DEEP DIVE

2023

ORIZON
VALORIZAÇÃO DE RESÍDUOS

Apr, 2023

EQUITAS

SUMMARY

1. Overview

Orizon's brief overview

Orizon is a landfill operator that seeks to extract maximum value from municipal solid waste. It currently operates 15 sites in 9 states, receiving approximately 10 million tons of municipal waste per year from both public (60% of volume) and private (40% of volume) waste collectors. With the waste disposed in its Ecoparks, the company exploits revenue opportunities through the capture of biogas emissions, the issuance of carbon credits, the generation of energy, the production of biomethane and the recycling of materials. As of 2022, Orizon has captured approximately 1 million m³/day of biogas, produced 89 thousand m³/day of biomethane, issued credits of approximately 1.8 million tons of carbon dioxide equivalent (tCO2e), while generating 47.1 MW of renewable energy for the grid. We see plenty of room for growth on all fronts. The company is on the cusp of a major energy transition to renewable fuels in Brazil (and the world) and has the ability to capitalize on its unexplored biomethane potential. We estimate that it could multiply its biomethane production by 10x in less than 5 years (adding BRL 500 million EBITDA) from its current landfills alone. In addition, it is expanding its landfill footprint (acquiring 10 landfills since 2021) and expanding these operations from a pure gate fee play to a full waste-to-value strategy.

The company started in 1999 as Haztec, focusing primarily on environmental services, water and waste treatment, and residue-related equipment manufacturing. From 1999 to 2013, the company went through a period of high M&A activity, entering many different businesses that turned out to be incompatible. The mismatched and unprofitable operations resulted in an unbalanced capital structure, which led to a capital injection. In 2013, Inovatec entered the business and started an operational turnaround process. The new controller (59.3% at the time) decided to focus primarily on waste disposal and treatment and started a major divestment process of non-core operations. The team also established a waste-to-value strategy, changed the management of key operations, and restructured the company's capital structure. All of this enabled the company to return to profitability with a new strategic positioning. In February 2021, Orizon launched its IPO, raising BRL 382 million in a primary offering, and entered a new phase of rapid growth.

Since its IPO, Orizon acquired 10 landfills, entered the biomethane and energy business with its Paulínia-SP plant, and announced other waste-derived projects such as the Waste to Energy (WTE) in Barueri, organic fertilizer production with Sabesp and mechanized waste recycling (UTMs). It went from 7.5 million tons of waste received to 10.1 million tons today, while expanding its biogas collection from 775 thousand m³/day to 1.0 million m³/day. Despite being the current market consolidator, Orizon has a relatively small market share of 12%, while its largest competitor and market leader, Solvi, has 16%. In our view, the company has plenty of room to grow its asset base both organically and inorganically while deploying capital at high expected returns on invested capital (above 30%) to add energy and biomethane production capacity and other ancillary revenue streams to its current landfill operations.

Recently, the regulation of the sector has undergone important changes that open rare opportunities for Orizon's business case. Both the New Sanitation Bill (Federal Law Nº 14.026/2020) and the New Gas Bill (Federal Law Nº 14.134/2021) are important regulatory changes to the previous legal framework that should stimulate growth in the segment. Currently, around 40% of the country's municipal solid waste is illegally disposed of in open-air dumpsites. The latest regulation provides a detailed timeline for municipal compliance with proper waste management in line with international guidelines and environmental best practices. It establishes a clear roadmap from larger cities to smaller ones to adapt to the new regulation. It also anticipates legal implications for public managers who don't follow proper waste disposal guidelines.

On another front, the New Gas Bill has opened the market to free competition between private players and incumbent state-owned enterprises (SOEs). It sets clear guidelines for the distribution, marketing and transportation of gas, which is expected to unlock around BRL 150 billion in new investment by 2030. Brazilian biomethane production alone is expected to grow from 400,000 m³/day to 30 million m³/day in the same period. Abegás (association of gas distributors) believes that all imported diesel could be replaced by biomethane in the next decade, reaching a consumption of 30 million m³/day (larger than the current industrial usage of natural gas in Brazil). This is a huge opportunity for well-positioned players like Orizon to take the lead and capitalize on this highly profitable market.

The format of our investment memorandum is inspired by Baillie Gifford's framework of company analysis.

Why we invest in Orizon

Orizon has a unique combination of **i) monopolistic landfill positioning** in its areas of influence, **ii)** brownfield growth projects with relatively **simple execution**, **iii) exposure to structural long-term growth trends**, such as energy transition and GHG (Greenhouse Gas) emission reduction, **iv) strong run rate ROIC** (around 35%-40%) with less than 2-year payback projects, and **v) compelling valuation** (approx. 6x EV/EBITDA 2023e with more than 14% real IRR).

Looking at the waste management market alone, the company has only begun to fill in the blank spots on the map with a 12% market share. Historically, the municipal waste market has grown at 3% to 4% with the major players representing only a fraction of this universe. Orizon is just scratching the surface in terms of market share gains. We see the company growing at approximately 8% per year through 2026, reaching 15% market share.

In the biomethane business, the company's growth prospects are even higher. Currently, Orizon produces around 89,100 m^3/day of biomethane (or 22.5% of Brazil's total production), and we expect the company to multiply this volume by 10x by 2030 (while the industry is expected to grow 75x by then, leaving Orizon with less than 5% market share). The company's high growth will come from the 28 purification modules it expects to install over the next 7 years. In terms of biogas capture, the current 1 million m^3/day of biogas production is already enough to enable half of this biomethane volume, with the rest coming from organic landfill growth. Our observations indicate that the surge in incremental supply is closely aligned with the expected increase in demand for molecules. Our channel check indicates that current interest in Orizon's biomethane production is 10x larger than the company's full production potential. Recently announced deals signed by Volkswagen, Scania, Yara and Copergás with Raízen and Orizon show the heated demand for this future biomethane supply.

5-Year Success Scenario

In 5 years, Orizon would have reached half of its current growth plan and would be producing approximately 806,000 m^3/day of biomethane (8.6x its current volume), managing 13 million tons of waste per year (1.3x its current volume) and issuing 5.1 million tons of carbon dioxide equivalent credits (3x its current volume). The company's revenues would have grown nearly fourfold, and biomethane would be its primary revenue stream. The company would not have developed other ancillary revenue fronts such as UTMs, organic fertilizers, and WTE.

10-Year Success Scenario

The company would have reached its full biomethane production potential with its current assets, using all of its current landfills. It would have already achieved a higher share of waste disposal (around 26%). Other businesses such as mechanized recycling (UTMs), organic fertilizers and CBIOs (decarbonization credits) would have been developed. In total, there would be 5 new landfill acquisitions fully operational, with biogas and biomethane production, 20 UTMs in place, around 1.5 million m^3/day of biomethane production and running at 1.7 million CBIOs issued per year. Orizon would be running at BRL 4 billion EBITDA (9x today's) but on a much less capex intensive trajectory, capturing the high cash flow generation of its existing Ecoparks.

What could go wrong?

Although most of Orizon's projects are within its current operating footprint, the company faces a significant challenge in executing its robust expansion plan as growth prospects are high and concentrated in relatively few years. Orizon could also face potential delays in its growth agenda due to the bottleneck in the supply of biomethane purification modules. Today, there are very few major international suppliers of these modules, and the long-term trends discussed are at play around the world, which implies potential risks of module shortages.

We also see financial leverage as a source of risk to growth and value creation (Orizon's leverage is 4x net debt/EBITDA). The company may seek project partners or equity issuance to finance such growth. Depending on the terms, such a capital raise may be dilutive to current shareholders. This is currently under discussion and may remain a risk as the capex cycle progresses.

Management's engagement with public authorities is also a source of potential risk. As the majority of waste disposal is undertaken by local authorities and all landfill operations are subject to licensing by public authorities, the Company's day-to-day operations require constant interaction with government officials. Government persecution and allegations of corruption are unfortunately common in Brazilian history. Although we have very good references from the current management who have a clean track record, the company's interactions with government officials will always be a source of risk and something to be monitored.

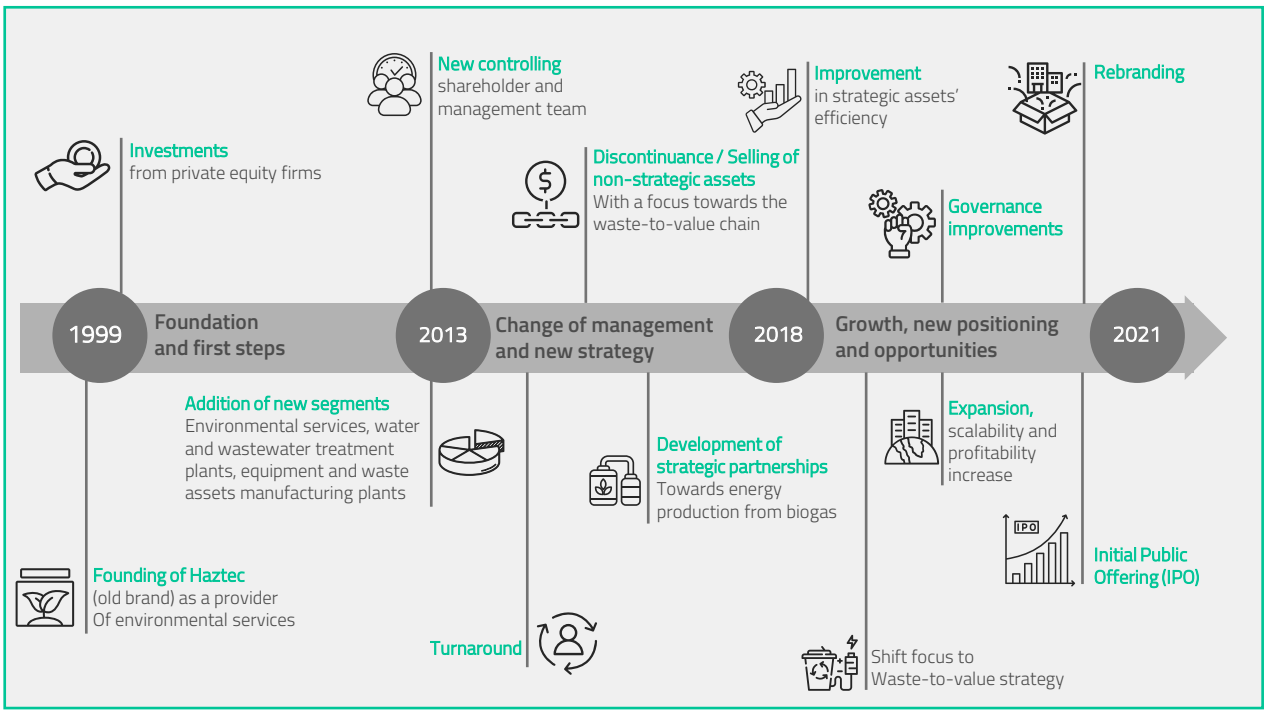
How Orizon fits in our portfolio

Orizon offers a unique opportunity to be exposed to long-term secular trends as well as idiosyncratic micro dynamics that are relatively unaffected by macro conditions and the political environment. This is an investment case where the outcome is much more dependent on management execution and specific competitive dynamics than on the domestic economic cycle or long-term interest rate movements. It adds to our portfolio exposure to growth trends in renewable energy and the potential development of the carbon credit market in Brazil.

10 QUESTIONS

1. **Can revenues double in the next 5 years?** Yes, in our base case, Orizon's revenues more than double in 5 years, mostly driven by biomethane expansion (from 8% of revenues in 2023 to 46% in 2028).
2. **10 years and beyond?** We expect the company to achieve approximately 20% of the solid urban waste management market share and 5% of total domestic biomethane production by 2033, leaving plenty of room for further growth in the same avenues it has been exploring.
3. **What are Orizon's competitive advantages?** Very difficult to replace its current landfill footprint operation and monopolistic presence in its areas of influence. Orizon also has differential access to capital (as the only publicly traded company in the sector) to finance its growth. It also has a first mover advantage in biomethane and other waste value alternatives.
4. **Does it have a unique culture?** The management team appears to have a strong focus on operational results and growth delivery, aligned with long term value creation. However, we need to better understand the company's culture and how it will evolve as the company grows.
5. **Do customers like it?** Customers have shown recurring demand for waste management over the years, indicating high satisfaction and limited alternatives given the "natural monopoly" characteristics of the business. In addition, industrial customers have signed long term contracts with Orizon for the supply of biomethane, which is a sign of confidence in Orizon's capabilities and quality of service.
6. **Are the returns attractive?** Yes, historical ROIC is around 20% with an EBITDA CAGR of 28% over the last 5 years.
7. **Are earnings expected to increase?** Yes, significantly. We estimate a run rate ROIC between 35% and 40% with a 5-year CAGR of 37% in EBITDA.
8. **What about capital allocation?** The track record is impressive. In the last 2 years, Orizon has acquired landfills with attractive valuations, engaged and developed a thermal power plant at record time and high ROIC, and announced profitable adjacent projects.
9. **Can we multiply our investment 5x in the next 10 years?** We see Orizon negotiating an attractive nominal IRR of 19.0%, which would be enough to multiply the investment by more than 5x in this time frame.
10. **What does the market not understand?** We believe that the market doesn't fully understand the value potential of the company, mainly due **to i) complex financial modeling**, **ii) lack of publicly traded peers** and **iii) low share liquidity.**

2. Orizon's History

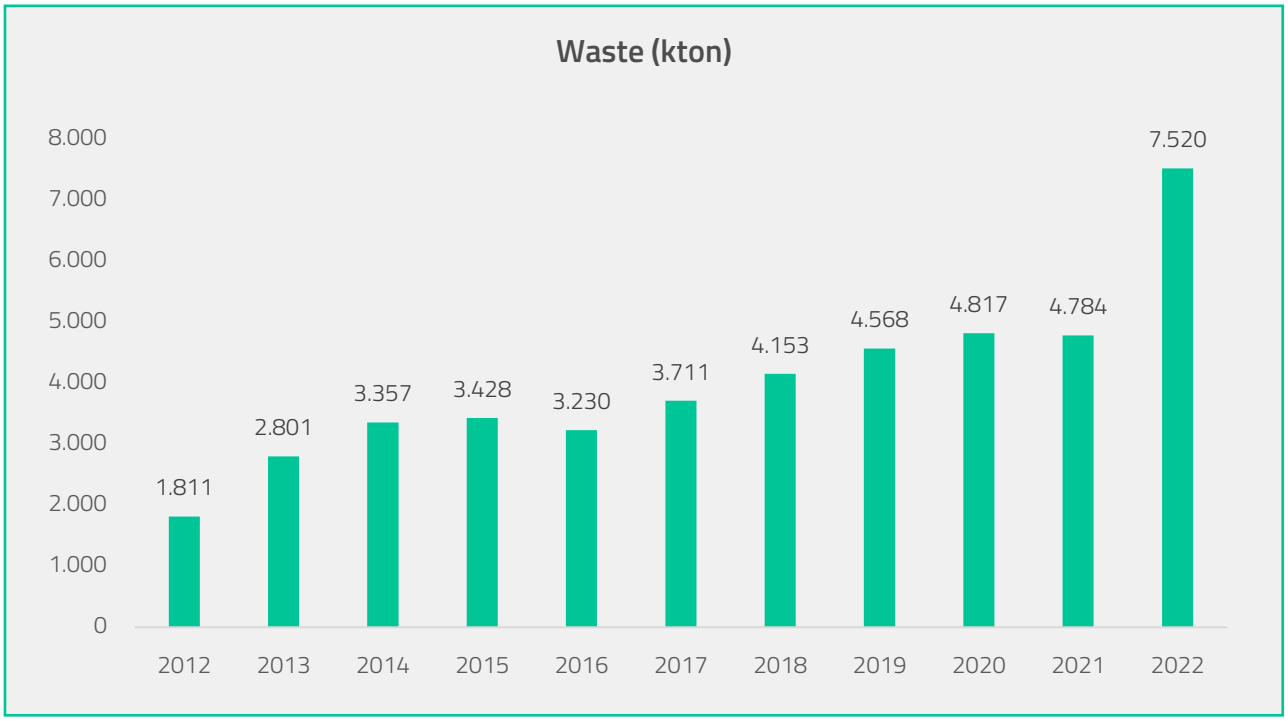


Orizon Meio Ambiente was founded in 1999 as Haztec Tecnologia e Planejamento Ambiental S.A. ("HTPA"), with activities in environmental services, water and waste treatment, and manufacturing of equipment related to residues. From 2007 to 2010, the Company invested in many segments through M&As, as well as in organic expansion of its activities in all its segments.

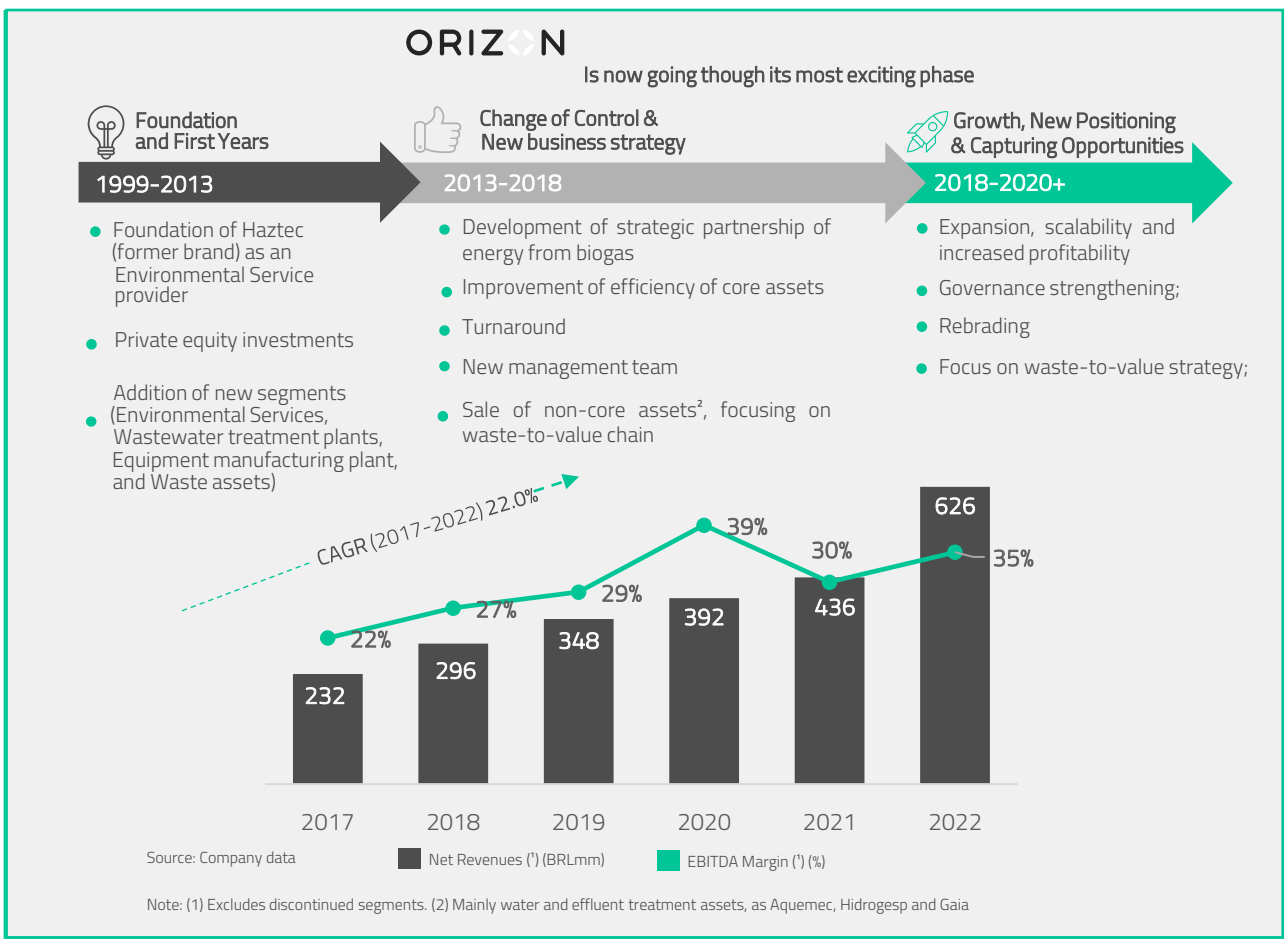
In 2009, HTPA's holding company, Haztec Investimentos e Participações S.A. ("HIP"), was established as an investment vehicle for HTPA's shareholders to provide greater strategic flexibility and financial leverage. However, unable to realize the synergies from its M&As and investments made over the years, Haztec began to look for new investors to restructure its balance sheet. In March 2013, after a new capitalization round, Inovatec became the majority shareholder with a controlling stake of 59.3%. The new shareholders, aiming for a turnaround, made several operational changes in the company, including the decision to focus on services related to **final waste disposal and the waste-to-value strategy.**

As part of this new business strategy, the company carried out a major divestment plan, which resulted in the sale of old companies such as Geoplan (industrial water treatment company), Hidrogesp (water and sanitation), Gaiapan (industrial residual waste treatment equipment supplier) and Tribel (largest environmental services provider at the time), while also terminating former activities as Aquamec (water and sanitation). Orizon also turned its attention to improving the operation of landfills, adjusting gate fees (price charged per tonnage of municipal waste received), initiating biogas exploration and energy operations in its eco-parks.

Since then, waste management and disposal has been Orizon's main source of revenue, accounting for 61% of its revenue in 2021, while the volume of solid waste received by the company has increased from 3.7 million tons/year in 2017 to 7.5 million tons/year in 2022 (CAGR of 15.2%).



This strategy has resulted in healthy growth and margin expansion: EBITDA margin increased from 22% in 2017 to 35% in 2022, representing a growth of 2.6 percentage points per year[1], and net revenues increased from BRL 232 million to BRL 626 million, representing an annual growth of 21.9%, higher that the growth of waste managed volumes.



1 Latest data available from 2017. CAGR from waste volumes also calculated from 2017 for comparison

In 2020, the company rebranded itself as Orizon Valorização de Resíduos and went public in February 2021. The primary offering of BRL 382 million allowed the company to expand further, acquiring 10 landfills and entering **other niches in the waste-to-value chain.**

In 2022, Orizon, through its subsidiary BioE, began operating a **purification module to convert biogas into biomethane** in Paulínia. This biomethane is currently sold to UTE (Thermal Power Plant) Paulínia, a joint venture between Orizon (33%), Mercurio Holding (33%) and Gera Energia Brasil (33%), which is used as an **input to generate electricity** sold to the grid at a very attractive PPA price (more details below). The company expects to invest heavily in biomethane production in the coming years, increasing its production from 89,100 m^3/day today to around 806,000 m^3/day in 5 years.

Other waste to value operations consist of **UTMs** (Mechanical Triage Units) **and UREs** (Energy Recovery Unit). UTMs are facilities with mechanical automated separation of waste, useful for recycling and waste recovery, which can add value by recycling valuable residues such as paper, plastic and aluminum, while also forming new fuel alternatives such as RDF (Refuse Derived Fuel). Just as a parameter, in the Paulínia landfill, Orizon estimates that only 20% of the total waste received goes to the UTM, where only 6.4% is currently recycled and 17% turns into RDF, which is later sold to the cement industry as a substitute for coking coal. The company has a second project in Jaboatão dos Guararapes, where it is testing the feasibility of a brand new UTM plant on a large scale so that it can be rolled out to other viable Ecoparks.

UREs, on the other hand, are thermal power plants fueled by waste that would otherwise be destined to landfills. In this front, Orizon has developed a pilot project together with Sabesp for the energy recovery of waste. Waste to Energy (WTE) is an alternative method of waste disposal, usually suitable for densely populated cities where additional landfill space is becoming increasingly scarce. Unlike conventional landfills, which cover waste with soil, WTE facilities consist of a giant incinerator that uses the heat content of the waste to generate electricity. Orizon plans to enter this alternative segment with its Barueri project, which is expected to be operational in 2026.

Orizon plans to extract value from the waste it receives at its landfill from many other sources, such as carbon credits, organic fertilizer production, and CBIOs issuance. We will discuss each of these opportunities in more detail later in this report, but it is important to note **management's focus on the waste-to-value strategy.** Since its IPO in 2021, the company's waste intake has grown from 4.79 million tons to 8.15 million tons, its biogas production has grown from 719,000 m^3/day to 958,000 m^3/day (which can be available for later purification into biomethane), its Carbon Emission Reduction (CERs) issuance has grown from 1.63 million tCO2eq to 1.82 million tCO2eq[2], and it has effectively entered the power generation business with 47.1 MW of secured capacity.

This significant growth is the result of careful planning and execution of operational activities that seize good opportunities. In recent years, Orizon was able to raise the volume of waste intake in its existing landfills, but the bulk of the increase in revenue and waste intake was due to the acquisition of Estre's assets. This acquisition took place after Estre filed for bankruptcy in May 2021. Orizon, together with Jive Investments, an asset management firm focused on distressed assets, bought Estre's distressed debt and converted that debt into ownership of its former landfills. Orizon then acquired Jive's stakes in these assets through a transaction financed by the issuance of bonds and shares to Jive. The total value paid in cash and shares was BRL 727 million and increased the company's footprint by 7 sites, reaching a total of 15 Ecoparks today. With the newly acquired landfills, Orizon almost doubled its waste intake and is in the process of extracting maximum value from the acquired assets through its usual strategy of biogas capture, biomethane production, UTM operation and carbon credit issuance.

2 Estimates were made with 3Q22 and 2Q22, annualized, already considering the incorporated Estre's old assets.

3. Management

Orizon's administrative structure is composed of six institutions: Statutory Directory, Board of Directors, Administrative Council, Financial Council, Audit Committee and Ethics Committee. The Board of Directors is in charge of establishing the general policies of the company and electing the directors, who are in charge of the management and administration of the company.

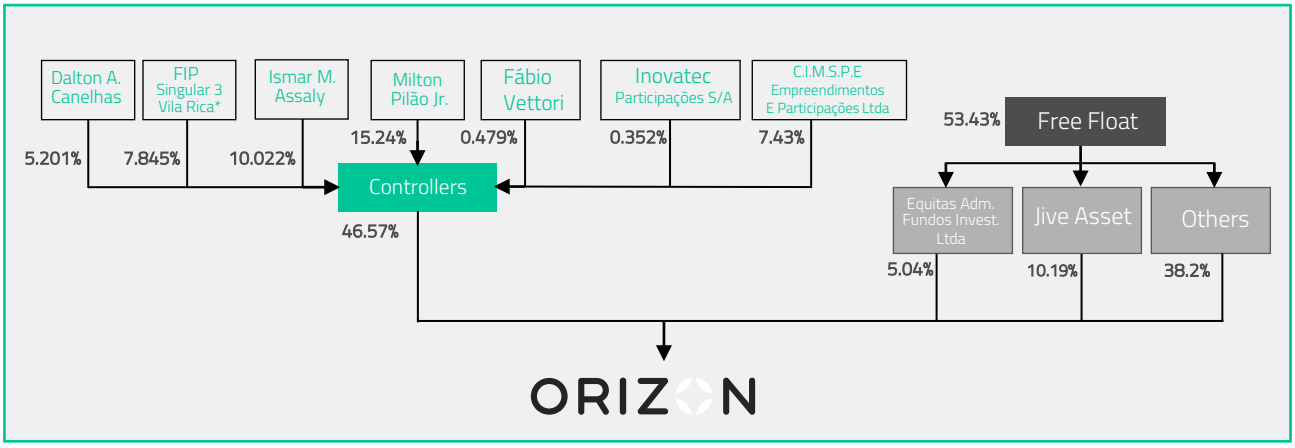
The company's top management is composed by Milton Pilão (CEO and Board Member), Dalton Canelhas Filho (COO) and Leonardo Santos (CFO and IR).

Milton Pilão is an industrial engineer and has extensive management experience in Pilão S.A. Máquinas e Equipamentos (former shareholder) in the production of machinery for the pulp and paper industry; in the Andritz Group (former executive) in the installation, equipment and services for industry; and in ATT Ambiental (former shareholder) in the treatment of hospital waste.

Leonardo Santos has a bachelor's degree in economics and a master's degree in finance from IBMEC. His previous work experience includes CPFL Energia, Estre Ambiental and Corporate Finance at EY.

Dalton Canelhas Filho is a Civil Engineer by FAAP and worked in Schahin and Alca. Since 2013, he has overseen Orizon's operations, assets and environmental licensing, and became COO in 2020.

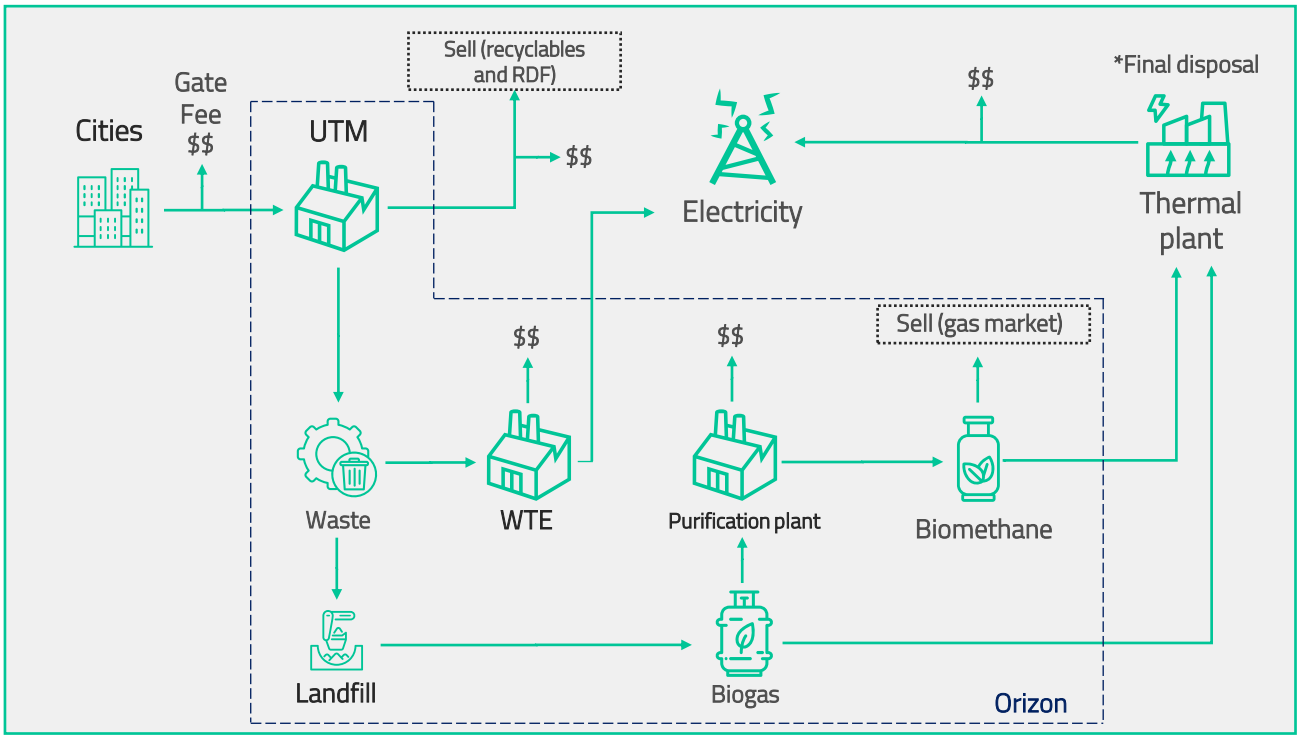
Milton, Dalton and Ismar (through FIP Singular 3 Vila Rica and own investment vehicles), together with Fabio Vettori (through C.I.M.S.P.E Empreendimentos e Participações Ltda.), are Orizon's controlling shareholders.



Source: Bloomberg and IR. (atualizado em Feb/22)

4. Orizon's opportunities

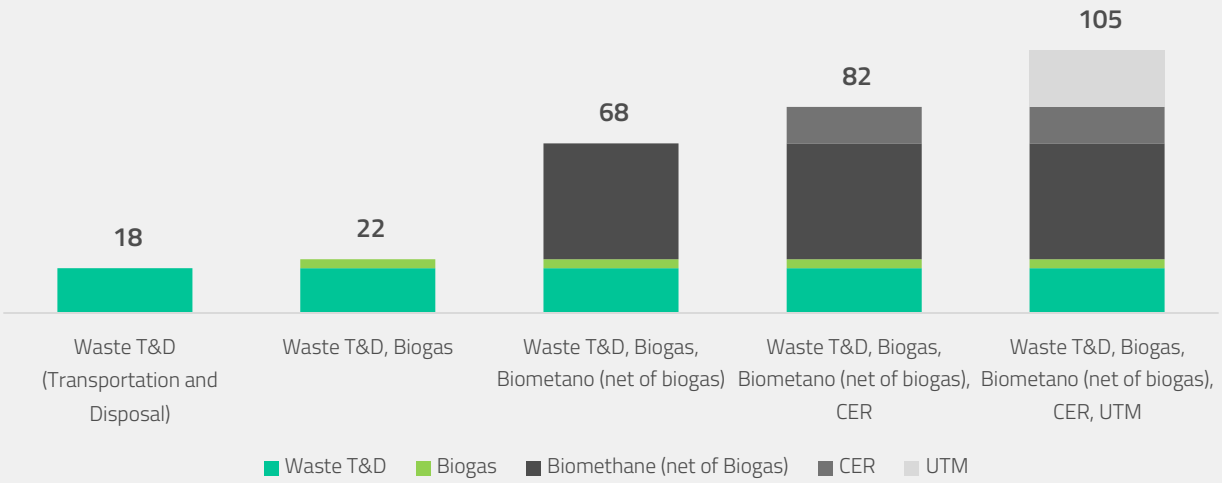
Originally, Orizon's activities were limited to waste management and treatment. However, Orizon has expanded the scope of its operations and broadened its presence in the waste-to-value chain. These segments include biogas collection, biomethane upgrading, mechanized recycling, co-processing, and carbon reduction credits. They all constitute a variety of revenue streams that are already being exploited at some sites and will be further scaled up in the coming years, leading to higher margins and value creation. Orizon's operations start with waste acceptance and end with biomethane production and energy generation.



As we will explain later in this report, **one of the main pillars of our investment thesis is based on the simple growth plan** that Orizon has laid out for the near future. The company's value accretion will come primarily from the addition of small businesses to its current pure-play landfill operation, such as: **i)** expansion of biogas capture, **ii)** biomethane production and commercialization, **iii)** rollout of UTMs (automated recycling units that better separate the waste content into valuable components that can be resold), **iv)** generation of carbon credits (CERs) by curbing methane emissions, and v) energy generation through thermal plant expansion.

It is important to note, however, that **all these projects depend on the core business of waste management, as landfill operations are the central pillar in Orizon's ecosystem.** The company's main competitive advantage comes from its unique waste treatment sites, which are fed by the surrounding urban areas (the company estimates an average radius of 35 km around each landfill), ensuring a continuous supply of waste material. By adding ancillary operations to the landfill, Orizon increases the value generated per tonnage of waste received and can maximize the value created from its assets. As an exercise, we have estimated the NPV that each additional business line contributes to the total NPV that can be explored per tonnage received at a landfill.

Value added per line of business aggregated (NPV per 1 ton received in landfill) - BRL/ton



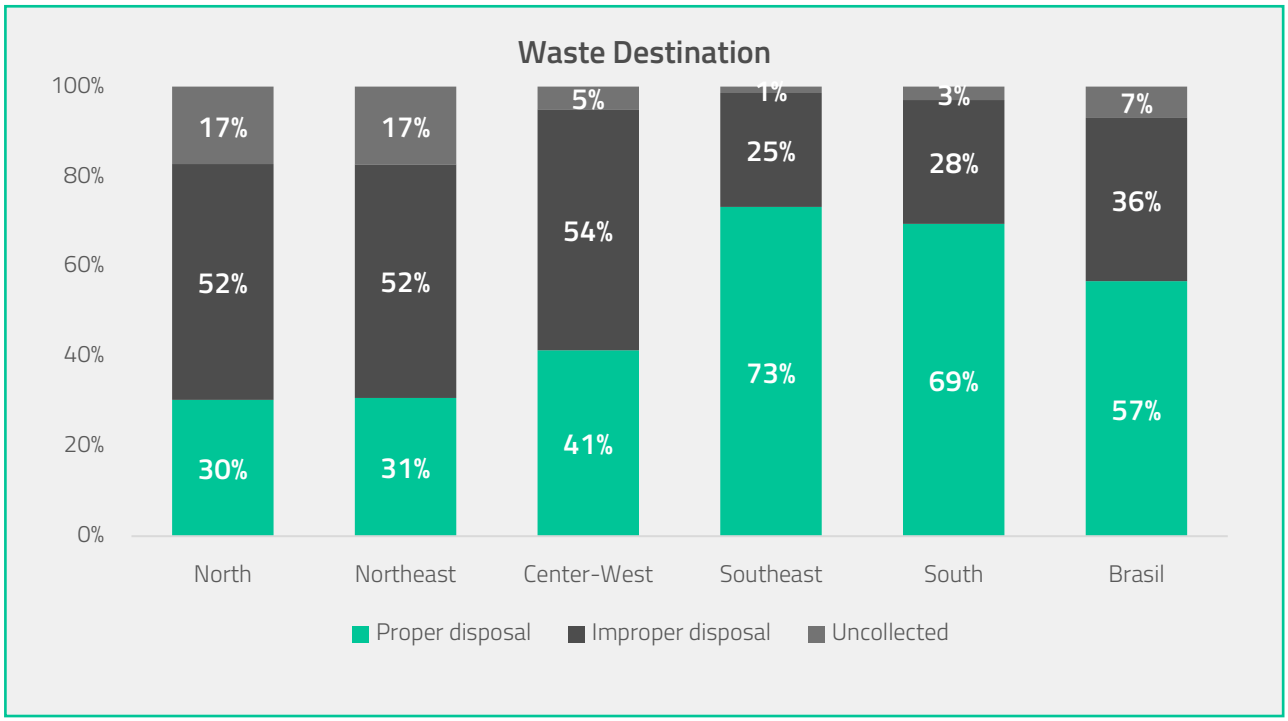
Source: Equitas.

As we can observe in the exhibit above, waste treatment and disposal represent only a fraction of the total potential value that can be extracted from waste. The NPV of the gate fee business is marginal when compared to biomethane upgrading or mechanized recycling. This illustrates the value accretion from adding ancillary businesses to the landfill and shows the attractiveness of Orizon's growth plan. In the following sections, we will take a closer look at each of these businesses and their competitive dynamics.

5. Background: Waste Management and Gas Market

5.1. Waste Management

In 2023, the sanitation situation in Brazil is still far from ideal. Some of the waste generated is still not even collected. In the North and Northeast regions, for example, 17% of the waste remains uncollected. According to a 2019 report by SINIR (National Information System of Solid Waste Management)[3], only 1.67% of the Municipal Solid Waste (MSW) generated in Brazil is recovered (reused, recycled or recovered as energy). Only 55% of the population has access to sewage treatment, while 18% has collected sewage and 27% has no sewage service at all. Access to clean water is also only 83%[4].



Source: Panorama 2022 Abrelpe (Brazilian Association of Public Cleaning and Special Waste Companies).

The bulk of the problem lies in Brazil's geography and legal framework for sanitation. At the time of the 2007 legislation (Law 11,445/2007), the necessary incentives for the universal and quality provision of sanitation services were insufficient, and there was no legal process for the regulation of sanitation actors. Some of the legislation is specific to water treatment and distribution, but we will focus on what is applicable to waste management.

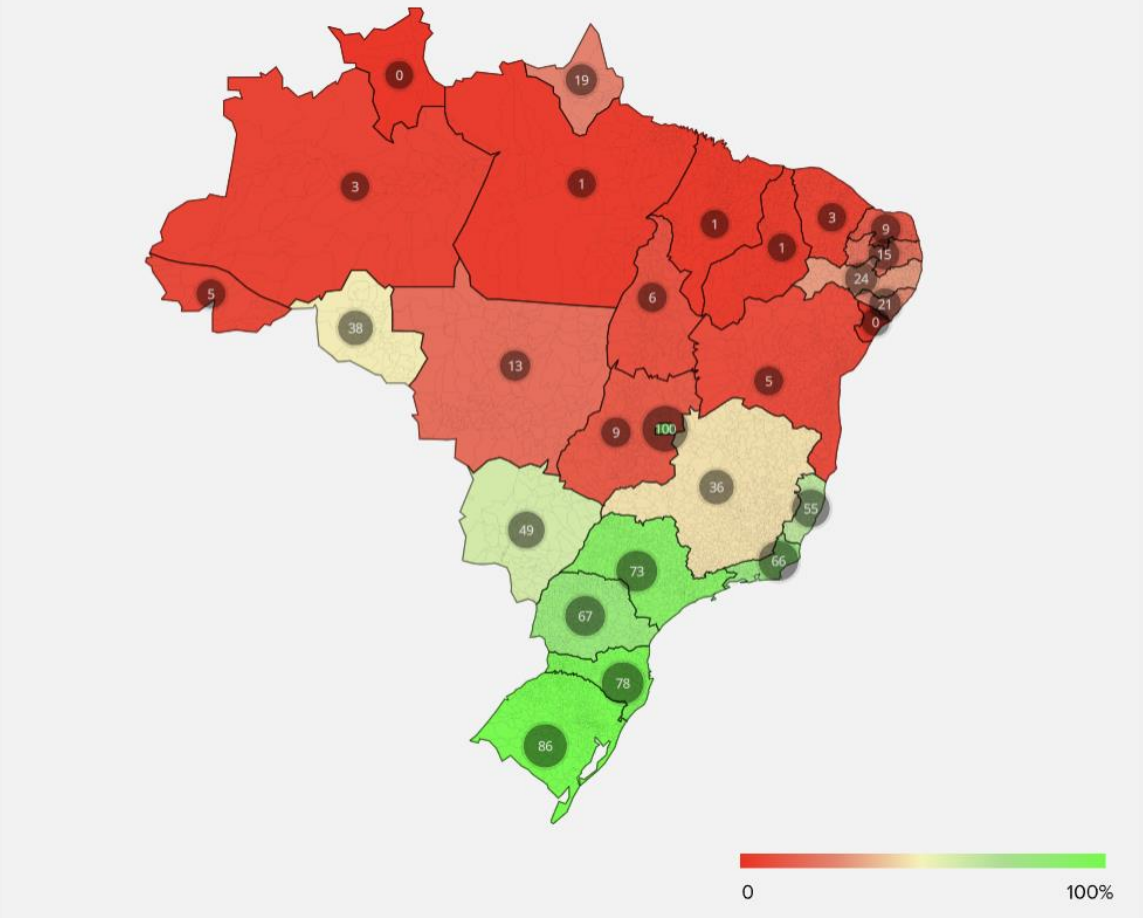
The new sanitation law, Federal Law nº 14,026/2020, is an important reform that seeks to improve the state of sanitation in Brazil, bringing benefits to the population and the environment. This law is a great opportunity for social development and improvement of living standards in Brazil, promoting a more efficient and sustainable management of hydric resources and urban waste.

