement and stone).
- The variation rate in added value within the individual sectors has been used as the independent variable, while the variation of added value within the manufacturing sector has been selected as the dependent variable.

[2] Cf. the article by Antonio Tajan (Vice President and European Commissioner for Industry) and Michel Barnier (European Commissioner for the Internal Market and Services) in "Il Sole 24 ore" of 20 December 2012.

[3] Production of pesticides and other agri-chemical products, paints and coatings, production of soaps, detergents, perfumes and other products for personal hygiene.

— Certain factors of no significance for assessing the impact of the variation rate in the added value of the manufacturing sector were excluded after the initial analysis.

— That said, we do not mean to say that the excluded sectors do not have a role to play in the growth of added value, but rather that they follow **different dynamics** from the general aggregate (such as, for instance, in the case of the production and processing of iron and steel).

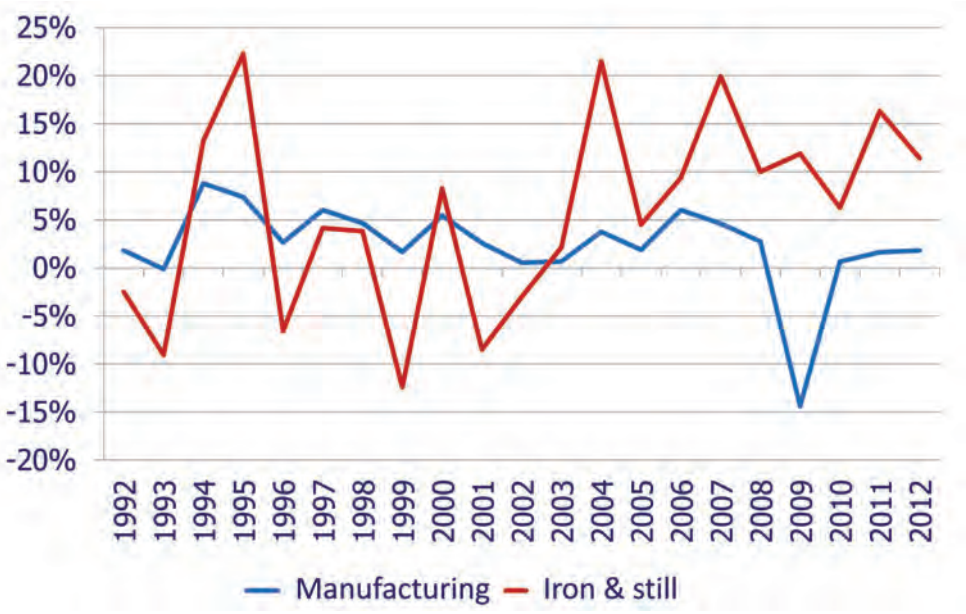


Figure 4. Comparison of the variation rate in added value of iron and steel and of the entire manufacturing sector, 1992-2012

Source: The European House - Ambrosetti re-elaboration of OECD data, 2013

7. The second analysis made it possible to identify three main sectors with **high coefficients and good levels of significance:**

— the **rubber and plastics** production and processing sector;

— the **basic metals** production and processing sector;

— the other **non-metal materials** production and processing sector.

A model has been developed on the basis of regression coefficients for estimating the **variation in the added value of the manufacturing sector:**

— The model appears particularly significant with a correct **R^2 value equal to 0.71.**

— The coefficient assigned to the rubber and plastics sector is the highest of the three sectors considered: **0.44** compared with 0.11 for basic metals and 0.40 for other non-metal materials.

— Which indicates that, all other things being the same, an **increase of 10%** in the added value of plastics entails a **4.4% increase** in the added value of the European manufacturing sector.

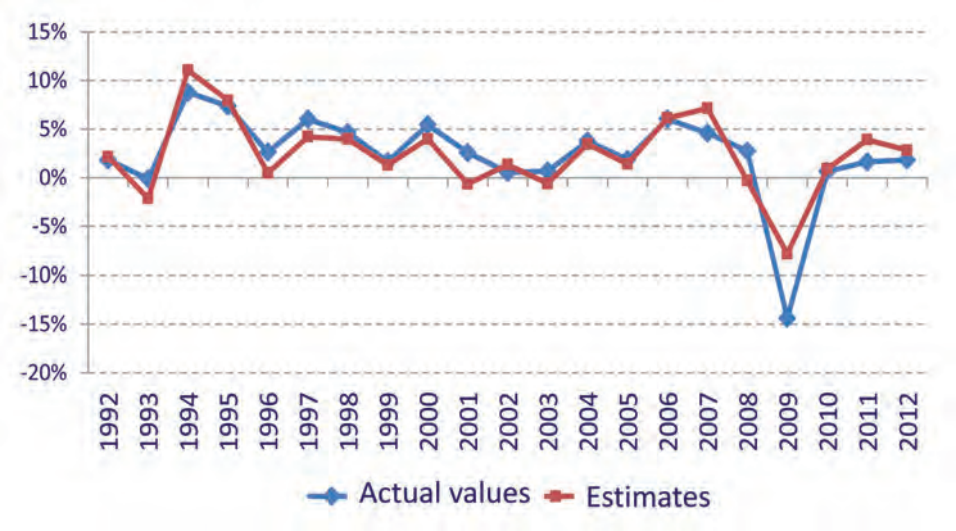


Figure 5. Comparison between the estimates (output of the three-regressors model used) and the real values of the variation rate in added value of the manufacturing sector in Europe, 1992-2012

Source: The European House - Ambrosetti re-elaboration of OECD data, 2013

— **Three reference scenes** have been developed on the basis of these estimates:

- "Business as Usual (BAU) scene," with an annual average growth rate of 0.3% for the rubber and plastics sector during the period 2012-2015.[4]
- "Downturn scene" (average annual variation in the rubber and plastics sector of **-4.5%** between 2012 and 2015).
- "Plastic-led scene" (annual average growth rate of **4.5%** in the rubber and plastics sector of between 2012 and 2015).

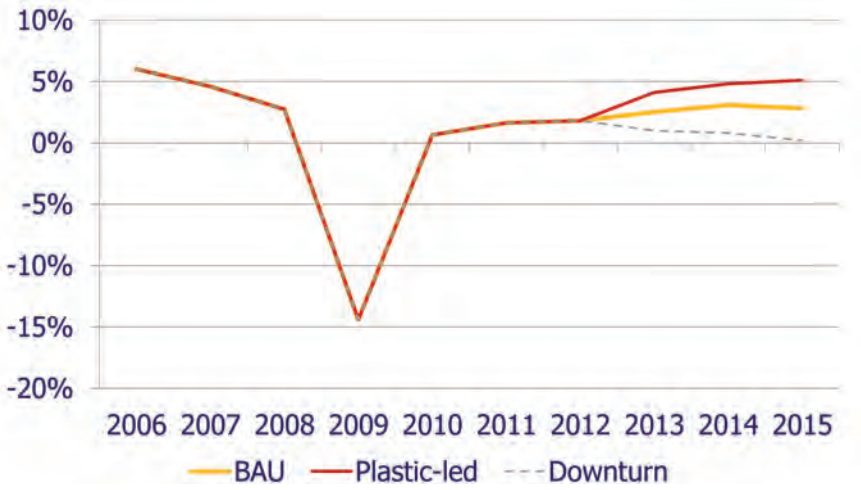


Figure 6. Estimates of the model according to the three different growth scenes in the rubber and plastics sector: growth rates for the European manufacturing sector, 2006-2015

Source: The European House - Ambrosetti re-elaboration of OECD data, 2013

[4] The "business as usual" (BAU) growth rate has been estimated by projecting the current results of the rubber and plastics industry in the 2012-2015 three-year period. The growth rates of the downturn and plastic-led scenarios were hypothesised to remain constant and with opposite sign so as to assess, all other things being the same, the effect of a change in the growth rate for added value in the rubber and plastics sector.

— The model shows how the contribution of the plastics sector can prove decisive for growth in the European manufacturing sector and for reaching the target of a 20% share of GDP for the sector by 2020.

Potential employment and GDP generated by the plastics industry

8. To assess the impacts of the plastics sector on the **Italian economy**, we applied the **input-output analysis:** [5]

— We have used the interdependence matrices to estimate the impacts on the economic system from strengthening the plastics sector and in particular:

- **direct impacts**, those directly correlated to the sector analysed and relative to the effects produced on the plastics sector production chain;
- **indirect impacts**, generated through the production chain comprised of suppliers of goods and services of activities directly linked to the plastics sector;
- **spin-off effects**, generated through expenditure and consumption that are the result of direct and indirect impacts; they consist of the increase in spending registered in the geographic area of reference relating to the strengthening of the plastics sector and which is generated from the greater presence or scope of economic activities and work units.

— An increase in the end demand of the output in a given sector generates a multiplication process, through successive waves, in which the net increases in output of each sector would become increasingly smaller with each phase and end up at zero.

— The **multipliers of the plastics supply chain** obtained from the analysis of the sectorial interdependence matrices show that:

- €100 increase in GDP in the plastics supply chain generates an increase of **€ 238 in GDP** in the economy as a whole (multiplier of 2.38).
- For every annual work unit created in the plastics sector, **2.74 annual work units** are created in the economy as a whole (multiplier of **2.74**) through inter-industrial relations (indirect impact) and an increase in demand (spin-off effect).

[5] Cf. Chapter 6 for a detailed illustration of the methodology and results of the input-output analysis. A brief description of the process and a summary of the main conclusions will be provided below.

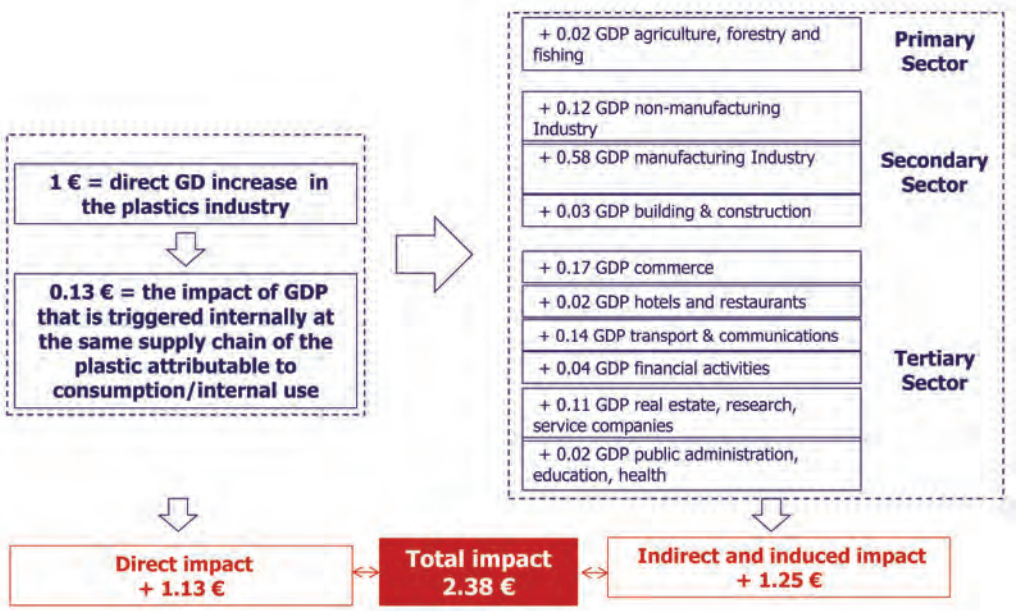


Figure 7. Multipliers of the plastics sector on GDP in Italy

Source: The European House - Ambrosetti re-elaboration of ISTAT data, 2013

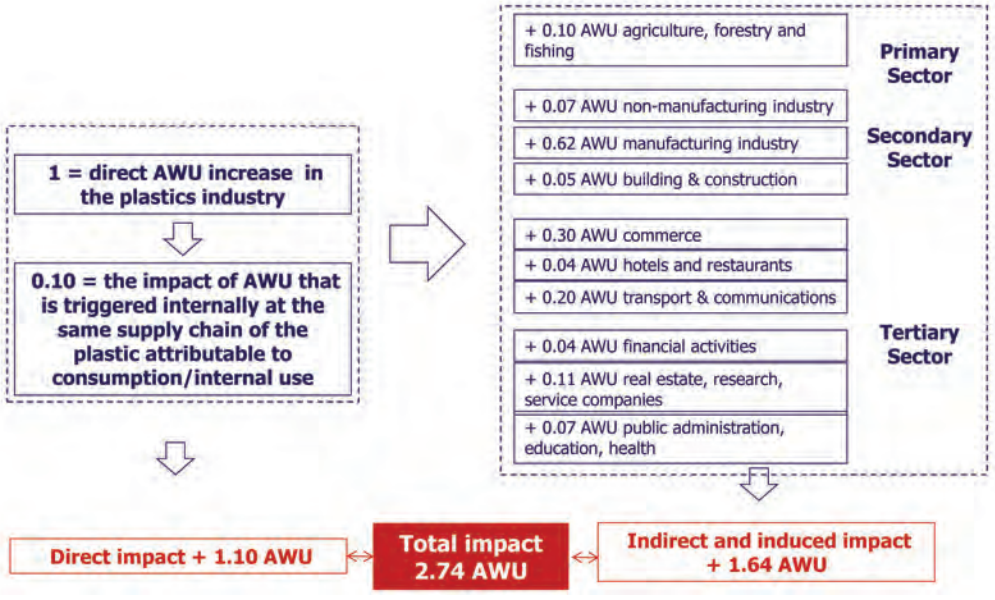


Figure 8. Multipliers of the plastics sector on employment (annual work units) in Italy

Source: The European House - Ambrosetti re-elaboration of ISTAT data, 2013

- Indirect impacts and spin-off effects are **highly labour intensive:** the plastics sector has very high multipliers on labour, whereby for every 100 AWUs generated in the sector, 274 AWUs are generated in the economy through an indirect impact and spin-offs. In other words, due to high economic activation in terms of GDP, the sector is characterised by an even greater employment activation.

9. The plastics sector is therefore significantly linked with other manufacturing activities with reference to Gross Domestic Product (GDP) and employment in Italy as well:

- In the light of the turnover generated by the plastics supply chain in Italy (€43 billion), owing to the multiplier derived from the analysis, a hypothetical **10%** increase, amounting to €4.3 billion, would entail **a 0.6% increase in GDP and 4.6% in manufacturing.**
- As regards employment, a 10% turnover increase in the plastics supply chain would generate **40,000 new jobs in Italy.**

PART II

SCENARIO FOR PLASTICS IN ITALY AND EUROPE

5. Competitive international positioning of the Italian and European plastics supply chain

KEY MESSAGES OF THE CHAPTER

— With some 1.5 million workers, approximately 63,000 companies and a turnover of approximately €300 billion, the plastics industry **occupies a position of primary importance in the manufacturing system of the EU-27.**

— Italy **ranks number three in Europe** in terms of workers, turnover and added value in plastics production and converting, after Germany and France only. Our country is moreover the **second country in Europe for consumption of plastic products** after Germany.

— The **plastics machinery sector** (Italy is nr. 3 in the world in terms of trade balance and production value, fourth in terms of exports), and **the end-of-life supply chain** constitute a point of excellence for Italy.

— The competitiveness of the Italian supply chain faces a number of **strategic challenges:**

- Transformation of the chemicals industry and resulting impacts on the competitiveness of the plastics supply chain.
- Management of the end-of-life cycle for plastic products.
- Growing “external” competition (inside and outside the EU).
- The country context and its vision of industrial policy.
- Competitive gaps, such as the cost of energy and logistics.
- Negative perception of public opinion as to the real value of plastics that feeds prejudices and complicates decision-making.

— Italian and European companies find themselves in a highly competitive international context that is undergoing change with the emergence of new players (from Asian economies), the “downstream” integration of oil-producing companies, the advantages of shale gas and shale oil for the U.S., and the potential **asymmetries** linked to future changes in the system of custom duties on imports in the EU.

Main stages in the development of the plastics industry in Italy and Europe

1. Plastics were invented at the end of the 19th century[1] in the **U.S.** and the **UK**, and were subsequently produced industrially in Europe as well. As of the early years of the twentieth century in particular, **Italy and Germany** developed first rate chemicals industries, capable of competing at world level with the U.S. and Japanese multinationals. Strong industrial development was registered in the production of synthetic polymers between 1941 and 1960.

2. The biggest expansion phase for the Italian and European plastics industry occurred in the post World War II years. Key stages for the sector in Italy include:

- 1952: Inauguration of the Montecatini cluster in **Ferrara**, at the time the largest petrochemical plant in Europe.
- 1953-1954: Establishment of the Ente Nazionale Idrocarburi (ENI) [National Hydrocarbons Authority] to develop strategic initiatives in the field of hydrocarbons, research and chemicals production.
- 1956: Sicedison (joint venture between Edison and Monsanto – U.S.) launches the construction of the **Mantua** petrochemical site, completed in the early years of the 1960s.

3. The 1960s were key years for the national industry – a decade during which Montedison was founded and Giulio Natta was awarded the Nobel Prize for Chemistry:

- 1962-1965: Establishment of an Edison joint venture to create companies active in basic chemistry, synthetic fibres, intermediates, polymers and fertilisers; following these actions, **Porto Marghera, Priolo and Mantua** emerged as some of the most important petrochemical clusters in the country.
- 1963: Giulio Natta and Karl Ziegler were awarded the Nobel Prize for their discoveries in the chemistry and technology of high molecular weight polymers. Giulio Natta's research on synthesis of high polymers led to the discovery of the **stereospecific polymerisation of polypropylene**, and led to the production of **isotactic and syndiotactic polypropylenes**, which would be used extensively in many fields of technology.
- 1966: Creation of **Montedison** from the merger of Montecatini and Edison, the biggest private chemicals group at the time.

4. In the 1980s, the chemical industry in Europe continued to constitute one of the engines for the development of national industrial systems:

- 1983: Creation of Himont, a joint venture between Montedison and Hercules (U.S.), which would in subsequent years emerge as the global leader in polypropylene and help to disseminate technology created in Italy for the production of this type of plastic throughout the world.

[1] The patent for celluloid, the first semi-synthetic material, derived from cellulose (which would become a great commercial success, but whose use would be gradually reconditioned by the inflammability of such material), dates from 1869.

— 1986: Establishment of the European Vinyls Corporation (EVC), a joint venture between ICU (UK and EniChem (Italy), which went on to become the biggest producer of PVC in Europe.

— 1998: Polimeri Europa ranks nr. 4 in Europe (after Boralis, Elenac and Dow) with a production capacity of 1.5 million tonnes.

Recent developments in the plastics industry in Europe and the world

5. Plastics production has **increased constantly** at global level, going from 1.5 million per year in 1950 to 288 million in 2012, for a compound annual growth rate (CAGR) of **8.7%.**

6. In Europe, in 2011, plastics production accounted for some 60 million tonnes, or approximately **21%** of world production as a whole:

— Global plastics production reflects the demand for plastics in the world, with a general balance between the different macro-geographic areas.

— China has passed Europe and the U.S. in production and consumption, accounting for **nearly one quarter** of the world demand.

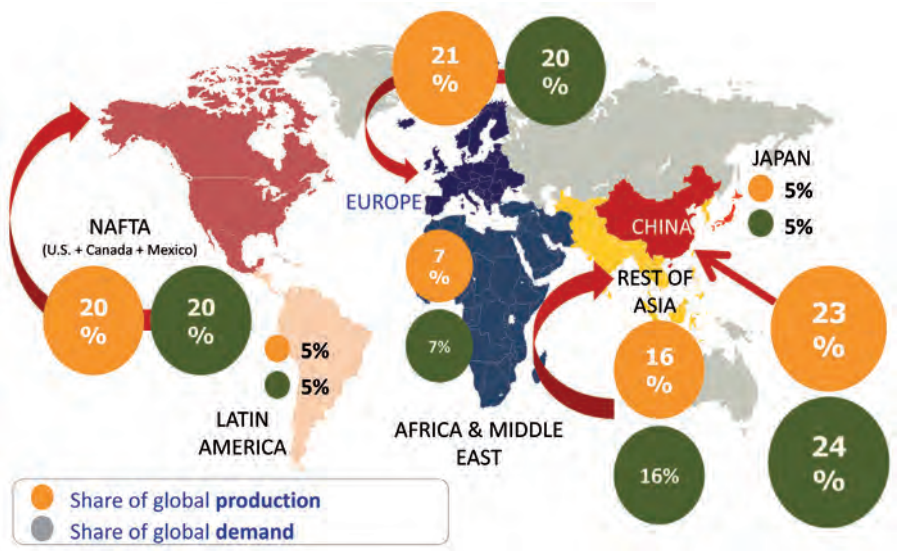


Figure 1. Global distribution of plastics production and demand (percentage of total) per macro-geographic area, 2011

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

7. The competitiveness of the European (and Italian) plastics industry is influenced by a number of disruptive factors (***"game changers"***) in the global arena:

— The competitive advantage of the U.S. in terms of energy after the discovery of shale gas

and shale oil deposits.[2]

— The growth of **China** on the global scene of plastics production and plastics machinery (even though it does not yet seem to equal the quality and excellence of the products made by Western competitors).

— The development of the plastics processing sector in **India**, above all thanks to the development of manufacturing sectors using these products, such as the automotive industry.

— "Downstream" integration of the supply chain in **oil producer countries**.

— The potential role of **Brazil** (and other Latin American countries) in the production of biofuels and bio-based plastics.

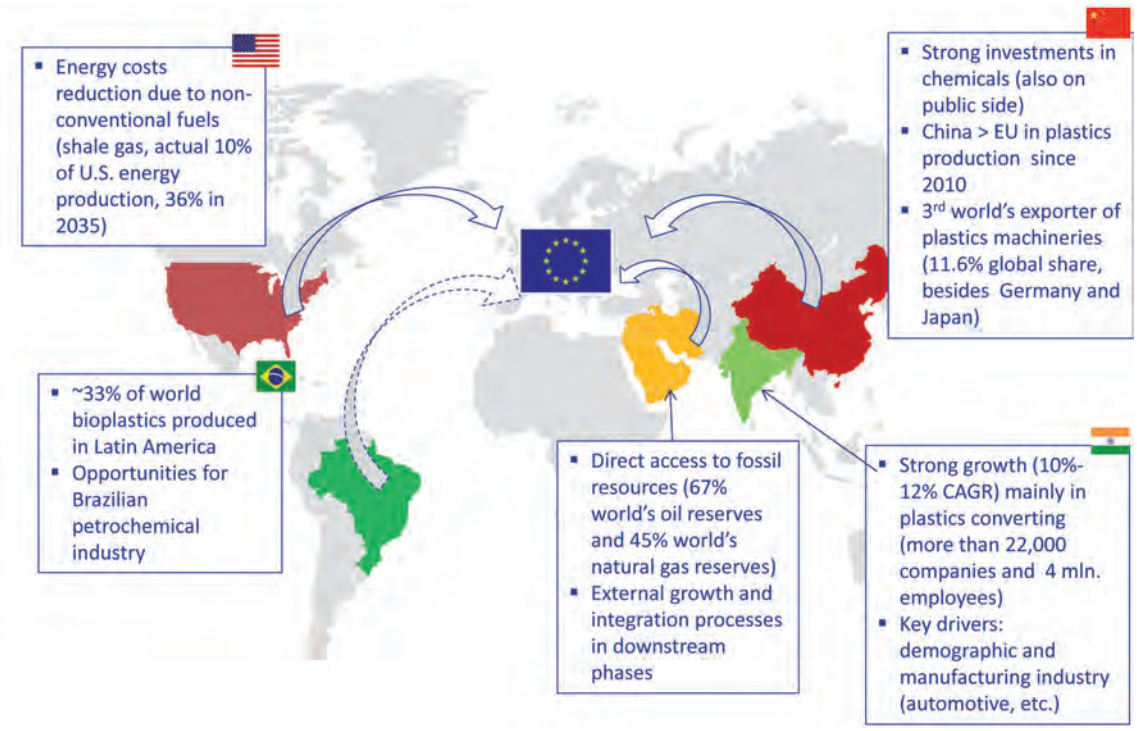


Figure 2. The global geopolitical scene for plastics and the threats to Europe

Source: The European House - Ambrosetti elaboration based on different sources, 2013

Note: CAGR - Compound Annual Growth rate

[2] Shale gas is methane gas produced by unconventional deposits of partially-diagenised clay, the result of anaerobic decomposition of organic material contained in the clay. Shale oil is petroleum obtained from new drilling techniques which break up the clay and make it possible to extract the crude oil even found in pores of impermeable rock. The reservoirs of oil shale and bituminous clay are concentrated predominantly in the U.S., with the rest distributed among Brazil, Australia and China.

8. The **production of man-made fibres**[3] is an indicator of the sector's development at global level:

- **China**, which in 1983 had only a 4% share, emerged as the world's leading producer of man-made fibres in 2012, with **66%** of the global market.[4]
- The **EU-U.S. axis**, which in 1983 accounted for an aggregate of **58%**, today accounts for **12%** of world production.
- Europe and Italy nonetheless continue to maintain specialisations of excellence in production niches in the sector.

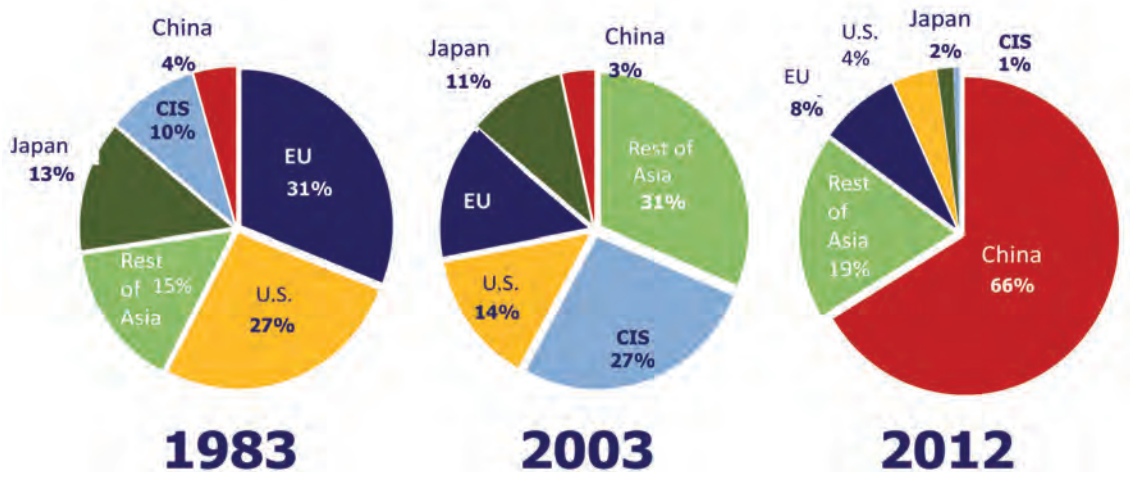


Figure 3. Geographic shift of global production of man-made fibres (in percentage), 1983 - 2012

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

9. In terms of global **demand**, plastics consumption has grown steadily since 1990 (+5%). This *trend* will continue in the near future (cf. the analysis for 2025 presented in Chapter 1): demand for plastics is expected to grow already in 2017 at an average annual rate of **3.7%**, exceeding 289 million tonnes.

