arpel
REGIONAL ASSOCIATION OF
OIL, GAS AND BIOFUELS SECTOR COMPANIES
IN LATIN AMERICA AND THE CARIBBEAN

Energy Transition of the Refining Sector

Content

Executive Summary

Climate change, the driver of the current process of energy transitions to a low-carbon economy, represents an unprecedented challenge for humanity, and particularly for the oil and gas industry. Reducing emissions and meeting the growing demand for energy is balanced by increasing energy security and access to energy.

Over the past 20 years, ARPEL has been addressing the various challenges that climate change and - more recently - energy transitions represent for industry in the region. The White Paper "Energy Transitions in Latin America & the Caribbean – the role of the oil and gas industry" seeks to contribute to the development of a roadmap for the countries of the region. It reflects the commitment and position of ARPEL companies to support the process of energy transitions. On the other hand, in 2021 the "Roadmap to boost the contribution to the Sustainable Development Goals (SDGs) of the oil gas industry" was published. This outlines a path to work with companies in the sector in the United Nations 2030 Agenda and an even broader framework of socio-environmental sustainability and human development. In that document, SDG 13 (climate action), SDG 7 (affordable and clean energy), SDG 8 (economic growth and decent work), SDG 9 (industry, innovation and infrastructure), SDG 12 (responsible production and consumption) and SDG 5 (gender equality) were prioritized, all of which are considered in this report.

Under this framework of reference, ARPEL decides to go a step further and develops this document to visualize and analyze the impacts and opportunities derived from the process of energy transitions in the refining industry in Latin America & the Caribbean, and its potential contribution to this process and its possible routes of action.

Considering that the combustion of hydrocarbons is one of the main causes of the increase in greenhouse gas emissions, there is a need to move towards decarbonized energy systems, where the refining industry plays a leading role.

Energy transitions will have a strong impact on oil refineries by reducing demand for their products, refining margins, and causing more frequent and deeper volatilities. In addition, a growing demand for the reduction of the carbon footprint, competition from new players, and the increasing cost of maintaining the social license is expected.

Despite possible considerations regarding the "delay" of peak oil demand and the still strong importing position in the region, the time window for investing in industrial settings is extremely short considering that some countries will begin to have surpluses and dump them into the market, which will have an immediate impact on margins.

[1] https://www.arpel.org/library/publication/519/
[2] https://www.arpel.org/library/publication/531/

The threat to the refining market, sustained demand for petrochemicals with lower margins, and industrial and commercial synergies drive refining/petrochemical integration, although there are few opportunities in the region for raw material scale, stable regulatory frameworks, and domestic demand in countries that justify global-scale plants.

It should be noted that the decision to accompany the avant-garde countries represents for the regional refiner additional costs that -when applied to their products- could limit the population's access to refined products, with the consecutive increase in the social gap.

Energy transitions and increasing environmental demands in general have a high cost that it is not always clear who should bear it.

Consequently, the refining sector faces a critical moment that requires immediate action, with enormous challenges for its economic performance and its survival.

The focus for immediate action should be on setting net-zero carbon emission targets, whether through mitigation actions, process optimization, improved energy efficiency, increased chemical production, introduction of renewable raw materials and low-carbon solutions. Digitalization itself contributes to the energy transition, and to a more efficient operation that will reduce the economic break-even point in the face of the trend of low/declining margins.

There are areas of opportunity in integration with petrochemicals, recycling of petrochemicals, the value chain of electric vehicles, advanced biofuels and biochemicals, renewable generation, the integration of key companies in the region and the improvement of the refinery configuration if the time window allows it.

In any case, companies should be extremely critical of the evaluation of their asset portfolios and the continuity or drastic measures of transformation, investment or divestment of their assets of insufficient scale, configuration or performance.

In parallel, they should rethink their future business model in relation to their raw materials, their industrial configuration, the products they will produce and market, their participation in the entire value chain of electric vehicles and alternative fuels, and their progress in decarbonization.

The top management of the refining sector should consider its business as a multidisciplinary knowledge center for energy production and management, and from that strength find its place to endure over time.

1 Energy Transitions

The world is constantly changing, whether due to natural or anthropogenic causes, and sometimes these changes represent relevant challenges for humanity. Among all the adversities society faces in everyday life, climate change poses unprecedented global challenges for current and future generations.

Scientific evidence points to the use of fossil energy as the main anthropogenic cause of climate change. The combustion of hydrocarbons is one of the main contributors to greenhouse gas emissions, beyond what nature can absorb. The rapid increase in the concentration of CO2 in the atmosphere results in global warming which, as a result, can have a catastrophic impact on the planet.

The world needs more energy, the point is, how it is generated and used with minimal effect on the environment and human health. That is why the world is on its way to the energy transition. World leaders, policy makers, investors and society at large are driving the decarbonisation of energy systems by switching from fossil fuels to renewable sources and capturing CO2 emissions, among others.

The question remains whether nuclear energy, with its fusion or fission processes, constitutes a viable and acceptable alternative for society as a solution to reducing emissions and global warming. Different countries take opposite directions in this regard, while some dismantle nuclear generation plants, others start new plant projects.

Energy transitions will be a catalyst to transform the sector by bringing greater competition, environmental and operational demands, and lower margins. For the refiner, this presents great challenges, along with the opportunity to transform their business and show greater resilience to the energy future.

That's why it's important to ask, where to start the transition? And how will the energy transition affect global (and regional) oil refining?. Transportation, power generation and industry emissions account for more than 73% of global CO2 emissions. The transport sector accounts for 55% of total oil demand, and oil refining accounts for 90% of the fuels used in transportation.

The pressure on the downstream industry to act on climate change comes from four main fronts:

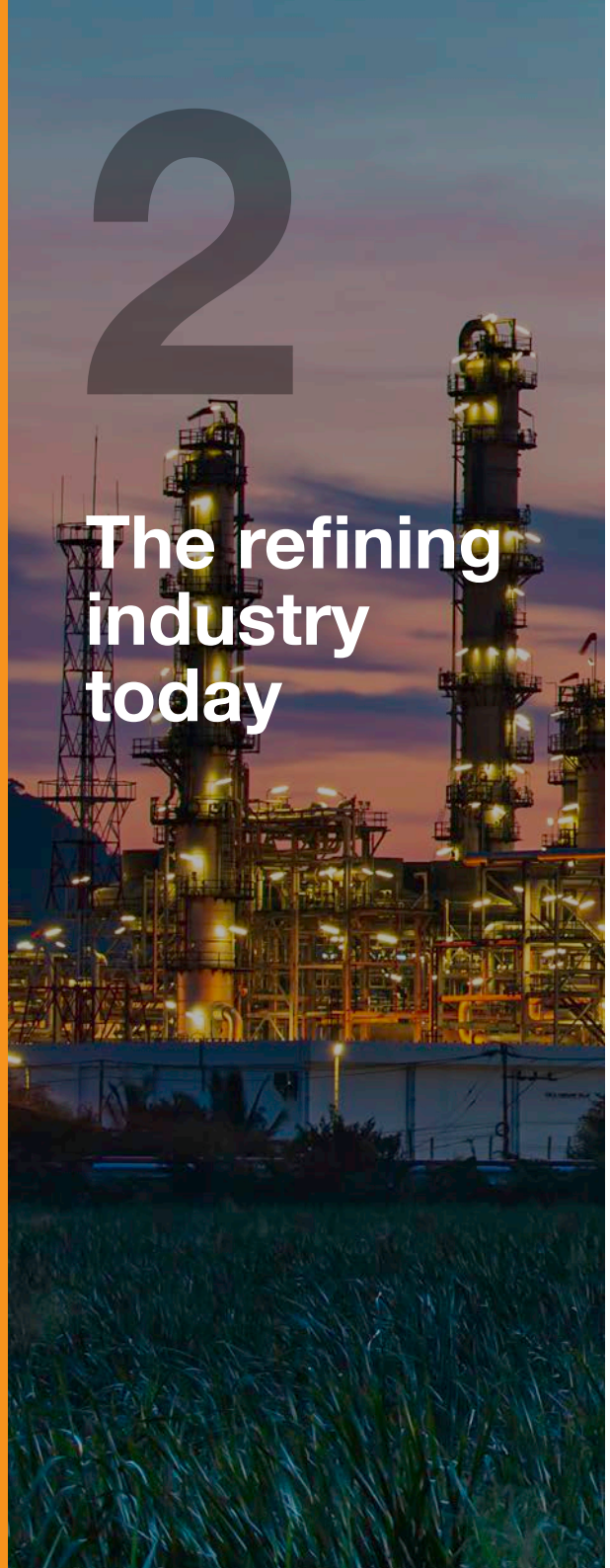
- Governments
- Enterprises
- Financial institutions
- General population, through consumer preferences, activists, and "influencers"

The transition to alternative fuels will have an impact on the future of oil refineries around the world by reducing demand for their core products and reducing refining margins.

