



MINISTÉRIO DE MINAS E ENERGIA
SECRETARIA DE PLANEJAMENTO E DESENVOLVIMENTO ENERGÉTICO

2031

TEN-YEAR ENERGY EXPANSION PLAN



1. Economic Assumptions

In this chapter, the assumptions adopted in the PDE 2031 will be presented regarding the expected changes in the Brazilian population and households in the next ten years, as well as the world and national economy, which subsidized the energy demand projections.

It is important to highlight that the work of preparing scenarios and forecasts for the medium and long term is quite challenging in any context, given the high degree of uncertainty regarding the future. This work becomes even more complex when the world is still facing the impacts of the COVID-19 pandemic and uncertainties are even greater. That is why sensitivity exercises were performed in this study. Based on a set of

sociodemographic and world economic assumptions, three scenarios were designed for the Brazilian economy: a benchmark scenario, with the highest probability, and two alternative scenarios – lower and higher – developed from the sensitivity of the behavior of the variables considered key to economic growth over the next ten years.

The scenarios designed and the assumptions adopted are described below and can be found in greater detail in the Technical Note “Cenários econômicos para os próximos 10 anos”, published in December 2021 by EPE.

1.1 Sociodemographic Outlooks

In the next ten years, it is expected that there will be a continuation of the trend of a slowdown in the rate of growth of the Brazilian population observed in recent history, reaching an average growth rate of 0.6% p.y. between 2021 and 2031, rising from around 214.1 million in 2021¹ to a level of 226.3 million of habitants in 2031. The expected change in the Brazilian population until 2031 can be seen in **Chart 1 - 1**².

This lower population growth can cause important impacts on the domestic economic growth in the medium and long term, since this can imply in a lower availability of labor, but this depends on how human capital will evolve over the timeframe considered in this study.

Regionally, no significant changes in the demographic distribution are expected. Although there is a prospect of more substantial population growth in the North and Center-West regions, most of the Brazilian population will continue to be concentrated in the Southeast (41.8%) in 2031, as can be seen in **Chart 1 - 2**.

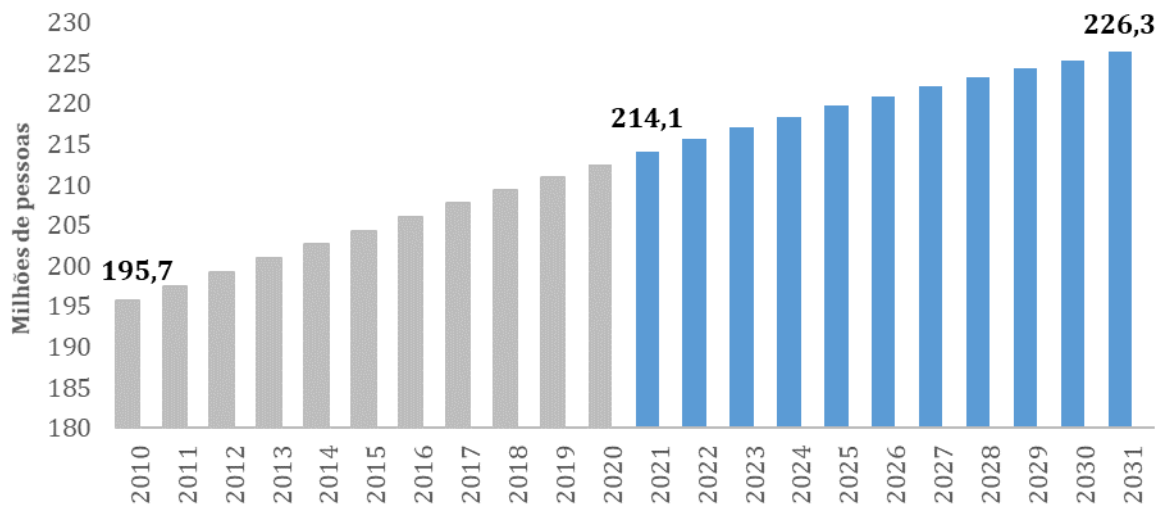
With regard to households, it is expected that they will have a stronger expansion than that of the population in the ten-year period, in line with the general assumptions of an increase in the population's income and a gradual reduction in the housing deficit. Private permanent households are expected to grow, on average, by 1.5% p.y. in the same period, going from about 72 million in 2021 to the level of 84 million households in 2031.

Thus, a drop in the population per household ratio over the ten-year period is expected, from about 3 in 2021 to 2.7 in 2031.

¹ Demographic and household data for 2021 are EPE forecasts.