10. Regarding the different types of plastics, with 23% of global demand, **polypropylene (PP)** is today the most sought after resin, followed by low density polyethylene **(LDPE and LLDPE)**, with 27% of global demand. In general, traditional plastics (such as polyolefin, PVC, PS and EPS, PET) represent ca. 85% of the total demand.

[3] Man-made fibres include, in addition to synthetic fibres, cellulose fibres as well, which nonetheless represent only 8% of the total.

[4] Chinese growth took off as of the early years of the millennium; in 2003, the economics of the rest of Asia, including Taiwan, amounted to 31% of the total.

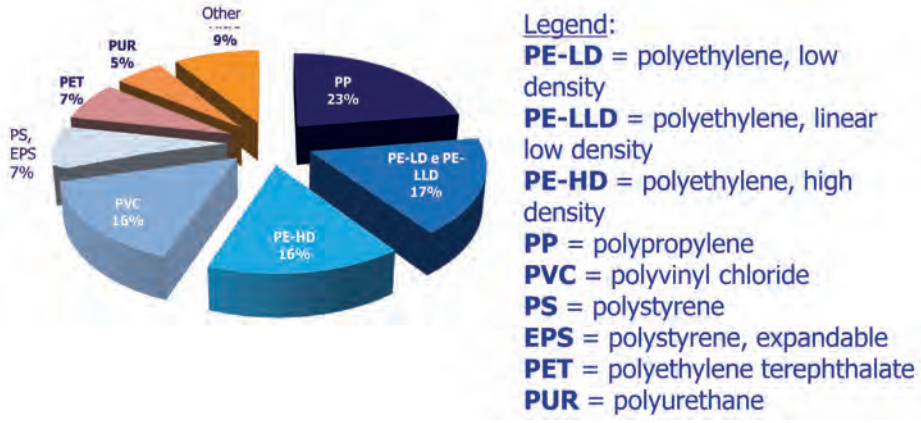


Figure 4. Distribution of global demand per type of plastic (in percentage), 2011

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

Demand in Mio t 1990 – 2017e by type of plastic	1990 in Mio t	2012 in Mio t	2017e in Mio t	Growth p. a. 2012 – 2017e
PE-LD, PE-LLD	18.8	42.0	50.4	3.7%
PE-HD	11.9	37.3	43.9	3.3%
PP	12.9	54.6	63.9	3.2%
PVC	17.7	37.4	44.9	3.7%
PS	7.2	11.6	13.4	3.0%
EPS	1.7	5.7	7.4	5.3%
ABS, ASA, SAN	2.8	7.3	8.7	3.5%
PA[1)]	1.0	2.9	3.5	5.0%
PC	0.5	3.7	4.7	5.0%
PET	1.7	17.0	21.5	4.8%
PUR	4.6	12.9	16.3	5.0%
Other Thermoplastics	2.8	8.8	10.7	4.0%
Total	83.6	~241	~289	3.7%

Figure 5. Distribution of global demand per type of plastic, 1990-2017

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope Market Research Group (PEMRG) and Consultic Marketing & Industrieberatung GmbH data, 2013

11. The plastics industry occupies a position of primary importance in the economy of the EU-27; more specifically it:

- Employs **approximately 1.5 million people**, with a production fabric of ca. 63,000 companies.
- Generates a turnover of ca. **€ 300 billion,** nearly double that of the textiles-clothing sector.
- Registers **a trade surplus constantly** (ca. €20 billion in 2011[5]).

[5] Value referring to plastics production and converting, not including the plastics machinery industry and the recycling supply chain. Source: PlasticsEurope, October 2012.

	Companies	Turnover (billions €)	Employees ('000)
Production	2,636	89	167
Converting	55,559	194	1,185
Machinery	3,700	17	100
Recycling	1,000	2	30
Total	62,895	302	1,482

Figure 6. Details of the plastics supply chain in the EU-27, 2011

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope, EUROMAP, Plastics Recyclers Europe, ASSOCOMAPLAST and ASSORIMAP data, 2013

— Plastics converting constitutes the most significant phase in the supply chain in terms of companies, employees and turnover. Considering the industry at the EU-27 level in the strict sense, converting accounts for:[6]

- 95% of all companies (over 58,000 between plastics production and converting companies);
- 68% of the turnover (total: €283 billion);
- 88% of all employees (more than 1.3 milliion workers).

12. In the period 2005-2011, with the effects of the crisis, the European plastics production and converting industry registered a reduction in **added value** and **employees**, for an average annual reduction of 1.7% and 1.0% respectively at the aggregate level.

[6] Source: The European House – Ambrosetti re-elaboration of PlasticsEurope estimates for 2011.

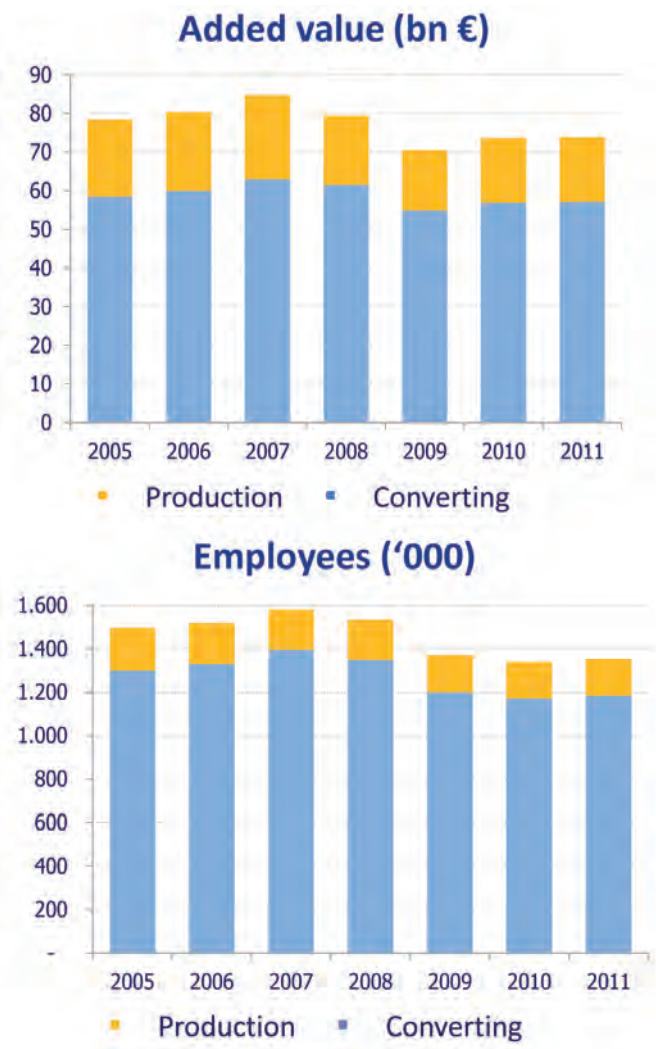


Figure 7. Added value and employees in the plastics production and converting industry in Europe, 2005-2011

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013 - Note: Estimates for 2010 and 2011

13. After the drop registered between 2007 and 2009, the plastics production index is back at the levels of the beginning of the 1990s.

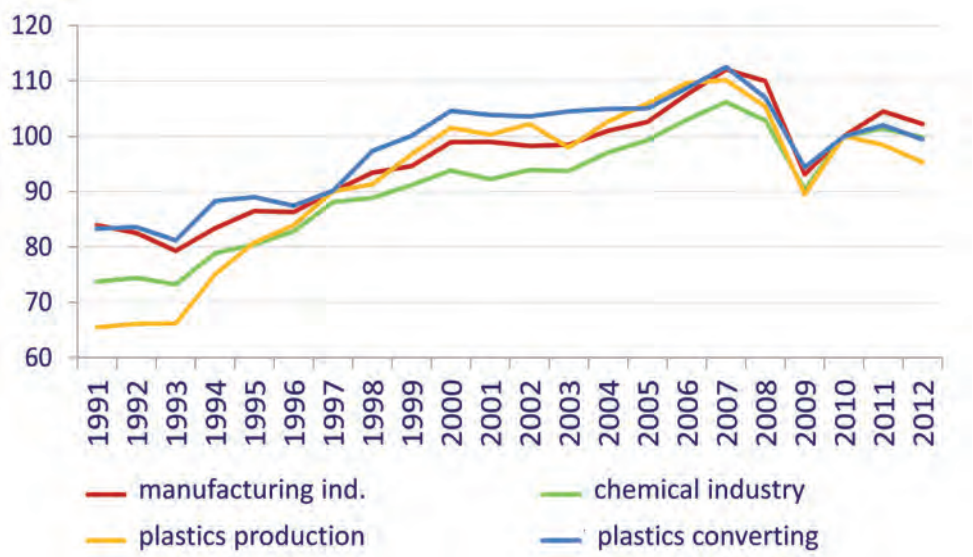


Figure 8. Industrial production index in the EU-27: comparison between manufacturing, chemicals industry, plastics production and converting (2010 = 100), 1991-2012

Source: The European House - Ambrosetti re-elaboration of Eurostat data, 2013

14. Downstream from the supply chain, **packaging** constitutes the main destination for the use of plastics in Europe (39%):

- Together with construction, packaging accounts for **60%** of the entire use of plastics in EU.
- Applications in the **automotive industry** (8%) are growing more rapidly than in other sectors, rising by approximately 10% between 2010 and 2011, thanks in part to new composites used in the latest generation vehicles.

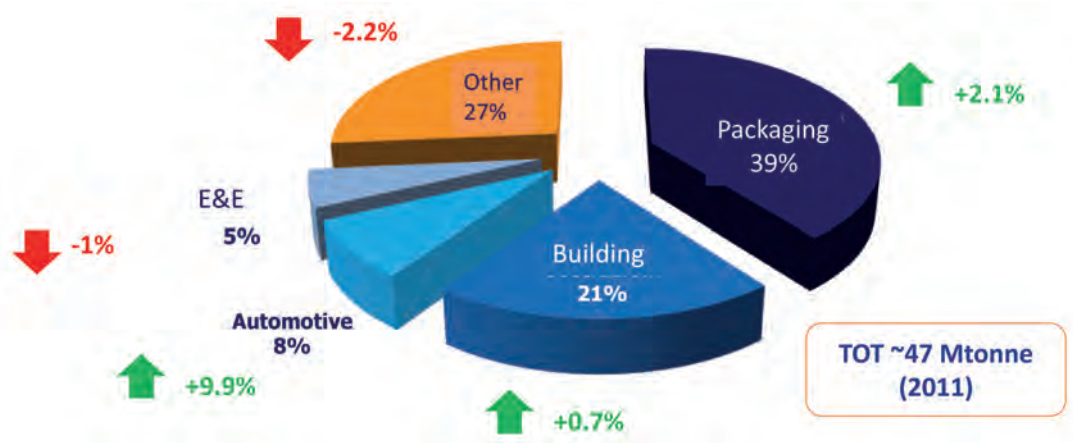


Figure 9. Distribution of the destination of plastics in Europe and percentage variations from the previous year, 2011

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

Dimensions and competencies of the plastics supply chain in Italy

15. The plastics supply chain plays **a central role in the Italian economy.** Our country is:

— **Number 3** in Europe[7] in terms of employees (146,000), turnover (€32 billion), and added value (ca. €8 billion) in the plastics production and converting phases, behind Germany and France. In Italy, like the rest of Europe (with the exception of Germany), nearly 90% of the workforce and 87% of the added value are in plastics converting.

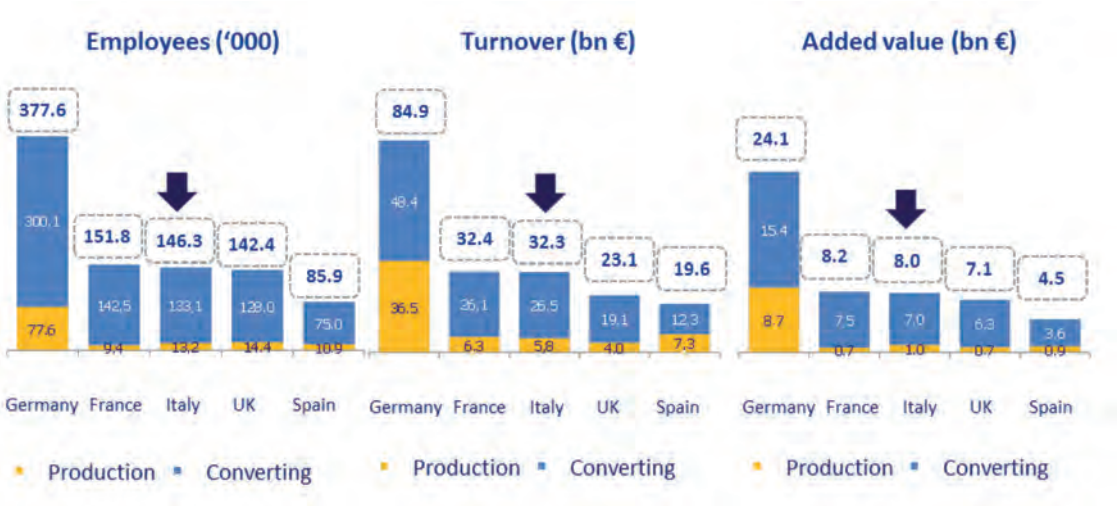


Figure 10. Added value (in billion euro), turnover (in billion euro) and employees (in thousands) in the top five European plastics markets, 2009

Source: The European House - Ambrosetti elaboration of Eurostat data, 2012

[7] Comparison based on 2009 data for homogeneous values between the different countries.

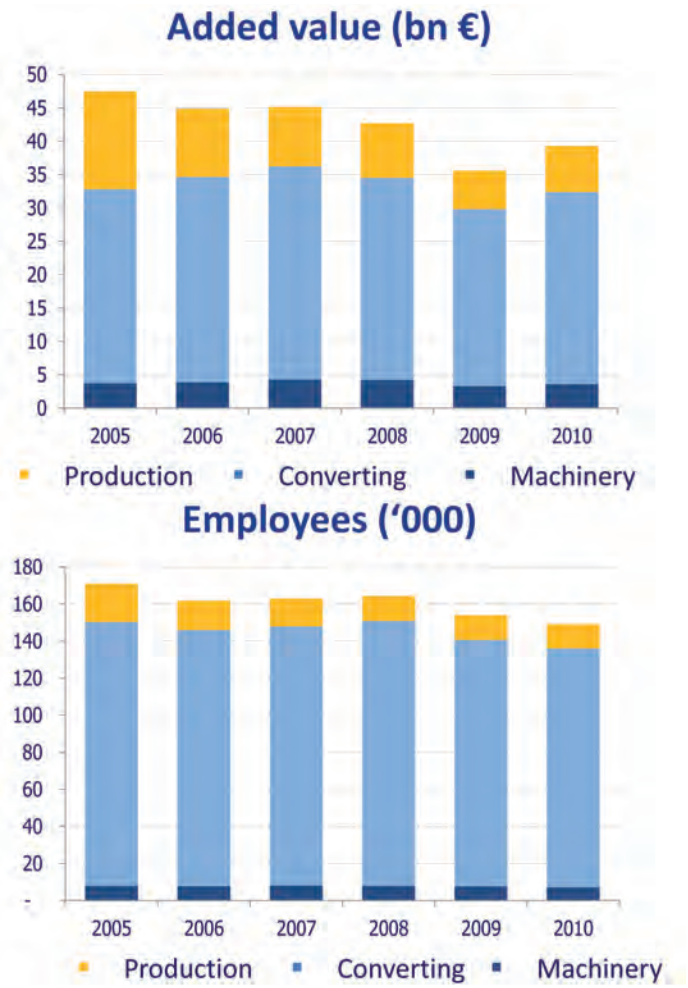


Figure 11. Added value (in millions of euros) and employees (in thousands) in the Italian plastics supply chain, 2005-2010

Source: The European House - Ambrosetti elaboration of PlasticsEurope and ASSOCOMAPLAST data, 2013 – Note: Historical data not available for the plastics recycling industry.

— **Number 2** in Europe as **a consumer market** of plastics after Germany (7.1 and 11.9 million tonnes/year respectively).

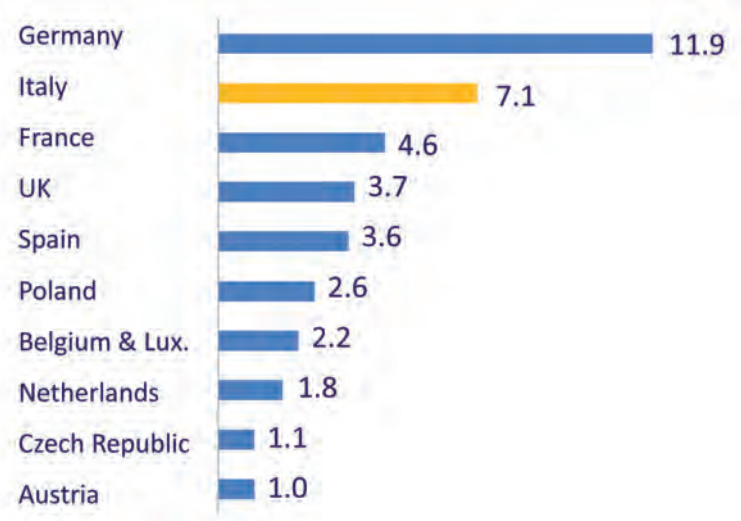


Figure 12. Demand for plastics in Europe: top 10 countries ('000 tonnes/year), 2013
Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

16. The Italian plastics supply chain felt the effects of the global economic crisis as of 2007. In 2012, the plastics production and converting values stood at ca. 20 percentage points below the levels of 2004. Production growth was nonetheless registered in the plastics machinery sector (+11% in the period 2005-2012).

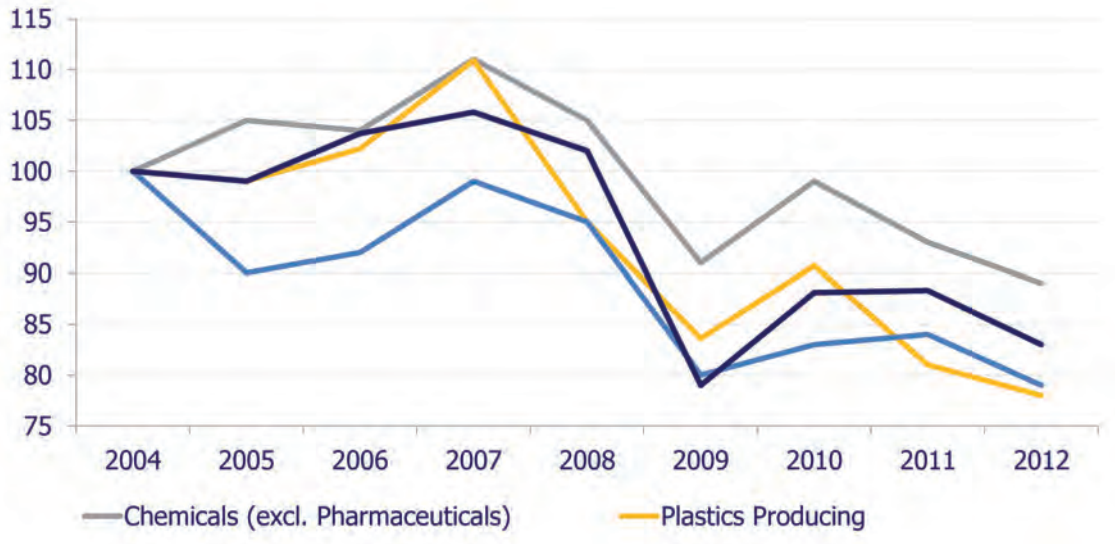


Figure 13. Industrial production index for the plastics sector in Italy (2004 = 100), 2004-2012
Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

17. The growing international competition notwithstanding, the Italian **rubber-plastics machinery** industry has maintained a **strong export propensity,** growing by 5.9% in the 2011-2012 two-year period. The Italian machinery industry has:

— **Larger size** companies compared with the national average (**51 employees** compared with the Italian average of approximately 10 employees in industry[8] per se).

— **Critical mass**, with **a production value of € 4 billion** in 2012 **and more than 7,000 employees**[9]. Italy ranks number 3 in production value, after China and Germany.

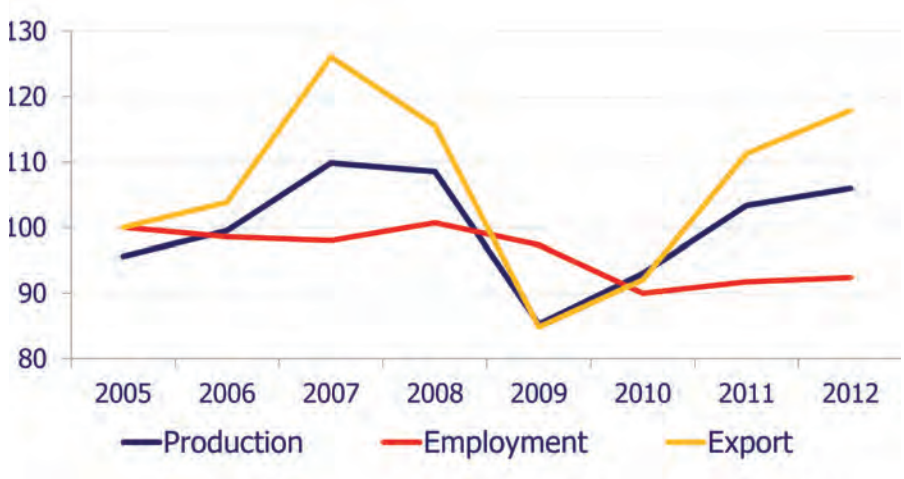


Figure 14. Trend in production, number of employees and exports by the Italian plastics machinery industry (2005 = 100), 2005-2012

Source: The European House - Ambrosetti re-elaboration of Assocomaplast data, 2013

— **High trade openness rate:**

- **Fourth per export value** at global level, with a **10.4%** share among the top 10 manufacturing/exporting countries, behind Germany, China and Japan, with a 13% growth rate in the 2010-2012 three-year period (€2.57 billion in 2012). Italy's exports to the 10 main markets account for 56.3% of the total.
- **Third in terms of trade balance** at world level (trade surplus of €1.9 billion in 2011). The change in the balance in the 2010-2012 three-year period is positive and growing (CAGR of 11.5%).

[8] Figures referring to manufacturers of machinery and equipment for rubber-plastics. The average size of Italian companies falls below 4 employees per company, if industry and services are taken into account. Source: Istat, 2012.

[9] Employment and turnover in the sector are concentrated in Lombardy and Veneto: the effects of the growing Asian competition in machinery for rubber-plastics are felt especially in Central-Northern Italy.

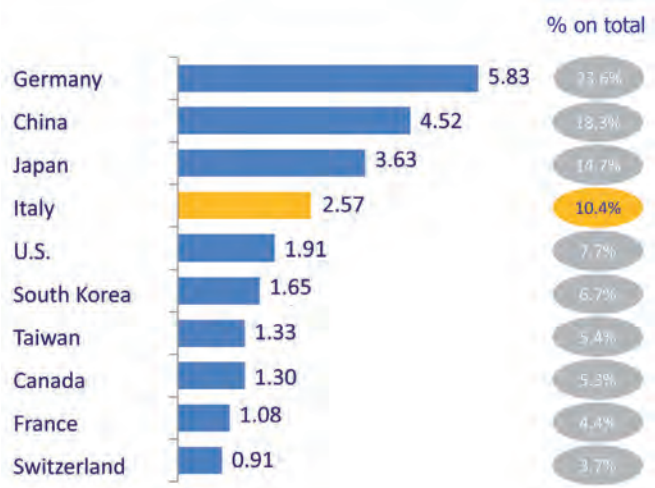


Figure 15. Exports by the leading rubber-plastics machinery manufacturers in the world (in billion euro), 2012

Source: The European House - Ambrosetti elaboration of ASSOCOMAPLAST data, 2013

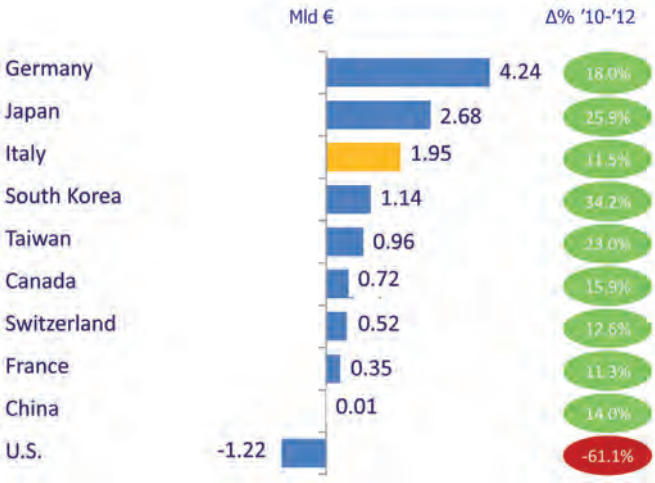


Figure 16. Trade balance of the top ten rubber-plastics machinery manufacturers in the world (in billion euro), 2012 and average Δ% 2010-2012

Source: The European House - Ambrosetti elaboration of ASSOCOMAPLAST data, 2013

18. **"Green chemistry"**[10] and research on **bioplastics**[11] **in Italy** can represent an important direction for the future development of the plastics industry:

Today, the sector is still in the development phase, with **135 operators, 1,300 employees and an overall turnover of € 370 million.**[12]

— Italy is **one of the countries in the forefront** of **bio-based plastics** and **bioplastics**, with important initiatives such as the Green Chemistry Technological Cluster, the Matrix project in Sardinia, Chemtex (M&G Group) in Tortona, and other industrial operators.

