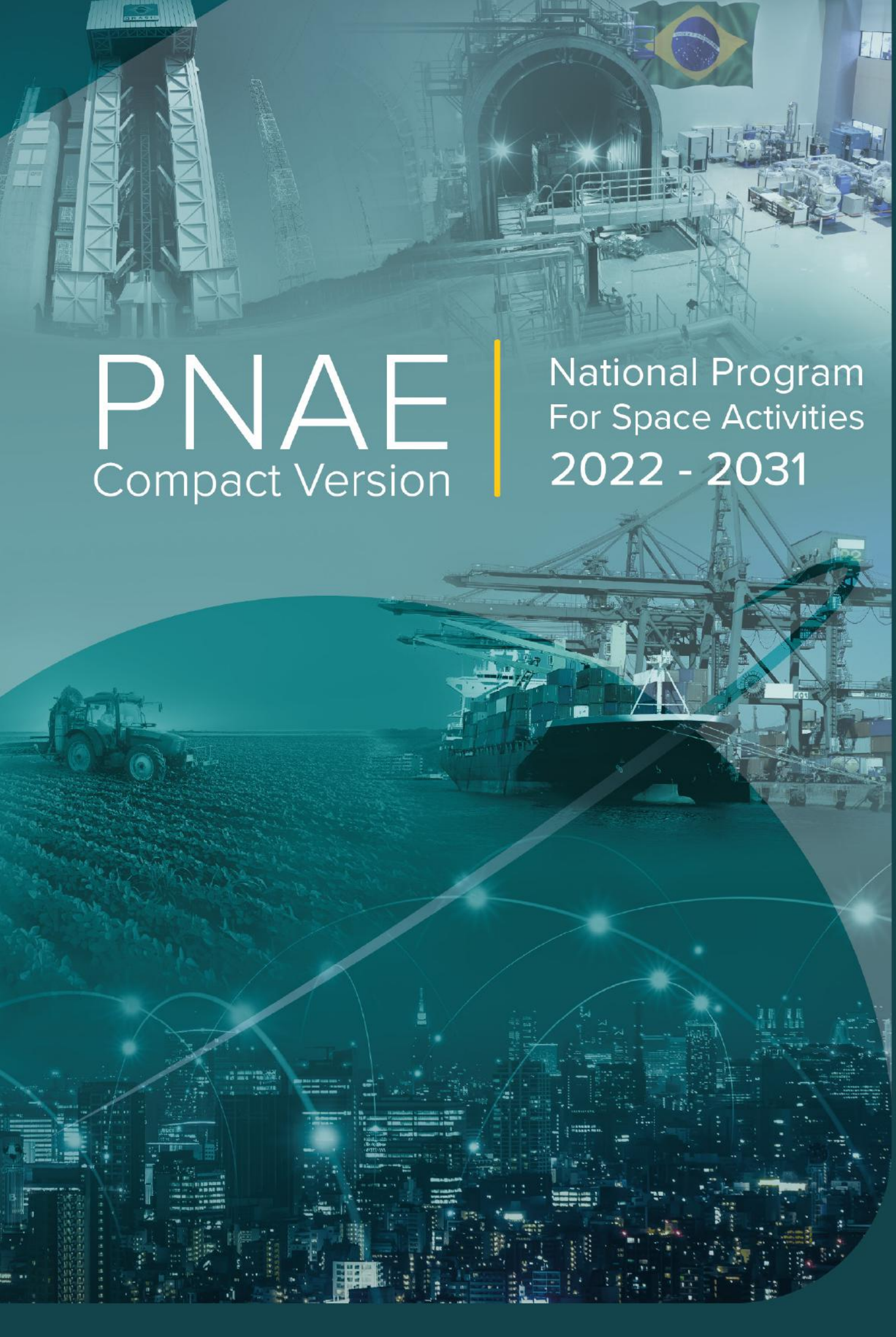

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2022 - 2031


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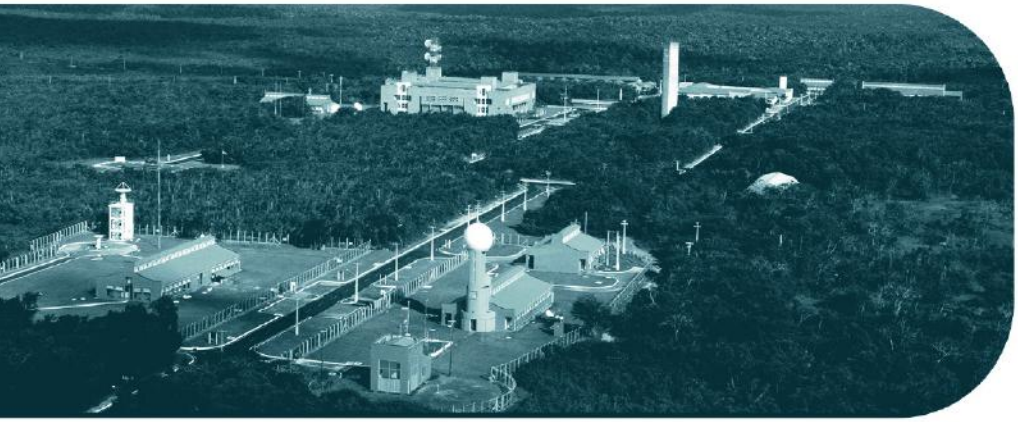

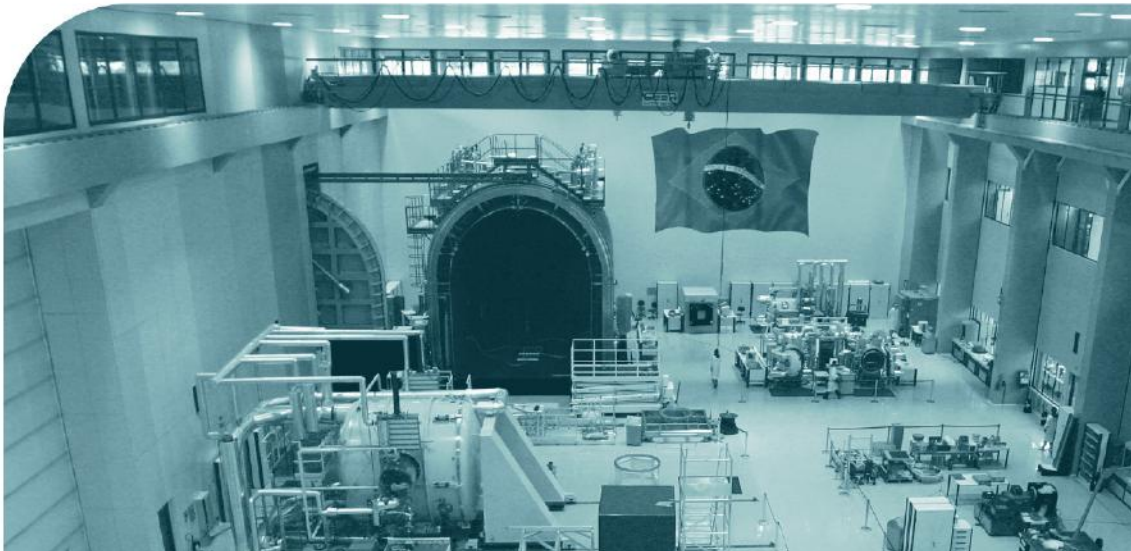

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National Program
For Space Activities
2022 - 2031

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PNAE
Compact Version

National Program For Space Activities 2022 - 2031

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BRAZILIAN SPACE AGENCY

Revision team

This edition of PNAE is the fruit of a collective work, which started in 2019.

From the establishment of the Working Group GT-PNAE, through the AEB Ordinance Nº 107 of May 13, 2019, several institutions and professionals have worked, propositionally and constructively, in the direction of building the PNAE for the next decade.

This objective was achieved.

In this regard, the Brazilian Space Agency pays its respects and thanks, especially, the following participations:

Institutions that participated in the GT-PNAE
Brazilian Space Agency - **AEB**
Brazilian Aerospace Industries Association - **AIAB**
Alcântara Launch Center - **CLA**
Barreira do Inferno Launch Center - **CLBI**
Commission for the Coordination and Deployment of Space Systems - **CCISE**
Department of Aerospace Science and Technology - **DCTA**
Brazilian Air Force General Staff - **EMAER**
Aeronautics and Space Institute - **IAE**
Industrial Promotion and Coordination Institute - **IFI**
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Definitions

The overall definitions adopted in this edition of the PNAE are presented. These concepts point to the framework of comprehension that should be considered for the interpretation of the PNAE 2022-2031. However, they do not imply an absolute formalization of what they describe, since there may be some flexibility in some concepts. More specific definitions are presented throughout the document as they happen to be used.

Space Application: good or service that depends on the operational capability of spacecrafts.

Spacecraft: vehicle or device, or part thereof, intended for access to and operation in outer space or the exploration of celestial bodies, so as to be classified generically as payload; satellite, space vehicle, space exploration vehicle and launch vehicles, or their systems, subsystems, equipment and components; orbital space station; support base for space missions of longer duration or farther from the Earth's surface.

