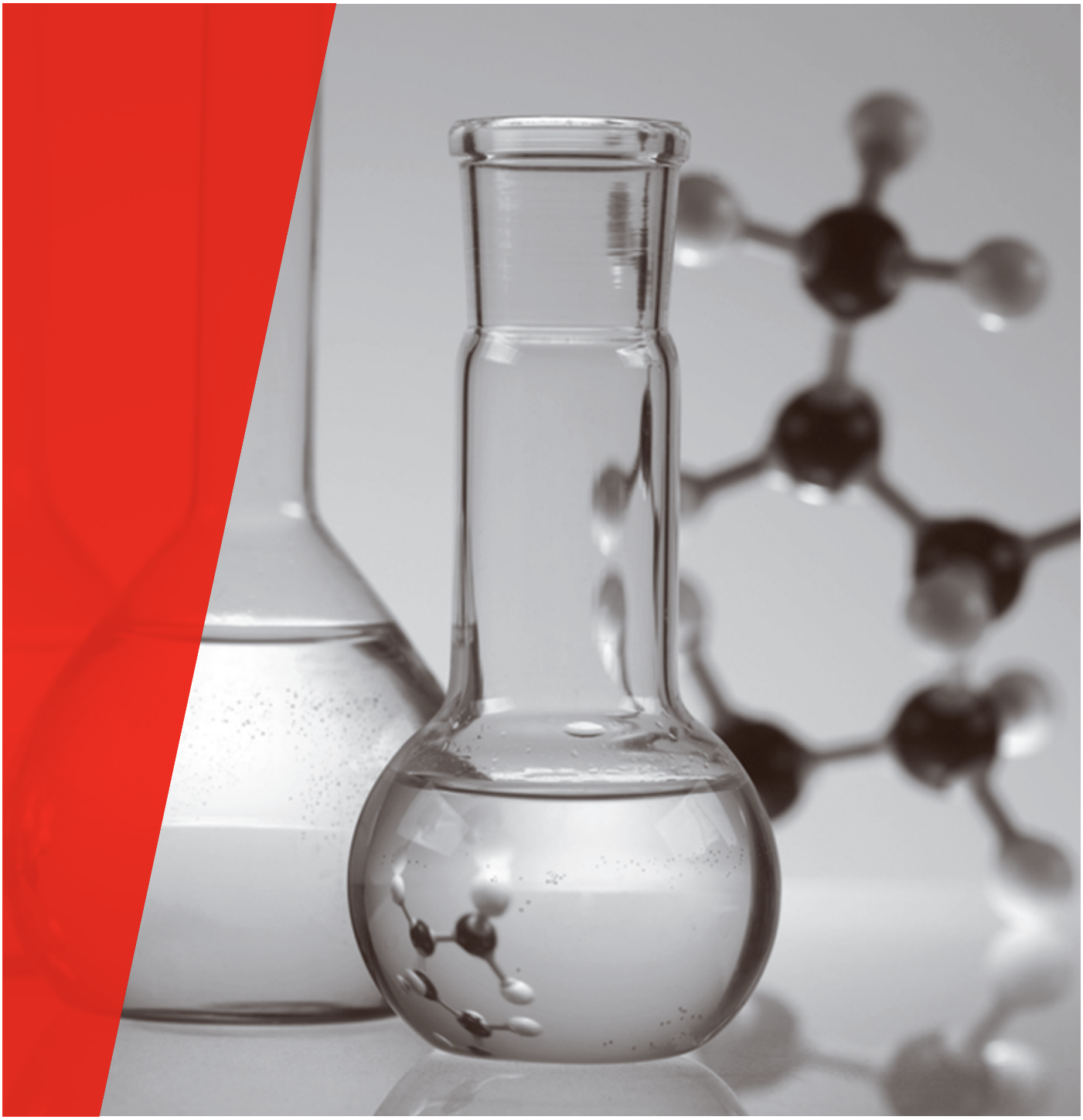

STUDY OF THE POTENTIAL FOR DIVERSIFICATION OF THE BRAZILIAN CHEMICAL INDUSTRY

Final report in conjunction with Gas Energy

BAIN & COMPANY

Bain & Company | Gas Energy

Study of the potential for diversification of the Brazilian chemical industry: final report

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Introduction

The mission of the Brazilian Development Bank (BNDES) is to promote the economic and social development of the country; to that end, it supports programs, projects and developments across various sectors of the economy.

To promote structural projects and contribute to an environment that enables investment, the Bank created the Fund for Structuring Projects (FEP). The fund supports studies and research that contribute to the formulation of public policies and promote the development of projects related to the economic and social development of Brazil and Latin America.

The FEP is funded through part of the annual profits of BNDES. Its resources, which are non-reimbursable, fund scientific research, the identification of projects, and studies on public sector policies, including comparative studies.

The results help foster public debate on priority subjects, disseminating quality information to allow the best possible assessment of alternatives. In this sense, the work does not aim to build propositions and does not necessarily reflect the opinions of BNDES. The content of the studies and research is public and should be widely disseminated throughout society.

FEP Monitoring Committee

Executive summary

Between 2000 and 2006, the trade balance of the chemical industry in Brazil remained relatively stable, with an annual deficit between US$6 billion and US$9 billion. Starting in 2007, the trade deficit increased substantially, reaching US$28 billion in 2012.[1] Two principal factors contributed to this phenomenon: the divergence between the growth of production in the national chemical industry and the evolution of domestic consumption; and the increase in value added of imports in relation to exports of chemicals.[2]

To help reverse this situation, the study proposed through the Public Call for Proposals BNDES/FEP No. 03/2011 seeks to identify and evaluate opportunities to diversify the Brazilian chemical industry, with emphasis on higher value-added chemical products, the strengthening and expansion of commodity chains, and the development and implementation of new technologies. The study also seeks to contribute to the design of instruments and actions of an industrial policy for the chemical industry.

The study identified and ranked 66 segments of the chemical industry in groups: primary, secondary and tertiary, based on Brazil's potential competitiveness in each of them. The 21 segments identified for primary focus were further analyzed during the study. These segments accounted for US$8.9 billion of Brazil's trade deficit in 2012 (72% of the total deficit within the scope of the study).[3] The importance of the primary focus segments is also evident through the growth of imports in these categories (10% per year between 2008 and 2012) and the value added by the respective imported products (average of US$2.99 per kilogram compared with US$0.93 per kilogram for the other segments).

Cosmetics and personal care, agrochemicals[4], food additives for animals and chemicals for exploration and production are among the segments with better competitive conditions, which we define as segments where the size of the Brazilian market is attractive for investments in local production. All of those segments have domestic markets that are relevant in a global context. Segments of the chemical industry that add value to locally available and competitive raw materials can also be attractive for investments. We identified opportunities in aromas, flavors and fragrances, cellulose derivatives, food additives for humans, silicon derivatives, surfactants, butadiene and isoprene derivatives, aromatic derivatives, polyurethanes (PU) and their intermediates, lubricants, carbon fiber (CF), specialty polyamides, high-tenacity polyester, oleochemicals and chemicals from renewable sources.[5]

Investment opportunities identified in the primary focus segments could amount to between US$33 billion and US$47 billion between 2015 and 2030. If these investments were to materialize, the trade deficit for these segments could be reduced by between US$22 and US$38 billion per year in 2030. The five primary focus segments with the greatest potential to improve the trade balance alone could generate as many as 19,000 new jobs by 2030 *(see Figure 1)*.

In addition, investment opportunities in the production of chemicals in Brazil, using alternative technologies from renewable sources (notably biomass) could contribute US$15 billion to US$35 billion in revenue for the industry in 2030, positively impacting the Brazilian trade balance.

Capturing the opportunities identified requires the implementation of policies and actions to improve the competitive conditions of the chemical industry in Brazil; currently, the country is not in a competitive position to attract productive investment for most of the opportunities identified. The competitive challenges identified by the study[6] and their respective proposed solutions are consolidated and prioritized into six main groups.

Figure 1: Market investment and segment impact

	2012							2030			
Segment	Brazil market (US$B, 2012)	Share of Brazil (% of world)	Growth-local market (07–12)	Growth-global market (07–12)	Imports (US$M, 2012)	Exports (US$M, 2012)	Trade deficit (US$M, 2012)	Investment (US$B, 2015–2030)	Impact on trade balance (US$B, 2030)	Impact on GDP (US$B, 2030)	Jobs created (thousands)
Agrochemicals	9.7	20.50%	16.10%	7.60%	5.400	500	4.900	1.7 – 5.3	7 – 18	3.6 – 8.2	4.6 – 10.4
Petrochemical derivatives[1]	7.4	2.40%	2.30%	2.70%	3.537	847	2.690	20 – 25	5 – 7[2]	5.5 – 6.5[2]	3 – 4[2]
Chemicals for E&P	0.71	3.6%	24.6%	11.2%	85	9	76	2.0 – 2.8	2.0 – 2.8	0.4 – 0.6	1.3 – 1.8
Food additives[3]	1.75	5.4%	7.6%	3.8%	825	935	–110	1.2 – 1.7	1.5 – 2.2	0.7 – 1.0	0.9 – 1.4
Oleochemicals	0.66	2.8%	23.2%	8.1%	230	179	51	0.6 – 1.3	0.9 – 1.8	0.4 – 0.9	0.5 – 1.2

Notes: 1) includes aromatics, butadiene and isoprene derivatives, specialty polyamides, high-tenacity polyesters, PU and their intermediates; 2) represents the impact on trade balance, GDP and jobs generated for petrochemicals refers to the year 2025; 3) includes food additives for humans and animals
Sources: Bain & Company; Gas Energy

Add value to oil and natural gas belonging to the Brazilian Federal Government in pre-salt reserves, allocating them to long-term, productive and internationally competitive investments: The Consortium[7] proposes the implementation of public policies for the production of chemicals from part of the volume of hydrocarbons (oil and gas) belonging to the Federal Government that will be produced by fields under production-sharing contracts. The availability of hydrocarbons from the Federal Government would be developed through long-term supply contracts (minimum of 15 years) for producers identified through a competitive process, and linked to investments in petrochemical production capacity in Brazil, preferably in chemical segments classified as primary focus. Chemicals derived from these investments should have their import duties reviewed to ensure that their competitiveness is also reflected in the downstream chains.

Improve the regulatory environment: The Consortium identified specific improvement proposals for the primary focus segments, with the aim of facilitating access to raw materials, reducing costs, encouraging markets to adopt better quality products and streamlining registration and approval processes for the production and commercialization of chemicals. Of special note is the agrochemicals segment, where the main opportunity is the improved management of the product registration queue, prioritizing those registrations that bring greater socioeconomic benefits in general and to agribusiness in particular. Greater agility in processing these registrations should result in the increased local production of agrochemicals, whose trade deficit reached approximately US$5 billion in 2012. Another important proposed improvement is a necessary change in the regulatory framework for access to biodiversity to allow the advancement of research of such bioresources and to further develop and production of bio-based chemical solutions to attract more investment and economic development for Brazil.

Add value to Brazilian agribusiness through investments in the local production of chemicals produced from raw materials derived from biomass: The Consortium sees an opportunity to capitalize on the synergies in assets and

skills within agricultural and industrial segments already well developed in Brazil. In the sugarcane derivatives segment, the Consortium detailed two Repeatable Models®: construction of biorefineries in close proximity to existing sugarcane ethanol infrastructure and construction of biorefineries in new agricultural frontiers associated with the agricultural development of sugarcane varieties suitable for the production of biomass for the chemical industry. The segment should adopt the same logic for other possible sources of biomass for chemicals, such as eucalyptus and pine pulp, orange, palm and others.

Develop and implement investments targeting improvements in logistics infrastructure that support local chemical commodity chains, such as railways, roadways and maritime transportation: In railways, the Consortium proposes the prioritization of projects in the National Logistics Plan and the building of connections between the rail network and existing petrochemical complexes. In road transport, the proposals are centered on projects that improve access to the Port of Santos and ease transportation regulations. Regarding maritime transportation, the proposals aim to improve the conditions of ports that are relevant to the Brazilian chemical industry, such as the Port of Santos and Aratu, and to ease regulations for chartering vessels for shipping in Brazilian coastal waters.

Increase efforts in technological innovation with strategic priority given to the primary focus segments and biomass chemicals: Although efforts in innovation are often influenced and preceded by productive investments, the Consortium believes that Brazil should target a substantial increase in research and development (R&D) efforts by strengthening incentives for R&D to overcome current technological challenges. The Sectorial Technologies Agendas identified and prioritized these challenges for biomass chemicals, which map to the primary focus segments through the study of investment opportunities in each segment. The technological challenges must be translated into R&D initiatives which will then be monitored and improved upon regularly through management and governance mechanisms that integrate the government, private initiatives and research institutes. Public policies for innovation in the chemical industry should be strengthened and integrated through specific incentive programs and through the creation of a knowledge platform specifically for the chemical industry.

Simplify the tax system: The Consortium proposes initiatives to improve the tax system, ensuring tax equality, stable rules and tax exemptions that encourage investment in the chemical industry. Recognizing that this issue relates to all industries, the Consortium proposes public policies that increase the competitiveness of the chemical industry in three dimensions: increased cost competitiveness, reduced investment cost in production capacity and achievement of tax equality between domestic and imported products. The Consortium also points out the need to implement long-term tax policies, ensuring a stable environment for the implementation of sectorial investments, which typically require long periods for maturation and return on invested capital.

The transformation of the public policy proposals summarized here into a government plan is essential for the investment opportunities listed in this study to materialize. This transformation depends on a structured effort around a specific policy program involving government entities, including Civil House, Ministry of Development, Industry and Foreign Trade (MDIC), Ministry of Mines and Energy (MME), Ministry of Finance, Ministry of Agriculture, Ministry of the Environment, Ministry of Health, Ministry of Science, Technology and Innovation (MCTI), Ministry of Transport, Ministry of Planning, and others. The details of the proposals must be prepared only after dialogue with the private sector, represented by the Brazilian industry associations.

This report is organized as follows: In chapter 1, the Consortium presents the objectives and scope defined for the study, as well as the classification of the segments of the chemical industry; chapter 2 describes the investment opportunities in the primary focus segments; chapter 3 presents proposals for sectorial public policies developed by the Consortium; and chapter 4 summarizes the estimated impacts for the year 2030, once the identified investment opportunities have been implemented.

1 The trade deficit in the chemical sector in Brazil reached US$32 billion in 2013.

2 Defined as the value per unit of weight, measured in US dollars per kilogram of product.

3 The scope of this study, as identified in the Public Call for Proposals, covers 57% of the imports and exports of the chemical industry in 2012. Pharmaceuticals (e.g., dipyrone), fertilizers (N—nitrogen, P—phosphorus and K—potassium) and plastic polymers (PE, PP, PVC and PET) were not included within the scope of the study.

4 Considered as the main categories of pesticides: insecticides, herbicides and fungicides.

5 The segments "Chemicals for Mineral Processing," "Chemicals for Leather" and "Chemicals for Concrete" were also considered as part of the primary focus, and, although not detailed in this report, were analyzed during this study and are covered in specific reports.

6 Based on the detailed study of the primary focus segments, the analysis of international reports, the completion of approximately 120 personal interviews and the compilation of survey responses of participants and observers of the chemical industry.