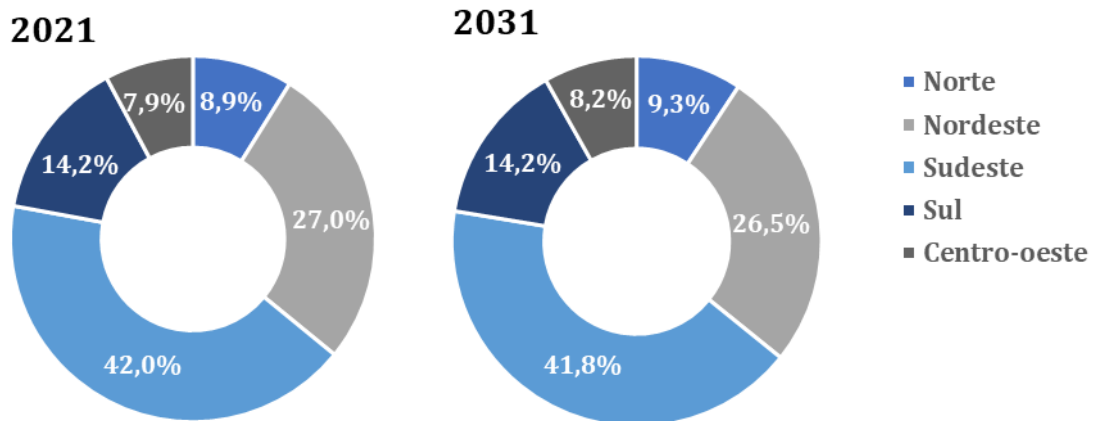
² EPE's demographic forecasts are based on forecasts from the study “Projeções da população: Brasil e unidades da federação” (Population forecasts: Brazil and federation states), 2018, from IBGE. However, an adjustment was made to change the base date from July 1st to December 31st.

Chart 1 - 1: Brazilian population development



Source: Prepared by EPE, based on IBGE (2018).

Chart 1 - 2: Brazilian population development by geographic regions



Source: EPE (forecasts), based on IBGE (2018).

1.2 Prospects for World Economy

Understanding the dynamics of the global economy is crucial to understanding how the Brazilian economy can leverage future opportunities, as well as face potential challenges that may arise in the medium and long term. Therefore, this study covers the main assumptions for the world economy, based on the World Economic Outlook studies of April and July 2021, by

the International Monetary Fund (IMF), for the time frame until 2026. For the long term, assumptions were built based on studies such as Exxon (2019), OECD (2018) and PWC (2017).

The COVID-19 pandemic heavily impacted the global economy in 2020. According to the IMF (2021), that year there was a drop of 3.3% in world GDP and 8.5% in world trade. The expectation is

that in 2021 there will be a significant recovery, although the pace of recovery of countries varies. In the following years, global economy is expected to return to a more moderate level of growth.

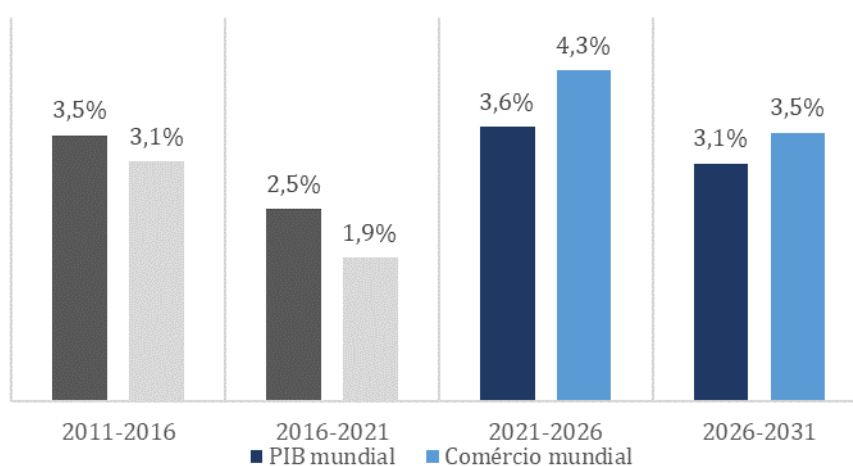
After a year of downturn in economic activity, developed countries are expected to show a substantial recovery in the short term, especially the United States. In later years, the perspective is that the growth of these economies will be more modest, in part, due to population aging, which can have impacts on the availability of labor in the long term.

On the other hand, developing countries should experience a greater expansion rhythm, making these economies have an increasing participation in the world economy. It is worth mentioning that, over the timeframe of this study,

China should go through a process of gradual deceleration of its economic growth rate, as a result of its transition strategy to a structure with greater development of the services sector and greater participation of consumption, to the detriment of industry and investment. Such a shift could have significant impacts on world trade as demand for commodities declines.