[3] PANORAMA - 2022 ABRELPE.
[4] BKR AMBIENTAL: https://blog.brkambiental.com.br/agua-para-todos/#:~:text=Como%20funciona%20o%20acesso%20%C3%A0,14%25%20os%C3%A3o%20crian%C3%A7as%20e%20adolescentes

At its core, the 2020 Law provides the legal framework for sanitation, allowing the service to be provided by **regional units that include several municipalities**. This model had several advantages, such as **i)** improving **economies of scale**, **ii)** allowing the **universalization of sanitation**, **iii)** ensuring **technical viability** and, most importantly, **iv)** guaranteeing **financial feasibility**. The new law also requires **i)** that sanitation providers secure contracts exclusively through concessions and tenders, which promotes better regulated services, **ii)** reformulated ANA's (Waters and Sanitation National Agency) competencies to **regulate and institute** rules to sanitation services, **rather than to implement** policies related to sanitation itself (Article 3 of Law 9984/2020), **iii)** reformulate the attributes of personnel (Hydric Resources' Specialist), on the bureaucratic front. In summary, the legal framework for sanitation has been structurally reformulated to better serve the Brazilian population.

On the economic side, the new sanitation law stablishes parameters to guarantee economic sustainability and visibility of returns of investment to private players in the sector. One example is the framework that **requires municipalities to charge a tariff** for the services they provide to their citizens (both solid waste and wastewater). This charge can be demanded either by a private concessionary arrangement (similar to electricity charges by distributors) or by an increase in municipal tax already currently paid. This was implemented in order to improve the quality of the service and to enable more cities to honor the costs associated with adequate waste collection, disposal, and treatment (today approximately 1600 cities explicitly charge for these services). It transforms an otherwise discretionary expense into an earmarked expense for mayors. In many cases, the budget constraints associated with waste payment obligations have led public officials to opt for illegal waste disposal. Whenever these fees are not sufficient, the Union can finance specialized technical services through subsidies. This ensures the viability of more sanitation services. The map below shows how precarious waste disposal and treatment was in Brazil in 2019.

Percentage of municipalities by state with adequate final disposal of solid waste



Source: SINIR's report – 2019[5]

[5] SINIR 2019: https://sinir.gov.br/relatorios/nacional/

Some changes may take time to be fully implemented. For this reason, the new sanitation law has established a clear timetable for municipalities of different sizes to bring their solid waste management into compliance with the new legislation. It differentiates cities by population size and sets different deadlines for full compliance and dumpsite closure. For example, capital cities and metropolises had until August 2021, while cities with more than 100 thousand inhabitants had until August 2022. Cities with more than 50 thousand inhabitants have until August 2023 and cities with less than 50 thousand inhabitants until August 2024. It should be noted that these targets may be difficult to achieve and that some municipalities may still fall short of the required standards. Nevertheless, the legal framework is essential, as it sets guidelines for how public managers should handle urban solid waste. It also opens the possibility for public managers to be penalized by being in violation of the law.

The new legislation has also defined sanitation metrics and goals to be achieved in the future. The PLANARES (National Plan of Solid Waste) includes provisions on waste management, waste logistics, economic viability, coverage and energy production. We believe that the most explicit goals can benefit Orizon through **biogas and energy recovery and improvements in final waste disposal.** We highlight four key goals from the plan: **i)** improving the **economic viability** of waste management by requiring all waste management providers to charge for the services they provide, **ii) completely eliminating inadequate waste disposal** by 2040, **iii) increasing biogas recovery,** and **iv) increasing energy recovery** from solid waste to 994 MW in 2040 (from zero today). Currently, there are no operational waste-to-energy plants, and according to the SINIS database, biogas is used in only 12.5% of landfills.

5.2. Gas Market

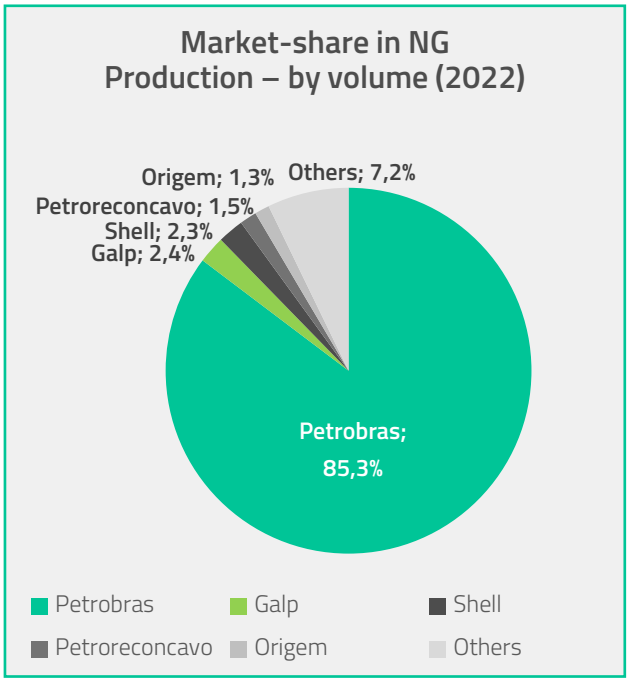
Biomethane derived from landfills has approximately the same chemical composition as fossil natural gas, making it a direct substitute. Therefore, a comprehensive understanding of the natural gas market dynamics is essential to understand the prospects of the biomethane market. Brazil's natural gas market has been historically dominated by state-owned enterprises (SOEs), primarily Petrobras, exhibiting **high concentration and vertical integration** across the entire production chain. This has created market inefficiencies, deterred private sector participation, and hindered advancements in cost efficiency and infrastructure expansion. In response, the 2021 gas law aimed to address these challenges and create a competitive, efficient, and functional gas market. **This monopolistic environment has had a significant impact on consumer prices and infrastructure investments, resulting in higher prices and a considerably smaller pipeline network** compared to other countries. The following text delves deeper into these issues and explores the implications of the new regulatory framework on the gas market, fully analyzing both supply and demand and its effects on pricing. It also shapes a specific view on biomethane future in Brazil, digging deeper into its specific characteristics.

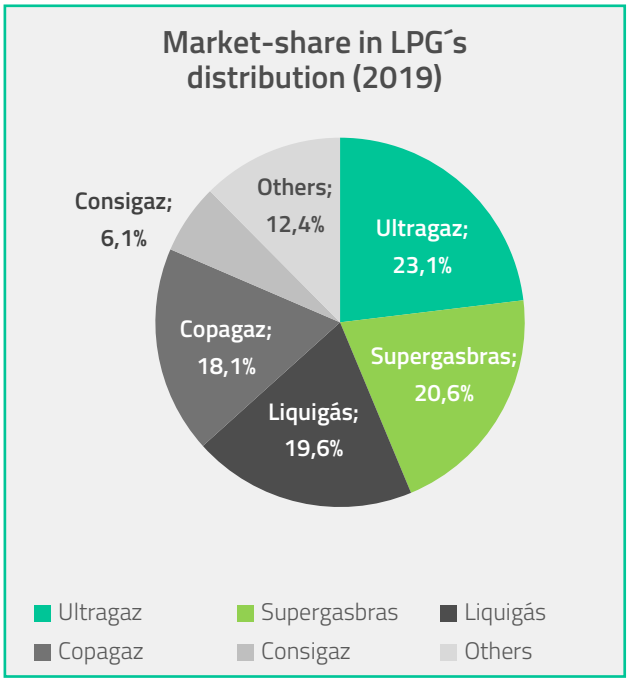
Most natural gas in Brazil is produced from oil-associated wells (circa. 85% of total production, mostly offshore) and transported to processing plants on land. NG (natural gas) is sent to NGPUs (natural gas processing units), while oil is sent to oil refineries where, among other things, LPG (liquefied petroleum gas) is produced. It is important to note that while natural gas is mostly methane, LPG is roughly composed of propane, propene, butane and butene. After processing, LPG can be transported through the grid or bottled in cylinders to be transported by trucks, while NG is mainly transported through pipelines, though it can also be transported in liquefied form (LNG). After transportation to urban and industrial centers, NG and LPG are distributed to end users.

In Brazil, gas markets are characterized by **high concentration and vertical integration in all three links of the production chain:** exploration and production, transportation, and distribution/commercialization (historically, most assets were owned by Petrobras, and only in recent years has the state-owned company reduced its footprint by selling transportation pipelines and Gaspetro). The dominance of SOEs left the sector with a lack of regulatory framework, which was mostly exercised by the companies themselves. **Monopoly status throughout the gas chain was represented by SOE dominance of transportation networks,** strong presence in national production volumes, and control of 15 of the 16 NGPU infrastructure in Brazil. This led to some market dysfunctions, which were partially addressed by the corporate divestment program initiated in 2021 (with the sale of Gaspetro) and the new gas law approved in April 2021. We will examine these market issues in turn, and how the new regulatory framework addresses some of the key obstacles to a fully competitive, free, and functional gas market. But first, it is important to explain in more details how market dominance has been and continues to be sponsored by Petrobras and a few private players in the production, transportation, and distribution of gas byproducts.

Starting with natural gas, Petrobras currently represents 85.3% of total Brazilian production. The company also operates all 3 offshore outflow pipelines and controls 3 of the 4 regassification terminals in the country. Although some of the transportation infrastructure is privately owned, Petrobras is responsible for the majority of onshore transportation capacity utilization (contracting 100% of available capacity in 2020). Prior to the privatization of Gaspetro, the government also had a direct or indirect stake (through Petrobras) in 24 of Brazil's 27 state-owned distribution companies.

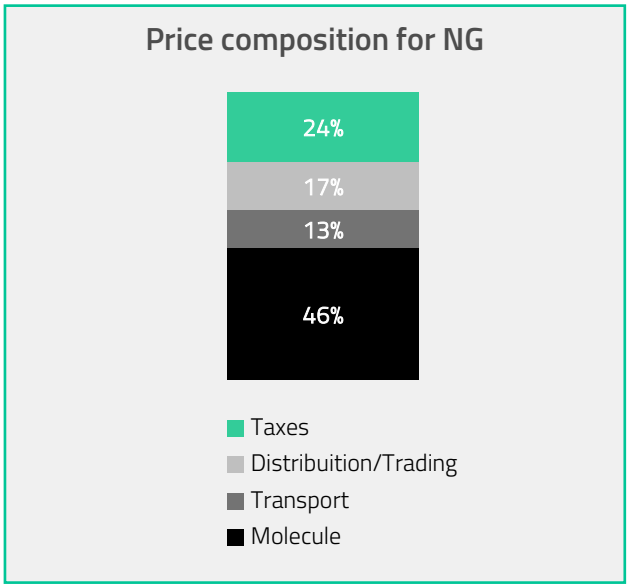
Turning to the LPG market, Petrobras' dominance is supported by its oil refineries: of the 17 refineries in Brazil, 13 are controlled by the state-owned company, while the remaining 4 private refineries do not produce LPG. **While Petrobras has a quasi-monopolistic structure in production and imports, distribution is carried out by private companies in a highly concentrated market:** 4 out of 19 distributors hold 83.4% of the market, with other minor players such as NGC Distribuidora, Fogas and Amazongás.

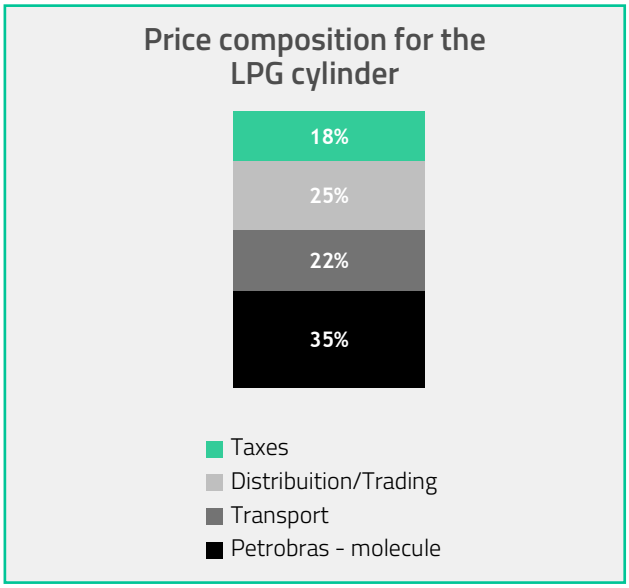




Source: Valor[6]

The entire industry was structured with the state or state-owned companies driving investment and controlling assets in most of the gas value chain. As a result, the use of assets and infrastructure was often driven by **maximizing asset utilization and public service rather than profitability.** This dynamic ultimately discouraged potential private players from entering the market as competitors, resulting in Petrobras maintaining its monopoly status for a long time, even after the opening of the gas market in 1997. **The continued monopolistic environment hindered the cost efficiency improvements and expansion investments** that a more competitive, market-oriented environment would provide. The figure below shows natural gas prices by component. As can be seen, transportation and distribution account for a significant portion of the final price of natural gas:





Source: CNI[7]

6 VALOR: https://valor.globo.com/empresas/noticia/2023/01/30/petrobras-deve-ter-ate-25-da-oferta-de-gas-para-pais-ter-mercado-competitivo.ghtml
7 UMA ANÁLISE DA NOVA LEI DO GÁS À LUZ DO INTERESSE PÚBLICO – CNI: https://static.portaldaindustria.com.br/media/filer_public/76/50/7650a980-3032-48cd-be46-c20f4cb044e7/estudo_pl_do_gas_final_dez_vf.pdf

The result is seen in both the production and distribution of NG and LPG and has a direct impact on families and businesses. Consumer prices for NG and LPG in Brazil are significantly higher than in comparable markets. In addition, Brazil currently has only 9,400 km of pipelines, while other countries such as Argentina, the US and Europe have 16,000 km, 497,000 km and 200,000 km of gas pipelines, respectively. **This clearly indicates underinvestment over the years in the transport and distribution infrastructure for natural gas.** In the case of LNG, the situation is further aggravated by the anti-competitive behavior of the few centralized and vertically integrated players exercising oligopolistic power. The current market structure prevents an efficient functioning of supply and demand, resulting in prices that are on average 2 to 3 times higher than international comparable prices.

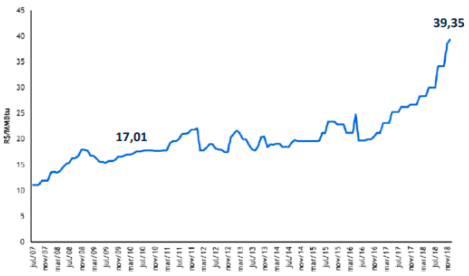
Country	Extension (km)	Capacity (billion m³/year)	GDP per capita (USD 2021)*
Brazil	9,400	65	$14,710
Argentina	16,000	73	$21,521
Mexico	18,700	91	$18,838
Europe	200,000	687	$46,861
China	90,000	600	$17,531
USA	497,000	855	$63,014

Gas price comparison

Comparison of natural gas prices for distributors – 2018 / USD MMBTU

Fonte: EPE, 2019

Natural gas molecule sales price to distributors – (BRL/MMBTU)



Fonte: MME, 2019

One of the most expensive among the main references of the G20.

Source: MME[8]

[8] MME: https://www.gov.br/mme/pt-br/assuntos/secretarias/petroleo-gas-natural-e-biocombustiveis/novo-mercado-de-gas/apresentacoes-1/20190625_Apresentao_MME_CI_Senado.pdf

5.2.1 The New Gas Market

To correct this problem, in 2019 the federal government launched the "Novo Mercado do Gás" program, which aimed to stimulate competition and efficiency in the Brazilian gas market. The program sought to **ensure energy security with fair and efficient prices for consumers through the development of new infrastructure,** with the construction of new gas transportation and distribution networks, as well as the expansion of gas import and export terminals, and to **promote innovation through incentives for R&D of new natural gas technologies.** During this period, Petrobras signed an agreement with the Federal Prosecutor's Office and the São Paulo State Prosecutor's Office (MP-SP), known as the "Termo de Compromisso de Cessação de Conduta" (TCC), to end an investigation into unethical and illegal practices in the gas and oil industry in Brazil, while committing to appropriate competition standards. This term was an important initiative to ensure transparency and ethics in the gas and oil industry and aimed to promote corporate responsibility.

In April 2021, a new law was approved by Congress and a new regulatory framework was created. The so-called "Nova Lei do Gás" (Law 14.134/2021) aimed to **improve the competitiveness and security of the gas sector in Brazil by simplifying regulation and creating a single and clear legal framework for gas.** Among the main pillars of the new law, we highlight **i)** the creation of a favorable framework for private investment in the gas sector, aimed at expanding production and transportation nationally, potentially creating a gas hub in Brazil, and **ii)** the creation of measures to increase the competitiveness of gas in relation to other fuels, such as diesel and coal. Some of the most important changes are discussed below.

The reform of the regulatory framework

The new law simplifies the procedures for obtaining licenses and permits for the construction and operation of natural gas transmission pipelines, which is expected to reduce red tape and attract new investment. One example is the **change from a concession regime to an authorization regime.** Under the previous bidding process, the government was required to develop a project, conduct an in-depth study to understand the economic conditions, set a timetable, and hold a public auction. **The whole process often took years to complete, and basically no player other than Petrobras bothered to develop the pipelines.** Moreover, the concession contract was ultimately the responsibility of the state, which created the possibility of contingent liability and economic rebalancing of the contract. Under the authorization regime, however, projects are designed and proposed by private players to the public regulator, which then receives the proposed contract and decides whether to approve it. **This gives private companies a central role in the planning process, while increasing their autonomy and capacity to manage risks in setting contract specifications.** Once approved, the economic viability of the project is entirely in the hands of the private operator, relieving the public authority of the need to restructure the contract.

Stimulation of competition

Based on the regulatory framework successfully implemented in the electricity sector in the 1990s, the new law improves the rules that reduce verticalization, with the aim of **reducing the market power of incumbents and preventing the creation of new (regional) monopolies.** To achieve this, the law prohibits players in different parts of the value chain from exercising control over the board of directors or legal representation of distribution and transportation companies. The law also prohibits vertical integration between natural gas pipeline operators and companies involved in the exploration, import and trading of natural gas. It also institutionalizes the transportation contracting model based on the **entry and exit tariff model,** allowing independent contracting. **This is a key aspect of the new law for independent gas producers and landfill operators like Orizon. It creates the possibility for these players to sell directly to end consumers under long term contracts paying a transportation fee for the owner of the grid.** It also promotes network integration, replacing the previous model where a single price was charged to all users. The new law also requires gas carriers to allow interconnection with other facilities. **These changes have significantly reduced the entry barriers for new players interested in gas transportation.**

Creation of a free market for natural gas

The law establishes the framework for a natural gas free-market consumer who can purchase natural gas from any supplier. The format of the free-market contracts will be dictated by ANP, and the law allows for the creation of a clearing house (similar to CCEE in the electricity sector) responsible for overseeing the free market.

Development of infrastructure for distribution

Article 29 of the law ensures that free market consumers and producers not connected to the natural gas distribution network can build the necessary infrastructure themselves. The operation and maintenance of such facilities will be provided by the distribution company, which will reimburse the owner of such facilities. This directly benefits industrial companies that consume gas on a larger scale than households and are located far from the existing distribution network. These companies will now be able to build the necessary network extension themselves, increasing access to gas and improving distribution coverage without having to rely on the current concessionaires to implement investments.

Open access to infrastructure

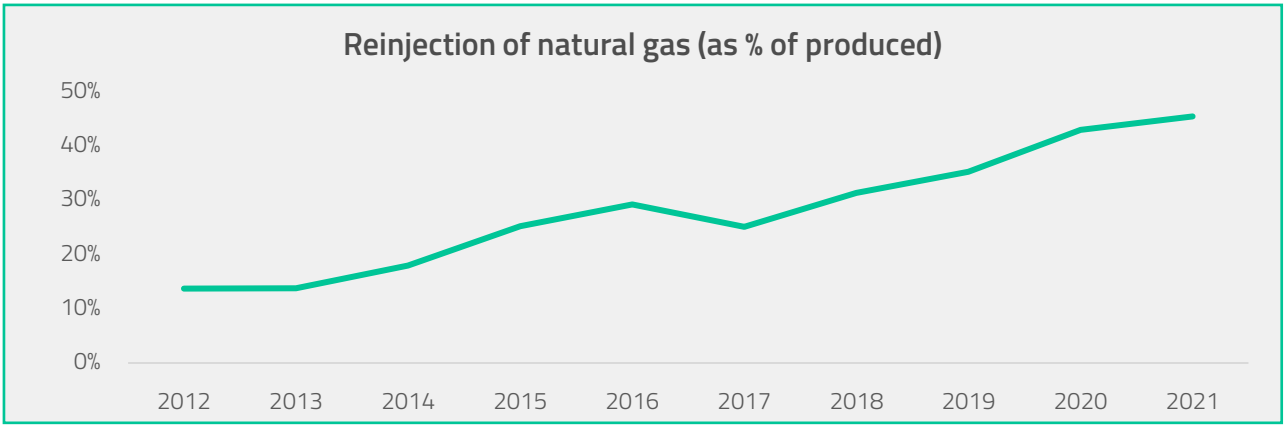
The new law encourages the entry of new players and the import of LNG by allowing third parties free access to key infrastructure currently operated by Petrobras. This should lead to an expansion of gas supply through access to regasification terminals and natural gas processing units (NGPUs). However, the infrastructure owner will have priority access to its own infrastructure, leaving only spare capacity for third-party users.

Although the new gas law has brought many advances over the previous competitive environment, some challenges to a fully operational gas market remain. One example is the last link in the gas chain, the distribution network. In Brazil, state governments are responsible for regulating gas distribution, setting operating parameters, conducting public concession auctions for the operation of the gas distribution network, and setting the tariff model. Many of the states previously served by Gaspetro had outdated frameworks established in the 1990s that did not provide incentives for operational efficiency and prudent capital allocation. **The gas distribution tariff model in these states was based on a cost-plus model, with a fixed mark-up of 20%** for any capital or operating expenditure incurred by the distribution company, whether for network expansion, personnel costs, or others. **This created incentives for inefficiency and waste** because the operating company had no risk and no goals or obligations to guide the best service provision. A total of 9 states operated in this way. We see only 3 states (SP, MG and ES) as benchmarks for state regulation and believe that this tariff model may change in some of the lagging states after Petrobras' sale of Gaspetro to Compass (which controls the distribution company in São Paulo and is a division of Cosan S.A.). We are amid a market transition and many inefficiencies are still to be addressed.

5.2.2 Supply Outlook

To understand the supply and demand dynamics expected for the gas industry in Brazil, we analyze the current supply scenario and how it might evolve in the coming years. Today, transportation infrastructure is undoubtedly the industry's main bottleneck. Last year, Brazil's consumption was 72.7 million m³/day, while domestic production was 136.1 million m³/day. Imports were around 25 million m³/day due to infrastructure inefficiencies, particularly the lack of gathering pipelines connecting offshore domestic gas production to onshore demand. The lack of gas offtake pipelines (mainly in onshore pre-salt reservoirs) resulted in an **outstanding volume of 67 million m³/day of gas reinjected into production wells, many times higher than the technical requirements for proper well life utilization.**

Natural Gas Supply (million m³/day)	2018	2019	2020	2021	2022
National Production	111.94	122.43	127.45	133.75	136.13
Reinjection	35.1	43.17	54.66	60.84	66.96
Lost and Burnt	3.72	4.36	3.37	3.38	3.49
Consumption per unit of E&P	13.74	14.16	14.62	14.31	4.44
Absorption in UPGNs	4.29	4.21	4.28	3.73	14.01
Domestic supply	55.09	56.53	50.52	51.49	47.23
Imported supply	29.03	26.95	26.26	46.18	25.44
Total supply	84.12	83.48	76.77	97.67	72.67

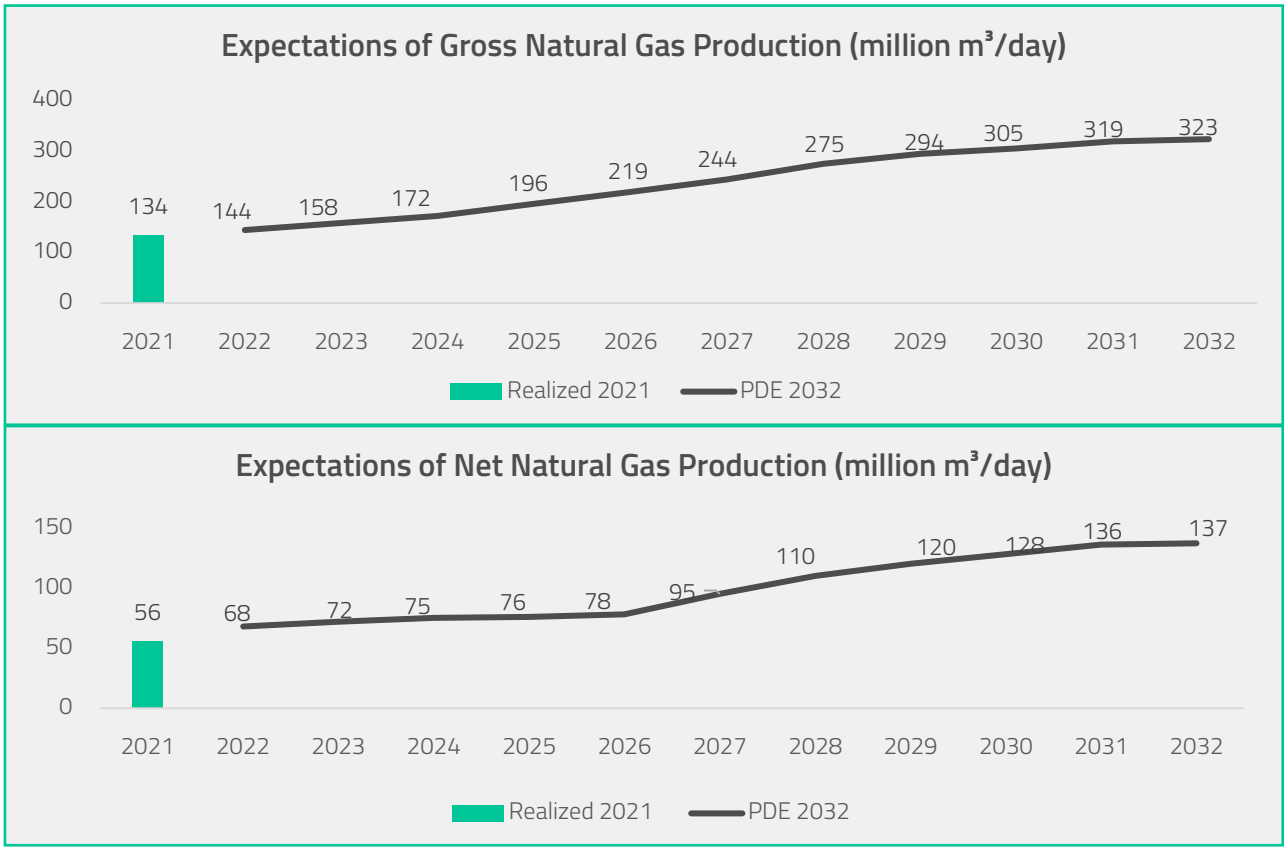


Source: ANP[9]

The IBP estimates that Brazil's gas pipeline transportation capacity is approximately 179 million m³/day. Five new projects are expected to be completed by the 2032 Energy Development Plan. Rota 3 Drainage and Transportation from Itaboraí-Guapimirim are two projects in Rio de Janeiro and will be completed in 2024, each with a capacity of 18 million m³/day. Another new transportation pipeline will be built in Ceará, with a new extension of 80 km as a preliminary phase of the project. The other two projects are pre-salt drainage (Bacia do Seal and BM-C-33), with a capacity of at least 16 million m³/day.

These are only projects that have already been approved and planned. However, as mentioned above, we believe that with the new law new projects will be launches in the future, and the ones presented here may only be a fraction of what can be achieved in the long run. According to the National Confederation of Industry (CNI), **the new gas market is expected to attract more than BRL150 billion in investments and generate more than 4 million jobs by 2030.** The regulation unleashes a huge potential for growth in the sector. The EPE estimates a volume of 323 million m³/day in 2032, or a CAGR of 8.4% 22-32, in gross production and 7.0% in net production (the forecast of net natural gas production represents the total production after deducting own consumption, injection, combustion and losses).

[9] ANUÁRIO ESTATÍSTICO BRASILEIRO DO PETRÓLEO, GÁS NATURAL E BIOCOMBUSTÍVEIS: https://www.gov.br/anp/pt-br/centrais-de-conteudo/publicacoes/anuario-estatistico/arquivos-anuario-estatistico-2022/anuario-2022.pdf



Source: EPE[10]

In terms of onshore gas supply, much of the growth will come from the development of the biomethane industry. Currently, Brazil's biomethane production is around 400,000 m³/day, but Abiogás (Associação Brasileira do Biogás) estimates that this volume will grow significantly in the coming years. According to the association, **25 new plants have already been announced in the country, with a capacity to produce approximately 30 million m³/day by 2030 (10% of total gross gas supply).** These new projects are expected to require investments of BRL 60 billion. Our channel checks with various industry players suggest that this figure could be even higher, as the mapped demand for biomethane is already higher than this figure today, and the opportunities for using green methane are many, as we explain in the next section of this chapter. Some of the current key players are:

ORIZON

Orizon started its biomethane production in 2022 and has a plan to expand its renewable gas supply to the market to a range of 700 to 900 thousand m³/day by the end of 2025. Currently, the company produces approximately 90,000 m³/day at a landfill in Paulínia (SP). The volume is currently destined for the Paulínia Verde thermal power plant (15.7 MW), but excess production at the site is expected to be marketed on the private market from 2024. In 2023, Orizon also signed a biomethane contract with Copergás (of 60,000 m³/day) to supply the upgraded biogas from the Jaboatão dos Guararapes landfill, starting in 3Q2024.

gás verde

Gas Verde is a private company owned by URCA Energia, acquired in Jan/22 for BRL1.2 billion. It currently has an assured capacity of 17.5 MW and 8.5 MW in Nova Iguaçu and São Gonçalo, respectively, fed by Orizon's biogas under long-term contracts. The company has a biomethane forecast to expand operations and implement purification modules to convert the biogas received into biomethane. The forecast for 2023 is 130,000 m³/day in Nova Iguaçu and 70,000 m³/day in São Gonçalo. Gás Verde already operates a biomethane production module in Seropédica with a capacity of 120,000 m³/day. It plans to invest a total of BRL 500 million in Seropédica, Nova Iguaçu and São Gonçalo to reach a production capacity of 400,000 m³/day by 2024.

[10] MAPA SIGÁS EPE: https://gisepeprd2.epe.gov.br/WebMapEPE/

raízen

Raízen is the largest producer of ethanol and sugar in Brazil. The company plans to start its first biomethane production plant in 2023 at its Piracicaba - SP sugarcane mill, together with the second-generation ethanol plant. The total investment is estimated at BRL 300 million, reaching approximately 70,000 m³/day of biomethane production. Raízen expects to expand biomethane production capacity to all of its 35 sugarcane mills in the next 10 years, reaching a total capacity of 3 million m³/day. The company has already announced firm sales contracts with Yara, Volkswagen and Scania for a total of 77,800 m³/day. The company also intends to use some of this volume to replace diesel in its own agricultural fleet.

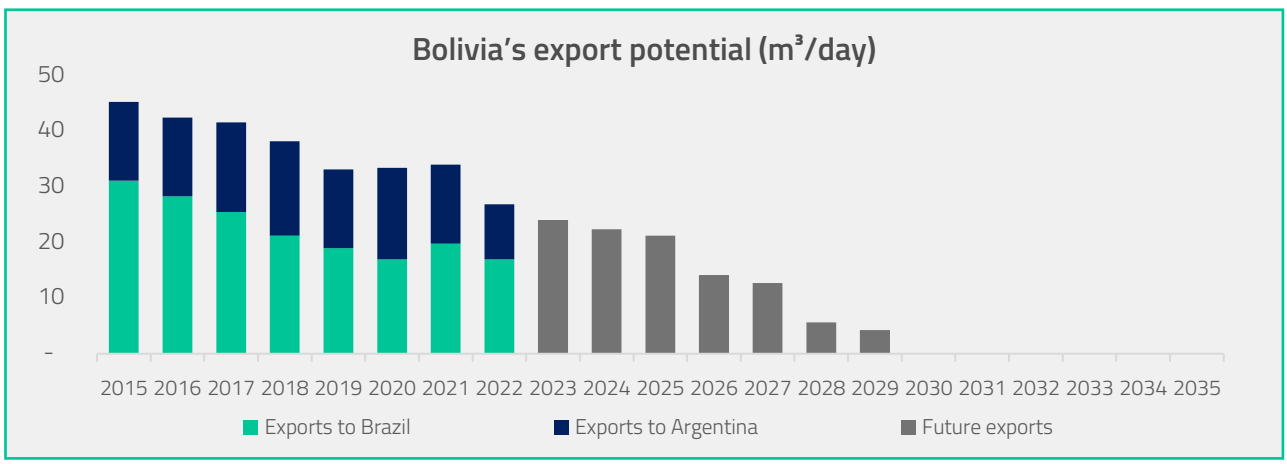
ecometano MDC

Ecometano owns GNR Fortaleza, a landfill that receives 5 kton/day. Ecometano operates the biogas treatment plant and has a production capacity of 85,000 m³/day of biomethane. The biogas treatment plant is being expanded to reach a total capacity of 108,000 m³/day of biomethane by next year. It also operates the GNR Dois Arcos, a landfill owned by OSAFI, which receives 700 tons/day and has a biomethane production capacity of 15,000 m³/day. It has plans to increase the total biomethane production to 400,000 m³/day by 2024, including the start of biomethane production at Solvi's Caieiras-SP landfill.

In summary, the new gas law creates the conditions for increasing the volume of marketed gas. The additional supply, combined with a more competitive environment, may promote a decline in gas prices for the end consumer, which would stimulate demand. This applies to both LPG and natural gas. The changes provided by the new law will remove bottlenecks and create a regulatory environment that will encourage the entry of new players and price reductions, potentially reversing the position from net importer to exporter of natural gas. A price reduction would have a significant impact on the energy supply of the Brazilian industrial sector and expand access to the nearly 14 million families that currently use firewood as an energy source.

Bolivian Gas Depletion

Declining investment in new gas drilling in Bolivia and the difficulty of discovering new wells, along with the depletion of current mature reserves, pose a major risk to Bolivia's exporter status. According to a study conducted by Wood Mackenzie, Bolivia could become a net importer of natural gas by 2030. In 2021, the government tried to counter this trend by launching the National Exploration Plan. Since then, however, **only 3 of the 20 announced wells have been drilled and found to be dry**. This has discouraged private players from investing in further drilling, contributing to the continued decline in Bolivia's overall production. It is extremely relevant for the Brazilian gas market, because of the total 24 million m³/day of gas imports in Brazil in 2022, **GasBol represents 17.5 million m³/day.** This is an overhang demand that will be released and left unattended soon and could be supplied by other national gas sources.

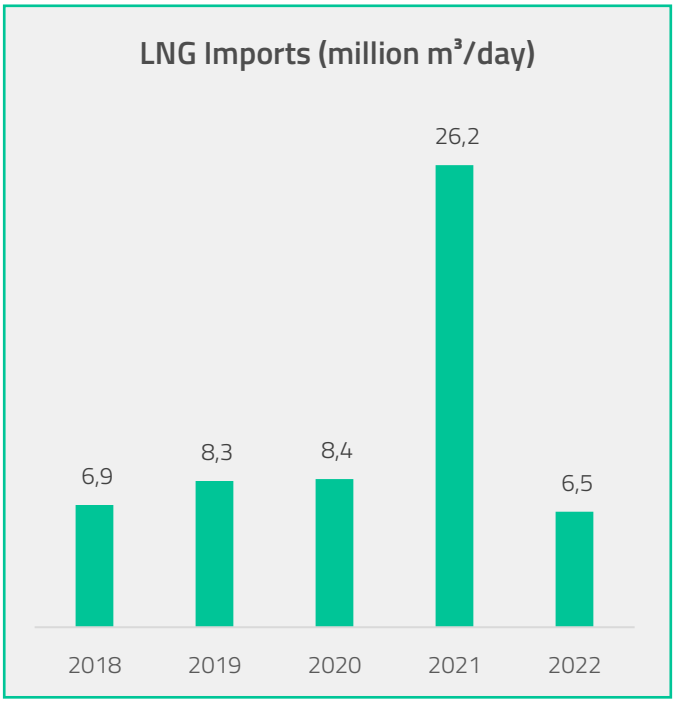


Source: Wood Mackenzie[11]

[11] WOOD MACKENZIE: https://www.woodmac.com/press-releases/bolivian-gas-production-to-decline-faster-than-expected-exports-to-brazil-and-argentina-to-cease-by-20303/

European LNG import agreement with the US

After the Russian-Ukrainian war in February 2022, Europe has experienced a great threat of gas shortage and energy crisis. Before 2022, Russia accounted for 40-55% of Europe's gas demand. When Western sanctions were imposed on Russia, Europe was forced to reduce its gas purchases from the country to around 9%. This situation created price pressures that were felt throughout the production chain and had a significant impact on inflation indexes across the continent. Industrial and residential controls were also put in place to ensure energy security. Today, Europe is still dependent on gas imports and faces the challenge of replacing Russian gas in its energy matrix. In that sense, **the European Union has set a target of zero gas imports from Russia by 2030. The United States also signed a commitment to increase LNG supplies to Europe from 15 billion m³ in 2021 to 50 billion by 2030.** This is very relevant to Brazilian supply, as 94% of Brazil's LNG imports in 2021 came from the US. LNG imports in Brazil are usually required when hydrology is unfavorable (as it was in 2021) and thermal plants on the coast must be turned on. **Competition with European demand could make LNG prices more expensive or even lead to a shortage of LNG,** opening a market not served by domestic gas producers.

