

# Innovation and Italy's Chemicals Industries

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Italy's many small and medium-sized chemical companies are crucibles of innovation, whose exports have helped the country to establish a strong presence in the global chemicals market.

**T**he birth of Italy's process industries can arguably be traced back to around 700 B.C. and the Etruscans.

According to archaeological discoveries, the people of Etruria — an ancient region of central Italy — were the first in the West to have workshops for forging iron (*1*).

The first glimpse of Italy's chemicals industries as they are known today, however, did not appear until the 19th century with the establishment of its earliest chemical companies. Noteworthy forerunner companies included the Giovanni Schiapparelli company, founded in 1824 in Milan; Carlo Erba in 1853 in Milan; Azienda Coloranti Nazionali e Affini (ACNA) in 1882 in Cengio; Menarini Industrie Farmaceutiche Riunite (Menarini) in 1886 in Naples; and Società Anonima delle Miniere di Montecatini (Montecatini) in 1888 in Montecatini.

These and other early companies were established to satisfy the basic needs of that period, such as dyes for the textile industry and explosives for military applications. In fact, ACNA, despite its name being an Italian acronym that translates as National Dyes Company and Affiliates, was first contracted to produce dynamite rather than dyes.

Although Carlo Erba was Italy's first pharmaceuticals company, it is Menarini (now known as the Menarini Group) that today remains vital as Italy's largest pharmaceutical group.

Note: Monetary values have been converted from euros to U.S. dollars, based on an average rate of €1 = ~\$1.33 for the year 2013.

Tuscany-based Montecatini had its roots in the mining industry, exploiting the region's copper mines. After the discovery of pyrite in Tuscany, Montecatini shifted its efforts to the production of sulfuric acid; it later made its mark in ammonia production and became known for its widely used Montecatini-Fausser process for fertilizer production.

## Italy's chemicals industries in the 20th century

The diversification of Italy's chemicals industries continued with the launch of companies that formed the foundation of some of the leading chemical companies there today. Chimico Mineraria Rumianca (Rumianca; 1915, Genoa) produced a portfolio of products, including caustic soda, ammonia, dichlorodiphenyltrichloroethane (DDT), and sulfuric acid. Meanwhile, Società di Navigazione Italo-Americana (SNIA; 1917, Milan) opened the door to Italy's synthetic fibers market.

Italy entered the electrochemical industry with the launch of Società Elettrochimica del Toce (1918, Novara), which produced calcium carbide and acetylene. The company was later acquired by Montecatini and expanded into synthetic fibers. Meanwhile, the De Nora company was established in Milan and today remains one of the world's largest suppliers of metal-coated electrodes for the chlor-alkali industry.

Some of these formative companies eventually became subsidiaries of Ente Nazionale Idrocarburi (ENI, the national

hydrocarbons authority), Italy's multinational petrochemical company. For example, Società Elettrochimica del Toce was integrated into the ENI Group's EniChem Fibre, and the company's know-how eventually flowed into ENI's Versalis Co. — today Italy's largest petrochemical company.

The period between the two World Wars saw the birth of Italy's pharmaceuticals industries, mainly in the Emilia-Romagna region — which, along with the other northern regions of Lombardy, Piedmont, and Liguria, were among Italy's most economically advantaged areas. As early as 1911, these latter regions were known as Italy's chemical industrial triangle. In addition to the availability of capital, factors that contributed to the triangle's suitability for industrial growth included access to railroads and a major harbor at Genoa, and proximity to energy markets in nearby France and Belgium (2).

Important early pharmaceutical companies included Aziende Chimiche Riunite Angelini Francesco (today Anglia; 1919, Ancona), Laboratorio Farmacologico Reggiano (today Recordati; 1926, Correggio), Chiesi (1935, Parma), and Farmitalia (a joint venture between Montecatini and France's Rhône-Poulenc; 1935, Milan).