Given this, GDP and world trade are expected to grow, respectively, by an average of 3.3% p.y. and 3.9% p.y. in the period 2021-2031, as can be seen in **Chart 1 - 3**. It is important to emphasize that the level of uncertainty is still very high, so there are a series of risks that could compromise the actualization of this scenario, such as the emergence of new variants of the virus that make vaccines ineffective, geopolitical conflicts, and others.

Chart 1 - 3: Evolution of GDP and world trade



Source: EPE (forecasts) and IMF (historical). Note: EPE forecast for 2021.

1.3 Prospects for Brazilian Economy: benchmark

After registering a 4.1% shrinkage in the national GDP in 2020, impacted by the COVID-19 pandemic, the Brazilian economy showed a recovery process throughout 2021. This growth is driven, on the one hand, by the expansion of foreign demand amid the resumption of

international economies, and on the other hand, by the progress of Brazilian population vaccination, which began in January and has been following the rhythm defined in the National Immunization Plan, and a large part of the Brazilian population is expected to be vaccinated by the end of 2021.

However, the consequences of the COVID-19 pandemic are still uncertain, with the appearance of new variants and the recent increase in the number of cases in some countries. Despite this increase, the worldwide vaccination progress has allowed a reduction in the number of deaths from the disease.

Due to these issues and the uncertainty inherent to the construction of medium and long-term economic scenarios, two sensitivities were drawn, in addition to the benchmark scenario, which will be described in this section.

Based on the general assumptions described above, a more likely scenario for the domestic economy was prepared. Generally, in the benchmark scenario, the beginning of the timeframe is marked by a continuity of the Brazilian economy recovery process from the COVID-19 crisis that started in the second half of 2020. In the following years, the economy is expected to grow at a moderate pace, with gradual advances in economic reforms and investment expansion.

As for the short term, the expectation is that the immunization of a large part of the population by the end of 2021 will contribute to a gradual reduction in the number of cases and the absence of new waves, allowing the continuity of the process that is currently taking place of gradual reduction of social distancing measures. This scenario will allow for a greater pace of growth in economic activity, consolidating the process of activity recovery. Still in the short term, there are uncertainties related to the evolution of inflation and the impacts of the adoption of a restrictive policy by the Central Bank, as well as the water scarcity.

In terms of sectors, the resumption of activity should be driven mainly by industry, especially in the manufacturing and extractive sectors. On the other hand, the service sector should maintain the gradual pace of growth, as vaccination progresses and activities with the public are resumed, and also with the recovery of the job market. Agriculture

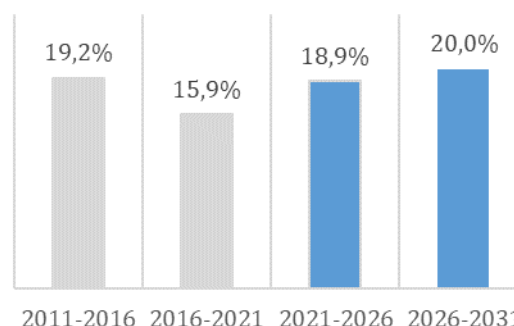
should contribute to a positive rate favored by the increase in external demand in the period.

An environment of greater economic stability is expected for the coming years, with recovery of both consumer and investor confidence, in addition to a gradual recovery of the job market, stimulating domestic demand.

Furthermore, the approval of some reforms, even if only partially, should contribute to improving the business environment and making the Brazilian economy more competitive, especially in the second five-year period.

With a better business environment and greater confidence by economic agents, there is an expectation of a greater expansion of investments. A segment that should stand out in this period is infrastructure, due to the existing bottlenecks. Investments in this sector have a strong impact on the economy as a whole, due to their indirect effects on other sectors. In addition to expanding production capacity, it makes the economy more efficient, generating productivity gains. Therefore, in this scenario, it is expected that, with the development of the grant policy, there will be an expansion of investments in infrastructure, which should reduce the bottlenecks that exist today and produce gains in competitiveness and productivity, especially in the second half of the timeframe considered. **Chart 1 - 4** shows the progress of investments over the next ten years.

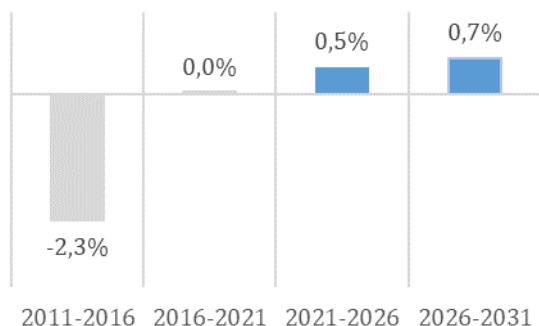
Chart 1 - 4: Progress of investment rate (% of GDP)



Source: EPE (forecasts) and IMF (historical). Note: EPE forecast for 2021.