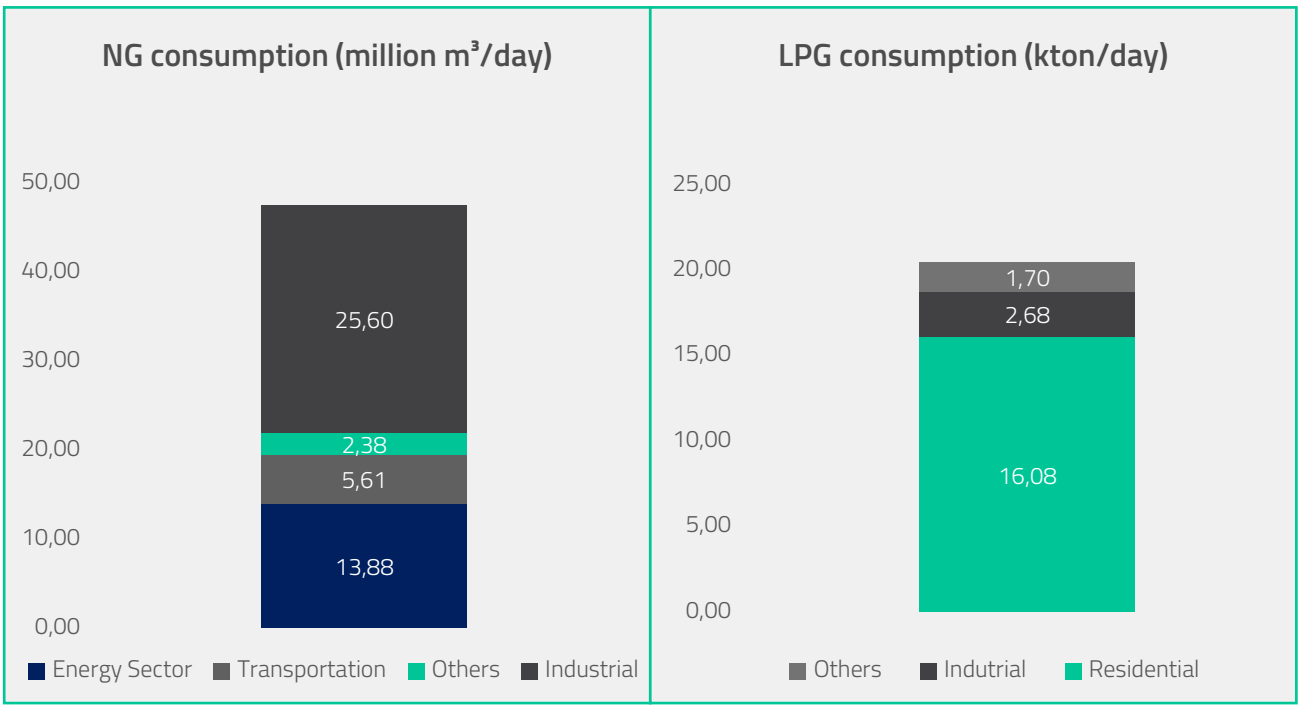


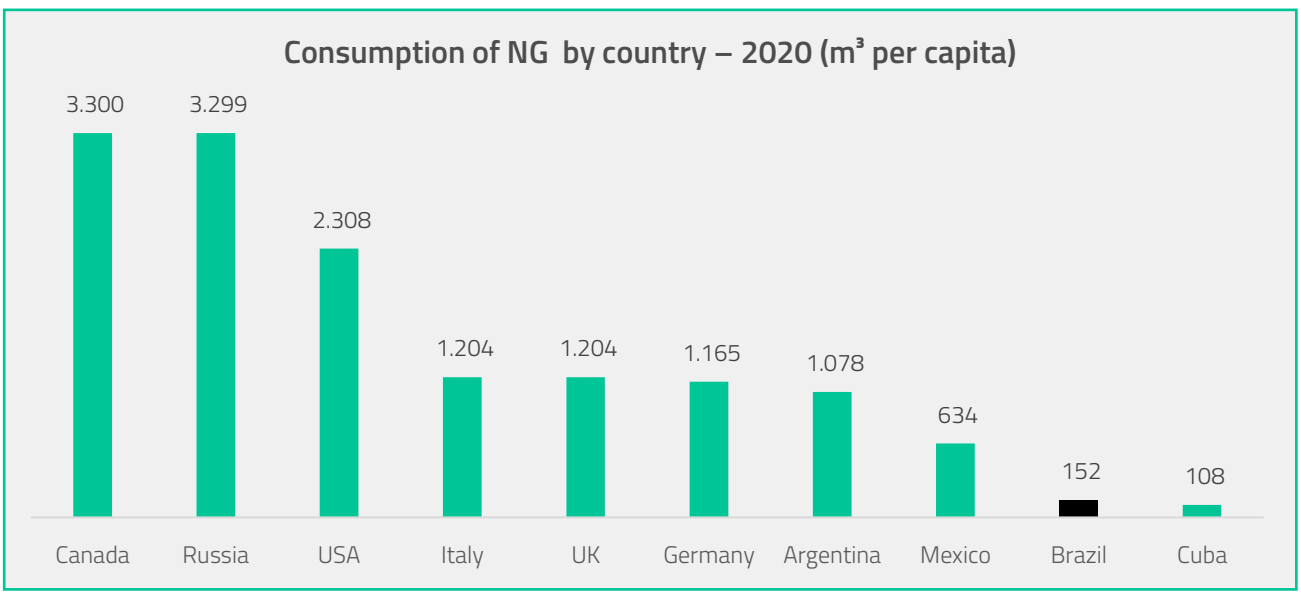
Source: MME[12]

[12] MME – BOLETIM MENSAL DE ACOMPANHAMENTO DA INDÚSTRIA DE GÁS NATURAL – 2022: https://www.gov.br/mme/pt-br/assuntos/secretarias/petroleo-gas-natural-e-biocombustiveis/publicacoes-1/boletim-mensal-de-acompanhamento-da-industria-de-gas-natural/2022-2

5.2.3 Demand Outlook for Natural Gas and Biomethane

Natural gas consumption in Brazil has historically been limited by the inefficiencies and limited supply characteristics described above, which have limited further market development and industrial use. Current gas consumption is heavily concentrated in thermal power generation and industrial demand, which accesses gas supply mainly through pipelines and regasified LNG imports. Demand from commercial and residential buyers is fragmented, being mainly supplied by LPG cylinders, while the demand from transportation consumers is also met by CNG (Compressed Natural Gas). Data on consumption is presented below.





Source: EPE[13]

[13] EPE – BALANÇO ENERGÉTICO NACIONAL:

It is expected that natural gas demand will continue to grow with the forementioned infrastructure developments, as well as other uses for new gas sources not previously served by fossil gas. The Energy Development Plan 2032 and CBIE (a private consulting company specialized in energy) project growth of natural gas demand from the current traditional segments, reaching **126 m³/day by 2032** (CAGR - 2.5%). However, these projections do not consider several structural changes that could significantly increase gas demand in the future. Below, we list some of these factors.

Law 14.182/21

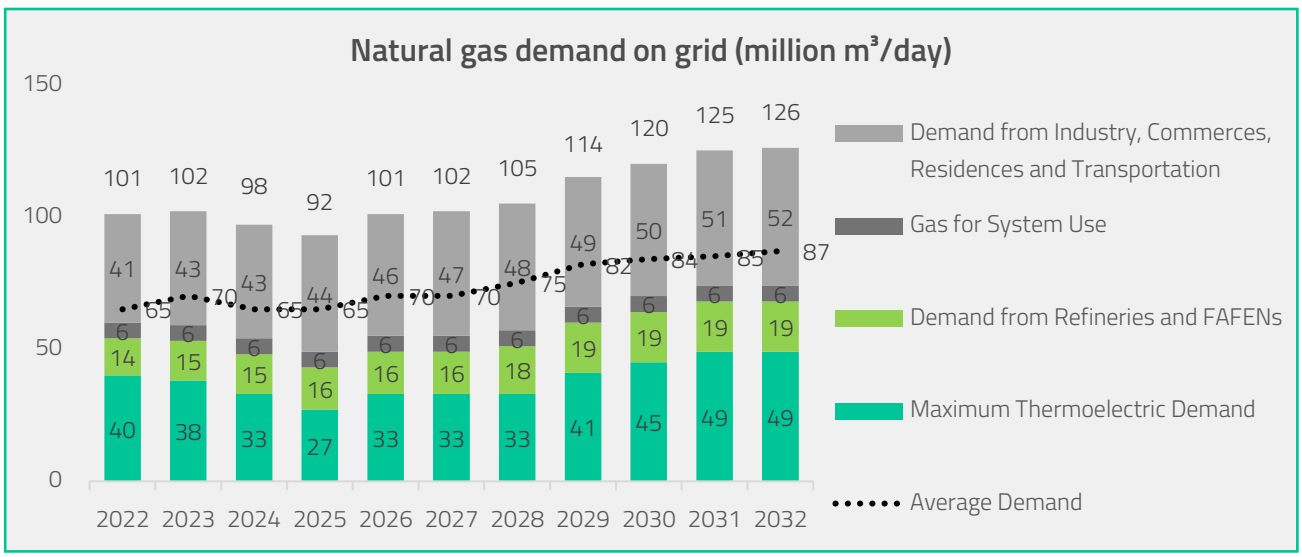
Law 14.182/21, which was passed as part of the privatization process of Eletrobras (formerly a state-owned electricity company in Brazil), established the requirement for public auctions of gas thermal energy capacity in the rural regions of Brazil. **These regions are currently not served by the existing pipeline infrastructure** (mainly Center-West and North-West). The auction terms have already been set by ANEEL (the electricity regulator) and **are expected to contract a total of 8 GW of gas-fired thermal capacity** (approximately 10% of Brazil's current electricity demand). The regionalization of thermal capacity is seen as a government subsidy to further expand the current gas pipeline network and should uncover new pockets of demand that are currently underserved by the market.

National fertilizer plan

The plan was formulated in 2022, due to the disruptions of the global fertilizer supply chain as a consequence of the Russia-Ukraine war. As an agricultural powerhouse, **Brazil is a heavy consumer of fertilizers, importing approximately 85% of the total NPK consumed.** The shortage threat that rose in 2022 sparked the public debate and led to the drafting of the National Fertilizer Plan. Most of the basic inputs for fertilizer production are present in Brazilian territory and can be used to nationalize part of this production. **The goal is to reduce fertilizer imports from 85% to 45% of total consumption by 2050.** FAFEN-PR and FAFEN-MS are examples of fertilizer plants that are expected to come on stream in 2025 and 2028 respectively, **increasing gas demand by 3 million m³/day.**

Expansion of distribution pipelines

The current demand for gas in the residential and small commercial sectors is also expected to grow significantly over the next decade, creating room for expansion of the privately owned distribution networks. An expectation embedded in these total volume projections is a further penetration of piped gas in these segments from the current 2% to 14% in the next few years (the same as the international average). This will open new markets in the future and correlate with the entry of new private players in the gas distribution segment. Some recent movements in this front are worth highlighting, such as **i)** Compass's acquisition of 51% of Gaspetro in July 2021, adding 18 new distribution assets in different states to its previous Comgas operation in São Paulo, **ii)** Compass's acquisition of Sulgas in October 2021, allowing entry into Rio Grande do Sul, and **iii)** the 2023 auction won by Energisa to enter Espírito Santo's gas market.



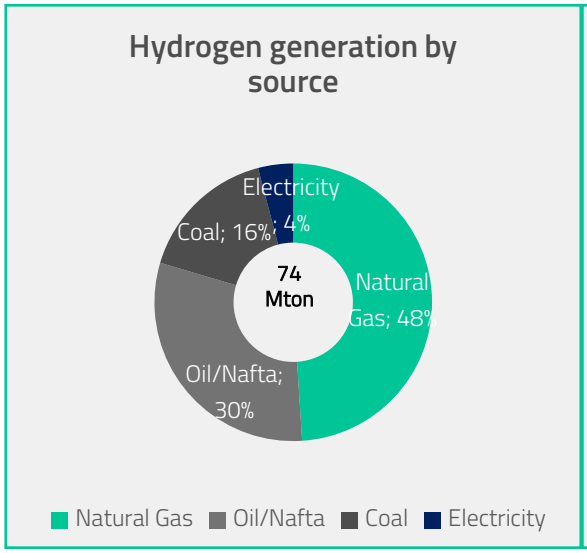
Biomethane should have specific demand drivers that can separate its price dynamics from natural gas. **There is already a general trend in the market for consumers to pay premiums for biomethane molecules over the natural gas substitute due to its net zero emissions component.** We see many demand drivers that can uniquely impact biomethane and expand its market opportunity beyond what is embedded in current PDE and CBIE natural gas forecasts. Below we detail some of these drivers.

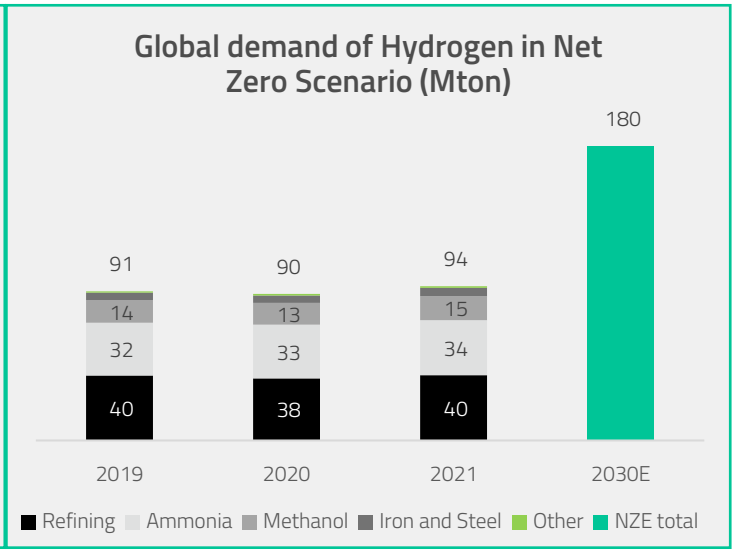
Diesel Substitution

One of the greatest opportunities for biomethane is its ability to replace diesel in heavy-duty vehicles. Transportation is the biggest challenge/opportunity in the global decarbonization effort, and biomethane could be a viable alternative. In Brazil, 33% of energy consumption comes from this segment, which is currently 90% fueled by diesel. Abiogás's studies on "dual fuel" engines show that hybrid vehicles that can mix biomethane and diesel on a scale of 0 to 100% can effectively reduce the carbon emissions of trucks and harvesters in the fields by 86.7%. The switching costs from pure diesel vehicles to this dual fuel engine are also insignificant and economically feasible even for small players. Other association studies also show that if Brazil were to exploit its entire biomethane potential, it would be sufficient to replace 70% of all current fossil diesel consumption. Abegás (Brazilian Association of Gas Distributors) has advocated the creation of "blue corridors" in São Paulo, Rio de Janeiro and Espírito Santo, with tax incentives for CNG/LNG consumption. The idea is to encourage heavy vehicles to switch from diesel to natural gas or biomethane on the most frequently used roads, based on the European example of fueling stations equipped to receive CNG. Another study by CBIE showed how biomethane could play a fundamental role in replacing diesel imports. The study analyzed different scenarios of diesel demand in Brazil and showed how imports could be completely replaced by ramping up biomethane production. For example, **in the base case, where Brazil's GDP is assumed to grow at a 2.0% CAGR and no additional refining or import capacity is added, there would be a diesel supply deficit close to 11 billion liters which is equivalent to 29 million m³/day of biomethane.**

Green hydrogen

Hydrogen (H_2) is extremely important in many industrial processes and is cited worldwide as one of the energy alternatives to fossil fuel derivatives. Although hydrogen is the most abundant element in the universe, it is rarely found in its free, isolated form (H_2). Therefore, it is produced by two different methods: **i)** reforming and **ii)** electrolysis. Most of the hydrogen produced today is reformed and is called **"gray hydrogen"** (because of its greenhouse gas emissions), representing 95% of total world production. Other forms of hydrogen production, such as the production of "blue hydrogen" and "green hydrogen" are being extensively researched and developed around the world. **Blue hydrogen** consists of the production of hydrogen by reforming methane molecules, but through the subsequent use of carbon capture and storage technologies that partially prevent CO_2 emissions by 60-65%. **Green hydrogen,** on the other hand, is produced by electrolysis of water using green energy as an input. Although carbon emissions are neutral in this case, energy consumption is significant, making the process almost economically unviable. A study by IRENA (International Renewable Energy Agency) showed that green hydrogen from electrolysis will only be economically viable between 2030 and 2040 at a cost of USD 2.6/kg H_2. In contrast, the current cost of gray hydrogen produced by reforming is around USD 2.0/kg H_2. **An alternative to this trade-off between economic feasibility and environmental benefits is the use of biomethane in the reformulation process.** As a natural gas equivalent, biomethane could easily be used as an input in the production of hydrogen with zero net carbon emissions (or even a negative carbon footprint, depending on its origin) and with economically viable operations. It could benefit from the current NG infrastructure while requiring much less energy input than electrolysis processes. According to Abiogas, the production of 1 kg of hydrogen requires 4/5 m³ of biomethane. In 2018, Brazilian refineries and FAFENs are estimated to have consumed ~320 thousand tons of gray hydrogen. This amount could be produced with ~4 million m³/day of biomethane with a much cleaner process. The use of green ammonia is also cited to facilitate energy transportation and storage in remote areas such as the Amazon and rural areas. Ammonia is also being considered as an alternative for some transportation fuels such as seagoing vessels, as highlighted by the recent announcement by Maersk, together with Keppel Offshore & Marine, to commence studies to develop ship-to-ship bunkering in the Port of Singapore in 2021.



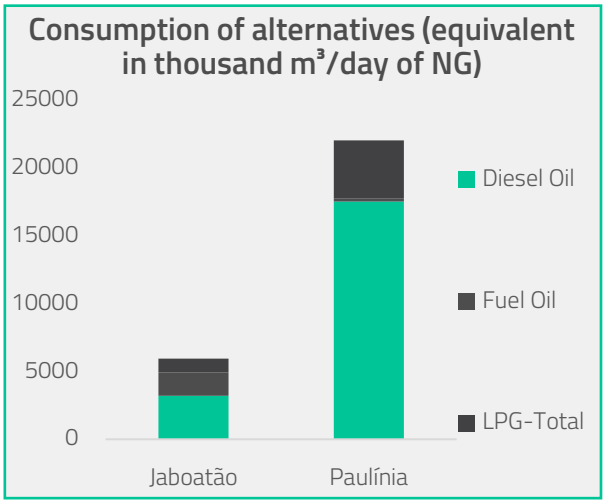


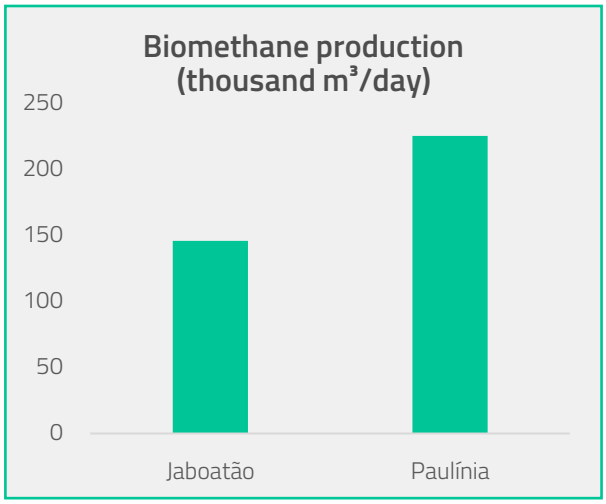
Source: IEA[14]

Zero emissions trend

The environmental attributes of biomethane alone are a very important source of demand. We see it as a demand broadening factor that should increase the procurement of this fuel/energy source compared to its current fossil alternatives. There are already some signs of confirmation of this hypothesis. Many of the incipient contracts being signed in the market today by industrial users of biomethane are being paid with a premium over the energy equivalent of natural gas. These premiums were unheard of 2 to 3 years ago (in fact, discounts were the norm) and are now the baseline in purchasing negotiations. Orizon already sees current demand and unsolicited inquiries **from potential customers in the order of 10 times its total potential production capacity.** Also, earlier this year, the ceramic industry in the state of São Paulo signed an agreement to achieve 50% of total gas consumption from biomethane by 2030. At current consumption levels, this would represent an additional demand of 900,000 m³/day of biomethane. Other industries are also following this trend, such as the steel and automotive industries.

Looking specifically at Orizon's production sites, we believe that much of its biomethane production will be commercialized using the existing pipeline network that passes through its landfills. Nevertheless, some potential customers who currently use LPG or other fossil fuel alternatives as an energy source might be served by CNG from biomethane and represent an incremental demand possibility. In this context, we tried to estimate what would be the addressable market for potential buyers of Orizon's biomethane around its production sites'. We analyzed ANP's[15] data for industrial oil-derived fuels usage in municipalities surrounding Paulínia and Jaboatão dos Guararapes assuming a **150km radius of influence area** and calculated how much was sold of the three main industrial fuels: Diesel Oil, Fuel Oil, and LPG. Later, we used EPE's[16] data to estimate these sectors consumption breakdown. Converting these data to natural gas equivalent, we found the results below.

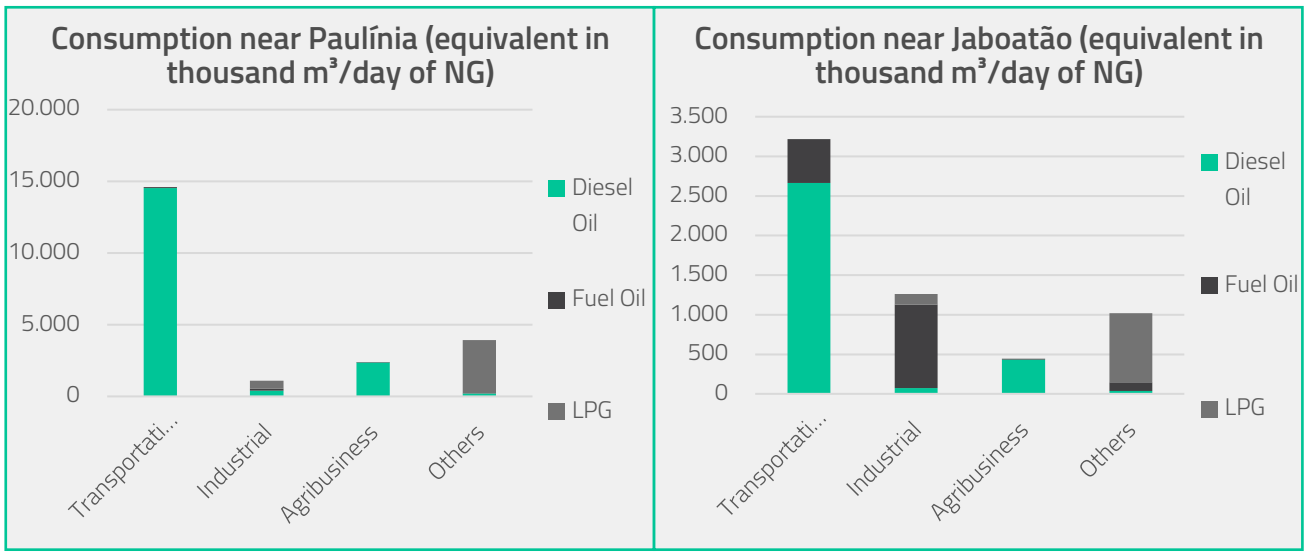




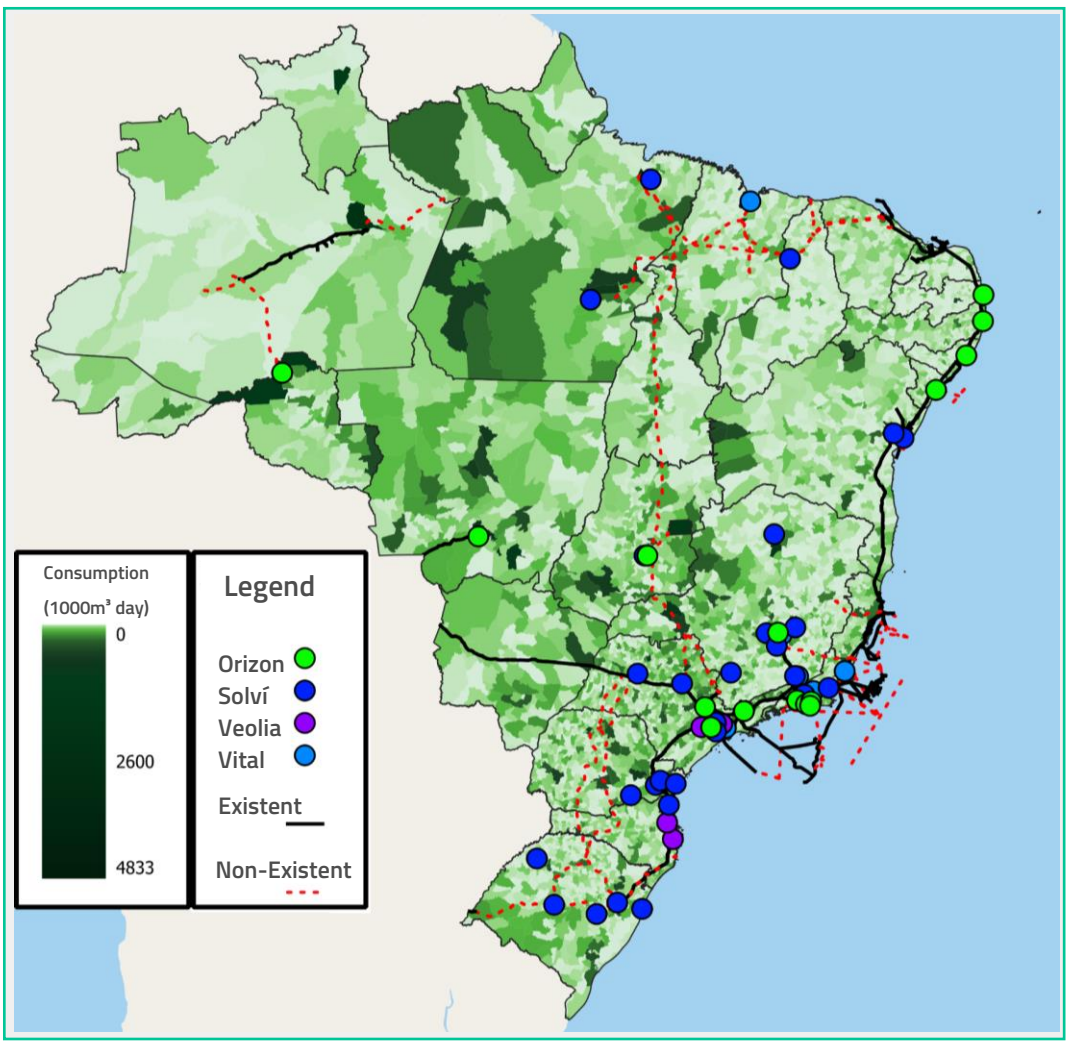
[14] IEA: https://www.iea.org/reports/hydrogen

[15] ANP: VENDA DE DERIVADOS DE PETRÓLEO E BIOCOMBUSTÍVEIS

[16] EPE: BALANÇO ENERGÉTICO NACIONAL



These graphs show **i) higher overall consumption in Paulínia,** as a more developed and populated region, **ii) more intensive use of fuel oil, diesel and LPG in the transportation sector,** and **iii)** total addressable market for biomethane seems to be around 22 million m³/day in Paulínia and 6 million m³/day in Jaboatão. The goal of this study was to map all potential buyers for Orizon's biomethane in the context of off-grid delivery. While the bulk of biomethane is bound to be delivered by grid, as an efficient logistical solution, we see plenty of space for delivery by truck in CNG format, substituting fossil fuel solutions. The map on the left shows consumption of fuel oil, diesel oil and LPG, in 1000m³ of NG equivalent per day, as well as landfills that potentially could supply biomethane. It clearly demonstrates how there are many pockets of potential demand currently not reached by pipeline infrastructure, as well as some landfills that could produce biomethane and will need to use other forms of distribution (such as trucks).

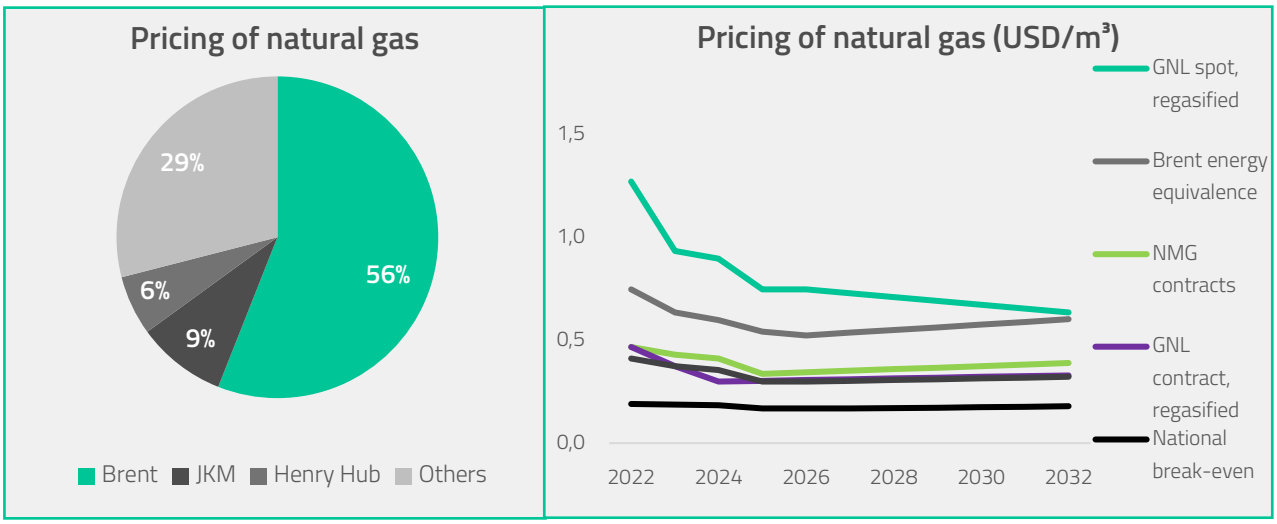


Source: Equitas, ANP, EPE, IBGE, and companies' data.

5.2.4 Pricing

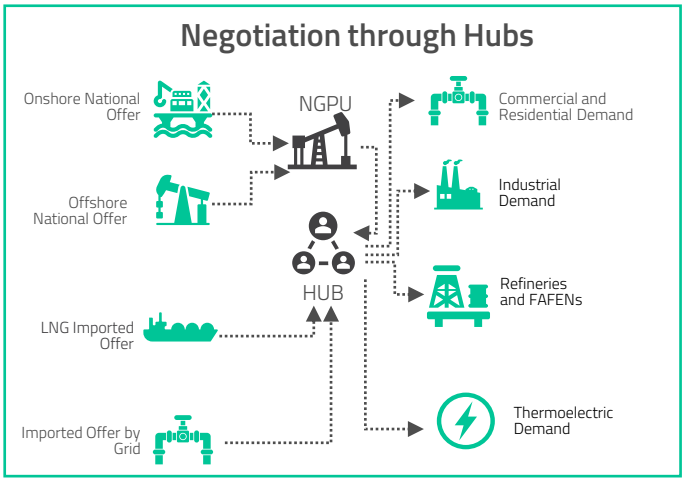
As with most commodities, it is extremely difficult to predict future natural gas prices, let alone biomethane prices. We see major vectors influencing both supply and demand over the next few decades, with conflicting effects on price. The resulting effect is quite difficult to estimate, while most external consultants seem to predict a normal backwardation curve for the domestic gas price. We prefer to be conservative in our numbers and consider all the factors involved in these market projections. One thing that partially reduces our forecast risk is that most of the deals currently being negotiated by Orizon are structured in **long term contracts (~10 years) with fixed prices,** which adds some predictability to our projections. We also see specific factors influencing biomethane prices that could more than offset the increasing supply of natural gas in Brazil, as discussed above.

First, it is important to understand the logic behind current natural gas price dynamics and how foreseeable events could change them. Current natural gas pricing in Brazil follows a **gas-to-oil pricing logic.** This means that gas **prices are constrained between the energy equivalent price of converting oil into LPG and the break-even price of producing gas.** This is because the supply of gas in Brazil is extremely limited, with a significant lack of infrastructure in many regions, making oil a more direct alternative in most places than other gas from other sources. As a result, gas prices are more linked to Brent prices than to gas prices at international hubs (Henry Hub, TTF). The 2032 Energy Development Plan suggests that infrastructure investments could turn the Brazilian gas market into a gas hub, which would bring pricing closer to a gas-to-gas dynamic.

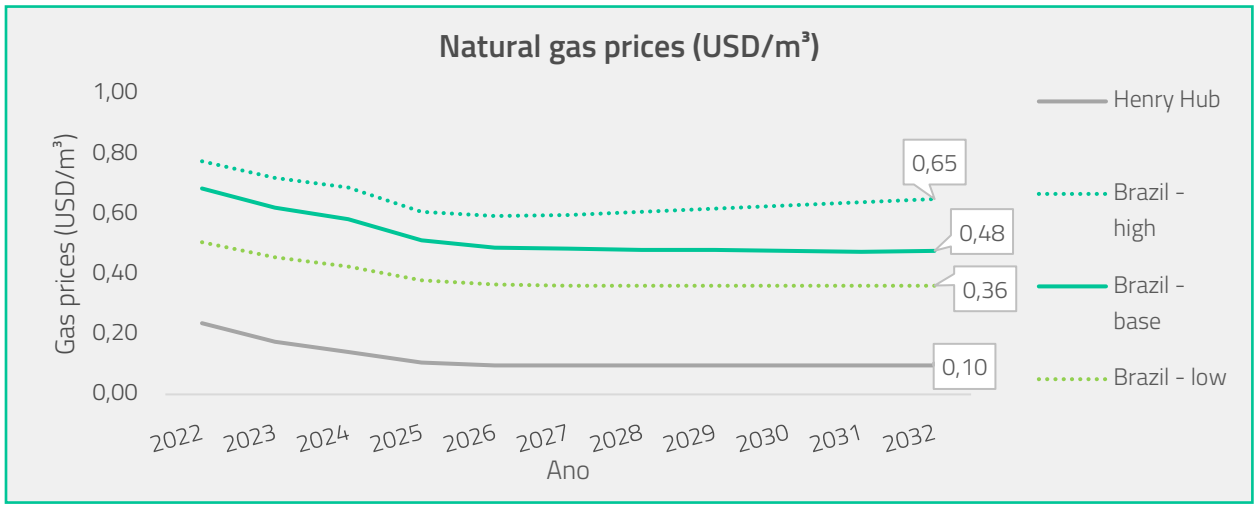


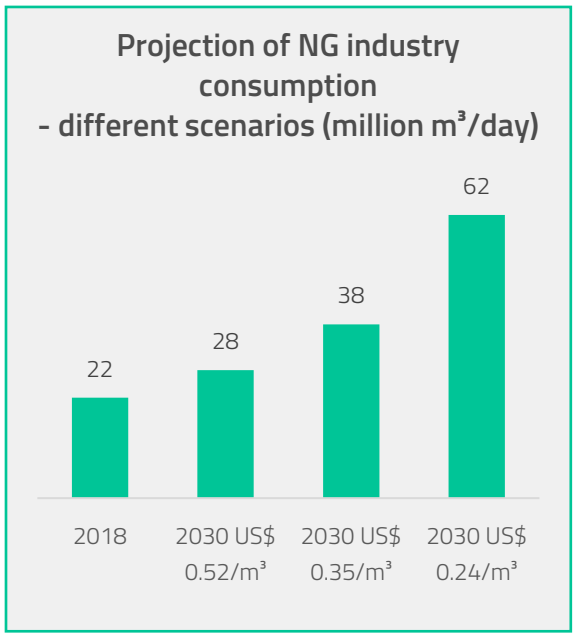
Source: Petrobras. Pricing of natural gas

The 2032 Energy Development Plan presented 3 different price scenarios based on different assumptions of infrastructure investment completion. In the more bearish scenario for gas prices, it predicts that natural gas molecule prices would decrease by -29% by 2032, while in the more bullish scenario it would decrease by -10%. All these scenarios do not consider some of the important supply and demand factors that we have listed above, such as **i)** Bolivian gas reserves depletion and import reduction, **ii)** industrial substitution from other fuels to gas as network distribution develops, and **iii)** LNG imports competition with Europe.



This hypothetical reduction in the price of natural gas would have a significant impact on the energy supply of the Brazilian industry and expand access to the nearly 14 million families that currently use firewood as an energy source. The resulting increase in demand could open new markets and increase gas penetration in the industrial energy matrix.



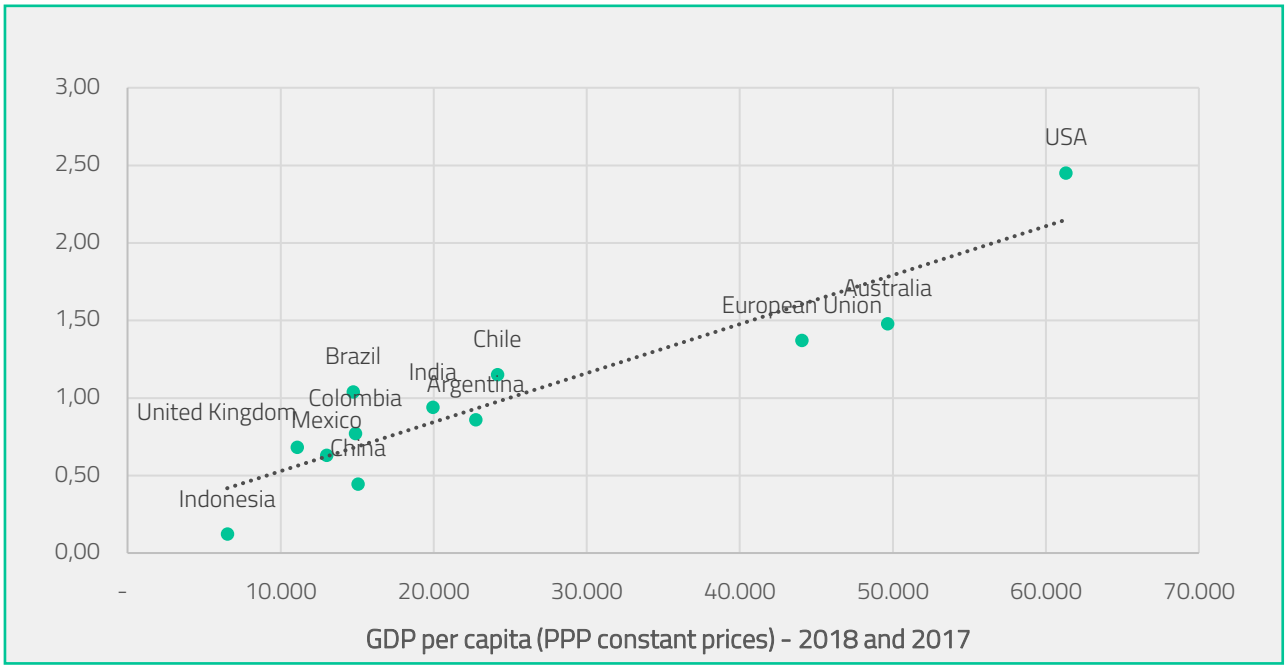


The graph above shows the result of EPBR's projections of the potential demand for natural gas in the industrial segment under different price scenarios. These projections were made by forecasting gas demand in different sectors (steel, glass, aluminum, chemicals, pulp and paper, and ceramics), maintaining the energy matrix, and then sensitizing gas prices with elasticities for gas demand in each sector. As we can see, there is a huge difference between the potential demand of the highest and the lowest price range. In the first scenario (USD 0.52/m³), the projected demand for the analyzed sectors in **2030 would be approximately 27.5 million m³/day,** while in scenario 3 (USD 0.24/m³) the demand could reach 62.2 million m³/day. This difference is mainly explained by the substitution of natural gas by other energy sources and the additional consumption related to cogeneration, which is possible in the long term due to technological changes.

In summary, there are many factors that will influence gas prices in the coming years. Although current prices are still partly benchmarked to natural gas, **biomethane already has its own market dynamics. We strongly believe that environmental concerns and the transition to cleaner energy will play a major role in its pricing. Also, as noted above, current demand is many times greater than potential supply from major players, which supports our view that near-term off-take negotiations will not be a source of concern for Orizon.**

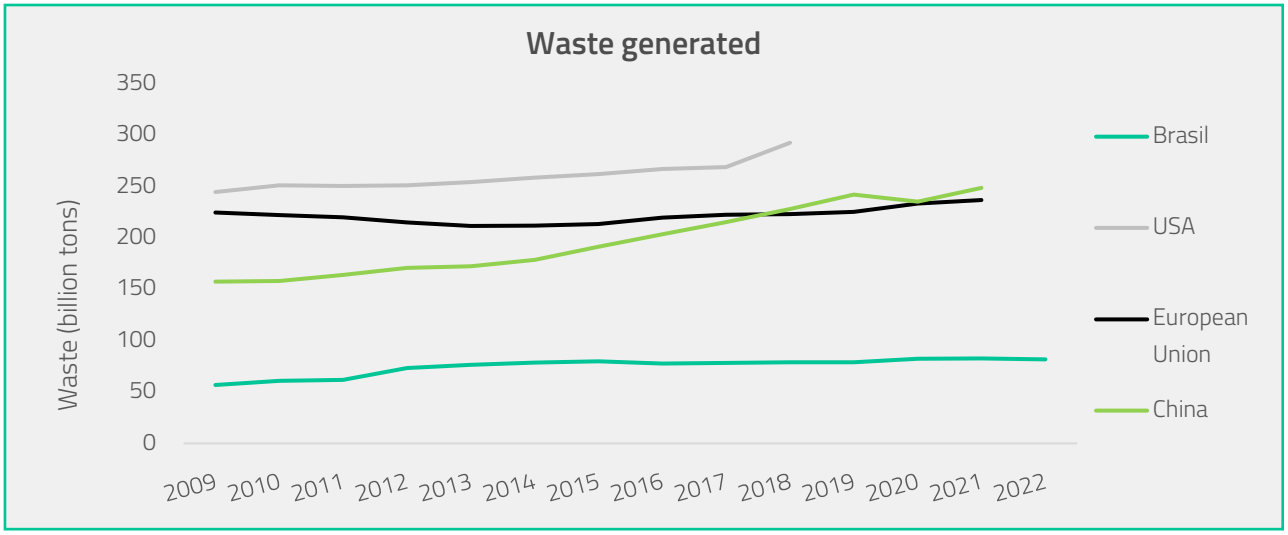
6. Waste Management 101 and Orizon's operations

More environmentally responsible regulations and social behavior have reduced waste generation from historically high levels on a per capita basis in many places. **Nevertheless, richer countries tend to generate more waste** than poorer ones, as waste generation is a direct function of economic activity and household consumption. Using data from several studies and sources, such as Holland Circular Hotspot, EPA, Eurostat, Abrelpe and others, **we find a strong linear correlation between waste generation and GDP per capita** (R^2=0.85). The data is from 2017 and 2018 and is shown below.

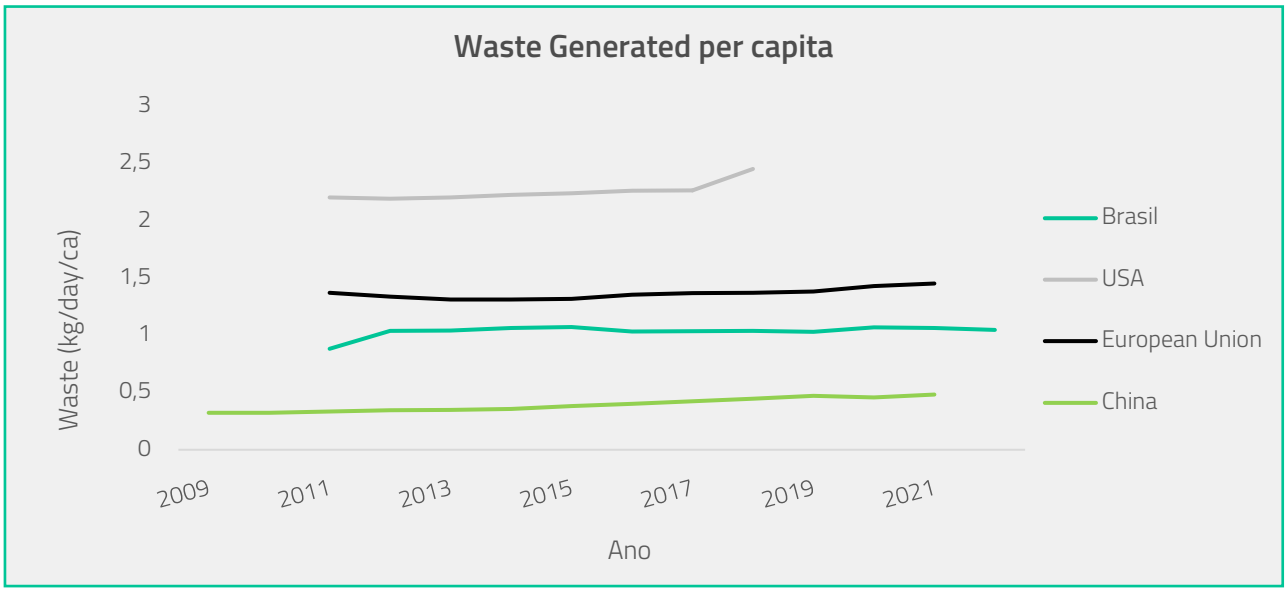


Source: Variables[17]

The following graphs show historical data for waste generation, both total and per capita, for several countries. Brazil produces a small fraction of waste compared to the US, European Union, and China, but Brazilian per capita generation is close to European levels, despite significant wealth disparities.