Refining in Latin America & the Caribbean, in general terms, cannot fully provide the quantity and quality of conventional fuels that their countries demand. Imports of refined products have increased substantially and competition with other regions could increase due to energy transitions.

Oil refining has been, and will continue to be, a major supplier of fuels and raw materials.

This paper analyzes the challenges and potential strategies of refining companies in theregion, in the face of energy transitions.



2 The refining industry today

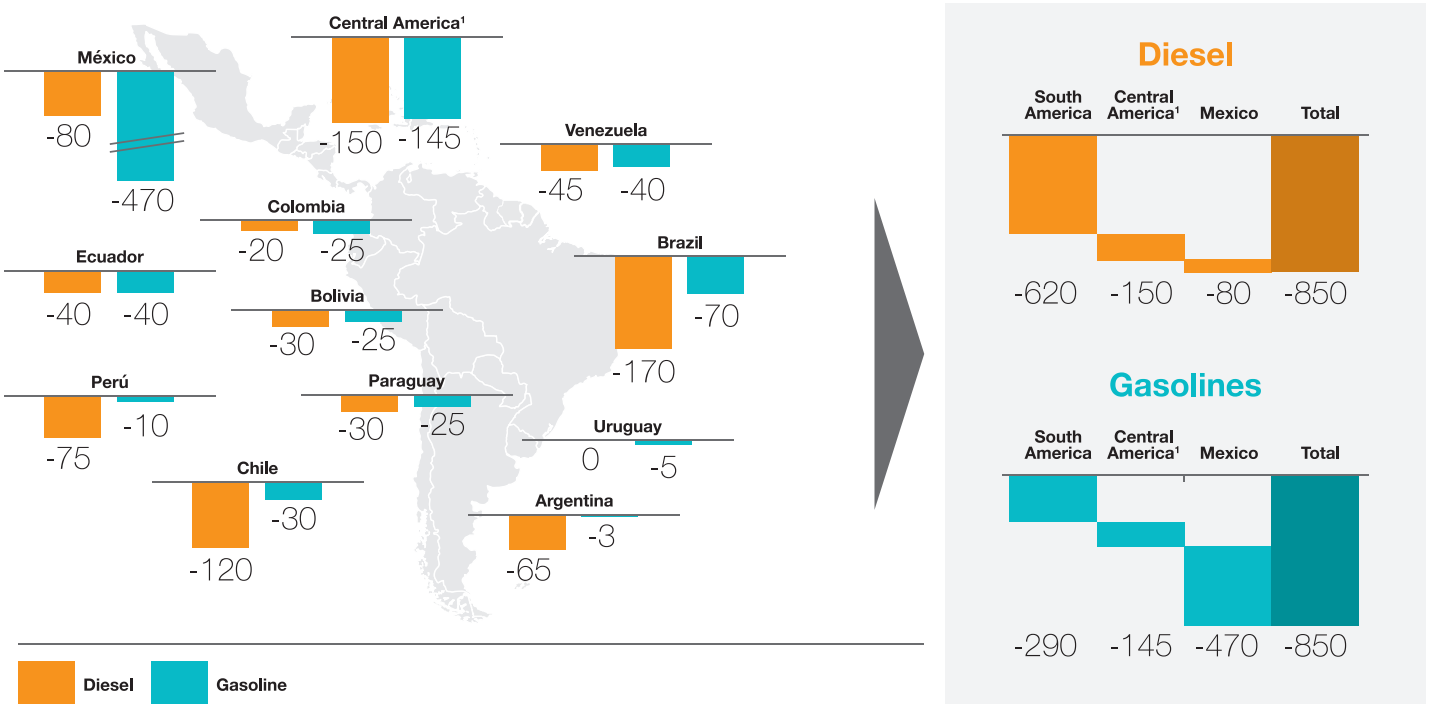
The downstream industry, with more than seven hundred refineries and more than one million fuel outlets (service stations) globally, is a very fragmented and heterogeneous sector in terms of ownership, industrial scale, configuration and quality of fuels.

Over the past decade, the sector has already been challenged beyond its own margin cycles, the imbalances between capacity and demand, the fact that it is a capital-intensive industry due to increasingly stringent regulations on industrial operations, the quality of fuels, and changes in the quality of available raw materials. This context has led to the closure of small-scale refineries, low conversion and product quality.

The reduced scale, low complexity, and high construction costs in refineries, challenge the realization and proper return on investments.

Latin America & the Caribbean, despite being an exporter of low octane and/or high sulfur products and crude oil that fails to be refined in the region, is a strong importer of quality refined products, especially diesel and gasoline. In addition, the regional energy matrix contains a high percentage of hydrocarbons, with almost total predominance of hydrocarbons in the transport sector. The figure below shows the size of the region's negative trade balance in the main refined products:

Regional Balance of Gasoline and Diesel (kbd)

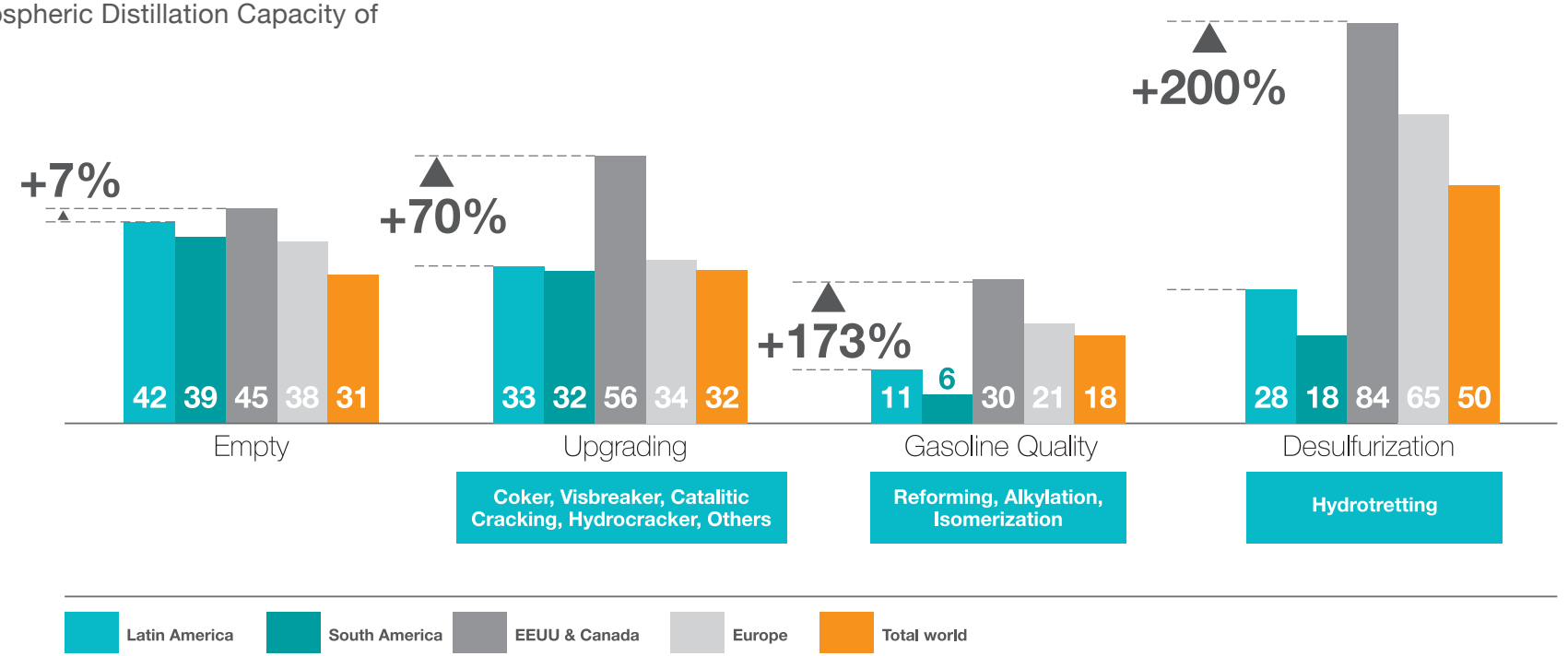


Nota: balance regional esperado para 2020

Despite having regional raw materials, most refineries in the region do not meet the volumes and quality demanded. Refining capacity in the region has a heterogeneous scale, with some plants of low configuration and total conversion and desulphurization capacity, as shown in the following figure.

Comparative Refiney Configuration by Region

Base 100=Total Atmospheric Distillation Capacity of the country/region



Global refining margins are highly volatile, with low margin cycles being compounded by resistance to the closure of existing capacity, by the entry of new large-scale capacity into Asia/Middle East and conversion capacity and driven by strategic decisions by crude exporting countries. The sector's return on capital in the region is limited by high capital and construction costs, although access to relatively low-cost self-consumption energy, and the distance of most refineries in the region from more liquid markets (e.g. USGC) favors this.