Therefore, total factor productivity (TFP) is expected to show a gradual but significant growth, given the recent history, as can be seen in **Chart 1 - 5**. It is important to emphasize that advances in TFP will be increasingly important for long-term economic growth, given the lower demographic contribution over the ten-year timeframe, as explained in section 1.1.

Chart 1 - 5: Progress of Total Factor Productivity (TFP)

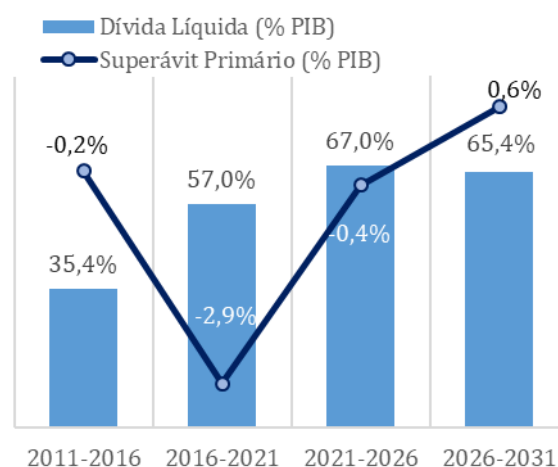


Source: EPE (forecasts) and FGV (historical until 2019). Note: EPE forecast for 2021.

With regard to public accounts, it is expected that, after the high primary deficit in 2020 due to increased spending to contain the impacts of the pandemic on the economy, fiscal policy will once again aim to achieve growing primary results over the next few years. With this, the expectation is that the Public Sector Net Debt/GDP (PSND/GDP) ratio will resume a decreasing trajectory at the end of the first five-year period. **Chart 1 - 6** shows the

development of the government's primary balance and the PSND/GDP ratio over the next five years.

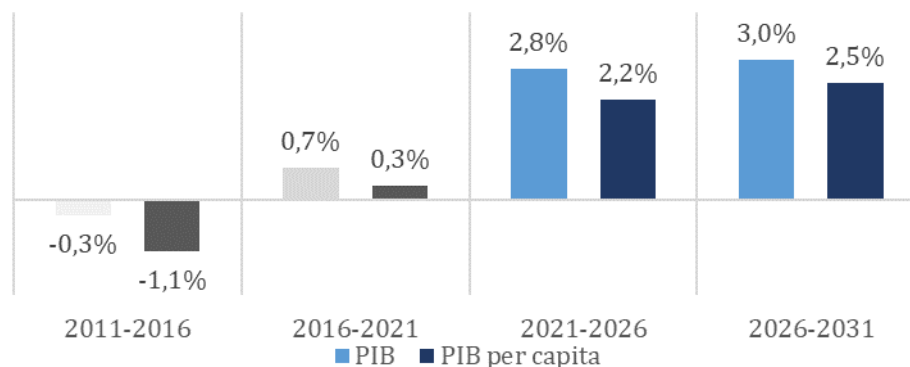
Chart 1 - 6: Progress of public sector indicators



Source: BCB (historical data), EPE (projections). Note: EPE forecast for 2021.

Given the assumptions analyzed above, Brazilian GDP should display an average annual growth of 2.9% between 2021 and 2031, as can be seen in **Chart 1 - 7**. GDP per capita, on the other hand, is expected to grow, on average, 2.3% p.y. in the same period, reaching a level of around BRL 46 thousand in 2031 (in BRL 2020).

Chart 1 - 7: GDP and GDP per capita development (% p.y.)



Source: EPE (forecasts) and IBGE (historical). Note: EPE forecast for 2021.

From a sectoral perspective, it is expected that the scenario of greater stability and greater confidence on the part of economic agents, in a context of stronger domestic demand and a recovery in the labor market, will allow for a more substantial pace of growth in industry and services. The expectation is also that the reforms and investments carried out over the timeframe will allow a modest gain in competitiveness of domestic producers at the end of the timeframe, especially in industry.

The recovery of international economies should generate additional impetus, especially for agricultural, mineral and energy commodities, which include some energy-intensive segments, such as cellulose and some metallurgy products.

In this regard, an average annual growth of 2.8% is expected between 2021 and 2031 for the agricultural sector, benefiting from the country's good international competitiveness for these products, whose demand should continue to expand in the coming years. It is worth mentioning that the assumptions for the sector also consider the outlook in the report “~Projeções do Agronegócio: Brasil 2020/2021 a 2030/31” (MAPA, 2021), which foresees a considerable expansion in the domestic production and consumption of grains and meat over the next ten years.

With regard to the industry, the expectation is for an average annual growth of 3.1% between 2021 and 2031 over a ten-year timeframe (**Chart 1 - 8**). In this scenario, the good performance expected for the extractive segment stands out, driven by international demand for iron ore and for oil production in the Pre-Salt region.