Space Activity: systematic effort to design, develop, prepare, implement, operate, or use space infrastructure.

Space Infrastructure: ground equipment, logistical resources, facilities, tools and computer systems, and spacecrafts necessary to enable space applications, to conduct the country's space activities, or to implement and enable the entire life cycle of space systems.

Microsatellite: artificial satellite with mass between 10 kg and 100 kg.

Minisatellite: artificial satellite with mass between 100 kg and 500 kg.

Nanosatellite: artificial satellite with mass between 1 kg and 10 kg.

Geostationary satellite: artificial satellite in equatorial orbit at a distance of about 36,000 km from the Earth's surface and with an orbital period equivalent to the Earth's rotation period.

Large size satellite: artificial satellite with mass greater than 1,000 kg.

Medium size satellite: artificial satellite with mass between 500 kg and 1,000 kg.

Small size satellite: artificial satellite with mass of less than 500 kg - covers nanosatellites, microsatellites and minisatellites.

Brazilian Space Sector: set of public institutions and private entities; laws, rules, regulations and licenses; space infrastructure; human resources; and technologies that play a role in the development and conduct of space activities in Brazil.

Space System: the combination of space infrastructure elements that jointly and integrally address the delivery of a given space application.

Critical Technology: technology classified as fundamental for obtaining and maintaining the operational requirements of a certain space activity of interest to the country, that is considered difficult to obtain on the international market or that is subject to restrictions and embargoes.

Multiple Use Technology: technology that can be used in the Brazilian Space Sector and in other sectors of Brazilian society.

Note: This document adopts the standard references of weights, measures and currency traditionally used in the official documents of the Government of Brazil: kilograms, meters, kilometers and the Real (BRL).

Summary

A message from the President of the Brazilian Space Agency

Carlos Augusto Teixeira de Moura

History shows how much technological, logistical, and even life-sacrificing efforts were required for mankind to set out to conquer space. We are privileged heirs. In contemporary society, we enjoy and depend greatly on space systems for the quality of life, security, and progress so longed around the world; on the "Brazil continent" in particular.

Yes, we are a continental country with monumental challenges and enormous opportunities. Delivering solutions for the several demands of Brazilian society is the focus of our space program. We have already done a lot; the legacy is unquestionable. And we have ample conditions to advance further and provide a complete set of space systems that are consistent with the greatness of our territory, our seas, our population, our economy...

Therefore, we see the space systems as cross-cutting tools of integration, capable of serving various public policies and productive activities. The scope and efficiency of space activities can - and should - become a vector for development. And, given its fundamental nature for the operation of various public and private sectors of the country, we are a critical national infrastructure.

With this understanding, this vision and this responsibility, the Brazilian space sector has focused on the paths and projects pursued over the last ten years, under the guidance of the National Program for Space Activities (PNAE), 2012-2021 edition. Taking into consideration the profound and dynamic changes that have occurred in the global space market and the status of our results, the new version of the PNAE, valid for 2022-2031, has been elaborated by many parties and with the unparalleled capabilities of our valiant space working minds. It will give us the basis and directions for the continuity and growth of space activities in the country.

We have an internal market, physical and immaterial competencies. We have creative people and the will to grow, with real possibilities of inserting ourselves in the global value chains, whether in science and technology or in the exploration of the most diverse services.

The challenge is set. Proud of the privilege of having achieved this multi-author product, the Brazilian Space Agency thanks the confidence of all professionals involved. To the Brazilian society, our respect for their support and resources. Yes, we can and will do much more!

We do have space here!


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National Program

for Space Activities

PNAE 2022-2031:

The Brazilian Space Program

The Brazilian Space Program – PEB must focus on meeting the needs of society, with the highest possible levels of efficacy, effectiveness and efficiency. This is the purpose for which the PNAE 2022-2031 is established as an instrument of the Brazilian State.

This edition of the PNAE is established as an important chapter of the national infrastructure, since the products - goods, applications and services - that derive from space systems enable almost all economic activities in the country. Its impacts reach communication, logistics, urban mobility, civil defense, mining, environment, health, education, and science sectors, among others. Moreover, they are fundamental for precision farming, the consolidation of smart cities, the use of renewable energy, and the transition to a more digital and inclusive society. They underpin modern and future human activity in all its dimensions.