The current context of the sector imposes strong competitive challenges, especially for some plants with a marginal economy and difficult subsistence. In addition, mainly for small-scale refineries, there are challenges to make current or mandatory investments that have low or no return.

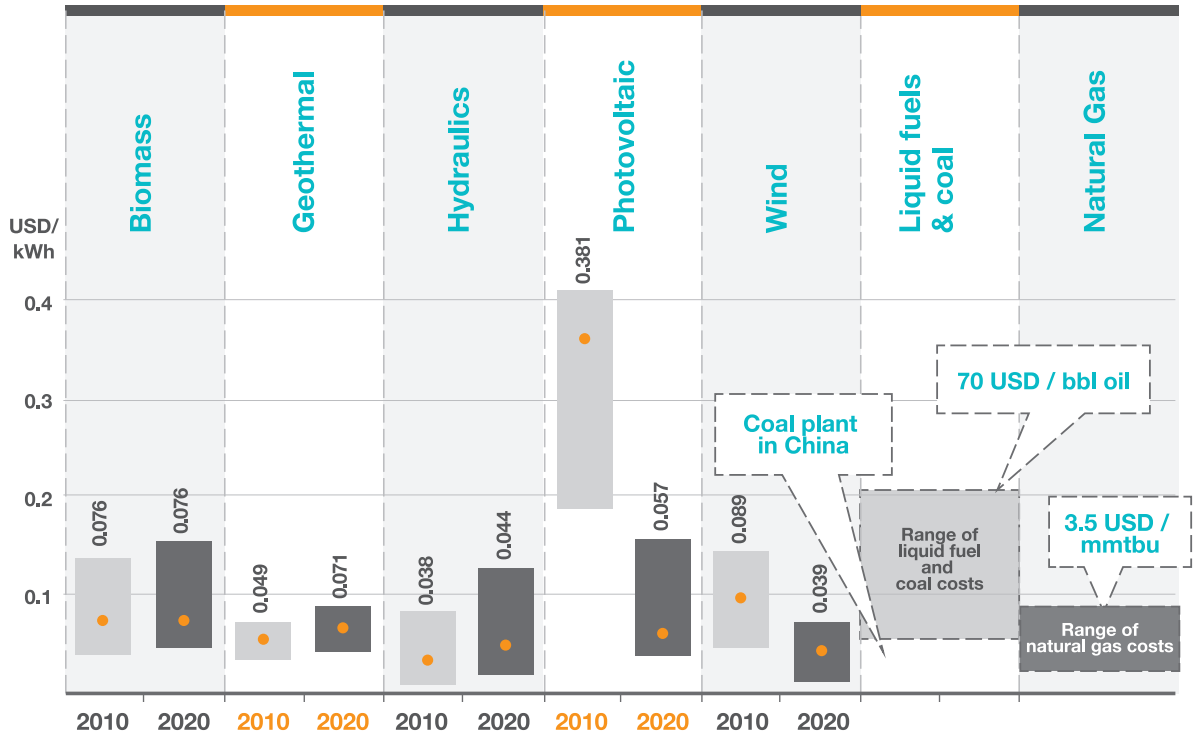
3

Drivers and impacts of energy transitions

Decarbonization as a global goal (and local commitment) supported by technological developments, drives a shift in energy sources, raw materials, the type of energy for the consumer, and participants in the refining industry's value chain.

This decarbonization process is promoted by governments through regulations for refiners, marketers, and the final consumer, and extends to the application of taxes on carbon emissions. Globally, more than 20% of carbon emissions are subject to some sort of economic penalty that affects refiner's margins. It is clear that social and political pressure, such as innovation levers, will continue to drive decarbonization.

Technological developments, on the other hand, allow the reduction of the Levelized Cost of Energy (LCOE) of non-traditional renewable energies, especially solar and wind energy. The last decade shows developments favorable to these energy solutions, which position them more competitive against the expected range of fossil fuel costs, as shown in the following figure:



Financing for hydrocarbon industry projects, in particular for refining, faces increasing challenges as the capital market and investors turn their attention to renewable energy projects,
which promote a better balance with the environment. Financing tends to consider more broadly the viability and sustainability of investments, beyond the traditional mechanisms of debt or issuance of securities. Given the appetite for this type of projects, capital costs will be lower for carbon-neutral or carbon-positive projects.

These drivers accentuate energy transitions, with an impact on the energy value chain in general and particularly in the refining sector. The most notorious impacts are global oversupply of capacity and production, margins or differentials product vs. crude oil with longer and deeper cycles, competition from new players over historical customers of the oil industry and increasing cost of maintaining the social license to operate in the refining and distribution of fuels segment. These factors together will limit economic performance and return on capital employed in the sector.

Demand for traditional fuels will be affected by transitions, highlighting their growth first and shrinking considerably in the long term. Peak oil demand is visualized in a closer time horizon with some regions reaching it in the short term, and the sustained global oversupply in refining further affects margins, which, over time, will suffer more frequent and deeper volatilities.

In turn, changes in mobility habits and consumption patterns of the end consumer will create space for new competitors in a value chain that is currently dominated by refiners.

An example of this phenomenon is the participation of the automotive industry, which already invests in lithium mining, battery technology, electric charging stations and fleet management software. Electrification will undoubtedly play a key role in energy transitions, with electricity's share of global secondary energy consumption expected to reach 20% by 2040.

Another impact that energy transitions will bring, will be the need to produce higher quality fuels from the point of view of their impact on the environment, either by their composition or by the raw materials that are used, with increasing pressure on the decrease of the carbon footprint. This, coupled with social pressure regarding products, raw materials, industrial operations, water use, emissions, and effluents, will progressively increase the cost of balancing with the environment, or that of the refiner's environmental license to operate.

The following table summarizes the main drivers and impacts of energy transitions:

Emissions regulation:
Of the refineries
Industry and vehicles
Economic advantages to the user of lower emission

Regulation on energy efficiency and use:
Industry
Public and private transport

New consumer trends:
Electrification and efficiency of motors
Consumer "green" energy preferenc

Tecnology:
Reduction of renewable production and storage costs
Decreasing levelized cost of energy (LCoE) for alternative sources

Cost of Capital:
Relative penalty of hydrocarbon projects
Lower capital costs for carbon/carbon neutral projects

Convergence of sectors
Dispute of the market share of the transport sector between traditional and new suppliers
"Crossover" of players, e.g. automotive to mining/electricity, battery refining, transportation services

Lower regional deficit:
Stagnant demand
Limited investments in new or increased capacity or even capacity closures

Declining global margins:
High impact on the margins of the balance between increasing capacity and stagnant or decreasing demand
Sustained "oversupply" of refining
Deeper and more frequent volatility

New competitors in traditional refiner businesses:
Energy service companies in the vehicle segment
Automotive companies in the transport sector
Generators/producers of renewables to industry

Environmental License Cost:
Product requirements
Cost of balancing with the environment
Energy efficiency and carbon footprint requirements

4

Mobility and changes in consumption patterns

The mobility sector is in a period of extreme disruption. Energy transitions have boosted the search for alternative fuels for the transport sector. Decarbonisation trends and technology are changing the way cars work mainly in terms of motorization/ traction, the energy source used and levels of automation, with the expectation that fully autonomous vehicles will be the vehicles of tomorrow.

Changes in human perception of transportation are represented in the combination of multiple energy sources, autonomous vehicles, and mobility-as-a-service that technology brought to society.

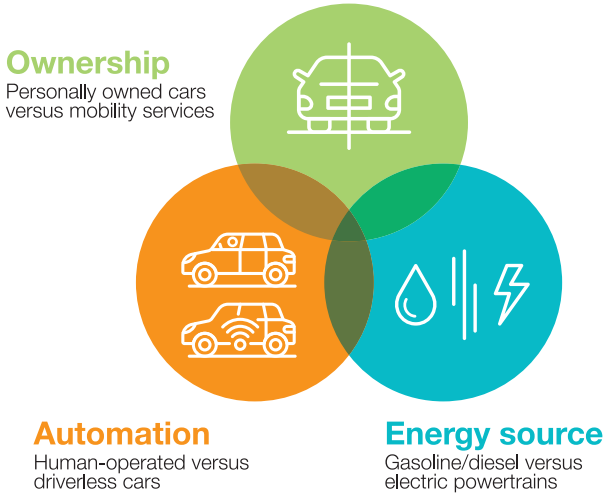
Latin America & the Caribbean are one of the regions that have the greatest amount and diversity of natural resources that facilitate the search for alternative fuels, which could reduce dependence on imports of traditional fuels or those that are developed in the future. Within this region, Brazil is the main player in terms of volume and market of biofuels, however, other countries also bet on this product. For its part, gas, in all its forms, used for both light and heavy transport, is or will be another viable alternative for the reduction of greenhouse gas emissions, being a low-cost alternative mainly in countries that already produce it and have developed transport and distribution infrastructure.