[17] LEAP – UNEP; Holland Circular Hotspot; Panorama Abrelpe; Eurostat; EPA; Australia's Department of the Environment and Energy and Statista

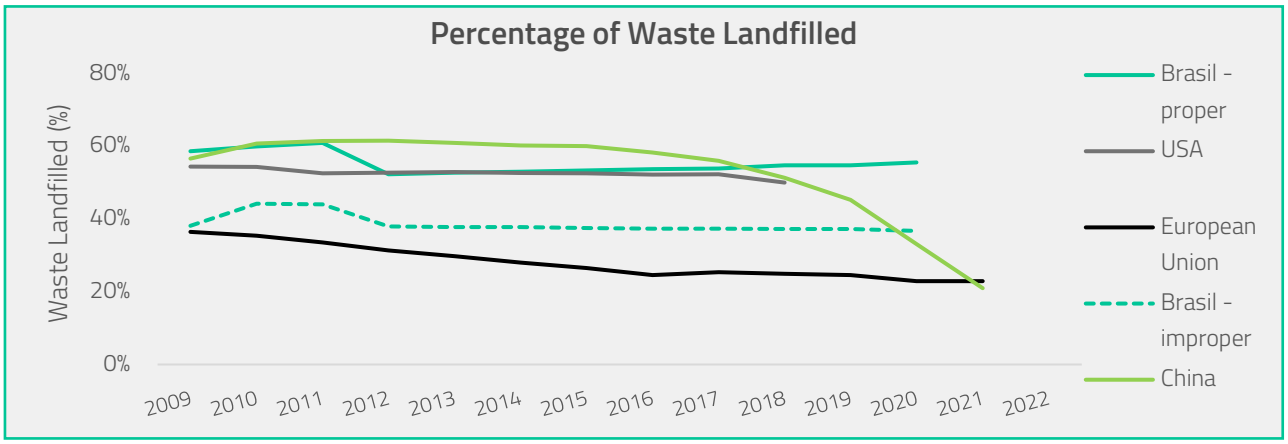


Source: Variables[18]

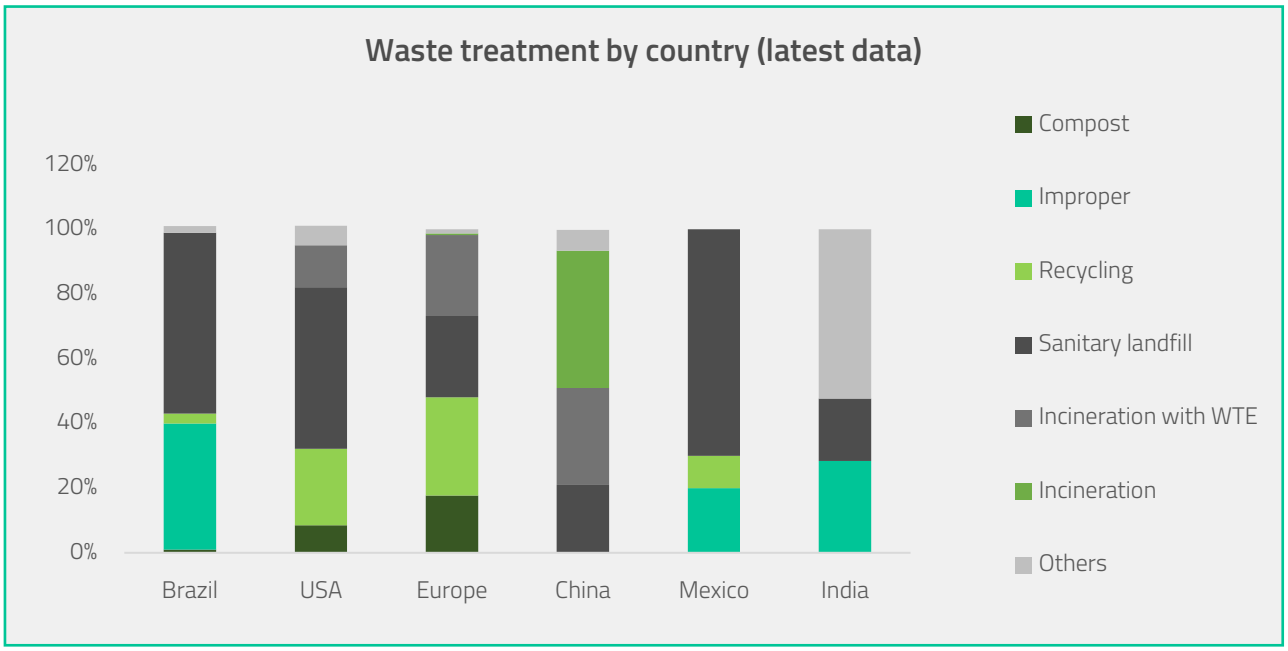
The previous graphs provide a general overview of waste generation in Brazil and in some relevant peer countries. In China, for example, waste generation has risen sharply over the past decade, driven by economic growth. In the other countries mentioned, waste generation increased more moderately, even in the context of improving economies. This can be explained by **i)** ESG policies playing a more important role in policy making, and **ii)** waste generation per capita was already at a higher level for the given economic development, especially in Brazil.

In a world of increasing demand for environmentally and socially responsible practices in administrative, governmental, and economic activities, issues such as waste generation and treatment are likely to receive more attention. Moreover, it is not only governments that are concerned about waste, but also private actors such as large corporations, media and information providers, and the general public. In this context, waste treatment and disposal are modern concerns, especially in crowded urban areas.

As will be discussed later, waste, if properly and responsibly disposed, ends up in one of two main destinations: **landfilling or incineration.** Landfilling is less expensive and is the most common proper destination for waste in the United States and Brazil. China, on the other hand, has seen an increase in incineration and a decrease in landfilling, as has the European Union. The reason for this is that, while landfilling is much less expensive than incineration, it requires large areas of land near urban centers, which are becoming increasingly scarce in densely populated areas. Since waste has poor logistical properties, it is essential that landfills be located relatively close to where the waste is generated. Even in Brazil, some high-density metropolitan areas, such as São Paulo and Rio de Janeiro, are facing intense discussions about waste disposal due to the current exhaustion of landfills and lack of land availability.



[18] Abrelpe; Eurostat; EPA; China's Statistical Yearbooks



Source: Variables[19]

Waste management, prior to landfilling or incineration, involves several operations along the value chain with different competitive dynamics and profit profiles. The first link is waste collection and transportation. This business has low barriers to entry and low technology requirements, and generates little value in Brazil, in addition to being problematic and bureaucratic due to significant involvement in government relations related to collection and sweeping contracts. Some examples include **i) inefficiencies in government operations, ii) payment arrears, and iii) contractual and transactional irregularities.** According to Selurb (National Union of Urban Cleaning Companies), 70% of municipalities outsourced public cleaning in 2020, and around 15% to 18% defaulted in 2019 (representing BRL18 billion in arrears in a total market of BRL 28 billion). This situation could evolve significantly if the tariff on citizen beneficiaries is effectively implemented (as we mentioned, the new sanitation law provides for this). However, the implementation of this tariff model for waste collection is highly unpopular and faces political resistance at the municipal level. From today's perspective, its implementation is highly uncertain. In the US, on the other hand, the waste collection business is almost the opposite of that in Brazil; waste collection companies are usually profitable and face an environment with **i)** less bureaucracy, **ii)** synergies with final disposal operations, and **iii)** lower municipal debt delinquencies.

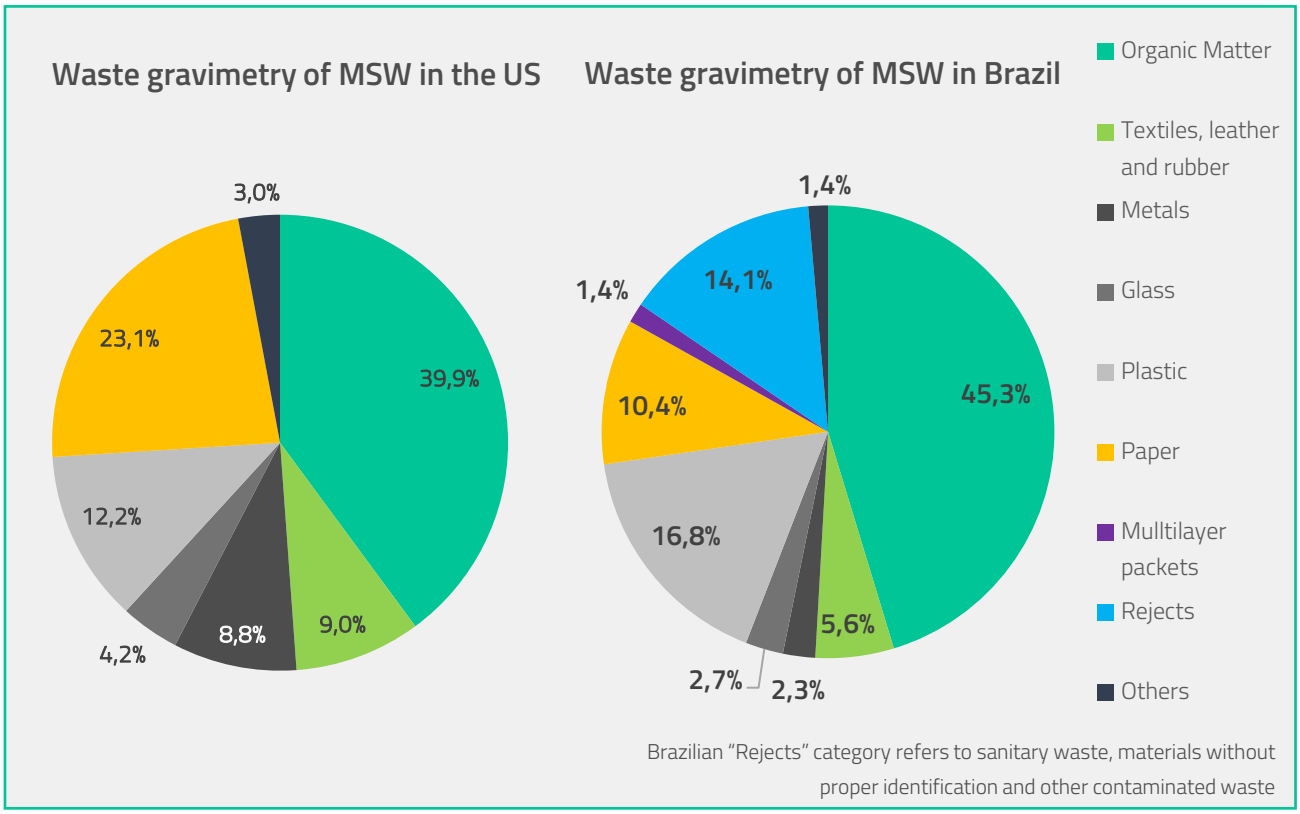
In Brazil, the last link in the waste chain (landfilling) generates much more value than collection and sweeping. Through **gate fees,** payments made by waste collectors to landfill owners to ensure proper waste treatment and disposal, Orizon is rewarded for taking waste collected from households and disposing it properly. However, the company is also involved in other parts of the **final stages** of waste management: rather than simply burying waste, **Orizon extracts value from useful by-products from the waste chain.**

This position is in line with the modern challenges of waste management: treating it in the context of a circular economy, generating useful by-products for other economic and industrial activities, while complying with environmental, social and governmental guidelines for waste management. This value creation comes from many sources: through **recycled materials**, **co-processed waste** sold to industry as fuel, **energy** provided in waste-to-energy plants (incineration), the issuance and marketing of **carbon credits**, **biogas** collection, and through the production of **biomethane**. The latter is where we believe Orizon has the greatest potential for value creation, with the commercialization of biomethane to the grid.

[19] Abrelpe; Eurostat; EPA; China's Statistical Yearbooks; Holland Circular Hotspot.

6.1. What can be done to waste

Municipal Solid Waste (MSW) can be treated in different ways and can be used for different purposes, depending on how it's composed and where it's sourced. Not all waste has the same composition and **different parts of the waste composition can have different destinations.** Paper and metals can be recycled, organics can be fermented, and some inert parts may not have financially attractive byproducts. Even when recycling is possible, co-processing and energy recovery through incineration are possible alternatives, although not always economically viable. However, **landfilling is still a very attractive alternative in Brazil.** It is the most efficient waste destination due to **i)** much less capital-intensive operations compared to other alternatives such as incineration, and **ii)** significant additional revenues from biogas collection and biomethane production. In addition, Brazil's waste is mostly organic (see figure below), which makes methane emissions potentially higher than average and biogas collection favorable and attractive.

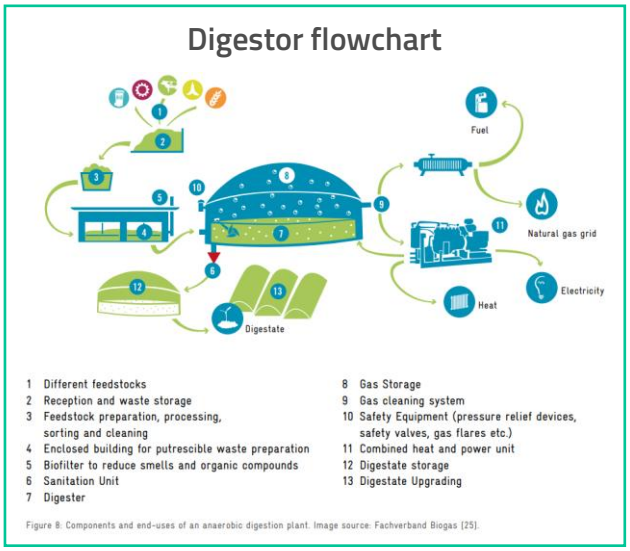


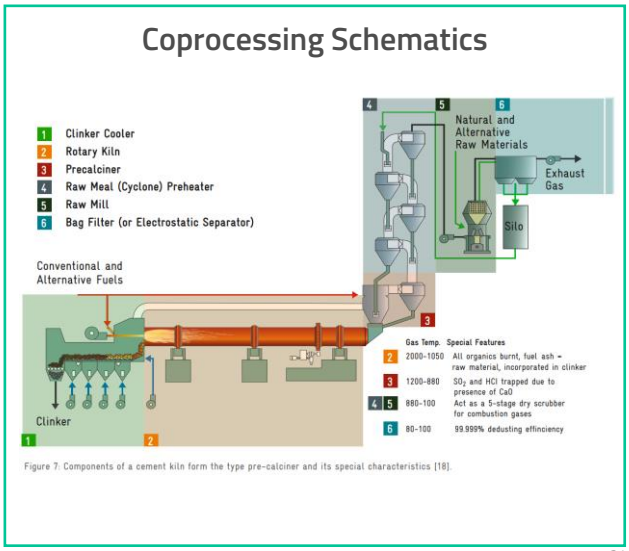
Brazilian "Rejects" category refers to sanitary waste, materials without proper identification and other contaminated waste

Source: Abrelpe[20]

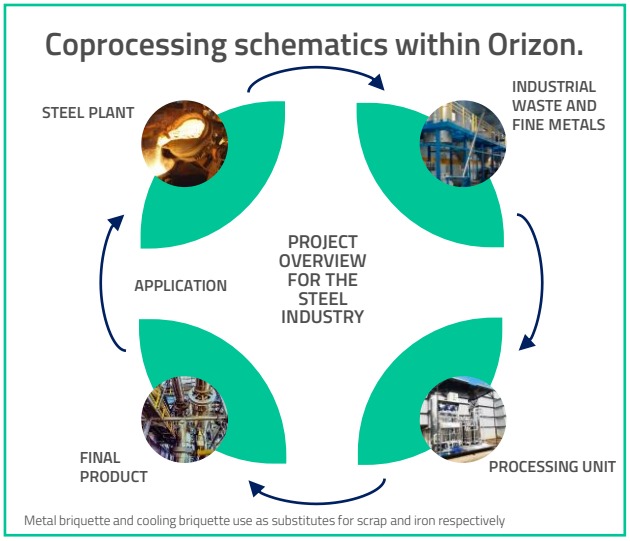
Prior to final disposal, waste can be recycled and then co-processed or fermented in digesters. Digesters are containers in which waste is placed, ideally after separation of inorganic materials, to be fermented to produce **i) biogas,** an energy input, and **ii) digestate,** which is mainly used to produce organic plant fertilizers. Although Orizon doesn't have a digestion business, it is starting a pilot project with Tera at its landfill in Paulínia to produce organic fertilizer, which should be operational by mid-2023. Orizon is also present in the recycling, separation, and co-processing of solid waste (an industrial process that transforms waste into a renewable equivalent of fossil coking coal, widely used as a fuel in the cement industry - RDF).

[20] PANORAMA DOS RESÍDUOS SÓLIDOS NO BRASIL – 2020.





Source: GIZ[21]



While recycling, co-processing and digestion are environmentally positive ends to waste, they are not always financially feasible and may require additional waste treatment and final disposal. Rejects may need to be incinerated or landfilled.

Landfilling is the process of burying waste under controlled conditions and is an extremely cheap process (compared to other responsible disposal methods), with low initial investment and low maintenance costs. However, landfills require significant land area and can have some environmental impacts if not operated properly, particularly with regard to methane emissions, the risk of leachate leakage, and odors. Incineration is an alternative to landfilling that burns waste, reducing space requirements and toxic compounds over time, while generating energy in the form of either electricity or heat. However, it is much more capital-intensive and costly to operate, and also requires gas filters for gas combustion byproducts.

In landfills, the capture of biogas (which is then used to generate energy, purified into biomethane, or burned in flares) is a key value driver for Orizon. It appears to be a key growth avenue for the next few years due to **i) easy replicability in existing landfills,** as biogas is naturally produced in all landfills, **ii) consistency of the waste-to-value chain, iii) ESG trends in Brazil,** and **iv) low cost of implementation** compared to digesters. Fermenters and digesters, which require a dedicated biogas collection infrastructure and organic waste separation process, lack scalability and are not applicable for value creation in operational landfills. Therefore, while digesters are slightly more environmentally friendly with lower emissions and higher biogas recovery efficiencies, landfill capture is more economically viable and easier to scale.

[21] WASTE-TO-ENERGY OPTIONS IN MUNICIPAL SOLID WASTE MANAGEMENT – GIZ: https://www.giz.de/en/downloads/GIZ_WasteToEnergy_Guidelines_2017.pdf

Biogas collection from landfills

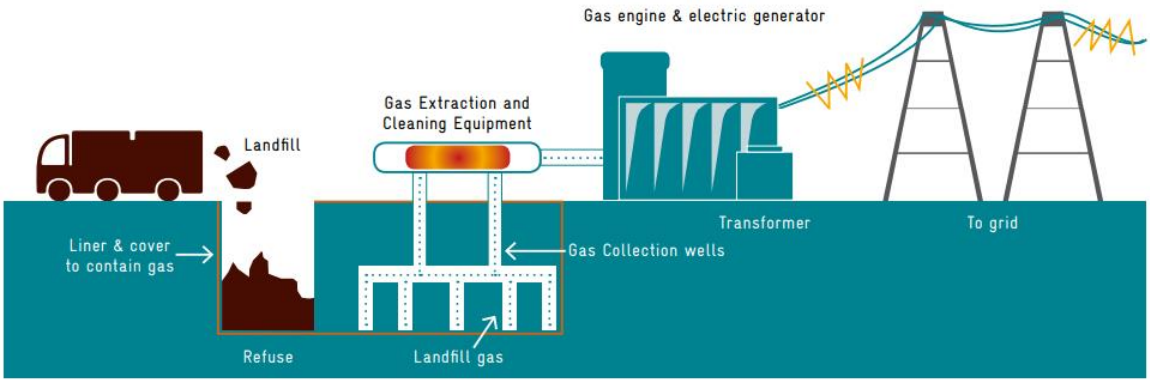
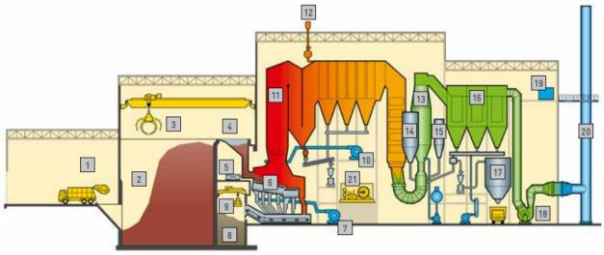


Figure 9: Components of landfill gas capturing system with electricity production [32].

Incineration



WASTE DELIVERY	INCINERATION	FLUE GAS CLEANING	ENERGY RECOVERY
1 Tipping hall	5 Ram feeder	13 Flue gas reactor	21 Steam turbine / generator
2 Waste bunker	6 Incineration grate	14 Hydrated lime	
3 Waste crane	7 Primary air fan	15 Activated carbon	
4 Waste feeding chute	8 Bottom ash bunker	16 Bag filter	
	9 Bottom ash crane	17 Residue silo (fly ash)	
	10 Secondary air fan	18 ID fan	
	11 Steam boiler	19 Emissions Monitoring System (CEMS)	
	12 Boiler safety valve	20 Stack	

Figure 5: Components of a muncipal solid waste incineration plant with flue gas cleaning. Image source: Doosan Lentjes GmbH [14].

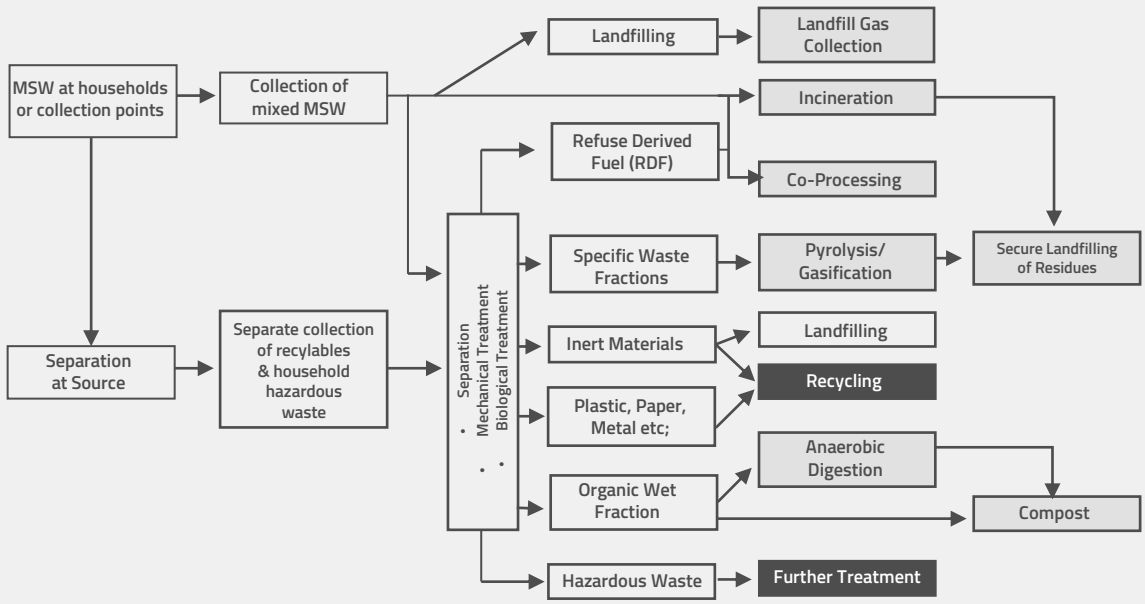


Figure 4: overview of MSW material flow and its different utilization and treatment options. Collection of separated waste streams makes the utilization of different treatments more viable.

Source: GIZ[22]

[22] WASTE-TO-ENERGY OPTIONS IN MUNICIPAL SOLID WASTE MANAGEMENT – GIZ: https://www.giz.de/en/downloads/GIZ_WasteToEnergy_Guidelines_2017.pdf

6.2. Waste Treatment and Disposal

Waste disposal takes place after waste is collected and transported to landfills. It is important to note that waste has **i) low compactness,** which increases transportation costs, and **ii) low market value,** for obvious reasons. In addition, **proper waste disposal, as opposed to waste collection, has a very high barrier to enter given (i) high capex requirements for special treatment of soil, waste and leachate** to meet environmental standards and avoid pollution of nearby areas**; and (ii) lengthy process to comply to environmental requirements and obtain installation and operation permits**. These features make landfilling into a **hyper-local operation with natural monopoly characteristics,** where landfills essentially collect all (or nearly all) of the waste in their area of influence. According to the Goldman Sachs Landfill Tracker (03/10/2022), in the U.S, for example, it costs over USD 10 per ton haul waste 50 miles by truck, compared to a landfill price of ~USD 35 per ton, making **waste management a transportation-intensive market.**

It is important to note that **each landfill operation has a different competitive landscape,** determined by its influence area, waste generation potential, and potential competitors. In the U.S., this market has been consolidating for many years, with **mature companies competing in a more concentrated market and in an integrated waste management/disposal and collection model.** We believe that these two facts, along with hyper-locality, have driven the US into an oligopoly-like pricing and operating market.

Hyper-locality is a characteristic of the industry, as high transportation costs are a reality everywhere. Competition is almost nonexistent, and in Brazil, unlike the U.S., waste management is more fragmented and less integrated with collection and transportation, which drives down tipping fees.

Currently, Orizon operates 15 landfills with an average life of over 30 years and receives approximately 10.1 million tons of waste per year, with a presence in several parts of Brazil, including Cuiabá (MT), Porto Velho (RO), Jaboatão dos Guararapes (PE), João Pessoa (PB), Maceió (AL) and several landfills in the states of São Paulo and Rio de Janeiro.

Its customers include both public entities (approximately 60% of total volume) and private players (40% of total volume), such as large condominiums and commercial properties. Typically, waste acceptance contracts have multiple maturities, with the public sector preferring longer term contracts (up to 30 years of supply) and private players leaning towards spot, one-year contracts. **Pricing varies from landfill to landfill, determined by the specific supply and demand dynamics of each region,** with gate fees paid by tonnage received.

Orizon is the main player in its area of influence, making it very difficult for municipalities and private actors near its landfills to find alternative waste destinations. The barriers to entry for newcomers are very high, making it difficult to enter greenfield sites and to compete in established regions. The scarcity of suitable land for waste disposal and the highly complex and time-consuming permitting process to obtain environmental approval to operate a new landfill (up to 5 to 10 years) make it almost impossible for newcomers to enter established regions quickly.

As mentioned above, since i) municipal solid waste is very expensive to transport, ii) the process to obtain all the operational permits and environmental licenses is lengthy, taking many years (typically 5-10 years), iii) costs to operate a landfill are very low compared to the total investment needed to build the infrastructure of a fully functioning landfill capable of extraction biogas and producing biomethane or energy, once a landfill is established in a location it creates a major disincentive for any competitor to invest in a competing site in the same area of influence. So, landfills enjoy a kind of captive market for the area of influence they serve, which to some extent guarantees a stable inflow of waste.

At the national level, the market is highly fragmented, with Solvi, Orizon and Simpar being the main players in municipal solid waste management. They account for 16%, 12% and 4.5% of the volume market share, respectively. In addition, around 37% of the volumes properly disposed are operated by municipalities. These factors, together with the new regulatory framework, the increasing investment necessity to fully explore waste value potential and the possibility to commercialize gas nationally, creates opportunities but adds complexity to operations, creating an environment conducive to consolidation favoring larger structured companies like Orizon against smaller local players. The M&A activity has intensified recently, driven mainly by experienced private companies. Orizon appears to be the main consolidator, leading major asset acquisitions after its IPO, such as the assets of Estre after its bankruptcy and the landfills of Cuiabá and Porto Velho. Some of the industry's acquisitions are presented below.

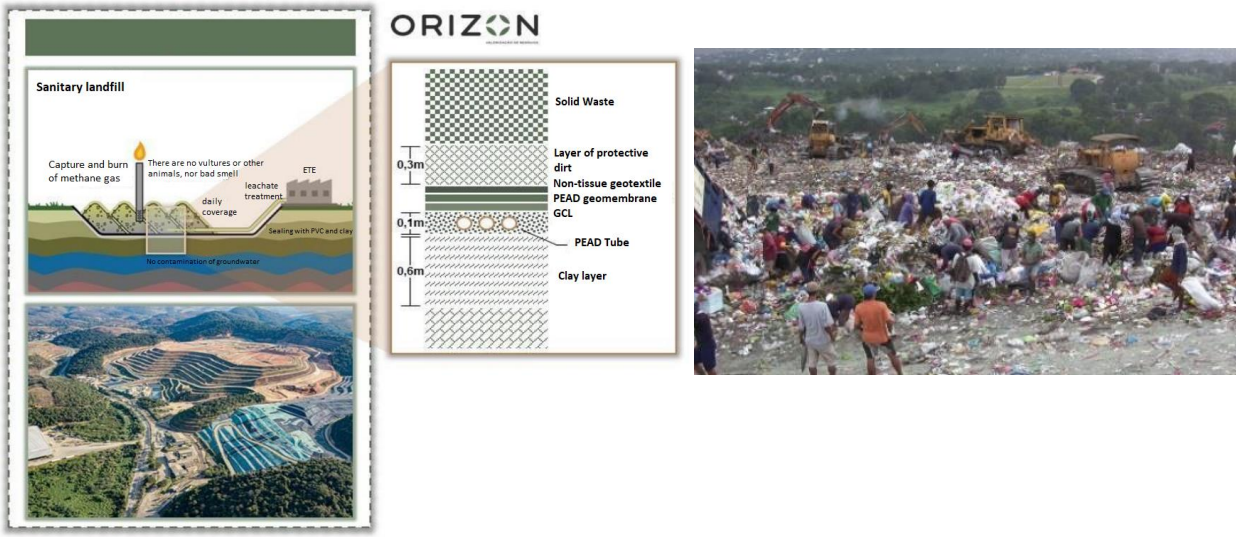
Buyer	Bought	Value (million BRL)	Operation	Date
Estre	Cavo Serviços	610	Waste Management	03/2011
Estre	Resicontrol, GeoVision, Viva Ambiental CTR Itaboraí	1,500 in 5 years	Waste Management, Collection, Recycling	04/2012
Solví	Essencis (Estre)	500	Waste Management	12/2016
Orizon	Estre	840	Waste Management, Recycling	11/2021
Grupo Urca	Gás Verde S.A	1200	Biomethane	01/2022
Orizon	33% UTE Paulínia	516	Biogas to Energy and Biomethane	05/2022
Orizon	Cuiabá's landfill	81	Waste Management	02/2022
Orizon	51% CTR Porto Velho S.A	10	Waste Management	01/2023

Source: Variables[23]

Today, around 55% of Brazilian municipal waste is properly disposed in landfills, while 37% is improperly disposed in open-air dumpsites. This improper waste management leads to several harmful consequences for society, endangering surrounding communities and damaging the environment. Such aspects of improper waste management include **i)** the proliferation of disease-spreading animals such as rats and vultures, **ii)** the agglomeration of informal waste collectors who work in unhealthy conditions around the landfills, **iii)** soil contamination due to leachate retention, and **iv)** greenhouse gas pollution due to large amounts of untreated methane emissions from the organic waste decomposition process.

[23] https://pipelinevalor.globo.com/negocios/noticia/orizon-compra-aterro-em-cuiaba-marcando-entrada-no-centro-oeste.ghtml; https://www.istoedinheiro.com.br/cade-aprova-compra-da-essencis-pela-solvi/; https://fusoesaquisicoes.com/acontece-no-setor/orizon-paga-r-840-milhoes-por-aterros-da-estre-e-quase-dobra-de-tamanho/; https://epbr.com.br/urca-energia-adquire-gas-verde-e-vai-expandir-producao-de-biometano/; https://apsis.com.br/noticias/grupo-estre-negocia-aquisicao-da-viva-ambiental/; https://www.investe.sp.gov.br/noticia/dahestre-tem-plano-de-investir-r-1-5-bilhao/; https://valor.globo.com/empresas/noticia/2014/12/09/solvi-assume-controle-da-essencis.ghtml

Illustration of Orizon's landfills (left picture) vs. a common dumpsite (right picture)

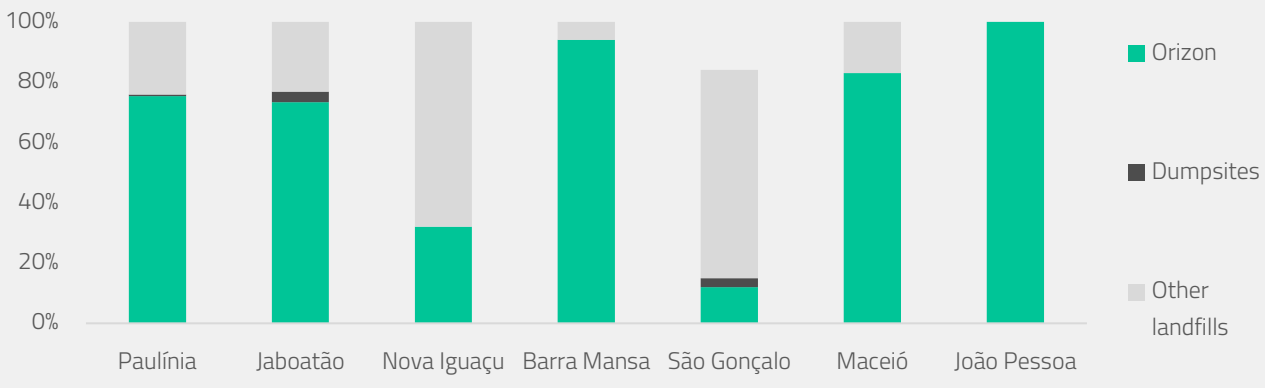


We see the aforementioned regulatory shift as a great opportunity for Orizon to expand and grow its business as municipalities rush to manage their waste disposal on relatively scarce landfill operators. We believe this growth potential will come mainly from inorganic activities and greenfield projects rather than organic spillover growth. That's because the waste volumes received by Orizon's current landfill operations are in very little direct competition with dumpsites.

Nonetheless, the regulatory shift has turned its attention to major white spots in Brazil's waste management sector. These opportunities consist of areas previously served by illegal dumpsites. They now represent great greenfield opportunities for legitimate landfill operators like Orizon. We see the company very well positioned to leverage its expertise and expand its footprint to serve these regions. One such example is the recent acquisition of the brand-new Porto Velho landfill, which is expected to receive its first volume of waste in March 2023. Prior to Orizon's entry into the region, Porto Velho's solid urban waste was mainly sent to the "Lixão da Vila Princesa" dumpsite. There are no other options for proper disposal in the city, making Orizon's strategic negotiating position very strong.

In addition to growth opportunities in new locations, Orizon's opportunities for organic growth in its existing landfills were analyzed. We used SNIS data to estimate how much waste is sent to Orizon, to dumpsites, and to other landfills in each of Orizon's areas of influence.

Market share in influence areas (in percentage of waste volumes)



Source: SNIS

Looking at individual operations, we see that some landfills already have a large share of the municipal addressable market or their area of influence. In these cases, volume growth is limited by regional organic waste generation. That's the case for Maceió, Paulínia, Jaboatão, Barra Mansa and João Pessoa. On the other hand, some landfills still have plenty of room to grow. This is the case in Nova Iguaçu and São Gonçalo, where Orizon is losing market share to the Seropédica landfill (operated by Simpar), one of the largest in Brazil. The landfill has a long-term supply contract with the City of Rio de Janeiro, which guarantees receival of all the city's waste until 2036. With the end of Simpar's contract, Orizon is perfectly positioned to gain market share in this area of influence due to its proximity to waste collection areas and cheaper transportation.

Although landfilling is the most common method of waste disposal, it is not the only appropriate method. There are several other alternatives, widely used in other regions, that can address waste disposal needs. They include **i) recycling, ii) waste to energy, iii) composting** and some others. Although Orizon operates in some of these other waste destinations, we believe that in Brazil, landfill disposal for solid urban waste will be the main destination option for several decades. This is due to the more valuable economics of waste utilization in this model (generation of complementary revenues through biogas, biomethane, energy production and recycling), which is based on a relatively low-cost operation. Nevertheless, some isolated opportunities in other ways to treat solid urban waste may emerge and will probably be considered by Orizon's management.

6.3. Biogas and Biomethane

As mentioned above, one of the key growth drivers for Orizon is the ability to expand biogas and biomethane production in the medium and long term. This is mainly due to **i)** the easy replicability of the business at existing landfills and **ii)** the demand for biomethane as a substitute for fossil fuels in power generation, industrial applications and internal combustion engines. We see the company expanding its biomethane production from 89,100 m³/day to 750,000 m³/day in 2028, increasing from 6.5% of revenues to 41% of revenues. This rapid growth plan depends on the correct expansion of its biomethane purification modules to eight landfills.

6.3.1. Biogas Engineering

When waste is landfilled, it can undergo three different types of chemical reactions[24]. Bacterial decomposition is the primary form of waste decomposition and converts organic matter to methane and carbon dioxide if it occurs in the absence of oxygen, or to fertilizer if it occurs in an oxygen-rich atmosphere. Volatilization converts waste into volatile gases, such as NMOCs (non-methane organic compounds). Finally, other chemical reactions can occur when certain components, such as bleach and ammonia, are disposed with ordinary waste.

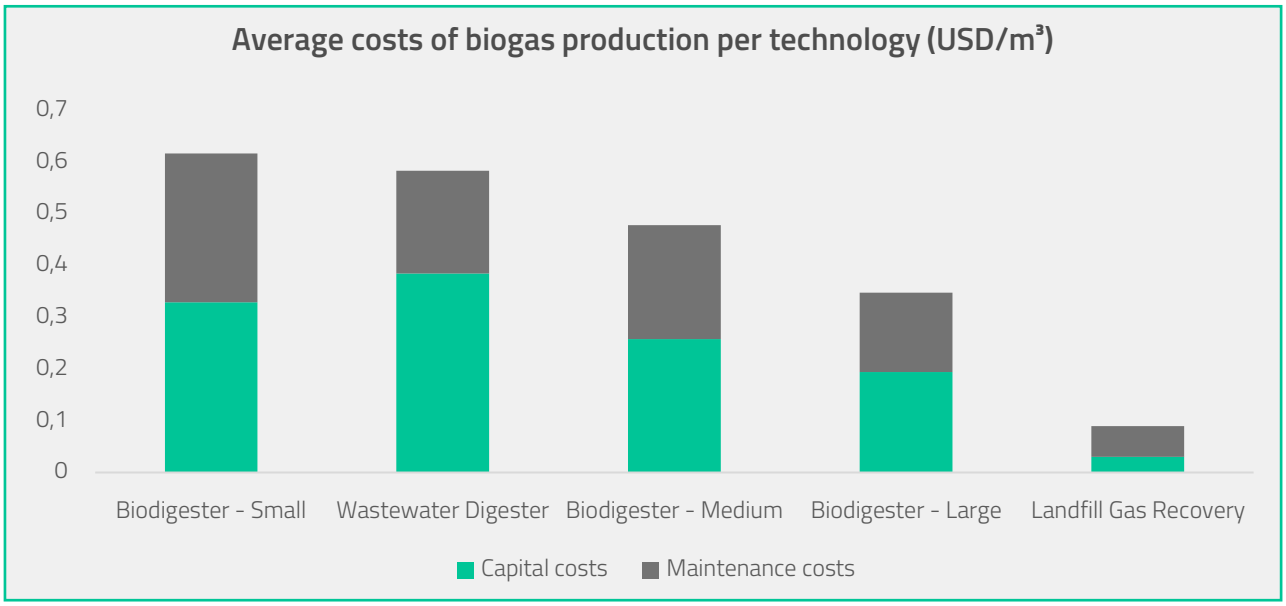
While methane is useful for energy production, NMOCs and other gases are mostly harmful and must be filtered. Some conditions, such as temperature and landfill maturity, affect the final composition of landfill gas. For example, while higher temperature increases methane production, it also accelerates the production of toxic gases, while more mature waste depletes oxygen and increases methane production (anaerobic fermentation).

Basically, biogas is composed of methane and carbon dioxide at approximately 50%/50% ratio, depending on the forementioned conditions. The result in methane production can be estimated by the methanization factor[25], equivalent to 100 m³/ton of organic fraction of the waste (throughout its life), or can be simulated by LandGEM[26] (Landfill Gas Emissions Model), from the EPA. Brazil's solid waste composition, which is predominantly organic, favors biological treatment in landfills.

In the modern, state-of-the-art landfill, the site is specially prepared for biogas collection, with good sealing to prevent gas leakage and oxygen ingress. Non-organics (glass, some plastics, electronics, etc.) would be separated prior to landfilling, and the landfill would leave enough space for moisture to infiltrate all of the disposed waste. Water infiltration can aid in biogas production, but its excess is converted to leachate, which is mainly pumped out of the landfill. If pumped and treated, some leachate can be returned to the landfill, improving biogas production and byproduct quality. When landfill gas is produced, it is collected through piping, pre-filtered already in the landfill, compressed in a gas pump, and stored.