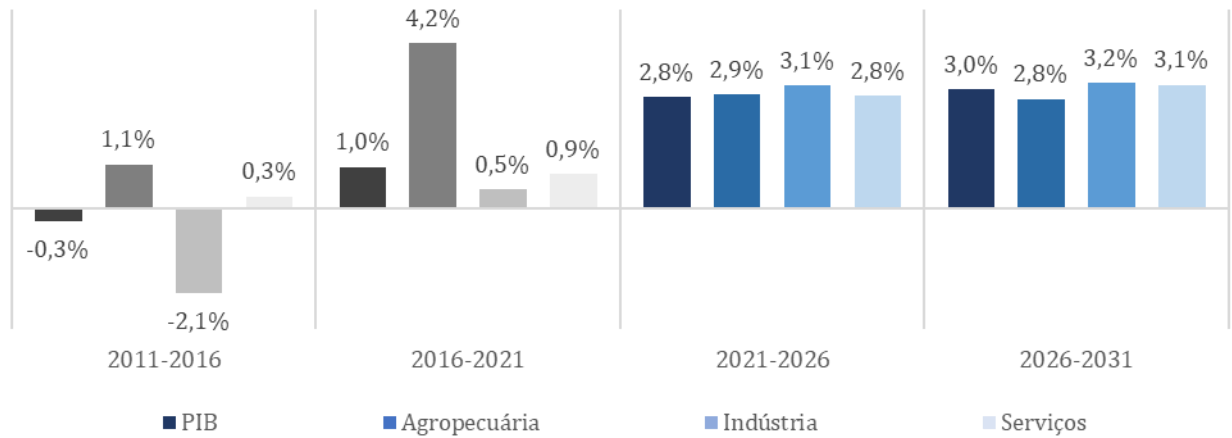
In the case of transformation industry, the performance in the period should be driven by stronger domestic demand and investments, especially in the case of segments more focused on the domestic economy and some energy-intensive sectors, which are largely producers of intermediate goods. The recovery of the labor market and household consumption should increase demand for both non-durable and durable consumer goods,

the latter also benefiting from better credit conditions in a context of greater economic stability and lower risk.

The construction industry should benefit from the grant projects planned for the coming years, with increased investments in infrastructure, both related to energy and transport, as well as sanitation and housing. Regarding the last two, the COVID-19 pandemic reinforced the need for important advances in these areas, due to the large number of Brazilians living in inadequate housing conditions and with restricted access to water and sewage, in addition to the lack of essential utilities. Thus, it is expected that these areas will be the focus of investments in the coming years (**Chart 1 - 9**).

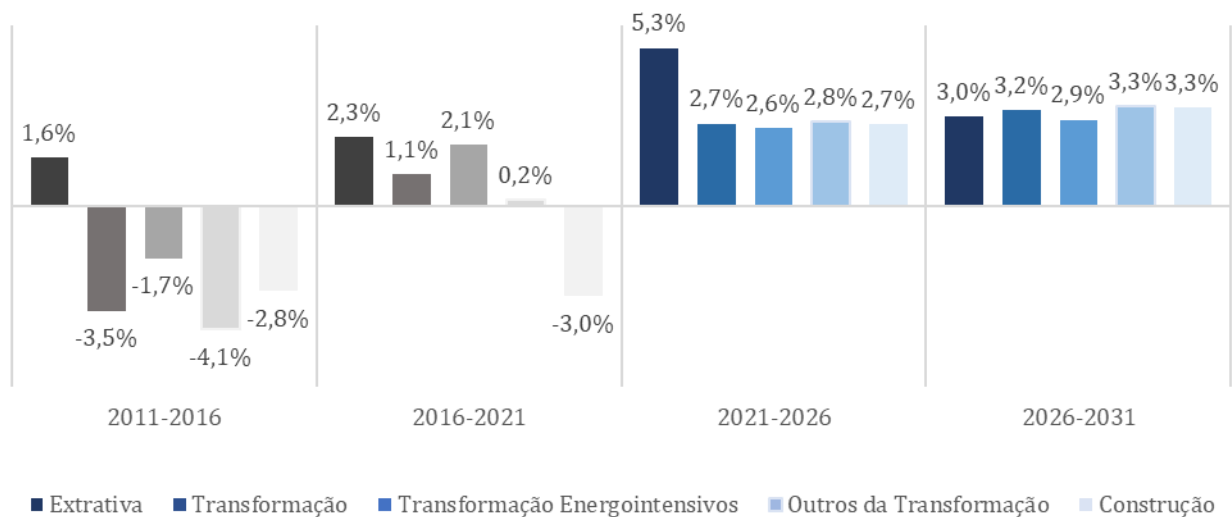
The service sector is expected to grow at an average rate of 3.0% between 2021 and 2031, driven by expanding income and domestic demand. The sector will also benefit from the activities of the industrial and agricultural sectors, stimulating demand for trade, transport services and services provided to companies. The outlook for leisure and tourism services is also quite positive, which the country has a natural vocation for, with great attractiveness to tourists.