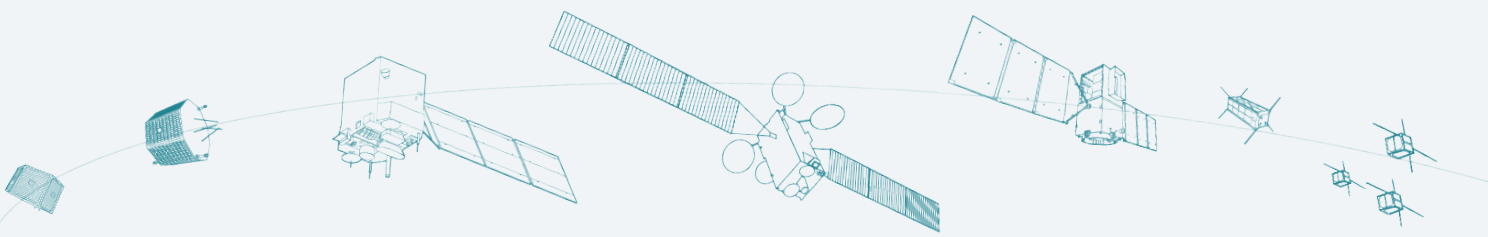
Therefore, the disciplines of Science, Technology and Innovation - CT&I should increasingly combine with those of Infrastructure. This set must also broaden its interfaces with National Defense, in order to better exploit the multiple nature of space systems in this sector. In this manner, the Brazilian Space Program will be able to overflow its benefits to all public policies in progress in the country. The relevance of this edition of the PNAE is rooted in the awakening to these interactions and is shaped by the awareness of this role.

Despite the fact that the space theme cuts across several different public policies, independent undertakings in the Brazilian space sector must be designed in such a way as to enable synergies and enchainments. In this way, the PNAE 2022-2031 is organized in the sense of bringing together, according to common logic, the different national initiatives in the space area. It presents the Sectorial Programs as an instrument for the Brazilian space program to expand its scope and deliver value to society in a more coordinated, efficient, effective and efficient manner.

Each country presents its own peculiarities. It is these peculiarities that dictate the direction each space program takes. In Brazil, autonomy is still being pursued in the space sector. We seek coherence among independent programs that should be complementary. Greater dynamism is being sought in Brazil's space market. It seeks to supply space goods and services that meet the population's needs, with its own technology that is appropriate to Brazilian geographic and social contexts. In order to consolidate its support for the country's space activities, society must be aware of the importance of the whole process.

The challenges ahead are enormous. The Brazilian Space Program must be a State program and, therefore, it must be conducted as such. In order to do so, it is necessary to understand the evolution of public administration and of space activities themselves. It is necessary that the PNAE understands this reality and reflects it in pragmatic solutions and implementations that adapt to and reinforce themselves with the conditions and yearnings of the Brazilian State. In conjunction with this effort, the State, by internalizing the importance of the Brazilian Space Program for society, must support it with the necessary resources for its full development.

The PNDAE assigns to AEB the responsibility of proposing the PNAE and thus organizing space activities in Brazil. This arrangement places it as the main institutional reference of the national space sector. In this sense, the transition to the new reality of the Brazilian Space Sector demands the AEB's leadership. The Brazilian Space Agency structures itself for this purpose.



Vision of Future:

To be the leading South American country in the space market

The international space economy grows every year. In the wake of this evolution, it generates and distributes wealth, leverages the technological and socio-economic development of the nations that invest in it, and also breaks paradigms. It is the reflection of an inevitable trend. Meanwhile, Brazil is building a society that increasingly consumes space goods and services, in such a way as to strengthen, in its territory, the growing dependence on this economic and technological aspect.

If the Brazilian Space Sector does not have the minimum conditions to meet the needs of the country, it means fostering other nations space programs and, consequently, giving up national potential. In this scenario, it is essential that Brazil, as a whole in its space sector, places itself as a supplier of the space products that its society demands. As a result, besides promoting the expansion of its autonomy and reinforcing its sovereignty, the country may become a relevant player in the international economic scenario.

The strategic management of the space sector in Brazil emerges from this context. Additionally, it must consider the different forces influencing it, in order to broaden the perception of the opportunities on which it should focus. Thus, it is necessary to reinforce the understanding that the Brazilian Space Sector must act in a way that continuously supports national public policies. It is from this interaction that the results of the country's space activities arise. By providing innovative solutions to national challenges, the potential and the transversal positive impacts of a strong space sector for Brazil are better materialized. To guarantee an improved governance to the Brazilian Space Sector that makes this process viable is an essential condition to turn its activities into results for society.