Greater awareness of air and noise pollution, traffic congestion in large cities, and increasing urbanization have influenced policymaking by limiting conventional internal combustion engines in national and municipal governments, with increased initiatives to reduce emissions in mass and private transport.

Some countries have already set targets for the increasing use of biofuels by 2030. As a consequence of these regulations, the growth of demand for ethanol and biodiesel could be accelerated, reducing the carbon intensity of fuels in the transport sector.

In the region, the use of first-generation biofuels, which are those that displace the use of land for food production, is not yet questioned, but in more developed countries increasing limitations are established on the percentage of these biofuels, placing stricter barriers for those that displace more land for their production (such as palm oil-based biodiesel).

These changes in the sector result from the convergence of demands for more sustainable fuels, technological advances and purchasing and use behavior on mobility.



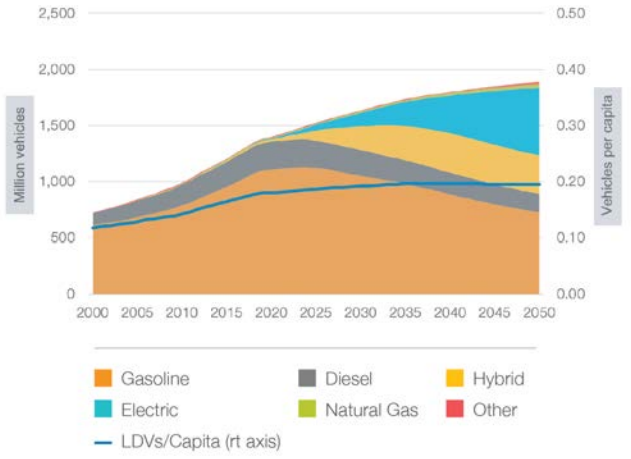
Accelerated by the pandemic, society has changed its consumption patterns due to new methods of remote work, reducing mobility as a service, the shared fleet, and the use of transport. Also, increasing efforts towards electrification and the demand for private vehicles. Some factors have stopped the trend of greater efficiency in transport, but the social and government awareness of decarbonization has been accentuated.

As can be seen in the figure below, there is a growing trend towards electrification and gasification both for light vehicles found in the region and globally, affecting the entire value chain of the automotive industry.

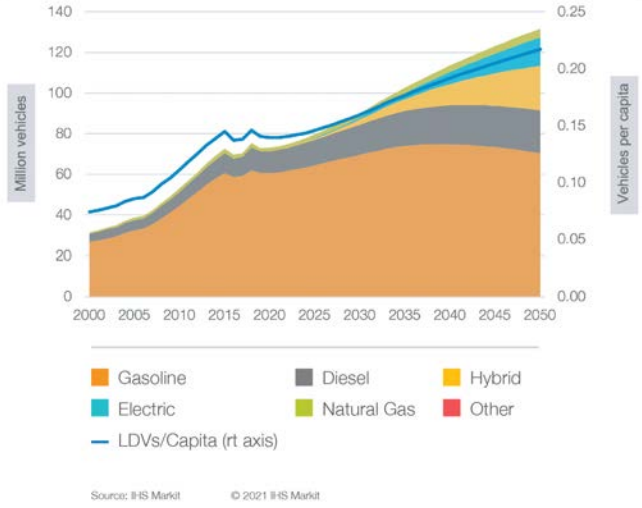
As for the heavy fleet, all-electric trucks are expected to account for a significantly small portion of the market, while hybrid trucks account for a larger portion or those with new low-carbon fuels such as LNG or H2 will gradually displace diesel trucks.

In parallel, the concept of circular economy will radically change consumption patterns and the hydrocarbon value chain, adding completely new areas including sorting, collection, and recycling. It is, therefore, a shift that requires an ecosystem-wide approach, where each actor plays a role. Producers and marketers of raw materials or single-use products that allow recycling will have to transform their value chains. The petrochemical industry will have to commit to new technologies and recycled raw material in its processes, and governments will have to encourage demand for change (through selective taxes, investments or support for recycling and education to society).

Prospects for the global light vehicle fleet



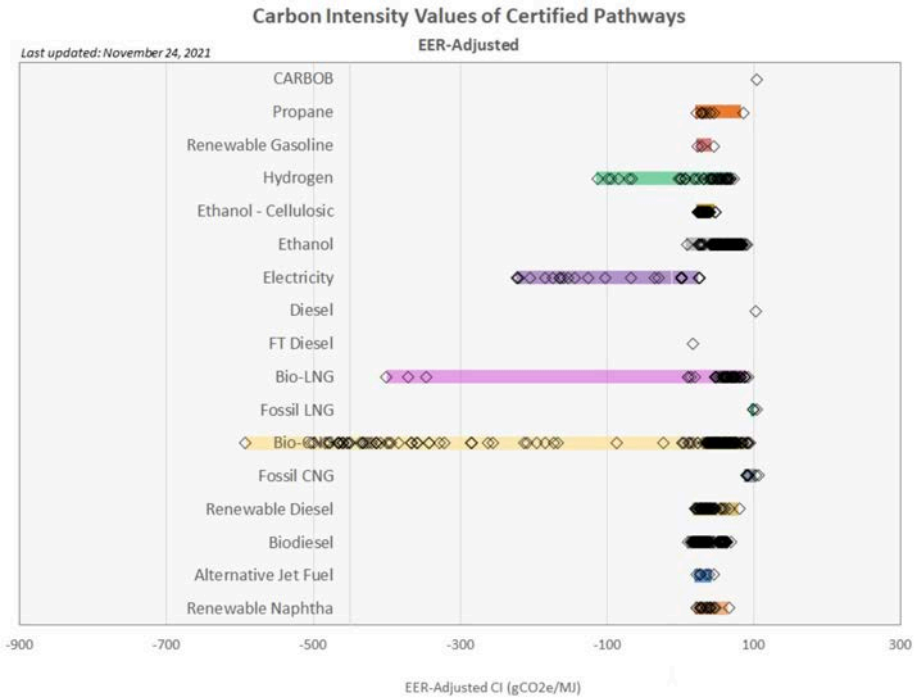
Fleet of light vehicles in Latin America



Source: IHS Markit © 2021 IHS Markit

Low-carbon alternative fuels

Although petroleum-based fuels have been accessible and the main source of energy for transportation in the last century, the effort to reduce emissions has driven the analysis of alternatives with a lower carbon intensity than gasoline and diesel, in the full life cycle. For reference, it is worth reviewing initiatives similar to the current search for alternative fuels, which have occurred in history whenever there has been a global oil price crisis.



Biofuels, particularly biodiesel and ethanol, have led the way to alternative fuels globally and in Latin America & the Caribbean. Whether by carbon intensity mandates or by blending mandates, biofuels have become an integral part of the energy transition.

Argentina, Brazil and Colombia are examples of aggressive biofuel blending mandates, with Brazil pioneering ethanol, which is also offered as a 100% replacement for gasoline.

	Ethanol		Biodiesel	
	2020	2030	2020	2030
US	10%	10%	4%	4%
Canada	5%	5%	2%	2%
Portugal	10%	10.0%	10%	10%
Netherlands	3.5%	3.5%	3.5%	3.5%
China	3%	10%	5%	5%
Brazil	27%	27%	13%	15%
Argentina	12%	12%	10%	5%
Colombia	10%	10%	12%	12%
Uruguay	5%	8.5%	5%	0%

Global demand for biofuels is expected to increase in the coming decades. However, there are limits to biofuels related to the use of natural resources such as land and water. Accessibility to feedstock sources, combined with changes in the powertrain of combustion vehicles to electric, impose limits on the future of biofuels.

To a greater or lesser extent, either from technological centers, from the automotive industry, from traditional fuel producing companies, or from governments, other alternative fuels of low carbon content are promoted, and giving space to technical and commercial developments in favor of gas in different forms, and hydrogen.

Mobility

Technological advances continue to transform society, the way we live, work, and, consequently, how we move. As an example, the way the world is connected today helped maintain a certain level of productivity in the face of the extreme absence of mobility generated by the COVID-19 pandemic.

Thanks to technological connectivity, the population is rethinking the ownership of a vehicle and companies are adapting to remote work. For Latin America & the Caribbean, mobility as a service plays an important role in the economy, since a large part of the working population depends on public transport - which is also insufficient - and does not have the resources to acquire and maintain a private vehicle. Autonomous vehicle technology, combined with electric vehicles, may be the future to further reduce transportation costs.

At the core of technological changes in transport, the electrification of the powertrain, mainly for light vehicles, has become the strategy adopted by policymakers and the automotive industry.