Chart 1 - 8: Progress of macro-sector added values



Source: EPE (forecasts) and IBGE (historical). Note: EPE forecast for 2021.

Chart 1 - 9: Progress of industrial added values



Source: EPE (forecasts) and IBGE (historical). Note: EPE forecast for 2021; Energy-intensive Transformation is a subgroup comprising the food and beverage, pulp and paper, cement, ceramics and glass, steel, aluminum and alumina, petrochemical and soda-chlorine sectors.

Box 1 - 1: Energy intensity and the structure effect

Energy is a fundamental input for economic activity. Energy intensity is an indicator that describes the energy need of a given economy to provide goods and services, and is calculated by the ratio between the domestic energy supply and the Gross Domestic Product (GDP) in a period, such as a year. It is worth mentioning that this intensity is different among the economic sectors. The energy intensity of an economic sector is given by the ratio between its final consumption and its added value, and the more intensive this sector, the greater the need for energy to generate 1 unit of added value.

Energy intensity is often used as a proxy for energy efficiency, including to monitor the efficiency target of the Sustainable Development Goal - Affordable and Clean Energy (SDG7), the UN's clean and affordable energy goal. However, despite having the advantage of easy access to data, this indicator can lead to wrong conclusions about energy efficiency. This is because it can be influenced by factors that are not related to energy efficiency in the traditional concept. One of the main factors is the effect of the economic structure on the indicator.

For example, a country that has a high share of basic manufacturing activities, which are generally energy-intensive and with low added value, can be interpreted as less efficient in terms of energy use, even if these industries adopt highly energy-efficient technology in their plants. In addition, the movement of production chain international fragmentation that has taken place in recent decades has displaced several energy-intensive industries from developed countries to emerging countries, with the former exchanging the domestic production of these goods for imports. Since the energy intensity indicator does not consider energy embedded in imports, the comparison between the energy efficiency of each country using this indicator can mask reality. Therefore, the international comparison of energy intensity should be done with caution.

Comparing energy intensity over time can also lead to distortions, as the country's economic structure changes over time. Thus, the increase in the participation of more energy-intensive sectors may end up being interpreted as a reduction in energy efficiency, even if advances in this direction have occurred in these industries. In addition, in periods of crisis, the trend is for industrial plants to operate with idle capacity, which leads to inefficiencies in a situational manner. With the resumption of production, the tendency is for efficiency levels to return to the pre-crisis level.

Energy efficiency can be measured by the ratio of final energy consumption to physical production or energy service. The less energy consumed for the same energy service, the greater the efficiency. Intensity can be used as a proxy for efficiency when it is properly broken down, isolating other factors that contribute to changes in intensity and in the same context (US DOE, 2021). The use of the ODEX* index circumvents this type of distortion, as it considers the variation of consumption indicators and weights in relation to the weight in consumption, reducing the influence of the structure effect. In Chapter 9, Chart 9-7 shows ODEX calculation for Brazilian industry in the ten-year timeframe, while box 9-1 shows the concepts for calculating energy efficiency in the PDE.

*ODEX is an efficiency gain index that considers the variation of consumption indicators and weights in relation to the weight in consumption, reducing the influence of the structure effect.

1.4 Alternative Scenarios

As mentioned earlier, the crisis caused by the COVID-19 pandemic continues to impose a high level of uncertainty in the global and domestic environment, making the task of building economic scenarios even more complex. In the process of drafting scenarios for the medium and long term, it is necessary to separate the short-term elements

from the structural ones. Therefore, it is possible to reach a higher or lower growth than the current rates, depending on several aspects that influence the economy future behavior.

In the previous section, the scenario considered the most likely – the benchmark

scenario – was described, which for this reason was chosen as the basis for the study as a whole. Due to the high level of uncertainty, two alternative scenarios were prepared, one lower and one higher, based on the sensitization of the assumptions

adopted for the variables considered key in the economic growth of the next ten years, according to **Table 1 - 1**. These scenarios are briefly presented below.