As noted above, all organic matter produces biogas, and this collection is not limited to landfill biogas. Wastewater treatment, waste treatment in biodigesters, and biogas production from agricultural residues (sugar cane bagasse and vinasse are the most common) are also common ways of using residues as an energy source. **However, landfill gas is still the cheapest way to collect biogas, as suggested by the IEA research:**

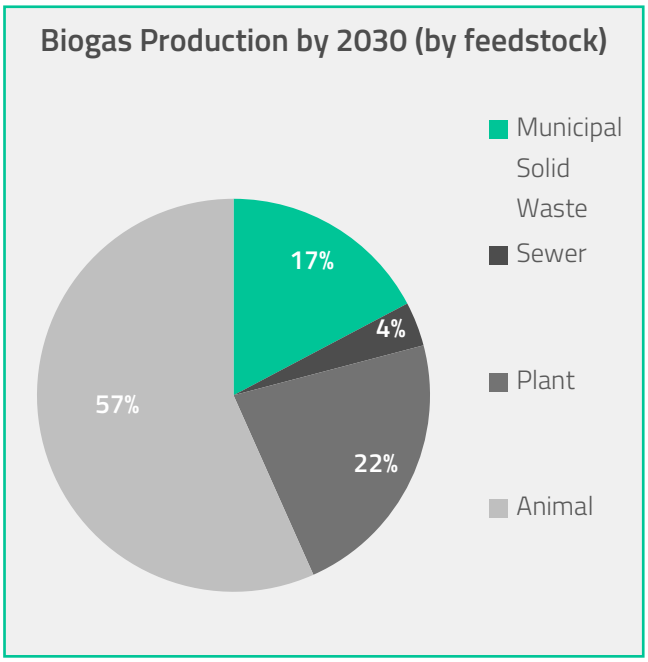
[24] LANDFILL GAS BASICS: https://www.atsdr.cdc.gov/HAC/landfill/PDFs/Landfill_2001_ch2mod.pdf
[25] NFORME TÉCNICO – POTENCIAL ENERGÉTICO DOS RESÍDUOS URBANOS – EPE: https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-372/topico-492/Informe%20Urbano%20EPE-DEA-007-19%20-%20rev.pdf
[26] EPA: https://www.epa.gov/catc/clean-air-technology-center-products#software



Source: IEA[27]

After landfill biogas is captured and filtered, it can be sent to a thermal plant for electricity generation or purified to produce biomethane, a natural gas equivalent, for later commercialization. Other types of biogas production are either more expensive to operate, require much higher capex, or are many times more difficult to replicate on a larger scale compared to landfill gas recovery (shown by figure above). This puts Orizon in a very attractive position given the growth prospects for biomethane. **We see the company as a competitive player as one of the lowest cost producers in the industry.**

Abiogás estimates that Brazil will produce 29.6 million m³/day of biogas from various sources in 2030. Panda.org considers a higher production of sugar cane, resulting in 32.7 million m³/day of biogas, with the following breakdown by feedstock.

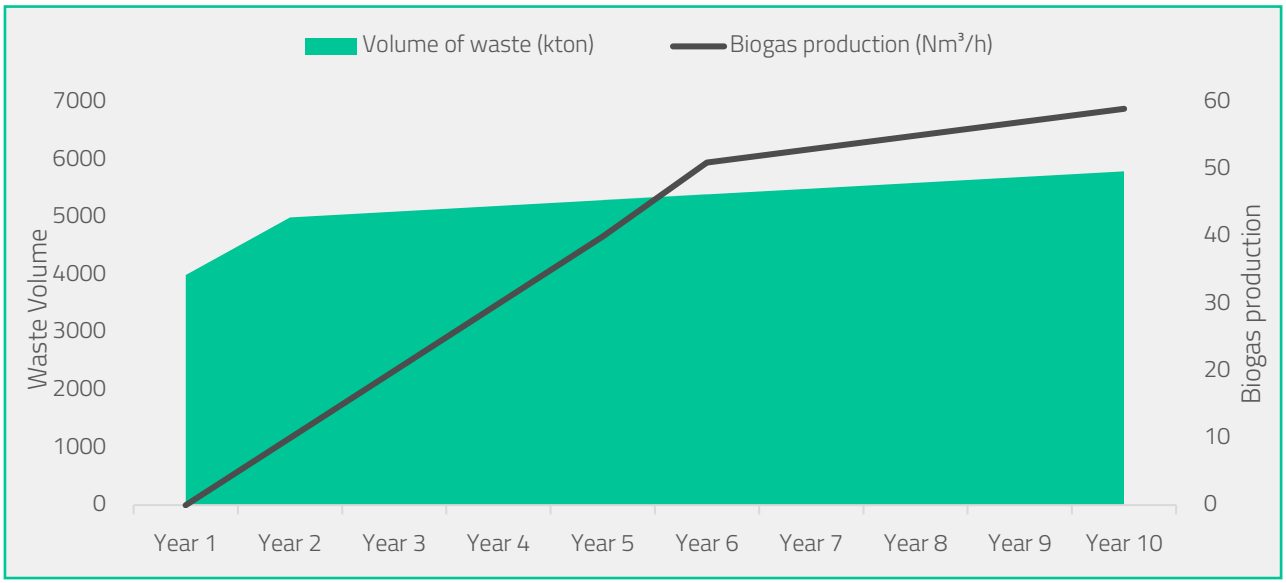


Source: Panda.org[28]

[27] IEA: https://www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth/sustainable-supply-potential-and-costs
[28] POTENTIAL SUSTAINABLE BIOFUEL PRODUCTION IN BRAZIL – 2030: https://wwfbr.awsassets.panda.org/downloads/potencial_producao_sustentavel_biocombustiveis_english_web.pdf

6.3.2. Biogas Business

Biogas production is proportional to landfill waste and organic matter. Orizon provides biogas collection statistics in the company's 10-K, as shown below. Even after the landfill is closed to new disposal, biogas can still be collected as newer waste is fermented later, but biogas production decays rapidly and lasts as a useful gas source for up to 5/6 years post closure.[29]



Source: Orizon's 10-K

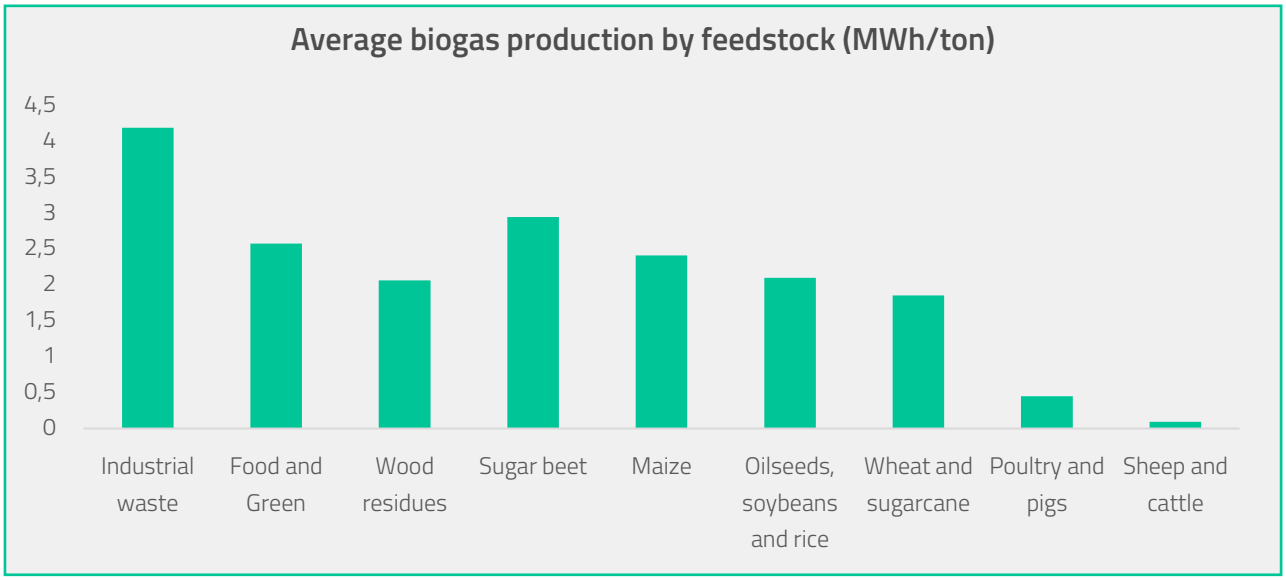
As mentioned earlier, thermoelectric plants receive fuel, burn it, boil water, and pass it through a turbine to generate electricity. Currently, Orizon has two business lines related to thermoelectric plants, and both business lines are different even though they share similar physical principles of operation.

The first line of business is the **sale of biogas directly to thermal plants,** passing only through the filtering system of the collection system. This happens in the landfills of Barra Mansa, Nova Iguaçu and São Gonçalo, with supply contracts until 2031, 2034 and 2030 respectively, for an average of 480 thousand m³/day of biogas. At the end of these contracts, we believe Orizon will implement a biogas to biomethane purification unit to add more value in its waste management process.

The other business line related to biogas is the collection in the landfills of Jaboatão dos Guararapes and João Pessoa, where **Orizon is part of a consortium with ASJA.** The agreement stipulates **that Orizon will supply all the biogas collected at the two landfills to the thermoelectric plants, in exchange for 25% of the revenue from the electricity generated.** Currently, Jaboatão dos Guarapes is the second largest producer of biogas in Orizon's footprint, capturing approximately 296,000 m³/day. The company sees the landfill as a great opportunity to produce biomethane and is currently negotiating to exercise its call option to purchase the entire UTE from ASJA. The idea is to redirect the current biogas production, which is currently used for energy generation, to biomethane production, which will allow the company to maximize its value. The UTE operation has a PPA at an attractive price of BRL 332/MWh that expires at the end of the year, while the free-market electricity prices are much more depressed (averaging BRL 100/MWh), making the production of biomethane the more profitable use of the biogas captured in its landfill.

Another way to produce biogas is through fermentation of agriculture products, especially sugar cane and by-products of ethanol production. The agriculture and ethanol industries have many organic by-products, especially vinasse, which can be used for biogas production and directed to thermoelectric plants or purification to biomethane. This biomethane can then be fed into the grid or used to power machinery and farming vehicles. For comparison, the graph below shows how much biogas is produced from different feedstocks in MWh/ton.

[29] ORIZON

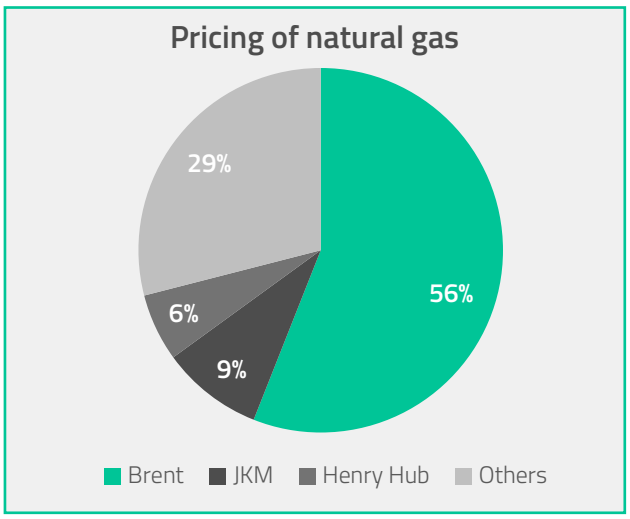


Source: IEA[30]

Currently, the main producers of alternative biogas are Raízen, Vibra and São Martinho, in an extremely fragmented market with approximately 700 biogas plants[31] from agriculture and agro-industry. They mainly produce biomethane from sugarcane vinasse, a byproduct of sugarcane crushing. Today, this process accounts for approximately 18% of domestic biomethane production and is expected to grow aggressively. Raízen[32], for example, expects to produce 3 million m³/day of biomethane in 10 years. Brazil has a huge potential to produce biomethane from sugarcane biomass, given its large harvest of 596 million tons per year[33], making it the world's largest producer. However, as explained above, fermentation is a more expensive process than landfilling and competes with other uses of sugarcane biomass (such as cogeneration, composting and second-generation ethanol).

[30] IEA: https://www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth/sustainable-supply-potential-and-costs
[31] CIBIOGÁS MAP
[32] EPBR: https://epbr.com.br/petrobras-e-raizen-vao-estudar-parceria-no-negocio-de-biometano/
[33] CONAB: https://www.conab.gov.br/ultimas-noticias/4688-conab-realiza-pesquisa-de-campo-sobre-cana-de-acucar#:~:text=De%20acordo%20com%20os%20dados,596%2C06%20milh%C3%B5es%20de%20toneladas.

6.3.3. Biomethane Business



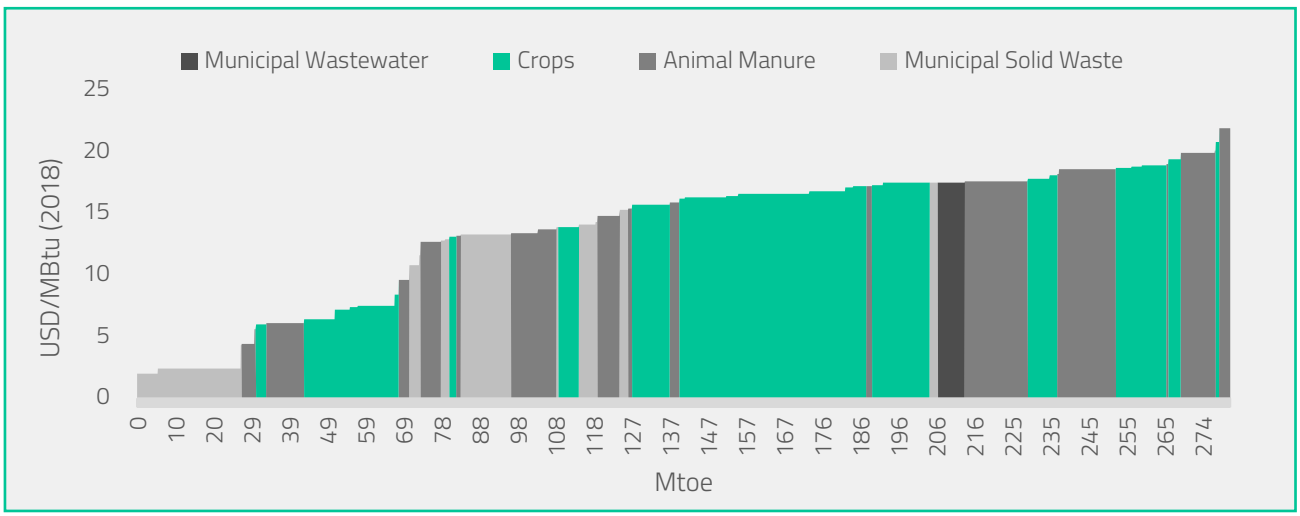
Source: Petrobrás. Pricing of natural gas

Biomethane isn't just a new green fuel, it has approximately the same composition as natural gas, with approximately 2.196 kWh/m³ of electric energy equivalence[34] (depending on thermoelectric efficiency), making it a direct substitute for natural gas. It can also be used as a substitute for fossil fuels in ICEs and is an excellent alternative for trucks, industrial machinery and light vehicles. However, while natural gas prices have traditionally been driven mainly by Brent, Henry Hub and JKM, biomethane does not yet have a clear price dynamic.

Just for comparison, in Europe, the production of biomethane costs around 80€/MWh (expected to cost 57 by 2050), while TTF gas price costs 134€/MWh[35]

This clearly shows that biomethane production has market viability. In Brazil, the trade of biogas and biomethane is still in its infancy and the pricing mechanisms among players are still being formed. Biomethane production projects have different technological paths (as explained above), resulting in different production costs as well. Public contracts are currently negotiated based on natural gas prices and some variable premium paid due to the biomethane environmental attribute. We currently see many producers preferring long-term supply contracts (10-20 years) with prices linked to the Brazilian inflation rate, fearing that biomethane prices will correlate with fossil fuel prices (given their commutability). Orizon has some public contracts in that format as well. One of them is the recently announced agreement with Copergás to supply 2,500 m³/day for 10 years at a fixed price of BRL 3.2/m³.

An IEA study attempted to estimate the marginal cost curve for biomethane production around the world. It found that the economically available global biomethane capacity today is approximately 700 Mtoe and that the most cost-effective production alternative is from landfill biogas upgrading.



Source: IEA[36]

[34] JANUS&PERGHER: https://januspergher.com.br/wp-content/uploads/2020/05/Boletim-T%C3%A9cnico-Purificador-de-Biog%C3%A1s-2020.pdf
[35] FITCH: https://www.fitchratings.com/research/corporate-finance/fitch-ratings-cuts-near-term-gas-price-assumptions-oil-prices-unchanged-05-12-2022
[36] IEA: https://www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth/sustainable-supply-potential-and-costs

After purification of the biogas into biomethane, the gas is transported to the end user. In Brazil, it can be injected into the natural gas grid under conditions set by the ANP, or it can be compressed for transportation by truck. The latter is usually more expensive restricting the influence area around landfills. Our channel checks suggest that the economically viable radius of CNG from production sites range from 100km to 150km. Therefore, projects that are close to the grid, which is the case for the most important of Orizon's landfills, can access a broaden market and more off take options.

Today, the Paulínia landfill collects approximately 480,000 m³/day of biogas and is the only facility that processes it into biomethane. The company sells 180,000 m³/day of its biogas to its subsidiary (Orizon Energia e Gas Renovável - BioE), which is responsible for the purification and subsequent delivery of the biomethane produced (around 89,100 m³/day) to a thermoelectric plant for energy production, managed by the UTE Paulínia consortium. However, the requirement of upgrading biomethane (instead of biogas) for thermoelectric plants is inefficient since **the purification process is costly and biomethane has no advantage over biogas for electricity conversion in thermal plants.**

On the other hand, biomethane can be sold to third parties as a natural gas equivalent, via grid or via cylinders, which cannot be done with crude biogas. The current operation in Paulínia burns biomethane at UTE Paulínia, selling energy generated by BRL 1,802 MWh. The UTE is required to supply 15.7 MW to accomplish the terms of the emergency auction of 2021 won by Orizon. However, after 2025, when the PPA contract expires, Orizon plans to sell this biomethane on the market and only produce energy locally using biogas as fuel.

While biogas is a ready-to-use fuel and requires less capex to get started, the biomethane business requires a whole new set of equipment to produce it. The purification (or upgrading) modules are not high-tech equipment, but they do have a significant cost associated with them. The company estimates that a purification module with a biogas processing capacity of 2.5 m³/h requires an investment of **BRL 50 million. Given Orizon's forecast to increase biomethane production to a range of 33k m³/h to 36k m³/h, the investment requirement will be somewhere close to BRL 1.3 billion in the next years.**

6.4. Carbon Credits

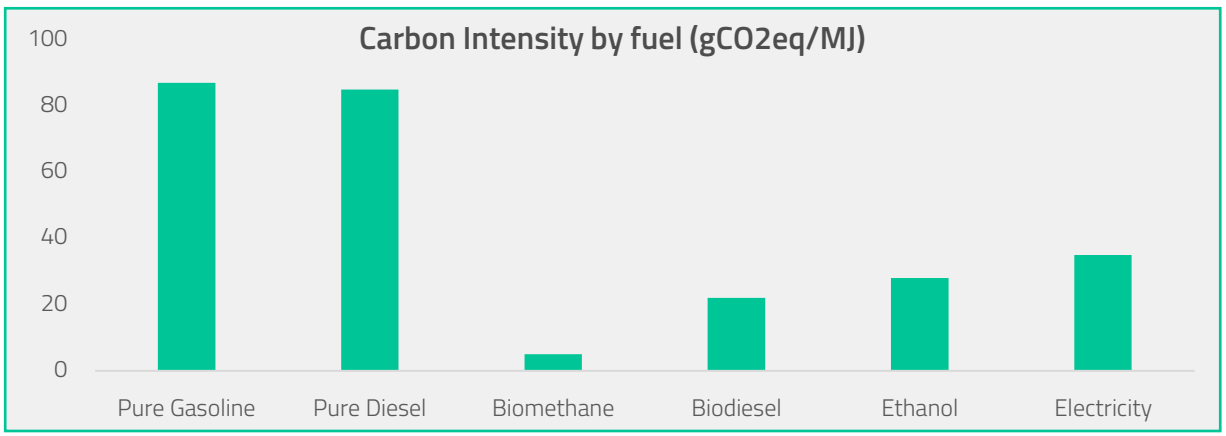
Carbon credits were introduced to reduce greenhouse gas emissions and are now used in two main carbon markets: the compliance market and the voluntary market. Orizon currently issues carbon credits in the voluntary market but plans to enter the regulated CBIO market soon by selling its biomethane as a substitute for fossil fuel in ICEs. The voluntary market is currently the main carbon market in Brazil, but demand for carbon credits is expected to grow in the future due to increasing standards for green activities.

The guidelines for issuing carbon credits and reducing greenhouse gases were first presented in the Kyoto Protocol in 1997. This treaty focused on mitigating climate change and reducing emissions of major greenhouse gases in industrialized countries. Carbon credits were the mechanism chosen to control these emissions. The Paris Agreement of 2015 renewed the Kyoto Protocol and expanded its goals to include all greenhouse gases and all countries.

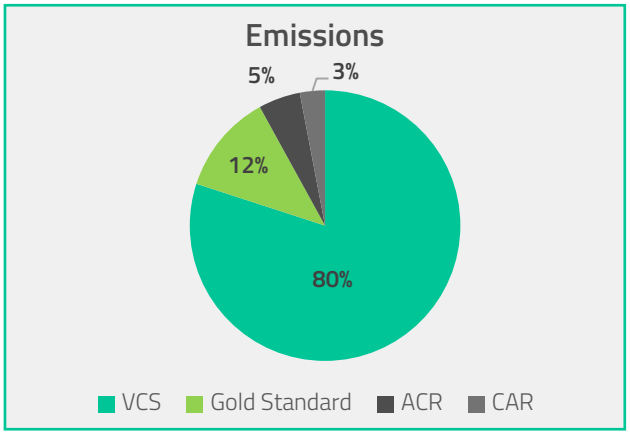
The idea is to use market mechanisms to cap global greenhouse gas emissions and achieve net carbon neutrality by 2050. Carbon credits generated are certificates of reduction of carbon (or carbon dioxide equivalents, such as methane) issued by an industry or commercial activity and validated by a validation agency (either private or public). They are intended to mitigate carbon emissions and provide incentives to reduce or remove carbon (from the atmosphere). Carbon reduction is legally mandated in some developed countries, with market parameters set by institutional players in accordance with annual greenhouse gas reduction targets.

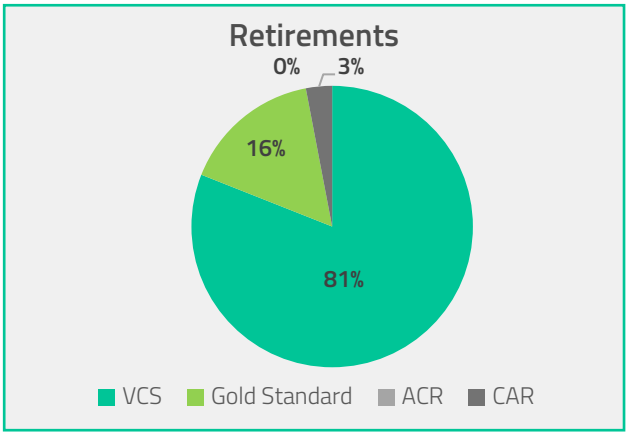
There are two main carbon markets in the world[37], the compliance market and the voluntary market. **The compliance market is defined by a regulatory framework and is based on the carbon emission limits in a particular country.** Typically, the regulation sets a maximum carbon emission quota per year allowed for different industries, setting the maximum carbon allowed by companies within sectors. Companies that produce more greenhouse gases than their quota are heavily fined by the authorities unless they reduce their carbon emissions or buy carbon credits from less carbon-intensive peers. Therefore, the system rationally privileges the most efficient companies in terms of carbon reduction over the less efficient ones, allowing the lower cost carbon reducers to offset the higher carbon intensive players. In other words, companies that exceed the carbon emission limit must buy carbon credits from companies that fall below the limit, creating an economic incentive to reduce GHG emissions as well as a dynamic market for trading carbon credits.

The voluntary market, on the other hand, has emerged organically to meet the needs of companies that voluntarily seek to reduce their carbon footprint. It is not supported by any legal or regulatory framework and relies on private third parties to validate the production methodology and issuance of CERs. The main players in CER certification standards are Verra (80% market share), Gold Standard (12%) and American Carbon Registry (5%). Companies that want to issue CERs need to contract one of the standards to study their carbon reduction project (it may involve many different methodologies to measure CO2e reduction or capture) and determine their annual CER issuance as well as what type of CER to issue (it can be either from carbon reduction, less valuable, or carbon sequestration, more valuable). Companies can then sell their CERs to other companies that want to reduce their carbon footprint, sell to traders who want to speculate on the value of CERs, retire their credits to reduce their own carbon emissions, or store them for future carbon offsetting.



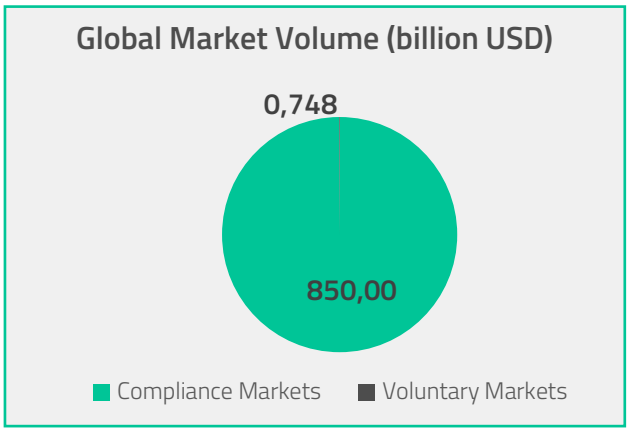
[37] KPMG: https://kpmg.com/xx/en/home/insights/2022/05/regulating-carbon-markets.html

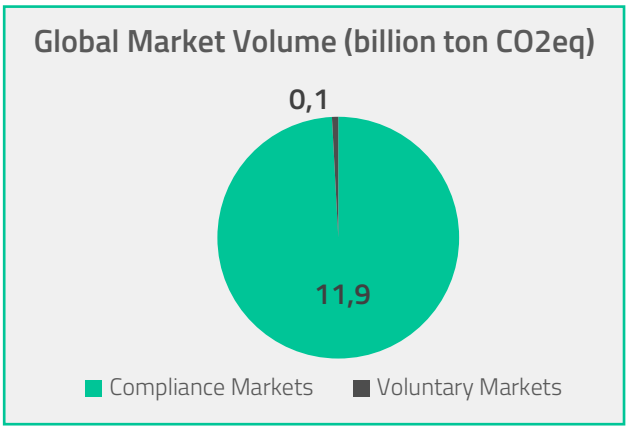




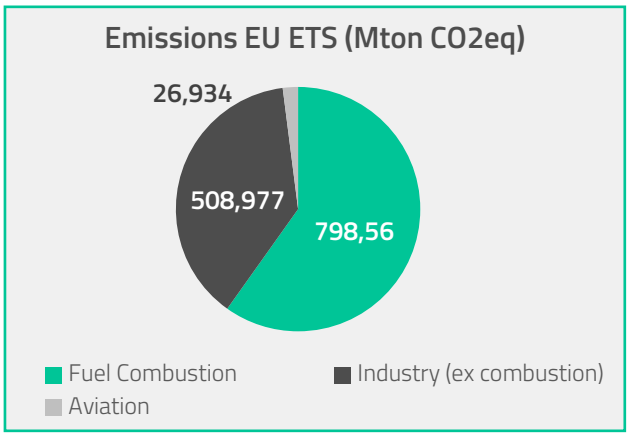
Source: ICCBr[38]

The voluntary market is still very small compared to the compliance market globally, but it is the largest market in Brazil. It is important to emphasize that the voluntary carbon market is an OTC (over the counter) market and that access to demand is limited to a few large players worldwide. Therefore, most Brazilian CER proponents typically sell their credits to these resellers, who have unique access to foreign markets and enjoy high margins in trading these securities. However, **we believe the greater opportunity for domestic players to improve their results and take advantage of carbon neutral trends is in the compliance market.** According to the World Bank's January report, regulated markets account for only 23% of total global carbon emissions (12Gton of CO2eq). The largest exchange and benchmark is the European Union Emissions Trading Scheme, but each year more countries are adopting some form of regulated market framework. As shown below, the total global regulated market is more than 100 times larger in volume than the global voluntary market. Verified carbon emissions in the compliance market come primarily from the energy and industrial sectors, as exemplified by the European Union Emissions Trading System (EU-ETS).

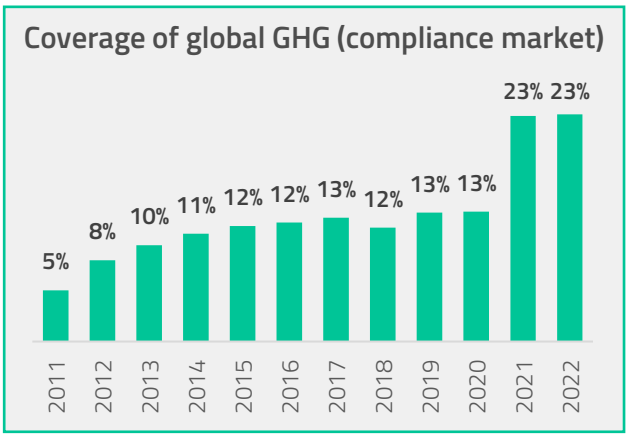




Source: Ecosystem Marketplace and SuperRico[39]



Source: European Environment Agency[40]



Source: World Bank[41]

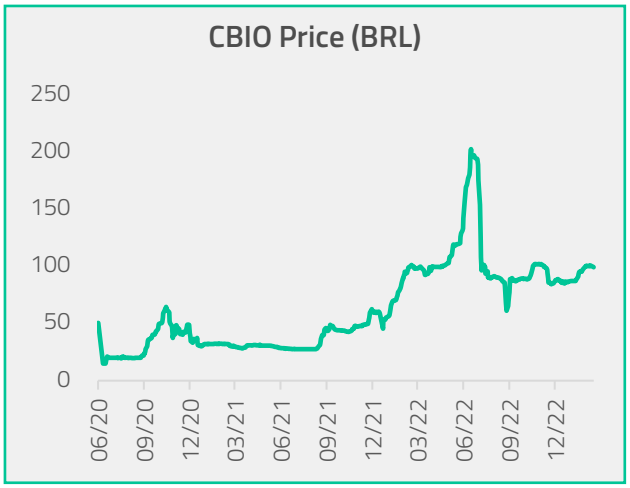
[38] ICCBR: RELATÓRIO 2022 – OPORTUNIDADES PARA O BRASIL EM MERCADOS DE CARBONO

[39] EM: https://data.ecosystemmarketplace.com/; SUPERRICO: https://www.superrico.com.br/artigos/planejamento-financeiro/qual-o-potencial-do-mercado-brasileiro-de-carbono#:~:text=Desse%20total%2C%20somente%2012%20bilh%C3%B5es,efeito%20estufa%20que%20em%202008.

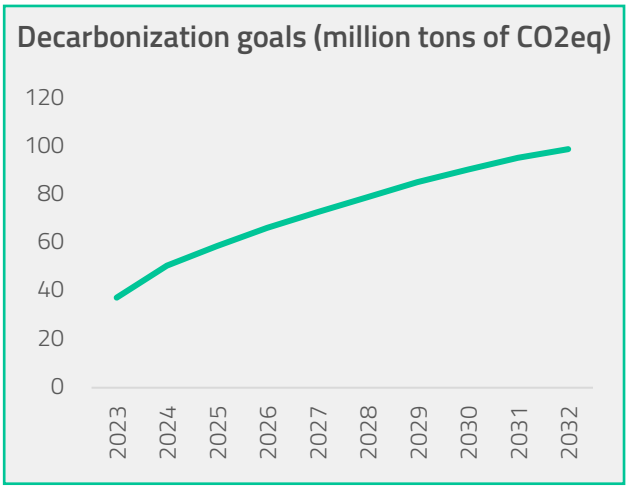
[40] EEA: https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1

[41] WORLD BANK: https://carbonpricingdashboard.worldbank.org/map_data

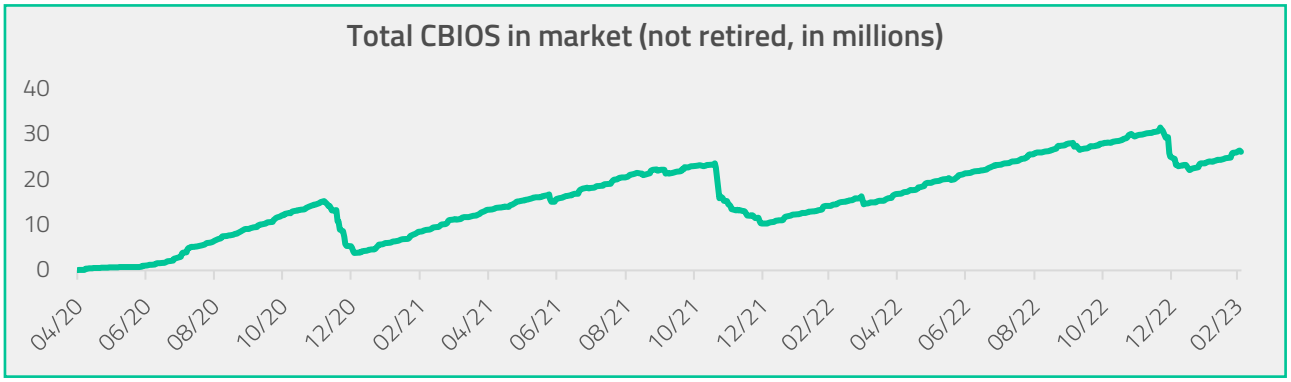
In Brazil, the regulated market is represented by the RenovaBio policy, established by the government in 2017 and regulated by the ANP (National Petroleum Agency) as an interim measure to increase the adoption of renewable fuels nationwide. The regulator allows biofuel suppliers, such as biodiesel industrial plants, ethanol mills and biomethane producers, to issue a certain amount of CBIOs according to their biofuel supply and production methodology. The idea is that each CBIO is equivalent to one ton of CO2eq, and the amount awarded to a producer reflects the amount of CO2eq avoided by their biofuel. Cleaner fuels and industrial operations will result in higher CBIOs being issued to a particular agent. Certified industrial sites are regularly monitored by ANP agents and produce a fixed ratio of CBIOs per biofuel sold. Companies can then sell these CBIOs to fuel distributors who have annual tCO2eq limits. The exchange takes place on the open market within the B3 system (Brazilian Securities Market). The prices of these CBIOs vary according to the dynamics of supply and demand and have been highly volatile in recent years:



Source: B3[42]



Source: NovaCana[43]



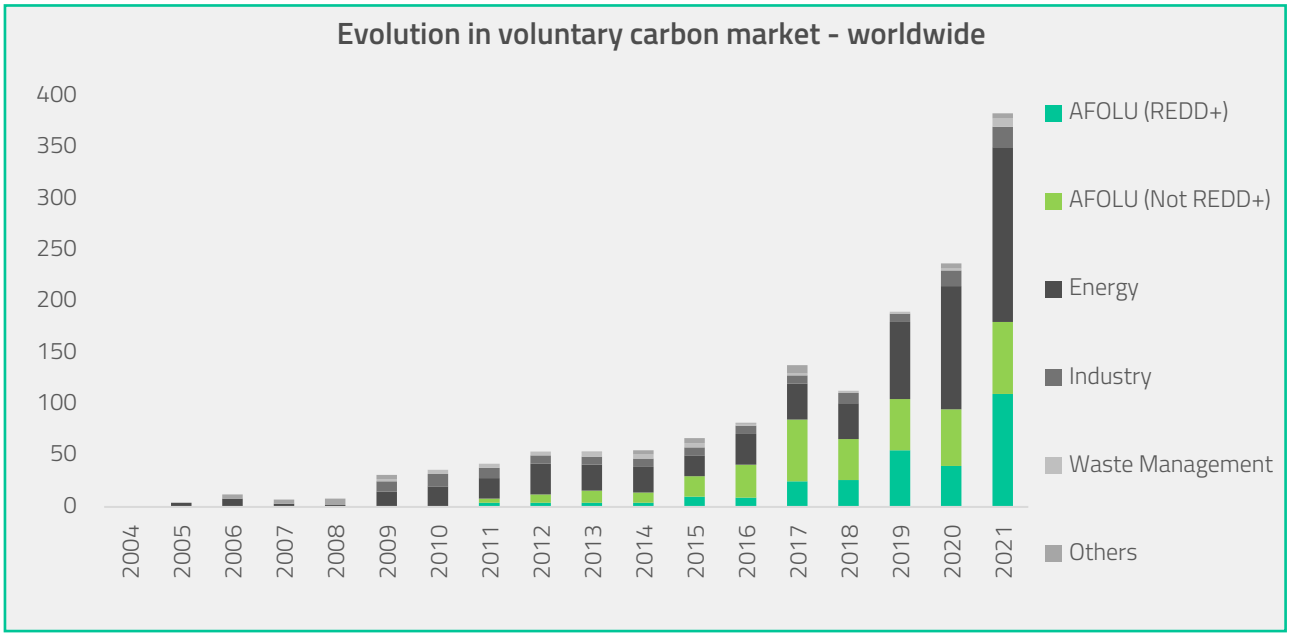
Source: B3[44]

Today, Orizon is only present in the voluntary market by avoiding methane emissions at its landfills. It does this either by capturing the biogas emission and burning it on flares or by upgrading it to biomethane. **The methane molecule is approximately 25 times more potent than carbon dioxide in terms of greenhouse gas emissions**. Thus, by burning methane in flares, Orizon achieves a ~96% carbon dioxide equivalent pollution reduction and therefore issues CERs.

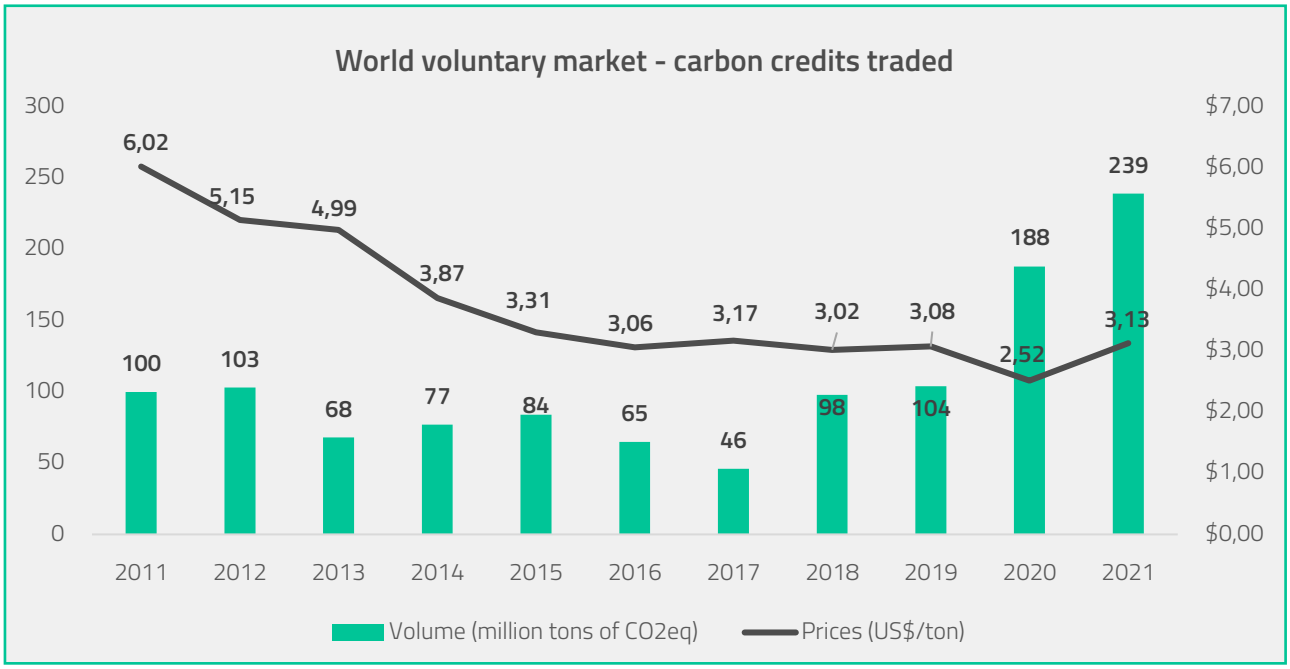
Management aims to enter the regulated CBIO market soon. It would do so by selling its biomethane as a substitute for fossil fuel in ICEs. This could be a huge opportunity for additional cash flow generation once it starts selling biomethane directly to customers. The company says it is already in talks with ANP to certify its Jaboatão dos Guararapes landfill and Paulínia sites for the issuance of CBIOs. The carbon dioxide reduction for equivalent joules compared to other fossil fuels such as gasoline or diesel is approximately 0.0031688 CBIOs/m³. This means that for every 315 m³ of biomethane produced by Orizon, it would issue one CBIO unit. We believe Orizon will be able to produce approximately **305 million m³ of biomethane in 2033, which is equivalent to 970,000 CBIOs or BRL100 million at current prices.**

[42] B3
[43] NOVA CANA: https://www.novacana.com/noticias/cnpe-aprova-aumento-de-metas-de-cbios-pelas-distribuidoras-em-2023-para-37-47-creditos-091222
[44] B3

In the voluntary market, carbon credits are classified under four main activities: **i)** AFOLU (Agriculture, Forestry and Other Land Use) through carbon sequestration, **ii)** REDD+ (Reduction of Emissions due to Deforestation and Forestry Degradation), **iii)** energy through carbon reduction, and **iv)** waste treatment through methane capture. Global emissions have increased significantly since 2018 and are expected to increase further in the coming years. The proliferation of corporate ESG practices and rising demand from society for greener activities will continue to drive demand for carbon credits in the voluntary market. Ecosystem Marketplace's research shows the current size of the market, while McKinsey's research shows that demand for carbon credits is set to grow 100x by 2050.