Early resin businesses included Società Italiana Resine (SIR; 1922, Milan) and later Azienda Nazionale Idrogenazione Combustibili (ANIC; 1936, Ravenna). Italy's rubber industry began with the establishment of Ferrara Chemical Pole (1935, Ferrara). Today, the Ferrara site collectively hosts companies such as LyondellBasell (polypropylene and Ziegler-Natta catalyst), Versalis (elastomers, polyethylene, polyethylene catalysts), and SO.F.TER. Tecnopolimeri (synthetic polymers, polyamide compounds).

Meanwhile, the early phases of Italy's petrochemicals industry were beginning, with the formation of Azienda Generale Italiana Petroli (AGIP; 1926, Rome). AGIP, subsequently acquired by the ENI Group, was the first Italian company to produce gasoline, diesel, fuel oil, and liquefied petroleum gas.

The onset of World War II in the late 1930s transformed Italy's chemicals industries. Companies shifted their focus from the production of explosives, ammonia, nitric acid, benzene, and toluene (typical of World War I efforts) to liquid fuels, greases, pharmaceuticals, and synthetic rubbers. The rubber industry, in particular, was boosted in 1939 by the creation of Società Anonima Industria Gomma Sintetica (SAIG), which constructed two plants in the agricultural regions around Ferrara and Mantua. The sites were chosen for their proximity to ethanol feedstock, which was produced via natural fermentation of agricultural products. By 1943, though, German occupation of Italy put a halt to the progress of many domestic industries.

After the war, chemical companies that helped Italy regain its footing included the agrochemical company



▲ **Figure 1.** Italy's chemicals industries are largely consolidated in the country's resource-rich northern regions.

SIPCAM (1946, Milan), which formed the foundation for today's SIPCAM-OXION Group, a multinational producer of chemical intermediates; and FACI (1949, Genoa), which processed vegetable and animal fats into stearin. Today, FACI remains active in the same sector.

In the 1950s, Italy experienced its "economic miracle," as the nation restored its economy and infrastructure after the destruction of World War II. This era gave birth to Mossi & Ghisolfi (M&G; in Tortona), still one of Italy's leading chemical companies, and to ENI. M&G produced plastics and synthetic fibers, and was the first company to introduce polyethylene terephthalate (PET) to the European market. ENI, created by the Italian government in 1953, initially focused on the processing of oil and natural gas.

A highlight during this era came in 1963, when Giulio Natta, a professor of chemical engineering at Politecnico di Milano, together with German chemist Karl Ziegler, received the Nobel Prize in Chemistry for the synthesis of isotactic polypropylene and high-density polyethylene. The Montecatini company capitalized on Natta's discoveries, producing synthetic materials for use in home furnishings,

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appliances, and other consumer goods.

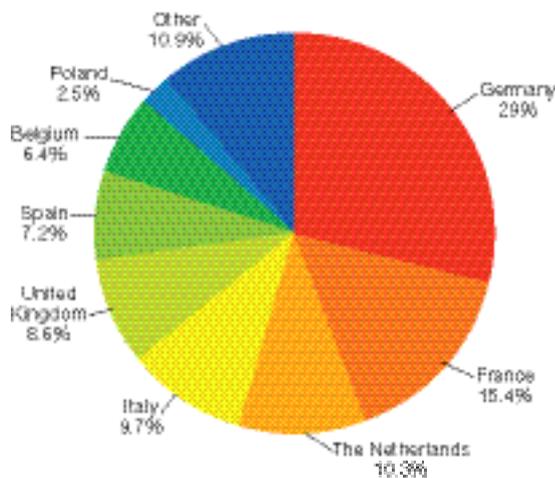
The advent of distillation columns, large-scale reactors, and piping in the 1960s fostered the creation of larger-scale plants — including petrochemical plants — capable of leveraging economies of scale. However, the development of the Italian petrochemicals industries would be forestalled by the Middle East oil crises of 1973 and 1979. Oil-based production slowed, and the petrochemicals industries did not show signs of recovery until the 1980s, when new sources of oil became available (e.g. from the North Sea near Norway). Even then, Italian companies — in particular ENI — turned their attention to natural gas production, a sector that remains strong in Italy today.