Table 1 - 1: Major differences in assumptions between the benchmark and alternative scenarios

CRITICAL POINTS	LOWER SCENARIO	BENCHMARK SCENARIO	HIGHER SCENARIO
DEVELOPMENT OF THE PANDEMIC	New waves of the disease result in a longer duration of the pandemic in Brazil.	Vaccination rhythm allows for immunization of a large part of the population in 2021, with a gradual reduction in the number of cases and absence of new waves.	Acceleration in vaccination rhythm allows for a sharp reduction in the number of cases and the absence of new waves.
CONFIDENCE AND PACE OF RECOVERY	High uncertainty scenarios interrupt economic recovery, which becomes stagnant in the short term	A scenario with less uncertainty related to the pandemic allows for an increase in confidence and a sustained recovery process.	A more favorable scenario allows for a sharp increase in confidence and an accelerated recovery process.
APPROVAL OF REFORMS AND THE BUSINESS ENVIRONMENT TOTAL FACTOR PRODUCTIVITY	Difficulty in approving reforms Slow growth	Approval of important reforms along the timeframe Gradual growth	Approval of important reforms already in the short term Strong growth
PUBLIC ACCOUNTS	Difficulty in carrying out fiscal adjustment	Fiscal adjustment with gradual reduction of the PSND/GDP ratio	Fiscal adjustment with a significant and faster reduction in the PSND/GDP ratio

Source: EPE.

LOWER SCENARIO

The bottom scenario has as its basic short-term premises the existence of new waves of the COVID-19 pandemic, increasing the duration of the health and economic crisis. Therefore, in this scenario, it is expected that stricter isolation measures will be adopted that cause significant negative impacts on economic activity, interrupting the recovery process.

In this scenario, the crisis has an intense impact on sectors more focused on domestic demand, especially services, due to the need for new measures of social isolation. As a result, there is a greater number of establishments that declare bankruptcy and leave the market permanently.

In the following years, the economic environment continues displaying high level of uncertainty, which hinders the recovery of the labor market and the confidence of players and, consequently, of domestic demand. This more complex context means that there is low expansion in investments, especially those considered riskier, such as infrastructure. Thus, the volume of investments reaches the level of around 19% of GDP.

Furthermore, in this scenario, the greater difficulty in approving reforms prevents significant improvements in the business environment and in the competitiveness of the Brazilian economy. As a

result, productivity is practically stagnant over the ten-year timeframe, growing, on average, by 0.2% p.y. in the period.

In relation to public accounts, in general, the primary result is affected by the lower level of collection due to less vigorous economic growth. This causes the PSND/GDP ratio to increase over the timeframe.

In short, the issues presented above lead to an average GDP growth of 1.9% in the ten-year period, a rate lower than that achieved in the benchmark scenario.

In this scenario, the lower level of household income and consumption result in weaker demand

HIGHER SCENARIO

This scenario considers more vigorous growth rates in the short term. In it, the faster process of vaccination of the Brazilian population results in a sharp reduction in the number of cases and deaths from COVID-19 and an absence of new waves of the disease, allowing for a strong recovery of the economy.

In this context, there is a more intense recovery of activities, especially services, which resume full operation of activities more quickly. The most positive scenario for the labor market and income leads to an increase in demand and production of all activities.

For the following years, a stronger and faster recovery of players' confidence is expected, which causes a strong recovery of domestic demand, with the realization of important investments for the development of the country. In this scenario, investments reach the level of approximately 22% of GDP. As in the reference scenario, the infrastructure sector also stands out, but investments in this sector happen more significantly and quickly in this scenario.

In addition, important reforms are expected to be carried out, generating direct and indirect impacts on the economy. One of these effects is on

and production in the service and industrial segments focused on domestic consumption. The lower level of investments and the absence of important reforms contribute to this performance, and the bottlenecks that prevent an increase in productivity and national competitiveness persist.

The sectors of agriculture, extractive industry and some segments of the transformation industry focused on exports, on the other hand, should grow at higher rates, following the expected performance for GDP and world trade, with an increase in the relevance of the sectors that produce commodities in the period.

the business environment, significantly improving the competitiveness of Brazilian economy. In view of this, a more intense expansion of productivity is expected, reaching an average growth rate of 0.9% p.y. between 2021 and 2031.

As a result of these factors, the Brazilian GDP shows a significant growth trajectory, reaching an average rate of 3.9% p.y. over the ten-year timeframe.

In this scenario, the higher level of population income and household consumption increase domestic demand, resulting in greater growth in service activities and in the manufacturing and construction industries. In the case of industry, there is an additional boost related to investments in infrastructure, which has chain effects on industrial production. Thus, growth is expected in the production of energy-intensive sectors of intermediate goods, such as metallurgy, chemicals and non-metallic minerals.