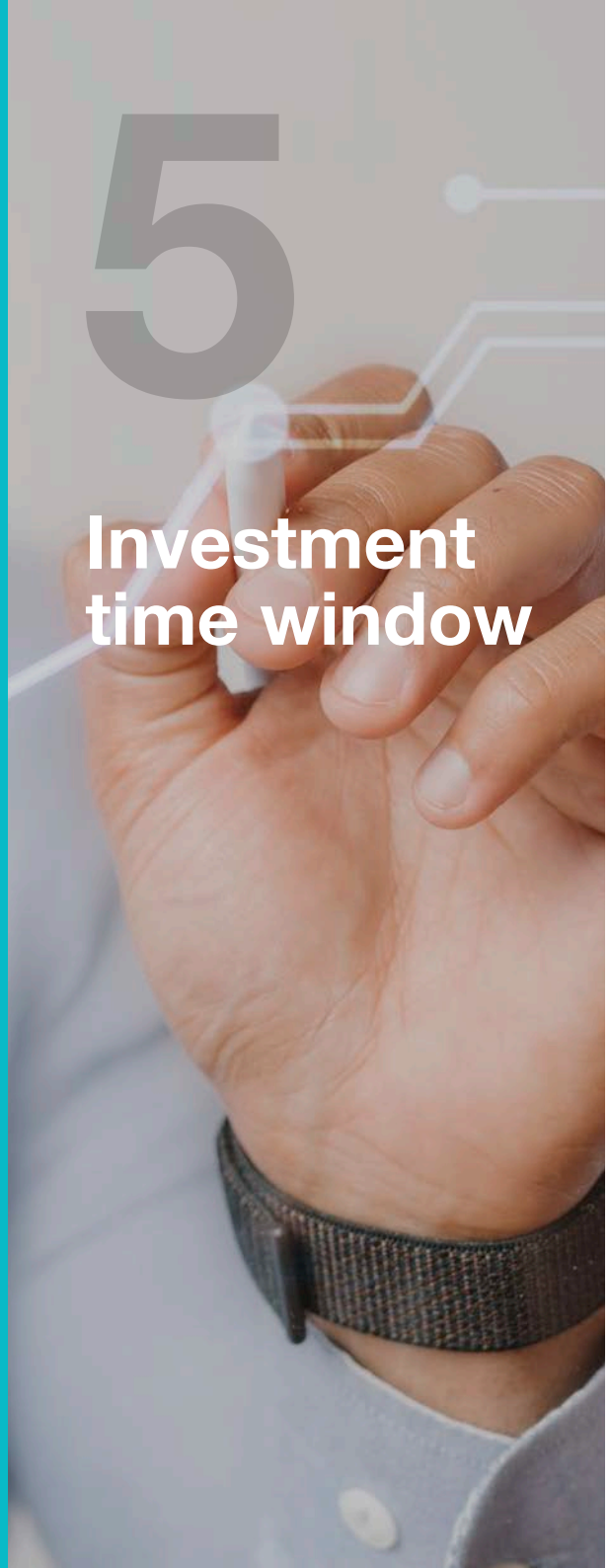
Medium and heavy vehicles are expected to adopt a combination of natural gas/LNG, fuel cells and some electrification, as powertrains of the future.

The vehicle fleet in Latin America & the Caribbean is still in very early stages of penetration of electric vehicles and other alternative powertrains. Questions remain about the transition to alternative powertrains, as the region lacks a robust power grid, and the economy relies heavily on road transportation of goods and people over long distances, on inefficient road systems. In addition, the purchasing power of the population limits the possibility of switching to cleaner, and at the same time more expensive, energy sources. In addition, Governments justifiably have other priorities, such as the economy or the promotion of health, education and development in general, which limits the amount of resources they can devote to the promotion of these alternatives.

Despite global trends, the region is still experiencing growth in the automotive fleet and a growing demand for internal combustion engines, with peaks in demand expected in horizons greater than a decade for gasoline, and up to two decades for diesel in some countries.

In other countries, added to the uncertainty regarding the horizon of penetration of other energy sources in the industrial and transport segments, there is economic uncertainty that has a high impact on the demand for refined products.

If we consider the potential impact of electric vehicle development and the use of other energy sources for mobility on refining capacity, the region's net gasoline and diesel import position will delay the volumetric impact on refiner sales in general, although it will impact first in the most commercially balanced countries in gasoline. However, the greatest impact is expected not to be by volume, but by the low relative margins expected by the global trend of demand vs. supply of refining capacity.



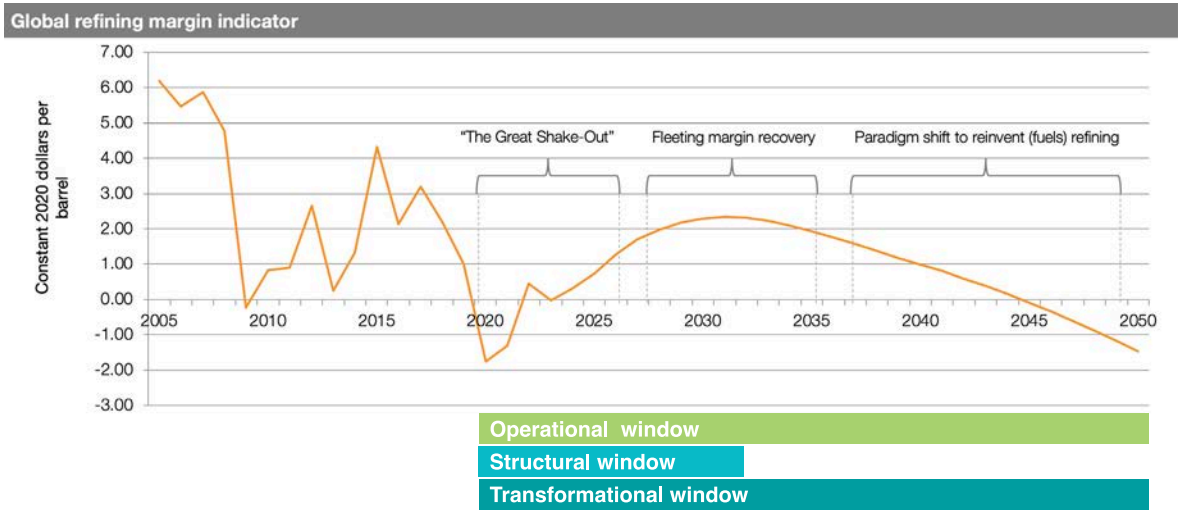
5 Investment time window

To adapt and overcome the challenges of the energy transition, the refining sector in Latin America & the Caribbean will have to invest in its facilities and human capital.

The conjuncture of energy transitions hurts expectations regarding the refining margin profile of the future, and challenges discipline on invested capital. The low relative returns on hydrocarbon investments over the past decade, and the commitments of corporate investors to Environmental, Social and Governance (ESG) discipline, increase the difficulty of access to capital for traditional hydrocarbon projects, and particularly for refining projects, which are generally energy-intensive and carbon-intensive.

Refining faces three categories of investments, and each category has a different window in time that corresponds to the potential return on these investments and the validity of the challenges for each category. The timeline of such windows is related to the prospect of oil refining margin.

The time windows for refineries in Latin America & the Caribbean are heterogeneous according to the region and the refinery, but in general terms they are favored by the import position in the main refined products, a still growing demand and some economic protection due to the distance to the most fluid markets for a good part of the assets. On the other hand, the configuration of the facilities has significant gaps in scale, conversion and production capacity of high-octane and low-sulfur products, in relation to the expected consumption trends. As seen in the figure below, three types of investments within the industry stand out: operational, structural, and transformational.



Source: IHS Markit

Window of time for operational investments:

They are the type of investments “business as usual”. The refiner will continuously invest in operational excellence, energy efficiency and digital transformation. This combination contributes to reducing operating costs and emissions. Operating investments are usually low to medium capital.

There is still a significant gap in energy efficiency in refining in Latin Americaand the Caribbean compared to industry leaders globally. Some countries in the region have made progress in setting zero emissions targets and this will impact the decisions of refining companies. ESG reporting policies will force refineries to give special consideration to energy efficiency, including scopes 1 and 2. Energy efficiency programs have the simultaneous benefit of reducing emissions and operational costs as a competitive advantage. Investing in energy efficiency brings benefits of reduced operational cost, reduced emissions, and minimized bottlenecks in process units.

Apart from other investments, the investment in energy savings is independent of market conditions and is maintained over the life of the refinery. However, the return on investment depends on the cost of energy

(in many cases of the processed barrel itself). The time window for these investments is continuous and durable, provided that it is considered that the refinery can remain in economic operation for several years. The biggest opportunities in energy efficiency are thermal integration of processes, efficiency of equipment, furnaces and boilers, shaftwork efficiency, and operational practices.

Time window for structural investments:

The need to increase conversion and meet product quality specifications remains a constant pressure for refineries in the region. However, these investments require medium to high capital investment, and the agility of strategic decision-making has lagged behind the pace of demand and policies to improve product quality. Will it be too late for the region's industry to take on these traditional projects?