7 Defined as Bain and Gas Energy joint team.

1. Context

a. Objective

The Brazilian chemical industry recorded significant growth between 2000 and 2011 and closed the year 2012 with US$153 billion[8] in revenue, according to the Brazilian Chemical Industry Association (ABIQUIM).

Between 2000 and 2006, the trade balance of the chemical industry in Brazil remained relatively stable, with an annual trade deficit of between approximately US$6 billion and US$9 billion. However, starting in 2007, the trade deficit increased substantially, reaching US$28 billion in 2012.[9] Two main factors contributed to this phenomenon: the divergence between the growth of production in the national chemical industry and the evolution of domestic consumption, and the increase in the value added of imports in relation to exports of chemicals.

With the objective of contributing to the future reversal of this situation, the study proposed in Public Call for Proposals BNDES/FEP No. 03/2011 seeks to identify and evaluate opportunities to diversify the Brazilian chemical industry, with emphasis on higher value added chemical products, the increased integration and branching of existing commodity chains and the development of new technologies. The study also seeks to contribute to the design of instruments and actions of an industrial policy for the sector.

b. Scope and segments of primary focus

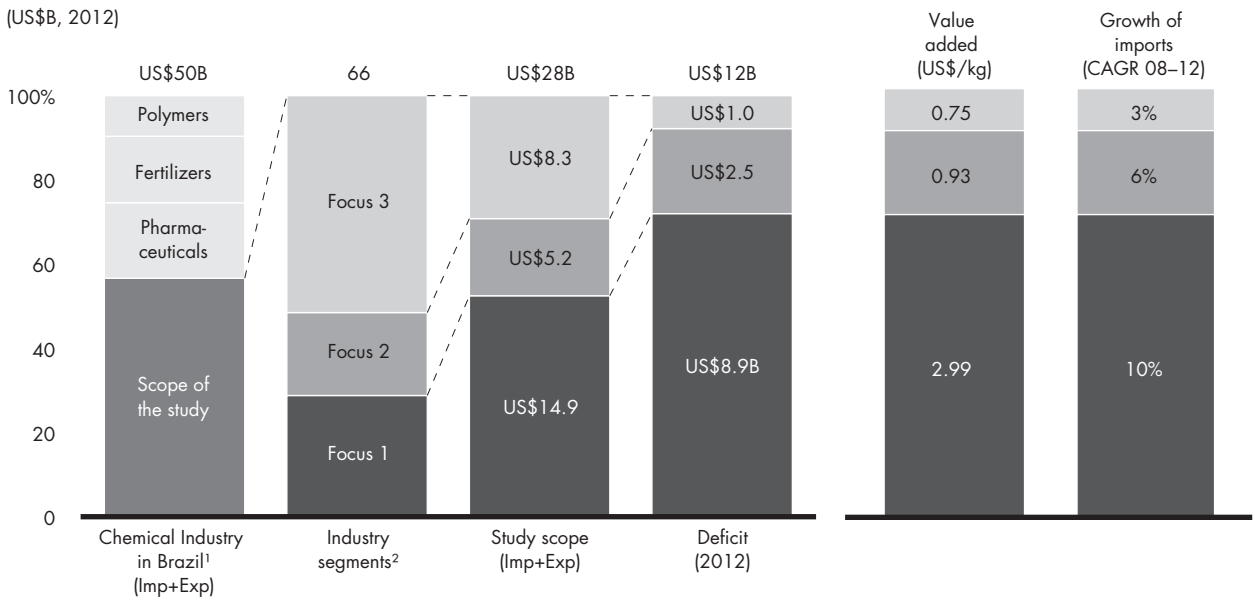
The scope of this study, as stipulated in the Public Call for Proposals,[10] includes 57%[11] of the imports and exports of the chemical industry in 2012. The industry was divided into 66 distinct segments,[12] which were classified as primary, secondary or tertiary focus.

The study focused on the 21 primary focus segments, which accounted for US$8.9 billion of the trade deficit in 2012, representing 72% of the deficit related to the segments within the project's scope. The products in these segments not only have a higher average value added than those in others but also face a scenario of increasing imports. Between 2008 and 2012, imports in these segments grew on average 10% per year *(see Figure 2)*.

Among the segments with better competitive conditions, those in which the size of the domestic market offers a competitive basis for attracting new investments stand out. The six segments with the highest competitiveness index include three segments in which the country possesses a high global market share (agrochemicals, cosmetics and personal care, and food additives for animals) as well as the segment with highest projected global growth (chemicals for E&P[13]). *Figure 3* provides a summary of key indicators for the segments studied with primary focus.

Another relevant factor in the local segments with the highest potential for competitiveness is raw material, including raw material from both renewable sources and fossil fuels (petrochemicals). In the segments food additives, cellulose derivatives, and aromas, flavors, and fragrance, Brazil has a significant comparative advantage in renewable raw materials, which are inputs in these segments. The two stand-out advantages are the high national agricultural productivity in inputs such as sugarcane, corn, soy and wood used for cellulose, and Brazilian biodiversity. In addition, the country may have the potential to provide competitive petrochemical raw materials due to not only the expected increase in the domestic production of hydrocarbons but also the possibility of directing part of this increase towards the production of chemicals in Brazil. This steering can be made possible through public policies, which are addressed in the section 3.a. of this report.

Figure 2: Project scope and importance of trade balance



Notes: 1) is the average sum of imports and exports during the period 2008–2012; 2) is chemicals from renewable sources were also selected for study and analyzed as a segment. As it overlaps with the other sectors, it is not considered in the analysis presented in the previous table.
Sources: AliceWeb; Bain & Company; Gas Energy

Figure 3: Competitiveness of the primary focus segments

Competitiveness	Segment	Brazil market (US$B 2012)	Brazil share (%)	Global growth (07–12)	Brazilian growth (07–12)	Imports (US$M)	Exports (US$M)	Unit price (US$/kg)
+	Cosmetics	**41.8**	**9.7%**	4.1%	**12.4%**	**830**	**580**	**5.4**
	Agrochemicals	**9.7**	**20.5%**	7.6%	**16.1%**	**5,400**	500	**11.3**
	Food additives for animals[1]	1.10	**10.0%**	3.7%	10.1%	458	310	2.5
	Butadiene and isoprene derivatives[2]	1.95	**5.7%**	1.1%	3.2%	860	**740**	2.5
	Aromas, flavors and fragrances	1.20	5.1%	3.3%	6.5%	295	317	**5.2**
	Chemicals for E&P	0.71	3.6%	**11.2%**	**24.6%**	85	9	1.7
	Surfactants	1.54	5.7%	3.0%	6.9%	315	185	3.0
	Aromatic derivatives[3]	2.52	1.6%	3.8%	5.2%	**1,154**	0	1.2
	PU	1.50	3.5%	1.6%	5.8%	944	83	2.7
	Cellulose derivatives	0.33	1.3%	6.3%	1.1%	190	37	3.5
	Lubricants	**4.5**	3.5%	1,0%	2.6%	**1,127**	209	2.4
	Food additives for humans[1]	0.65	3.0%	3.8%	4.1%	367	**625**	2.8
	Oleochemicals	0.66	2.8%	8.1%	**23.2%**	230	179	1.7
	CF	0.10	9.4%	**7.9%**	**107.4%**	97	0	**24.4**
	Chemicals for mineral processing	0.19	4.1%	2.3%	7.6%	93	8	2.2
	Chemicals for leather	0.38	**8.1%**	2.8%	3.7%	111	83	1.7
	Silicon derivatives	0.42	3.0%	3.7%	5.2%	190	**536**	2.5
	Chemicals for concrete	0.17	1.7%	3.7%	5.0%	30	4	1.1
	Specialty polyamides	1.28	1.7%	1.9%	-5.2%	509	14	3.4
–	High-tenacity polyester	0.13	2.1%	4.5%	-3.0%	70	10	2.0
	+ Chemicals from renewable sources							

Notes: 1) the food additives segment was divided to facilitate analysis; 2) excludes butadiene and isoprene; 3) excludes BTX; the segment, chemicals from renewable sources, which cuts across the other segments, was also analyzed to identify opportunities. Sources: Bain & Company; Gas Energy

We classified the primary focus segments into four groups, according to the principal competitive advantage of the respective segments: strong local demand, competitive and available raw material, potential competitive raw material, and competitive raw material with emerging technology *(see Figure 4)*.

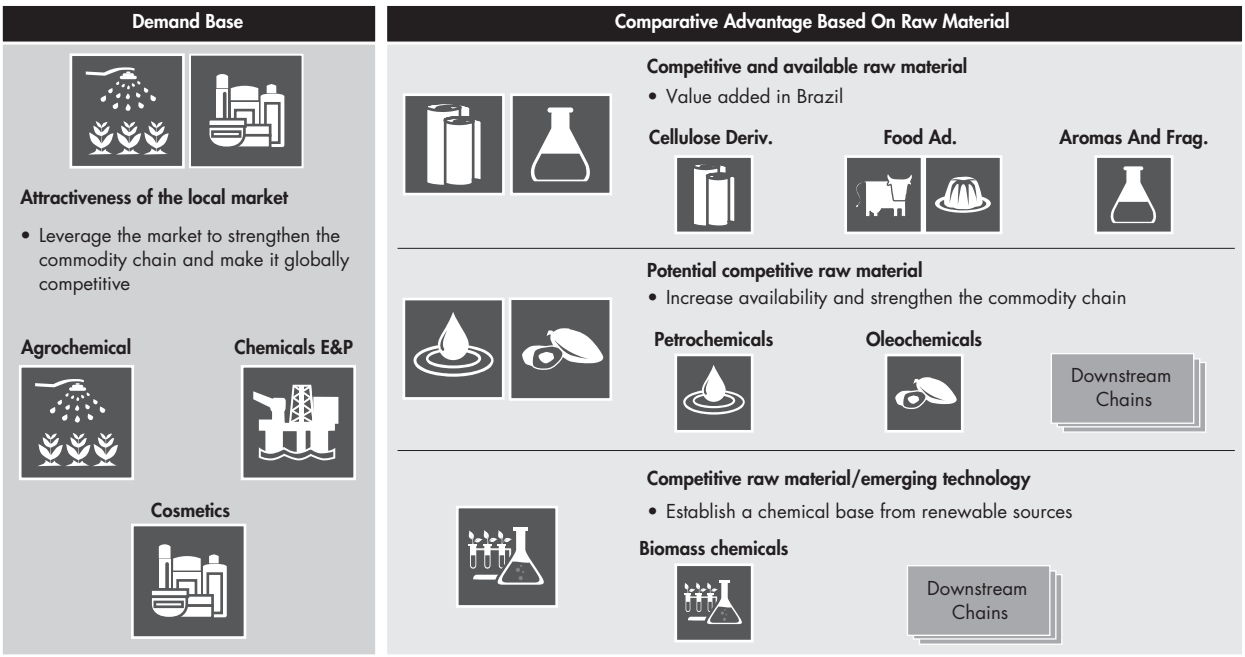
Each segment should consider the following strategic recommendations based on its competitive advantage:

- Segments in which the local market is attractive (cosmetics and personal care products, agrochemicals, food additives for animals and chemicals for E&P): Improve business regulations to take advantage of the relevance of the local market to attract new, globally competitive investments and strengthen local commodity chains.

- Segments that have competitive local raw materials (aromas, flavors and fragrances, cellulose derivatives, food additives for humans, silicon derivatives): Use the availability and competitiveness of local raw materials to add value locally through the strengthening of existing commodity chains in Brazil. Also seek to export not only raw materials but also chemical derivatives with higher value added.

- Segments with potentially competitive raw material (surfactants, butadiene and isoprene derivatives, aromatic derivatives, PU and their intermediates, lubricants, CF, specialty polyamides, high-tenacity polyester and oleochemicals): Increase the availability and competitiveness of local raw materials, encouraging new investments in production capacity in Brazil thereby reducing the trade deficit in these commodity chains and downstream segments.[14]

Figure 4: Primary focus segments



Source: Bain & Company, Gas Energy

- Segments with competitive raw materials and emerging technology (chemicals from renewable sources): Increase the competitiveness of emerging technologies that have the potential to establish a chemical base from renewable raw materials.

A summary of the description of each of the primary focus segments follows,[15] summarizing key facts, opportunities, and challenges.

8 US$162 billion (2013).

9 US$32 billion (2013).

10 Not included in the scope of the study are the segments pharmaceuticals (e.g., dipyrone), fertilizers (N—nitrogen, P—phosphorus and K—potassium) and polymers (PE, PP, PVC and PET).

11 AliceWeb (2012).

12 The segmentation was conducted according to business logic, that is, products that share costs (same chemical chain or raw material chain) or have similar applications and markets were, in principle, grouped together in one segment.

13 Exploration and production of oil and gas.

14 A petrochemical complex for the use of oil and natural gas belonging to the state: The Consortium proposes a discount of 6% to 16% in the price of oil from the state and from 4% to 14% in the price of first-generation petrochemicals, then transfer gains to downstream segments of the petrochemical sector.

15 The segments "Chemicals for Mineral Processing," "Chemicals for Leather" and "Chemicals for Concrete" were also considered as primary focus segments and, although not detailed in this report, they were analyzed during this study and have specific reports.

2. Primary focus segments—characterization, opportunities and challenges

a. Segments with attractive local markets

Cosmetics and personal care[16]

The Brazilian market, which recorded revenues of US$41.8 billion in 2012, represents approximately 10% of the global market and is the third largest in the world. Estimates predict an average annual growth of 8.9% between 2013 and 2017, which is higher than 4.8% growth predicted for the world market during the same period.

Imports of cosmetics and personal care products accounted for only 2% of the Brazilian market in 2012, of which deodorants, perfumes and make-up products were the representative items. Brazilian exports are also of little relevance to companies, with volumes totaling just 1% of the Brazilian market. Latin America accounted for 80% of Brazilian exports in 2012. The Latin American market (except Brazil) is expected to grow 5% per year until 2017.

Local production, however, does not yet take advantage of the complete raw material base available to it through local biodiversity, in which Brazil already presents competitive advantages. The current regulatory hurdles presented by law on access to biodiversity make it difficult to explore these raw materials.

In addition to the issue around access to local biodiversity, the main difficulties faced by companies with local production are: the limited availability and competitiveness of inputs such as propellant gas (used in aerosols) and certain petrochemical derivatives (e.g., plastic packaging and surfactants), and also the high complexity and value of the tax burden in the sector.[17]

Changes are needed to overcome these difficulties and attract new investments in local production. These changes include the use of a portion of the oil and gas belonging to the Federal Government, from the pre-salt reserves, to foster investments in the local production of inputs from petrochemicals; the adaptation and revision of the Regulatory Framework for Access to Genetic Resources so that the country can use its biodiversity as a competitive advantage while respecting standards of sustainability; the strengthening of small and midsize enterprises that act as outsourcers in the Toiletries, Fragrance and Cosmetics (HPPC) sector; and the simplification of the tax structure, such as the creation of a unified federal value-added tax (Federal VAT).

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Increased local production of aerosol deodorants to replace imports from Argentina, which totaled US$230 million in 2012. This would take advantage of the expected increase in natural gas prices in Argentina, resulting from the reduction of price incentives currently in place. The increasing availability of local propellant gas will also contribute to increased production of other items sold via aerosol dispensers, such as household insecticides and shaving products, whose imports totaled US$50 million and US$10 million in 2012, respectively.