Another turning point for Italy's chemicals industries arrived in the 1980s, in the wake of a mismanagement scandal at Montedison (established in 1966 in Milan as a joint-venture of the Montecatini and Edison companies). In the 1970s, Montedison was the largest Italian chemical company, employing 150,000 people worldwide and producing a spectrum of products that included dyes, fertilizers, pharmaceuticals, synthetic fibers, intermediates, and even olive oil.

Along with Montedison's decline and the reorganization of its assets, the prominent positions of other large, multinational Italian chemical companies began to fade. Italy's chemicals industries then saw the emergence of many small and medium-sized enterprises (SMEs), which have become instrumental to Italy's recent success in chemicals.

### Italian chemistry and the quality domestic product

Europe's chemicals industries (excluding pharmaceuticals) had sales in 2011 of approximately \$854 billion, representing 23.4% of the world's chemicals sales. Italy is the fourth-largest chemicals producer in the European Union (EU) (Figure 2) and the tenth largest worldwide, with



▲ **Figure 2.** Italy's chemicals industries sales (excluding pharmaceuticals) in 2011 were the fourth-largest in the European Union. Source: (3).

2011 sales of \$70.5 billion (3). Today in Italy, about 3,000 chemical companies employ 113,000 people (320,000 when indirect jobs are included).

One unique measurement of the economic impact of Italy's chemicals industries is their contribution to the nation's quality domestic product (QDP). A more-comprehensive indicator than gross domestic product (GDP), the QDP measures the impact of high-quality products with higher added value and greater competitiveness in the international market. In this context, "high-quality" and "high-added-value" products are those with relatively high desirability or durability, such as the products of innovation (defined in terms of the product's advanced and desirable characteristics, or its use in a new application).

Today, QDP products account for 47.9% of Italy's GDP. Nearly 60% of that is attributable to products of the chemicals and pharmaceuticals industries — higher than any other industrial sector, and evidence of the inherent value of the sectors' output (4).

### Italian chemistry today

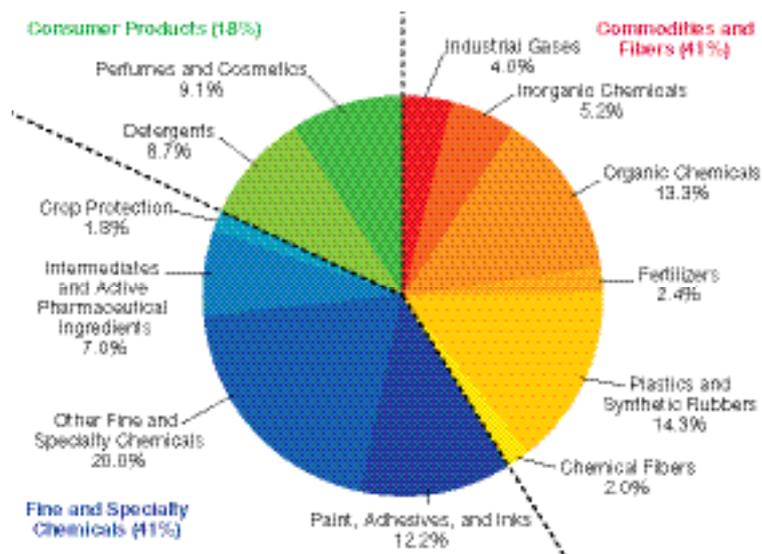
Today, Italy's chemicals industries are highly research-and-development intensive, with 4.3% of the industry's employees dedicated to R&D activities — more than double the average of Italy's manufacturing industry in general (about 1.9%). This propensity is reflected in both R&D expenditures per employee and added value per employee, in which the chemicals, petrochemicals, and pharmaceuticals industries lead all other sectors (5).

Italian companies produce nearly all types of chemicals. In 2010, 41% of products were fine and specialty chemicals, another 41% were commodity chemicals and fibers, and the remaining 18% were consumer products (Figure 3) (5).