[10] Green chemistry is geared to achieving significant improvements in the eco-efficiency of chemical products, services and processes, so as to obtain a sustainable, cleaner, and healthier environment and a competitive edge through the planning, production and use of efficient and efficacious chemical products and processes that are more ecological and prevent pollution at molecular level.

[11] Cf. Chapter 7 for a discussion in greater depth.

[12] Source: Assobioplastiche – Plastic Consult, "*Il mercato italiano dei poimeri compostabili*," July 2013.

The National Green Chemistry Cluster

The National Green Chemistry Cluster was established in 2012 to act as a driving force for sustainable economic growth in the territories and the entire national economy in what is known as the "green chemistry" sector.

The cluster will rely on the involvement of public and private operators active in the field of innovation and cooperation with institutions to promote a series of actions and interventions in line with the European Union's strategic agenda from the perspective of the priorities of research and innovation (e.g. the "Horizon 2020" Framework Programme) and the territorial policies.

This initiative is the brainchild of Novapont, Versalis (ENI Group), Chemtex Italy (M&G Group) and Federchimica, it comprises SMEs, universities, authorities and organisations that carry out research and innovation projects and develop policies on the territory.

In particular, four projects have been launched in specific areas of research: 1) sustainable technologies for the production of new elastomers and lubricating oils; 2) third generation biorefinery; 3) production of chemicals by fermentation; 4) carboxylic acids from biomass.

"Green" reconversion of the Porto Torres petrochemical site in Sardinia: the Matrìca project

The **Matrìca** project, a joint venture by Versalis and Novamont, concerns the creation and management of a green cluster as part of the plan to reconvert the Porto Torres petrochemical site in Sardinia. With an overall investment exceeding one billion euro (€500 million for the chemical plant alone), the site will consist of 7 plants (operational as of 2016) integrated and self-sufficient from the point of view of the resources used and a research centre already launched.

The aim of the Matrìca project is to become an industrial and technological leader in this segment on the global stage, with **more than 350,000 tonnes per year** of bio-based materials produced and brought on the market:

- Production of chemical intermediates and bioplastics[13] through an integrated third generation biorefinery that will use non-food agricultural waste and raw materials.
- Virtuous synergies with the agricultural sector and local crops, capitalising on the strong agricultural tradition in Sardinia and the local ecosystems.
- Employment opportunities (300 new direct jobs) and income differentiation for the agricultural entities in the territory.

Development of Proesa technology by Chemtex (M&G Group) in Tortona

In 2004, the M&G Group embarked on R&D activity in the field of biomass chemistry with the study and development of second generation bioethanol and chemical products from renewable sources, using biomass cultivated on marginal fields not in competition with food crops.

[13] The cluster will ensure a combined offer: biodegradable or matrix plastics such as biomonomers, biolubricants, biofillers, bio intermediates additives for elastomers and bioplastics.

The start of construction of the first plant for the production of second generation ethanol in Crescentino, Province of Vercelli, was announced in 2011 (operational as of the end of 2012), together with the development of Proesa technology used to obtain biofuels and chemicals from non-food plant varieties.

Research in chemistry for plastics (conventional and bioplastics) is conducted in the territory of the Tortona Proplast Consortium which provides R&D and training services in the field of plastics converting, materials engineering and product engineering.

19. One of the most sensitive moments in the supply chain for the industrial system is the post-consumption phase relating to the **end-of-life of plastic waste.** Italy has **sizeable potential** in the second life cycle of plastics, thanks to expertise in recovery and recycling.

20. End-of-life processing leads to new uses for plastics and has positive repercussions along two different lines, namely to:

— Improve the way **public opinion** perceives plastics and their potential uses in the post-consumption phase.

— Produce **new goods** from plastic waste that is currently disposed of.

21. **3.3 million tonnes of plastic waste** is generated every year in Italy, and approximately **51% is recovered** through recycling for new uses or for energy purposes:

— In the EU-27, nine countries reach a plastic waste recovery rate above 90%.

— This rate could be increased in Italy (which is in line with the European average of 60%) by taking action on the waste-to-energy front.

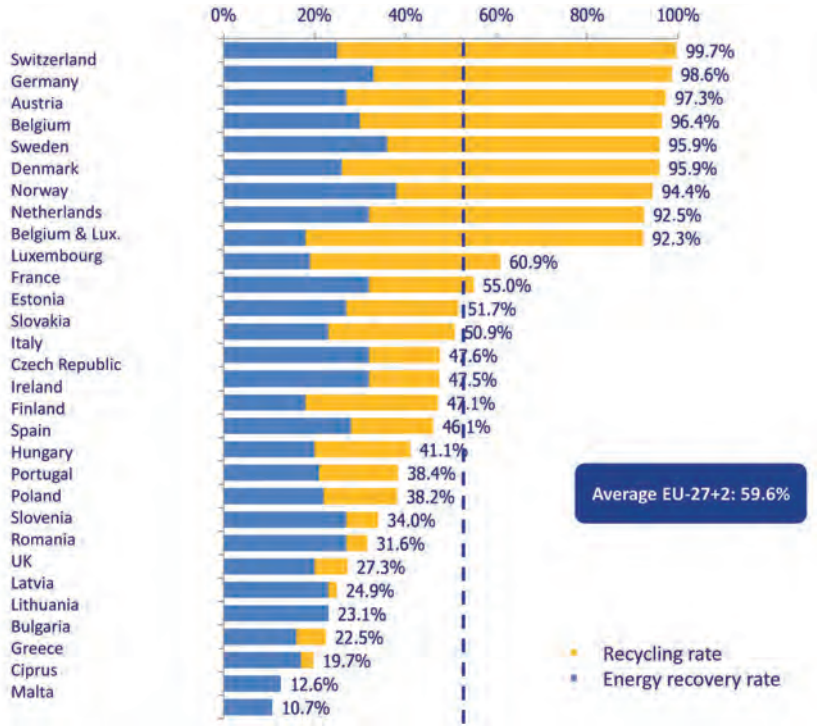


Figure 17. Plastic waste recycling and energy recovery rate in the EU-27, 2011

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope and Consultic GmbH data, 2013

Strategic challenges for the Italian plastics industry

22. The Italian plastics supply chain faces a number of important **challenges**:

- Transformation of the chemical industry and resulting impacts on the competitiveness of the plastics supply chain.
- Management of the end-of-life cycle for plastic products.
- Growing "external" competition, including with asymmetries owing to political decisions at EU level.
- Lack of an industrial policy vision on the preconditions for concrete development of the sector.
- The negative perception of public opinion, which complicates decision-making.

23. The Italian chemical industry has been transformed in the last fifty years:[14] the cessation of important components of the national chemical supply chain (owing also to debatable industrial policymaking decisions) has meant that small and medium-sized chemical enterprises in the plastics sector have been transformed so that they can remain competitive.

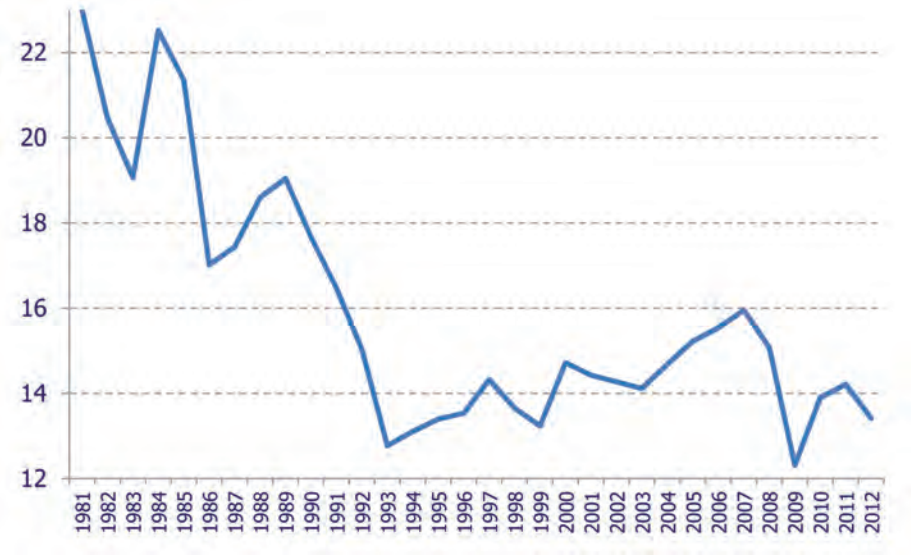


Figure 18. Chemical production in Italy (in billion euro, constant values in 1981), 1981-2012
Source: The European House - Ambrosetti re-elaboration of Istat and Federchimica data, 2013

24. Approximately 83% of the Italian plastics industry today consists of companies with fewer than 20 employees, with medium-sized and large enterprises accounting for **6%** of the total (compared with **22%** of companies with more than 50 employees in Germany and 13% in France).

[14] In the 1970s, Montedison was the fourth chemical company in the world. Today, Italy is still home to important production sites and major groups (Italian and foreign) for plastics converting.

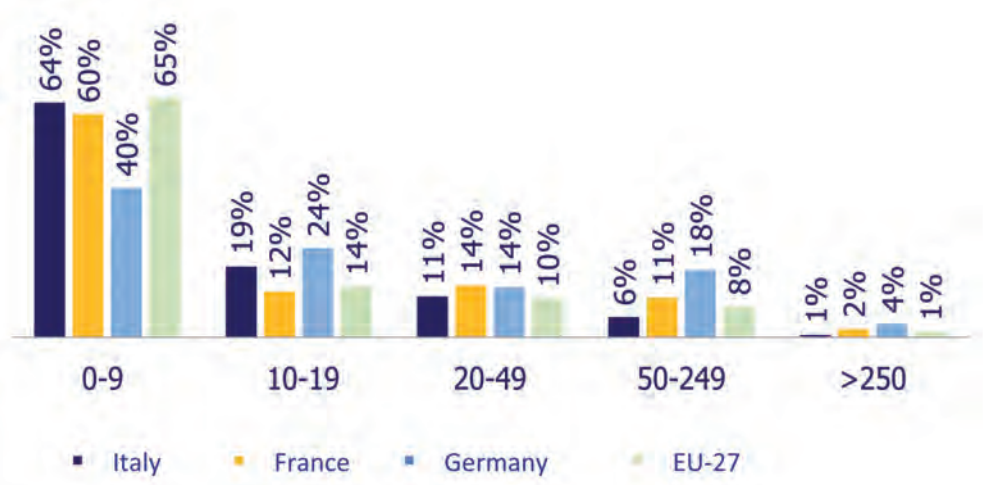


Figure 19. Composition of the plastics industry in Italy and in the main European competitors in terms of employees

Source: The European House - Ambrosetti re-elaboration of Eurostat data, 2013

	Companies			Employees			Turnover (bn €)		
	Italy	Germany	France	Italy	Germany	France	Italy	Germany	France
Production	340	415	229	13,189	77,588	9,366	5.8	36.5	6.3
Converting	9,557	6,382	4,042	133,108	300,053	142,450	26.5	48.4	26.1
Total	**9,897**	**6,797**	**4,271**	**146,297**	**377,641**	**151,816**	**32.3**	**84.9**	**32.4**

	% su A.V. manufacturing			Employed by company			Turnover per employee ('000 €)		
	Italy	Germany	France	Italy	Germany	France	Italy	Germany	France
Production	0.6%	2.3%	0.4%	39	187	41	440	470	674
Converting	3.9%	4.0%	4.2%	14	47	35	199	161	183

Figure 20. Plastics production and conversion: comparison between Italy, Germany and France, 2009

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

25. In the current situation in Italy, the economic and financial crisis, the trends in internal demand and changes in the credit market[15] have had strong impact on manufacturing and, by extension, on the plastics supply chain.

26. An analysis conducted on companies belonging to the plastics sector[16] in the period 2002-2011 revealed a **critical** economic and financial situation **in terms of revenue generation** and level of **debt to third parties.**

— Most of the companies in the sector have suffered during the economic crisis with **moderately positive** average revenue generated from operations **but with a worsening trend** during the decade under review.

[15] The difficulties accessing credit and the external debt of companies as already noted.

[16] Analysis conducted using AIDA and Prometeia data, 2013. The sample includes activities for converting new or used plastic resins into semi-finished or finished products: plastic products for industry, plastic products for construction and for packaging.

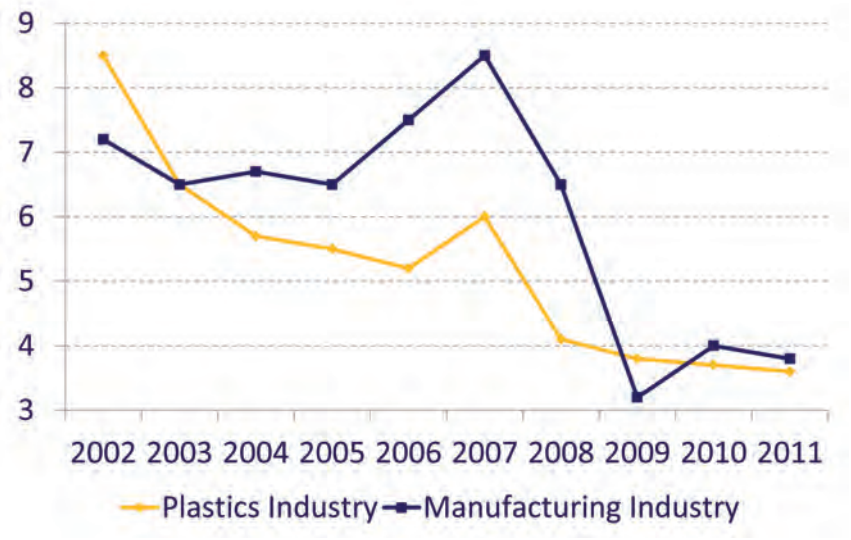


Figure 21. Revenue generated from operations by companies in the plastics and manufacturing sector, 2002-2011

Source: The European House – Ambrosetti re-elaboration of AIDA and Prometeia data, 2013

— An examination of the ROE (*Return on Equity*, amount of net profit returned on net capital) and RIO (*Return on Investments*, which measures the revenue generation of industrial management) shows that financial management has a negative impact on the total, unlike extraordinary management which makes a positive, albeit slight, contribution to the total revenue generation.

— The average *leverage* (ratio between financial debts and shareholders' equity) is greater than that of companies in the manufacturing sector. The debt peak was registered in the pre-crisis phase; the trend was interrupted and started decreasing after 2007, and today stands slightly above the values registered at the start of the period.

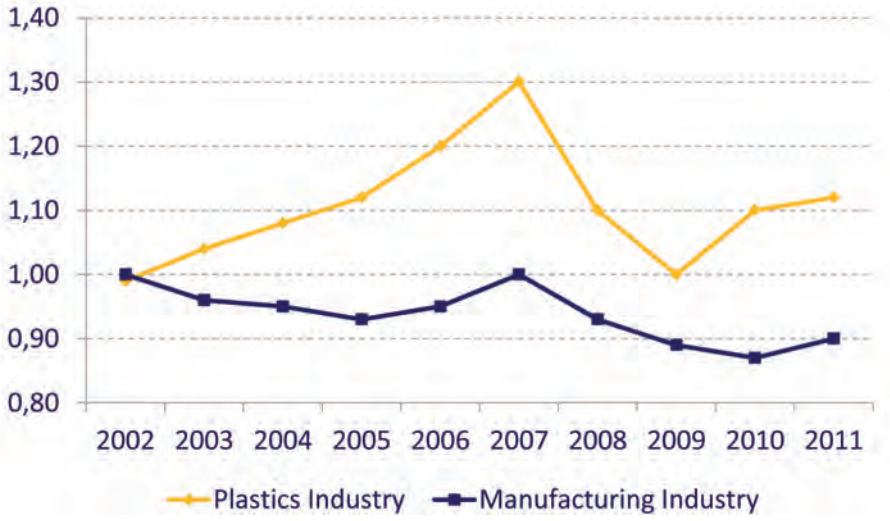


Figure 22. Financial leverage of companies in the plastics sector and the manufacturing industry, 2002-2011

Source: The European House – Ambrosetti re-elaboration of AIDA and Prometeia data, 2013

27. The difficulties with financing and revenue generation in the sector have in part been affected by the "situation in Italy," which has impacted the entire manufacturing industry and in particular a sector with higher average debt such as that of plastics. **The high invested capital intensity** (29.8% of production) makes the sector particularly vulnerable to exogenous factors that influence interest rates on capital.

28. The plastics supply chain, like most manufacturing sectors, has to deal with new international competitors growing stronger:

— **China** is registering growth in the sector thanks to investments by large local groups and the supply of cutting-edge technology by western countries (sometimes with participation in equity). In 2010 China overtook Europe for plastics production (with a 23% global share compared with 21% for Europe), and in 2009 it overtook Italy in terms of value of rubber-plastics machinery exports.[17] There is generally a contingent safety problem with machines from non-EU countries (including China), which in many cases do not comply with the EU directive (CE marking).[18]

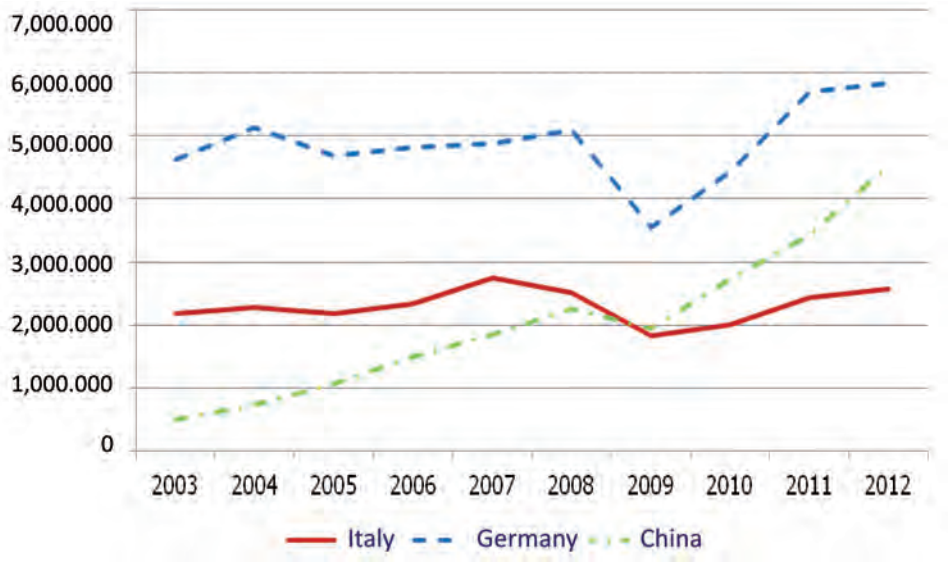


Figure 23. Exports of machinery, equipment and moulds for plastics and rubber (for the sector as a whole, in thousand euro), 2003-2012

Source: ASSOCOMAPLAST, 2013

— In **India**, production volumes in the plastics converting industry are expected to grow from the current 9 million tonnes to 18 million tonnes in 2015, with the number of employees growing from 4 million to 7 million.

— **Arab countries,** owing to the extraction of oil and natural gas, are assuming a growing role

[17] For example, in the mould subcategory, the share of Italian imports from China has gone from 2% in 2003 to 19% in 2012. During the same period, imports in Italy from Germany were reduced from 42% to 27%. Source: ASSOCOMAPLAst, "Profilo 2012 dell'industria italiana delle machine per la lavorazione di materie plastiche e gomma," June 2013.

[18] According to recent customs figures, more than 90% of machines manufactured outside the EU do not comply with the machinery safety directives. Source: ASSOCCOMAPLAST, 2013.

in plastics production as well through:

- external growth;[19]
- an extension policy of investments downstream as well (converting) to create local employment opportunities and to capture value along the entire chain.

29. In terms of international trade, the entry into force of the EU's new general scheme of preferences (GSP) on 1 January 2014 will do away with or significantly reduce the duties applied on goods imported in Europe from certain emerging markets (East Asia and Africa in particular),[20] with strong potential competitive asymmetries to the detriment of the (Italian and European) chemical-plastics industry.

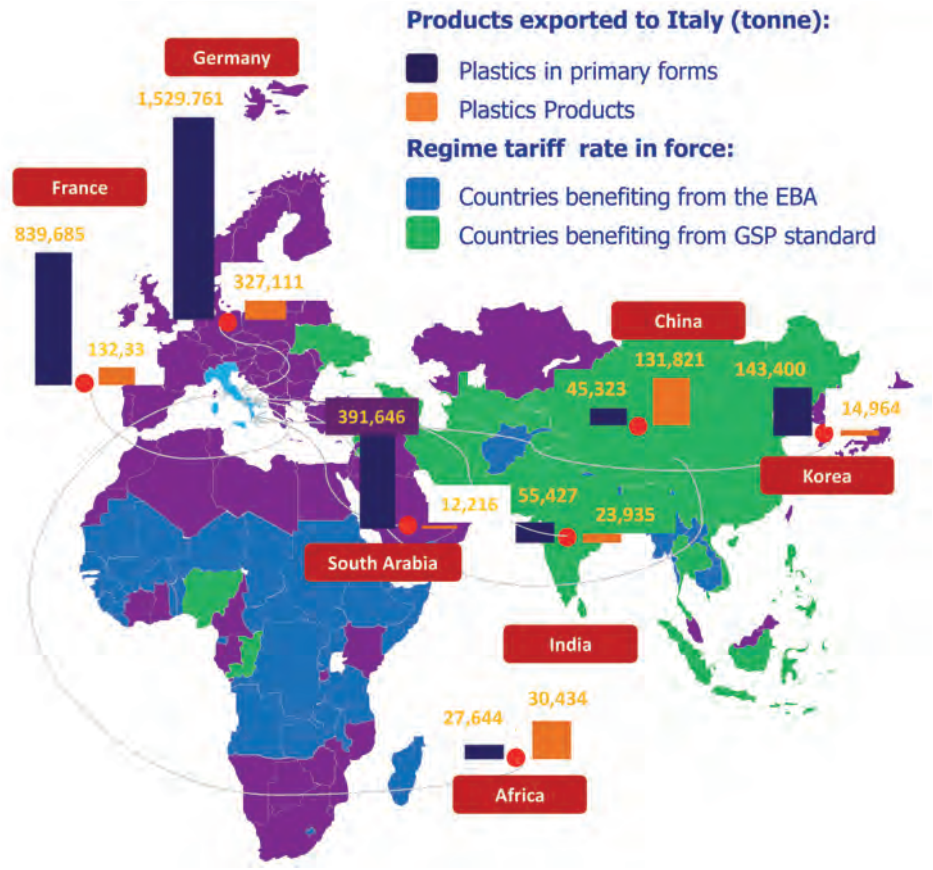


Figure 24. Imports of plastic materials and products to Italy (in tonnes) and its main trading partners, 2012

Source: The European House - Ambrosetti re-elaboration of Istat – Coeweb data, 2013

[19] For example, in 2007, the Saudi Basic Industries Corporation (SABIC) acquired the plastics division of General Electric (GE Plastics) for $11.6 billion; today, SABIC Innovative Plastics generates ca. $6 billion and employs 9,000 people in 35 countries, with a portfolio of 40,000 products divided into 5 macro-areas.

[20] A new tariff system (with concessional duties) will enter into force in the beginning of 2014 to promote imports in Europe from emerging and developing economies: the GSP provides for the abatement of customs duties on various categories of identified products taking into consideration the potential of the exporting country and the European reference market. There are three possible configurations: 1) GSP standard (6,350 products covered), which provides for a reduction of export duties for certain "sensitive" products as they are called (capable of distorting competition in the internal market) and the complete cancellation of duties on products known as "non-sensitive;" 2) GSP+ (6,400 products covered), which provides for the cancellation of duties on sensitive products when the duty is composed of ad valorem and specific taxes, and the complete cancellation of duties on "non-sensitive" products; 3) EBA (Everything But Arms) which provides for the cancellation of import duties for "sensitive" and "non-sensitive" products, with the exception of arms.

30. A subsequent source of competitive asymmetry between Europe and emerging economies is represented by legislative consumer safety and environmental protection requirements which chemical companies in the EU-27 must comply with, such as the **REACH Regulation** on chemicals and the **Machinery Directive** on the safety of machinery at the work place.

31. In more general terms, there is a perceptible **dualism** in the EU between plastics producing and non-producing countries (e.g. the markets of Northern Europe) which, having relocated production in developing countries with low labour costs long ago, are more attentive to increases in the price of the products, than to the impacts on employment and the industrial system.