- Increased exports of various categories of cosmetics, especially products for makeup, hair and skin care, to Latin America, taking advantage of the growth of the regional market and growing transactional volumes, which is estimated at US$700 million in 2017. In addition, there is opportunity to replace Argentina as the principal exporter of deodorants in the region.

Agrochemicals[18]

The Brazilian market, which registered revenues of US$9.7 billion in 2012, represents approximately 20% of the global agrochemicals market. Between 2006 and 2012, the segment experienced average annual growth of 16.1%, compared with 7.6% per year for the world market.

The agrochemical segment consists of high value-added products. In 2012, the average unit price of Brazilian imports of these products was US$11.3 per kilogram, the second highest among the segments analyzed in this study.[19]

Although it is the largest in the world, the local market is mainly supplied by imports, which accounted for 56% (US$5.4[20]) of local demand in 2012—a percentage that has been growing in recent years.[21]

The main difficulties faced by participants in this segment with local production are: gaps in the regulatory environment—the current registration process for agrochemicals in Brazil is seen as bureaucratic, slow, costly and uncertain; lack of equal tax treatment for domestic and imported products because the imported manufacturers are not supervised with the same rigor applied to domestic producers; structure of the Common External Tariff (CET) and outdated import duties, which do not take into account the principle of tax escalation and discourages value added in local production; and barriers on exports arising from the need to meet local requirements, which are not necessary in the country of destination.

To overcome these difficulties and attract additional productive investment, Brazil must improve its regulatory environment. Efforts should be concentrated mainly on improving the management of the product registration queue by prioritizing those that, if approved, would bring larger benefits for local agribusiness, such as combating new pests or reducing the price of the agrochemicals. Socioeconomic efforts could include reducing the trade deficit and benefits resulting from increased local production.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Formulation of patented products with installation or expansion of multipurpose plants, mainly in the South Central region of the country, by global participants; and product formulation by national participants for global participants: The focus should remain on the tropicalization and improvement of current formulations of families such as strobilurins and neonicotinoids or those used with sugarcane, soy, corn or cotton.

- Formulation of generic products (with expired patents) and those products with a small number of companies holding registration for local production (e.g., carbosulfan, carfentrazone-ethyl and procymidone), to promote this opportunity, it will be necessary to install multipurpose plants, with an approximate capacity of 150,000 tons per year, focused on the production of agrochemicals whose imports totaled US$720 million in 2012.

- Synthesis of generic products, requiring the installation of plants with 10,000 to 20,000 tons per year of capacity, dedicated or multipurpose, integrated into the formulation stage: They should be focused on the synthesis stage of agrochemicals for local consumption and export, preferably with patents close to expiration, such as pyraclostrobin, or agrochemicals used with crops produced on a large scale such as sugarcane, soy, corn and cotton. It is possible to replace imports totaling approximately US$2.4 billion in 2012.

Food additives for animals[22]

The Brazilian market, which registered revenues of US$1.1 billion in 2012, represents approximately 10% of the global market. Between 2009 and 2012, it had an average annual growth rate of 10.1% compared with 3.7% per year for the world market.

The country is the fourth largest exporter of lysine, accounting for 19% of world exports. Total exports for the segment represented 28% of local demand in 2012. However, Brazil still imports all of its local demand for methionine, which represents 10% of the global market.

To manufacture these products, the main raw materials required are sugar and propylene, respectively. Greater availability and a competitive price for propylene depend on the construction of a petrochemical complex. Sugar is already considered a competitive raw material in the country.

The main difficulties faced by participants in this segment with local production are low availability of raw materials such as propylene at competitive prices; high cost of investment in Brazil, approximately 40% to 50% more than in other countries such as the US; and lack of incentives for research on new chemical production routes due to a slow and bureaucratic environment for innovation.

Changes are needed to overcome these difficulties and attract new investments in local production. Changes could include use of part of the oil and gas belonging to the Federal Government, from the pre-salt reserves, to foster investments in the local production of petrochemical raw materials; tax exemptions for investments in the chemical industry; and increased investments in R&D on alternative routes for the production of methionine.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become attractive:

- Local production of methionine, via the synthetic process, as a result of the investment of approximately US$700 million in the installation of two plants: Each plant will have a capacity of 100,000 tons per year, which can have a positive impact of US$600 million per year on the trade balance in 2030. It is worth noting that:
  - Even considering the tax exemption for investments and an increase in import taxes from 2% to 14%, local production would be competitive only after a reduction in the cost of propylene.
  - There is an opportunity to invest in the research of alternative routes for the production of methionine, for example, via fermentation or from glycerin.
- Increase the local production capacity of lysine to meet the growing local demand and increase the relevance of Brazil as an exporter of this product: The need for investment is estimated at approximately US$300 million for the installation of two plants, each with a capacity of 100,000 tons per year, which can have an impact of US$350 million in 2030 on the trade balance.[23] In addition, there is an opportunity to produce threonine and tryptophan[24] through the installation of a lysine plant, with the potential to export and supply the domestic market.

Chemicals for E&P[25]

The Brazilian market, which recorded revenues of US$712 million in 2012, represents approximately 3.6% of the global market. Growth is expected to average 18% annually until 2021 compared with 8% per year for the world market.

Imports of chemicals for E&P accounted for only 12% of the local market, concentrated in drilling fluids. Exports are also small and account for 1.3% of the local market.

The expected growth in local demand is mainly due to the intensification of offshore oil well drilling, particularly in the pre-salt reserves, in which drilling fluids represented 70% of the local demand for chemicals for E&P in financial value in 2011.

Based on regulatory trends in Brazil, E&P players will be required to continuously reduce the environmental impacts of oil exploration. The development of environmental requirements will reduce the use of oil-based drilling fluids (obtained through petroleum distillation) and thereby increase the share of natural and synthetic-based fluids.

In the case of synthetic-based fluids (polyalphaolefins [PAO], linear alpha olefins [LAO], internal olefins [IO], esters), Brazil does not have a surplus of raw materials from the conventional route, which uses n-paraffins derived from petrochemicals, either ethylene or natural gas. Investments in local production of PAO via this route would depend on importing LAO. There is also the oleochemical route, for both esters and olefins, in which the wide availability of soy, the main raw material, and the potential for expansion of palm and palm kernel plantation stand out. However, the technical feasibility of using esters in fluids is still being studied.

The main difficulties faced by participants in this segment in starting the local production of PAO, LAO and IO are: the limited availability of ethylene, a raw material in the production of LAO via the conventional route, at competitive prices; the high cost of investment in local production via the oleochemical route; and the pricing of vegetable oils as food, not as fuel, which raises the price of the natural raw material.

To overcome these difficulties and attract new investments in local production, changes are necessary, such as: changes in the policy on natural gas use, which include regulating the fractionation of ethane contained in natural gas processed in natural gas processing units (NGPUs) and the consequent increase in the availability of ethylene; tax exemptions for investments in the chemical industry to encourage local production via the oleochemical route; and incentives for R&D in the oleochemical route through financing, such as the proposal to create a chemical innovation.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Local production of PAO, via the conventional route, using imported LAO, through the construction of a plant with 30,000 tons per year of production capacity, located in São Paulo or Rio de Janeiro: The local market for drilling fluids was US$200 million to US$300 million[26] in 2011.

- Local production of PAO via the oleochemical route using soy, palm or palm kernel as raw materials: However, there is the need for both investment in research and tax exemption for investments so the cost of the final product is competitive with products that are created the conventional way.

b. Segments with competitive and available raw material

Aromas, flavors and fragrances[27]

The Brazilian market, which recorded revenues of US$1.2 billion in 2012, represents approximately 5% of the global market. It is estimated that the market will grow at an average of 6.7% annually between 2012 and 2017, higher than the growth in the world market, 5.2% per year, predicted for the same period.

The segment aromas, flavors and fragrances is made up of high value-added products when compared with other segments and had an average import price of US$5.2 per kilo in 2012.[28] It can be noted that imports include products with higher value added (US$18.5 per kilo) compared with exports (US$4.1 per kilo).[29]

Given the profile of exports in this segment, there are opportunities to develop production of value-added aromas, flavors and fragrances based on raw materials in which the country has a competitive advantage, such as orange, [30] clove, lemon and eucalyptus oil. There is also potential to replace imports of aromas, flavors and fragrances through the strengthening of the fine chemicals industry, which depends on public policies aimed at increasing the competitiveness of petrochemical-based raw materials,[31] or by developing alternative production routes to replace imported synthetic raw materials with inputs derived from the local biodiversity.

The main difficulties faced by companies in this sector with local production are difficulty in accessing local biodiversity due to existing regulatory restrictions; lack of incentives for R&D on alternative production routes; and imposition of regulations on the shelf life of products, currently classified as food.

Changes are necessary to overcome these difficulties and attract new investments in local production, including updating the Regulatory Framework for Access to Genetic Resources so that local biodiversity can serve as a source of competitive advantage while respecting standards of sustainability; and fostering R&D of alternative production routes to replace imported synthetic raw materials.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Local production of orange derivatives, which have high value added, with the aim of exporting them: The possibility exists to increase the export value of these products, which totaled US$216 million in 2012, from US$3 to US$4 per kilo (essential oils and terpenes derived from orange) to US$28 per kilo, based on the production of orange aromas.

- Local production of other essential oils, such as clove, lemon and eucalyptus oil with higher value added, whose average export prices are US$27, US$24, and US$23 per kilo, respectively: Based on this, it could also be possible to increase the value of exports of essential oils, which totaled US$129 million in 2012.

- Local manufacturing of products based on renewable sources that can replace products with synthetic origins, currently being imported by the country, for example: menthol (from the eucalyptus essential oil) and vanillin (from ferulic acid). Imports of these products totaled US$40 million in 2012. It should be noted that the vanillin from renewable sources would have greater value added in relation to that produced via the synthetic route.

Cellulose derivatives[32]

The Brazilian market for derivatives of soluble cellulose, which recorded revenues of US$330 million in 2012, represents approximately 1.3% of the global market. Between 2007 and 2012, it experienced average annual growth of 1.1% compared with 6.3% for the world market during the same period.

Although Brazil is the fifth largest producer of soluble cellulose, primarily short fiber, representing approximately 8% of global production capacity in 2012, and the competitiveness of Brazilian wood is high, imports of soluble cellulose derivatives accounted for 57% of the local market in 2012.

The principal derivatives of soluble cellulose are viscose, which accounts for 74% of the overall volume of the product, cellulose acetate (14%) and cellulose ethers (7%). The chemical chain of these derivatives is characterized by in-

sufficient local production, which leads to increasing volumes of imports. Imports of viscose yarn totaled 104,000 tons in 2012, while imports of acetate grains totaled 15,000 tons and imports of ethers totaled 32,000 tons.[33]

The main difficulties faced by local producers operating in the segment are the high investment costs; the lack of competitiveness compared with international producers who are already established and have clear competitive advantages; and the need for research on new applications and adaptations in the type of soluble cellulose, as the technology used by some international participants is not adapted to Brazilian soluble cellulose, which is short fiber.

To overcome these difficulties and attract new investments in local production, changes are necessary, such as tax exemption on investments in the chemical industry and, especially, the adoption of measures to reduce the cost of electricity and labor; create changes in the process of modifications in the CET on import duties for products and, in the case of beginning regional production, encouraging them; and investments in R&D to adapt the production technology used for cellulose ethers for use with soluble short-fiber cellulose.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Local production of viscose fibers integrated with the production of soluble cellulose: This integration could add value to soluble cellulose, as the fiber is 2.5 times the value of cellulose. This would reduce imports, which reached 104,000 tons of cellulose yarn per year and contributed to a deficit of US$375 million[34] in 2012.

- Construction of a plant with global scale for the production of cellulose acetate grains: The investment required for a plant with a capacity of 60,000 tons per year is estimated at US$600 million. This initiative could contribute with a positive impact of US$136 million on the trade balance.

- Diversification of the cellulose ether participant, who has a single carboxymethyl cellulose (CMC) plant, to enable them to produce other ethers while attracting global participants to produce other ethers in the country: These initiatives have the potential to reduce the deficit of US$144 million recorded in 2012.

Food additives for humans[35]

The Brazilian market for food additives for humans recorded sales of US$650 million in 2012, representing approximately 3% of the global market, and saw average annual growth of 4.1% between 2007 and 2012 compared with 3.8 % per year for the world market during the same period.

Exports were US$625 million in 2012 and were concentrated in the following products: gelatin (US$275 million) and glutamic acid (US$182 million), of which Brazil is the first and third largest exporter, respectively. Imports totaled US$367 million in 2012, distributed across various subsegments. It is worth noting that albumin imports tripled between 2008 and 2012, coming to represent approximately 10% of the imports in this segment.

The main difficulties faced by companies operating in this segment that have local production are: the high investment costs, exacerbated by the taxes imposed; the excessive bureaucracy to obtain tax credits when exporting processed products with higher value added; and the lack of incentives for, first, the R&D of new raw materials for the production of gelatin, to avoid the risks associated with the decrease in local availability of the remains of animal skins obtained from tanning operations after the separation of the leather; and, second, the search for solutions to increase the volume, currently insufficient, of whey, the main raw material in albumin.

To overcome these difficulties and strengthen Brazil's position as one of the largest exporters of gelatin and glu-

tamic acid, changes such as the following are necessary: Tax exemptions on investments in the chemical industry; improvements in the drawback system, resulting in incentives, not only for exports but also for adding value locally to exported products;[36] promotion of research on alternative routes for the production of gelatin, such as those that use animal bones as inputs; and research on operational and technological alternatives to supply whey, for example, by organizing cooperatives and producing whey concentrates.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Expansion of gelatin production capacity by 2030 for the country to maintain its share of global production (15% of total global exports in 2012): The investment required is estimated at US$700 million. The impact on the trade balance expected in 2030 would be approximately US$350 million.

- Expansion of glutamic acid production capacity by 2030 for the country to maintain its share in global production (16% total global exports in 2012): The investment required is estimated at US$150 million, equivalent to 180,000 tons of annual capacity. The impact on the trade balance expected in 2030 would be approximately US$250 million.

- Local production of albumin, encouraged through the formation of cooperatives or producing whey concentrates, to make its use in the local dairy industry economically viable: The potential exists for replacing albumin imports, which totaled US$34 million in 2012.

Silicon derivatives[37]

The Brazilian market recorded revenues of US$420 million in 2012, representing approximately 3% of the global market. Between 2007 and 2012, it had an average annual growth rate of 5.2%, compared with 3.7% for the world market during the same period.

Imports in the silicon production chain were equal to 20,000 tons in 2012 or US$93 million.[38] In the siloxane production chain, which is not manufactured locally, imports in 2012 totaled 22,000 tons or US$69 million. However, in the silicon metal production chain, Brazil exports 85% of its production with the remaining 15% used in the local market for metal alloys.

The absence of local siloxane production is due to low demand in Brazil, which corresponded to 34,000 tons in 2012, while new world-scale siloxane plants have production capacities between 100,000 and 200,000 tons per year. In addition, there is a competitive disadvantage for local production destined for export due to the low availability of methanol, one of the main raw materials, and the high costs of investment in constructing a local siloxane plant.