Source: FGV[45]



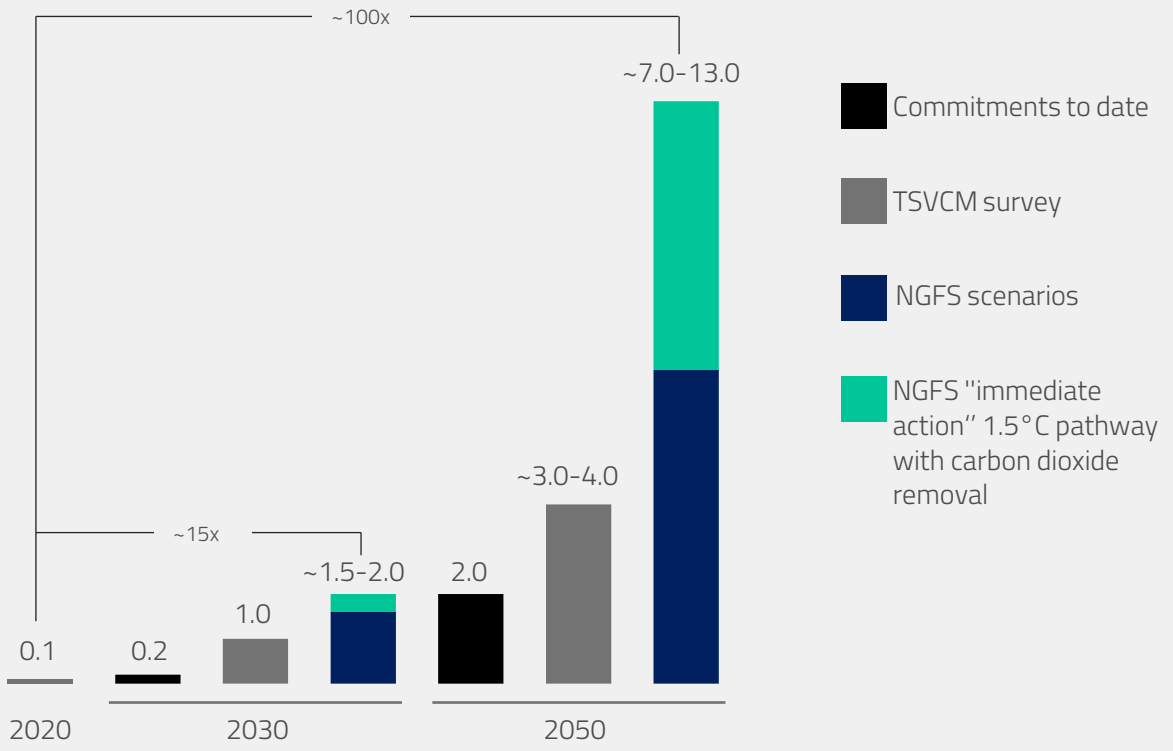
Source: Ecosystem Marketplace[46]

[45] FGV – MERCADO DE CARBONO VOLUNTÁRIO NO BRASIL: https://eesp.fgv.br/sites/eesp.fgv.br/files/ocbio_mercado_de_carbono_1.pdf

[46] EM: https://ecosystemmarketplace.shinyapps.io/PublicCarbonDashboard/_w_eda96f8d/#tab-5813-1

Global demand for voluntary carbon credits could increase by a factor of 15 by 2030 and a factor of 100 by 2050.

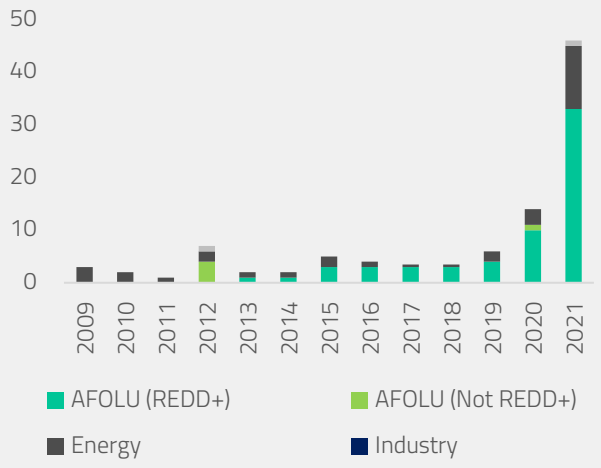
Voluntary demand scenarios for carbon credits, gigatons per year



Source: McKinsey[47]

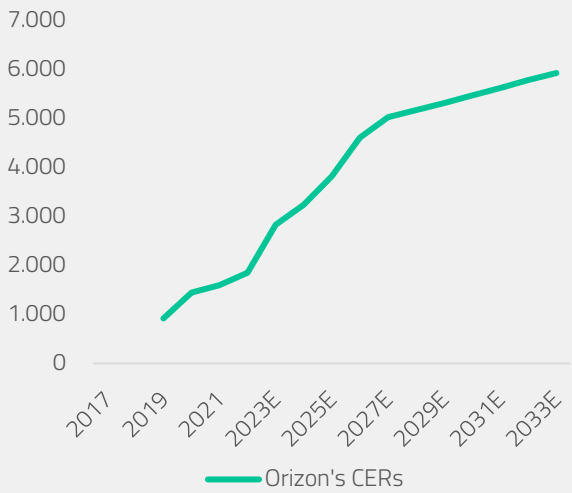
In Brazil, the voluntary market is the main carbon market. In 2021, almost 45 million tCO2eq were generated, compared to almost 14 million in 2020, and 13 million were retired. Both have grown significantly in recent years. Orizon, as a waste management company, avoids carbon emissions by properly disposing municipal waste, collecting methane emissions in landfills, and producing biogas. The company has increased its carbon credit issuance in recent years. We expect the company to continue to increase its CER generation, reaching a net revenue of BRL 1.42 billion by 2033.

Evolution in voluntary carbon credit market - Brazil



Source: FGV[48]

Global Market Volume (billion ton CO2e)

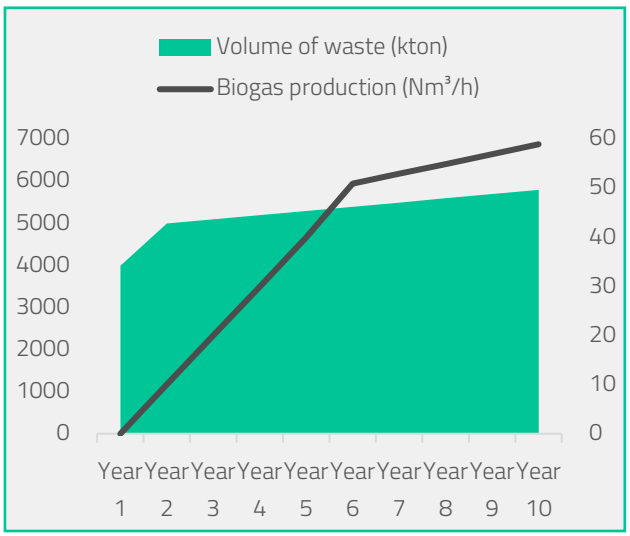


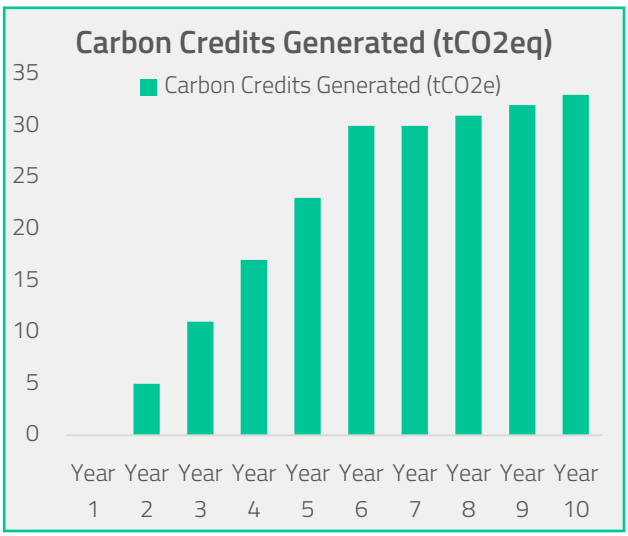
Source: Orizon and own estimates

[47] MCKINSEY: https://www.mckinsey.com/capabilities/sustainability/our-insights/a-blueprint-for-scaling-voluntary-carbon-markets-to-meet-the-climate-challenge

[48] FGV – MERCADO DE CARBONO VOLUNTÁRIO NO BRASIL: https://eesp.fgv.br/sites/eesp.fgv.br/files/ocbio_mercado_de_carbono_1.pdf

The generation of CERs can continue even after the landfills have stopped receiving waste. This process continues for approximately 6 years and is closely linked to biogas production. Currently, Orizon only has CER certification and emissions from four landfills. Some of the company's assets, especially those acquired from Estre, can't issue carbon credits yet. This is because the emission of carbon credits can only happen if the **emissions are effectively prevented, measured, and certified.** Burning biogas at the landfill without proper measurement does not validate carbon credits. Orizon plans to measure and generate carbon credits at all its landfills.





Source: Orizon. Carbon credits generated in landfill maturing and operation.

6.5. UTMs and Recycling

Ideally, urban solid waste would be reused as much as possible. Although landfilling is a much more appropriate way to treat and dispose of waste than dumpsites, it still has some drawbacks in terms of environmental impacts (such as land use and methane emissions after completion). The ultimate best treatment of waste would be to properly separate all incoming municipal waste into different homogeneous groups and direct each type to its proper treatment. Plastics and glass would be sorted and recycled, metals would be turned into scrap, and organics could be composted or landfilled to produce either biogas or fertilizer. The difficulty, however, lies in the efficient segregation of incoming waste. It usually arrives at treatment facilities as a heterogeneous mix of different materials, and segregation is extremely complex.

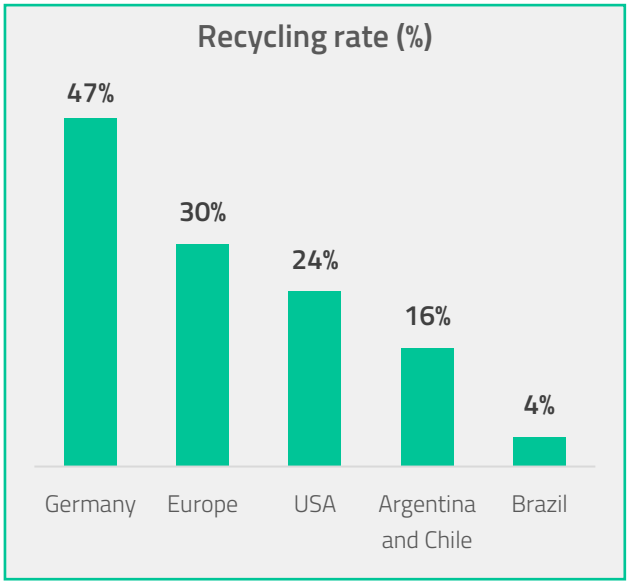
Functional UTM at Paulínia, with incoming waste. Picture taken from research team during visit

UTMs (Mechanical Triage Units) are industrial facilities that attempt to maximize this waste separation process. It extracts as much glass, paper, plastic, and metal as possible from the incoming waste to be bundled and sold. This process is done semi-automatically with people working alongside machines within a landfill operation. UTMs generate value through **i) the sale of recycled materials, ii) the generation of recycling credits, and iii) the production and sale of RDF** (Refuse Derived Fuel, used in industrial cement plants as a substitute for coking coal). Waste that cannot be separated is landfilled. The generation and commercialization of recycling credits is still in its infancy, but the logic is similar to that of carbon credits: it represents a commitment to recycling that can be freely traded in order for companies to comply with regulations.

In general, recycling is an extremely profitable form of waste treatment, with the recovery of valuable outputs such as aluminum, plastic, and paper. Recycling is a great opportunity for Orizon because it means less volume for final disposal and more landfill capacity while recovering valuable outputs. However, as mentioned above, Brazil's waste is mainly organic, which is ideal for biological treatment rather than recycling, making the operation of UTMs unprofitable in many locations. Given that waste generation is linked to income, waste from wealthier regions with higher dry content is more suitable for UTM operations.

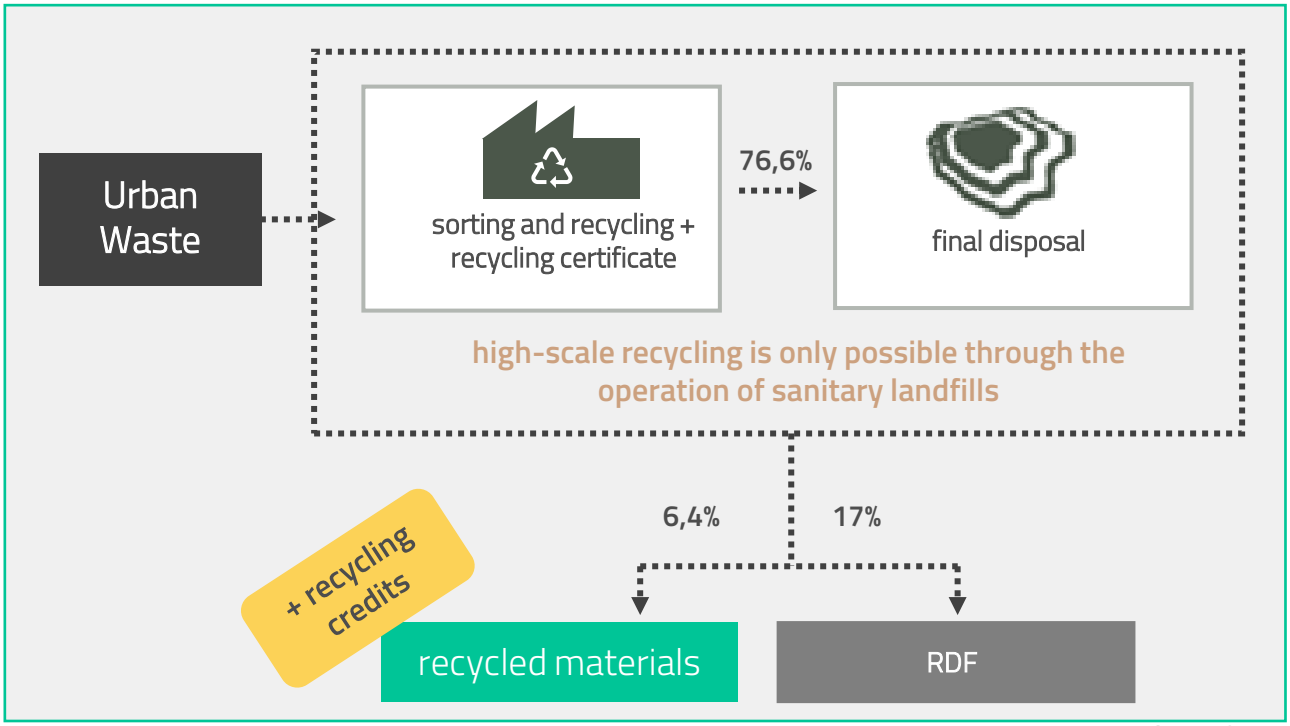
In 2018, according to official databases, **less than 4% of Brazil's waste was recycled, while the recycling rate in developed countries can surpass 40%.** The National Plan of Solid Waste (PNRS) in Brazil set a recycle goal of 20% of all collected waste by 2040. It sets tax benefits for companies that implement it as well as special subsidized credit lines to fund investments in these projects. This represents a huge opportunity for the development of Orizon's business in increasing recycling at its landfills. Currently, the company has 2 UTM sites, **i)** one in Paulínia, acquired from Estre, with a waste acceptance capacity of 300 ktons per year, and **ii)** one in Jaboatão dos Guararapes, a brand-new operation with a waste acceptance capacity of 500 ktons per year, which Orizon is using as a pilot to study the economic viability of the operation. The plan is to study both the UTM operation approach (Paulínia is more automated, while Jaboatão is more labor intensive) and decide whether to roll it out to other landfills.

According to Abren (Brazilian Association for Energy Recovery from Residues), Brazil currently has a recycling potential of 10% to 14% of total residue weight. This estimate takes into account recycling rates in Europe, which average between 20% and 30%, as a benchmark to strive for, and the composition of waste in Brazil, which is less amenable to recycling (more organic fraction).



Recycling comparison between countries, 2018 to 2021.[49]

The main goal is to use UTM as an ancillary business to landfill operations, rather than making it the company's core business. Paulínia's UTM operation, for example, receives only close to 20% of the waste that enters the landfill each year. Of the waste sent to the UTM, it recovers around 6.4% in recyclables and 17% as RDF. Since the average price of the recyclables is BRL 2,000.00 per ton and the average price of the RDF is BRL 200.00 per ton, it can generate approximately BRL 29 million of revenue per year in the cruise operation, or 6.3% of the total net revenue of Paulínia, considering the total revenue of the plant. Although it is a good source of revenue with a positive EBITDA, it is still small compared to the complex operation of a full landfill with ancillary services and represents only a marginal increase in value.



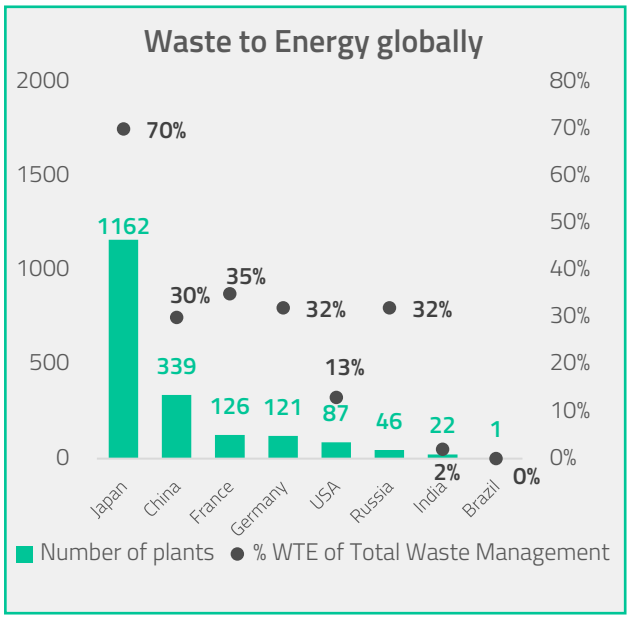
Source: Orizon.

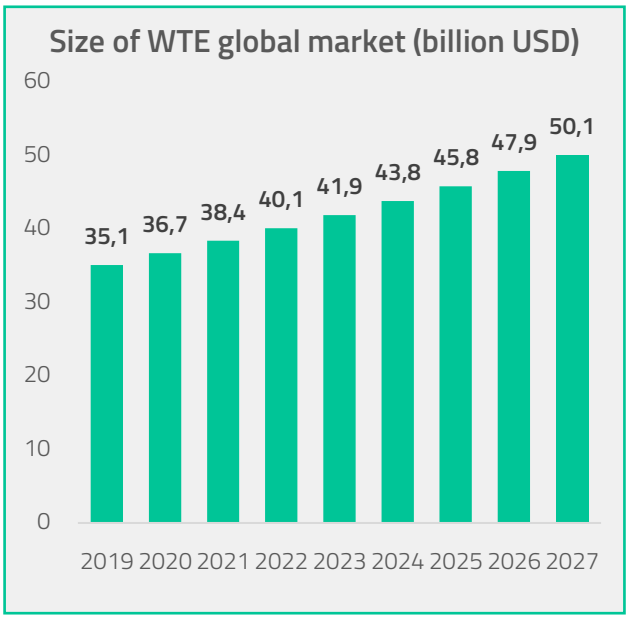
The UTM in Jaboatão dos Guararapes, on the other hand, receives around 500 ktons of waste per year (~33% of the total waste received at the landfill) and, similarly to the one in Paulínia, separates this waste for recycling. RDF is not yet produced in this UTM, but it is a great opportunity for Orizon, given the low investment for implementation (around BRL 10 million) and the current proximity to an important industrial complex that needs its products. We expect the company to expand its operations to other landfills in the future, which could increase value creation and extend the landfill's useful life.

[49] EUROSTAT: https://ec.europa.eu/eurostat/databrowser/view/env_wastrt/default/table?lang=en; EPA: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials; PCVISA: https://picvisa.com/en/cutting-edge-technology-the-essential-recycling-accelerator-in-brazil/.

6.6. Waste To Energy

As mentioned before, there are other destinations for waste that are currently being adopted in other countries. Waste to Energy (WTE) is the main alternative to landfilling, and is growing fast, especially in China. According to a recent conversation with Abren (Associação Brasileira de Recuperação Energética de Resíduos), waste to energy is the best destination for waste from an environmental perspective. It requires much less land, has zero methane and leachate emissions, and leaves no residue behind. The downside is that projects are much more capital intensive than landfills and the plant must install filtering systems for other toxic gases produced throughout the combustion process. Nevertheless, as large tracts of land near urban areas eventually become scarcer, it is reasonable to expect that WTEs will become a viable alternative. Comparisons of WTE in different countries and forecasts for the global WTE market are shown next.





Source: Orizon's 10-K

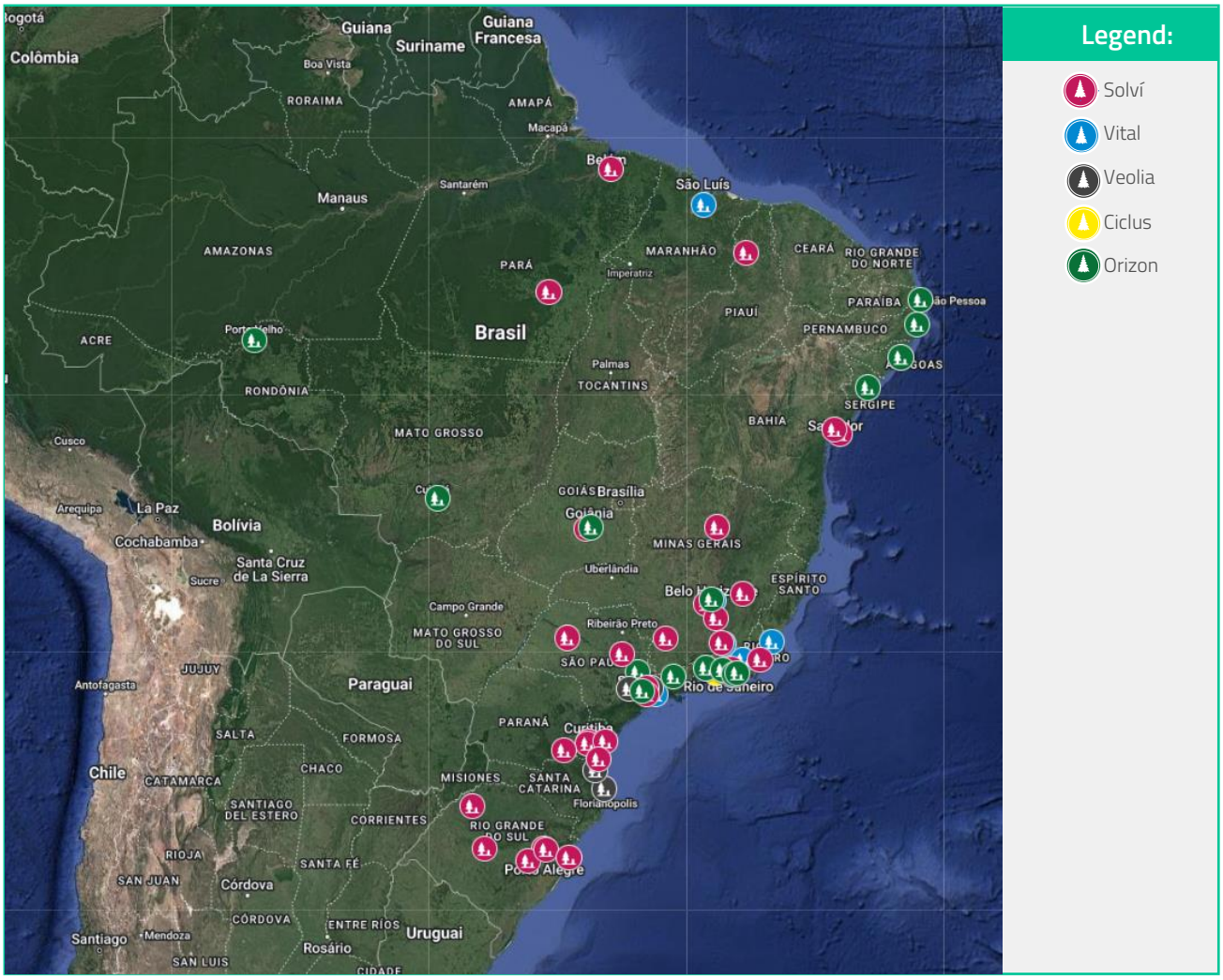
Orizon is ahead of the industry by announcing the first waste-to-energy project in Latin America. The project will be located in Barueri-SP in partnership with Sabesp (which owns a 20% stake) and has a standing agreement to receive all of the city's municipal waste from 2026 (when construction is expected to be completed) to 2045. **The total investment is up to BRL 530 million, to be disbursed between 2022-2025.** The volume of municipal solid waste is estimated at 870 tons per day, with a price of BRL 200/ton in 2026. **The energy capacity of the project is 20 MW, with an assured capacity of 16 MW, and it has already signed two PPAs in energy auctions** (the first in September 2021 and the second in October 2022), representing 82.5% of the installed capacity at an average price of BRL 554.27/MWh[50]. It is important to note that Orizon already had a signed contract to sell energy to CEMIG (a state-owned energy distributor) starting in 2018. Orizon and CEMIG negotiated a cancellation agreement that included Orizon's payment of 12MW at BRL 55/MWh (real values and gross of taxes) until 2033. The cancellation of the contract allowed Orizon to enter the PPA in the mentioned auctions and enable the economic viability of the WTE. We see this operation as a starting point and strategic move to develop expertise in other waste treatment alternatives and as another growth path the company could explore in the future.

Given the geographic extension of Brazil, **we believe that WTE solutions will be developed as alternatives only to some of the country's large cities. Landfilling alternatives will likely represent the bulk of waste disposal solutions for the foreseeable future.**

[50] ORIZON

7. Close Competitors

The solid urban waste sector in Brazil is fragmented and operated by private companies and municipalities. The market has changed significantly in recent years, with players shifting their strategic positioning from fully verticalized (from waste collection to waste disposal) to niched operations. Part of this is due to the Estre's Chapter 11 event and the many capitalization rounds that have occurred in the sector (as seen in Haztec's background and many others). We see this as an opportunity for professional and well-managed players to gain market share and lead sector consolidation. Below, we take a closer look at some of Orizon's key competitors and their current positioning. The map shows the major players in Brazil.



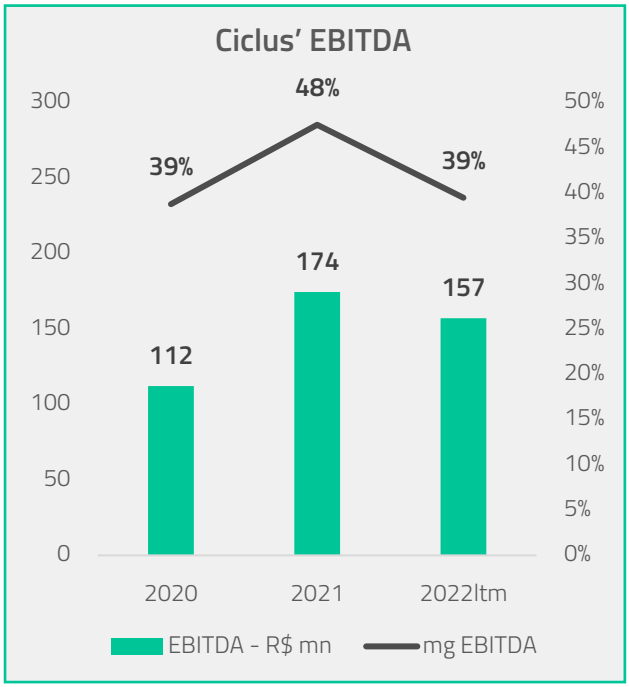
Source: Orizon.

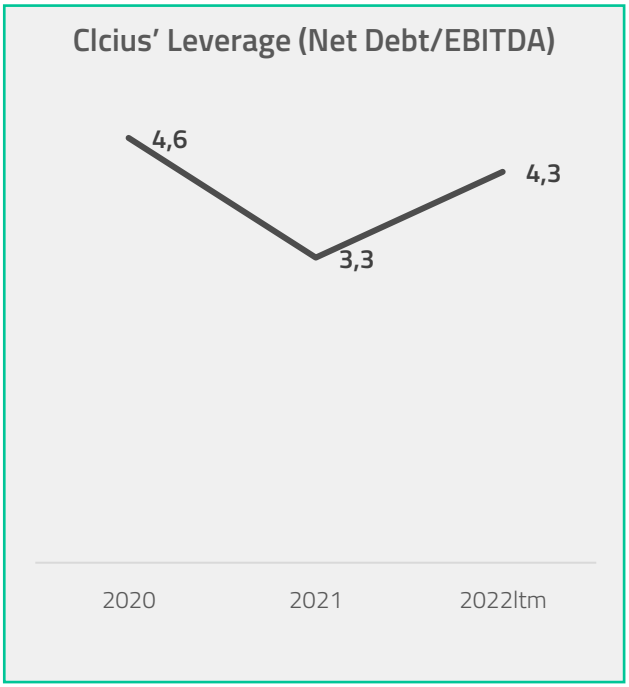
Ciclus Ambiental (Simpar)

Simpar is a holding company that controls several companies in the transportation industry, some of which are publicly traded (such as JSL, Movida, Vamos). Its controller, Fernando Simões, has a long history in the Brazilian capital market and has several private investments through its holding, which includes Ciclus in its portfolio since 2021.

Ciclus Ambiental is an important player in the waste treatment and disposal market, with a similar business approach to Orizon. It began operations in 2010 at the Seropédica landfill in Rio de Janeiro with a binding agreement to receive all of Rio de Janeiro's municipal waste until 2036, allowing the closure of the Gramacho and Sericó dumpsites. The company follows the same waste-to-value strategy, receiving approximately 10,000 tons/day of solid waste (4.5% market share) and capturing 480,000 m³/day of biogas, while generating 1 Mt or carbon credits per year. Ciclus currently has a **take or pay**[51] agreement with URCA energy for the supply of 384,000 m³/day of biogas to be upgraded to biomethane. Current on-site production is 120,000 m³/day of biomethane and will reach 200,000 m³/day by the end of 2023. The gas distribution network is far from the landfill, so the gas has to be compressed into crates to be transported and used as a substitute for fossil fuels in motor vehicles and industrial plants in the state. Ciclus also has an on-site power generation facility that supplies 96,000 m³/day of biogas to 2 motor generators and plans to install 4 more soon. The company also has plans to build a waste-to-energy plant with an installed capacity of 30MW, start a UTM operation (of around 1.5 thousand tons per day) to extend the useful life of landfills, and install a solar power generation operation of up to 5MW.

Ciclus' operations are very similar to Orizon's, with a well-mapped waste-to-value chain and ancillary revenue generation from the disposal line. According to Ciclus' management, the growth strategy is to gain market share by improving asset returns and growing organically through greenfield developments.

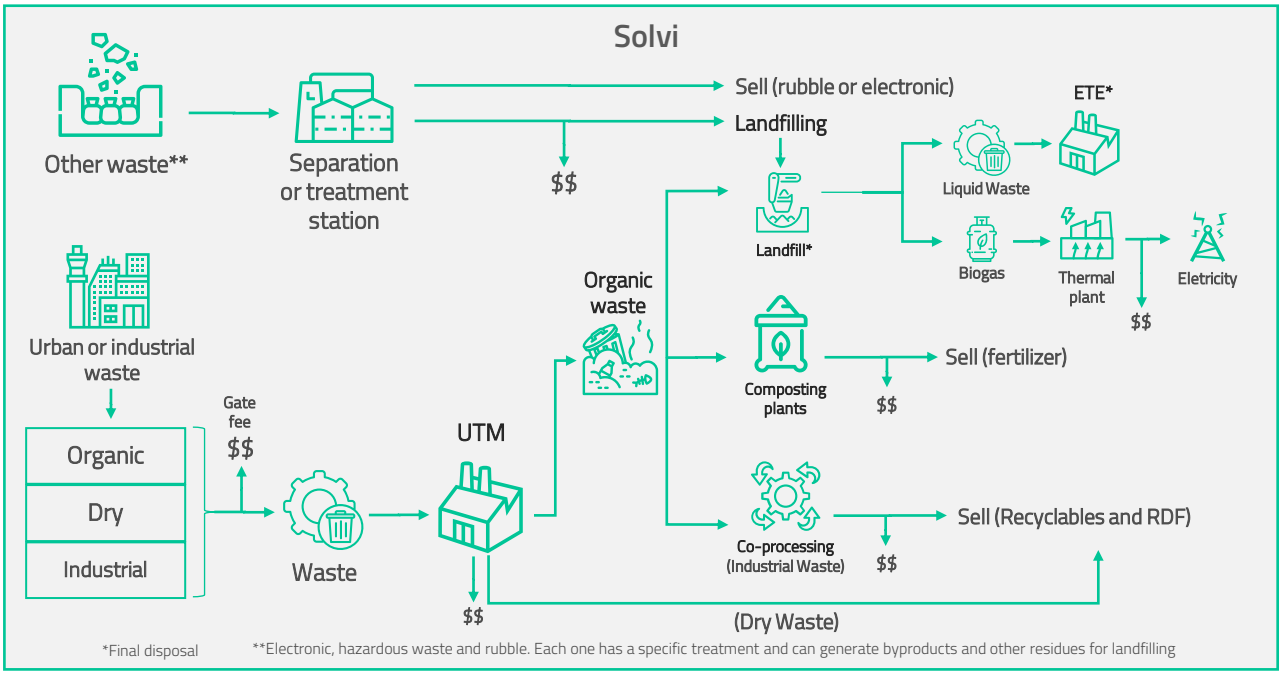




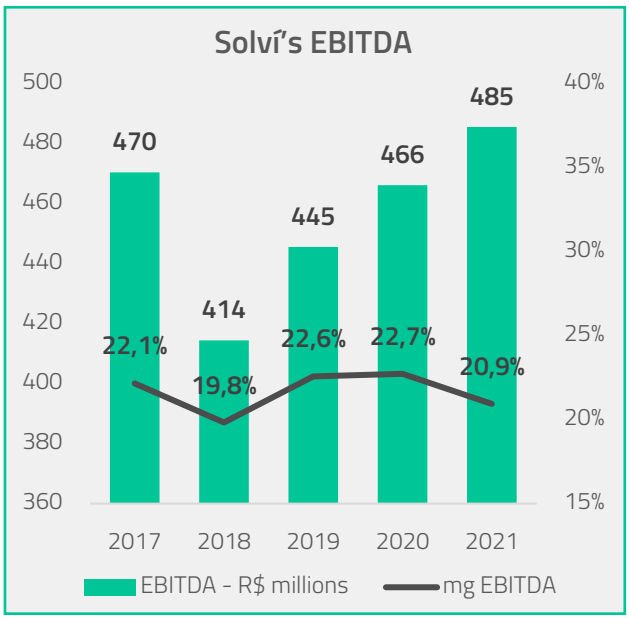
[51] Take or pay agreements are energy contracts under which buyers have to pay, regardless of using or receiving the fuel

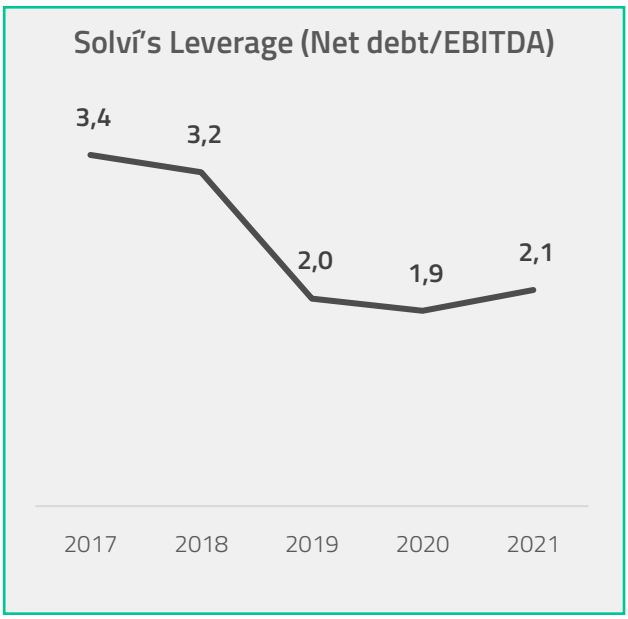
Solví

The Group was created in 1997 with the incorporation of Vega Engenharia and Relima (urban cleaning and sweeping companies) by Suez Ambiental (the Franco-Belgian multinational group). In the following years, Suez expanded into the treatment of industrial waste and the operation of landfills, starting with the treatment and disposal of solid urban waste. In 2006, Solvi was created after an MBO orchestrated by the Brazilian management directors who bought Suez and entered a new phase of growth. The new directors soon introduced the renewable energy and UTM businesses, becoming pioneers in mechanical sorting and recycling in Latin America. In 2012, Solví started its operations in Bolívia, and in 2015 it launched its first thermoelectric plant fueled by biogas in Minas do Leão - RS, just before launching other plants in Salvador - BA and Caieiras - SP. Since then, other plants have been built and put into operation, increasing Solví's presence throughout the Brazilian territory, while diversifying its presence in the residual value chain. It has developed many different business products, such as incineration, composting, manure treatment, industrial treatment, treatment and disposal of hospitals residues, soil decontamination, and so on. In 2020, its incinerator in Taboão da Serra was selected as the only one to process and adequately treat residues of substances that deplete the ozone layer.



Solví is currently the market leader in waste management and a strong competitor to Orizon. It has many activities in common with Orizon, such as final waste disposal, co-processing, biogas collection and purification, and recycling, among other activities (as shown above). The company operates the largest landfill in Latin America (and one of the largest in the world) in Caieras - SP, which receives approximately 10,625 tons of waste per day and operates the largest thermal plant fueled by biogas in Brazil, with an installed capacity of 29.5 MW. In total, Solvi has 39 landfills (34 in Brazil), receiving nearly 12 tons of waste per year, with a total installed capacity of 64.2 MW and issuing a total of BRL 18 million in carbon credits per year. The company reported a total revenue of BRL 2.3 billion in 2021, with an EBITDA of BRL 485 million and a net profit of BRL 80 million. Historically, the company has been able to grow while maintaining a healthy capital structure with leverage of around 2x net debt/EBITDA.





Vital

Vital Engenharia Ambiental is another player that operates in different parts of the waste value chain. It is present in incineration and final disposal of waste in landfills, sweeping and public cleaning, waste collection and beach cleaning, among others. Through some of its subsidiaries, such as EcoUrbis, Vital operates in several Brazilian regions, with a presence in São Paulo, Rio de Janeiro, Minas Gerais and Maranhão.

Vital may have significant scale in terms of gross revenues (more than BRL 500 million in 2017, latest available data) compared to Orizon (BRL 602 million in 3Q22ltm). However, Orizon's footprint is larger (14 vs 7 landfills), with a higher capacity for organic growth in its current landfills, and its revenues are concentrated in the later stages of waste treatment and disposal, a notoriously better segment in terms of value creation.

Veolia

Veolia is a French company with an international presence that specializes in the management of waste from industrial activities such as chemicals, oil and gas, and metals and mining. It also receives and disposes of solid municipal waste. Veolia has four landfills in Brazil, located in Santa Catarina and São Paulo. While it does not have a large footprint in Brazil, such as Solvi and Orizon, Veolia is a large player with great investment capacity and is considered a relevant competitor.

Recently, Veolia acquired most of Suez SA, a French company mainly active in wastewater and waste treatment. This transaction has enabled them to achieve several synergies and has confirmed the high level of consolidation in the sector.

8. Insights from global comparable companies

Growing concern about waste management is a trend typical of wealthy countries. While today's developed countries, such as the U.S. and Europe, took a long time to properly manage waste as they became wealthier, **developing countries, such as Brazil, can accelerate waste management trends by benefiting from the examples and know-how of developing countries.**

In the US, the core business of waste management is waste disposal and collection. While Orizon is only active in the former, US companies are mostly also present in municipal waste collection, trying to ensure the supply of waste to their landfills. The collection business in the US has fewer entry barriers and less significant operating, technology and opportunity costs, but is more profitable than in Brazil **due to a highly concentrated waste management industry. The combination has both strategic value and synergies with waste disposal in a highly verticalized industry.** While waste is an operational liability for disposal, it is also an input for other activities such as waste-to-energy, biogas and biomethane production, recycling, etc.

As a general trend, high transportation costs are driving hyperlocal markets. As mentioned earlier, it costs over USD 10/ton to haul garbage 50 miles, with a landfill price of USD 35/ton. Therefore, long transportation distances increase costs beyond profitability, and landfills and other waste treatment facilities move to form a hyper-local market. Research shows that across the industry in the US, **the top 2 players average 90% of local market share, and consolidation of players is a long-term trend.** The top four companies have grown from 38% to 61% of the national market share in 15 years (Goldman Sachs report) and are expected to gain further share in the coming years. In Brazil, we believe these similar trends will lead to a localized, oligopolistic industry with pricing power.