32. In addition to the critical factors relating to competition on foreign markets, in an overall context of declining internal demand and difficult access to credit, companies in the plastics supply chain also have to deal with **characteristic problems of the Italian system** – first and foremost, energy and logistics costs:

— **Energy costs** constitute a burden on the production of chemicals in Italy, having an impact on margins already squeezed by the recession. Furthermore, the cost of energy in Italy is far higher than in other countries in Europe and elsewhere;[21] this difference now seems unsustainable, especially for the plastics production industry, which is high energy intensive by nature.[22]

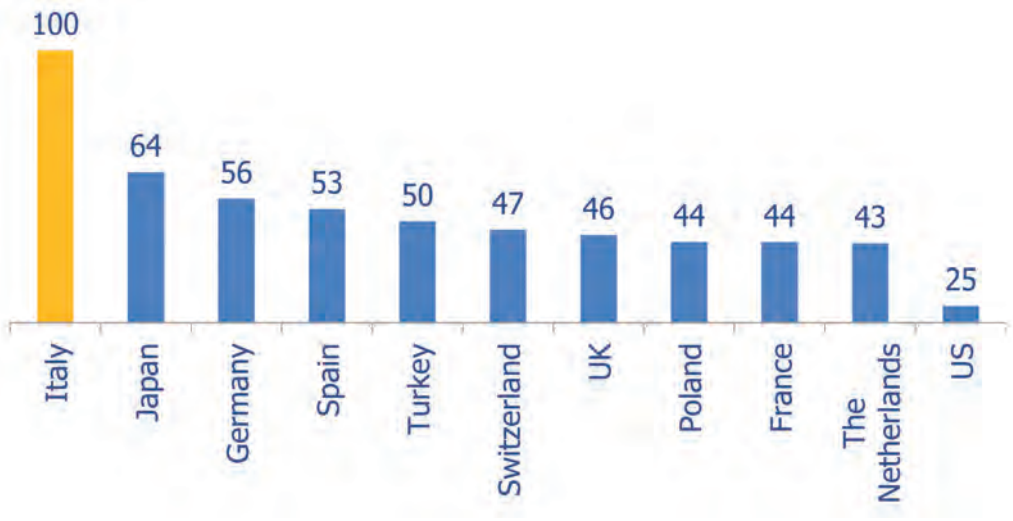


Figure 25. Average electricity prices for industry (Italy = base 100), 2012

Source: The European House - Ambrosetti re-elaboration of International Energy Agency – IEA data, 2013

[21] The cost of energy for industrial use in Italy has traditionally been 30% higher than the European average. In the last two years, this difference has widened further (especially because of the pricing component, i.e. the charges fixed by the Agency for Electricity and Gas and the Customs Agency have gone up by 116% from 2011). Source: Federchimica, 2012.

[22] In Italy, the chemical industry accounts for 16% of the energy demand of the national industry as a whole. The sector has moreover improved its energy efficiency: in this respect, the chemical industry ranks only behind Germany (while not being able to take advantage of the far larger average size of the German sites) and has improved its performance by 45% since 1990. Source: Federchimica.

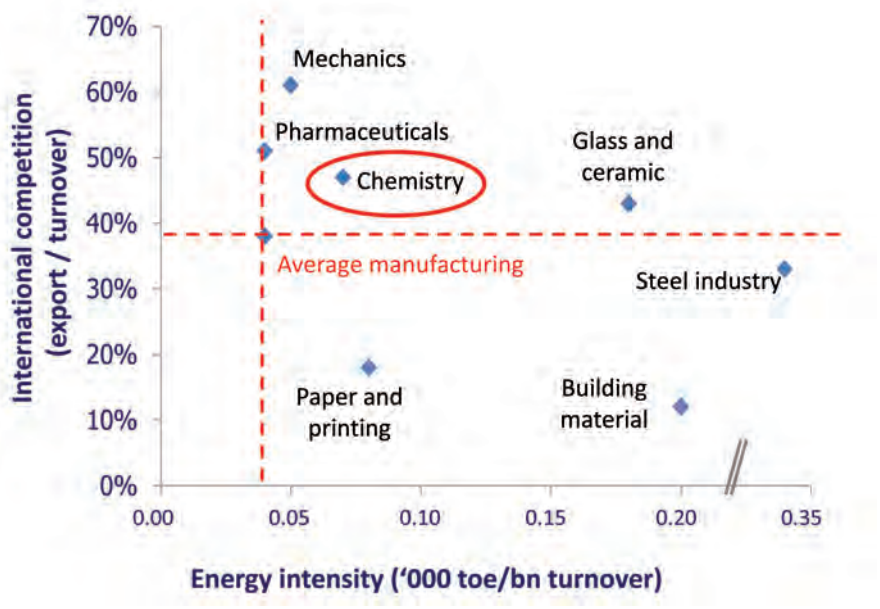


Figure 26. Sensitivity of Italian manufacturing sectors to the cost of energy

Source: The European House - Ambrosetti re-elaboration of Federchimica data, 2012

The average impact of the cost of electric energy for plastics manufacturing companies is **6%**[23] of turnover, and reaches double that amount (approximately **12%**) in the case of plastic waste recycling and sorting companies.

— **Logistics** is also a factor that penalises the competitiveness of the plastics supply chain (among others), owing to an infrastructure and communication system (via land and sea) which is not capable of satisfying adequately the requirements for speed, accessibility and economy.

[23] This value is calculated on the turnover, including subsidies linked directly to the price of the product, plus or minus variations in stocks of finished products, work in progress and goods and services purchased for resale, less purchases of goods and services for resale. Source: Federazione Gomma Plastica, 2013.

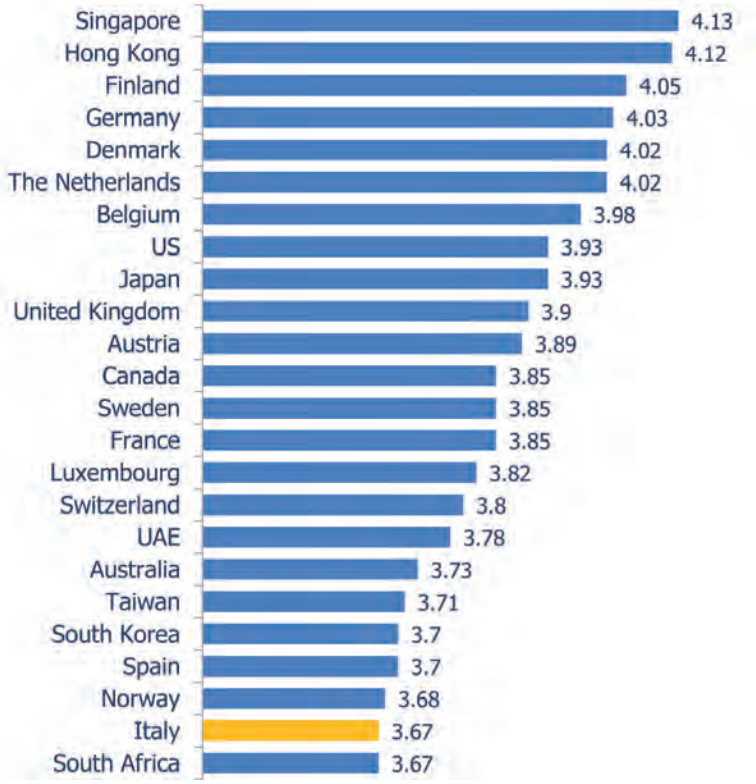


Figure 27. Logistics performance indicator, 2012

Source: The European House - Ambrosetti re-elaboration of World Bank data, 2013

33. On the cultural front, the average Italian citizen has **a negative perception of plastics**, which complicates the industrial policy decision-making process. A study of 6 key European markets shows that **43% of Italians** are suspicious of plastics (a rate higher than the EU-6 average of 41%), while in Germany, which is very active in communication on socio-environmental themes, the proportion of citizens with a negative perception of plastics is very contained (22%).

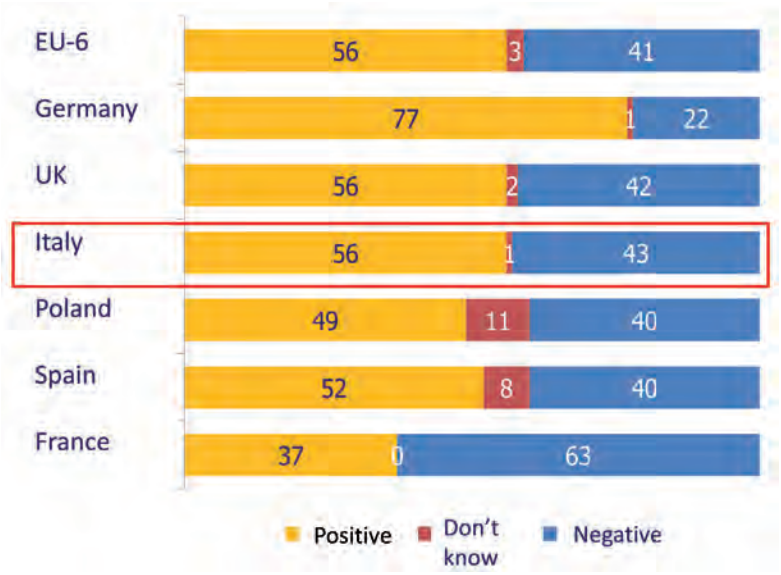


Figure 28. Attitude of European citizens to plastics (in percentage)

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, "Attitudinal survey on plastics in Europe", 2011

34. There is a problem of informational "ignorance" in our country. An analysis of the responses has shown that certain **prejudices** about the effects of the recovery of plastics for energy purposes persist. Compared with the European average, Italians are more concerned about the negative externalities connected to the incineration of plastics than about human health.

% answers	EU-6	Germany	Spain	France	Italy	Poland	UK
Environmental damage	19	12	30	21	21	16	20
Difficulty in recycling	14	9	17	16	10	7	24
Harm to human health	10	32	8	4	2	5	0
Excessive use of plastic	10	8	7	8	12	4	18
Excessive production of waste	8	5	8	10	6	11	8
Lack of efficient systems of recycling	6	9	5	6	5	7	4
Generation of toxic substances by incineration	5	0	0	3	26	2	0
Pollution generated by the packaging	4	1	2	4	6	8	1
No advantage compared to other materials	3	6	7	3	1	2	0

Figure 29. Main reasons for a negative perception of plastics in Italy and the other five European countries (in percentage), 2011

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, "Attitudinal survey on plastics in Europe", 2011 - Note: Main responses from the sample

6. Contribution of the plastics supply chain to the Italian economy

KEY MESSAGES OF THE CHAPTER

— We have examined the reference categories of the plastics sector provided by ISTAT ("Fabbricazione di articoli in gomma e materie plastiche" [Manufacturing of rubber and plastic materials] and "Fabbricazione di prodotti chimici" [Manufacturing of chemicals]) and have estimated the **direct impacts, indirect impacts and spin-off effects on the national economy** from an increase of the **Gross Domestic Product (GDP)** and the **Annual Work Units (AWU)** in the plastics sector in Italy.

— In terms of **Gross Domestic Product:**

- **The direct impact** from the expansion of the plastics sector amounts to 1.13, where 1 represents the direct increase in GDP, and 0.13 the impact of GDP that is activated inside the supply chain itself attributable to internal consumers/users.
- **The indirect impact and spin-off effects** amount to **1.25**, which breaks down into an impact of 0.73 in services, 0.50 in industry, and 0.02 in agriculture.

On the whole, a €100 increase in GDP in the plastics supply chain generates – through inter-industrial relations (indirect impact) and the increase in demand (spin-off effect), a €238 increase in GDP in the economy (**multiplier of 2.38**).

— In terms of **employment**:

- **The direct impact** amounts to **1.1**, where 1 represents the AWUs in the sector, and 0.1 the direct impact on the total work units in the plastics sector.
- **The indirect impact and spin-off effects** amount to **1.64**, which breaks down into an impact of 0.80 in services, 0.74 in industry and 0.1 in agriculture.

Each AWU increment in the plastics sector results in an increase of 2.74 work units in the economy as a whole (**multiplier of 2.74**).

— "Plastics" are therefore **a strategic sector and a growth driver for Italian manufacturing as a whole:** for every €100 of GDP generated in the plastics sector, €58 of GDP are generated in other manufacturing activities; and for every work unit produced in the plastics sector, 0.62 units are generated in other manufacturing activities.

Economic impact estimation methodologies

1. Different methodologies and techniques can be used to estimate the **impacts** produced by an industrial branch or sector. Such methods and techniques can generally be contained in two large groups:

- The first estimates the changes (impacts) brought about by specific investments in the sector[1] in the economic activity of a delimited territory.[2]
- The second (more suitable for placing the plastics sector in the overall Italian context) analyses the economic links of a sector with all the others in the medium to long-term timeframe to gauge the importance on a larger territory (and not limited to the local dimension).

2. We applied the methodology for estimating the **direct and indirect impacts as well as the spin-off effects** on the plastics sector, which uses matrices of sectorial interdependence (**input-output matrices**).

The input-output matrix model

This methodology was developed by Wassily Leontief, a Russian economist awarded the Nobel Prize for economics in 1973, who was the first to develop accounting and analytical models that constitute the elements of modern input-output analysis.

With reference to Italy, the first input-output table was constructed in 1950 by the *Mutual Security Agency*[3] and later re-elaborated and updated by the ISCO[4] in 1953. ISTAT has worked on this topic from 1959 to the present, publishing continuous updates of the input-output tables and delving into the analysis in greater depth to identify subdivided economic transactions for 77 production sectors. Furthermore, with the development of the European System of Accounts[5] in 1970, the table of transactions has been an integral part of national accounts for all EU countries.[6]

[1] For example, a new industrial plant, the opening of a research centre for plastics, the construction of sites and offices for carrying out activities.

[2] The (urban, provincial, regional) territory is delimited in accordance with the analysis to be carried out in order to identify what expenditure and what economic activity to include in the estimation. In this case, the more the territory is delimited, the easier it will be to calculate the investment or potential of the sector, because the impacts are measured by registering the changes that occur in the expenditure, revenues, mobility flows and employment. The economic impact thus calculated has certain methodological limits attributable to the lack of statistically significant results or data that can be extended to other contexts or used to make inferences at the level of the economy as a whole. Furthermore, confusion can occur between short, medium, and long-term impacts and the assessments are often conducted one time only and not continuously.

[3] Agency created in 1951 to implement the Mutual Security Act, i.e. the American legislation for the concrete implementation of the Marshall Plan.

[4] International Standard Classifications of Occupations.

[5] Eurostat, European System of Accounts (ESA).

[6] Its theoretical structure has been refined and its practical application extended as the years have gone by. Today, it is used widely in economic and social policy applications in a vast number of fields including national accounts, regional economics, environmental economics, commerce and transport, in the study of technological changes, employment, and growth of economic development.

Structure and objectives of the sectorial interdependence analysis

3. The *input-output* matrix was based on the assumption that goods and services produced in the sector can be registered simultaneously in a table per origin and per destination.[7]

- A set of transactions develops among the different constituent units of the economy over a defined timeframe, determined by the requirements of the end use and the technological characteristics of the economic system.
- In more recent applications, the implementation of input-output analyses has been geared to measuring the impact of a change in demand in any sector/ branch (in our case, that of plastics) on the entire economic system.

4. The relations between the different economic sectors are depicted in the diagram below:

- Relations or interdependences (physical or monetary) between the different economic sectors that absorb resources to produce goods and services are analysed in the initial situation (time zero).

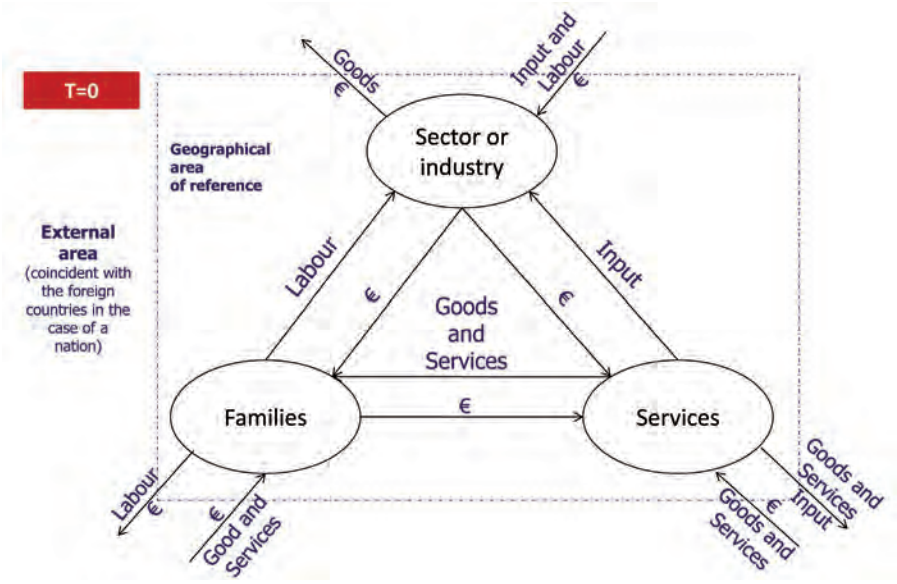


Figure 1. Reference diagram for economic relations analysed by economist Leontief: initial situation

Source: The European House-Ambrosetti elaboration, 2013

- After a period of time (time 1), the expansion of an industry or a sector activates a series of relations inside the economic system which in turn activate other relations with other industrial sectors, in accordance with the diagram of sectorial interdependences. For example, an increase in demand in a given sector will produce a series of effects (shown in the diagram

[7] OECD, 2006.

by the red line), such as:

- increase of the supply of labour for the sector to function;
- overall increase of wages and salaries paid in the sector;
- increase of goods and services required for the sector in expansion to function.

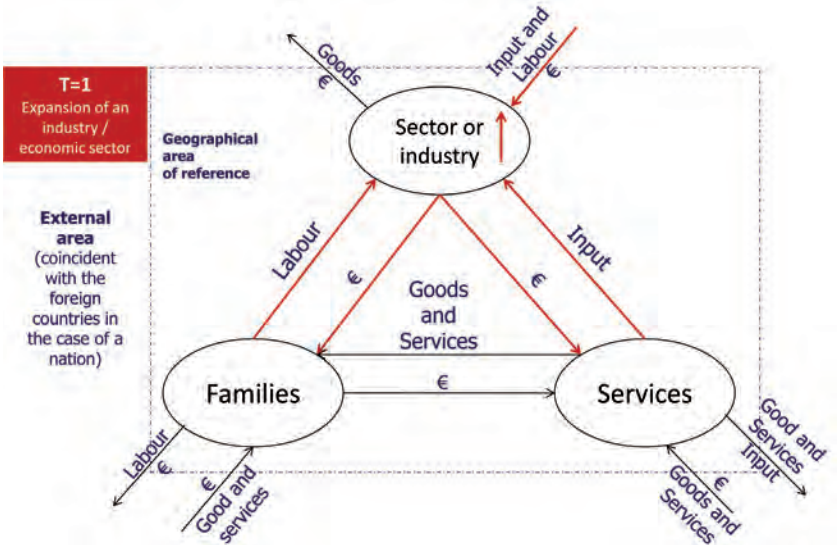


Figure 2. Reference diagram for economic relations analysed by economist Leontief: expansion in an economic sector/industry

Source: The European House-Ambrosetti elaboration, 2013

— For the first time interval, the impacts will be confined to the same sector in which the effect occurs; in the subsequent time interval, owing to the sectoral interdependence effect, other economic sectors will be involved and, as a result, increases are registered in the labour supply, wages and salaries and in the demand for goods and services required in the entire production supply chain and in other industrial sectors, thereby producing an expansion in the economic system.

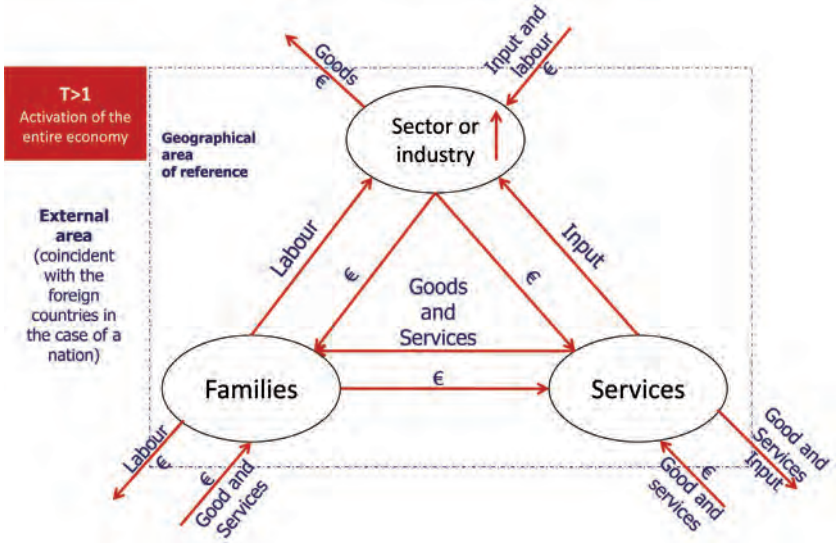


Figure 3. Reference diagram for economic relations analysed by economist Leontief: complete activation of the economic system

Source: The European House-Ambrosetti elaboration, 2013

5. The algebraic translation of this reference diagram leads to the construction of matrices of sector interdependence or input-output matrices.

6. The central element of the input-output analysis consists of the fact that the national economy is conceived as **a set of production units**, each of which carries out a double order of transactions:

- on the one hand, as **buyer** of goods and services from other units, which it uses as inputs in its own production activity;
- on the other hand, as **seller** of its product to other economic sectors.

7. Every company operating in a production sector produces an output, acquiring and combining certain inputs from other production industries/sectors: the inter-sectorial flows can be expressed in monetary or in physical terms. The economic system is therefore crossed by flows that connect the different production units.

8. The methodology of sectorial interdependence and the hypotheses by Leontief on the relations between the industrial sectors make it possible to identify the level of production necessary to satisfy the demand, taking into account the **internal consumption of the sector itself**, which is the consumption that makes it possible to generate an increase in production.

Example of internal consumption and use in sectors

As regards the plastics sector, a simple example consists of the creation of a new production plant or a new research centre.

Such an undertaking requires for instance the deployment of the operating staff, researchers, chemists, the publication of studies and the formation of study groups in the case of the research centre, etc.

Each of these elements entails the use of resources of the sector itself. The professionals involved are in fact resources that already work inside the sector. Therefore, if a new plant or research centre is created, then professionals who are already part of the sector are necessarily used, and the investment in the sector that is required to open a new plant or research centre is greater than the cost involved, given the need to make greater use of current resources or to create new ones.

9. Input-output tables are often used to define ranks of importance for the destination of investments between different economic sectors. Nevertheless, the use of multipliers as an instrument for selecting how to use funding has its limits. For example, input-output analyses carried out in other studies, with reference to GDP, have shown the following multipliers:

- University system 5 to 8 times;
- Elementary and secondary education: approximately 1.5 times.

Based on these results, an investment in the university system would seem the preferable option. Nevertheless, faced with a restricted budget, it would make no sense to invest only in the universities and not in elementary and secondary schools, since students who enrol in universities must first go through elementary and secondary schools.

10. Multipliers and estimations are used to **grasp inter-industrial and inter-sectorial relations**, rather than produce ranks of importance. An understanding of existing relations between sectors can serve to analyse the connection between them and then to investigate the actual, concrete capacity of an economy to reach specific objectives.

Assessment of the economic impact of strengthening the plastics sector

11. We have replicated the illustrated methodology to estimate the direct, indirect and spin-off effects on the national economy of an increase in GDP and annual units of work (AWUs) in the plastics sector.

12. We started with the analysis of the national accounts to gauge the activities registered by ISTAT that include activities that refer to rubber and plastics. In the manufacturing sector, ISTAT identifies and makes available databases for the analyses with reference to the following two divisions regarding plastics:

— **Manufacturing of rubber articles and plastic materials.**[8] This division is characterised by raw materials used in the manufacturing process, which does not, however, entail that the manufacturing of all products made with these materials is classified in this division.

[8] a) Manufacturing of tyres and tubes, regeneration and reconstruction of tyres; b) Manufacturing of other rubber products, manufacturing of natural or synthetic, non-vulcanised, vulcanised or hardened rubber products; manufacturing of conveyor belts and transmission belts; manufacturing of rubber hygiene articles; manufacturing of rubberised textile fabrics; manufacturing of articles of clothing in rubber, rubber boots, rubber ropes and cables, rubber yarns and textiles, bands, rubber accessories and lining, manufacturing of rubber upholstery, inflatable rubber mattresses, ebonite tubes, repair materials in rubber, textiles impregnated, spread, covered or laminated with rubber, water mattresses in rubber, shower caps and aprons in rubber, diving gear in rubber, sex articles in rubber, car mats in rubber, lining for mattresses in foam rubber and semi-finished products, expansion joints for the construction industry, latticed foam rubber, rubber covering for floors. Manufacturing of semi-finished plastic products: plates, sheets, blocks, films, lamellae, strips; manufacturing of finished products in plastic: rigid and flexible tubes and their accessories in plastic; manufacturing of cellophane films and sheets; manufacturing of expanded polyurethane; c) Manufacturing of packaging in plastic; d) Manufacturing of elastic covering for floors; e) Manufacturing of doors, windows, racks in plastic for construction; Manufacturing of parts in plastic for footwear; h) Manufacturing of objects for the office and for school in plastic; i) Manufacturing of other articles in plastic, manufacturing of various articles in plastic. Source: Istat, 2013.

— **Manufacturing of chemicals,**[9] which includes the converting of organic and raw material using chemical processes and the formation of specific products; basic chemical elements and the production of intermediate and final products obtained with subsequent processing of said basic chemical elements are therefore included.

13. ISTAT does not provide the utilisation flows separately for every economic activity at this level of detail, but only **aggregated** at the division level. Given the importance of the sector for Italy, **more in-depth statistical information should be made available** to enable a deeper and more granular reading of the sector.

14. Utilising matrices of sectorial interdependence (see section 4), we analysed the impact of the plastics sector on the national economy on a number of levels:

— **direct impacts**, those directly correlated to the sector analysed and relative to the effects produced on the plastics sector production chain itself;

— **indirect impacts** generated through the production chain comprised of suppliers of goods and services of activities directly linked to the plastics sector;

— **spin-off effects** generated through expenditure and consumption that are the result of direct and indirect impacts. They consist of the increase in expenditure that is registered in the reference geographic area relative to the strengthening of the plastics sector and is generated by the greater presence or importance of economic activities and work units.

In consideration of the composition of the statistical sample on which the analysis was carried out, the values of the direct and indirect impacts and spin-off effects appear underestimated: more specifically, if in addition to plastics production and converting, the other phases of the plastics supply chain (machinery for rubber-plastics and plastic waste recycling/recovery activities) could be included in the analysis of the input-out matrix as well, the impacts would be even more significant.

Multipliers for plastics on the Gross Domestic Product

15. **The direct impact** from the expansion of the plastics sector amounts to 1.13, where 1 represents the direct increase in GDP, and 0.13 the impact of GDP that is activated inside the supply chain itself attributable to internal consumers/users.