Italian chemical companies can also be categorized as small and medium-sized domestic companies (38%, defined as companies with fewer than 250 employees and with annual sales not exceeding €50 million [\$67 million]), large domestic companies (26%), and foreign-owned companies (36%) (6).

Despite the emergence of SMEs, many multinational companies and other large firms remain important players in Italy's chemicals industry. Today, M&G is Italy's largest chemical company, as well as one of the world's largest PET makers, producing almost 1.6 million m.t./yr of PET. M&G is also a leader in the biofuels and biochemistry sectors.

The ENI Group is arguably Italy's most important multinational company. ENI today employs more than 78,000 people in 90 countries, with operations in the oil and gas, chemicals, petrochemicals, energy, process engineering, and construction sectors. ENI processes 2.2 million bbl/day of crude oil, and holds a leading position in the European natural gas market. The company's



▲ **Figure 3.** Italy's chemicals industries are diverse. This diagram shows the production share for the three key sectors in 2011 (excluding pharmaceuticals). Source: (5).

2012 operating profits of \$26 billion place it among the world's top 20 petrochemical groups (7).

The ENI subsidiary Versalis, with 6.1 million m.t./yr of product and 5,800 employees, is the largest Italian petrochemical company. In addition to producing basic chemicals such as ethylene, propylene, butadiene, and benzene, Versalis also manufactures polyethylene, styrenics, and elastomers for a variety of applications.

Geographically, the Italian chemicals industries remain concentrated in four northern regions, namely Lombardy, Piedmont, Emilia-Romagna, and Veneto. These four regions are home to nearly 76% of the Italian chemicals industries' workforce. The Lombardy region alone has nearly 40% of Italy's chemical and pharmaceutical companies, employing more than 72,000 people — 4.2% of the entire European Union's chemical industry personnel (8).

### Italy's global export market

Italy's share of the world chemicals market in 2012 was 2.6%. Italy's exports have continually increased over the past 20 years, and in the EU, Italy is second to only Germany in this regard. In particular, Italy holds a strong position in the export of pharmaceutical ingredients for generic drugs.

As a measure of the country's success in the export market, exports as a percentage of Italy's total chemicals sales rose from 18% in 1993 to 48% in 2012 (5). Overall, the sales value of Italy's chemicals industries' exports increased by 70% between 2000 and 2011 (9).

SME companies — which tend to make specialty products with a high QDP value — are more active in exports than large companies, with their traditional focus on commodity chemicals. From 1999 to 2010, SMEs' share of

exports increased from 39% to 54%, while the share for large companies declined from 61% to 46% (5).

Italy's most important trading partners are its European neighbors: Germany (which receives 15% of Italy's exports), France (9.6%), and Spain (6.4%). The U.S. and the United Kingdom are also key recipients of Italy's exports (5).

Despite its growing export market, in 2012 Italy's chemicals industries had a trade deficit of \$13.7 billion. This deficit was primarily confined to the commodities and fibers sectors (*i.e.*, products of comparatively low QDP value and with much competition). By contrast, the fine chemicals and specialties sectors registered a modest trade surplus of about \$2.0 billion, and the cosmetics, paints, adhesives, and detergents sectors experienced an even greater surplus. Products such as additives for lubricants and cements, antioxidants and stabilizers for plastics, and auxiliary chemicals for leather, textiles and paper also saw significant trade surpluses.

### Innovation and R&D

Another area in which Italy excels is the creation of new products — *i.e.*, the products of innovation. In fact, in 2012, Italy's chemicals industries led those of other EU countries in this regard, introducing 870 new products, versus 770 from Germany, 429 from France, and 267 from Spain (9). Italy's particular innovation strength is polymers; 27% of Italy's chemical industry patents are in polymers, versus an average of 20% for its peers in the EU.