Considering the silicone[39] production, the main difficulties faced by local producers are the insufficient local demand related to the low density of the local manufacturing industry; the lack of incentives for local demand in applications where silicone consumption would offer greater economic and societal benefits; and the absence of competitive advantages for local production destined for export, due to the fact that the main raw material, siloxane, is not produced locally.

To overcome these difficulties and attract new investments in local production, the following changes are necessary: new regulations to encourage demand, such as mandating the use of non-halogenated flame retardants in polymers to reduce the risk of poisoning during fires; use of the potential surplus in the inflexible supply of dry

natural gas for the local production of chemicals based on methane; and tax exemption on investments in the chemical industry.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Expansion of local production capacity of silicone by 50,000 tons per year until 2027, which could contribute a positive net impact of US$226 million on the trade balance in 2027: This impact would allow a reduction of the trade deficit, which would go from US$428 million in 2012 to US$202 million in 2027.

- Local production of siloxane through the installation of a plant with a production capacity of 100,000 tons per year: It is worth mentioning that, due to insufficient demand, it would be necessary to export surplus production. As a result, the tax exemption on investment is essential to ensure the competitiveness of local production.[40] This investment would have a positive impact of US$154 million on the trade balance in 2027 and would represent a reduction of the deficit from the US$202 million quoted in the previous opportunity to US$48 million.

c. Segments with potential competitive raw material

Surfactants[41]

The Brazilian market recorded sales of US$1.54 billion in 2012, accounting for approximately 5.7% of the global market. An average annual growth rate of 5.3% is projected between 2012 and 2018, higher than the 4.2% annual growth rate predicted for world market growth during the same period.

Imports of surfactants accounted for 20% of revenues in the Brazilian market in 2012. These imports were concentrated in nonionic and anionic surfactants, which represent 56% and 22% of total imports, respectively. Brazilian exports, although corresponding to only 12% of the local market in 2012, showed a steep growth rate of 16% per year between 2008 and 2012.

The local market demonstrates a low sophistication of demand. One reason is its concentration in anionic surfactants, cheaper substitutes for nonionic surfactants in many applications.

Even so, the main imported products are nonionic surfactants. It is noteworthy that the raw materials (mainly ethylene, a raw material for the production of ethylene oxide, in turn, the main raw material of non-ionic surfactants) of these products are not found in Brazil at competitive prices.

In the case of cationic and amphoteric surfactants, there are also barriers to the supply of fatty acids and alcohols, raw materials that have a high volume of imports. This fact is explained mainly by the low availability of palm and palm kernel oil locally.

The main difficulties faced by local producers are low competitiveness of important raw materials, mainly due to the low local availability of ethylene; lack of incentives in R&D on surfactants produced from natural raw materials in which Brazil is already competitive (soy and sugarcane); and informality in the cleaning products market, as informal products use lower quantities of surfactants and use lower value-added surfactant formulations.

Overcoming these difficulties and attracting new investment in local production will require certain actions, such as changes in the natural gas use policy, which include regulating the fractionation of the ethane contained in

natural gas processed in NGPU and the use of a portion of the oil and gas belonging to the Federal Government, from the pre-salt reserves, to foster investment in the local production of petrochemical raw materials; and greater formalization of the cleaning product manufacturers.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Installation of a MES (anionic surfactant) plant with a production capacity of 50,000 tons per year and integrated with the supply of raw materials based on vegetable oils rich in C16 carbon chains: A critical success factor in the installation of a MES plant would be a prior association with major customers in the household cleaning products market. This initiative would contribute to the substitution of imports, which in 2012 equaled approximately US$110 million.

- Production of ethylene oxide based on alcohol ethylene with the installation of a plant that makes use of bioethene, focused on the production of ethoxylates that would be consumed in end products with higher value added.

Butadiene and isoprene derivatives[42]

The Brazilian market, which recorded revenues of US$1.95 billion in 2012,[43] represents approximately 5.7% of the global market. Estimates predict an average annual growth rate[44] of 4% between 2012 and 2030, higher than the global growth rate of 3% projected for the same period.

Net imports of butadiene and isoprene derivatives accounted for 14% of local demand or 65,000 tons in 2012 and were concentrated in butadiene rubber (BR), which represented 75% of total imports. Exports are concentrated in styrene-butadiene rubber (SBR), which accounted for approximately 66% of all exports. This volume is due to excess capacity in the production of eSBR.[45]

Although Brazil is an exporter of butadiene and isoprene, it imports some of the final products, thus missing the opportunity to add value locally. As a result, the trade balance for the most relevant products in the butadiene and isoprene derivatives segment showed a deficit of approximately US$231 million in 2012.

With the expected growth of the local market, the trade deficit for the segment could reach approximately US$900 million in 2030 if investments are not made in local production capacity.

Participants that have local production within this segment face three main difficulties: the lack of readily available petrochemical raw materials at competitive costs; lack of the long-term supply security necessary to enable investments; and the lack of incentives for the use of locally produced tires despite the anti-dumping measures adopted in 2013.

To overcome these difficulties and attract new investment in local production, changes are needed, such as using a portion of the oil and gas belonging to the Federal Government from the pre-salt reserves to foster investment in the production of petrochemical raw materials locally, encouraging the adoption of "green tires" through the Inovar-Auto program and other measures to increase the consumption of locally produced products.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Installation of new sSBR[46] and eSBR plants in Brazil has the potential to replace the importation of 145,000 tons and 73,000 tons,[47] respectively, by 2030.

- Expansion of local production capacity of BR from 49,000 tons in 2012 to 153,000 tons in 2030 to meet the estimated increase of net imports.[48]

- Expansion of local production capacity of isoprene rubber (IR) from 10,000 tons in 2012 to 21,000 tons in 2030 to meet the estimated increase of net imports.

Aromatic derivatives[49]

The Brazilian market, which recorded revenues of US$2.5 billion in 2012,[50] represents approximately 1.6% of the global market. Estimates predict an average annual growth rate of 5%[51] between 2012 and 2030, higher than the growth of global consumption, projected at 4% per year during the same period.

Imports of aromatic derivatives accounted for 47% of the Brazilian market or US$1.2 billion in 2012 and were concentrated in styrene products and purified terephthalic acid (PTA). It is estimated that with the increase in local demand,[52] this deficit will reach US$1.6 billion in 2030.

Brazil imports final and intermediate products, such as styrene and PTA, and exports commodities. Adding value through local production can therefore help to replace imports of these intermediate and final products.

The main difficulty faced by local manufacturers is the low availability of petrochemical raw materials at competitive costs and with long-term supply security.

To overcome this difficulty and attract new investments in local production, a portion of the oil and gas belonging to the Federal Government, from the pre-salt reserves, should be used to foster investment in the production of petrochemical raw materials locally.

If this initiative were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Expansion of local production of expandable polystyrene (EPS), given the increase in estimated net imports from 36,000 tons in 2012 to 130,000 tons in 2030: Possible changes in regulations could increase local demand even further.

- Expansion of local production of styrene, given the increase in estimated imports from 199,000 tons in 2012 to between 416 and 664,000[53] tons in 2030

- Installation of a global-scale PTA plant if there is the expansion of polyethylene terephthalate (PET) production: In this scenario, estimates show an increase of PTA imports from 457,000 tons in 2012 to 1.047 million tons in 2030.

- If the Styrolution-Braskem ABS plant is built,[54] after 2015, the construction of second plant can be considered: The growing demand for ABS could increase imports from 79,000 tons per year in 2012 to 93,000 tons per year in 2030.

There is no opportunity for investment in a new polystyrene (PS) plant until 2030 because there is already surplus production. As such, the growth in local demand for PS combined with the increase in imports of 60,000 to 70,000 tons per year in 2030 only justifies the expansion of existing plants.

Polyurethanes and their intermediary products[55]

The Brazilian market, which recorded revenues of US$1.5 billion in 2012, represents approximately 3.5% of the global market. Estimates predict an average annual growth rate of 6%[56] between 2012 and 2016, higher than the growth in global demand of 4.8% per year projected for the same period.

Net imports of PU and their intermediates accounted for 63% of local demand or US$862 million in 2012. It should be mentioned that the Brazilian trade deficit increased by 64% between 2008 and 2013 as a result of three factors: stagnation of local production capacity of methylene bisphenyl diisocyanate (MDI) and polyether polyol; disablement of the local production capacity of toluene diisocyanate (TDI); and an increase of 25% in local demand[57] for these products during the same period.

The addressable market for PU and their intermediates tends to be smaller than the total local market because of the production capacity already installed and the trade flows between local subsidiaries and their headquarters.

The main difficulties faced by local producers are lack of readily available petrochemical raw materials at competitive cost and with long-term supply security; high investment costs, exacerbated by the taxes imposed; and lack of export incentives that could enable the construction of plants with capacity greater than local consumption.

To overcome these difficulties and attract new investments in local production, changes such as the following are necessary: use of a portion of the oil and gas belonging to the Federal Government, from the pre-salt reserves, to facilitate investment in the production of petrochemical raw materials locally; tax exemption for investments in the chemical industry; protection of the internal market through anti-dumping measures and improvements in the process to create a CET as a temporary support for the industry until structuring actions are implemented; and improvement in the drawback system, resulting in incentives for not only exporting but also adding value to exported products.[58]

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:[59]

- Expansion of the local polyether polyols plant to 225,000 tons per year in the short term: And in 2030, construction of an additional plant with a capacity of 225,000 tons per year. These initiatives can have a positive impact of US$960 million on the trade balance in 2030, also taking into account investments in the production of polyester polyols to accompany the increase in local demand.

- Construction of a TDI plant with a production capacity of 150,000 tons per year with further expansion to 200,000 tons per year in 2030: It is estimated that an investment of US$600 million can have a positive impact of US$550 million on the trade balance in 2030.

- Construction of a midsize MDI plant with production capacity of 250,000 tons per year, taking into account the export of surplus production: The necessary investment is estimated to be approximately US$1.0 billion, and could have a positive impact of US$425 million on the trade balance in 2030.

Lubricants[60]

The Brazilian market, which recorded revenues of US$4.5 billion in 2012,[61] represents approximately 3.5% of the global market. Estimates show an average annual growth rate of 2.8%[62] between 2012 and 2016, higher than the growth in world demand, projected at 2.3% per year for the same period.

Net imports of lubricants accounted for approximately 22% of local demand or approximately US$1 billion in 2012. It is important to note that there was a 30% increase in imports between 2008 and 2012. And in 2012, 60% of the trade deficit for this segment came from imports of base oils, while finished lubricants and additives accounted for 23% and 17% of imports, respectively.

The base oils with the highest consumption in Brazil are those from Groups I, II and III derived from refining. There are no plans for the expansion or construction of new refining units and the opportunities identified focus on synthetic oils from Groups IV and V (PAO and esters) and expansion of re-refining operations.

The main difficulties faced by participants in this segment who have local production are lack of stricter regulations on the use of lubricants in some industries, especially in the food industry, as many factories do not follow the international resolution to use specific food-grade lubricants; lack of security in the supply of vegetable raw materials, such as soy, used in the production of biolubricants; and lack of supervision on the disposal of lubricants, reducing the potential supply of raw materials for re-refining.

To overcome these difficulties and attract new investments in local production, changes will be needed both in the regulatory environment and the supply of raw materials. Efforts to supply vegetable raw materials and the integration of derived products suggest the creation of an oleochemical complex.[63]

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Development of the production of biolubricants (Group V, renewable route) to take advantage of the country's competitive advantage in vegetable raw materials.

- Re-refining to increase the use of used or contaminated oil (UCO) through more efficient technologies: Operating at full potential, that is taking advantage of 100% of the available UCO volumes and employing technologies with 80% efficiency, the production of base oils via re-refining can double in Brazil. This could create a positive impact of US$285 million on the trade balance from 2012.

- The production of group IV (PAO) lubricants could take place in association with the production of PAO for drilling fluids,[64] and could supply a niche for the high value-added lubricant market (approximately 1% of Brazilian demand for lubricants).

- Construction of a petrochemical complex for the supply of raw materials: This would lead to the inclusion of units for the production of Groups I and II base oils, taking advantage of the potential availability of paraffinic oil from the pre-salt reserves.

The production of base lubricants through the Gas to Liquids (GTL) process was analyzed but was disregarded because of the high-cost investments and risks involved.

Carbon fiber[65]

The Brazilian market for carbon fiber (CF), which recorded revenues of approximately US$100 million in 2012, represented approximately 9.4% of the global market. The market experienced an average annual growth rate of 107.4% between 2007 and 2012, compared with 7.9% per year for the world market during the same period.

The increase in the size of wind turbine blades led to an increase in the use of CF and consequently a growth in demand. Although Brazil is a leading exporter of wind turbine blades—producing 20% of the blades installed

worldwide in 2013—the country has no local CF production. The Brazilian demand for CF is met entirely through imports.

With the expectation of growth in local demand, the trade deficit caused by the lack of CF could reach US$290 million per year in 2020.

The CF segment consists of high value-added products and has the highest average import unit price among the segments analyzed in this study (US$24.4 per kg in 2012). CF is often used in products that require high performance. For this reason, consumers tend not to accept manufacturing defects and variations in product specifications.

As such, CF manufacturing presents technological challenges. Currently, the production route via polyacrylonitrile (PAN) accounts for 97% of world production of CF. Routes via tar and rayon produce CF of lower quality than that produced via PAN. Despite producing large surpluses of acrylonitrile, a raw material for the PAN precursor, Brazil does not have the technology required to transform it into CF.

There are other difficulties participants in this segment face in starting local production, such as the current import tax charged on the PAN precursor—even though there is no national production of this product—which increases the local cost of CF production; the high investment costs, exacerbated by the taxes imposed; and the excessive bureaucracy to claim tax exemption on raw materials when there is export of the final product only after the second process, such as with the import of PAN precursor and the export of wind turbine blades.

To overcome these difficulties and attract investment in local production, the following changes are necessary: reduction in the import tax on PAN precursor, which requires a review of the list of NCMs that do not have local production;[66] tax exemption on investments in the chemical industry; and improvements in the drawback system to reduce bureaucracy around the intermediate drawback, which would allow for the reduction of taxes on PAN precursor when exporting the final product.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:[67]

- Construction of a plant for the local production of CF with a capacity of 9,000 to 16,000 tons per year,[68] initially using imported PAN precursor: The opportunity depends on forming a partnership with a traditional participant in the CF segment due to the difficultly in accessing PAN precursor. The Bain-Gas Energy Consortium estimated that this investment could have a positive impact of US$78 million to US$136 million on the trade balance in 2020.

- As a second step, the use of the acrylonitrile surplus can be considered to start the local production of PAN precursor: In this case, an additional positive impact of an estimated US$32 million to US$56 million per year on the trade balance in 2020.

Special polyamides[69]

The Brazilian market, which recorded revenues of US$1.3 billion in 2012,[70] represents approximately 1.7% of the global market. Despite the negative average annual growth registered between 2007 and 2012 (-5.7%), estimates project an increase of 2.4% per year in local demand[71] between 2012 and 2030.

Imports of specialty polyamides accounted for 32% of local demand or 128,000 tons in 2012. Estimates show a trade deficit of approximately US$436 million in 2012 in the segment, which could rise to US$684 million by 2030.