The commodity producing sectors, such as agriculture, extractive industry and manufacturing segments, should show good growth in the period, due to the positive outlook for both domestic and foreign demand. The better business environment and the reforms implemented will allow for a

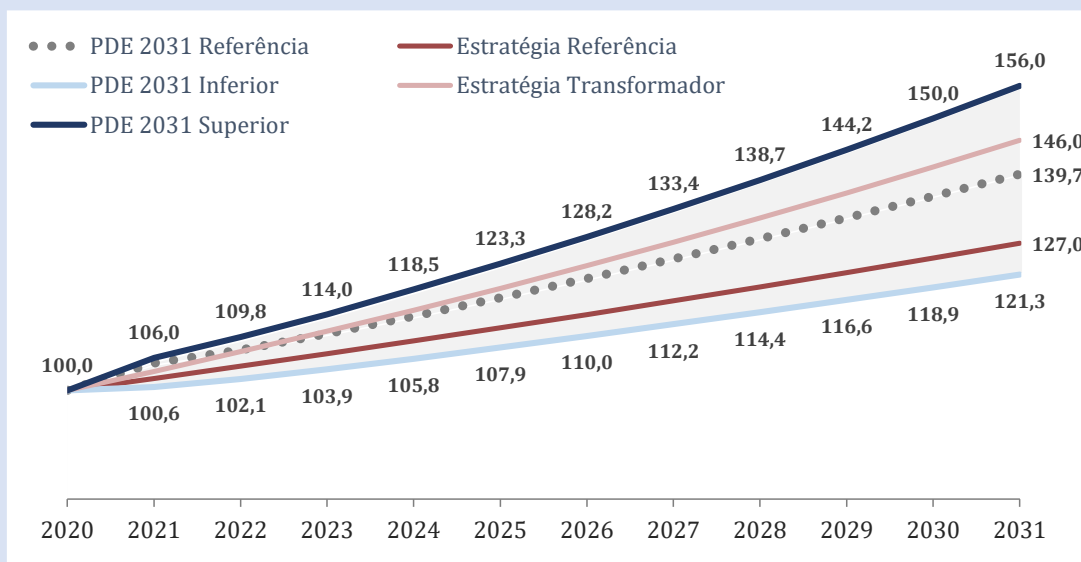
greater degree of national competitiveness, although with timid effects in the ten-year generating stimulus for the development of activities with greater technological content, timeframe.

Box 1 - 2: The PDE 2031 and Decree No. 10,531/2020

In compliance with Decree No. 10,531, of October 2020, which establishes the “Estratégia Federal de Desenvolvimento para o Brasil no período de 2020 a 2031”, the economic scenarios of the PDE 2031 were prepared considering, along its three possible pathways, the growth expected for Brazilian GDP in the “Benchmark” scenarios of 2.2% p.y., and “Transformation” of 3.5% p.y. of said document, as shown in **Chart 1 - 10**.

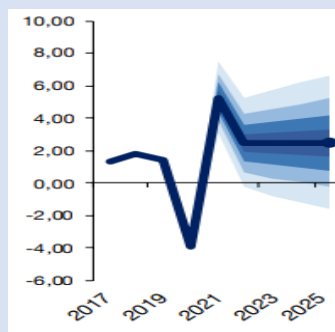
In its Macroeconomic Bulletin, the Ministry of Economy presents a series of estimated scenarios, in addition to the official indicator grid, as a way of dealing with the uncertainty present in the construction of prospective scenarios, since the variance in relation to the expected growth becomes greater as the forecast timeframe is increased (**Chart 1 - 11**). It can be concluded that the economic scenarios of PDE 2031 are compatible with the “neighborhood” strategy adopted in the Macroeconomic Bulletin.

Chart 1 - 10: Development of Brazilian GDP in PDE 2031 and Estratégia Nacional scenarios



Source: EPE. Note: EPE forecast for 2021 in the PDE 2031 scenarios.

Chart 1 - 11: GDP scenarios from the forecast variance of the models used – Ministry of Economy



Source: Ministry of Economy (Macroeconomic Bulletin – Sep. 21).

**MAJOR POINTS OF THE CHAPTER
ECONOMIC ASSUMPTIONS**

- *Over the next ten years, Brazilian population is expected to grow, on average, 0.6% p.y., from 214.1 million in 2021 to 226.3 million in 2031. Regarding the number of permanent private households, the expectation is that there will be an average growth of 1.5% p.y., from around 72 million in 2021 to approximately 84 million households in the country at the end of the horizon.*
- *With regard to the world economy, it is expected that, within the timeframe of this study, developing countries will grow at more significant rates, increasing their contribution to the world economy. GDP and world trade are expected to grow 3.3% p.y. and 3.9% p.y. in the ten-year period, respectively.*
- *The Brazilian economy should show a dynamic recovery in the coming years, reaching an average annual GDP growth rate of 2.9%. In the medium term, an environment of greater stability is expected; this will allow an expansion of investments and the carrying out of reforms, even if partial, that will foster productivity and competitiveness gains.*
- *In sectoral terms, the economic recovery is driven by industry, while services resume more slowly, as vaccination and control of the pandemic advance. In the following years, a more substantial pace of growth in industry and services is expected due to greater economic stability, a better business environment and increased investments. Commodity exporting sectors should perform well throughout the period.*