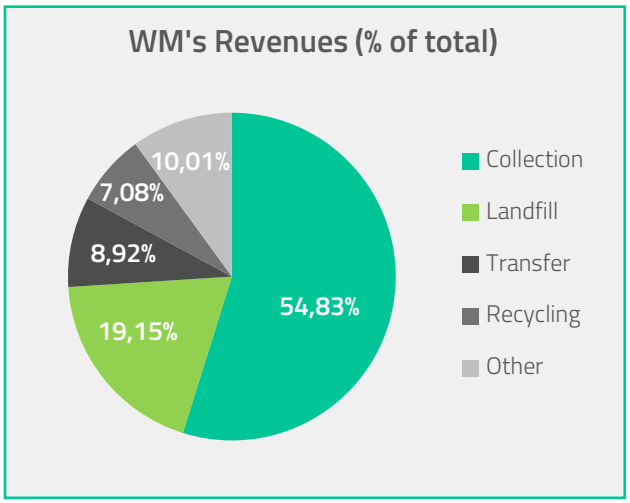
We look at US companies to try to assess what the future of waste management in Brazil could look like. It is also interesting to note the higher maturity of the companies in terms of scope of operations, financial efficiency, value creation, and scale of operations (both in terms of waste managed and number of facilities). We analyze four of the largest US companies in the segment: **Waste Management Inc, Waste Connections, Republic Services Group, and Green for Life.** These are good examples of companies that operate at all stages of the waste value chain and make good use of all the biological and chemical byproducts of waste management.

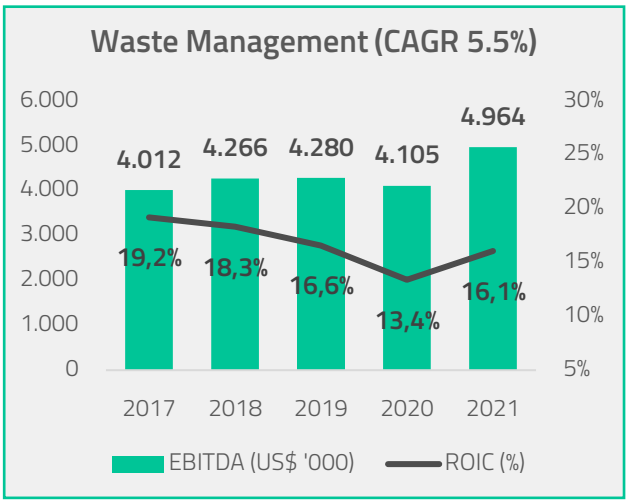
Waste Management (WM Inc)

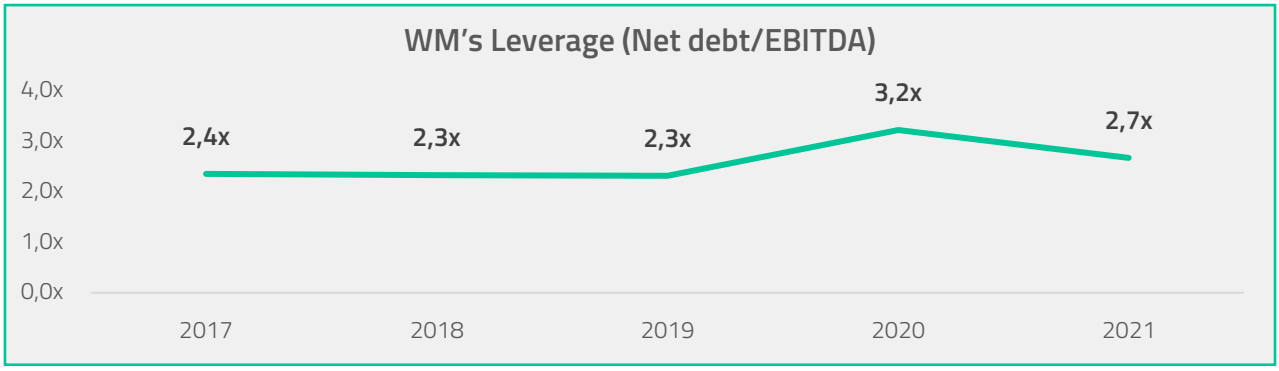
The company is active in waste collection, landfilling, transfer and recycling. **For commercial and industrial waste, WM operates under medium-term contracts** (typically 3 years), **while for residential waste, contracts are based on regional authority and exclusivity of collection.** WM owns 259 solid and hazardous waste landfills and 337 transfer stations and receives tipping fees for the waste it disposes. The company receives 123 million tons of waste each year and currently has a market capitalization of USD 66.5 billion on the NYSE.

In addition to collection and landfills, WM operates **transfer stations**, which are intermediate areas where waste is stored until it is consolidated or compacted and then transferred to other facilities. WM profits from the initial deposit and saves on waste transportation costs by increasing waste density during compaction and better managing waste volume by transferring it to its own facilities. This dynamic is facilitated by an extensive rail network in the United States.

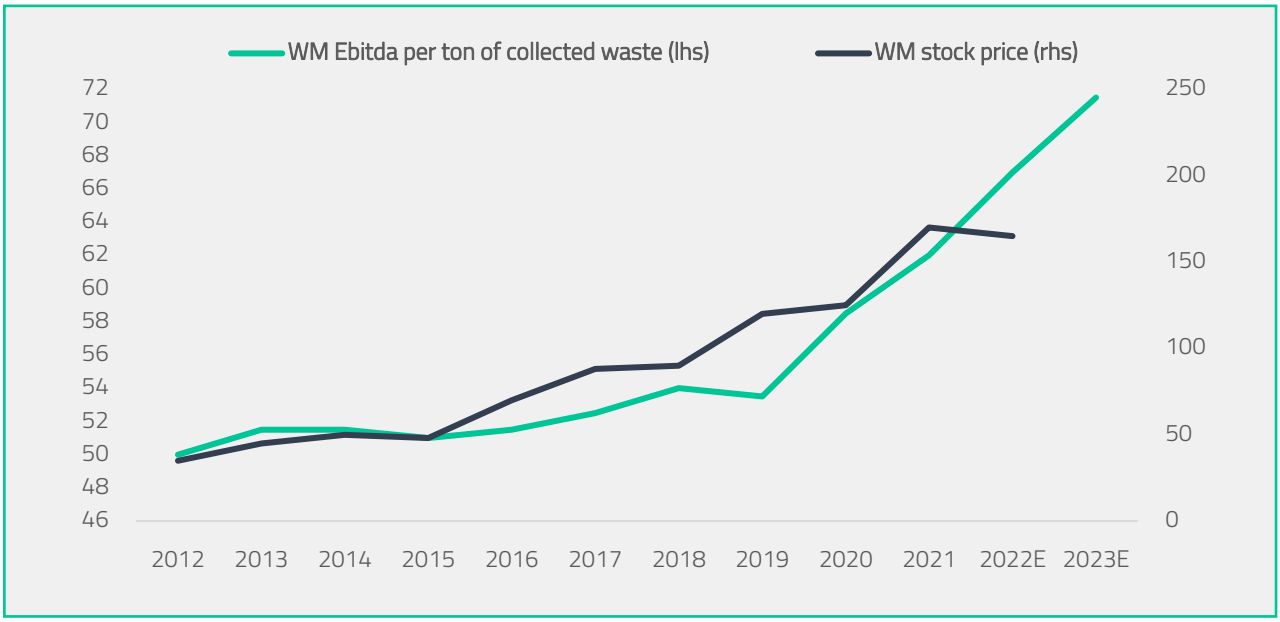
MW manages single-stream recycling facilities, which improves waste volumes from residential customers and increases the content of recycled materials recovered. Recycled materials can be resold to industry as processed materials or as recycled commodities. WM also produces biogas and biomethane (RNG) for use in industrial processes or at its own facilities. Other activities include providing energy and environmental services to customers and collecting construction and residential yard waste. According to the 8-K filed in February 2023, major planned investments are in renewable energy and recycling. MW's 2022 revenue breakdown and operating data are shown.





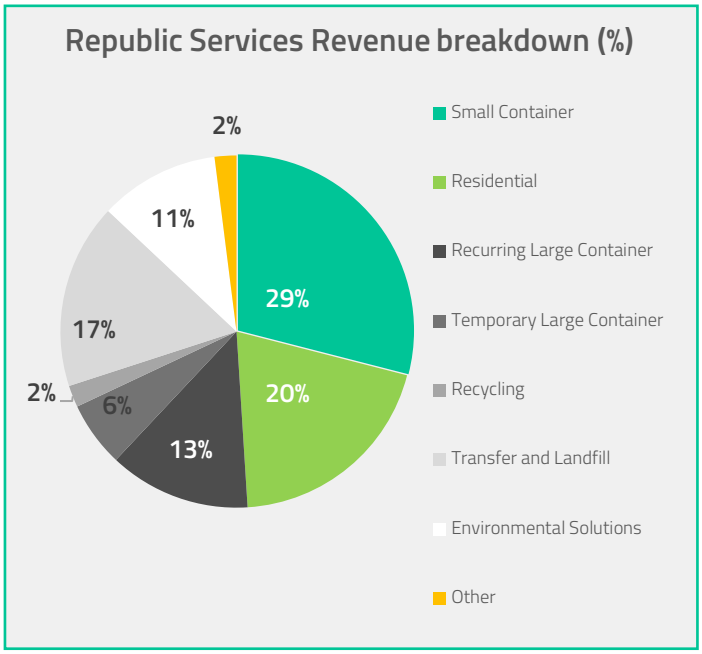


Source: WMs 10-K

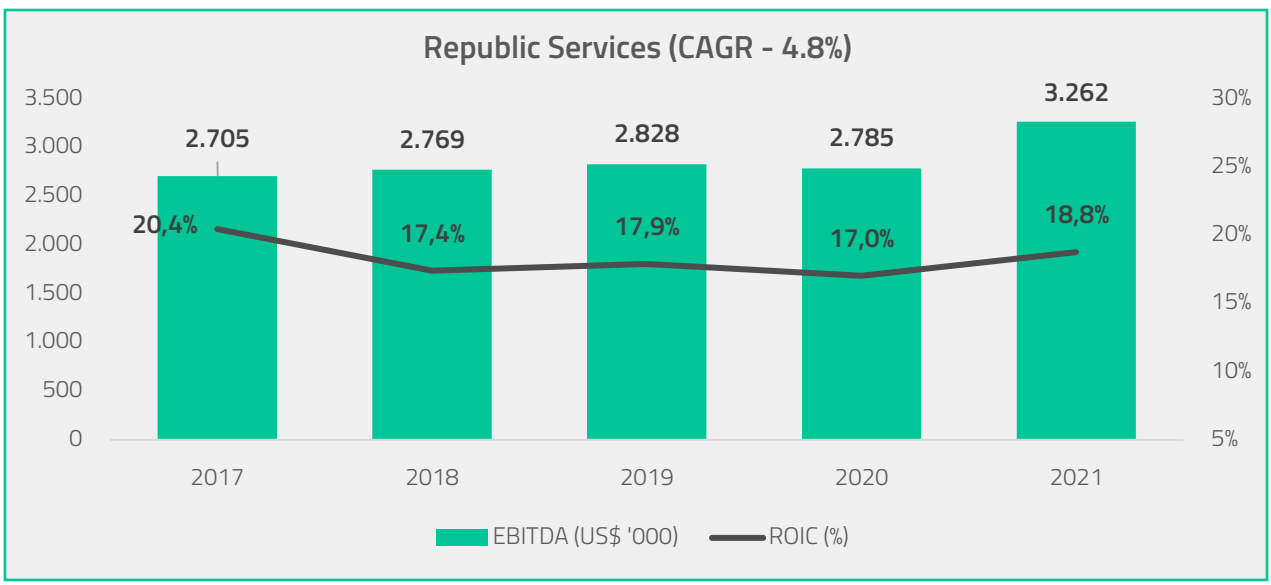


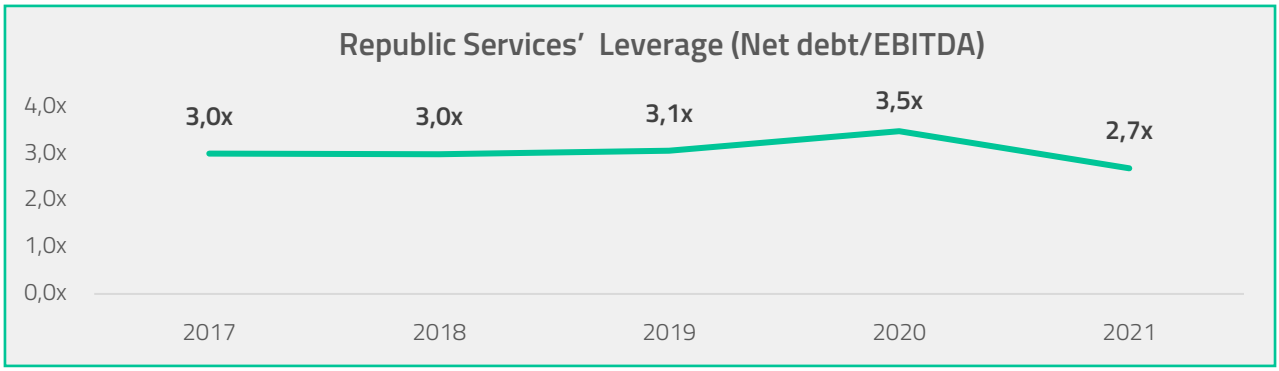
Source: Goldman Sachs

Republic Services (RSG)



This is another major waste service provider that is prioritizing investments in market verticalization. The company currently operates numerous business units, including 353 collection facilities, 206 active landfills, 233 transfer stations, 72 recycling processing centers, and 74 landfill gas and renewable energy projects. In addition, Republic Services operates other environmental services such as saltwater disposal wells and deep injection wells. The company currently disposes of 68% of the waste it collects at its own landfills and is working to increase verticalization in regions that are not fully integrated. The annual volume of waste disposed is approximately 3.8 billion m³, which represents only 11% of total revenues. This is influenced by the company's high level of vertical integration, which ensures less costly waste disposal. Most of its services are the collection and transportation of municipal solid waste from its areas of influence and value creation through gas to energy and recycling operations. It currently has a market capitalization of USD 42.8 billion on the NYSE.

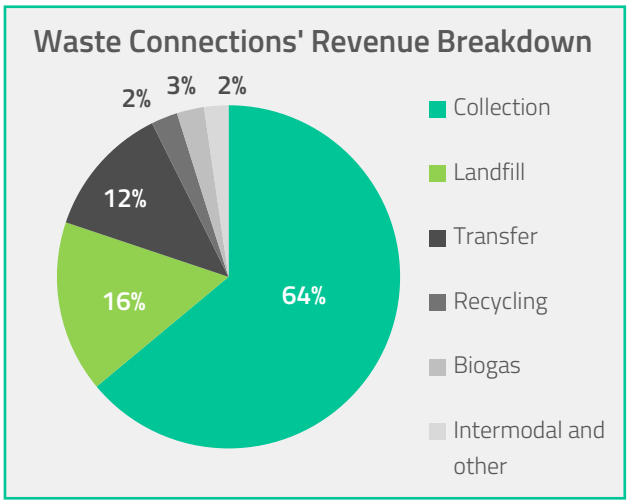


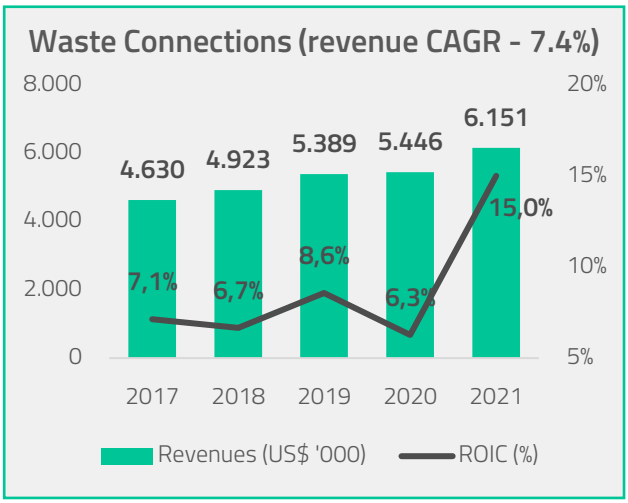


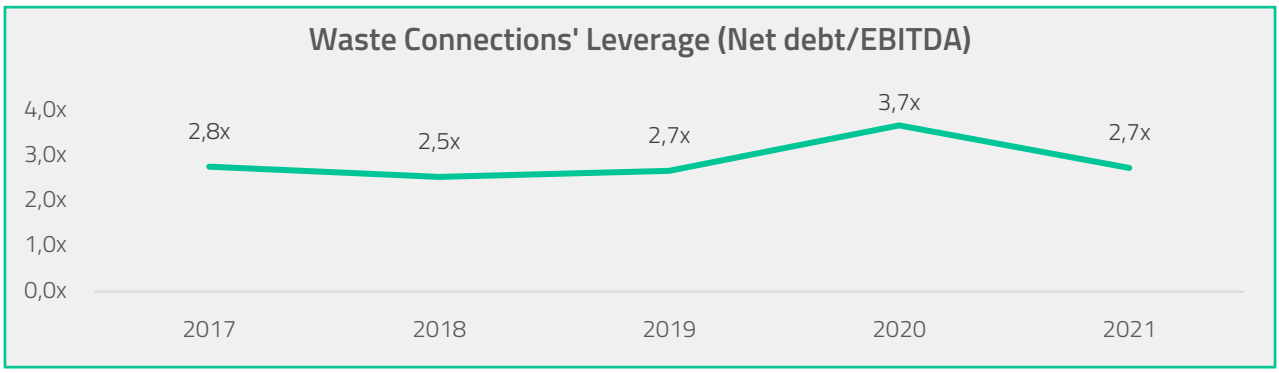
Source: Republic Services' IR

Waste Connections (WC)

The company takes a slightly different approach to waste management services. Instead of focusing on highly competitive markets such as large urban centers, it targets secondary and rural markets where it can achieve high market share by focusing on exclusive contracts, vertical integration, and asset positioning. As noted above, waste treatment and disposal can be a business with national scope but local business dynamics, and Waste Connections creates value by focusing on its local competitive advantages. The business depends on proper asset positioning, hopefully minimizing transportation costs, and providing vertically integrated services to offset smaller waste volumes. In addition, Waste Connections manages its operations on a decentralized basis, placing management authority closer to the customer and improving the efficiency of value creation, decision making and strategy. The company has 75 landfills and 157 transfer stations and manages 47 million tons of waste annually. It currently has a market capitalization of USD 36.3 billion on the NYSE.



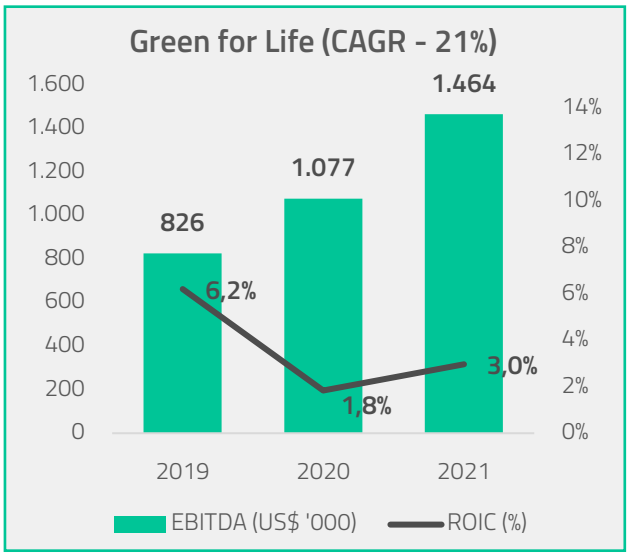


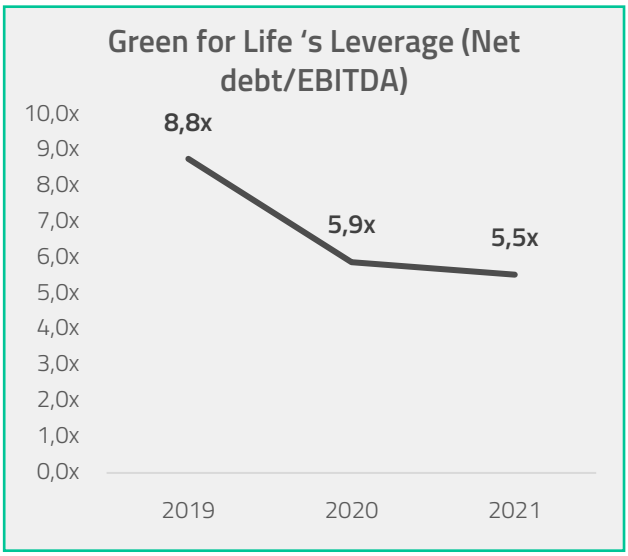


Source: Waste Connections IR

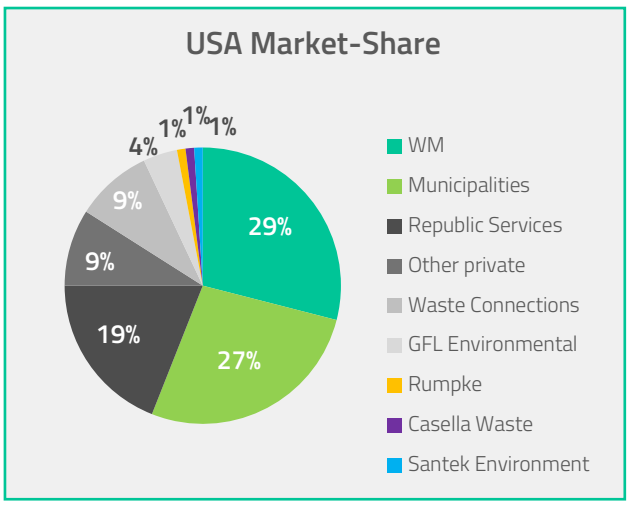
Green For Life Environmental (GFL)

GFL is a publicly traded company active in waste collection through municipal contracts, residential subscription contracts and commercial contracts. As part of an oligopolistic market, GFL focuses on long-term contracts with control of waste for final disposal, allowing the company to verticalize the entire waste chain. Its fees are adjusted annually for CPI and fuel costs. The company's strategies focus on three main drivers. The first is to generate stable, organic revenue growth by offering comprehensive services across all business lines and expanding into new geographic markets through careful planning and execution. The second is to execute accretive acquisitions in line with industry practice, drive operating cost efficiencies and replicate the Company's strong competitive position in new markets. The third is to increase the verticalization of acquired assets. The company manages 22 million tons of waste per year and currently has a market capitalization of USD 12.2 billion on the NYSE.

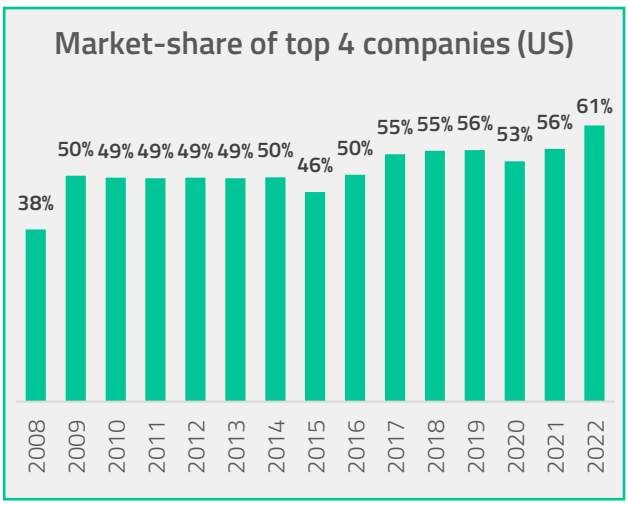




In general, the waste management business strategies of WM, Republic Services, Waste Connections, and GFL are similar. They generally focus on **exclusive service arrangements** with both municipal and residential customers, benefit from a **regional market with *quasi*-inelastic demand**, seek to **maximize the verticalization** of their environmental services, and are **heavily engaged in the consolidation process**. Although the focus is on internal growth, increasing market penetration and customer retention, they have all expanded through acquisitions, using inorganic growth to capture service synergies and enter new local markets not previously served. This has resulted in a highly concentrated market where the top 4 players control over 60% of the market.



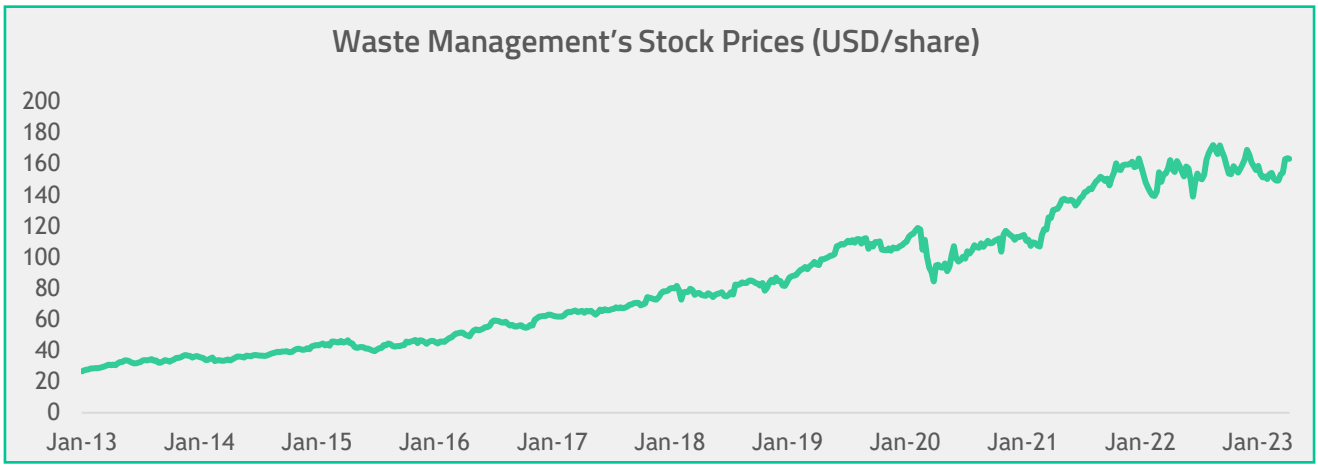
Source: Statista[52]



Source: Goldman Sachs

These companies benefit from extremely positive market dynamics and have been able to generate value to its shareholders at an impressive rate, which has reflected in their historical stock price performance, as indicated by the following graphs.

[52] STATISTA: https://www.statista.com/statistics/1098982/us-market-share-of-landfill-volume-by-company/


Waste Management's Stock Prices (USD/share)
200
180
160
140
120
100
80
60
40
20
0
Jan-13
Jan-14
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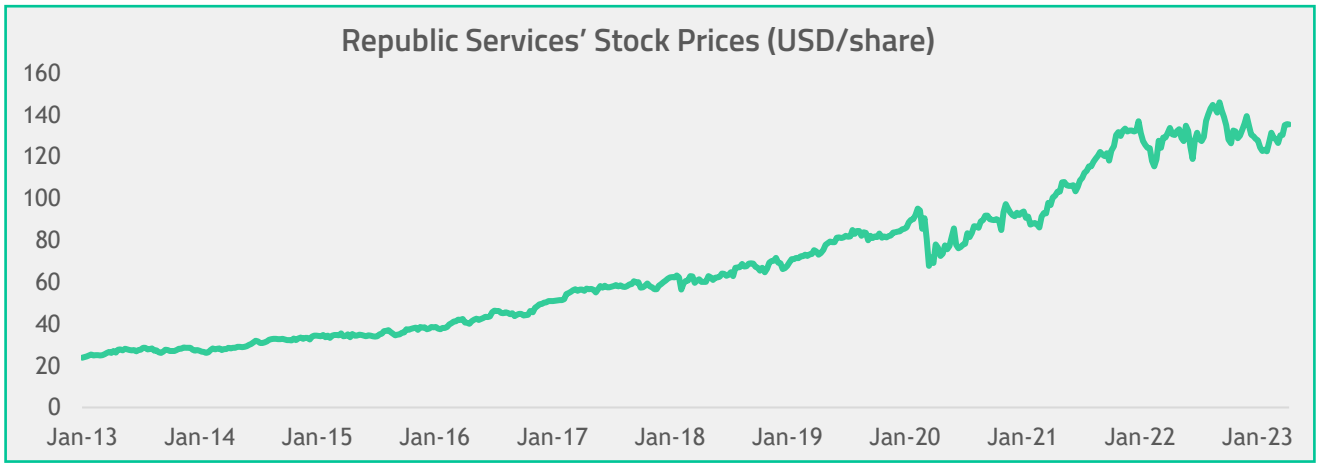
Republic Services' Stock Prices (USD/share)
160
140
120
100
80
60
40
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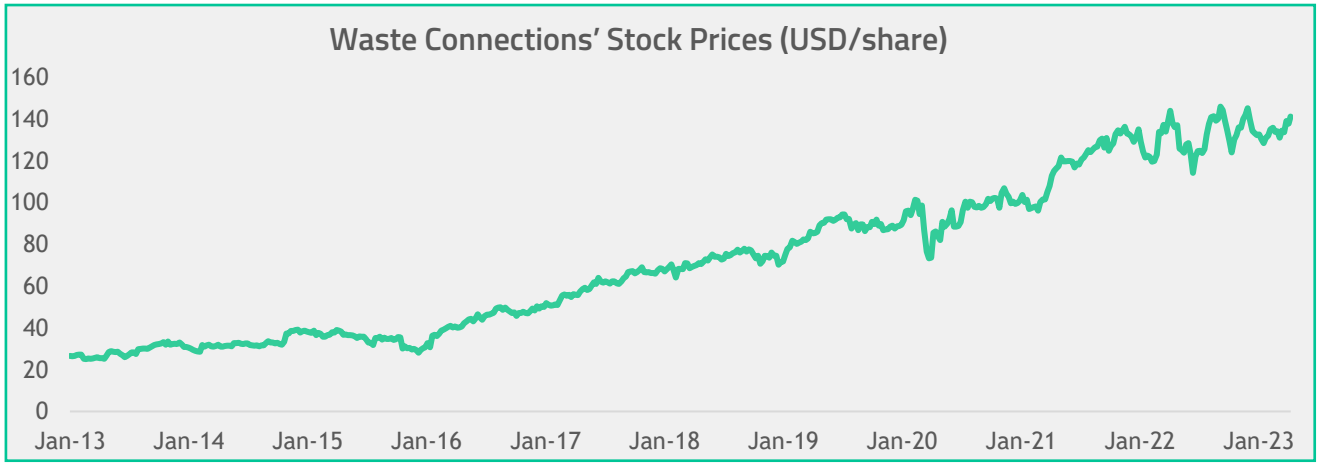
Waste Connections' Stock Prices (USD/share)
160
140
120
100
80
60
40
20
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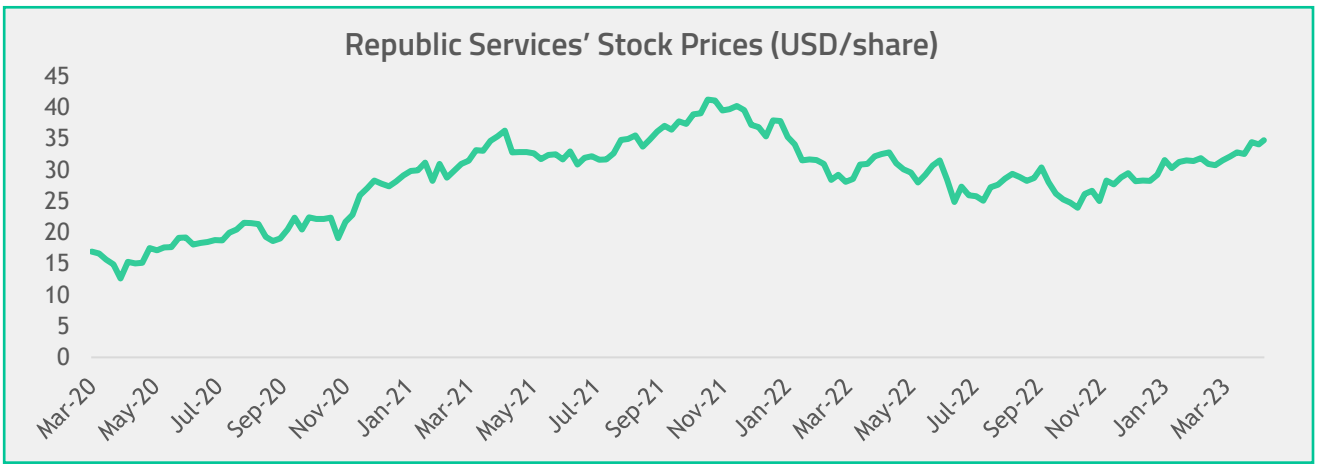

Republic Services' Stock Prices (USD/share)
45
40
35
30
25
20
15
10
5
0
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
Mar-23

Some international deals and valuation data points

Three deals by international companies are good examples of the value perception of biomethane as well as the strategic moves made by some major traditional energy players. The first is the acquisition of the biogas (RNG) producer Archaea by British Petroleum (PB). The second is the investment announced by the former in a joint venture with Republic Services. The third was Shell's proposal to acquire 100% of Danish biogas producer Nature Energy Biogas S/A for USD 2 billion.

British Petroleum acquired Archaea in December 2022, with the intention of accelerating the transition to renewable energy by growing its biogas and biomethane business. The company leveraged its existing biogas operations to integrate Archaea's business with BP's trading capabilities. The transaction is expected to double BP's biogas EBITDA to USD 2 billion by 2030. In addition, the acquisition of Archaea will reduce BP's carbon emissions (with net zero target by 2050). But what really caught our attention was the valuation of the acquisition. The purchase was made for USD 3.3 billion in cash and the assumption of USD 800 million in debt, for a total enterprise value of USD 4.1 billion. At the end of 2022, the transaction was valued at 29x EV/EBITDA with an EBITDA of approximately USD 140 million. With an expected EBITDA of USD 500 million in 2025, the multiple was 8.2x EV/EBITDA 2025. For comparison, we see Orizon negotiating at 3.9x EV/EBITDA 2025. **This deal highlights how valuable these assets are perceived to be by large traditional fossil energy companies trying to transition to a cleaner energy matrix.**

On the same theme, another important transaction[53] involving Archaea was the joint venture with Republic Services announced in May 2022. The idea was to capitalize on the synergies between landfill operations and biomethane production by combining Archaea's expertise in renewable natural gas production and marketing with Republic Services' availability of biogas. Archaea is expected to develop, design, construct and operate RNG (biomethane) facilities at 39 Republic Services landfills by 2027. The total investment commitment is USD 1.1 billion (USD 300 million from Republic Services and USD 800 million from Archaea) over five years and is expected to generate more than 935,000 m³/day of biomethane. The joint venture has also entered into a biogas supply agreement with Republic Services to ensure the long-term viability of the RNG operation. Negotiations for the sale of biomethane to end users are expected to generate annual volumes of 12.5 million MMBtu and will be structured as long-term, fixed-price contracts.

Another emblematic recent transaction was Shell's acquisition of Nature Energy Biogas S/A of Denmark. It is the largest producer of renewable natural gas in Europe, with full feedstock supply, infrastructure and operating sites. Nature Energy has in-house expertise in the design, construction and operation of RNG plant technology. It currently operates 14 production sites with associated distribution infrastructure and feedstock agreements, guaranteeing an annual production of 486,000 m³/day of biomethane. The company is at a rapid growth phase, with revenues expected to quadruple since 2018 and biomethane production to increase to 690,000 m³/day by 2030. The valuation paid by Shell is estimated at 60x EV/EBITDA 2021. **This shows once again how fast this market is growing globally and how valuable companies in this segment are perceived to be.**

[53] https://www.prnewswire.com/news-releases/republic-services-and-archaea-energy-launch-landmark-joint-venture-to-develop-39-new-renewable-natural-gas-projects-across-us-301541230.html

9. Channel Checks

Throughout our analysis process, we engaged in multiple discussions with a range of industry players, which contributed to our understanding of Orizon's investment potential. A few of these conversations are noteworthy and reinforced our belief in the tremendous opportunity within Brazil's waste and gas market. To convey the most critical aspects, we summarized these dialogues below.

President of ABREN – 02/2023

We had the opportunity to speak with the President of the Brazilian Association for Waste to Energy Recovery, who provided us with a thorough understanding of waste management in Brazil. He underscored the inadequacies of waste management and collection in Brazil, which lag far behind other nations. For instance, while recycling could potentially address 10 to 14% of Brazil's total waste, only a meager 3 to 4% of waste is currently recycled. Additionally, while most comparable countries, Europe, the United States, and China, have closed their landfills, Brazil still relies heavily on open-air dumps.

As a strong proponent of energy recovery from waste, he emphasizes incineration as the optimal approach, citing high volume reduction, minimal environmental impact, and energy recovery as key advantages. He also advocates for waste recycling before incineration to maximize energy recovery. Despite the potential benefits, waste-to-energy operations may face some obstacles before becoming widespread in Brazil. Notably, Brazil's (with Orizon's plant) first waste-to-energy operation in Barueri is not set to begin operations until 2026.

Competitor Renewables' Expert – 03/2023

He is a partner at a competitor company that deals with natural gas commercialization, energy, distributed generation from biogas, and biomethane production and trading. With expertise in renewable energy, he shared his insights on biomethane production and related experiences. He explained that in the past, biomethane was traded at a discount to natural gas, but now it commands a significant premium, particularly among industrial customers with ESG-oriented policies. Gas station owners who purchase biomethane as a substitute for CNG, however, pay no premium for the renewable source. He also shared that his company's strategy is to gradually shift its contracted volumes from gas stations to companies.

In terms of transportation logistics, his company initially used "virtual pipelines" to deliver biomethane by storing the gas in crates and transporting it by truck. However, the current approach is to transport biomethane directly through the grid, reducing transportation costs and improving margins while increasing scalability. Nonetheless, some industrial customers situated far from the current pipeline infrastructure and using other fuel sources such as LPG, diesel, and fuel oil are interested in converting to biomethane and will continue to be served by trucks in crates.

Competitor CEO – 04/2023

The interviewee is very well-versed in the production and trade of biomethane. He explained the company's plan to decrease the use of trucks for transportation and move towards more grid delivery of its future production. Nevertheless, he also pointed out that there are industrial players located outside of the gas grid who still require energy sources and can be met by crates. As an example, he mentioned Ambev's location in Rio de Janeiro, which currently relies on truck deliveries. Being a player in the food and beverage industry, Ambev requires thermal energy from gas that doesn't contaminate their products with combustion byproducts. Previously, Ambev used LPG to power its operations.

Regarding Orizon, the CEO mentioned that the company has also witnessed the growing trend in biomethane, although it is still in the process of learning about it. Orizon has a significant flow of biogas that is quite relevant to its business. The CEO highlighted Orizon's competitive advantage of owning the biogas produced from its landfills, which sets it apart from his own company, who must rely on private contracts with existing landfills to purchase the biogas needed for its biomethane production. Additionally, the CEO commented on his approach to creating value at Orizon instead of competing in a value-destroying environment.

Orizon's former board member – 02/2023

During the conversation, we spoke with a former advisor and portfolio manager at Mare Investments and Mantiq Investments, private equity funds that invested in Haztec in 2009 prior to Inovatec's acquisition in 2013. Given his status as a long-term shareholder, he has closely monitored the operational improvements made at Haztec. He commended the current management team for their exceptional work in transforming the previously unprofitable operation into a profitable one. He believed that the company's shift in strategy towards waste-to-value, with a primary focus on waste disposal and treatment while maximizing biogas production and value extraction, was the right decision. Furthermore, he agreed with our optimistic perspective on the potential value creation of biomethane and saw it as a transformational opportunity for Orizon.

Orizon's former employee – 03/2023

The interview was conducted with a former employee of financial department who demonstrated a strong understanding of the company's business and provided insightful explanations about its operational complexities. When asked about biomethane, she explained that landfills require a certain maturation period to optimize biogas production through the fermentation process, and she offered quantitative methods for measuring and estimating this process. Regarding waste pricing, she clarified that public and private waste have different pricing structures with specific inflation adjustments. For instance, she mentioned the annual negotiation with municipalities to adjust prices based on inflation, but noted that the bureaucratic process can cause delays in implementing these adjustments.

10. Risks

The main risks associated with Orizon's investment case are related to the execution of its growth plan. Although most of the projects are located within currently operating landfills, Orizon will face a significant challenge in executing its full biomethane deployment plan in a timely manner. The Company will also be dependent on international suppliers for its biogas upgrading equipment and will be competing with major energy producers around the world that are also undertaking their energy transition to biomethane. **Therefore, supply constraints and timely execution of capital expenditures are key risks to our business case and projected earnings.**

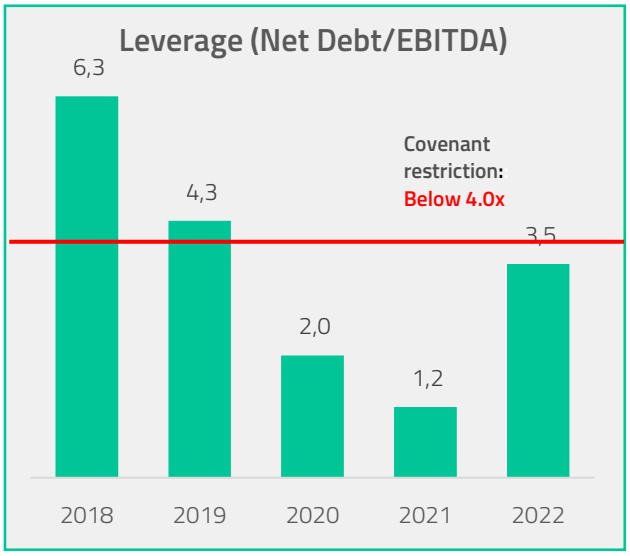
Waste inflow can also be a concern. As explained earlier, today's waste inflow is somewhat stable and guaranteed by municipal waste and private contracts in the surrounding regions of landfills. However, over the years, **some alternative waste destinations may be developed that could compete for the waste generated in the previously served areas.** One such example is the development of transfer units, which allow other landfills to expand their areas of influence because of the logistical improvements these units bring to waste transportation. The verticalization of municipal solid waste collection operations, combined with the operation of transfer stations, can make previously remote landfill areas economically feasible and provide competing alternatives to currently served areas. However, when we examine the U.S. market, these transfer stations did not lead to a loss of share by incumbent landfills. On the contrary, it helped to further consolidate the market by allowing major players to enter new regions. We believe that Brazil will develop in the same way, with major players such as Orizon using this alternative to increase their already existing influence in landfills.