16. **The indirect impact and spin-off effects amount** to **1.25**, which breaks down into an impact of 0.73 in services, 0.50 in industry, and 0.02 in agriculture.

[9] a) Manufacturing of pigments and colorants; b) Manufacturing of plastics in primary forms (manufacturing of plastic materials in primary forms: polymers, including ethylene, propylene, styrene, vinyl chloride, and vinyl acetate polymers, as well as acrylic polymers, polyamides, phenolic and epoxide and polyurethane resins, alchidic and polyester resins, and polyesters, silicones, polymer-based ion exchangers); c) Manufacturing of synthetic rubber in primary forms (synthetic rubber, lattice, mixtures of synthetic rubber).

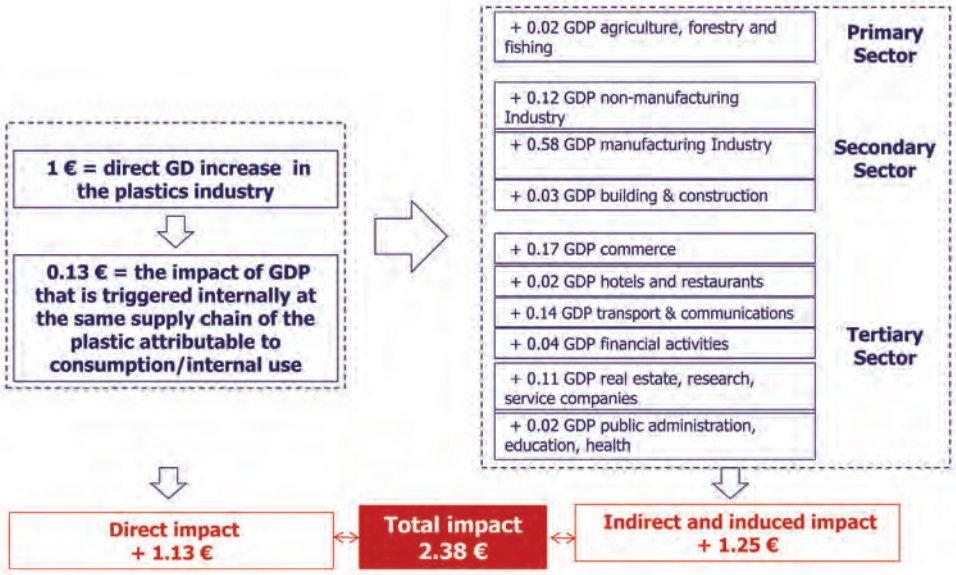


Figure 4. Multipliers for plastics on the increase of Gross Domestic Product in the economy

Source: The European House-Ambrosetti elaboration, 2013

17. The **manufacturing industry** (0.58), **transport** (0.14) and **commerce** (0.17) are the sectors that react most to an increase in GDP in the plastics sector. For every additional unit of GDP in the plastics sector, the GDP in those sectors increases by **0.89 unit.**

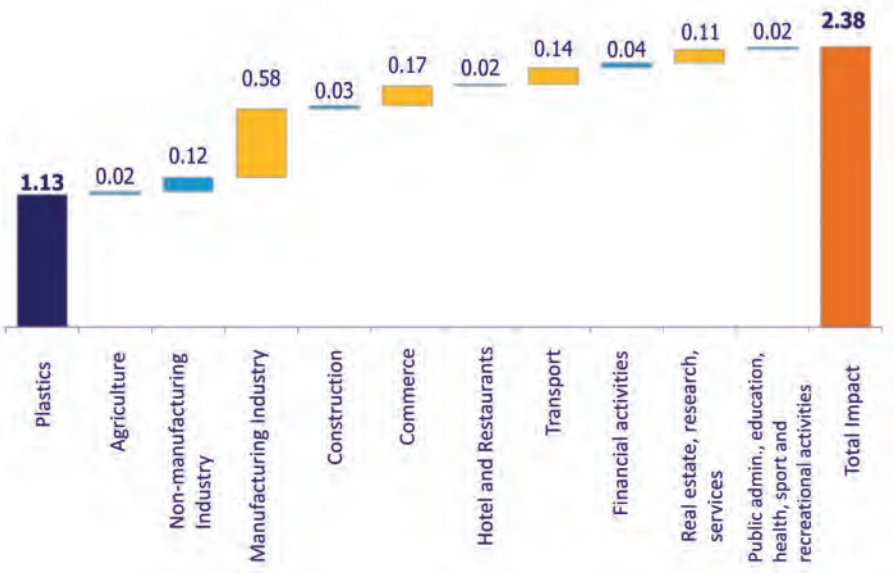


Figure 5. Breakdown of the impact of an increase in GDP in the plastics sector on the overall GDP of the economy as a whole

Source: The European House-Ambrosetti elaboration, 2013

18. To summarise, **for every euro of GDP generated in the plastics sector, the direct and indirect impact and spin-offs on the national economy amount to € 2.83 of GDP**, of which 1.13 are "retained" within the sector, while €1.25 of GDP are generated indirectly and as spin-offs: 45%

in manufacturing, 14% in commerce, 11% in transport and 9% in real estate, research and services to companies.

Multipliers for plastics on the work units

19. The **direct impact** is **1.1**, where 1 represents the Annual Work Units (AWUs) generated in the sector, and 0.1 is the direct impact on the total work units of the plastics supply chain.

20. The **indirect impact and spin-offs**, on the other hand, **amount to 1.64**, and break down in an impact of 0.80 in services, 0.74 in industry, and 0.1 in agriculture.

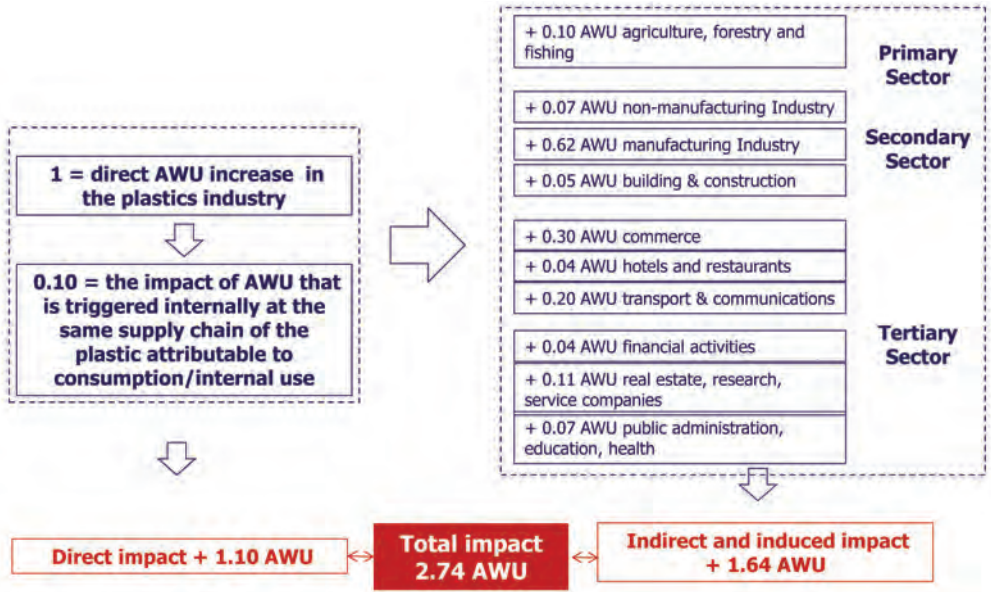


Figure 6. Multipliers for plastics on the increase of work units in the national economy

Source: The European House-Ambrosetti elaboration, 2013

21. With reference to work units, **manufacturing** (0.62), **transport** (0.20) and **commerce** (0.30) are once again the sectors that react the most to an increase in work units in the plastics sector. For every work unit added to the plastics sector, the work units created in these sectors increase by 1.12 units.

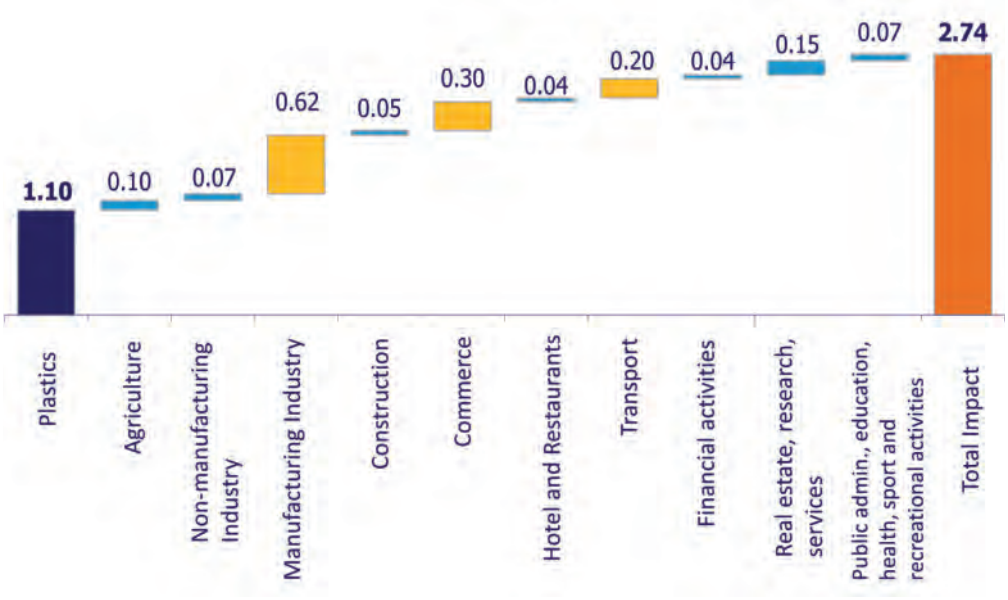


Figure 7. Breakdown of the impact of an increase in Annual Work Unit (AWU) created in the plastics sector on the total AWUs in the economy as a whole

Source: The European House-Ambrosetti elaboration, 2013

22. **Each unit increment in the plastics sector results in an increase in annual work units in the economy as a whole of 2.74.** Of these, 1.10 units are "retained" within the sector itself, while 1.64 AWUs are generated indirectly and as spin-offs: 38% in manufacturing, 18.5% in commerce, 12% in transport and 9% in real estate, research and services to companies.

Summary of the main results

23. In accordance with the purpose of this study, it was decided to implement the analysis of matrices of sectorial interdependence or input-output analysis.

24. This methodology is based on the analysis of flows between economic sectors and on the relations between them. An increase in the final demand for output in a given sector, in fact, generates a multiplier process by successive waves in which the net increments of output from each sector, for each phase, become smaller and smaller until they amount to zero. The sum of the net increments of output is summarised in the sectorial economic multipliers.

The multipliers for the plastics supply chain obtained from the analysis of the matrices of sectorial interdependence are as follows:

A € 100 increase in GDP in the plastics supply chain generates - through inter-industrial relations (indirect impact) and the increase in demand (spin-off effect) - **a € 238 increase in GDP in the economy** (multiplier of 2.38).

For **every annual work unit** (AWU) created in **the plastics sector, 2.74 annual work units** are created in the economy as a whole (multiplier of 2.74) through inter-industrial relations (indirect impact) and an increase in demand (spin-off effect).

Another interesting result is that plastics constitute a strategic sector and a growth driver for Italian manufacturing as a whole. **Plastics constitute a significant link with other manufacturing activities in terms of Gross Domestic Product as well as employment.** The activation coefficients are:

- For **every € 100 of GDP generated in the plastics sector, € 58 of GDP are generated in other manufacturing activities,** accounting for approximately 45% of the indirect impact and spin-offs generated in the national economy (excluding the impact on the plastics supply chain itself of 1.13).
- **For every annual work unit (AWU) produced in the plastics sector, 0.62 units are generated in other manufacturing activities,** accounting for approximately 38% of the indirect impact and spin-offs on employment generated in the national economy (excluding the impact in the plastics supply chain itself of 1.10).

25. Of particular importance, especially during this extended period of crisis, is that the **indirect impact and spin-offs** are labour intensive. Plastics boast very high multipliers on labour and, owing to a high economic activation in terms of GDP, the sector is characterised by an even greater employment activation level.

26. Finally, the calculated impacts pertain to the Italian economy as a whole. In other words, the multipliers refer to an increase in added value and employees in the plastics sector and the impacts produced for the country as a whole: territorial areas, provinces and/or cities, with high specialisation in the plastics industry, may register higher multipliers, owing to the greater intensity and size of the plastics sector in the national economy.

7. Innovation in the plastics sector

KEY MESSAGES OF THE CHAPTER

— The plastics sector is characterised by a **high rate of investment in research and development** and research on new applications is concentrated in a number of industrial sectors. The properties of plastics provide enhanced response to modern-day needs for security, low environmental impact, sustainability, practicability and light weight, biocompatibility and possible reuse. Significant opportunities for innovation are provided by modern technologies in machinery to apply to manufacturing of finished products.

— We have analysed **cutting-edge** applications in plastics **throughout the main industrial sectors** with widespread new functions and **benefits** for citizens, companies and the environment. Some examples:

- Automotive and aerospace: **higher safety standards and enhanced performance** (40%- 50% lighter in weight compared with alternative materials in a car of medium-power and fuel savings of 750 litres for every 150,000 km travelled).
- Electronics and mechanics: meeting the goals of energy savings and lightweight components to create **light and flexible flat screens**; creation of new polymers for batteries and sensors; high-level opportunities for future development of the 3D printing technology thanks to the use of plastics.
- Packaging: new functions in innovation, practicality and safety for food and beverages **("functional packaging").**
- Textiles-Clothing: creation of **new fabrics using innovative fibres, recycled plastic and polymer memory fibres** ("smart textiles") to improve human performance and provide new technical functions.
- Healthcare and biomedical: creation of biocompatible **prostheses increasingly less invasive** for patient health.
- **Construction:** optimisation of building thermal insulation to save energy, together with the durability, light weight and lower maintenance costs of products in plastic.
- Renewable energy sources: substitution of traditional materials with plastics to produce components for solar collectors, wind blades and polymer membrane fuel cells (under development).

— In the future, **composite materials** and **bioplastics** will be two further important sectors: the former thanks, above all, to the development of key sectors such as aerospace and renewable energy sources and the latter to biodegradable/compostable bioplastics (product innovation) as well as non-biodegradable bioplastics (process innovation). Compostable bioplastics in particular are already contributing to the integrated cycle of organic waste disposal.

New frontiers for the development of plastics

1. The development of applications in the field of plastics is concentrated in a number of sectors with a high rate of investment in research and development.

2. The mechanical properties of plastics **provide enhanced response to modern-day needs of manufacturing production:**

- security and safety of the products;
- low environmental impact;
- sustainability;
- practicability and light weight;
- biocompatibility;
- reuse.

Furthermore, **new technologies for the development of finished products in plastics** provide extensive opportunities to contribute to innovation in the plastics sector, such as, by way of illustration, the sophisticated machinery for blow moulding which reduce to a minimum the thickness of films for packaging and PET bottles or technologies for the production of windmill blades in renewable energy plants, etc.

	Features and Performance	Applications / Products
Automotive and aeronautics	• The use of the plastic will become increasingly important for the reduction of the weight of the vehicle and for the consequent reduction of emissions	• Plastic chassis • External and internal components for aircraft (composite materials) • Interior of cars (reducing the noise pollution)
Packaging (food)	• Plastic packaging prevents up to 40% of the current food waste	• The use of plastic packaging increase the life cycle of goods by 5-10 days, reducing food waste from 16% to 4%
Textile/ clothing	• The future is in the nanotechnology's field: development of antibacterial, anti-static and anti-UV properties, for improving fabrics; 'smart' fabrics	• Using films, fabrics and yarns to increase the resistance, the strength and for the improvement of hydrophilic properties; new uses of synthetic fibers in textile
Biomedical	• The intrinsic properties of plastics as the bio-compatibility, the shape memory and the high degree of adaptation of the prostheses	• Orthopaedic prostheses • Heart valves • Aortic stent • Supports for biotissues • Construction of artificial organs with the 3D printing techniques
B&C	• About 60% of the energy saving is attributable to the use of plastic. The blocks made from PVC and PE-HD = 85% less energy, -95% CO_2 released	• PVC and PE-HD blocks • Insulation materials for coating structures, 3D design of structures
Energy	• The wind turbines, made of plastic materials, provide 33% savings of GHGs, solar panels generate an energy return 340 times superior	• Wind turbines • Panels and photovoltaic cells • Tubes • Coatings
Electronics and ICT	• It is the sector with the highest content of plastics • Increasing use due to its malleability, lightness and energy saving	• LCD screens made of plastic (65% less energy use than conventional screens) • Flexible, new generation screens

Figure 1. Main sectors with a high development potential for plastics

Source: The European House - Ambrosetti elaboration, 2013

3. Applications in the **automotive** and **aerospace** sectors help obtain high safety standards in motor vehicles and enhanced performance in aircraft (carbon fibre-reinforced polymers).

— Approximately 25% of the Airbus A380 consist of composite materials. At full load, the A380 has an autonomy of 14,800 kilometres and consumes 3.3 litres of kerosene per passenger per 100 kilometres of flight.

  In the design of traditional vehicles, the future belongs to what is known as hybrid technology, which combines the advantages of metal and plastic in a single structure component, thereby increasing the mechanical resistance and stability of the parts so that subsequent functions can be introduced more easily and with more space saving.

4. Applications in the **biomedical industry** already make it possible to produce increasingly less invasive biocompatible prostheses, and will continue to do so.

— Polymers constitute approximately 45% of biomaterials and their typical applications range from orthopaedics, to cardiovascular prostheses, to the production of artificial internal organs.

— In certain circumstances, the organism "metabolises" the polymer, ultimately degrading it until it is completely eliminated.[1]

5. In the **food sector**, the use of PET, PP, PE and PS has revolutionised the way we think about the useful life of products.

— Packaging is to this day the best solution for preserving the nutritional and qualitative properties of food when it comes to problems of accessing food in various parts of the world.

— In the case of goods packaged in plastics, the package accounts for only between 1% and 3% of the overall weight of the product. The sum of energy consumption and other environmental repercussions owing to production, transport and disposal is positive often to the extent of being unbeatable.

6. In **construction**, new polymer-based materials can – among other applications – help optimise the thermal insulation of buildings and thus conserve energy. Furthermore:

— Thermal insulation sheets made of cellular material protect buildings from possible damage to atmospheric agents, thereby increasing their durability.

— For heating, drinking-water and waste-water pipes, plastic tubes are superior (in terms of performance) to those of conventional systems.[2]

— Encrusted water pipes can be reconditioned economically with a plastic covering that provides reliable protection for the tubes against future scaling.

7. The **textiles-clothing** sector has already experimented with new fabrics using innovative fibres, recycled plastic, memory fibres and "intelligent" textiles. The cutting-edge innovation is in:

— new textile products to improve human performances (medical, protection and sport);

— new textile products for technical applications (construction, transport, geotextiles, etc.).

[1] This phenomenon has been capitalised on to create medical devices for temporary use (e.g. suture strings and osteosynthesis systems), which are destroyed by the organism in times compatible with those needed by the device to perform its beneficial action.

[2] They are more convenient and require less energy in the production phase; they are more flexible than metal; moreover, they are not subject to oxidation and can be used for optimal quality drinking water supply.

8. In the **electronics** sector, energy conservation, light weight and mouldability of plastics make them among the most widely used materials for innovative applications.

9. As to **renewable energy sources**, plastics are indispensable for making solar collectors, wind blades (made entirely of reinforced thermohardening resins with various types of fibres) and in hydrogen fuel cells. In March 2007, the 27 EU heads of state and of government agreed in Brussels to increase the share of renewable energy sources in the energy balance, from 6.4% to 20% by 2020. An intelligent use of plastics will make a considerable contribution towards improving the European energy balance.

Some more innovative sectors for the use of plastics

Automotive and aerospace industries

10. The reasons for the success of plastics in the automobile industry are numerous: plastics can assume any shape without problems, thereby improving such aspects as safety, *comfort* and appearance, and can be worked with ease and at contained cost. Furthermore, thanks to their light weight (**40% - 50% lighter** compared with alternative materials in a car of an average engine size), plastics help attain significant fuel savings (750 litres less for every 150,000 km travelled in a car).

11. Today, a vehicle with an average sized engine, weighing ca. 1,000 kg, is made of up to **15% of plastics** (ca. 150 kg)[3]. It is estimated that, by 2020, the share of plastics in an average-sized car will be **18%**, with a general weight reduction approximately 300 kg.

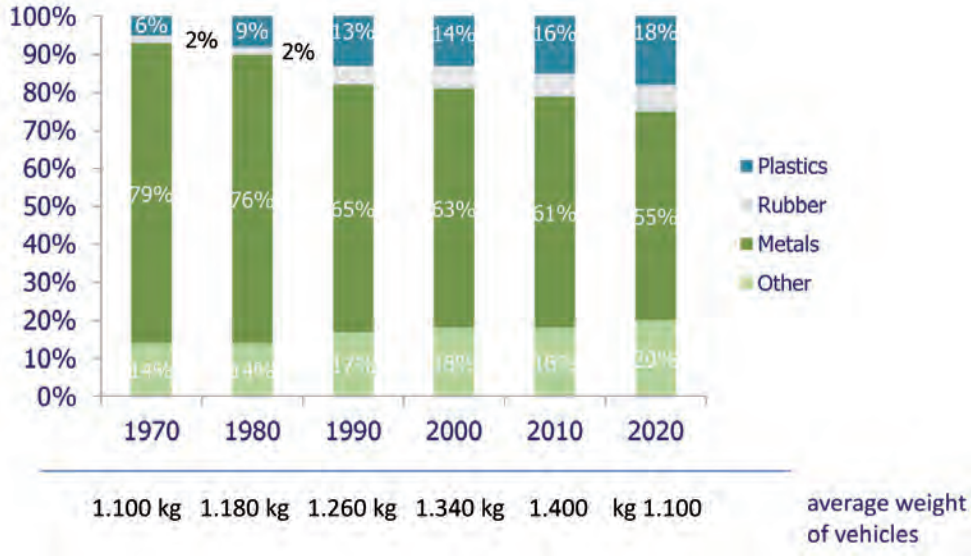


Figure 2. Composition of materials used for a vehicle (in percentage), 1970-2020
Source: The European House - Ambrosetti re-elaboration from various sources, 2013

[3] Various parts of the body, such as the spoilers, mudguards, bumpers, dashboard and lights are made of plastic, as many car sidings and interiors, seats, airbags, mats, linings, belts, supports and engine covers and other details.

12. Recent challenges in the automotive and aerospace industries, such as sustainability, reduction of fuel consumption, increase of performance and increase of the useful life of vehicles, give direction to investments in innovation in the plastics supply chain.

Plastics for energy efficiency: the case of Land Rover

Thanks to the use of innovative plastic composites, Land Rover has reduced the weight and fuel consumption of its latest model Evoque (2012):

- 13 kg thanks to thermoplastic materials;

- 16 kg inside the cab;

- 21 kg through the replacement of metal joints;

- 25 kg through the replacement of other components with plastic materials.

The overall reduction in weight amounts to approximately 75 kg, with 27% savings in **CO_2** emissions (130 grams of CO_2/km compared with 165 grams / km for the previous model).

13. Modern planes and the most recent aircraft would **be unthinkable without the use of plastic materials:**

- Inside an aircraft, the gates, windows, seats, internal upholstery and “décor” are all made with plastic materials; every single gram of material saved helps to make the aircraft as light and fast as possible.
- In order to meet the high safety standards required, high resistance plastics are indispensable for the most advanced components, such as the vertical and horizontal tail assembly, wing box, cargo back hatch, and the flaps.
- Thanks to their high flexibility, plastic materials inside the cockpit of helicopters help absorb engine vibrations and thus to guarantee passenger safety.
- Some plastics are nearly invisible to radar and infrared rays, making them a fundamental material for the production of stealth aircraft.

In the near future, the volatility of crude oil prices and ongoing research geared to the reduction of emissions will mean an ever greater dependence on plastics for civil as well as military aircraft.

Plastics for energy efficiency: the case of the Boeing 787

The new Boeing 787 was designed to obtain significant energy savings by optimising the materials used to make the aircraft:

- Use of plastic composites (plastics and carbon fibres) **from 12% to 50% in the production of the fuselage.**
- **Fuel consumption savings of 20%.**
- **Savings in production costs of 30%** compared with the previous model (Boeing 767).

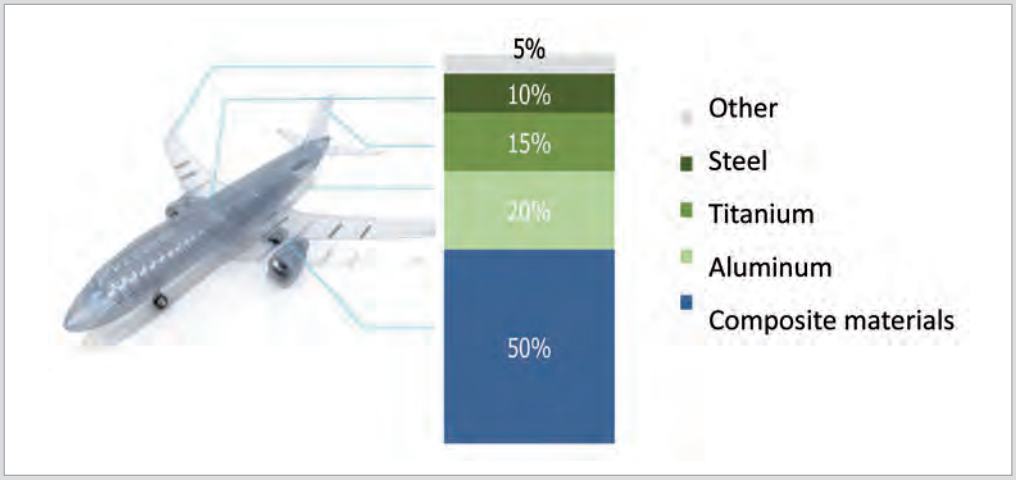


Figure 3. Composition of the basic materials of the Boeing 787

Source: Boeing, 2012

Electronics and mechanics

14. The latest screens (flat and flexible) are made from plastic substrates and capitalise on all the advantages of the material:

- **Flexibility:** Thanks to the use of plastic films that are superimposed for production, the latest generation AMOLED and Super AMOLED (*Active Matrix Organic Light Emitting Diode*) screens are the first flexible screens in the world.
- **Energy consumption:** Capitalising on the wafer-thin plastic layers, these screens weigh considerably less than those of their competitors.