Investments that pursue a capacity increase or conversion increase have a limited window of time for their realization.

The term of the project and execution until the implementation of this type of initiative can be extended up to five years, and the necessary terms of operation for a return on investment are at least ten years.

Despite the possible considerations regarding the "delay" of peak oil demand, and the still strong import position of the region, the time window for investment in industrial configuration is extremely short considering that some countries will begin to have surpluses and dump them into the market, which will have an immediate impact on margins.

Investments related to quality increases face a similar challenge, although in most cases, they are strictly necessary to adapt refineries to the demand of the domestic transport sector and represent the only way to continue operating in a sustainable economic way, taking advantage of the time window of increasing demand and "transport" protection.

In any case, several refineries in the region are in the process of transforming their facilities to adapt them to the highest quality requirements, both octane in gasoline, and sulfur content in gasoline and diesel. Some refineries, which have already made investment efforts at the time, are already taking advantage of the available time window with better margins than those refineries that still have those adjustments pending.

Window of time for transformational investments:

how can the industry reinvent itself and transform itself into the new reality that the energy transition will bring? Basically, there are two potential alternatives: one is the focus on the supply of raw materials to the petrochemical sector, a territory closer and more familiar to oil refineries; the other is to remodel and adapt the physical asset to supply the new era of fuels and be more integrated with other sectors that will arise from the new opportunities derived from the energy transition, for example, integration with petrochemicals and adaptation to alternative/ low-carbon fuels.

The time window for this type of investment, although it depends on the magnitude of the change, does not present a defined level since it means a change in the competitive position and a transformation of the industrial model so that it adapts better to future market conditions.

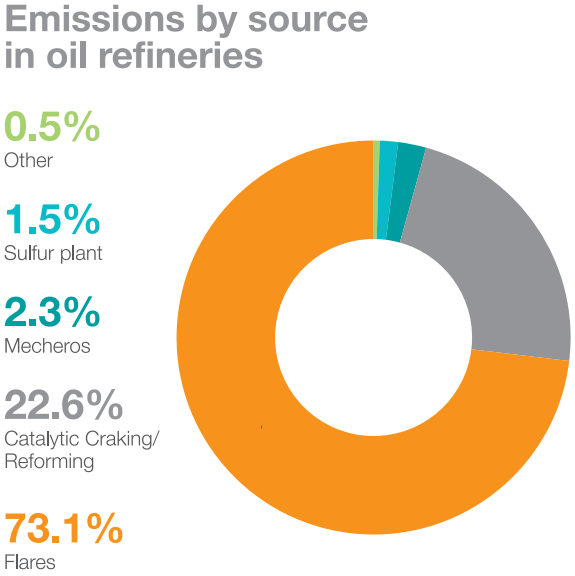
Integration with petrochemicals is discussed in a special section, later in this document. The adaptation of facilities for the loading or production of alternative fuels means a transformation that accompanies the trend of decarbonization and replacement of components and fossil fuels by renewables. While there is no expressly limited window of time for these investments, their early completion will allow for a shorter period of capacity vs. market stress for when market requirements and regulators limit operations as they currently operate.

In general, the availability of capital for these types of investments will decrease and their relative cost will increase. In any case, making strategic investment decisions at the right time will be crucial for the future of refining.

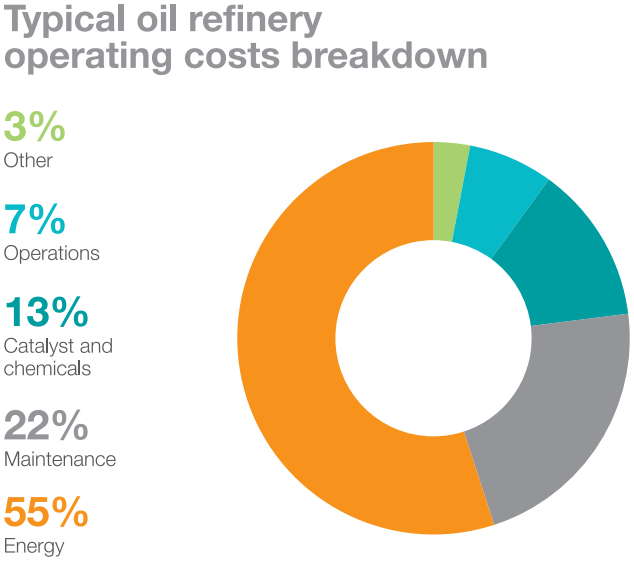
Energy efficiency

Oil refining is an energy-intensive process, contributing significantly to greenhouse gas emissions. In turn, energy use represents the largest operating cost component for a refinery, as shown in the graphs below.

Emissions by source in oil refineries



Typical oil refinery operating costs breakdown



The combined pressure to reduce emissions, reduce costs and improve margins makes the focus on energy efficiency extremely important for the region's oil refineries.

Emissions are mainly generated through combustion in furnaces, boilers, catalytic processes, and hydrogen generation. Support services, such as electric power, also contribute negatively to the refinery's carbon footprint.

The energy intensity of a refinery depends on several factors, such as the configuration of the refinery, however, the type of crude oil and the quality of the product are key variables. Likewise, energy consumption is influenced from the design stage of the installation to the operational stage.

Qualitatively, the region's refineries are neither the worst nor the best in terms of energy efficiency compared to other regions, and there is a wide range of configurations, age, and operating philosophies in Latin America & the Caribbean.

Greater demands are expected from refineries in terms of reporting and benchmarking of Environmental, Social and Governance (ESG) criteria. Most investors and policy makers are taking into account in their investments and regulations, the transparency and evaluation of companies' ESG data. The trend is to use ESG reporting to attract investors and increase societal support for the industry.

As discussed in the previous chapter, such investment decisions should be made soon, as a delay in the decision would extend the project's high-impact evaluation deadline beyond 2035, when some markets in the region expect to have reached peak demand for some fossil fuels. In this way, some investments that could be approved today will not be approved within five to ten years.

Given the short time available, the dilemma of some refineries is whether it is still convenient to invest in their facilities or direct those investments to another segment. Smaller-scale refineries that have not improved qualities and efficiency will be the first to be highly challenged. In any case, energy transitions represent opportunities for companies in the region, whether transformation and/or diversification.

6

Refining/ petrochemical integration

Even considering the impact of environmental awareness on single-use plastics, and the promotion and regulations in favor of the use of renewable materials, the demand for chemicals and petrochemicals has very high growth rates in relation to that of fuels from refining. Growth is highest in emerging markets and developing countries. Latin America & the Caribbean not only have a higher growth rate than those developed regions, but the demand is highly unsatisfied and is strongly importing this type of product.

There is a growing global trend of petrochemical and refined mix in the industry to maximize the added value of the processed barrel, installing integrated refineries and petrochemicals to take advantage of synergies and higher relative margins, with a breakthrough in new configurations of the concept of “Crude to Chemicals”, which allow to strongly increase the percentage of high-value chemicals in refineries.

The most integrated refineries have greater optionality and operational and commercial flexibility. This trend provides greater protection against margin cycles, lowering the economic break-even point of operations. The Refining / Petrochemical integration allows to reduce the risk of exposure to low or negative margins through the diversification of production and the greater added value. It can even provide better financial performance (e.g. +$1.5/bbl in the US).