Five critical factors for the strengthening of the space sector in Brazil are established:

- *articulation and convergence among the various stakeholders - government, industry, academia, and society*
- *raising public awareness around the subject of space*
- *creation of investment opportunities in the space sector*
- *prioritization of technologies that can provide innovation and be turned into products in the short and medium term*
- *harmonization of civilian and national defense initiatives in the space sector*

Addressing these factors leads to a flexible and dynamic planning that can include new technological trends in a timely manner and in alignment with society's needs. To this end, it is essential to constantly monitor the results of this planning, as well as the evolution of society's urges and the technological possibilities for meeting them. This composition results in the convenience of establishing a continuous and formal process of evaluation and updating of the planning of space activities in the country.

The State will not give up on acting in strategic niches. However, it should continuously compose its position as the sponsor of projects and initiatives, with the role of catalyzer of competitiveness and sustainability required by the Brazilian Space Sector. Thus, it will promote the conditions for the national productive sector to participate competitively in local and international markets in order to, jointly with the entire Brazilian Space Sector, meet the needs of society.

Strategic Space Goals

In order to develop in a continuous and stable way, the Brazilian Space Sector must be guided by clear State strategic goals. Only then can one expect its initiatives to overcome the limits of mandates and find continuity even in situations of political changes.

The establishment of the goals and guidelines of the Brazilian space policy takes place in the context of the PNDAE. It is the PNDAE that directs the State's actions to promote space activities that are in the national interest and for the benefit of society. In this way, based on the goals and guidelines of the PNDAE, in compliance with the other public policies being executed in the country and considering the challenges Brazil must face on its way to full development, we establish the Strategic Space Goals - OEEs.

There are seven OEEs, which seek to direct the Brazilian Space Sector in a way that enables the country to meet the following agendas: increase the presence of the Brazilian Space Program in the State's set of priorities; foster the entrepreneurship and competitiveness of the national production sector; scientific and technological development that is guided by the country's needs regarding space goods and services; and the continuous search for sovereignty and the increase of Brazil's autonomy in space activities.

OEE.1 – Establish, develop and maintain a Brazilian State Space Program, with guaranteed short, medium and long-term resources:

- **AXIS of ACTION 1.1:** Ensure a long-term planning that guides the Brazilian Space Sector's actions
- according to the Strategic Space Goals.
- **AXIS of ACTION 1.2:** Maintain a procedure for the identification and selection of space projects and missions compatible with the planning and reality of the Brazilian Space Sector.
- **AXIS of ACTION 1.3:** Sustain the Brazilian Space Program at a high level of institutional sponsorship in the country.
- **AXIS of ACTION 1.4:** Guarantee the level of investment necessary for the development and maintenance of the Brazilian Space Program.
- **AXIS of ACTION 1.5:** Maintain a legal and normative framework that enables the full and coordinated execution of space activities in the country.

OEE.2 – Promote effective service to the overall needs of society and the State:

- **AXIS of ACTION 2.1:** Continuously identify the needs of society and of the State that can be met through spatial solutions.
- **AXIS of ACTION 2.2:** Promote space missions that meet the needs of society and the State.
- **AXIS of ACTION 2.3:** Promote Sectorial Programs that complement the PNAE.
- **AXIS of ACTION 2.4:** Mobilizing the Brazilian Space Sector in convergence with the PNAE.
- **AXIS of ACTION 2.5:** Enhance positive externalities from space activities.

OEE.3 – Develop the national industry in a way to consolidate it competitively in the space goods and services markets and to generate socio-economic benefits for the country:

- **AXIS of ACTION 3.1:** Capacitate the national industry technologically.
- **AXIS of ACTION 3.2:** Promote mechanisms for quality management in the national industry.
- **AXIS of ACTION 3.3:** Foster industry according to its ability to sustainably exploit economic potentials.
- **AXIS of ACTION 3.4:** Promote the competitiveness of the national industry in international markets.
- **AXIS of ACTION 3.5:** Articulate initiatives that mobilize the national productive chain.
- **AXIS of ACTION 3.6:** Promote specific incentives for the space market.

OEE.4 – Stimulate business and entrepreneurship in the national private sector for the development and use of space goods and services:

- **AXIS of ACTION 4.1:** Boost the participation of private agents in the Brazilian Space Sector.
- **AXIS of ACTION 4.2:** Promote economic activities and new markets that use space applications.
- **AXIS of ACTION 4.3:** Enable private exploitation of space vehicle launches from Brazilian territory.
- **AXIS of ACTION 4.4:** Promote national socio-economic development from harmonious interactions between space activities and regional vocations.
- **AXIS of ACTION 4.5:** Associate technological development with business models that explore their economic viability.