The main producers of the latest generation screens and smartphones have endeavoured to develop and patent this new technology that already represents the future of the sector. Certain analyses predict exponential growth in demand for these new screens: from 3.2 million produced in 2013 to 792 million in 2020, generating a turnover of $41.3 billion by 2020. This therefore appears as the inevitable direction for the next generation of devices.

Figure 4. Innovative applications in the electronic sector: a flexible AMOLED screen

15. Another field of innovation in which plastics are already playing a very important role is that of **lithium ion batteries**, which at this point represent the future in the field of rechargeable batteries.

It is estimated that the lithium ion battery market could grow to an **annual turnover of $635 billion** by 2025. The fields of application are diverse, ranging from the latest generation of smartphones, to electric vehicles, which represent a larger market in economic terms.

Figure 5. Innovative applications in the electronic sector: recharging of lithium ion batteries

According to recent studies at the **University of Arizona**, plastics are bound to play an increasingly important role in the development of this product, by improving the main weak point, namely the deterioration of a battery in the recharging phase:

— The new **"lithium-sulphur"** (Li-S) batteries, lighter and more economical than those currently used in electric and hybrid cars, are made in particular using a **new polymer** created in the laboratory from sulphur waste. Thanks to this material, it is now possible to process the sulphuric element chemically at the liquid state and in so doing to **develop a special type of plastic** used to increase the autonomy of lithium batteries.

16. **Plastic** components are widely used in **flexible applications** which are in turn used more and more on the **technology and engineering front:** the use of plastics makes these materials more mouldable and adaptable.

Some of the main applications under development at this time are:

- Sensors (organic and inorganic).
- Circuits printed on particular plastic materials.
- Digital/analogue circuits more adaptable to use in particular situations.
- Image sensors used in cameras, biomedical equipment, the electronics trade and access systems (reading of digital fingerprints), or as scanning surface and interactive user interface for tablets, smartphones and smartwatches.
- Organic thin film transistors.

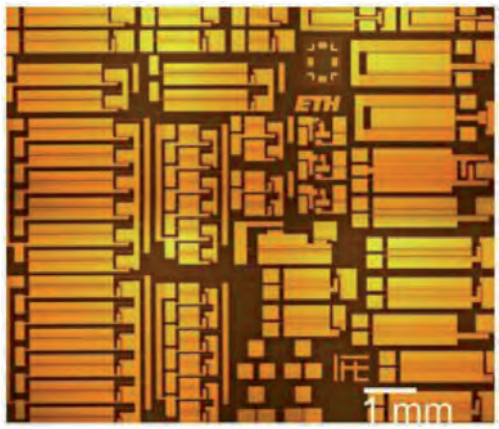


Figure 6. Innovative applications in the electronics sector: plastic electronic circuit (enlargement)

17. Plastics are a key element for ***3D printing,***[4] which some analysts consider to be a game changer for a **new industrial revolution**.

- The sector has grown rapidly in the last 5 years: from 2007 to 2011 it has developed at an annual growth rate of 300%-400%, in both the retail and professional segments (architects, engineers, and designers are already using this new technology).
- The prices for 3D printers have fallen considerably in just a few years:
  - from a price for a mid-range 3D printer approximately $30,000 to $1,000 today for a model of the same range in the retail segment;
  - from an average of over $1 million for a professional printer a few years ago to $75,000 today.

[4] 3D printing is essentially a process used to create solid objects in three dimensions from a digital model.

— 3-D printer sales, in both the retail and the professional sector, have grown by 300% in the last 5 years, fuelling **strong growth in applications as well**; for instance:
  - Boeing now produces more than **200 parts for airliner models** with 3D printing.
  - More than 1 million hearing aids, more than 40,000 limb prostheses, and more than 60,000 applications in dentistry have been produced using 3D printing.

18. Plastics are at the centre of this revolution, being the only material today capable of meeting fully the requirements of 3D printers: thanks to their intrinsic characteristics they can be used extensively in applications with a high quality guarantee for a sustained period of time.[5]

The use of 3D printers is expected to grow exponentially by 2025, and along with it the use of plastics, which will be used more and more for professional as well as small-scale production.

An example of 3D printing application: the DUS Architects building in Amsterdam

A paradigmatic example of plastics used in 3D printing technology in the construction sector is in progress in Amsterdam where the first house built with this technology will rise along the banks of the Buiksloter Canal:

— The house will be built entirely in plastic by printing the various parts of the building and assembling them in a second stage.

— The front façade and the interior atrium are expected to be completed by the end of 2013.

— The house will be used as a showroom and research centre for the new 3D printing technology.

Figure 7. Plan for the building constructed using 3D printing technology on the Buiksloter Canal in Amsterdam (The Netherlands)

Source: DUS Architects, 2012

[5] The main types of plastics used are ABS and PLA; advanced plastic fibres are also under study to meet specific production needs optimally.

Packaging

19. In Europe, more than 50% of goods are packaged in plastic materials; nevertheless, in terms of weight, plastics account for only 17% of all the materials used for packaging.

- Ten years ago, the average weight of plastics was approximately 28% greater to what it is today. Weight savings of 1.8 million tonnes per year, plus 1.5 million tonnes of plastic packaging for recycling, constitute a significant contribution towards an efficient use of resources.
- The most considerable contribution to energy savings is made by the protective function of the packaging. In the overall energy balance of a product, in fact, the content has the preponderant share while the packaging accounts for only a few percentage points. Thanks to solutions using plastics, the growing requirements for protection, flexibility, hygiene, unchangeability and conservation of the aroma can be met with respect for the environment.

20. A 1.5 litre PET (polyethylene terephthalate) water bottle contains double the amount of a 0.7 litre glass bottle; nevertheless, weighing 40 grams, an empty such 1.5 litre bottle weighs less than one tenth of the smallest glass bottle, therefore offering a decisively more favourable weight ratio between packaging and product.[6]

21. Plastic packaging of the future could already contain **fungicidal** compounds in its own polymer matrix, or be provided with new lining for **improved protection of beverages** of up to 30 times, or with barriers that reduce the transmission of oxygen to nearly non-existent levels.

22. Innovative trends in packaging for food include:

- *Functional packaging* to address the market's expectations for innovation, safety and convenience:
  - *Active packaging:* interacts with the product and the surrounding environment, releasing useful substances or absorbing undesirable substances to increase shelf life and security.
  - *Intelligent packaging:* provides indications on the conditions of preservation and quality of the product to inform consumers, producers and distributors.
  - *Smart packaging:* convenient; facilitates uses and consumption.

[6] The widespread use of PET in the packaging of food products is due to the characteristics of the material:
- Thanks to its mouldability, it encourages the search for new packaging designs to differentiate between brands;
- Transparency ensures that the products inside the packaging can be seen;
- The robustness of PET protects the product and the consumer;
- PET packaging is light in weight and easily transportable;
- A PET bottle can be closed hermetically again for efficient use when in movement;
- PET is an inert material and does not impair the taste of the product it contents.

— Reduction of the environmental impact of packaging.[7]

— Containment of logistics and transport costs (longer shelf life, more “logistical” products).

Examples of innovative packaging

— Multi-layer co-extrusion PP packaging that ensures that the product (e.g. a soup or beverage) has a shelf-life comparable to that it would have with traditional packaging: the rounded design of the cup guarantees sufficient resistance time at high temperature and is compatible with standard in-car cup holders (so that the product can be consumed securely whilst on the go);

— PET packaging with ergonomic and design qualities.

Figure 8. Examples of innovative packaging: a) packaging for a fresh soup produced by the French company Urban Foods with ergonomic and product preservation properties; b) bubble bath PET packaging, with ergonomic and design qualities

[7] In terms of:

— Efficiency: minimum use of materials and energy for the production of packaging, continued weight reduction (elimination of useless product layers) and minimisation of the wastefulness of products; packaging must ensure that the products contained are maintained and protected, minimising the wastefulness of resources for production; of fundamental importance is the reuse of products, where possible, by implementing programmes for the absorption of waste generated by industry, in distribution and in the tertiary sector.

— Cycle: packaging designed to reduce dependence on non-renewable resources through the generation of renewable energy from waste, the design of packaging in line with reuse possibilities, the use of compostable rather oxidisable materials, information for consumers about the origin of the products and the end of life.

— Security: packaging materials and components used for production, including inks, pigments and other additives must not entail any risks for human beings or ecosystems; the use of metals should be avoided or reduced to a minimum, and industrial processes that entail the release of volatile organic compounds must also be avoided, as must be the use of materials that risk contaminating the product (e.g. Bisphenol A).

Textiles and clothing

23. The textiles and clothing sector has for decades been at the centre of applied research in plastics, seen as an extended family.

24. Four areas of research and innovation seem particularly interesting today, among the many such areas in a highly dynamic sector: intelligent textiles, nanotechnologies applied to textiles, synthetic textiles with properties close to natural textiles, and "eco-sustainable" textiles or fibres.

25. More recent developments are geared to the very concept of textile, integrating different functions and rationales, to arrive at functions of real and specific "active" and "intelligent" interactivity with the external environment and/or the human body, in an increasingly more intense and more immediate manner (textiles capable of adapting to weather conditions, pressure, etc.). For all these reasons, they are referred to as "smart textiles."

26. The role of the user too is increasingly shifting from passive to active in defining the characteristics of a product that is no longer standardised, but is constantly evolving in nature and functioning.

27. The most advanced developments provide for the direct integration of the technology in textiles, making it an integral part thereof.

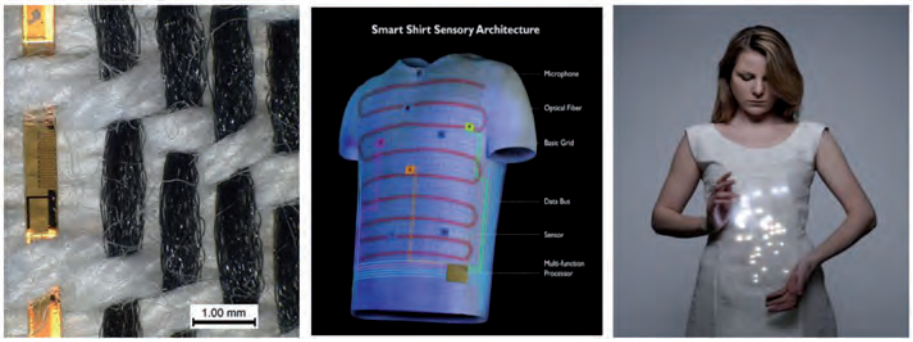


Figure 9. Examples of "smart textile" applications

28. These textiles are used most widely in the **medical sector** (medical monitoring, recording of physiological signals, rehabilitation control, assistance in first aid actions, etc.) and in highly technological clothing, even if similar rationales and applications have spread to broader market segments, including **mass consumption** products (e.g. remote control units integrated in clothing for audio devices, etc.).

29. Another field with high potential is that of **nanotechnologies applied to textiles** to create materials with highly innovative functions, structures and properties: the aim is to arrive (in the very near future) at a wide range of fibres with intrinsic characteristics with high added value and high functionality.

30. The most prevalent applications concern efforts to endow textiles with specific characteristics (e.g. to make textiles anti-microbial, fireproof, self-cleaning, etc.) and in general, to improve the finishing, thereby increasing the quality and added value of the product considerably.

31. In parallel, one area of research in which a great deal of work is focussed concerns the specific characteristics of synthetic textiles, through the continuous improvement (not only marginal by now) of the quality perceived by the users, a **gradual approximation of properties normally recognisable in natural fabrics** (touch, luminosity, softness of fabrics such as wool, cotton and silk), while preserving important qualities of synthetic textiles in terms of performance (ductility, resistance, durability).

32. These advancements are not limited to textiles produced entirely with synthetic fibres, but are also used (and increasingly so) in innovative clothing solutions that combine synthetic and natural fibres and/or the technical treatment of such fibres.

33. Another area at the centre of textile research today concerns **"eco-sustainable" textiles, including a portion of synthetic fibres obtained from the recycling** of plastics. Applications for patents in sustainable textile technologies are on the rise and place Italy in the more dynamic vanguard.

Innovation examples in textiles and clothing

A good example in this respect is provided by "Waste" Jeans, produced by Levi's as of 2012 using – on average – 29% polyester obtained from the recycling of plastics (where approximate 8 bottles are used to make one pair of jeans). Other companies have turned their attention to this type of approach to clothing: for instance, Virgin Atlantic has joined forces with Vivienne Westwood to make the uniforms of its crews eco-sustainable using polyester.

Figure 10. Jeans "Waste" from Levi's
Source: http://www.levistrauss.com, 2013

Biomedical industry

34. Polymers constitute approximately 45% of biomaterials[8] and their applications span from orthopaedics to cardiovascular prostheses and on to artificial organs.

- Nearly 80% of polymer materials used in the medical sector are PVC, polypropylene and polystyrene.
- The chemical affinity between many polymers and the tissues of the organisms confers excellent biocompatibility characteristics with these materials.
- Under certain circumstances, the organism "metabolises" the polymer, ultimately degrading it until it is completely eliminated. This property is capitalised on to create medical devices for temporary use (e.g. suture strings and osteosynthesis systems), which are destroyed by the organism in times compatible with those needed by the device to perform its beneficial action.

Polymers for medical purposes differ from those used in other applications above all in terms of the limited quantities of additives and monomer residues contained (which can be released in the textiles).

35. Some main applications in the biomedical field:

- Polyesters: Dacron (PET): vascular prostheses, suture rings for cardiovascular prostheses, non bio-absorbable sutures, reinforcement of damaged tissues (abdominal and inguinal hernia), replacement of ligaments and tendons.
- Polyglycolic acids (PGA) and poly-lactic acid (PLA): intramedullary rods, plates and screws.
- Polyamides: Nylon (non bio-absorbable sutures), Kevlar (replacement of ligaments and tendons).
- Polyethylene: films, containers, tubes, orthopaedic implants, articular cavities, hip prostheses, tibial plateau knee prostheses.

36. Polymers have vast applications in the bioengineering sector because they can be used to produce easily various items such as fibres, textiles, films, bars, geometrically complex shapes and viscous liquids.

- Polymers can be used to make a large part of compound materials that can have both a polymeric filler and matrix.
- Synthetic polymers have a chemical structure that is very similar to polymers that are found naturally in biological tissues, for example collagen, and in certain cases, it is possible to obtain chemical bonds between natural polymer chains and synthetic polymer chains.

[8] Biomaterial is defined as a material designed to interface with biological systems to evaluate, support or replace any tissue, organ or function of the body (II International Consensus Conference on biomaterials, Chester, UK, 1991).

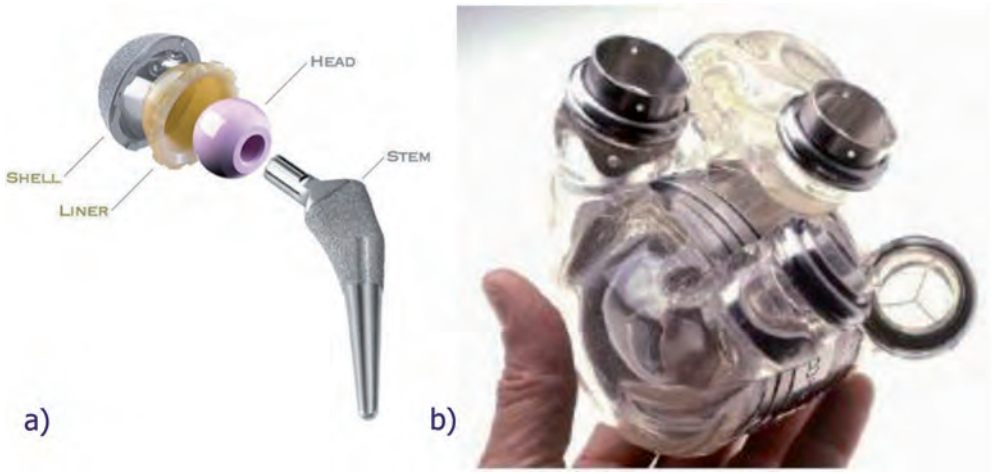


Figure 11. Innovative applications in the biomedical sector: (a) hip prosthesis (with shell, head and stem made of polymeric materials) and (b) artificial heart made of polyurethane

Materials for construction

37. The use of plastics in construction and civil engineering makes it possible to save energy, reduce costs, improve the quality of life and protect the environment.

- Plastics help to obtain products that are easy to install and require little maintenance. Very limited resources and energy are needed to ensure that they continue to function in time.
- Polymers have a series of properties which, exploited separately or in combination with each other, help to meet the increasingly more stringent requirements of the construction sector:
  - **Durability and anti-corrosive properties** (optimal properties for the production of tubes and fixtures).
  - **Thermal and acoustic insulation** (energy and economic savings and reduction of pollution).
  - **Light weight** (economic savings and reduction of labour and transport costs).
  - **Propensity for reuse** (recovery of plastic waste in the construction sector went up from 56.2% in 2010 to 57.6% in 2011).
  - **Low maintenance costs** (plastics provide the ideal covering for floors in homes and hospitals where particular hygiene requirements are called for).

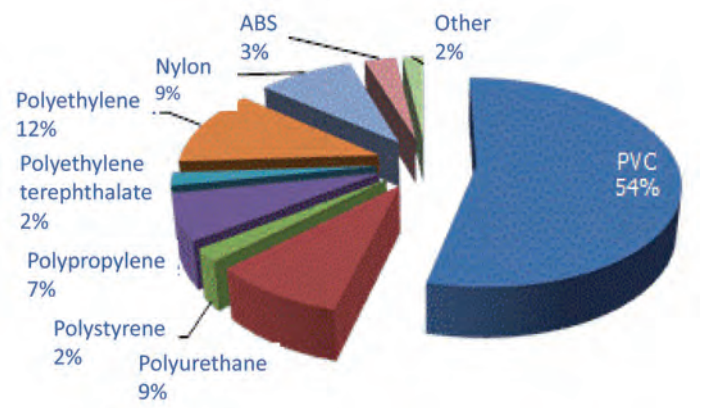


Figure 12. Types of plastic materials used in the construction sector

Source: The European House - Ambrosetti re-elaboration of Canadian Plastic Industry Association (CPIA) data, 2010

38. Some main applications in the construction sector:

- In the **design phase:** to give form to their imagination, designing buildings with innovative structures so that they can be erected in harmony with their setting, to reinforce structures, such as bridges that have to support very heavy loads, to allow the use of new technologies that use energy from renewable sources.
- In the **structures** of buildings: to soundproof walls, to insulate the basements, for the conveyance of drinking water and the disposal of waste water using appropriate tubes, to supply hot or cold air in the ventilation units or to recover heat.
- For the **exterior** of the buildings: to waterproof, cover and insulate the facades, to drain rainwater in the gutters and drain pipes, to insulate the roof, for the fixtures, to design the exteriors.
- For the **interior** of the buildings: for economical and efficient lighting systems from the energy point of view, for covering the inhabitable areas and more specifically those that call for particular hygiene requirements, such as kitchen and bathrooms, for ducts for wires and cables, to make multiple “décor” solutions possible, for textile accessories and household appliances.

Some innovation examples in the construction sector

The most innovative constructional examples include the Beijing National Aquatics Centre, the biggest building in the world covered entirely by ETFE (ethylene tetrafluoroethylene) at this time: the external surface area of the building consists of polymeric pillows that modulate the luminosity and provide flawless thermal insulation.

Figure 13. Innovative applications in construction: the exterior of the Beijing National Aquatics Centre, the world's largest building covered entirely by ETFE (ethylene tetrafluoroethylene)

39. Plastic components are on the whole often more economical to produce than alternative materials. The ease with which plastics can be moulded makes it possible to produce more components that can be assembled to form a unique object, thereby facilitating production and installation.

Renewable sources of energy

40. Energy that can be obtained from the sun, wind, geothermal sources and biomass is inexhaustible.

- Every year, the sun irradiates a quantity of energy on earth 15,000 times greater than the annual world consumption of primary energy.
  - One thousandth of the solar energy irradiated on Germany would suffice to cover that country's electricity needs. For example, there are municipalities in any given Central European country that generate heating, hot water and electric current using renewable sources of energy almost exclusively.
  - Modern solar collectors are capable of meeting up to 65% of the annual hot water needs of a household. Photovoltaic collectors, which transform solar energy into electric power,

cover the remaining energy need of a “passive house” as a minimum.

- Many essential components of the collector housing or the insulation of the tubes and the control unit are made using polymeric material.

— The **polymer electrolyte membrane (PEM) fuel cell**, which uses the chemical reaction between hydrogen and oxygen to release electric energy, is still in the developing phase:

- In this system, hydrogen, which is located in the fuel cell, is separated from oxygen by a wafer-thin plastic membrane, and the chemical reaction with oxygen then takes place in a controlled manner.
- The energy just generated can be used at will: to generate electricity and heat or, for instance, to supply cars and buses, as the first prototypes with fuel cell have shown.

— Wind power is just one of the many possibilities of using new renewable energy sources. To be able to operate on an industrial scale, the rotors require very long blades:

- Today, wind blades are made entirely of thermohardening resins reinforced with various types of fibre. Only these materials are actually capable of resisting optimally the permanent mechanical stress exerted by rotors of such size.[9] One thousandth of the solar energy irradiated on Germany would suffice to cover that country’s electricity needs. For example, there are municipalities in any given Central European country that generate heating, hot water and electric current using renewable sources of energy almost exclusively.

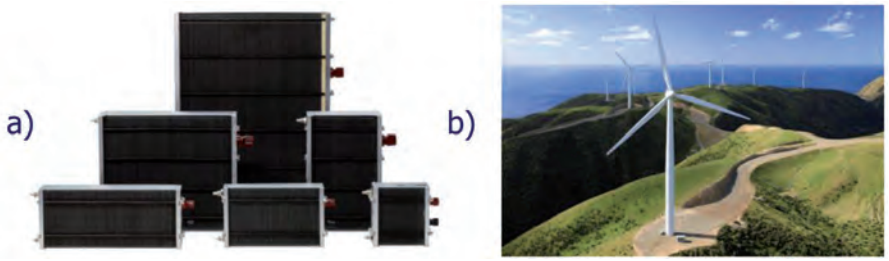


Figure 14. Innovative applications for renewable sources of energy: (a) polymer electrolyte membrane (PEM) fuel cells; (b) a wind farm

41. Europe plays a leading role in the use of new sources of renewable energy. In March 2007, the 27 EU heads of state and of government agreed in Brussels to increase the share of renewable energy sources in the energy balance, from 6.4% to 20% by 2020. An intelligent use of plastics will make a considerable **contribution towards improving the European energy balance.**

[9] Nowadays, wind farms are built with rotors 125 metres in diameter and rated output of 5 MW.

Composite materials and bioplastics

42. Two areas of interest in the plastics sector with ample potential for future developments in research and technology and many areas of application are:

- **composite materials,** in particular advanced and high performance such materials, obtained by combining polymeric resins with fibre (such as carbon and glass);
- **bioplastics,** i.e. plastic products derived, in whole or in part, from biological and "renewable" raw materials instead of fossils.[10]

43. The global composites industry is expected to grow in the short term, attaining **the $27.4 billion mark by 2016,** at an average annual rate of 5.3%, driven mainly by the aerospace and wind energy sectors.[11]

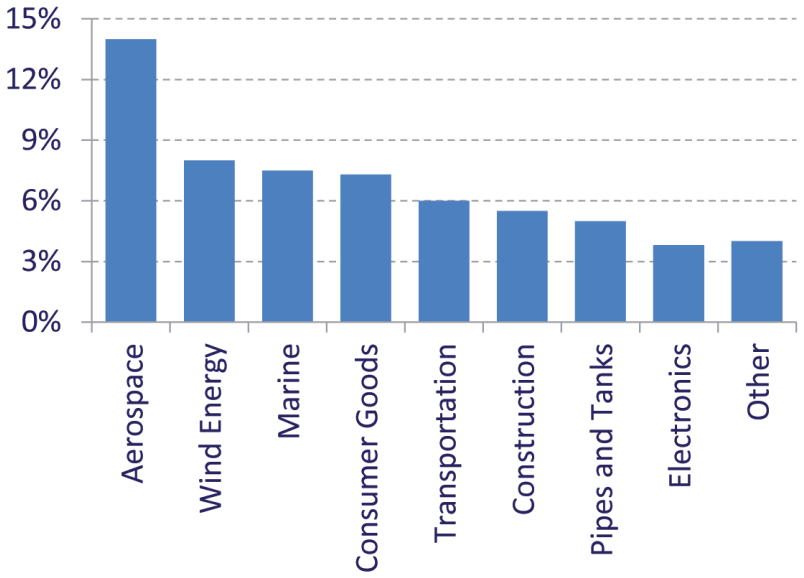


Figure 15.Anticipated average annual growth in composite materials per segment of destination at global level (in percentage), 2011-2016

Source: The European House - Ambrosetti re-elaboration of Lucintel data, 2011

44. **Carbon** is one of the fibres used mainly to reinforce composite materials, owing to its resistance, light weight and flexibility.[12] 90% of carbon fibre production is today concentrated in Japan and the U.S.:

- In Japan, three operators (Toho Tenax, Toray Industrial and Mitsubishi Rayon Group) account for **70% of the global production** of carbon fibre; the government promotes joint public-

[10] Coal, crude oil and natural gas.

[11] Source: Lucintel, "*Global Composite Market 2011-2016*," 2011.

[12] Carbon fibres, discovered in 1879 by Thomas Alva Edison and marketed as of 1960, together with glass fibres ushered in the era of composite materials, helping to create advanced composites for military and aeronautical use and then also for automobile products and consumer goods.

private projects especially in the automotive and aerospace sectors through the departments of the Ministry of Economic Affairs, Trade and Industry and ad hoc research centres.

— In the U.S., the multinationals Hexcel and Cytex cover approximately **15% of the global production** of carbon fibres; the use of composites is concentrated particularly in defence and aerospace applications.