A possible contributor to Italian innovation success is the fact that nearly half of Italy's chemical companies have an internal R&D department. The chemicals sector outperforms even high-tech sectors such as pharmaceuticals and electronics, where that percentage is still a robust 44%. In contrast, only about a quarter of Italy's manufacturing firms in general have an internal R&D department (9).

Investments in innovation and in R&D are accounted for separately. Innovation expenditures are less-structured than R&D expenditures. R&D money is devoted to programs with well-defined scopes, explicit objectives, and dedicated personnel. On the other hand, innovation expenditures are those resources devoted to continuous improvements of the products at hand — often, in effect, involving a trial-and-error approach that can lead to unexpected breakthroughs.

In 2012, investments in innovation exceeded \$1.1 billion. Meanwhile, investment in R&D was about \$732 million, 82% of which was spent internally, with just 18% of R&D expenditures taking place at external research institutions.

As a side note, in 2012, the 259 foreign chemical companies operating in Italy, which account for only 9% of all chemical companies operating there, invested nearly 37%

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of the sector's R&D expenditure. This follows from the fact that the international companies tend to be larger organizations with better-established R&D programs than the SME companies that dominate Italy's chemicals sector today.

Only 8% of Italian chemical companies collaborate with research institutions (universities and public or private research centers), versus an average of 14% throughout the rest of Europe (9).

A factor contributing to the domestic R&D gap is that Italy's chemical companies tend to be, on average, too small to engage in structured R&D activities. Many SMEs have not established a formal R&D department or R&D management structure — which can be vital to developing collaborations with research institutions, pursuing research grants, and gaining access to public R&D funding. Other factors include cultural differences in the way the academic and industrial worlds approach collaboration, as well as obstacles posed by Italian bureaucracy, which is often unwieldy and inefficient.

Despite these limitations, Italy's chemicals industries excel at innovation. This peculiarity might be explained by the fact that Italy's chemical companies have interpreted innovation as an internal, less-structured form of R&D activity — a sort of learning-by-doing endeavor, rather than a formal, strategic cooperation with research institutions.

### Social and environmental responsibility

Recent analyses show that Europe's chemicals industries lead the world in energy efficiency. A 2007 study by the International Energy Agency that tracks industrial energy efficiency and CO<sub>2</sub> emissions assigned the EU a benchmark energy efficiency index (EEI) of 100, with lower numbers corresponding to higher industrial efficiency (10). Italy, with an EEI of 77, ranked second only to Germany (EEI = 71) in Europe (11). Meanwhile, the U.S. scored 172, and the Middle East averaged 939 (10).

Italy also excels in its efforts to reduce greenhouse gas (GHG) emissions. Its chemicals industries reduced their GHG emissions from 30.5 million m.t./yr CO<sub>2</sub> equivalent (CO<sub>2</sub>e) in 1990 to 10.1 million m.t./yr CO<sub>2</sub>e in 2011. This 67% reduction puts Italy far ahead of the Kyoto Protocol's target of a 6.5% reduction by 2012. Furthermore, the decline in emissions positions Italy's chemicals industries a decade ahead of the EU's 2020 targets, which call for a 20% reduction in GHG emissions from 1990 levels; a 20% increase in the share of EU energy consumption produced from renewable resources; and a 20% improvement in the EU's energy efficiency (5).

Italy's impressive progress in this area might be attributed, in part, to the impact of the 1976 chemical plant accident in Seveso, north of Milan. That incident, which released 6 m.t. of tetrachlorodibenzo-*p*-dioxin (TCDD) to the environment, revealed the far-reaching impact of a chemical plant accident. Along with the subsequent Chernobyl (1986) and Toulouse

(2001) disasters, the Seveso incident reinforced a strong aversion by industry and the public to industrial risks throughout the EU. In response, the EU adopted industrial safety regulations known as the Seveso Directives.