However, the local production of products depends on solutions to redirect excess production capacity, as the local demand for primary and secondary intermediary products is insufficient to justify the installation of a plant with global scale.

The main difficulties faced by participants in this segment who have local production are the lack of incentives for demand for finished products produced locally, such as lighter vehicles; the low competitiveness of Brazilian production (use rates of polymers plants in the country are approximately 50%) as well as the tax rate applied on the importation of caprolactam, currently 12%, even though there is no national production of this product; and the lack of readily available petrochemical raw materials at a competitive cost and with the long-term supply security necessary to enable investments.

To overcome these difficulties and attract new investments in local production, the following changes are necessary: programs that encourage the energy efficiency of cars and increase the demand for specialty polyamides; reduction of the import tax on caprolactam from 12% to 2%, requiring a review of the list of NCMs that do not have local production;[72] and use of a portion of the oil and gas belonging to the Federal Government, from the pre-salt reserves, to foster investment in the production of petrochemical raw materials locally.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Expansion of the production of finished products, which can have a positive impact of US$105 million on the trade balance in 2030.
- Construction of a global-scale polymer plant with polyamide 6 (P6) technology, to improve the local cost position. This initiative is capable of contributing an additional US$80 million to the trade balance.

High-tenacity polyester[73]

The Brazilian market, which recorded revenues of US$130 million in 2012,[74] represents approximately 2.1% of the global market. Although there was an increase in local demand[75] of 6% per year between 2000 and 2013, domestic production decreased at an average annual rate of 9% per year.

Imports of high-tenacity polyesters—36,000 tons in 2013—accounted for 83% of local demand. If there is no increase in Brazilian production capacity, imports of high-tenacity polyethylene terephthalate (PET) filaments can reach 75,000 tons per year in 2030, equivalent to a deficit of US$146 million.

As industrial polymer plants are usually shared with PET "commodity" plants, the economic scale of this type of plant is approximately 120,000 tons per year. As Brazilian imports of industrial polymers—even considering all of the production of fibers in the country—would be only 75,000 tons in 2030, the demand for industrial filaments alone would not justify the installation of a polymer plant with an economically viable scale.[76]

The main difficulty faced by participants in this segment who have local production, in addition to insufficient local demand to justify local production, is the lack of readily available petrochemical raw materials at competitive costs and with the long-term supply security necessary to enable investments.

To overcome this difficulty and to attract new investments in local production, it is necessary to increase the competitiveness of petrochemical raw materials. Efforts should be concentrated on using a portion of the oil and gas belonging to the Federal Government, from the pre-salt reserves, to foster investment in the production of petrochemical raw materials locally.

If this initiative were implemented, the Consortium believes that the following local investment opportunity would become even more attractive:

- Expansion of the domestic production of high-tenacity PET fibers from imported industrial polymer: There is sufficient local production potential to meet all domestic demand. This initiative can have a positive impact of US$52 million per year on the trade balance in 2030 and a consequent reduction of the annual trade deficit for the segment to US$94 million.

Oleochemicals[77]

The Brazilian market, which recorded revenues of US$660 million in 2012, represents approximately 3% of the global market. Between 2007 and 2012, it saw an average annual growth of 23.2%[78] compared with 8.1% per year in the world market.

In 2012, the subsegments that had the largest effects on the Brazilian trade balance were fatty acids and alcohols, which had trade deficits of US$56 million and US$29 million, respectively, as well as glycerin, which registered a surplus of US$33 million.

The segment has a high potential in certain oleaginous raw materials of plant and animal origin, such as soy, glycerin and beef tallow, in which Brazil presents competitive costs. Although the country currently imports palm and palm kernel oil as well as ricinoleic oil, there is an opportunity to develop the local production of these raw materials (palm and castor-oil plants).

The Federal Government of Pará has 12.3 million hectares that offer ideal conditions for planting palm. By comparison, Malaysia and Indonesia, the world's largest producers of palm, together use 8.5 million hectares for cultivating the crop.

There is also an opportunity to expand the local cultivation of castor-oil plants, the oilseed with the highest concentration of ricinoleic acid. Although Brazil has been a world leader in the production of castor oil, the local cultivation has declined sharply due to low productivity. Currently, there is an opportunity to expand the cultivation of the castor-oil plants in Bahia, but it depends on investments in irrigation, mechanization of production and genetic improvements to increase crop productivity.

Participants in this segment that have local production face other difficulties, such as poor logistics infrastructure, which hinders the commercialization of palm and palm kernel oil produced locally (Pará); high investment costs exacerbated by the taxes imposed; and lack of incentives for the export of chemical products.

To overcome these difficulties and attract new investments in local production requires changes, such as improvement in the condition and operation of ports and ease of the chartering of ships for use in coastal waters, reducing the impact of logistics costs in the total cost of the products; tax exemption on investments in the chemical industry, which could encourage investments in the creation of an oleochemical complex; improvements in the drawback system and the return of Reintegra with competitive import fees to encourage exports.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Strengthening of palm production in Pará through the regularization of land titles: There is an opportunity to construct a plant for the production of alcohols and fatty acids derived from palm and palm kernel plants, with a capacity of 50,000 tons per year, expandable to 100,000 tons per year.

- Construction of an oleochemical complex in São Paulo, structured in three blocks, each intended for a raw material—tallow, soy and sugarcane[79]—through the installation of a global-scale plant for production of fatty acids based on tallow integrated with the oleochemical complex, and installation of a plant for production of biolubricants from soy.

- Expansion of castor beans and castor oil (ricinoleic oil) production, especially in Bahia.

d. Segments with competitive raw materials and emerging technology

Chemicals from renewable sources[80]

Industry experts[81] estimate that in 2020, the Brazilian market for chemicals produced from renewable sources could represent as much as 10% of the local chemical industry; accomplishing this, however, will require investments of approximately US$20 billion. Though the industry is still developing, it is very dynamic and complex, with many innovations occurring in products, processes and business models. For the country to reach its full potential, it needs to invest in the development of technologies, especially those related to the treatment of biomass and its conversion into chemicals.

Brazil offers advantages in the availability and competitiveness of various renewable raw materials, which can be segmented into two chains: carbohydrates, and natural oils and fats. In the carbohydrate chain, Brazil accounts for 30% of the world's production of sugarcane and 40% of the world's two major agro-industrial residues: sugarcane bagasse and sugarcane straw. In the natural oils and fats chain, the country stands out for its production of soybean oil, with an 18% share of global output.[82]

The main difficulties faced by participants in this segment in Brazil are low amount of resources made available through public bids in relation to the potential of this industry in the country; excessive bureaucracy imposed by biosafety legislation, which hampers research on genetically modified organisms (GMOs); and high investment costs exacerbated by the taxes imposed.

To overcome these difficulties and attract new investments in local production, the following changes are necessary: increasing incentives for R&D related to the segment of chemicals from renewable sources, with priority on the technological challenges identified in the Sectorial Technological Agenda of Renewable Chemicals; modifying the approval process for GMOs; and enabling tax exemption on investments in the chemical industry.

If these initiatives were implemented, the Consortium believes that the following local investment opportunities would become even more attractive:

- Installation of biorefinery facilities that use biomass, sugarcane straw and sugarcane bagasse as inputs in the vicinity of sugar and alcohol plants. There are two investment opportunities:

  – A location with existing sugarcane infrastructure: The investment required for the installation of an n-butanol chemical plant with capacity of 100,000 tons per year, for example, is R$1.42 billion. It is estimated that this investment can generate a positive impact of US$240 million per year on the trade balance.

  – A greenfield project in an agricultural frontier region: The total investment needed for basic infrastructure, agriculture and a chemical plant is R$3.9 billion. It is estimated that this initiative will generate a positive impact of US$800 million per year on the trade balance.

- Biochemical production taking advantage of the existing structure of the oil chain:
  - Enable integrated production of biochemicals from glycerin, such as epichlorohydrin and propylene glycol, to take advantage of the high volumes of production of this raw material in Brazil.
  - Encourage research on the use of soy as a raw material for chemicals.
  - Encourage the incorporation of external emerging technologies, such as olefin metathesis and research on new technologies and products based on palm and palm kernel oil.

16 Report 4—Cosmetics and Personal Care.

17 This segment already has one of the highest tax burdens in the economy, and there is a threat of increased taxes.

18 Report 3—Agrochemicals.

19 Trailing only the carbon fiber segment, which had an average import price of US$24.4 per kilo in 2012.

20 40% of imports of the primary focus segments.

21 Imports of formulated products grew 17% per year between 2008 and 2012, and technical products, 7%, of which 85% are not patented.

22 Report 4—Food Additives.

23 New investments in this area are already underway, such as that of Evonik in a lysine plant with a capacity of 100,000 tons per year.

24 The internal market for these products was 21 tons and 3.4 tons in 2012, respectively.

25 Report 3—Chemicals for E&P.

26 Equivalent to approximately 50% to 60% of the local market for drilling fluids.

27 Report 4—Aromas, Flavors and Fragrances.

28 The fourth highest among the segments analyzed in this study; close to the cosmetics segment (US$5.4 per kilogram).

29 These exports were equal to US$310 million in 2012 and were concentrated in essential oils of orange (40%) and citric terpene (20%).

30 Brazil is the world's largest grower/producer of oranges.

31 As was discussed in the proposal in Report 6—Petrochemical Raw Materials.

32 Report 4—Cellulose Derivatives.

33 Of which 16,000 tons are CMC and 16,000 tons are other ethers.

34 Viscose yarn is not considered in the calculation of revenue from cellulose derivatives because it is a Mercosur Common Nomenclature (NCM) of the textile industry.

35 Report 4—Food Additives.

36 The improvement of the drawback system would encourage the export of treated leather to avoid the de-industrialization of local tanneries.

37 Report 4—Silicon Derivatives.

38 In 2022, imports are estimated to be 37,000 tons if there is not an increase in local production capacity.

39 Synthetic polymer made up of silicon, oxygen and other elements.

40 Report 6—Economic and Financial Models—Siloxane.

41 Report 4—Surfactants.

42 Report 4—Butadiene and Isoprene Derivatives.

43 Corresponding to the consumption of 486,000 tons per year.

44 Average annual growth in volume.

45 eSBR is styrene-butadiene rubber produced by the emulsion polymerization process.

46 sSBR is styrene-butadiene rubber produced by the polymerization process in solution.

47 Lanxess announced that it will modernize the Triunfo plant (RS) and switch the plant from emulsion technology (eSBR) to solution technology (sSBR), which should help to reduce the lack of SBR.

48 Synthos announced a contract with Braskem for the supply of butadiene to the new BR plant. In the future, this plant could meet the full demand of the market for BR.

49 Report 4—Aromatic Derivatives.

50 Local production of 1.732 million tons in 2012.

51 Average annual growth in volume.

52 Driven by the principal consuming sectors, appliances and electronics, PS and EPS packaging, civil construction and automotive.

53 Depends on the production scenario for its derivatives.

54 Joint venture between Braskem and Styrolution, able to meet 80% of ABS demand by 2017.

55 Report 4—Polyurethanes and their intermediates.

56 Average annual growth in volume.

57 Motivated by the growth in construction, automotive and furniture industries as well as greater penetration of PU.

58 In addition, the maintenance of Reintegra constitutes a mechanism for encouraging exports that helps mitigate difficulties in recovering taxes on the value added in the chemical commodity chains.

59 Opportunities and impacts in the trade balance consider the availability of local petrochemical raw materials.

60 Report 3—Lubricating Oils.

61 Corresponding to a consumption of 1.6 million tons per year.

62 Average annual growth in volume.

63 Detail in the Report 3—Oleochemicals.

64 Report 3—Chemicals for E&P and Report 6—Polyalphaolefin (PAO) Business Model.

65 Report 4—Carbon Fiber.

66 Given the absence of local production, the import tax can be reduced to 2%.

67 Opportunities and impacts on trade balance consider the local availability petrochemical raw materials.

68 With the drawback and tax exemption, the competitiveness of the local production would be close to that of the US.

69 Report 4—Specialty Polyamides.

70 Corresponding to a local consumption of 382,000 tons per year.

71 Led by the automotive and textile industries.

72 The proof of a lack of local production allows for the import tax to be reduced to 2%.

73 Report 4—High-Tenacity Polyester.

74 Corresponding to a local consumption of 42,000 tons per year.

75 Increased demand for high-tenacity filaments in general and the substitution of polyamides by polyesters in industrial applications due to their lower cost.

76 The Suape Petrochemical Complex could be an alternative to meet the national demand. However, interviews with industry experts indicate that the focus of this petrochemical complex is not in the production of industrial polymer but rather the grids used in the manufacture of packaging and textile fibers.

77 Report 3—Oleochemicals.

78 Average annual growth in volume.

79 Sugarcane-based chemicals are detailed in the Report 4—Chemicals from Renewable Sources.

80 Report 4—Chemicals from Renewable Sources.

81 Various sources, such as USDA and ABIQUIM. 81 In addition, the country has a high potential for palm cultivation in Pará, as the state has 12.3 million hectares with ideal conditions for this crop.

82 In addition, the country has a high potential for palm cultivation in Pará, as the state has 12.3 million hectares with ideal conditions for this crop.

3. Public policy proposals

The Consortium conducted the Brazilian Chemical Industry Survey[83] with the aim of mapping and analyzing the key chemical industry participants' opinions of the challenges and competitive advantages Brazil offers in the primary focus segments.

The survey results showed the competitive dimensions and challenges that Brazil faces. That input directed the study toward the mechanisms that might build the foundations for encouraging and sustaining the development of the local chemical industry in each of the segments that we analyzed in depth.

The specific challenges most frequently mentioned were local petrochemical raw materials, regulation, infrastructure, and innovation and technology. Regarding raw materials, the respondents pointed to the following as the two main barriers: the demobilization of certain links in the production chain and the lack of long-term supply security, which mainly affects the manufacture of petrochemical products. Regulation-related barriers were mainly associated with the agrochemical segment, which confirms the complicated process involved in product registration. Also, in relation to regulation, the industry participants pointed out two other important issues: the need to review the legal framework around access to local biodiversity and gaps in legislation that encourage the use of more modern and higher quality products, which can provide benefits in terms of safety, human health and the environment. Regarding infrastructure, there are opportunities for improvements in virtually all logistics channels: highways, railways, waterways and port operations. In innovation and technology, there is a need for more public-private integration and the Brazilian model to support R&D still has areas that need improvement. Participants also mentioned other systemic challenges, such as the qualification of the local labor force.

The analysis of the results of the survey and the topics covered in the reports on the segments studied by the Consortium were consolidated and prioritized into six principal challenges, which are the subject of the detail and design of the proposals. These challenges cover the following dimensions: petrochemical raw materials, regulation, sugarcane as a raw material, infrastructure, innovation and technology, and fiscal policy.

a. Petrochemical raw material[84]

The Consortium conducted a diagnosis of the current state of the Brazilian chemical industry and a benchmarking exercise with other countries. Based on this, it proposed three lines of action to increase the availability of petrochemical raw materials in the long term and reduce their costs.

Alignment with fuel policy

The fuel policy greatly influences the guarantee of the local supply of naphtha, which is essential to the viability and security of investments in first- and second-generation petrochemicals.[85]

In this scenario, two lines of action are proposed:

- Establishment of a pricing policy for gasoline consistent with the international market to balance the pivotal economic factors. This practice tends to reduce the use of naphtha produced locally for the production of gasoline, making it available for applications in the chemical industry.