45. In Europe, all the main reference markets (Germany, France, the United Kingdom and Spain) have recognised the growth potential offered by this segment and have accordingly earmarked substantial investments to bolster their own competitiveness in industrial production and research.

Frontiers of research on composite materials in Europe

In **Germany**, the federal government has charted a plan for the development of its two main clusters dedicated to composite materials:

— CFK Valley Stade, established in 2003 in the vicinity of Hamburg which, with more than 100 partners, the seat of the Airbus Centre of excellence[13] and a university campus to train specialists in CFRP, focuses on aerospace, the automotive industry, wind energy, mechanical engineering, road, rail and sea transport and construction.

  The cluster's goals for 2015 are to:

  - diversify the activities (transfer the strong points of the aerospace sector to other industries also by capitalising on feasible synergies);
  - internationalise (develop long-term cooperation arrangements with international networks and organisations);
  - create value for the territory (from the Airbus site in Stade);
  - provide education and training for highly qualified staff in the field of composite and fibre-reinforced materials with polymeric matrix.

— **Carbon Composite** in Augusta, a network of industries and research centres for the promotion and application of technologies for high-performance composites for aerospace, the automotive industry, mechanics/automation and defence.

In **France**, one of the centres of excellence is the **West Composite Park in Nantes**, dedicated to the composites and aerospace industry, which has the advantage of being near the Airbus site (4,800 employees in Nantes and Saint Nazaire) and the **Technocampus EMC²** research centre (25 companies and 250 employees) in Bouguenais. Moreover, the national project of the **"Jules Verne" Technological Research** Institute is under way (investment of €500 million) aimed at becoming the global point of reference for the production of advanced composite materials, metals and hybrid structures in the next decade.

A second cluster is located in the Aquitaine region, in Bayonne, home since 2010 to **Compositatour**, a technological platform specialised in R&D and the design of robotics for composite materials.

[13] *The largest centre in Europe for the construction of light structures in carbon fibre-reinforced plastics (CFRP).*

In the **United Kingdom**, the research activity on composite materials revolved around the **National Composites Centre**, operational since November 2011 and housed in the Bristol and Bath Science Park. This centre of excellence is one of the two pillars of the national strategy on composite materials launched by the government in 2009, which has also established the **Composite Skills Alliance** and the **Composite Leadership Forum** (cf. Chapter 2).

Finally, in 2006, **Spain** created the **FidaMC Foundation** through cooperation between the (national and local) government and the multinational EADS: R&D is concentrated on the automobile, aerospace and transport industries.

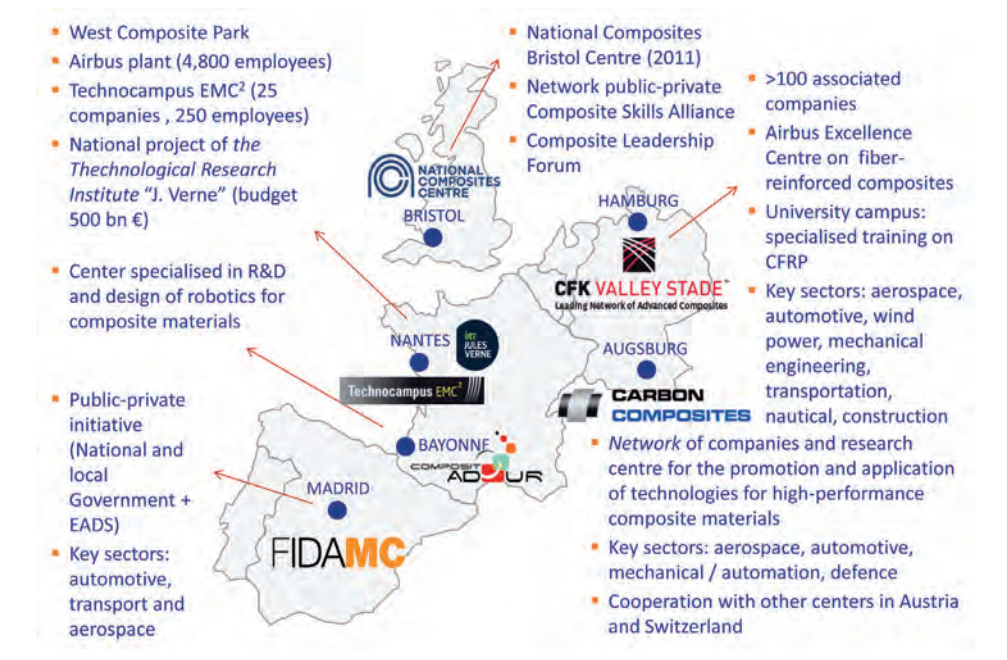


Figure 16. The main research clusters on composite materials in Europe

Source: The European House - Ambrosetti re-elaboration of CFK, CCeV, Compositadur, FidaMC, UK Composites and NCC data, 2013

46. Alongside the composites segment, another area of application with ample potential for development in terms of research and industrial applications concerns bioplastics, i.e. plastic materials generated through the use – including only partial – of raw materials of a biological nature instead of fossils:

— The plastics sector has traditionally been based on the use of **fossil raw materials** as a primary source (the production of polymers absorbs approximately 4%-5% of global oil consumption). The identification of production solutions geared to the replacement of fossil fuels is today one of the most significant lines of applied research in the field of plastics.

— Institutions too are looking at bio-products as a **sector with high potential:** bio-based plastics (whether biodegradable/compostable or not) have been identified by the European Commission as a key market capable of helping to steer the transition of the EU towards a bio-economy model (the Lead Market Initiative of the Enterprise and Industry DG for bio-based products and investments made in connection with the 5th and 7th Framework Programme of the European Union, dedicated to R&D projects in this sector are cases in point).

47. As a result, sizeable investments are being made in "*green*" innovations:

— In 2010, the chemical sector invested more **than 2% of its total turnover** in research and development.

— Italy is among the countries in the vanguard on this front:

o The National Green Chemistry Cluster – promoted by major industries in the Italy – will carry out a series of actions and interventions in line with the European Union's strategic agenda from the perspective of research and innovation priorities (e.g. the "Horizon 2020" Framework Programme) and the territorial policies (cf. Chapter 5).

o Many Italian companies are active in this sector, and have a certain market leadership.[14]

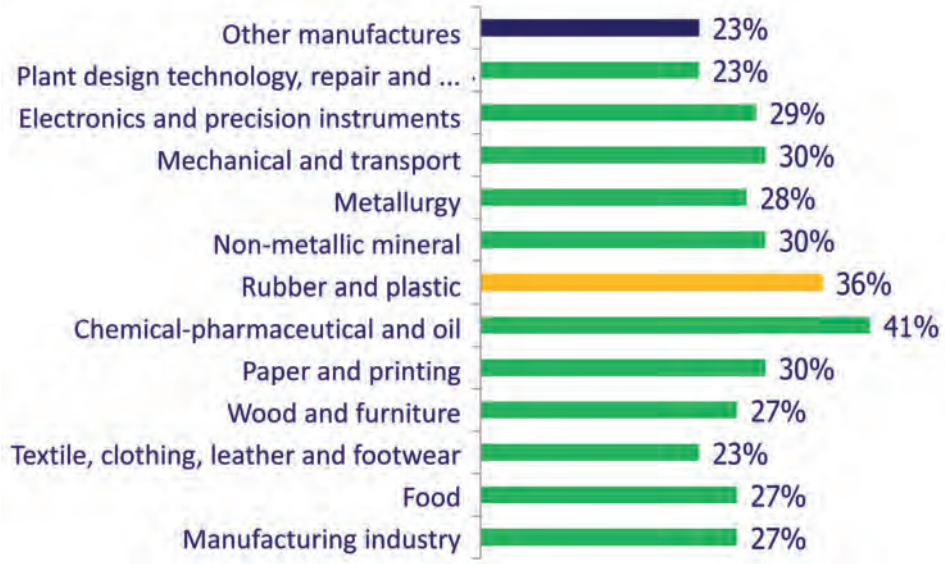


Figure 17. Manufacturing companies that have invested in green products and technologies[15] (percentage of total), average 2009-2012

Source: The European House - Ambrosetti re-elaboration of data in Fondazione Symbola, "Rapporto GreenItaly 2012"

48. The countries in the best position for research, development and applications in bioplastics are **Italy, Germany and the U.S.**

[14] For example, Ecozema won the contract to supply eco-compatible cutlery and cups at the London Olympics of 2012.

[15] Companies with at least one employee in industry and services that invested between 2009 and 2011 or planned to invest in 2012 in products and technologies with higher energy conservation and/or lower environmental impact. Source: Fonazione Symbola, "Rapporto GreenItaly 2012."

49. The bioplastics family is subdivided into two subgroups:

— Plastics produced using (in whole or in part) raw materials of non-fossil origin. At the end of the production process, these plastics can in turn have:

o Different properties from those produced using fossil sources: these are known as **"biodegradable/compostable bioplastics."** The innovation with regard to traditional products lies in the **characteristics of the product:** normally, these are plastics produced using only non-fossil fuels (e.g. corn);

o or the same properties as those of fossil raw materials: these are known as **"non-biodegradable bioplastics."** The innovation lies in the **process:** these are normally plastics made using partly non-fossil raw materials (e.g. a percentage of bioethanol).

50. Such types of production use a change of productive paradigm, going from an intensive approach (extensive use of energy, normally fossil, with strict production scale dictates) to an extensive approach (with lower consumption of non-renewable energy, with production dictates characterised by a reduced scale and greater fragmentation of production).

51. **Biodegradable plastics** today represent a niche sector which has nonetheless seen its volumes rise significantly in the last 5 years, with interesting opportunities for subsequent growth. Bioplastics may consist of biodegradable polymers and/or plant components, totally or partially of renewable origin, obtained through chemical and/or biotechnological processing. The main sectors of use are: *carrier bags*[16], for recycling, agriculture and packaging.

In this sector, there is certainly ample room for research and development to enlarge the range of possible raw materials that can be used for the synthesis of bioplastics (in particular agricultural waste) and applications in sectors where the renewable and biodegradable and/or compostable nature can constitute a system advantage (for example, food packaging, devices for agriculture, biomedicine).

52. The main advantages at this time are: biodegradability; reduction of disposal costs; savings of fossil fuel in production; use of production waste from the agri-foodstuff supply chain; creation of short supply chains on the territories; possibility of sustaining the organic fraction processing sector. Conversely, the disadvantages at this time are: efficacy not yet equal to that of traditional plastics in certain applications (in terms of resistance, lifetime / shelf life; use for the packaging of specific food / beverages); relative to the negative impact on the water footprint (which by 2014 will be part of the standards for ISO certification).

[16] The national positions on the evaluation of the use of bioplastics are today under the scrutiny of the legislator in many member states, in as much as they are seen as possible innovative alternatives to otherwise polluting products. Bio-shoppers are a case in point, for which in 2012 Italy pursued legislation linked to the fight against plastic pollution caused by shoppers, and in February 2013 France too came out in favour of biodegradable and compostable bags.

53. Alongside biodegradable bioplastics, the production and use of **non-biodegradable bioplastics** are spreading on a world scale, the latter being characterised by an "internal" component of non-fossil raw material, and thus produced according to traditional technologies with traditional properties, but generating less consumption of non-renewable energy sources. Owing to their characteristics, these products do not have the same limitations of use as their biodegradable counterparts.

54. The leading countries for research and production of non-degradable bioplastics are those that are richly endowed with non-fossil raw materials that can be used in combination with petroleum derivatives (e.g. Brazil with sugar cane for the production of bioethanol).

55. A significant case of a consumer product on a world scale with non-biodegradable packaging is the **"plant bottle" of Coca-Cola,** the production process of which entails only 70% fossil raw materials, and the remaining 30% consists of bioethanol.

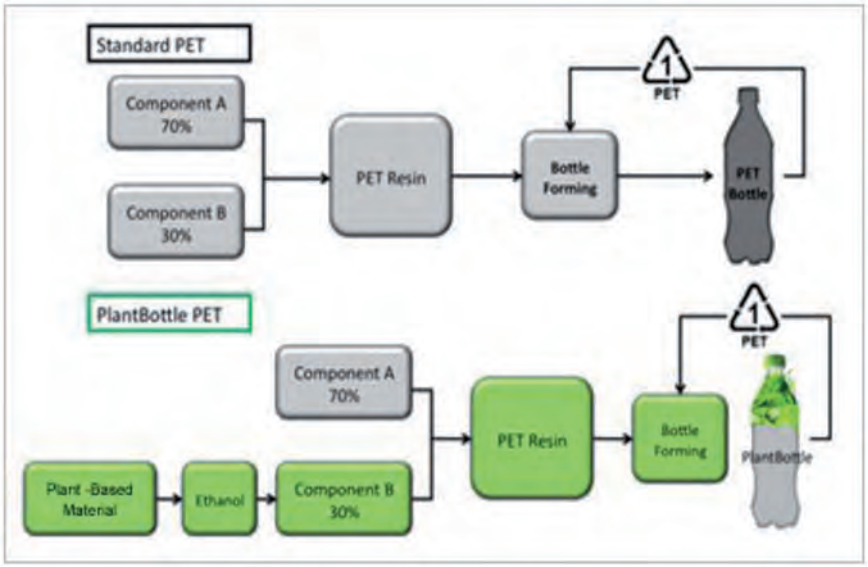


Figure 18. Schematic presentation of the production process for the plant bottle compared with that of a standard PET bottle

Source: The Coca-Cola Company, 2013

56. Overall, although it has certain limitations of use (in technical and cost-effectiveness terms), the bioplastics sector is today one of the fields with high expectations for future developments, including in Italy.

57. Global production of bioplastics amounted to approximately **1.2 million** in 2011, a figure that is expected to increase to approximately **5.8 million tonnes** by 2016. With 18.5% of the total volumes, Europe is today **the world's number three producer of** bioplastics, behind Asia (34.6%) and South America (32.8%).

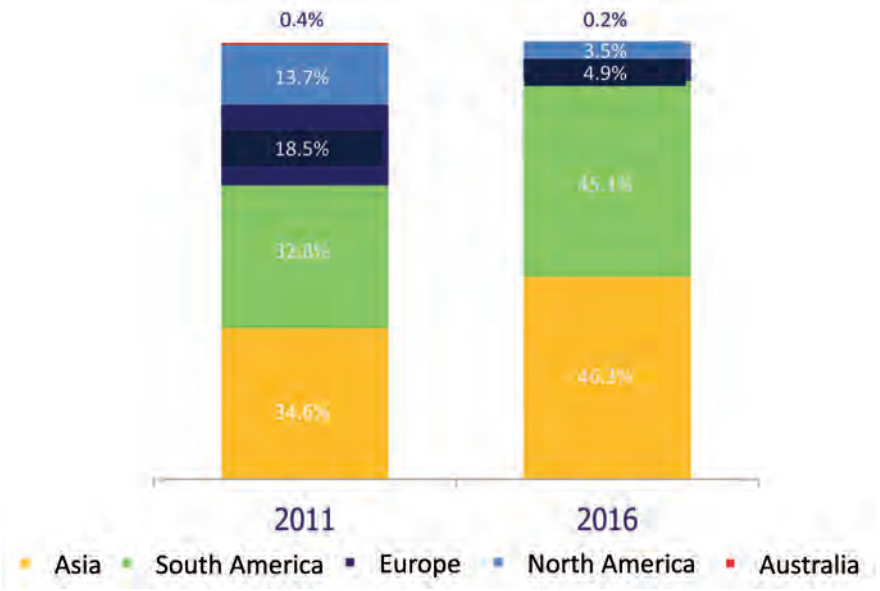


Figure 19. Global distribution of bioplastics production capacity (in percentage), 2011 and forecasts for 2016
Source: The European House - Ambrosetti re-elaboration of European Bioplastics and Institute for Bioplastics and Biocomposites data, 2013

58. The solutions provided by **non-biodegradable plastics** from renewable sources represent the main sector of bioplastics production (**58%** of the total in 2011) and are expected to increase in the near future (87%).[17]

59. In general, the bioeconomy industry in Europe generates an annual turnover of 2,000 billion € and accounts for 22 million jobs.

[17] For example, bioPet is expected to reach 4.6 million tonnes in 2016, accounting for more than 80% of the entire production (as opposed to 40% today), while bio-based polyethylene will reach the 250,000 tonne mark (4% of the total). Source: European Bioplastics, 2013.

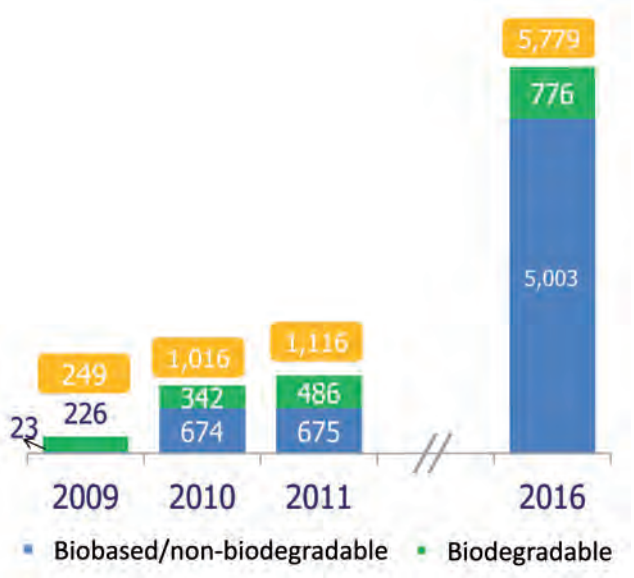


Figure 20. Global production capacity of bioplastics per type ('000 tonnes), 2011-2016
Source: The European House - Ambrosetti re-elaboration of European Bioplastics data, 2013

60. Bioplastics are one of the higher research intensity fields, including in national and international centres of excellence: for example, the research pipeline of Politecnico di Milano, focuses on "green plastics," in various guises including with the support of European funds.

61. Projects under study by the European Union point to subsequent potential for the plastics sector, particularly for its "green" applications.

- The European Commission is considering (through the work of the Joint Research Centre) introducing a *Product Environmental Footprint (PEF)* certificate for consumer products, with the idea of extending the current labelling on electrical household appliances. A multi-year process is required to arrive at a concrete formulation and not all the criteria to be included are yet clear at this time, even if the legislation should not be limited solely to the assessment of the carbon footprint. There are essentially two underlying reasons for this initiative:
  - The Commission has historically meant to direct the consumption of citizens to goods with a lesser environmental impact and an initiative to that end seems in line with that philosophy.
  - The experience of certain European countries – such as France, for example, with the two Grenelle laws to quantify the environmental impact of products placed on the market – is considered of interest in the enlarged European context.

— The European Commission is pursuing the ***Lead Market Initiative***, geared to promoting the placement on the market of products and services from certain innovative sectors that could be strategic for economic growth in Europe; they include bio-based products. The aim is to generate standardisation properties so as to arrive gradually at a green procurement in the Community area. The initiative is at the development phase at this time.

— As experts see it, the application of such legislation could have positive repercussions in the plastics sector, and bioplastics and ecoplastics in particular, (especially as regards historically competing materials, such as glass).

62. The strict integration between biodegradable bioplastics and the development of organic recycling (collected and recycled together with organic products) today affords an opportunity for their efficient circulation on a large scale and opens up extensive possibilities for the future, especially in a country like Italy, in which the quality of the plastics recycling process is comparable to the average standards of the more advanced countries. In addition to helping to improve the disposal of organic waste, if efficiently included in an integrated cycle, bioplastics can generate a new market.

8. End-of-life cycle of plastics

KEY MESSAGES OF THE CHAPTER

- The **"end of life"** of plastics is a fundamental phase because it gives the product a second use through **recycling** (generation of a new product), or **energy recovery**. Landfilling is the least efficient option in the entire end-of-life hierarchy of plastic waste and one of the aspects under examination by the EU at this time.
- In light of consumption growth at global level, recycling and recovery of plastics are going to play an increasingly **central role in waste management.**
- Some 52 million tonnes of plastic waste are produced annually in the EU-27, 60% of which is recovered. In Italy, 3.3 million tonnes of municipal plastic waste were produced in 2011, **51% of which was recovered** for recycling (0.8 million tonnes) and for energy use (0.9 million tonnes).
- The **key players** involved in the end-of-life cycle of plastic waste are: consumers (as "producers" of waste, but also actively involved in the collection, recycling and recovery of waste), institutions and consortiums. Each of these has specific rules and responsibilities to make the plastic waste recycling and recovery supply chain function more efficiently and to disseminate a "culture of reuse."
- The end-of-life cycle of plastics in our country has to face certain **challenges** which include:
  - Overcoming **discrepancies in the collection** of plastic waste on the national territory.
  - **Correct information for public opinion** including as regards plastic **waste-to-energy** opportunities and the containment of emissions in the atmosphere.
- Upgrading the entire plastics second life cycle in Italy (which today involves some **300 companies** with **approximately 2,000 direct employees**) could **improve the national context** and create **synergies** (together with the other phases of the plastics supply chain) with the competencies Italy has in developing waste collection, recovery and recycling models. Successful experiences abroad (for example in Germany and in northern European countries) show that it is possible to meet the goal of "zero plastics to landfill" in a short time.

The plastics recycling and recovery supply chain

1. By **"end-of-life"** is meant those processes carried out at the end of the useful life of a plastic product to give that product a second life. This can occur through:

- recycling and therefore generation of a new product;
- energy recovery from burning waste.

2. End-of-life management is (and will be in the future) of **growing strategic importance:**

- By 2015 a 30% increase in mechanical recycling is expected (from 5.3 to 6.9 million tonnes).[1]
- Disposal and incineration with energy recovery will remain the primary solutions in waste management.

3. It is estimated that approximately **25 million tonnes of** plastic waste were generated in the EU-27 in 2011, of which:

- Approximately 10 million tonnes were disposed of in landfills, while approximately 15 million tonnes (**60%**) were **recovered** – of which 35% (5.3 million tonnes) were recycled.
- Recycling and energy recovery grew from 2006 to 2011 at an average annual rate of **6.7%** and **6.8%** respectively.

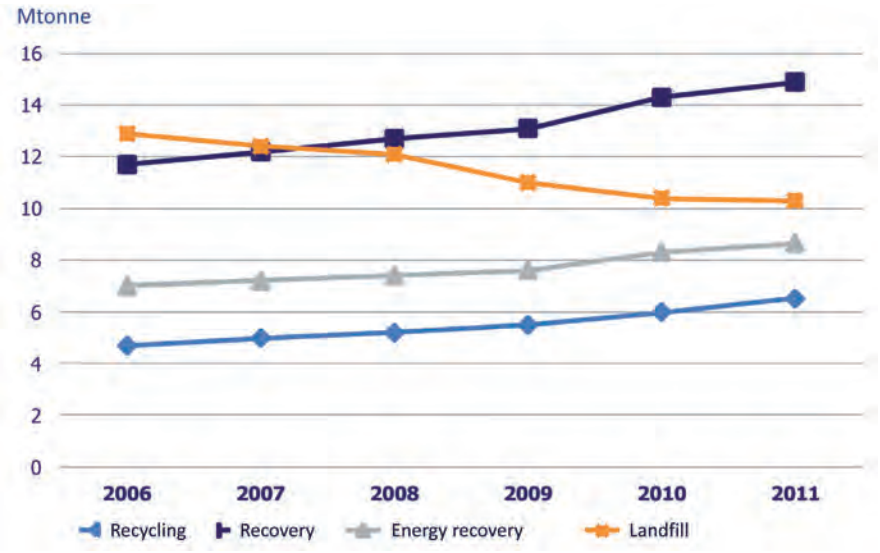


Figure 1. Destination of waste in Europe, 2006-2011

Source: The European House - Ambrosetti elaboration of PlasticsEurope data, 2013

[1] Source: European Commission, Green Paper "A European Strategy for Plastic Waste in the Environment", Brussels, March 2013.

EU Commission Green Paper on plastic waste

The EU Commission's Green Paper (March 2013)[2] addresses the requirement of the EU 27 to adopt an official guideline on plastic waste in the absence of legislation that regulates the sector, initiating extensive consultation on possible responses to the challenges posed by plastic waste management.

The main objectives are to:

- **Prevent disposal in landfills** through greater efficiency in the use of resources.
- Stimulate a **more sustainable plastics production** (recyclable products at reasonable costs).
- **Reduce the marine litter phenomenon** at global level.

Directive 2008/98/EC has paved the way to a new approach to waste management. The directive introduces the principle of extended responsibility and describes efficient and innovative means for sustainable production that takes account of the entire life cycle of the products.

The EU Commission has called on the Member States to adopt legislative measures in support of reuse and prevention, recycling and other waste recovery operations. Producers are encouraged to establish collection points for products at the end of their life cycle and to provide information on the possibility of reusing and recycling the products.

The plastics end-of-life industry in Italy: challenges and opportunities

4. In Italy, 3.3 million tonnes of municipal plastic waste were produced in 2011, due to a correlated growth in consumption:

- **50.9% (1.7 million tonnes)** were collected and recycled (0.8 million tonnes) or used for energy purposes (0.9 million tonnes)
- **49.1% (1.6 million tonnes)** were disposed of in the country's landfills.

[2] Source: European Commission, Green Paper "A European Strategy for Plastic Waste in the Environment", Brussels, March 2013.

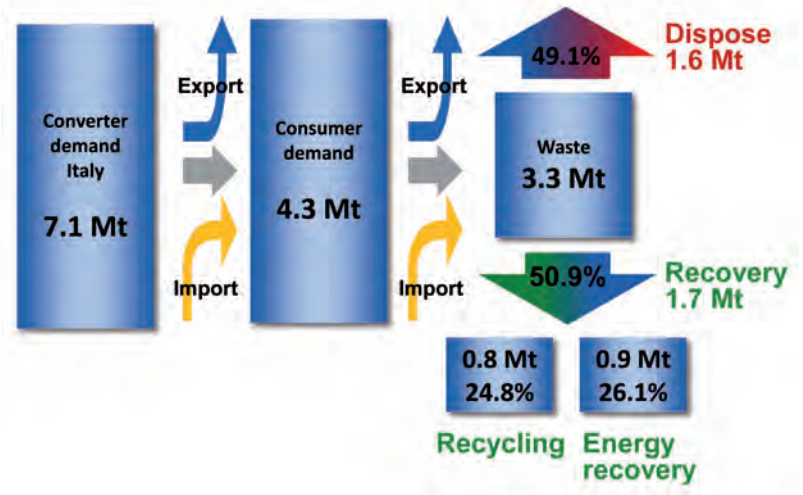


Figure 2. The plastics end-of-life supply chain in Italy

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope and COREPLA data, 2013

5. A significant share of plastic waste (**63%** of end-of-life plastics) consists of **packaging**:

   — 693,000 tonnes of plastic packaging were recovered in **2012** (an increase of 5.5% on an annual basis through sorted collection).