OEE.5 – Foster the development of scientific, technological and innovation competencies for the space sector:

- **AXIS of ACTION 5.1:** Maintain a management system of strategic technologies for the Brazilian Space Sector.
- **AXIS of ACTION 5.2:** Explore synergies with international partnerships to promote the national technological domain.
- **AXIS of ACTION 5.3:** Attract, develop and retain qualified human capital for the Brazilian Space Sector.
- **AXIS of ACTION 5.4:** Promote partnerships with universities, research institutes and industry for the development of space projects and missions.
- **AXIS of ACTION 5.5:** Foster innovation in the Brazilian Space Sector.

OEE.6 – Ensure nondependent development and control of national space systems:

- **AXIS of ACTION 6.1:** Act in the international context to raise the level of autonomy of the Brazilian Space Sector.
- **AXIS of ACTION 6.2:** Promote scientific and technological development that provides nondependency for the conduct of national space activities.
- **AXIS of ACTION 6.3:** Build the country's capacity in the basic segments of space activities: applications, satellites, launchers and ground infrastructure.

OEE.7 – Actively consolidate, in all sectors of society, the understanding of the direct and indirect, existing and potential benefits of the space sector for Brazil:

- **AXIS of ACTION 7.1:** Raise society's awareness about the role and transversalities of space products.
- **AXIS of ACTION 7.2:** Raise awareness of the importance of the Brazilian Space Program for the fulfillment of the country's public policies.
- **AXIS of ACTION 7.3:** Promote the integration of the communication activities among the institutions involved in the management of the Brazilian Space Program.
- **AXIS of ACTION 7.4:** Maintain a system for information dissemination, evaluations and diagnostics on the Brazilian Space Sector.

Brazilian Space Program Priorities

This section presents indicators for the identification of the Brazilian Space Program's priorities to be observed in its main function of serving society. Prioritization factors and key sectors are pointed out.

The prioritization factors indicate the main aspects that space activities should impact. By meeting them positively, the initiatives in the Brazilian Space Sector tend to add greater value to their results, since they strengthen the country's capabilities to face its challenges as a nation. The key sectors compile these factors with the reality that this PNAE found at the time of its edition, in order to direct the focus of the Brazilian Space Program to certain segments. By addressing them, separately or together, the initiative ensures its effectiveness.

These notes, however, do not represent a strict guideline. The needs of society, as well as the relationship of space technologies, prioritization factors and key sectors with the Brazilian reality, evolve over time. Therefore, constantly monitoring them and feedback on the decision-making mechanisms are fundamental actions so that the Brazilian Space Program can always impact society in the most positive way possible.

Prioritization factors

Six factors are listed for the identification of economic sectors and public policies that the Brazilian Space Program should observe when defining its priorities. These are evaluation aspects related to the daily life of Brazilian society. The effectiveness of a Brazilian Space Sector initiative is directly linked to the impact it has on the set of these perspectives.

Certainly, there are relations of dependence and even exclusion among the factors, depending on the initiative being proposed. Thus, there is no rule that can, for example, based on these criteria, provide an objective prioritization order among different initiatives. The observance of these criteria must be synchronized with the moment of decision-making. However, it is certain that by observing these factors, either isolated or as a whole, the capacity of the Brazilian Space Sector to show effectiveness, efficiency and efficacy is strengthened. The prioritization of investments must consider these issues.

Gross Domestic Product

*The **Gross Domestic Product** - GDP of each sector represents its importance in the country's economic growth process. Therefore, considering it as a guide in the prioritization process is fundamental.*

Transversality

*In addition to the direct impact on the economy, an important factor for prioritizing PNAE projects is the **ability to affect other public policies and other economic sectors**. This concept is embodied in the potential of a given sector to contribute to the goals of other areas of state activity.*

General benefits to society

*The **general benefits** that a given economic sector is capable of delivering to society reflect how much, within its actions, this sector contributes to the overall well-being of the population. Reinforcing the space agenda in niches that deliver services directly to citizens contributes to the main function of the Brazilian Space Program.*

Dependency on space services

*The greater the dependency of a certain economic sector or society on space products, **the greater the responsibility of the Brazilian Space Program towards the portion of society that relies on this sector**. Thus, meeting this need presents itself as a mechanism for amplifying the effectiveness of the program.*

National development

*The **national development** agenda is directly related to the country's economic issues. However, it only makes sense when it reflects positively on the quality of life and the general welfare of the population. In the same way that space activities must focus on the needs of society, the national development agenda must have society as its focus. The Brazilian Space Sector must be attentive to collaborate with this spectrum of action.*