- Establishment of a national policy for the supply of petrochemical raw materials that considers competitive sources of supply (local production or imports) and is integrated with the policy on fuel supply. This policy aims to ensure the supply of raw materials in the long term in line with the changes in fuel policies.

Policy on natural gas use

Brazil separates only 20%[86] of the ethane contained in consumed natural gas. One of the reasons cited is the broad specifications on the calorific value for natural gas, allowing the separation of the ethane fraction to be made solely on the basis of economic factors. As such, the greater availability of natural gas does not guarantee the greater availability of ethane for the petrochemical industry, given the competition for its energy use.

The Consortium proposes incentivizing or regulating the fractionation of the ethane contained in natural gas processed at NGPUs, thus limiting the use of ethanol as energy. The conditions necessary to make this alternative economically viable already exist in some NGPUs. The main ones are turbo expansion NGPUs with high capacity[87] and with the existence (or possibility of development) of demand for ethylene in regions close to the NGPU.

Oil and natural gas belonging to the Federal Government

With the discovery and development of the pre-salt reserves, the supply of oil and natural gas in Brazil is expected to grow by approximately 6%[88] per year until 2030. This will provide the country with a surplus of both energy and fuel.

To industrialize the oil from the pre-salt reserves, the Federal Government may use part of this production, which it owns, in a sharing arrangement in the pre-salt auctions,[89] directing it to the petrochemical industry.

Toward that end, the Consortium proposes the use of auction dynamics, which could abide by the following models or a variation of them:

- Auction of oil and natural gas belonging to the Federal Government.
- Auction of petrochemical raw materials belonging to the Federal Government.
- Auction of oil and natural gas belonging to the Federal Government with a subsequent private auction of the petrochemical raw materials.

The Bain-Gas Energy Consortium evaluated the socioeconomic elements for the proposed use of the oil and gas belonging to Federal Government based on a scenario of a new petrochemical complex built under these terms. This complex would require a discount for oil belonging to the Federal Government of US$0.5 billion to US$1.2 billion per year, with a range of values below the estimated additional revenue of US$1.0 billion to US$1.3 billion through petrochemical investments that would use the input *(see Figure 5)*. In addition, this complex would be capable of contributing a positive impact on gross domestic product (GDP) and creating 3,000 to 4,000 direct jobs.

b. Regulation[90]

Regulatory environment of agrochemicals

The results of the survey,[91] confirmed by comparisons with other countries, identify the regulatory environment as the main obstacle to strengthening the production of agrochemicals in Brazil. The country should concentrate efforts in this area to boost domestic production in the sector.

With the aim of improving regulation, the Consortium presented seven actions that should accelerate the process of registering agrochemicals in Brazil and ensuring tax equality between imported products and those manufactured locally:

- Enable notification of simple requests: Reduce bureaucracy in cases involving requests for registration that have a low impact and optimize the efforts of regulatory bodies.

Figure 5: Returns to investor, Federal Government and country in different discount scenarios

Conditions considered for a petrochemical complex

- Input load:
  - **200,000 barrels per day**
  - 330kta of ethane1
  - 360kta of propane1
- Refining and first generation
  - Refinery with PFCC3
  - Reform
  - Cracker light load
- Second generation
  - Styrenics
  - PU
  - Surfactants
  - Polyamides
  - Thermoplastics

	Estimated Direct Impact
Investment	**US$20–$25B** (Direct impact on GDP of ~ US$8–US$10B)
Trade balance	**US$5–$7B/year** from 2025
GDP (Recurring)	**US$5.5–$6.5B/year** from 2025
Tax revenues	**US$1.0–$1.3B/year** from 2025
Jobs created	**3,000 to 4,000 direct** (+ 8,000 to 9,000 indirect)
Discount on oil[2]	**US$0.5–$1.2B/year** from 2025

Notes: 1) ethane and propane inputs coming from a potential NGPU with capacity of as much as 7 million m^3 per day; 2) scenario with reduction in the import taxes on second-generation products by 50%; 3) Petroleum Fluidized Catalytic Cracking
Sources: Bain & Company; Gas Energy

- Optimize queue management: Reduce the time needed to analyze registrations that, if approved, would bring to agribusiness and the country greater socioeconomic benefits.
- Adjust the size of teams: Ensure adequate processing flow with regard to new applications for registration and reducing the size of the current queue.
- Outsource stages of the process: Increase the speed of analysis of certain technical steps.
- Implement an integrated and systematic management process: Centralize decision-making in a single body, improving communication and reducing bureaucracy.
- Simplify the registration of products destined for export: Guarantee equality between local requirements and those of the country of destination during the process of registering products for export.
- Inspect imported products: Guarantee equality in the inspection of manufacturers of imported goods and the inspection of local producers and avoid importing products with high levels of impurity.

Several of the improvement methods presented in this report to streamline the process of product registration are not new to the agrochemical industry. Moreover, a consensus among the various actors in this sector can be observed in relation to these proposals for improvement. However, one can observe the extremely slow pace at which these proposals are being implemented. It is necessary, therefore, to structure a robust governance to ensure that the methods proposed in this report are implemented effectively and efficiently.

Return on investment by improving regulation

By 2030, under a conservative scenario, a positive impact of US$3.6 billion per year in the country's GDP is expected, with a return of US$619 million in the form of taxes on income *(see Figure 6)*. Under an optimistic scenario, the impact would reach US$8.2 billion per year, with approximately US$1.4 billion in income taxes.[92]

To capture these socioeconomic benefits, it is necessary that the actions proposed in this report be implemented. One of these alternatives, which is to increase the size of the teams of the regulating agencies, would generate an additional cost to the Government of US$26 million to US$50 million per year.

The agrochemical sector also lacks a review of the CET and of import duties on the products in some of its chemical chains in a way that respects the principle of tax escalation.

Besides promoting GDP growth and government revenues, the proposed improvements, if implemented, should attract investments between US$1.7 billion and US$5.3 billion to strengthen local production. These initiatives could result in a positive impact of between US$7 billion and US$18 billion on the trade balance in 2030.

Access to biodiversity

The law on access to genetic resources[93] created the Council for Management of Genetic Heritage (CGEN), which is responsible for establishing guidelines and determining authorizations for access to biodiversity.

Figure 6: Socioeconomic impact of the proposed opportunities

Conditions considered

- Assumptions
  - Local demand in 2030: 1,340kt
  - Global demand in 2030: 6,050kt
  - 50% technician formulated
- Conservative scenario
  - Local production equals 100% of the domestic consumption of formulation and 50% of synthesis
- Optimistic scenario
  - Local production equals 30% of the world consumption of formulation and synthesis

	Conservative scenario Local production equals 100% of the domestic consumption of formulation and 50% of synthesis	Optimistic scenario Local production equals 30% of the world's consumption of formulation and synthesis
Investment	**US$1.7B** (Impact of US$0.8B in GDP)	**US$5.3B** (Impact of US$2.4B in GDP)
Trade balance	**US$7B/year** from 2030	**US$18B/year** from 2030
GDP	**US$3.6B/year** from 2030	**US$8.2B/year** from 2030
Tax revenues	**US$0.6B/year** from 2030	**US$1.4B/year** from 2030
Jobs	**4,600 directs**	**10,400 directs**
Increased cost of personnel	**US$20–26M[1]/year**	**US$38–50M[1]/year**

Note: Preliminary estimates for increased personnel, travel and so on.
Sources: Phillips McDougall; AliceWeb; Brazilian Institute of Geography and Statistics (IBGE); Bain & Company; Gas Energy

The bureaucracy imposed by the current regulation stipulates concession deadlines that are incompatible with the time horizon of research projects.[94] In many cases, the slow progress, lack of clarity and limits, and excessive complexity make it impossible to carry out the research with full adherence to legal requirements and, often, companies assume risks such as fines, penalties and lawsuits.

In a position paper developed by a coalition of industry organizations[95] led by the Brazilian Chemical Industry Association (ABIQUIM), companies listed the improvements they consider to be necessary:

- Establishment of a limit for the monetary dispensation of benefits, in terms of annual net revenue obtained by the manufacturer through the finished product, resulting from its access.
- In cases of non-monetary dispensation, an agreement between the benefited party and the party interested in access would be signed, without the participation of the Federal Government.
- De-bureaucratization of the process for paying the dispensation of benefits.
- Conservation projects should also occur at the location where the species is supplied and should include family farmers and productive communities.
- Dispensation of benefits from access to associated traditional knowledge of identifiable origin should not be more expensive than the dispensation of benefits in which knowledge is not identifiable.
- Prescription of the claim for civil damages.
- Treatment of only native species of Brazilian biodiversity.
- With the publication of the new legal framework, all resolutions of CGEN should be automatically repealed.
- The notification shall become a simple and non-bureaucratic procedure, performed electronically.
- Redefinition of the concept of access to associated traditional knowledge.
- Clarity in the legal definition that shipment is characterized by the transfer of a sample to the exterior for the purpose of access in which there is the transfer of responsibility for the sample.
- Withdrawal of the term "substances derived from the metabolism of living beings" from the concept of genetic heritage.
- Civil society and users must be part of CGEN and its thematic/sectorial chambers. Deadlines and dates for compliance and regulation should be clear to avoid legal uncertainty and to facilitate regularization.[96]

Demand incentives

The Consortium found that certain chemical segments in Brazil, when compared with the same segments in other countries, have gaps in their regulatory environments. These gaps often end up limiting benefits to safety, human health, the environment, and others, that some chemicals can provide. Actions that address these failures, as well as provide socioeconomic benefits, can stimulate demand for certain chemicals and attract more investment for local production:

- Chemicals from renewable sources: stimulate the use of cellulosic biofuels through the requirement of a minimum content of cellulosic ethanol in gasoline and fuel ethanol; and stimulate demand for renewables in offshore drilling fluids that meet the increasingly demanding requirements of biodegradability and toxicity established by the Brazilian Institute of Environment and Renewable Resources (IBAMA).

- Surfactants: Use incentives to formalize the household cleaning product market, the sector with the largest consumption of surfactants in Brazil, such as: establish a program with the National Agency for Sanitary Vigilance (ANVISA) to combat informality and strengthen the monitoring of regional health surveillance around informal manufacturers; encourage and facilitate the formalization of small and midsize producers of household cleaning products; and promote and disseminate programs that combat the informality of civil society, such as the Conscious Cleanliness Movement, from the Brazilian Association of Producers of Cleaning and Related Products (Abipla).

- Aromatic derivatives and polyurethanes: Encourage the thermal insulation of buildings by expanding the regulations to other types of buildings beyond housing, scope of ISO 15.575.

- Chemicals for concrete: Raise quality standards in civil construction that stimulate the search for more appropriate technical solutions, encouraging the use of chemical products for the sector.

- CF: Continue to encourage local investment in wind power generation and the production of fuel-efficient or electric cars.

- Silicon derivatives: Develop quality regulations that encourage the use of silicones.

c. Raw material sugarcane[97]

Brazil is the world's largest producer of sugarcane, which occupies one of the lowest cost positions relative to other sources of carbohydrates. In the long term, the country will remain a major exporter of sugar and ethanol, as well as attend to strong local demand. It is worth noting that second-generation raw materials (e.g., sugarcane bagasse and straw) may increase Brazil's competitiveness. Even so, in recent harvests, Brazilian mills have faced financial problems due to fluctuations in the international price of sugar, difficulties related to the competition between ethanol and gasoline in the domestic market, and increases in production costs.

From the perspective of the chemical industry, the strong competitive position of Brazilian sugarcane[98] is already attracting investment from foreign and domestic companies (such as the joint venture between Solazyme and Bunge, Amyris and Braskem), mainly in the Southeast.

There is an opportunity to accelerate investments in renewable sugar-based chemicals in regions with a higher concentration of sugar and ethanol plants, such as the Southeast, as well as in the sugarcane frontier regions such as the semi-arid Northeast.

In locations with existing infrastructure for the production of sugar and alcohol, policies for tax exemptions on investments—such as the Special Regime for Incentives for Investments in the Chemical Industry (Repequim)—specific funding programs, among other public policies already recommended for the chemical industry in general, are essential.

In the sugarcane frontier regions, however, greater government participation in guaranteeing infrastructure is paramount. For example, in the case of the semi-arid Northeast region, the establishment of a public-private

partnership (PPP) for the installation of a water catchment system for irrigation and the construction of road infrastructure would guarantee basic infrastructure and could attract private companies. The particular advantages of this region include: lower land prices, higher index of sunshine and the possible use of other sugarcane varieties better adapted to the local climate and soil. In addition, investments in agricultural frontier regions would have a higher socioeconomic impact[99] when compared with places where sugarcane infrastructure is already in place.

We evaluated proposals for sugarcane raw materials from a socioeconomic perspective.[100] The proposed models call for a chemical plant to supplement existing sugarcane infrastructure and for a biorefinery in the case of a greenfield project (expansion of the agricultural frontier). The annual tax waivers required for sites with existing infrastructure, between R$21 million and R$36 million, are still lower than the additional tax revenue of R$40 million *(see Figure 7)*. The scenario is similar for greenfield projects in the agricultural frontier regions, with tax waivers of between R$63 million and R$78 million compared with the additional tax revenue of R$100 million.

Along with the additional revenue, regional development and job creation are important advantages of the opportunities identified.

It is worth noting that the model and socioeconomic benefits presented here were calculated for only one chemical plant or biorefinery. The ability to replicate these projects depends on the expansion of the renewable chemicals segment, but growth forecasts for the segment are optimistic, between 5%[101] and 10%[102] of the chemical industry's revenues in 2022.

d. Infrastructure[103]

Railways

Railways in Brazil are underused due to the lack of an efficient railway network, poor condition of the existing railways and inconvenient geographic orientation of the existing network.

The Federal Government has sought to develop railway infrastructure through the creation of the Integrated Logistics Program (PIL) and the replacement of the vertical concessions model with horizontal concessions. The PIL contains 12 projected rail investments with an estimated cost of approximately R$91 billion, totaling interventions on approximately 11,000 kilometers of railway.

The Consortium foresees the need to prioritize projects and create connections with the implementation of five PIL projects and the creation of links between the rail network and the chemical complexes. The five projects selected are the northern section of the São Paulo railway ring; southern section of the São Paulo railway ring; access to the Port of Santos; track from Belo Horizonte to Salvador; and track from Sao Paulo to Rio Grande via Mafra.

The projects selected, along with the current network, make it possible to create a highly productive rail link in the Bahia-Rio Grande do Sul corridor connecting the chemical complexes of Triunfo, Paulínia and Camaçari with each other and consumer centers.

Roadways

The internal flow of chemicals are concentrated in two principal highway corridors: Paulínia to Camaçari; and Triunfo to Paulínia. Including the Paulinia to Rondonópolis corridor, the three roadways account for 90% of the transport of chemicals. Although all of them have bottlenecks, the government is proposing public works projects to ease the traffic congestion.[104]

Transportation bottlenecks effect the cost of transport vehicles and freight rates. Estimates indicate that if highways were in ideal condition, fuel and maintenance costs would be lower and overall vehicle costs could be reduced by 7%.