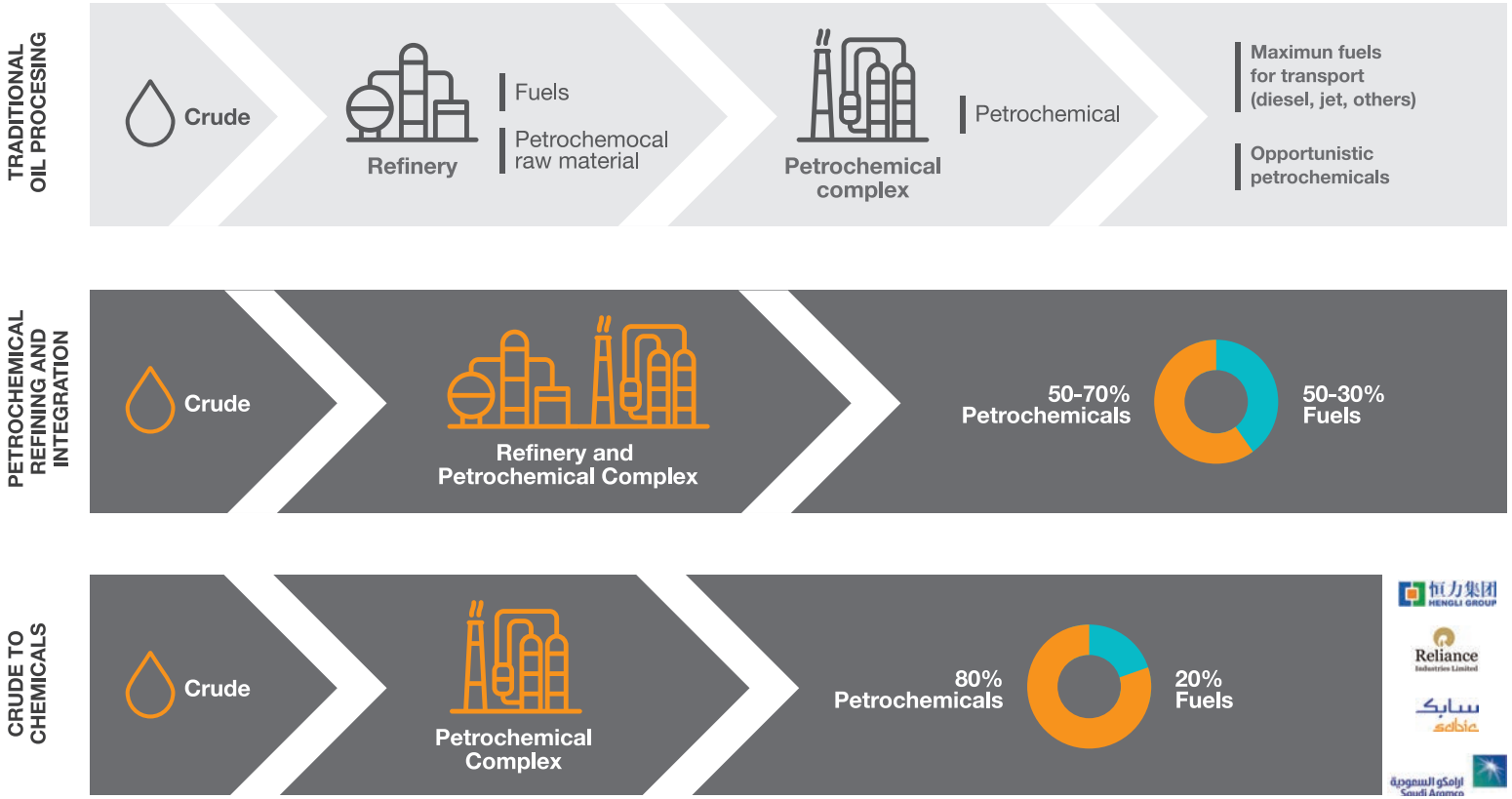
The threat to the refining market, sustained demand for petrochemicals with lower margins, and industrial and commercial synergies drive integration.

In any case, it must be considered that petrochemicals in the future will also face challenges related to emissions and pressures related to recycling that will entail higher costs.

In Latin America & the Caribbean, although petrochemical demand growth rates are high, there are few opportunities to have a scale of raw materials, stable regulatory frameworks and domestic demand in countries that justify world-scale plants, and that are in a position to compete in the export market, although there is some room to replace the high import volumes of the region.

The region in general has hydrocarbon resources for petrochemical development and there are international companies and capital interested in making investments in the petrochemical segment.

The current surpluses of light hydrocarbons and virgin naphtha, coupled with the limited demand for gasoline in the future, provide greater space for petrochemical developments in the region. On the other hand, scale is key in these developments and is presented as a great challenge for investments since they may not easily find significant markets in their proximity.



7 Digital transformation

Digitalization is a tool that allows a double benefit to refiners. On the one hand, the contribution to the energy transition itself, complying with regulations and growing conditions that contribute to the reduction of the carbon footprint. On the other hand, digitalization aimed at a more efficient operation in general, with lower reprocesses, lower unit energy consumption and more spaced stops, will help to maintain competitiveness and reduce the economic break-even point in the face of the trend of low/decreasing margins.

Although in some cases it is only the use of technologies that were already available a long time ago, the technology advances at great speed, so there are ample options for improvement, and it becomes a competitive advantage of the refinery for the long term.

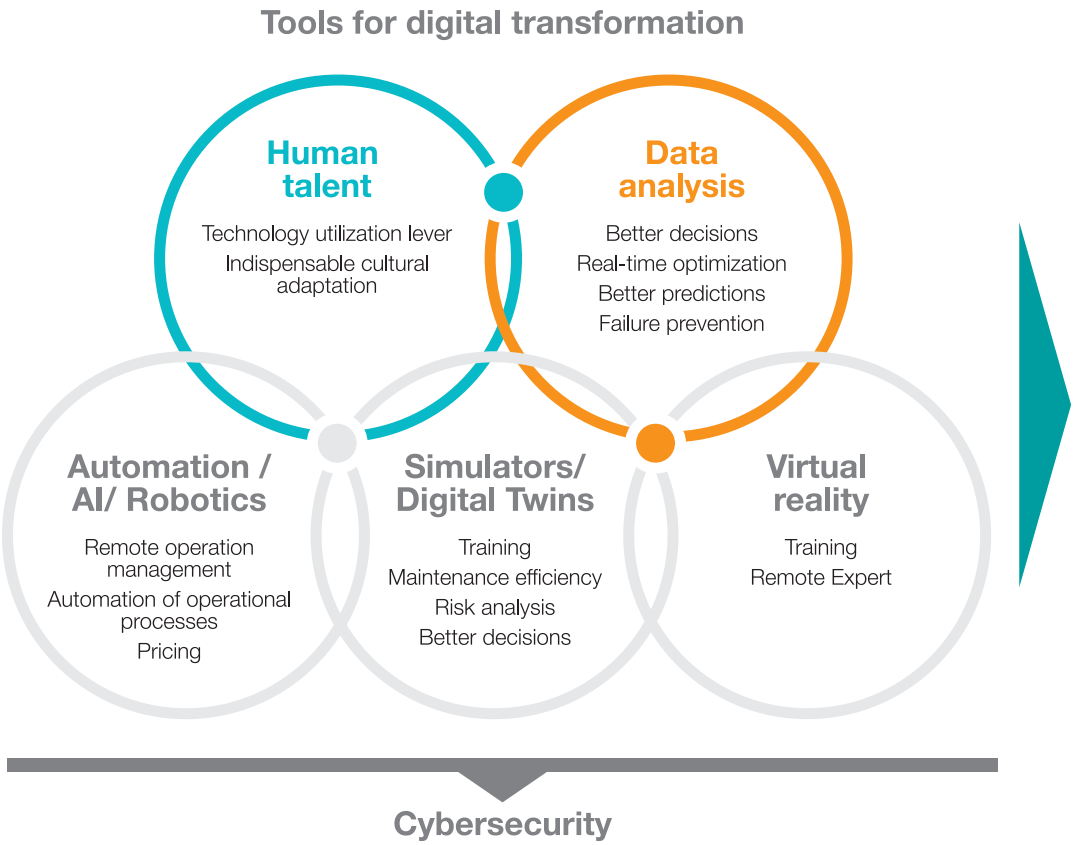
Digital transformation and the implementation of artificial intelligence will increase the efficiency of refinery operations.

This saves costs and makes it more competitive, as well as saving resources and emitting fewer greenhouse gases and other pollutants into the atmosphere.

Among the improvements that contribute to both competitiveness and energy transitions can be mentioned:

- Lower emissions
- Minor “Product Quality Giveaways”
- Lower water consumption
- Greater energy efficiency
- Lower losses of crude oil and products
- Minor reprocesses
- Increased asset productivity
- Lower volumes of out-of-specification product.
- Increased operational reliability.
- Fewer incidents and accidents.

Security is the third pillar to consider in the analysis of digital transformation. Technological improvements in the production process make it possible to increase the safety of the process, work and heritage. All these aspects also contribute positively to the competitiveness of the industry. Likewise, it is necessary to consider the fundamental role that cybersecurity occupies in the changes that are mentioned. All the tools needed to navigate digital transformation are largely tied to cybersecurity.



Capital savings	Longer cycles of stops Lower high-impact failures
Lower Man-Hours requirement	Increased labor productivity Staff available for other activities
Greater sustainability	Lower energy consumption Lower emissions Less pollution

Dilemma “Configuration improvement vs. Environment”

Energy transitions generate a dilemma for the refining sector since they pose a “trade-off” between the investments necessary for the economic sustainability of the business and the reduction of greenhouse gas emissions required to maintain the social license necessary to operate.