Global scenario

***Brazil plays a prominent role in various international agendas**. Brazil's territorial dimensions, alone, already impose responsibilities. Added to this are the magnitude of the country's population and its natural wealth, both in its continental territory and its Amazônia Azul (Brazilian maritime territory). This protagonism translates into the need to dedicate special attention to the sectors and national public policies that are related to these themes.*

Key sectors

For this PNAE period, we highlight eight sectors that represent opportunities for the establishment, nationally, of space projects and missions capable of composing a space infrastructure that broadly meets national priorities:

- *Infrastructure*
- *Agriculture and Livestock Farming*
- *Mining*
- *Environment*
- *Education*
- *Civil Defense*
- *Public Safety*
- *National Defense*

Sectorial Programs

The Sectorial Programs comprise space initiatives, projects or missions that aim space activities as a way to meet the specific needs of a given area of Brazilian society, in consonance with the set of national public policies and with the Brazilian Space Sector. Any sector of society, represented by a public or private institution, can propose a Sectorial Program to the Brazilian Space Agency. Upon receiving AEB's approval, the Sectorial Program integrates itself into the PNAE and expands its interfaces with the space activities that take place in the country.

In order to receive approval by the AEB and be linked to the PNAE, a Sectorial Program must be structured around the following minimum content:

- ***General Characteristics***
- ***Relevancy Analysis***
- ***Technical feasibility assessment***
- ***Financial viability assessment***
- ***Synergy with other initiatives***

After approval by the AEB, the Sectorial Program is formally included in the PNAE and in the list of initiatives of the Brazilian Space Program.

International cooperation

In cooperation projects in the space sector, elements of development and technological transfer are desirable to contribute to increasing the degree of maturity of critical technologies needed by Brazil. Promoting national industry in the logistics chain of the international market is fundamental. Such contributions should endorse research and development in Brazilian research institutes, universities and industries, as well as stimulate the space market in the country.

International cooperation on space initiatives must represent:

- funding alternative
- risk and cost sharing
- openness to new markets
- opportunity for technology transfer and acquisition
- strengthening strategic partnerships of a geopolitical nature

The purpose of international cooperation must be aligned with the goals of Brazilian foreign policy, with the planning instruments of the Brazilian Space Sector and with the legal framework in effect in the country. The cooperation actions must be justified and plausible, besides presenting evident benefits for the country.

Scenarios for 2022-2031

The PNAE 2022-2031 is based on forecasted scenarios to guide its planning for the decade. It proposes five alternatives, which are organized according to decennial investment expectations: *Scenario 0, Scenario 50, Scenario 100, Scenario 200* and *Scenario 1000*.

The budget availability that is set for the decade defines the feasibility of each scenario. Since the country's budget planning covers a four-year period, this information is not fully available in advance. Thus, we start from the scenario in progress in the year of publication of the PNAE 2022-2031, which is related to the Multiannual Plan - PPA for the period 2020 to 2023, and present propositions toward better scenarios that inspire the construction of future PPAs consistent with the fulfillment of this PNAE **Vision of Future**. The evolution of this construction determines the scenario that the PNAE 2022-2031 will fulfill throughout its term.

Over the course of the program, depending on the investment level variation, the scenarios should be adjusted. Periodic revisions of the PNAE should reflect and update these achievements in line with the country's budget cycle.

The initiatives of PNAE 2022-2031 are organized according to four **investment segments:**

Space Missions

They are undertakings that comprise the design, feasibility and availability of spacecrafts and ground infrastructure that jointly and integrally meet the goals of the Brazilian Space Sector or the delivery of a certain space application of the Country's interest. AEB adopts its execution and commits to its delivery after complying with a selection and adoption procedure for space missions- the ProSAME.

Access to Space

It includes the development of launch vehicles, their systems and subsystems. Enables the country to autonomously access spacecraft from the national territory.

Capacity Building

It comprises initiatives for human resources training and technological development to meet the needs of the PNAE, in order to increase the technical, technological and industrial capabilities of the Brazilian Space Sector.

Infrastructure and Applications

They are infrastructures, facilities and ground equipment; logistical resources, and also tools, applications and computational systems. They make it possible to conduct Brazilian space activities and deliver services to society and to the State through space systems.