For the chemical industry, highways are important not only for direct transport between chemical complexes, but also to allow access to ports such as the Port of Santos. In this case, companies are faced with a lack of roadway capacity to handle traffic, traffic congestion and a lack of parking. In addition, the risk of cargo theft along principal transportation corridors is high,[105] mainly in the states of São Paulo, Minas Gerais and Paraná.

The city of Santos plans to carry out projects such as overpasses and side roads. However, more must be done to improve roadways; to ensure the rapid completion of the Santos projects; create perimeter roads and parking in the area; and simplify the regulations for the transportation of hazardous materials. It is estimated that, with these measures, freight costs could be reduced by approximately 16%.

Maritime

The three main national chemical complexes are located in Camaçari, Paulínia and Triunfo. Given the distance between them[106] and the proximity of the complexes to the ports of Aratu, Santos and Rio Grande, coastal shipping is an attractive option. However, the infrastructure for maritime shipping currently faces three main limitations in the country: depth restriction in ports;[107] difficulty in docking; and insufficient supply of operational vessels.

Based on the restrictions presented for maritime shipping, six actions are proposed: three of them have high potential impact and can be executed rapidly. The other three actions can be considered structural, which is why they require more time for completion:[108] expansion of the cargo handling and storage capacity through new leases or authorizations for expansion in Santos, while maintaining the economic balance of the contracts; implementation of new berths for bulk chemicals, in the short term, in Aratu; effective implementation of the National Plan for Dredging II, including the planning of depth maintenance; optimization of the processes for environmental licensing; implementation of tax cuts to lower the costs of logistics operators; and ease of regulations for temporary chartering of foreign transport vessels (bulk and containers) for a limited period of time.

Energy

The high energy cost in Brazil is considered an obstacle to the local development of various sectors of the economy. Evidence of this negative impact can be seen in the economic and financial analyses of certain investment opportunities carried out during this study.[109] These analyses have shown that the high cost of energy in Brazil often prevents the local production of many products, especially those in electricity-intensive segments, such as CF. However, as it is a systemic factor and is not specific to the chemical industry, the subject of energy was not addressed in detail in the study.

e. Innovation and technology[110]

Brazil has a strong presence in commodity industries such as iron ore, oil and sugar,[111] which typically require less investment in R&D. Thus, to encourage R&D and attract fixed investments, mainly from private sources, it is essential to target the segments with higher value-added products. Doing so should encourage the mission of overcoming technological challenges that require higher investment in R&D.

The challenges for biomass chemicals have been identified and prioritized in the Sectorial Technologies Agendas with a focus on technologies for process, product and application. The Consortium classified them as level-1 challenges due to Brazil's competitive advantage in renewable raw materials, as mentioned in previous chapters.

Figure 7: Summary of direct impact expected in 2030

Calculations considered for bio refineries

- Assumptions
  - 71,000 ha planted area; 60,000 ha harvested area
  - 5Mtpy sugarcane
  - n-butanol: 100ktpy
- Existing infrastructure
  - n-butanol (bagasse and straw)
- Greenfield[1]
  - Sugarcane plantation
  - Irrigation[2] and logistics
  - Sugar and ethanol refinery
  - n-butanol (bagasse and straw)

		1 Existing infrastructure	2 Greenfield Project
Investment in the project		**R$1,4B** Direct impact on GDP: R$670M	**R$3,9B** Direct impact on GDP: R$1,8B
Trade balance		**R$240M/year** from 2020	**R$800M/year** from 2020
GDP		**R$180M/year** from 2020	**R$600M/year** from 2020
Tax revenue		**R$40M/year** from 2020	**R$100M/year** from 2020
Jobs		**100** direct	**2 mil**[1] direct
Government incentives	Tax waiver (REPEQUIM)	R$8M/year	R$8M/year
	Subsidies/finance	R$13M/year	R$37M/year
	Incentives for PPP	–	R$18M/year
	TOTAL	R$21M/year	R$63M/year
	Tax waiver (REIQ)[3]	R$15M/year	R$15M/year

Notes: Mechanized planting and harvesting; from a governmental perspective, it is necessary to evaluate different alternatives for the use of water (e.g., power generation and fruit production) and their socioeconomic impacts; considers additional investment in R&D equal to 4% of gross annual revenues for the producer of bio n-butanol
Sources: Bain & Company; Gas Energy

Mastering the technology for the fractionation of sugar into five-carbons (pentose) and six carbons (hexoses) is one example of a challenge for Brazil.

There is also the need for mapping the challenges for the other segments of the chemical industry. In detailing the primary focus segments, certain needs for investment in R&D were already raised, and these were classified as level 2. One example highlighted in the agrochemical segment is the R&D on biopesticides. However, the detailed prioritization of these challenges is still essential.

In addition, the review of public policies around innovation seeks to ensure an environment that is conducive to meeting the challenges listed. The focus is on four areas: finance, regulatory environment, tax relief and public-private integration.

BNDES and Financiadora de Estudos e Projetos (FINEP) offer financial aid programs similar to those of other countries with greater traditions of R&D, as shown in a study published by BNDES.[112] However, the Consortium identified the opportunity for these programs to increase their focus on the chemical industry.

The changes proposed in the regulatory environment aim to accelerate the time periods for project execution. Private companies indicated the need to facilitate the review of tariff exception claims and the approval of genetically modified organisms by National Biosafety Technical Commission (CTNBio). The Science and Technology Institutes stressed the importance of making Law 8,666[113] more flexible. These actions, together with the professionalization of Innovation and Technology Centers (NIT) via a centralized management team, also improve the public-private integration.

Additionally, the "Lei do Bem"[114] is an important benefit that the Federal Government offered to companies. However, small changes in the use of credits, such as their use in subsequent years in case of losses in the current year, can increase their effectiveness.

f. Fiscal policy[115]

Brazil needs a comprehensive tax reform that simplifies the taxes charged in the country. However, the adoption of a value-added tax (VAT) model, discussed for more than 20 years, is a very complex federal measure and presents several challenges, such as the unification of the ICMS[116], which depends on negotiations with state governments.

Other opportunities exist for improving tax policies. Reintegra, for example, encourages local production and export through compensation for certain taxes collected on the added value, and Convention No. 70, which aims to minimize existing conflicts with the ICMS.

There are even special tax regimes for the chemical industry. The tax exemption on first- and second-generation petrochemical raw materials, approved this year, is an important step toward increasing the segment's competitiveness. However, the law provides for a progressive return of the tax by 2018. Thus, the Consortium proposes extending the discount for the next 10 years.

Other important special regimes for the industry are still awaiting approval. The special tax regime to encourage investments in the chemical industry (Repequim) exempts investments in the chemical industry. As mentioned in the economic and financial analyses of this study, the cost of capital is one of the main obstacles in increasing local production capacity. The special tax regime for innovation in the chemical industry (REIQ-Innovation) encourages not only the demand for chemicals from renewable sources but also investments in R&D through exemptions on renewable raw materials subject to an additional investment in R&D.

In addition, there are measures to ensure competitive equality with the protection of Brazilian production such as increasing the CET and encouraging exports through the drawback system.

The opportunities identified to improve the tax policy for the chemical industry—although recognizing that a broad tax reform is necessary—are important to enable the actions proposed in the reports on the prioritized segments and to leverage domestic production through the increase in Brazilian competitiveness in higher value-added segments.

83 The survey, conducted in April 2014, had 94 participants who responded to 178 questionnaires and is detailed in reports 5A and 5B of this study.

84 Report 6—Public Policy—Petrochemical Raw Materials.

85 Detailed in Report 6—Public Policy—Petrochemical Raw Materials.

86 Agência Nacional de Petróleo ([ANP], 2013).

87 Considered more than 15 million m3 per day of associated natural gas.

88 Detailed in Report 6—Public Policy—Petrochemical Raw Materials.

89 The first auction under this regime was the Libra field in October 2013 with the Government's share set at 41.65% of the surplus (volume after repayment of production) of oil and gas.

90 Report 6—Public Policy—Regulation.

91 Research carried out by the Consortium in Report 5 of this study; included the participation of 94 respondents who indicated, in the segments where they had knowledge, a competitive score for each topic in the Porter Diamond.

92 It is important to emphasize that the analysis assumes an added value of 50% of revenue in the chain of inputs and services.

93 Established by Provisional Measure 2.186-16 of August 23, 2001.

94 Interviews with industry experts.

95 Ministry of the Environment (MMA), MCTI, and MDIC.

96 Position paper by ABIQUIM as member of the business coalition on genetic heritage legislation.

97 Report 6—Public Policy—Sugarcane as a Raw Material.

98 Analysis based on the report on chemicals from renewable sources. The cost per ton of fermentable products (sucrose for sugarcane and starch for corn) of sugarcane in Brazil is a proximately R$250 compared with approximately R$290 for corn in the US. Source: Nexant, Next Generation Biofeedstocks: Resources for Renewables, 2013.

99 The calculation of benefits for private companies was not detailed in the present study, however, the main factors influencing the decision are the cost of capital and fixed costs when compared with the productivity obtained.

100 Socioeconomic impacts along with their assumptions are detailed in Report 6—Public Policy—Sugarcane as a Raw Material.

101 The Council on the Competitiveness of the Chemical Industry—Greater Brazil Plan (PBM).

102 ABIQUIM. National Pact of the Chemical Industry.

103 Report 6—Public Policy—Infrastructure.

104 BR-101 in Bahia, BR-116 in Minas Gerais, BR-116 in Rio Grande do Sul and Serra do Cafezal, and BR-381 in Minas Gerais.

105 Global Cargo Theft—Threat Assessment (2013).

106 The distance between Camaçari and Triunfo is approximately 3,100 kilometers; between Paulinia and Camaçari, 1,900 kilometers; between Triunfo and Camaçari, 1,300 kilometers.

107 Depth at which you encounter the lowest point of the keel (part extending from bow to stern of a vessel); the depth is measured vertically from a point on the outer surface of the keel. Source: Secretariat of Ports (2014).

108 The sixth action was classified as secondary due its lower impact compared with the other five.

109 As detailed in the report Economic and Financial Analyses.

110 Report 6—Public Policy—Innovation.

111 Source: AliceWeb.

112 BNDES. Incentivos para implantação de centros de P&D internacionais no Brasil. 2012.

113 Brazilian Law that rules the procurement processes of Brazilian Government entities at Federal, State and City levels.

114 Law 11.196/05, that regulates tax incentives provided by Brazilian Federal Government to companies for R&D activities.

115 Report 6—Public Policy—Fiscal Policy.

116 "Imposto sobre Circulação de Mercadorias e Serviços," a state value-added tax.

4. Vision 2030

For Vision 2030, market forecasts and investment scenarios were considered for the segments identified as primary focus in Phase II of the study. The Consortium simulated the trade balance in 2030, assuming the market growth projected in the Phase III reports, according to three scenarios of productive investment:

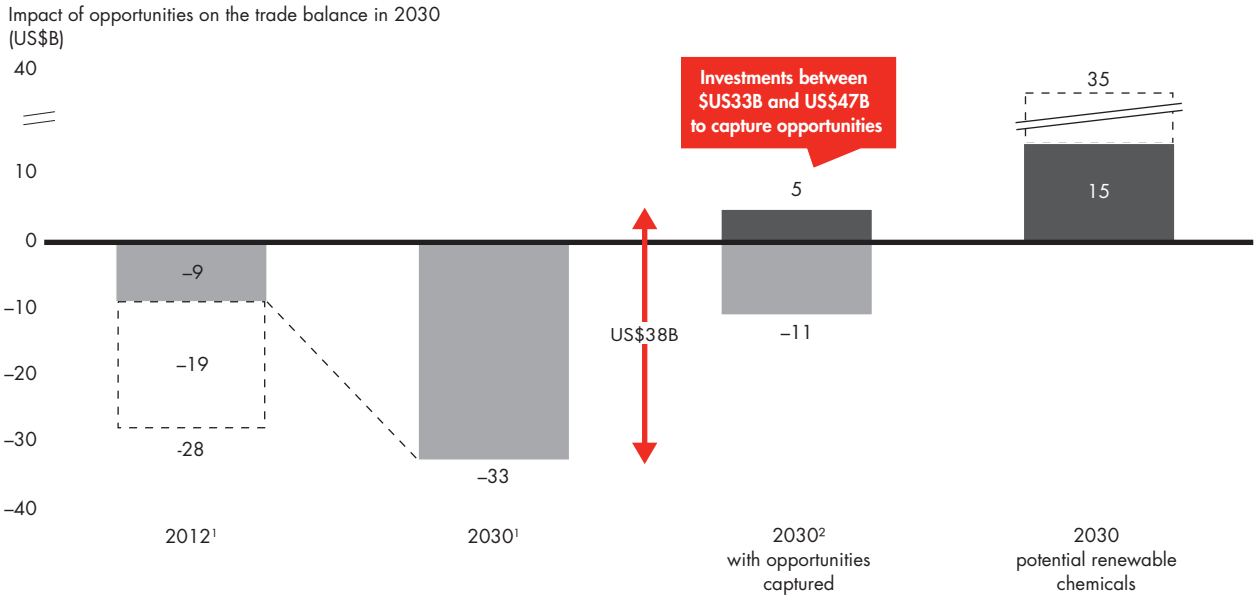
2030 scenario: Does not include the investments identified as opportunities in the Phase III reports, which does not indicate a total absence of productive investments. The base scenario considers the productive investments that are expected based on the current dynamics of each segment. In cosmetics, for example, the investments needed to meet the growing domestic demand are considered in the base scenario. However, even in this segment, those that replace the current import of aerosols and seek to increase Brazilian participation in exports to Latin American countries are considered opportunities that cannot be captured based on the current dynamics of the industry. As a result, they are considered opportunities in the Cosmetics Report but are not included in the base scenario, only the alternative scenario.

2030 scenario with captured opportunities: Based on these opportunities, highlighted in the Phase III reports, the impact of these investments on the Brazilian trade balance in 2030 was projected.

Potential of renewable chemicals 2030: Based on the opportunities from chemicals from renewable sources identified in the Phase III reports, the impact on the trade balance in 2030 was projected.