Configuration Competitiveness

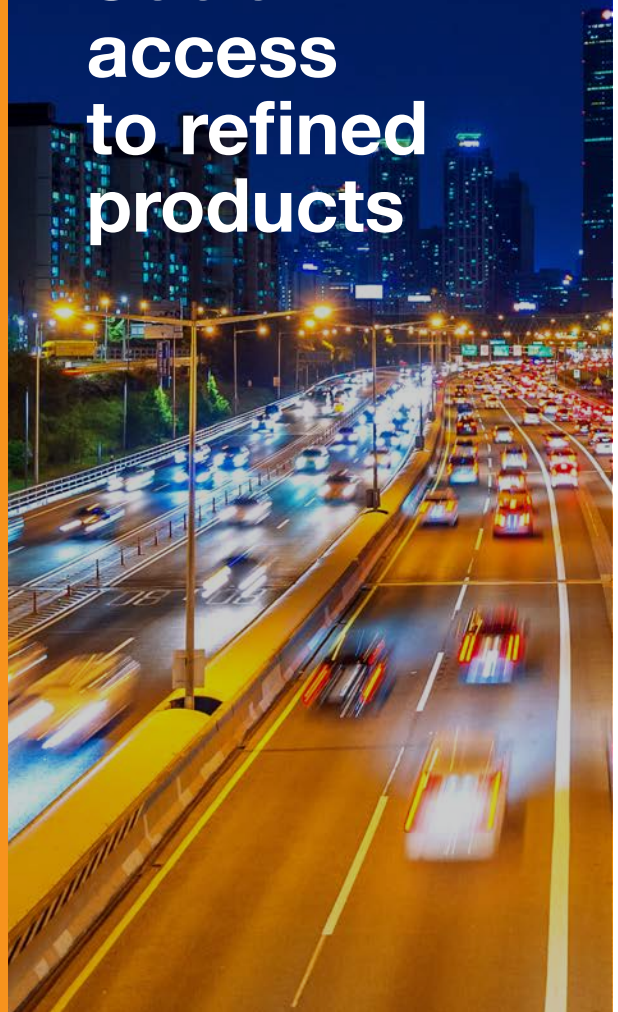
Higher conversion
Increased hydrotretting
Octane increase
Refining/Petrochemical Integration

Social License Requirements

Lower emissions
Lower energy consumption
Lower water consumption.
Less pollution

9

Social access to refined products



Latin America & the Caribbean is a region that has more than 15 countries (with more than 625 million inhabitants) where the GDP per capita does not exceed 7,000 dollars per year. The degree of satisfaction of the basic needs of the average population in these countries and in the region in general is low, and a good part of that population cannot access transport (neither public nor private), or hydrocarbons for heating or hot water.

On the other hand, the growing demands that accompany the trends or commercial impositions of developed avant-garde countries, related to the raw material used, emissions and effluents from industrial operations, emissions from engines, the composition of fuels and taxes on automobiles and fossil fuels, make increasing investments and expenses of refineries to stay in the market, meeting the increasingly demanding demand, complying with the corresponding regulations and maintaining the social license to operate. These higher investments and costs are transferred to prices that are more difficult to face by a significant part of the population of the region, partially limiting access to hydrocarbons as a source of energy, for a part of the population.

Some countries in the region have reduced the difficulty of society's access to hydrocarbons for transport and energy in their homes by granting subsidies or altering price formation mechanisms, with the consequent distortion of the sector's economy.

In any case, the decision of a large part of the countries of the region to accompany (even with some decalage of time) the trends of the avant-garde countries, represents for the regional refiner additional costs, which when applied to their products limit the access to refined fuels of a growing part of the population, causing an increase in the social gap with respect to those who can access these products.

Energy transitions and environmental requirements in general have a high cost and it is not clear who should bear this cost.

The entrepreneur of the sector is forced to make significant investments of doubtful return to stay in the market. The consumer faces economic constraints to face higher fuel costs (which have a high tax burden) in their industrial or family economy. Local and national governments are demanding decarbonization and less impact of operations and energy consumption, but they generally have other priority needs that limit the funds they can allocate to support transformation.

10

Strategic route of the refiner in the region

Refining faces a critical moment, with enormous challenges for its economic performance and its survival. This moment requires immediate action, as energy transitions have accelerated the challenges and potential impact on current operations.

The necessary actions of the refiner can be classified into the following three groups:

Focus of action: those mandatory actions and those applicable to almost any industrial and commercial configuration

Areas of opportunity: those actions that offer opportunities for the transformation of the current business and profitable and sustainable potential growth.

Portfolio review: actions required to exit or drastically transform operations before the value is strongly deteriorated, and it is too late to recover value from them.

Focus of action:

Actions that the refining sector in general must follow to remain competitive in a market that presents an unfavorable future context:

- Increase the production of chemicals/ petrochemicals vs. fuels
- Introduces renewable raw materials into processing or co-processing, and chemical recycling or waste recovery
- Produces combustibles, and other low-carbon products and solutions (H2, GNL, methanol, electric vehicles, batteries, etc.). It should be clarified that some of these solutions are still in the pilot stage in the region.
- Define a time horizon to reach zero net carbon emissions
- Optimize and improve energy efficiency in operations
- Analyze the own energy matrix: the type of electricity generation, fuel oil vs. gas, the efficiency of the process technologies that are adopted in the field, etc.
- Give yourself away from the circumstances and make sure you don’t back down from your competitive position

Areas of opportunity:

Alternatives that will not only transform the business, but could also offer protection of current assets, so that they do not lose their value, either partially or totally. They offer opportunities for the transformation of the refiner's current business and profitable and sustainable potential growth.

- Integration refining/petrochemical: industrial, commercial and operational.
- Industrial investments in petrochemistry
- Participation in the entire value chain of electric vehicles
- 2nd and 3rd generation biofuels and biochemicals
- Generation of renewable energy
- Production of green hydrogen
- Regional player integration, swaps, joint supply
- Configuration improvements whose scale and improvement in product performance and quality allow acceptable returns in a limited time window

It is worth noting that -sooner or later- the refineries in the region will process "cleaner" loads, and the fact of staying in the position of using the most abundant raw material, will leave the refinery in a marginal market position, so it must be tested at what points in the process biomass or oils can be included, which is also taken by the technical staff with a lot of interest and passion. The cost of biofuels and renewable feedstocks is still a constraint, but there may be no option in the future to continue processing only fossil components.

Refining companies are the key energy supplier to the region, with a close and frequent relationship with the consumer, which can be harnessed for the development of different value, "non-fossil" solutions.

These include, for example, electric charging or services related to charging at or outside service stations, bio-lubricants or other biomass-based solutions or other renewable energy, considering the local and international markets of each refinery and international, for example, aviation.

Portfolio Review:

Operations or assets that will need to be reviewed based on new trends. There is a limited time window to change your settings or redirect your activity:

- Small-scale, low-conversion refineries near or highly exposed to fluid/volatile markets
- First-generation biofuel plants (especially palm oil plants) that do not have significant commercial anchorage in their domestic market
- Lubricant blending operations

In summary, refineries in the region must, at this critical moment in the industry, take immediate action or continue with the actions that are identified here as “focus”, related to industrial and commercial optimization.

In parallel, they must rethink their future business model in relation to their raw materials, their industrial configuration, the products they will produce and market in the future, their participation in the entire value chain of electric vehicles and alternative fuels, and their progress in decarbonization.

On the other hand, refineries must be extremely critical of assessing the continuity or drastic measures of transformation, investment or divestment of their small-scale, configuration or performance assets.

Energy Transition of the Refining Sector

Reviewer Group
Yamila Hana, ANCAP, Chief of Commercial Strategy
Ventura Croce, ANCAP, Manager of Planning & Control
Pablo Calle, EP PETROECUADOR, Deputy Manager of Operations
Daniel Ciaffone, PAE, Executive Manager of Integrated Supply & Trading
Alejandro Ballarta, PETROPERU, Chief of Strategies & New Business
Diego Agrelo, YPF, Head of Dowstream Programming
Irenaldo Pérez, CUPET, Refining Manager, Cienfuegos Refinery
Dayana Beyra, CUPET, Technical Director, Ñico López Refinery
Kim Lemmers, STAATSOLIE, Process Engineer
Daniel Busropan, STAATSOLIE, Environmental Administrator
Ernesto Gómez, ECOPETROL, Production Manager Cartagena Refinery
Alejandro Vago, RAIZEN, Refining Director Argentina

Development Group
Irene Alfaro, ARPEL, Dowstream Director
Ricardo Buyatti, ARPEL, Downstream Manager
Felipe Perez, IHS MARKIT, Downstream Director & Strategist
Daniel Monzón, ARTHUR D. LITTLE, Partner
Pablo Ferragut, ARPEL, Senior Gas and Energy Manager
Ivan Ruschanoff, ARTHUR D. LITTLE, Business Analyst
Andrés Jiménez, ARPEL, Intern

Study developed in collaboration with:

ARTHUR D LITTLE

IHS Markit

arpel REGIONAL ASSOCIATION OF OIL, GAS AND BIOFUELS SECTOR COMPANIES IN LATIN AMERICA AND THE CARIBBEAN

Regional Headquarters:
Av. Luis A. de Herrera 1248. WTC. Tower 2. Floor 7. Of. 717.
CP 11300. Montevideo, Uruguay | Phone: (+598) 2623-6993

info@arpel.org.uy

www.arpel.org