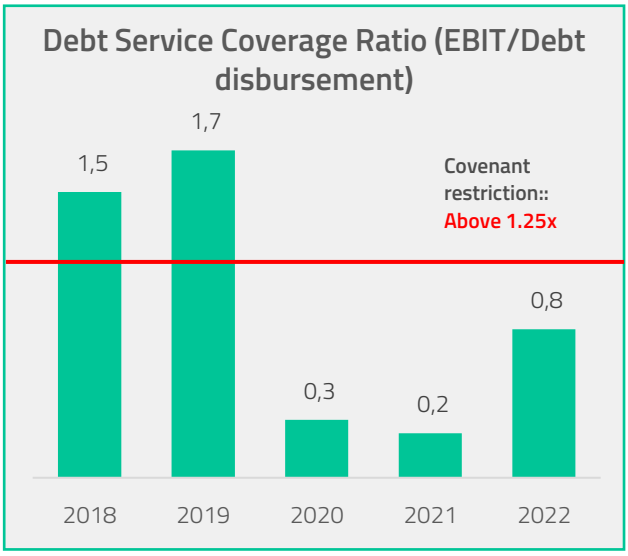
The company's performance is also directly related to the amount of waste it can process, which depends on the capacity of its landfills and the inflow of waste. In addition, effluent varies greatly throughout the year, particularly due to rainfall and climate variations. This creates a **risk of non-compliance and variability in the performance of secondary activities related to landfills,** such as waste-to-energy and biogas production. The Company's activities are therefore inherently hazardous. This, together with the possibility of non-compliance, may lead to legal problems and fines. Ongoing legal proceedings may also have negative consequences that are not yet reflected in Orizon's shares.

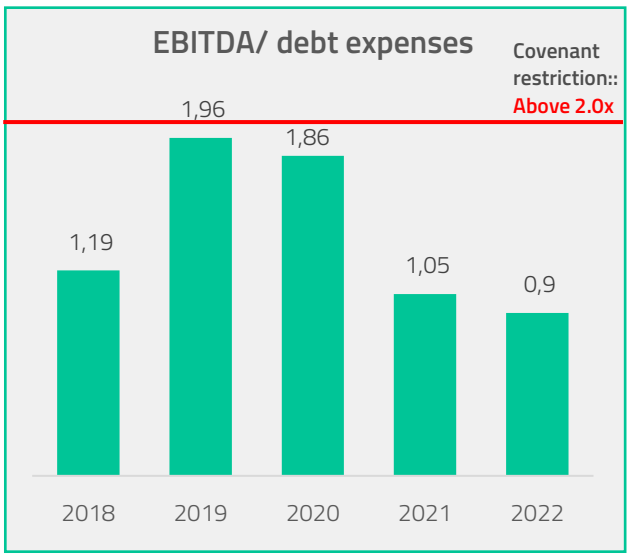
Orizon's results are also **closely linked to the prices of biomethane and other waste byproducts such as carbon credits and recycled materials.** As the gas market is undergoing a major transformation with new infrastructure and supply entering the market**, future natural gas prices (or biomethane for that matter) may be subject to downward pressure over time.** The same is true for carbon credits and recycled materials. **For CER volumes, it is extremely difficult to forecast either the volumes to be certified in the future or the prices of the volumes to be sold.** It is important to remember that Orizon is dependent on third party validation to issue carbon credits and on foreign brokers to sell its generated CERs, which also puts it in a vulnerable negotiating position. In the recycling business, there is a risk that other competing landfills could develop UTMs. This would increase the supply of recycled products, which should depress prices. We see these risks as inherent to the business, but still somewhat difficult to measure given the relatively new nature of the market. It should be noted, however, that most recent biomethane sales have been through fixed-price, long-term contracts, which at least minimizes the impact of short-term price volatility. We also model the business under very conservative price and volume assumptions to better address these concerns.

Another risk we see in the investment case relates to **Orizon's relationship with regulators.** From the beginning of its production chain, Orizon has been dependent on the enforcement of laws regarding the closure of landfills and the proper disposal of waste. In addition, the company participates in public tenders for municipal waste contracts to ensure acceptance at its landfills. Orizon also relies on a variety of operational and environmental licenses granted by public authorities to conduct its business. These greatly increase public relations interaction at all levels of government (federal, state and local), which could expose the company to potential investigations. Unfortunately, allegations of corruption are part of Brazil's history. In some cases, even unsubstantiated accusations, driven by ill-intentioned public officials, have started the investigation process simply to defend a private agenda. These accusations are enough to initiate extensive and very public legal proceedings, which alone could damage the company's image and business. We have very good references from the current management who have a clean track record on this front, and do not expect any irregularities from the management. Nevertheless, the company's interactions with government officials will always be a source of risk and something to monitor.

Finally, we also see **financial leverage as a source of risk to growth and value creation** in ongoing operations. It is important to highlight that Orizon plans to invest more than BRL 2 billion in the next 3 years, which would come on top of its leverage position of 3.5x net debt/EBITDA pro forma in 2022. In addition, the current financial debt covenants restrict the company to some strict conditions during the maturity of the debt: **i)** not to exceed a financial leverage (measured by net debt/EBITDA ratio) of 4.0x, **ii)** to maintain a debt service coverage ratio above 1.25x, and **iii)** not to allow an EBITDA/financial expenses ratio below a threshold of 2.5x.



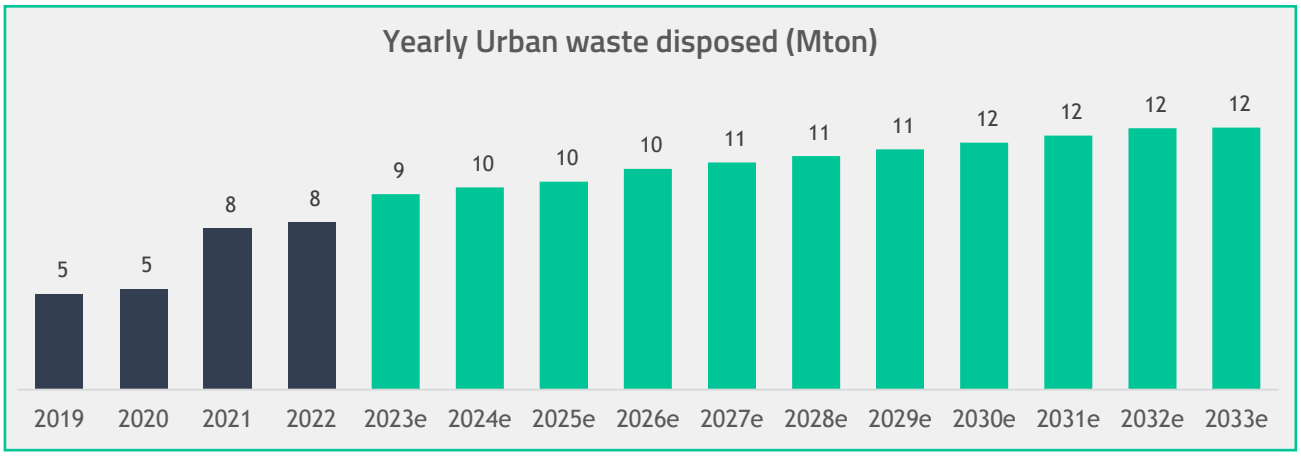


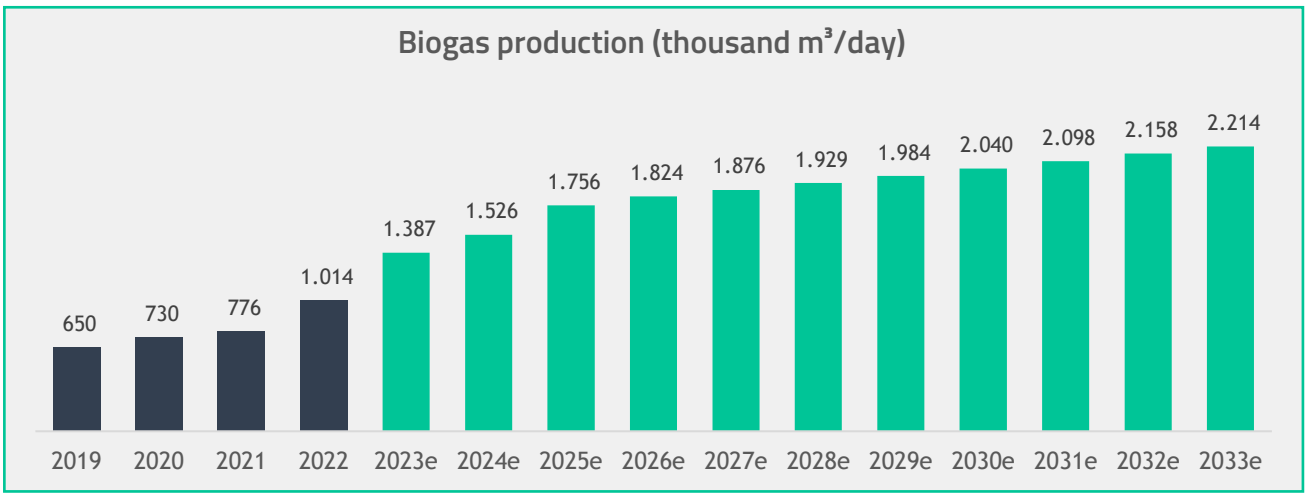


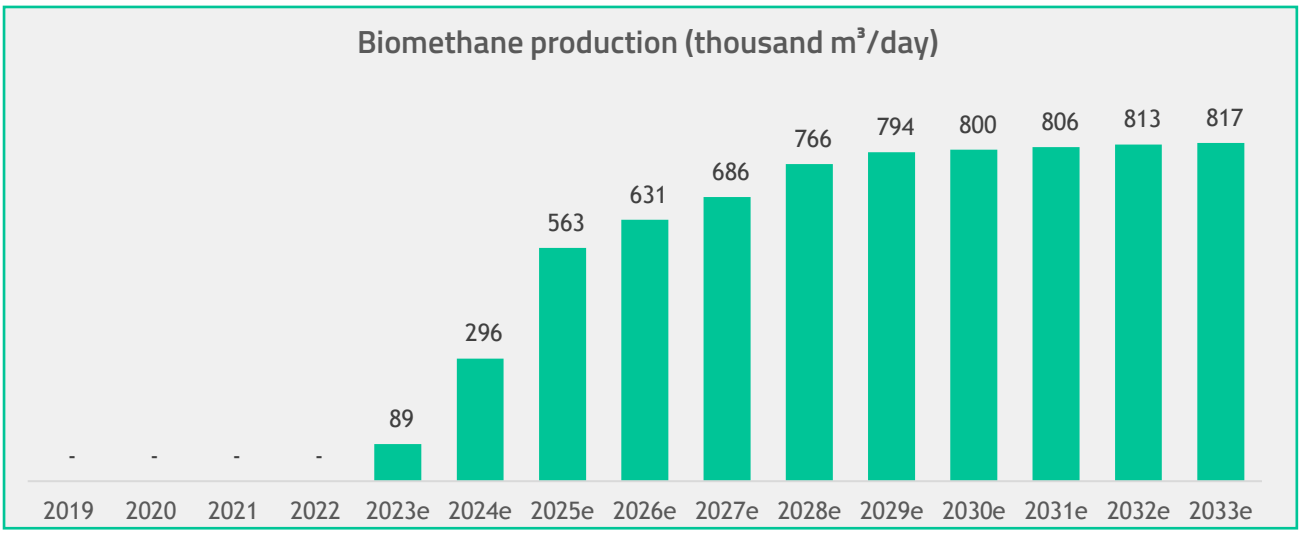
As we can see from the charts above, Orizon has a recent history of operating outside the confines of the Covenant. We see this as a potential constraint to its ambitious growth plan. Therefore, the company may seek project partners or equity issuance to finance such growth. Depending on the terms, such a capital raise could be dilutive to current shareholders. This is currently under discussion and may remain a risk as the investment cycle progresses. **However, based on our discussions with industry participants and potential financiers, we believe that Orizon will be able to access funding and execute its capital expenditure program with minimal dilution to shareholders given the strong economics of its projects.**

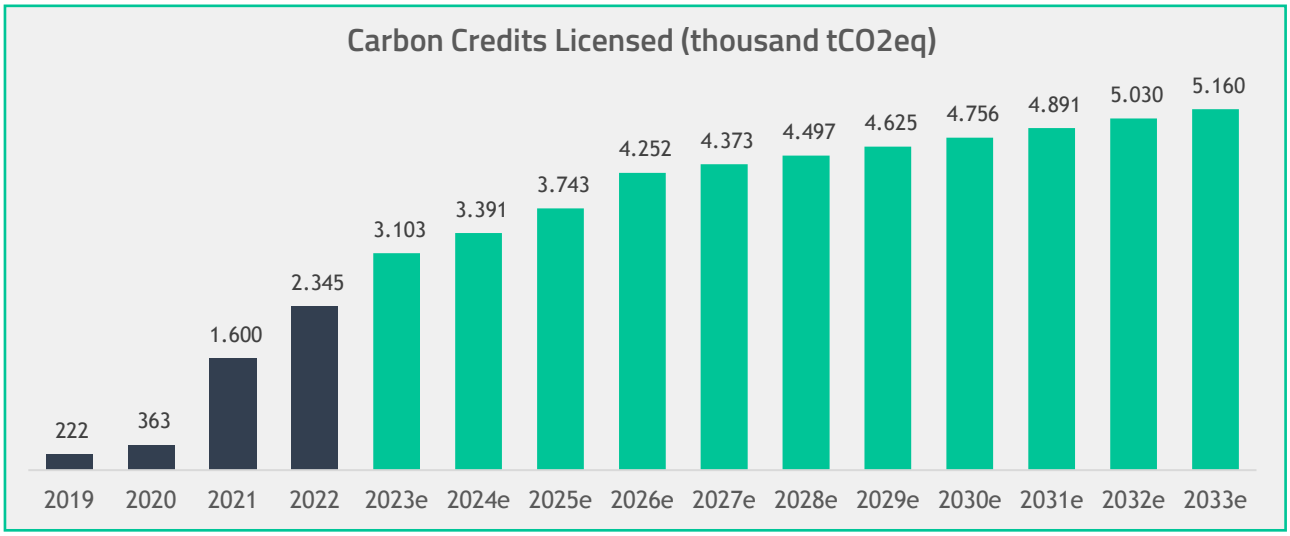
11. Valuation

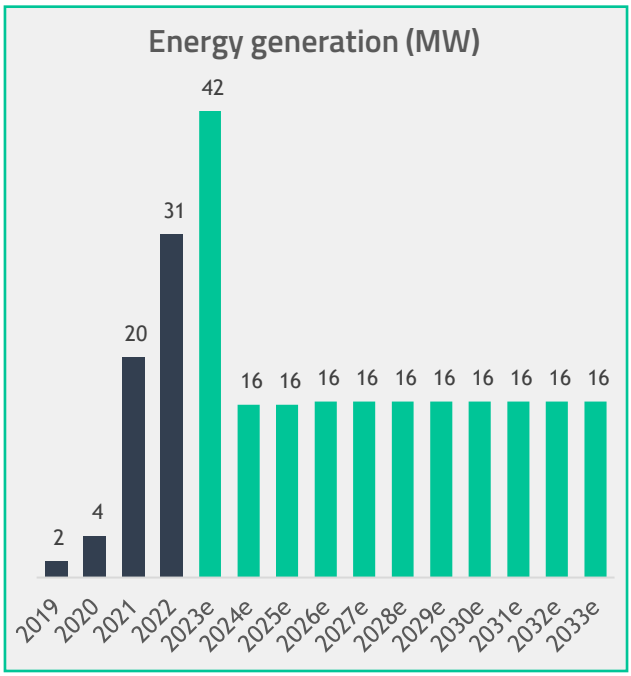
Below are our main projections for Orizon until 2033. We are conservatively modeling Orizon operations, following its stated growth plan. Our base-case assumes no new landfill acquisitions nor new PPA signings or existing contract extensions. Although we recognize relevant upside opportunities coming from inorganic growth, we are modeling only on the assumption of organic expansion due to the lack of visibility of possible terms of future acquisitions.

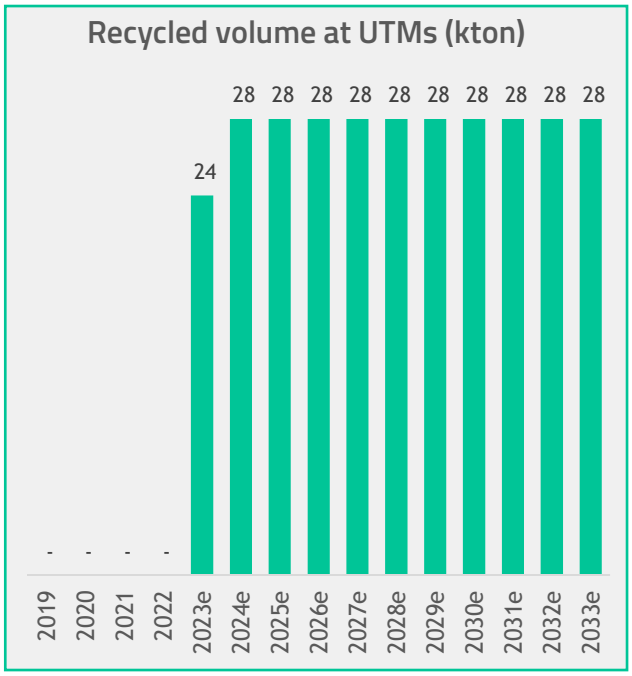




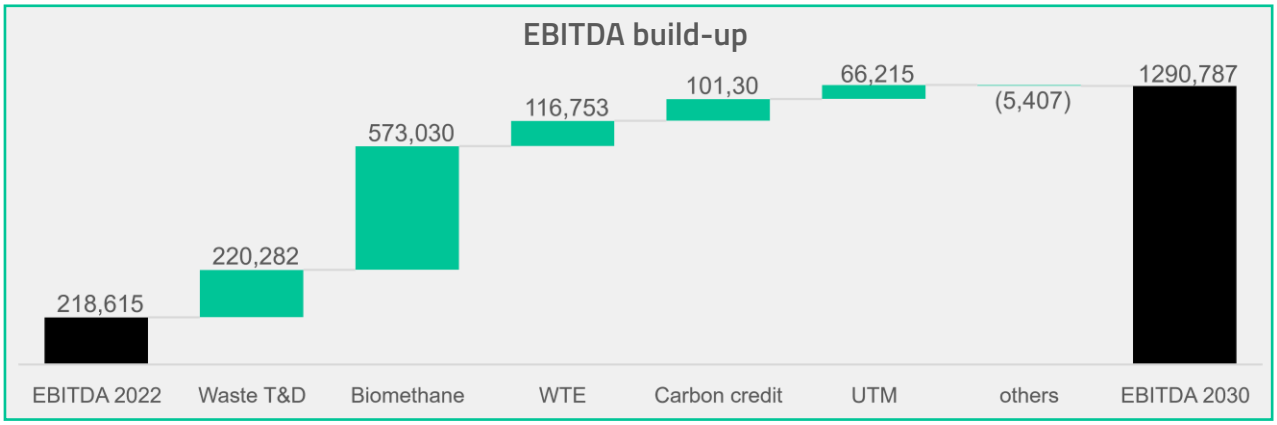




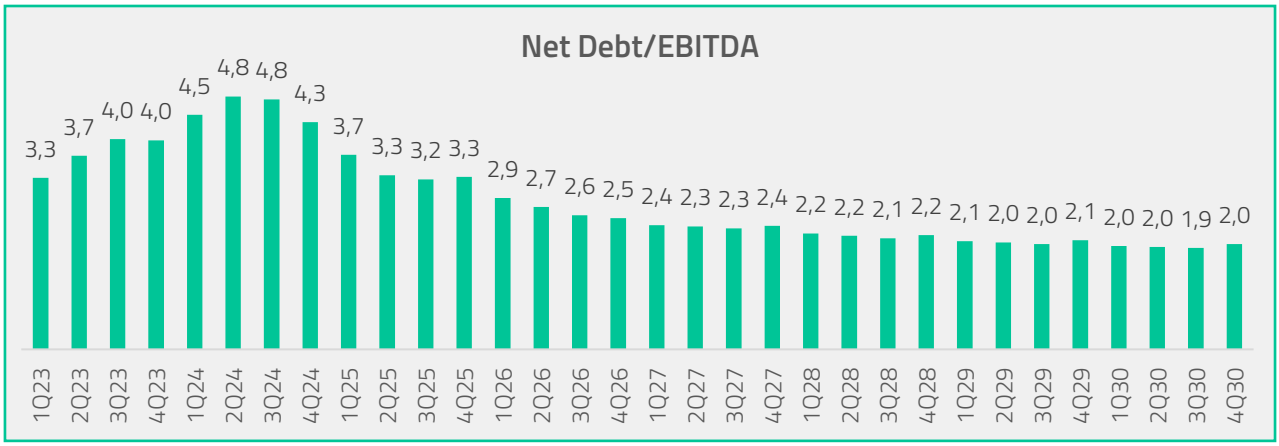




As can be seen in the charts above, the main growth drivers will come mainly from the expansion of revenue streams from currently operated landfills, rather than from the volume of waste received. **In the case of energy generation, as we explained earlier, the better use of the captured biogas molecule is to upgrade it to biomethane rather than thermal generation (we estimate energy break-even prices at BRL 655.2/MWh to make it as profitable as biomethane).** Below, we break down the expected EBITDA growth to 2030 by business line. We expect an EBITDA CAGR of 29% between 2022 and 2030, assuming only values as reported under IFRS rules (does not consider minority stakes in other operations such as Ecopark Santa Luzia (MG) and UTE Paulínia).



Given the rapid growth expected for the company over the next few years, we expect a significant capex outlay, which will be the main challenge to manage over the next few years before the EBITDA generation from the biomethane upgrading facilities kicks in. In addition, the leverage ratio is tightly sensitive to carbon credits sales, which are highly unpredictable. In our base case, we assume that the company sells around 60% of the CERs it generates each year (as it has done in recent years). As shown below, under this scenario, assuming that the company's capex will be 100% funded by new debt issuance, we expect the leverage to reach 5x net debt/EBITDA at the end of 2024 and to decline to the target ratio of around 2x thereafter.



With these assumptions and growth expectations we derived the following forecast for Orizon P&L in the coming years:

INCOME STATMENT	2021	2022	2023e	2024e	2025e	2026e	2027e	2028e	2029e	2030e	2031e	2032e	2033e	2034e	2035e
Net revenues	**434**	**626**	**908**	**1.246**	**1.672**	**2.030**	**2.209**	**2.433**	**2.602**	**2.750**	**2.908**	**3.076**	**3.222**	**3.412**	**3.604**
Waste Disposal and Treatment	267	492	707	777	829	885	944	1.007	1.075	1.147	1.225	1.308	1.369	1.462	1.478
Energy, Biogas and Carbon Credit	102	60	173	440	812	984	1.097	1.251	1.344	1.412	1.485	1.561	1.637	1.725	1.890
Waste Processing and WtE	39	31	27	29	31	161	168	175	183	191	199	207	216	226	236
Environmental Engineering	26	43	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Costs	**-203**	**-335**	**-376**	**-498**	**-654**	**-728**	**-794**	**-875**	**-937**	**-992**	**-1.051**	**-1.113**	**-1.163**	**-1.225**	**-1.299**
Waste Disposal and Treatment	(134)	(238)	(299)	(325)	(347)	(371)	(397)	(424)	(453)	(484)	(517)	(553)	(577)	(617)	(632)
Energy, Biogas and Carbon Credit	(9)	(9)	(54)	(149)	(281)	(323)	(361)	(413)	(444)	(466)	(489)	(513)	(536)	(565)	(621)
Waste Processing and WtE	(34)	(43)	(23)	(25)	(26)	(34)	(36)	(38)	(40)	(42)	(44)	(47)	(49)	(43)	(46)
Environmental Engineering	(26)	(45)	-	-	-	-	-	-	-	-	-	-	-	-	-
Gross profit (cash)	**231**	**291**	**531**	**748**	**1.018**	**1.302**	**1.415**	**1.558**	**1.664**	**1.758**	**1.858**	**1.963**	**2.059**	**2.187**	**2.305**
gross margin (cash)	*53%*	*47%*	*59%*	*60%*	*61%*	*64%*	*64%*	*64%*	*64%*	*64%*	*64%*	*64%*	*64%*	*64%*	*64%*
SG&A cash	(100)	(73)	(154)	(212)	(284)	(345)	(376)	(414)	(442)	(468)	(494)	(523)	(548)	(580)	(613)
EBITDA reported	**131**	**219**	**377**	**536**	**734**	**957**	**1.040**	**1.145**	**1.222**	**1.291**	**1.363**	**1.440**	**1.512**	**1.607**	**1.692**
ebitda margin (reported)	*30%*	*35%*	*42%*	*43%*	*44%*	*47%*	*47%*	*47%*	*47%*	*47%*	*47%*	*47%*	*47%*	*47%*	*47%*
EBITDA Proforma	**131**	**219**	**436**	**604**	**810**	**979**	**1.065**	**1.173**	**1.252**	**1.322**	**1.397**	**1.476**	**1.549**	**1.646**	**1.734**
ebitda proforma margin (reported)	*30%*	*35%*	*48%*	*48%*	*48%*	*48%*	*48%*	*48%*	*48%*	*48%*	*48%*	*48%*	*48%*	*48%*	*48%*
Depreciation	**(53)**	**(141)**	**(191)**	**(342)**	**(411)**	**(415)**	**(416)**	**(416)**	**(416)**	**(416)**	**(416)**	**(416)**	**(416)**	**(416)**	**(420)**
EBIT reported	**77**	**78**	**186**	**194**	**323**	**541**	**624**	**729**	**806**	**875**	**947**	**1.024**	**1.096**	**1.191**	**1.273**
ebit margin (reported)	*18%*	*12%*	*21%*	*16%*	*19%*	*27%*	*28%*	*30%*	*31%*	*32%*	*33%*	*33%*	*34%*	*35%*	*35%*
Financial result	**(99)**	**(154)**	**(110)**	**(91)**	**(77)**	**(64)**	**(52)**	**(40)**	**(29)**	**(17)**	**(6)**	**1**	**5**	**8**	**12**
equity income	1	8	29	39	48	18	20	24	25	27	28	30	32	34	36
EBT	(19)	(69)	105	142	294	495	592	712	803	884	970	1.056	1.132	1.233	1.321
effective taxes	(36)	(47)	(13)	(23)	(43)	(83)	(100)	(138)	(194)	(214)	(235)	(256)	(275)	(300)	(321)
Net Income	**(56)**	**(115)**	**92**	**118**	**251**	**412**	**492**	**574**	**608**	**670**	**734**	**799**	**857**	**934**	**1.000**
net margin	*-13%*	*-18%*	*10%*	*9%*	*15%*	*20%*	*22%*	*24%*	*23%*	*24%*	*25%*	*26%*	*27%*	*27%*	*28%*
ROIC (%)	**12%**	**4%**	**15%**	**8%**	**13%**	**20%**	**22%**	**25%**	**26%**	**28%**	**30%**	**32%**	**34%**	**36%**	**38%**

BALANCE SHEET	2021	2022	2023e	2024e	2025e	2026e	2027e	2028e	2029e	2030e	2031e	2032e	2033e	2034e	2035e
TOTAL ASSETS	**1.206**	**2.073**	**2.724**	**3.698**	**3.847**	**3.896**	**4.021**	**4.118**	**4.207**	**4.302**	**4.402**	**4.509**	**4.608**	**4.751**	**4.905**
Current Assets	**603**	**580**	**625**	**869**	**949**	**1.093**	**1.199**	**1.272**	**1.336**	**1.404**	**1.476**	**1.552**	**1.619**	**1.719**	**1.810**
cash & equivalents	401	241	120	120	120	120	120	120	120	120	120	120	120	120	120
accounts receivable	163	259	416	648	724	861	961	1.030	1.091	1.155	1.223	1.296	1.360	1.454	1.540
deffered taxes	7	14	22	35	39	46	52	55	59	62	66	70	73	78	83
others	31	67	67	67	67	67	67	67	67	67	67	67	67	67	67
Non-current Assets	**603**	**1.493**	**2.099**	**2.829**	**2.898**	**2.802**	**2.823**	**2.846**	**2.871**	**2.898**	**2.927**	**2.957**	**2.989**	**3.032**	**3.095**
receivables	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
deffered taxes	70	53	53	53	53	53	53	53	53	53	53	53	53	53	53
others	29	28	28	28	28	28	28	28	28	28	28	28	28	28	28
investments	4	44	73	113	160	59	79	103	128	155	183	213	245	279	315
PP&E	376	785	1.362	2.053	2.074	2.080	2.080	2.080	2.080	2.080	2.080	2.080	2.080	2.089	2.116
intangible assets	91	526	526	526	526	526	526	526	526	526	526	526	526	526	526
leasing	19	43	43	43	43	43	43	43	43	43	43	43	43	43	43
TOTAL LIABILITIES	**837**	**1.492**	**2.143**	**3.130**	**3.279**	**3.328**	**3.453**	**3.550**	**3.639**	**3.734**	**3.834**	**3.940**	**4.040**	**4.183**	**4.336**
Current Liabilities	**189**	**285**	**1.066**	**2.176**	**2.419**	**2.560**	**2.777**	**2.966**	**3.143**	**3.321**	**3.505**	**3.646**	**3.780**	**3.957**	**4.145**
suppliers	44	66	96	149	166	187	209	225	238	252	266	282	295	315	334
accounts payable	26	25	36	56	62	70	78	84	89	94	100	106	110	118	125
salaries	13	25	36	56	63	71	79	85	90	95	101	107	111	119	126
deffered taxes	39	67	97	150	168	189	212	227	240	255	270	285	299	318	338
deffered revenue	20	24	39	60	67	80	90	96	102	108	114	121	127	136	144
current debt	17	-	682	1.626	1.814	1.884	2.030	2.170	2.305	2.439	2.576	2.666	2.758	2.873	2.999
leasing	10	15	15	15	15	15	15	15	15	15	15	15	15	15	15
others	21	64	64	64	64	64	64	64	64	64	64	64	64	64	64
Non-current Liabilities	**648**	**1.207**	**1.077**	**954**	**860**	**768**	**676**	**584**	**496**	**412**	**329**	**294**	**260**	**226**	**191**
deffered taxes	46	61	61	61	61	61	61	61	61	61	61	61	61	61	61
deffered revenue	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
provisions	33	25	25	25	25	25	25	25	25	25	25	25	25	25	25
long-term debt	539	1.015	886	762	668	576	485	393	305	221	137	103	69	34	-
leasings	11	41	41	41	41	41	41	41	41	41	41	41	41	41	41
others	18	65	65	65	65	65	65	65	65	65	65	65	65	65	65
EQUITY	**369**	**581**	**581**	**568**	**568**	**568**	**568**	**568**	**568**	**568**	**568**	**568**	**568**	**568**	**568**
controling interests	356	550	550	538	538	538	538	538	538	538	538	538	538	538	538
minotity stake	14	31	31	30	30	30	30	30	30	30	30	30	30	30	30

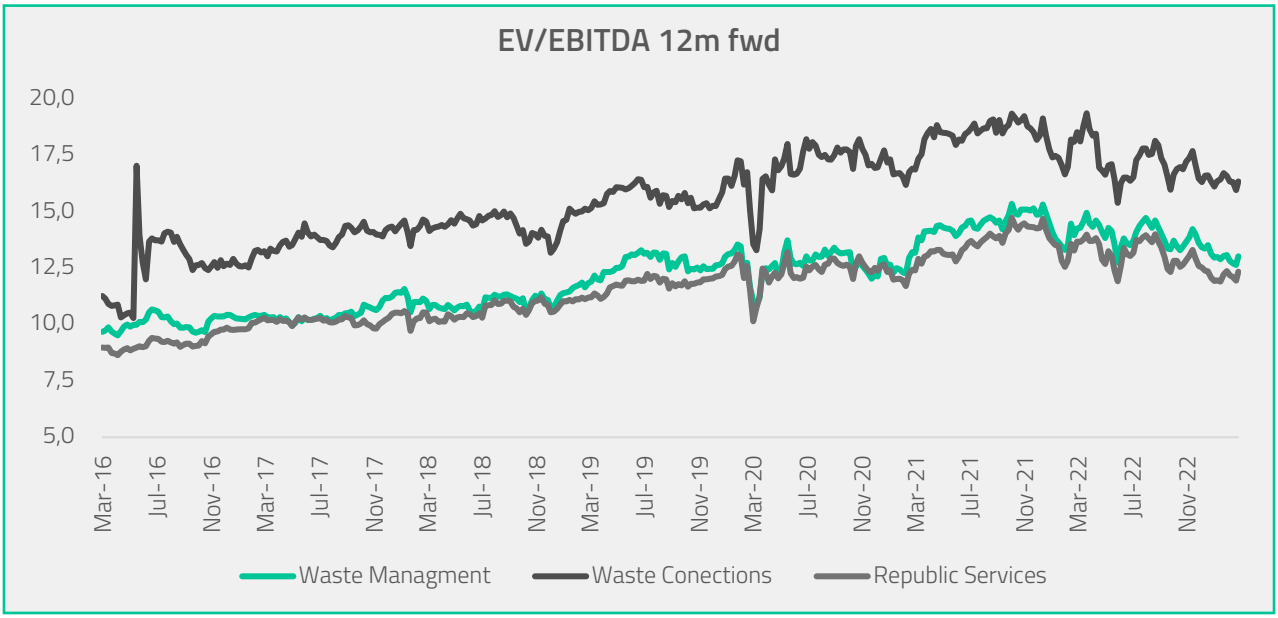
CASH FLOW STATMENT	4Q23	4Q24	4Q25	4Q26	4Q27	4Q28	4Q29	4Q30	4Q31	4Q32	4Q33	4Q34	4Q35
Cash Flow from Operations (CFO)	**186**	**344**	**590**	**734**	**853**	**941**	**977**	**1.036**	**1.097**	**1.159**	**1.216**	**1.279**	**1.354**
Net earnings	92	118	251	412	492	574	608	670	734	799	857	934	1.000
Depreciation	191	342	411	415	416	416	416	416	416	416	416	416	420
equity income	(29)	(39)	(48)	(18)	(20)	(24)	(25)	(27)	(28)	(30)	(32)	(34)	(36)
delta in working capital	(68)	(77)	(24)	(74)	(34)	(24)	(22)	(23)	(25)	(26)	(25)	(37)	(29)
Cash Flow from Investing (CFI)	**-767**	**-1.033**	**-432**	**-421**	**-416**	**-416**	**-416**	**-416**	**-416**	**-416**	**-416**	**-426**	**-446**
capex	(767)	######	(432)	(421)	(416)	(416)	(416)	(416)	(416)	(416)	(416)	(426)	(446)
proceeds from the sale of property	-	-	-	-	-	-	-	-	-	-	-	-	-
Cash Flow from Financing (CFF)	**461**	**689**	**-158**	**-314**	**-437**	**-525**	**-561**	**-620**	**-681**	**-743**	**-800**	**-853**	**-907**
debt issuance	682	944	187	70	146	140	135	134	137	91	92	115	126
debt dibursement	(129)	(123)	(94)	(92)	(92)	(92)	(88)	(84)	(84)	(34)	(34)	(34)	(34)
dividends received	-	-	-	119	-	-	-	-	-	-	-	-	-
dividends paid	(92)	(131)	(251)	(412)	(492)	(574)	(608)	(670)	(734)	(799)	(857)	(934)	(1.000)

As detailed above, the main value creation will come from the implementation of biogas upgrading modules that produce biomethane. By 2033, almost all of the expected capex will have been deployed and EBITDA generation will ramp up rapidly. We see the company achieving a run-rate ROIC of 30-35% after all biomethane capacity has been deployed. By then, the company's EBITDA will be 7x current levels and approaching billion-dollar net income. We see the company trading at a 14% real IRR, assuming a book value exit at the end of the last landfill life. However, it is critical to remember that these numbers are extremely sensitive to variations in biomethane price assumptions and carbon credit (CER) sales volumes. Below we present a sensitivity analysis of our IRR projection under different price scenarios.

real IRR (%)		% of CER generated sold per year				
		0%	30%	60%	80%	100%
Biomethane price (BRL/m³)	2,0	6.6%	7.6%	8.6%	9.2%	9.8%
	2,5	9.6%	10.5%	11.3%	11.9%	12.4%
	3,1	12.6%	13.4%	14.2%	14.7%	15.2%
	3,5	14.5%	15.2%	15.9%	16.4%	16.9%
	4,0	16.6%	17.3%	18.0%	18.4%	18.9%

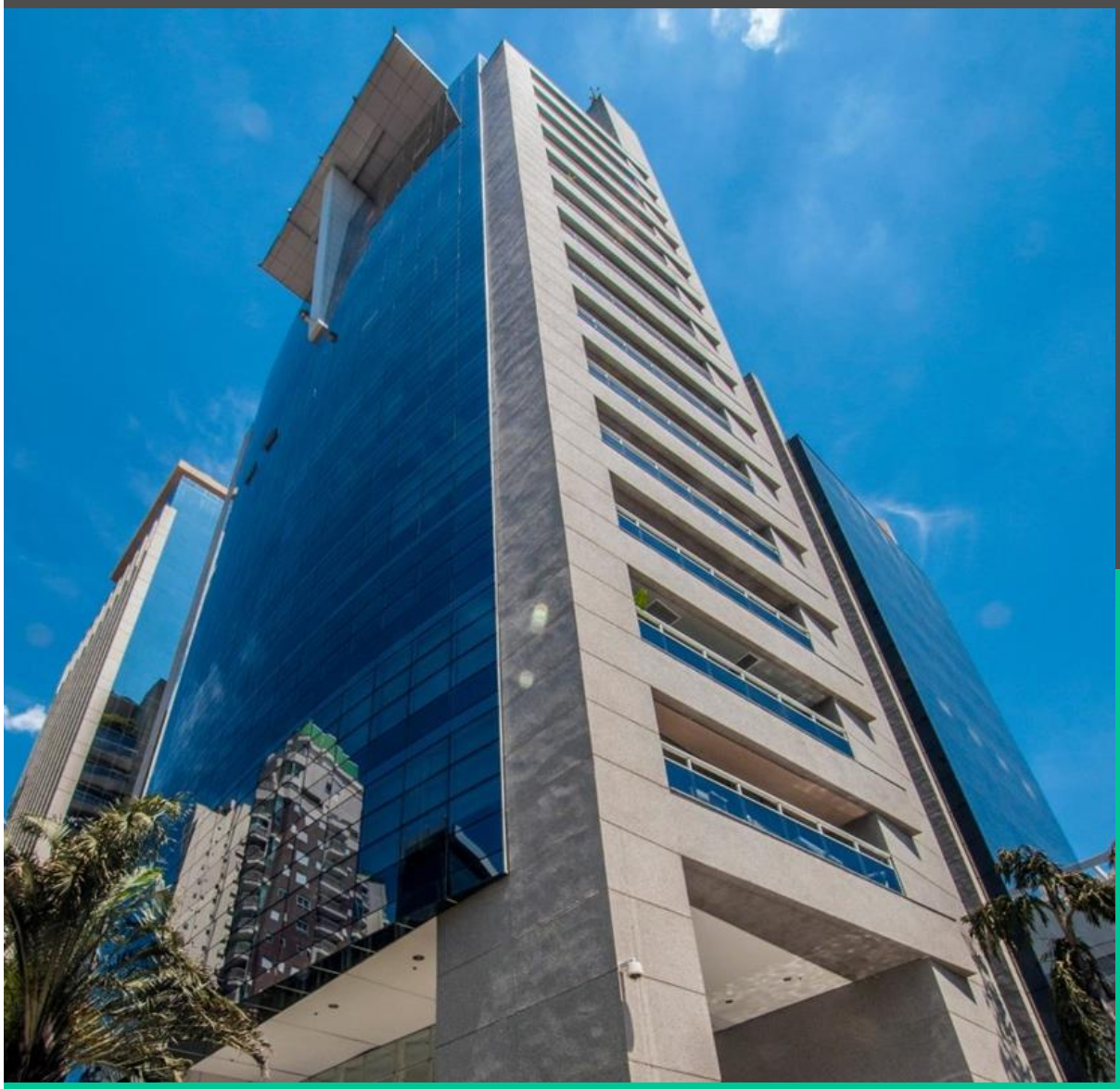
Looking at the company's multiples, we see that it trades at EV/EBITDA 2023 and 2024 of 6.2x and 4.6x, respectively. Looking at global peers, the average 12-month forward multiple is between 12x and 16x, despite the fact that these companies have lower expected growth in the coming years with lower run-rate ROIC.

	EV/EBITIDA 2023	EV/EBITIDA 2024	Avg ROIC (2019-2022)	EBITIDA CAGR (2019-2022)	EBITIDA CAGR (2022-2025E)
Waste Managment	13.3x	12.4x	14.1%	7.9%	7.2%
Republic Services	12.4x	11.6x	7.4%	10.8%	9.0%
Waste Conections	16.5X	15.2x	6.6%	10.9%	8.5%
Orizon	**6.2x**	**4.6x**	**15.3%**	**29.0%**	**55.3%**



In summary, we see Orizon's investment case as a great opportunity to benefit from the energy transition and the trend towards lower carbon emissions. The company has a lot of low-hanging fruits to capitalize on in the near term, while also presenting many options to explore in the future. We do not model further inorganic growth or other potential revenue streams from biomethane expansion such as CBIO generation and food-grade green CO2 production. We also don't model UTM expansion or WTEs at other sites. We believe this is the right approach given the current low visibility. However, even in this conservative scenario, we see the company as highly undervalued and believe the long-term story will deliver great returns to our funds.

EQUITAS



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