An additional measure of the chemicals industries' dedication to safe and sustainable practices is the increase in Italian chemical companies receiving environment, health, and safety (EH&S) certification. From 2005 to 2011, the number of chemical companies certified under OHSAS 18001 (the British standard for occupational health and safety) increased from 40 to 219, and the number of companies receiving ISO 14001 certification for environmental management rose from 327 to 381 (12). The Seveso II Directive of 2003 — which extended the earlier directive to cover risks arising from mining activities, from explosive substances, and from the storage of ammonium nitrate and ammonium-nitrate-based fertilizers — helped motivate Italy's chemical companies to pursue the certification programs.

### Strategies and the challenges ahead

Italy's emerging strategy for its chemicals industries can be summarized in the choices made for the products it develops and the technologies it uses.

*Products.* The past decade has been marked by a diminished interest in production of commodity chemicals in favor of higher-added-value products in the fine chemicals, specialties, and consumer products sectors. Expanded production of such products suits the strengths of Italy's SMEs, as these high-end sectors do not impose a size-based entrance barrier (*i.e.*, a production volume below which a company's products will not be cost-effective to produce) or require enormous capital investment.

*Technologies.* The industries' efforts have focused on the creation of new products — moving away from innovations in processes to innovative products, as witnessed by the large number of new patents granted to Italian companies. For many companies, this innovation, in practice, has represented a type of internal, less-structured, applied R&D activity.

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Thanks to these choices and a successful export market, Italian chemical companies were able to afford an internationalization process that gave rise to the Italian phenomenon known as fourth capitalism, which is exemplified by medium-size “pocket multinational” manufacturing companies that are particularly strong in the export market.

Thus, the past decade has seen the establishment of a successful strategy for Italy’s chemicals industries. However, to enable these industries to increase their worldwide competitive position, several challenges need to be addressed.

The first challenge is bureaucracy — the disconnect between regulatory authorities and the industries that function under their jurisdiction. For example, an Italian company’s decision to retrofit a plant is not only accompanied by the expected need to document the changes, pay taxes, and receive authorization from a variety of authorities, but frequently those agencies do not collaborate effectively with one another, thus further stalling progress. Italy will need to transform public officials and agencies from being inhibitors (as perceived today) to enablers of industry — with the goal of simplifying procedures and advancing a cooperative relationship between the regulators and the regulated entities.

The second challenge involves improving the collaboration between companies and research institutions. To stay competitive in the global market, products will need to be knowledge- and creativity-intensive — *i.e.*, they will need to remain innovative. This applies especially to Italy’s SMEs, which cannot rely on economies of scale to be competitive. Research institutions and industry must improve their cooperation to foster interdisciplinary approaches to progress and to establish long-term strategic collaborations. Also, companies will need to better structure their internal R&D functions, which might entail recruiting more highly educated

people (at the master’s and PhD levels) and envisioning longer-term research objectives to optimize R&D investments. SMEs, in particular, have no room for inefficiencies.

A third important challenge is the inefficiency of the regulatory system and the need to reduce the time required for product testing and the processing of legal contracts. For example, the average trial time for virtually any Italian product is five years — a factor that inhibits investment in some Italian companies, despite their products’ high quality. Increased digitization and modernization of communication and documentation processes will further help to accelerate progress; despite Italy’s modern society, many agencies still use pen, paper, and physical files, rather than email and electronic documents to expedite business.

A fourth challenge is infrastructure. Transportation is vital to the chemicals industries, and the safest and quickest way to move chemicals is by rail. However, Italy’s prevailing transportation policies focus on the nation’s roads, as they have since the 1950s. Italy will need to rebalance its transportation investments to improve its rail infrastructure.

A fifth challenge is energy costs. Italian companies pay 25% more for energy than their European neighbors, due to factors such as the government’s pricing and tax policies and the lack of a free market for energy in Italy. One solution might be for Italy to take advantage of its strategic geographic position to better utilize the Mediterranean region’s oil and gas pipeline network. Political hurdles and an aversion to risk by businesses have been obstacles in this regard. With reforms, Italy could become a European energy hub. Investment in offshore degasification stations for storing natural gas purchased from regional distributors and brought to Italy by sea could allow Italy to expand its position in petrochemicals by helping to feed European demand. 

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