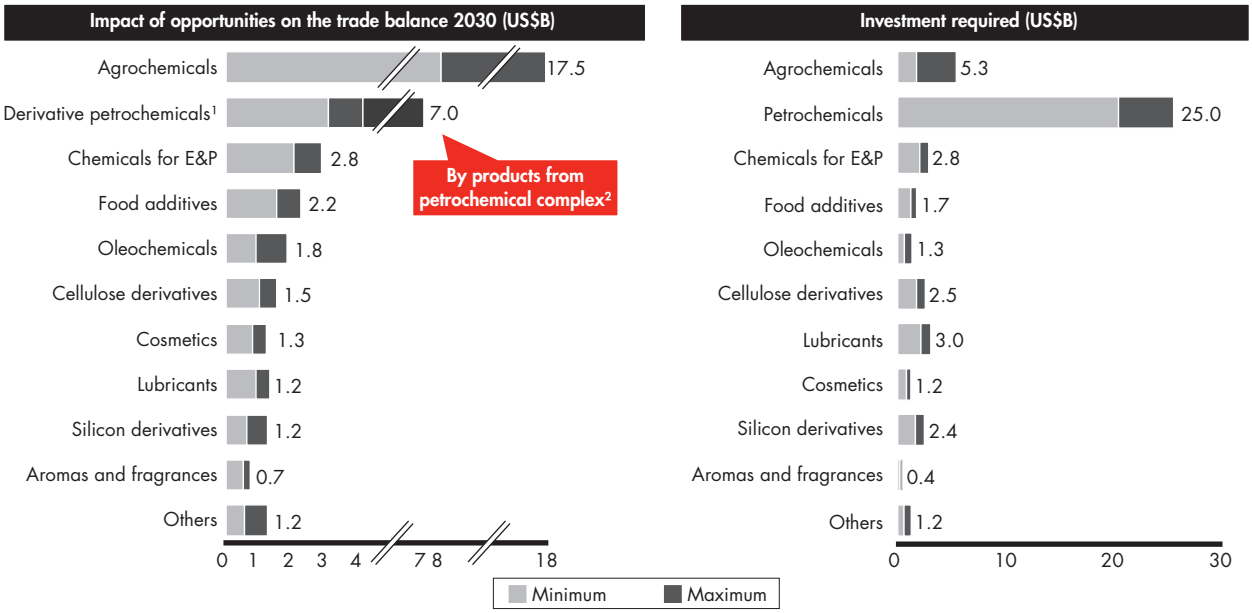
In the base scenario, the trade balance of the segments[117] under consideration would, in 2030, present a deficit of US$33 billion, or US$24 billion more than that recorded in 2012, which was approximately US$9 billion. In the

Figure 8: Trade balance scenarios 2030



Notes: 1) the primary focus segments; 2) includes the impact of the other products produced in the chemical complex, which are not the primary focus of the study (e.g., fuels and thermoplastic)
Sources: Bain & Company; Gas Energy

Figure 9: Impact of opportunities on the trade balance in 2030, and investments needed



Notes: 1) includes aromatics, butadiene and isoprene derivatives, specialty polyamides, high-tenacity polyester, and PU and their intermediates; 2) includes the impact of other products produced in the chemical complex, which are not the primary focus of the study (e.g., fuels and thermoplastic)
Sources: Bain & Company, Gas Energy

scenario where investments in identified opportunities are realized, the trade balance would reach a surplus of up to US$5 billion *(see Figure 8)*.

The scenarios presented in Figure 8 show an impact of as much as US$38 billion, relative to the opportunities identified, on the trade balance in 2030. Estimates also show that by that time, there is a need for investment of US$33 billion to US$47 billion to capture the opportunities identified in the study *(see Figure 9)*.

In addition to the opportunities mentioned in the reports on the primary focus segments, there are those related to chemical biomass, addressed in the Report on Chemicals from Renewable Sources. Because of the uncertainties in estimating the need for investment in the segment, the Consortium only considered the impact on the trade balance, which offers a potential between R$15 billion and R$35 billion. The opportunities cut across the commodity chain segments and the market, which may add further gains due to the competitive advantage of Brazil in renewable raw materials such as sugarcane. This advantage makes the country a potential exporter of these renewable chemicals.

All potential investments in the identified opportunities tend to bring significant benefits such as an increase in the country's GDP and job creation. The Bain–Gas Energy Consortium estimates the benefits from the opportunities identified in the segments of agrochemicals, petrochemicals, chemicals for E&P, food additives, and oleochemicals will lead to US$17 billion per year[118] of additional GDP and 19,000 new direct jobs in 2030.[119]

117 Segments classified as primary focus in the study Phase II.

118 The calculation of variation in GDP was based on the impact of the investments identified on the balance; the margins, taxes and expenses with estimated salary; and the value-added estimated for the direct suppliers. In the case of inputs that need to be imported, or that could be exported if they were not consumed in these segments, the value added was not considered in GDP.

119 For the calculation of direct jobs, we used data on employment and revenue per sector of the economy, published by the IBGE for the year 2009.

5. Reading guide for the study reports

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Report summaries		
Report	**Theme**	**Description**
Report 5	Research on the local competitiveness of the segments	Presentation and results of research conducted with industry participants, analysis of the competitiveness of the segments and Vision 2030
	Public policies for development	Presentation of the challenges and levers for competitiveness identified in the research and public policies to be detailed
Report 6	Petrochemical raw materials	Proposals for the use of oil and natural gas belonging to the Federal Government, the natural gas usage policies and the fuel policy
	Innovation and technology	Public policy proposals focused on innovation and technology and mapping of the potential technological challenges for the chemical industry
	Sugarcane raw materials	Public policy proposals focused on building biorefineries in the vicinity of sugar and ethanol plants and in agricultural frontier regions; explanation of the economic and financial model for n-butanol
	Regulation	Public policy proposals with a focus on the regulatory environment for the regulation of agrochemicals, access to biodiversity and demand regulation
	Infrastructure	Public policy proposals focused on logistics infrastructure for rail, road and maritime transportation
	Fiscal policy	Proposals for public policies focused on the fiscal environment
	Economic and financial models	• Economic and financial models for opportunities identified in: – CF – Food additives: methionine – Silicon derivatives: siloxane – Chemicals for E&P: polyalphaolefin

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7. Appendices

Appendix 1—Description of analysis methodology of the study

The study was initiated in May of 2013 and completed in November of 2014. The following three parts summarize the steps taken in the segmentation, initial prioritization and final classification of the segments of the chemical industry that were analyzed

Chemical segments considered during prioritization

For the initial prioritization, we analyzed 66 segments (*see Figure 10*). The structure used for grouping chemicals, proposed in Phase 1 of the study, consists of three levels, in order of increasing granularity: 2 groups ("chain" and "market"), 11 subgroups (presented in bold and underlined) and 66 segments. Segmentation was designed according to a business logic, that is, products that share costs (same chemical chain or raw material) or that have similar applications and markets were grouped together in the same segment.

Prioritization of segments for detailed study

The second step in the methodology used prioritization filters, which were intended to highlight the segments that would be studied in more depth in the next phase of the study. These segments were selected with the help of multicriteria analysis that employed the variables that constitute the model known as Porter's Diamond.

Figure 10: Chemical segments considered during prioritization

Chain	**Basic Organic**												**Basic Inorganic**											
	Acrylic acid and deriv.	Methacylic Acid. and deriv.	Fatty acids and deriv.	Aromatics	Butadiene & isoprene deriv.	Cellulose deriv.							Inorganic acids	Aluminum deriv.	Boron deriv.	Chlor-Alkali	Cobalt deriv.	White phosph. and deriv.						
	Waxes and petr. paraffin.	Copolymers	Cumene and deriv.	Tar deriv.	Elastomers	Ethylene deriv.							Industrial gases	Iodine and deriv.	Radioactive material	Niobium deriv.	Nickel deriv.	Titanium oxide and deriv.						
	Lubricants	Methane deriv.	Ethylene oxide and deriv.	Propylene deriv.	Vinyl derivatives								Silicon deriv.	Sulfates	Rare earth metals deriv.	Uranium	Elemental carbon deriv.							
Market	**Fine Chemical Intermediates**																							
	Intermediates for Resins												Industrial Intermediates											
	Specialty Polymers												**Catalysts and Additives**											
	Aramids	CF	Polybutylene terephthalate	Polycarbo-nates	Polyacetals								Food additives	Additives for construction	Additives for leather	Additives for mining								
	Specialty polyamides	High-tenacity polyester	Polyether polyols and PU	Polytetram ethylene ether glycol	Epoxy resins								Additives for E&P	Additives for polymers	Catalysts	Fragrances and flavorings								
	Inks, dyes and colorings, related products			**Soaps, detergents, cleaning products and cosmetics.**			**Agro-chemicals**	**Glues, ad. and sel.**	**Photographic**		**Others**													
	Synthetic organic dyes	Printing inks	Paints, varnishes and related products	Cleaning products	Cosmetics	Surfac-tants	Agro-chemicals	Glues, adhesives and sealants	Film, developers and papers	Explosives	Refrige-rants	Lab reagents	Others											

Note: The pharmaceutical, fertilizers and commodity plastic (PE, PP, PVC and PET) segments are outside the scope of the study
Sources: Bain & Company; Gas Energy

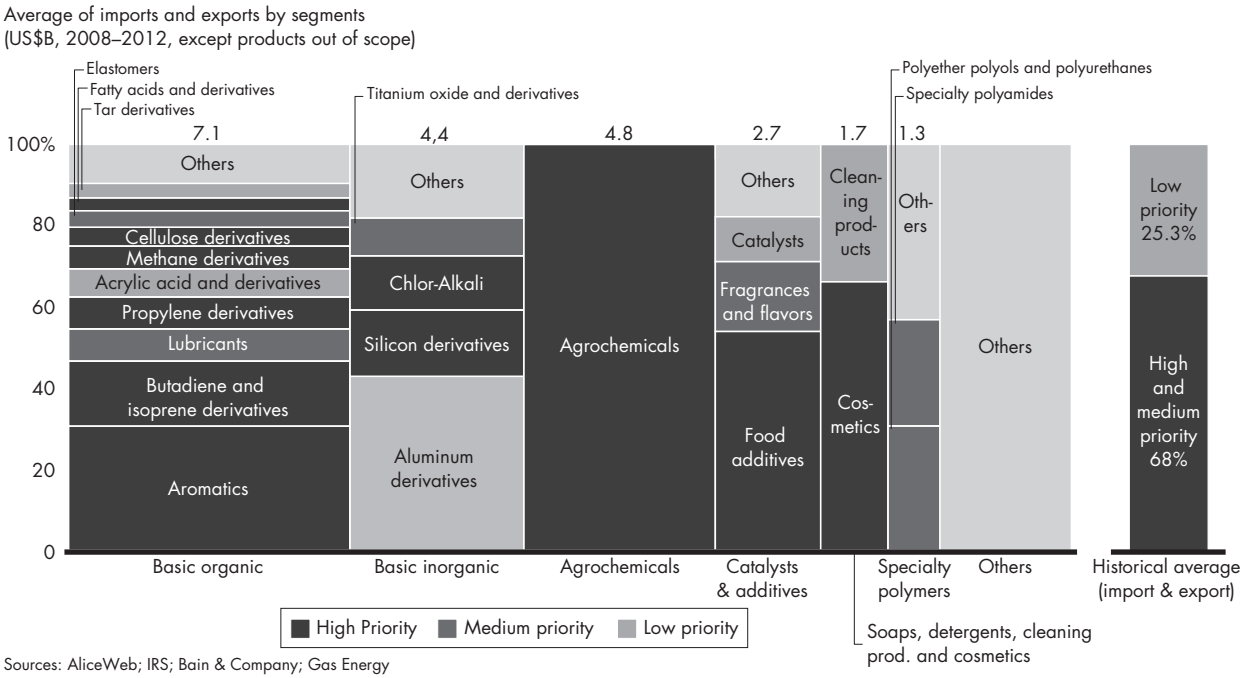
Figure 11: Criteria for prioritizing segments

		Criteria	Indicators	Source
Demand conditions	Quantitative	• Size	• Imports + exports (US$) average 2008–2012 • Production (US$) average 2007–2011	• AliceWeb • Associations • PIA
		• Growth	• CAGR of exports + import (%)	• AliceWeb
		• Value added	• Unit price (US$/kg) average 2008–2012	
	Qualitative	• Trend	• Demand trends	• Global Insight • Macrotrends
Factors of production		• Raw material	• Degree, present and future, of availability and cost competitiveness of the raw material	• Consortium • Validation with the UFRJ School of Chemistry • Interviews with experts
		• Technology	• Level of technological mastery and the potential to develop or purchase it	
		Human Resources; Regulatory environment; Infrastructure; Capital	• Availability of qualified labor • Quality of available infrastructure • Restrictions in the regulatory environment • Need for investment	

A multi-criteria analysis tool was used to ensure robustness of the result

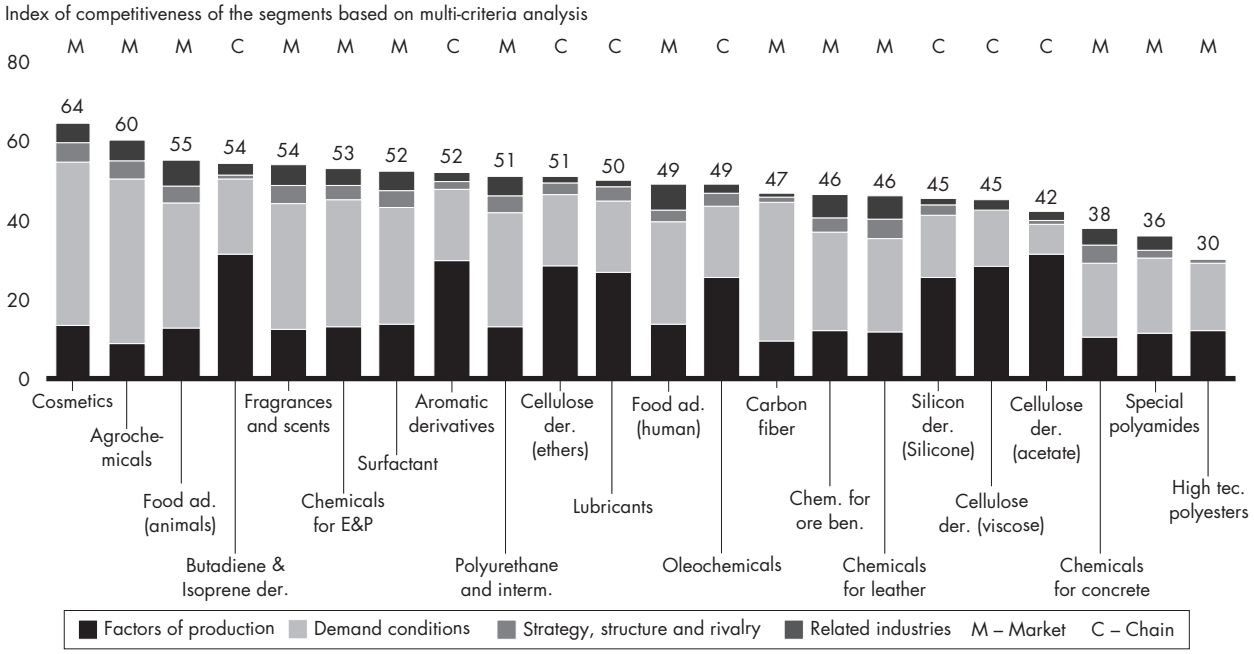
Sources: Bain & Company; Gas Energy

Figure 12: Prioritization of segments



Sources: AliceWeb; IRS; Bain & Company; Gas Energy

Figure 13: Index of competitiveness of the segments based on multi-criteria analysis



Sources: Bain & Company; Gas Energy

We used a set of criteria used to evaluate the "demand conditions" and "factors of production" *(see Figure 11)*.

Multicriteria analysis allowed us to classify the segments according to primary, secondary and tertiary focus, arriving at the initial prioritization proposed *(see Figure 12)*.

Classification of prioritized segments

A multicriteria analysis was used in which the alternatives (segments) were compared with each other, taking into account different criteria with specific weights. The aim was to highlight those alternatives whose set of characteristics best met the preferences of the decision maker.

The criteria used were based on the four dimensions of the Porter's Diamond: demand conditions; factors of production; related industries; and strategy, structure and rivalry *(see Figure 13)*.

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