   — Since 1998, collection has grown at an average annual rate of 14% (from 110,000 to nearly 700,000 tonnes in 2012, or 6.3 times the volume).

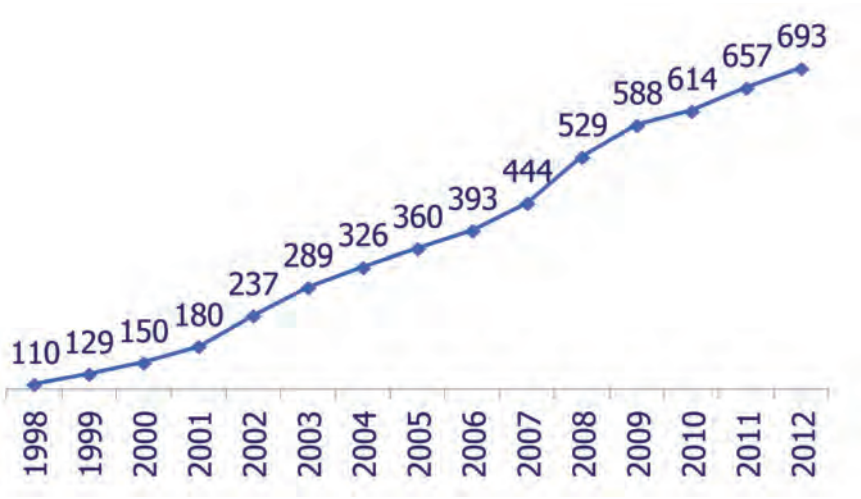


Figure 3. Urban sorted collection of plastic waste in Italy (in thousands of tonnes), 1998-2012

Fonte: elaborazione The European House - Ambrosetti su dati COREPLA, 2013

6. The players involved in the end-of-life cycle are:

   — **Consumers**: as “producers” of waste, they must be made more fully aware of collection (the starting point for the recycling and recovery supply chain).

- **Businesses**: which take part in the:
  - **generation** of plastic scrap and waste;
  - **collection** of waste;
  - **recycling and recovery** of plastic waste.
- **Institutions**: make transfers (including monetary) along the supply chain and plan specific agreements/conventions to foster waste recycling.
- **Consortiums**: specialist players who act as coordinators of the supply chain by monitoring the situation and providing relevant guidelines.[3]

7. With reference to the packaging supply chain in Italy, plastic waste produced by the consumer goes through **four successive phases** before it reaches the final destination and thus second use. There is a series of **intermediate phases and trade-offs** throughout the supply chain in which the national consortiums are involved.

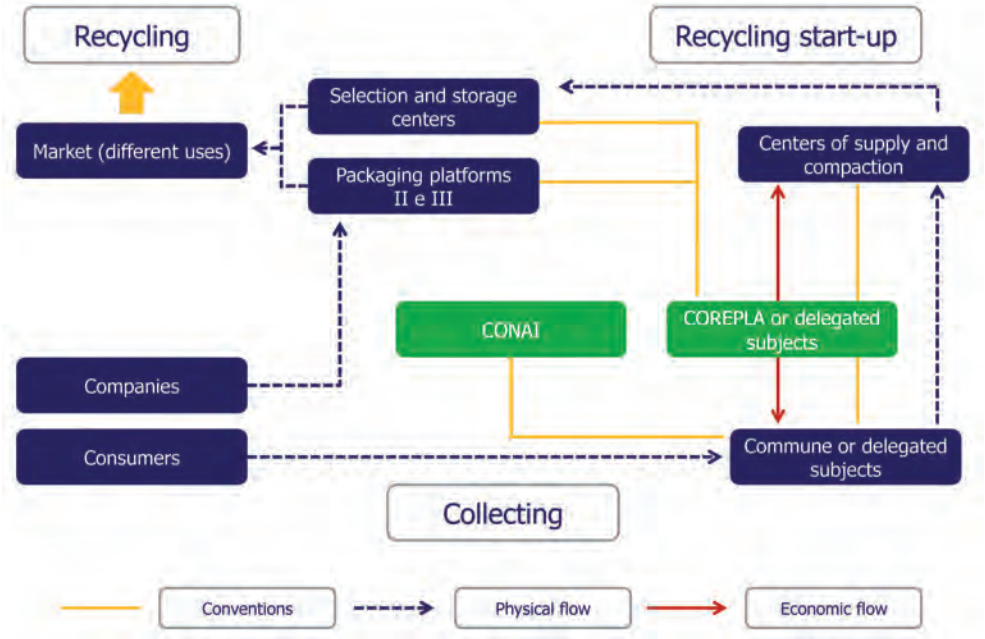


Figure 4. The packaging end-of-life supply chain in Italy

Source: The European House - Ambrosetti re-elaboration of CONAI data, 2013

8. Plastic waste management follows a **specific hierarchy in the end-of-life cycle** with an order of preference among the different destinations for plastic waste:

- **Prevention**: consists of reducing (through the development of non-polluting technologies)

[3] For example, the Consorzio Nazionale per la Raccolta, il Riciclaggio ed il Recupero degli Imballaggi in Plastica – COREPLA.

the quantity of and harm to the environment by:

- materials and substances used in plastics and packaging in the waste generated by them;
- plastic products, packaging and relative waste;

in the production process, marketing, distribution, use, and post-consumption management phases. In addition to use in industry, end-of-life management entails also raising awareness among citizens/consumers.

— **Reuse:** consists of any operation in which the plastic product or packaging is designed for a minimum number of rotations or refills or reuse for the same original purpose throughout its life cycle; at the end of reuse, the plastic product becomes waste.

— **Recycling:** is the treatment of plastic waste in a production process for the original function of the material or for other purposes, including organic recycling. Helps to reduce the environmental impact of disposal and precludes emissions by new materials in the environment. **Recycling is highly contingent upon the quality of the collection** which is absolutely necessary for the success of the process.

- In Italy, the development of the post-consumption recycling of plastics got under way in the 1950s, in parallel with the per capita consumption of products for industrial, commercial and agricultural use, and the recovery of end-of-life films, baskets and cassettes, canisters, vats and jars.
- Volumes increased gradually following the enactment of Legislative Decree 22/1997 (known as the "Ronchi Decree") which led to the sorted collection of packaging, sustained by the growth in the consumption of PET and HDPE bottles and containers for mineral waters, beverages and various liquids.
- Today, the sector boasts approximately **300 companie**s[4] with **some 2,000 direct employees** and a recycling capacity exceeding 1,500 tonnes/year, in large measure unused because of lack of supplies in the national territory.
- A successful experience in our country is represented by the Istituto per la Promozione delle Plastiche da Riciclo (IPPR) [Institute for the Promotion of Recycled Plastics].

[4] It is estimated that recycling companies that are affiliated with ASSORIMAP and re-introduce scrap, waste or leftovers of regenerated or recycled plastic materials in the production cycle, process approximately 80% of the entire quantity produced at the national level. Source: ASSORIMAP, 2013.

The "Istituto per la Promozione delle Plastiche da Riciclo" and the "Second Life Plastics" market

The Istituto per la Promozione delle Plastiche da Riciclo (IPPR) was created to promote the development of the recycled plastics market by boosting the visibility and facilitating the trade of "green products," helping match supply and demand among both private and public enterprises.

In 2004, following a decree enacted in 2003 that imposed environmental criteria on Italian municipalities in all phases of the procurement of goods and services, the **"Second Life Plastics" label** (abbreviated as **PSV** in Italian) was introduced: the **only certification at national level** for second generation plastics, which has through the years witnessed a significant increase in the number of certified products (from 35 in 2004 to 1,249 in 2011).

Street furniture is the category with the largest number of regenerated plastic elements (28% of products with the PSV label), followed by **packaging** and **waste collection** (19% and 17% respectively), for example for the production of waste bags, rubbish bins and bottle banks for street collection, containers for sorted household collection, in the office and for commercial use.

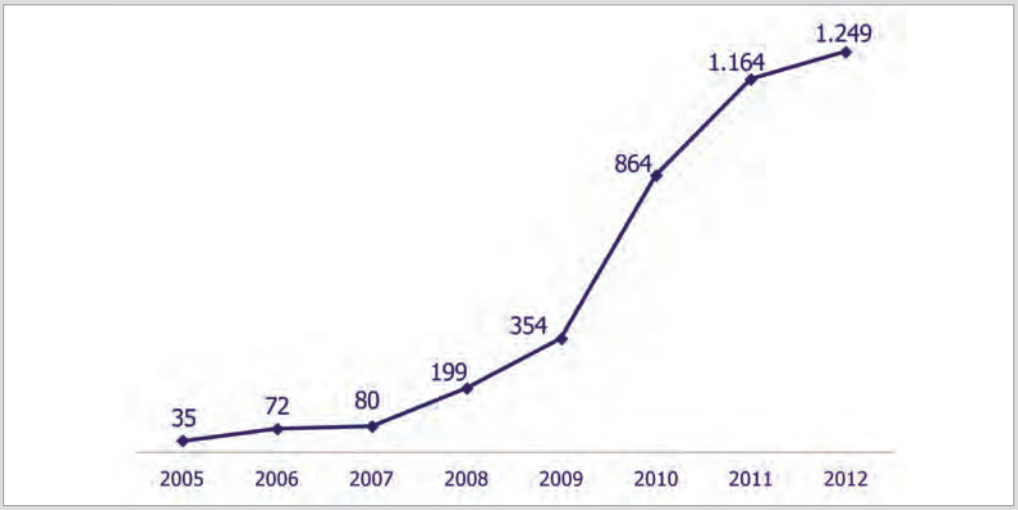


Figure 5. Products certified with the "Second Life Plastics" label in Italy, 2005-2012
Source: The European House - Ambrosetti re-elaboration of IPPR data, 2013

As of 21 September 2011, with the entry into force of the "minimum environmental criteria" for the contracts of the Public Administration in the catering sector and the supply of doors and windows, the recycled plastics market registered a subsequent growth. The aim is to establish a privileged dialogue with the public administration for entities that respect certain green criteria. The "Second Life Plastics" label remains the only ecological label for recycled plastics in Italy at this time.

In 2013 the labelling of new PSV products began, thereby increasing the number of products and, by extension, of companies that avail themselves of a privileged channel with the public administration. The national action plan for Green Procurement was updated in the same year.

Approved on 10 April 2013, this plan provides that at least 50% of public contracts are to be green by 2014.

The companies in the sector show that they believe more and more in the potential of second life plastics: the number of companies affiliated with the IPPR has gone up constantly from 2004 to 2011, from 25 to 139 (there are currently 61 concessionaires of the PSV label).

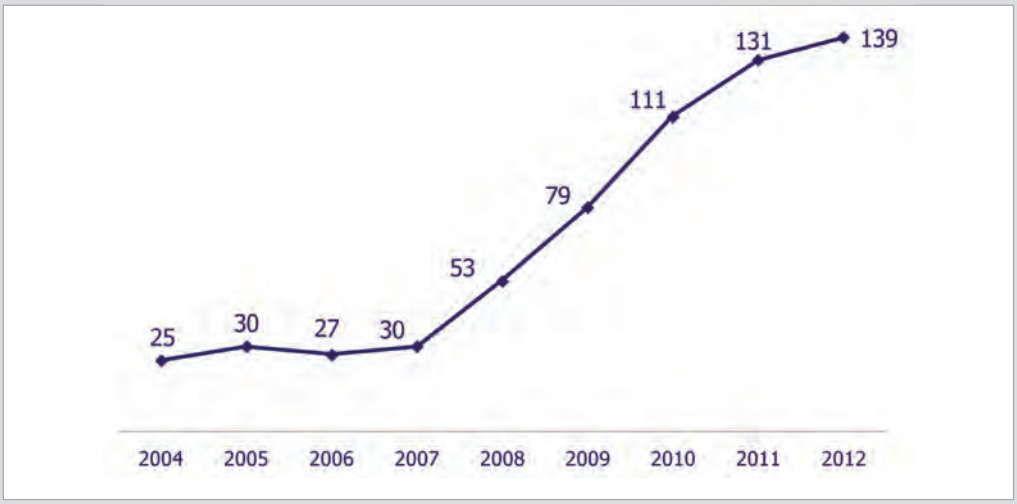


Figure 6. Number of companies affiliated with the IPPR, 2004-2012
Source: The European House - Ambrosetti re-elaboration of IPPR data, 2013

- **Recovery:** concerns the use of plastic and packaging waste as fuels to generate energy (waste-to-energy), with or without other waste, but with heat recovery. Energy recovery is the most widely used option at international level (9 countries in Europe have high energy recovery shares in the vicinity of 85% to 90%).
- The problem of energy recovery in Italy is linked to the negative perception of waste-to-energy, and as a result, our country can rely on **a share of less than 30% of plastic waste being destined for energy recovery.** The energy generated can be used for many applications, such as:
  - **District heating.**
  - Generation of energy for **industrial applications.**
- **Disposal in landfills:** disposal in landfills is the least preferred option in the end-of-life hierarchy of plastic waste. Europe is promoting many initiatives in this respect, alongside the association in the sector. The aim is to eliminate the disposal of plastic waste in landfills in the EU by 2020. Various countries, such as Germany, have already made progress towards that common goal at the national level (cf. Chapter 3).

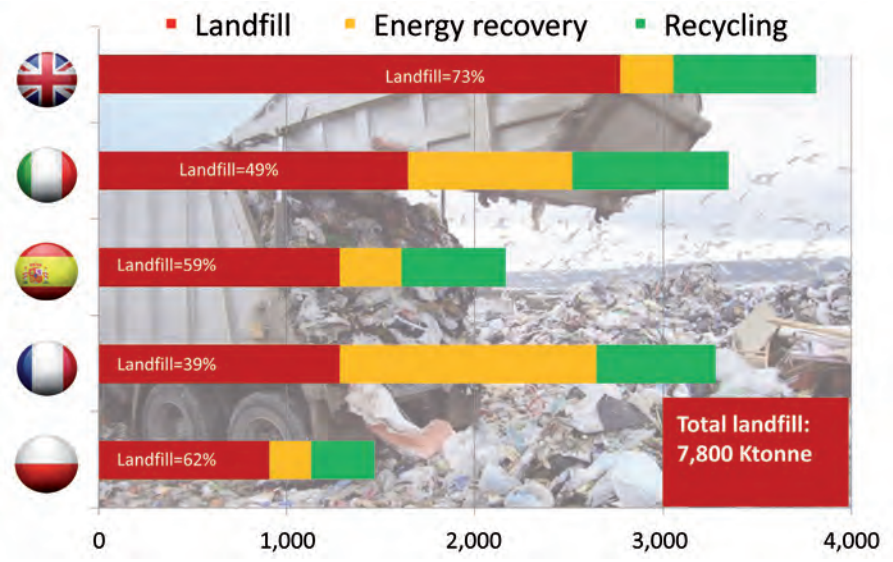


Figure 7. Impact of landfilling on the total waste in certain European countries, 2011

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, 2013

9. The second life plastics supply chain is facing certain **critical situations:**

   — A sizeable portion of plastic waste is disposed of in landfills (1.6 million tonnes, equal to **49.1% of the plastic waste collected in Italy**).

   — There are shortcomings in the collection phase,[5] with **considerable variances** in the collection of plastic waste (from 19.4 kg per inhabitant in the North of Italy to 8.9 kg in the regions of the South).

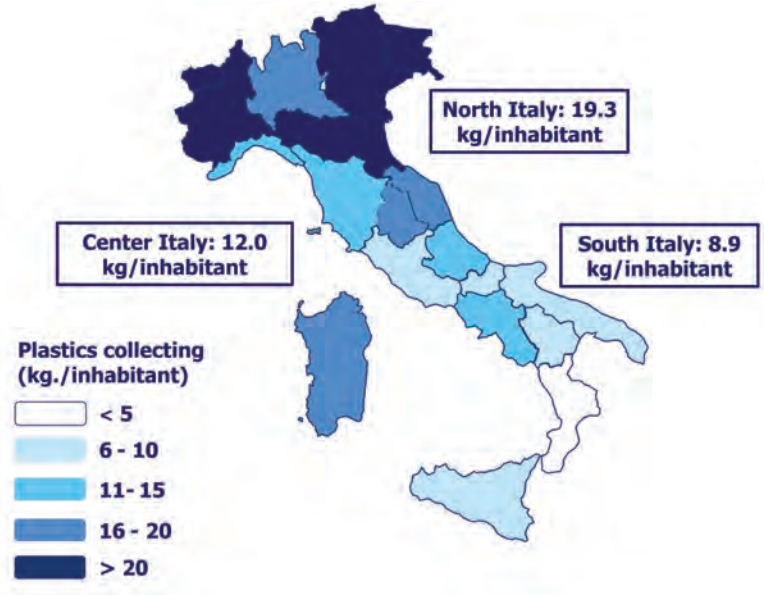


Figure 8. Collection of plastics in Italy (kg/inhabitant), 2012

Source: The European House - Ambrosetti re-elaboration of ISPRA data, 2013

[5] Materials can be collected according to sorting by the system in operation (sorted collection per type of product, or unsorted of all waste fractions based on the type of collection carried out). The subsequent phase in the selection of plastic packaging from urban collection (bottles, jars and other plastic packaging) can be carried out mechanically or manually, based on the type of plant: this activity helps to remove any extraneous fractions (glass, paper, aluminium) from plastic packaging and to subdivide the latter in accordance with the type of polymer that will be developed subsequently.

— The conversion of plastic **waste to energy**[6] is a key topic: examples from central-northern Europe show how it is possible to activate **virtuous mechanisms for the co-incineration of waste** in modern facilities that guarantee the containment of emissions in the atmosphere (cf. Chapter 3 with the Italian case of the Fusina plant, in Veneto).

Waste-to-energy: the Austrian case

Austria has in the last fifty years developed an attentive policy for waste reduction and recovery: the country's four incineration plants[7] treat a residual share of a highly advanced sorted collection and recycling system, but make a contribution towards the goal of *"Zero Plastic to Landfill 2020"*.

For example Vienna has waste-to-energy plants that use plastic waste as fuel to supply energy to the local district heating network during the winter and to air-condition homes in the summer. The main plant is in **Spittelau**, built in 1979 in the city centre and modernised subsequently in 1987.[8]

The plant is capable of generating energy for 60,000 households in the Austrian capital, producing:[9]

— 40,000 MWh of **electric energy**;

— 470,000 MWh of **district heating**.

Using plastic waste makes it possible to save annually, on average:

— 35,000 **tonnes of coke**;

— 35 billion m³ of **natural gas**;

— 25,000 tonnes of **oil**.

— There is a widespread **negative perception** in public opinion in Italy concerning the effects of health; compared with the European average, citizens are particularly sensitive to the negative externalities connected with the possible generation of toxic substances from the incineration of plastics.

The opposition of the local communities (citizenry and local administrative authorities)

[6] Plastic waste can be subjected to the waste-to-energy process because plastics are an optimal fuel, superior on average to fuel oil and can be burnt mixed with solid urban waste (SUW).

[7] The incinerators in Austria are located in Spittelau, Simmeringer Haide, Flötzersteig and Pfaffenau.

[8] The Spittelau structure arouses interest also because of the particular nature of the architecture adopted for the modernisation of the structure, to the point that the plant today attracts visitors in the Austrian capital. Its location in the centre of Vienna reflects the trust of citizens in policies for the management of services and the environment.

[9] Source: Wien Energie, 2013.

frequently leads to glaring cases like the decision of the Municipality of Naples to export waste abroad: this choice, in addition to generating **costs for the system**,[10] does not help foment **the development of a national waste disposal supply chain**, to the benefit of operators in other markets.

% answers	EU-6	Germany	Spain	France	Italy	Poland	UK
Environmental damage	19	12	30	21	21	16	20
Difficulty in recycling	14	9	17	16	10	7	24
Harm to human health	10	32	8	4	2	5	0
Excessive use of plastic	10	8	7	8	12	4	18
Excessive production of waste	8	5	8	10	6	11	8
Lack of efficient systems of recycling	6	9	5	6	5	7	4
Generation of toxic substances by incineration	5	0	0	3	26	2	0
Pollution generated by packaging	4	1	2	4	6	8	1
No advantage compared to other materials	3	6	7	3	1	2	0

Figure 9: Main reasons for the negative perception of plastics in Italy and in 5 other European countries (in percentage), 2011

Source: The European House - Ambrosetti re-elaboration of PlasticsEurope data, "Attitudinal survey on plastics in Europe", 2011 - Note: main responses from the sample

— The positioning of our country in the **international plastic waste flows**[11] is connected to the preceding point:

- Packaging, composed predominantly of plastic materials, accounts for 42% of the waste earmarked for export.
- Plastic packaging amounts to **81,000 tonnes: China** is the main destination with 50,000 tonnes (64%), followed by Austria, with 11,000 tonnes (22%).
- Italy has traditionally been a net importer of plastic waste, but this trend was reversed in the second half of 2008.
- Exporting waste is more convenient in certain cases than disposal within the national boundaries (cost per tonne, plants available, etc.), generating a profit for the importing country (which buys materials at low cost to re-use them).

[10] The cost for disposal in The Netherlands has been estimated at €11 million, with transport by sea, of 100,000 tonnes of waste over a two-year period, at a rate of two vessels per month of 2,000 tonnes (source: Sapna, 2013). The European Court of Justice had expressed particular concern already in March 2010 about the absence of a network of adequate, integrated disposal facilities in the country. More recently, in June 2013, the EU took Italy to the Court of Justice for the management of waste in Campania, calling for a fine of €256,000 for every day after the second conviction, for as long as Italy does not fall into line with the relevant regulations.

[11] In the decade 2000-2010, the quantity of the main materials traded overall has doubled at global level. The expansion has been particularly rapid for plastics, where the volume of trade in the same period has gone from 4.1 to 15.1 million tonnes, for an average annual growth rate of 14%.

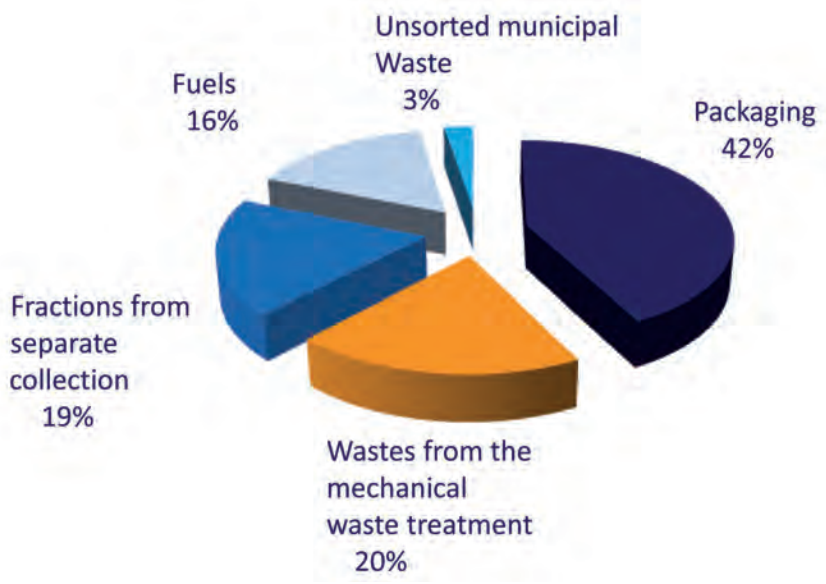


Figure 10. Distribution per type of exported urban waste, 2011
Source: The European House - Ambrosetti re-elaboration of ISPRA data, 2013

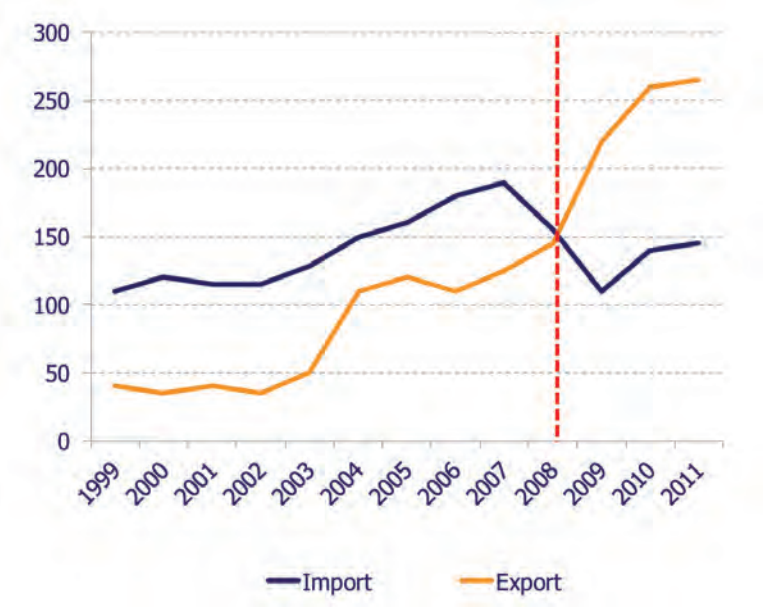


Figure 11. Distribution of Italy's foreign trade in plastic waste, 2013
Source: The European House - Ambrosetti re-elaboration of ISPRA data

10. Upgrading the entire plastics second life cycle in Italy could improve the national context in support of the spread of "end-of-life" awareness that could create synergies (together with plastics manufacturing, processing and machinery-producing industries) with the competencies Italy has in developing waste collection, recovery and recycling models: this would make it possible to give **plastics recycling and recovery a central role in waste management**.

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