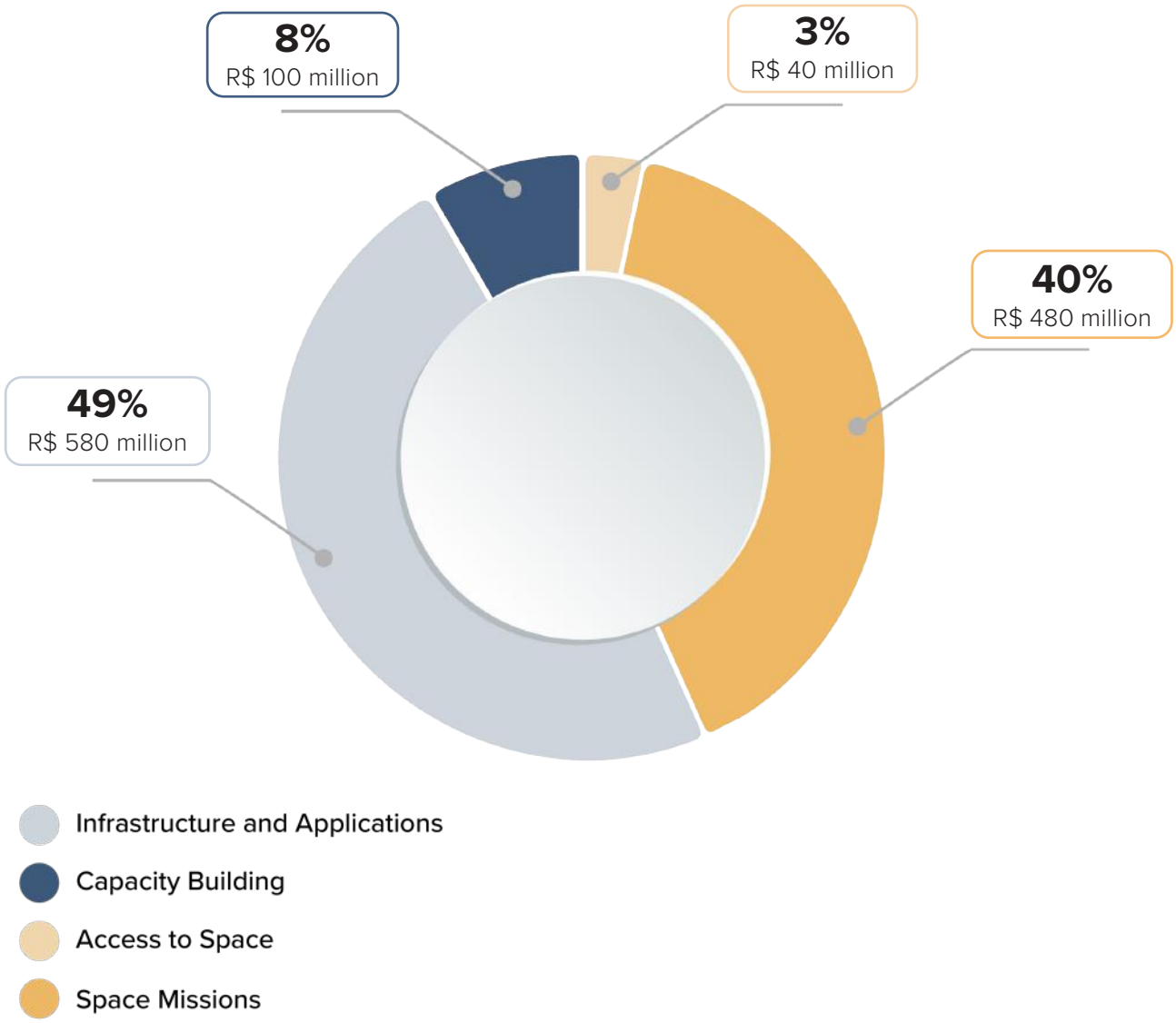
The following are the five scenarios for the PNAE 2022-2031, with the definition of the proportions corresponding to each investment segment.

Scenario 0

This scenario represents the maintenance, for the entire duration of the PNAE 2022-2031, of the PNAE's investment capacity corresponding to the year 2022. Thus, we work with an investment level of R$ 1.2 billion for the ten-year period 2022-2031.

The space infrastructure is developed in such a way as to make the Alcântara Space Center - CEA possible. International companies execute space launches from their national territory. Space missions with small satellites meet the needs of society and the State, focusing on environmental data collection and remote sensing. The capability to autonomously access space was achieved with the flight of the VLM-1 Microsatellite Launching Vehicle, with no further developments. The capacity building is aimed at providing the capabilities that the Brazilian Space Sector needs to make viable investments in this scenario.

The investments are distributed along the different strands as illustrated in the figure *Scenario 0*. Each year, the LOAs must allocate the resources according to the needs of each initiative.



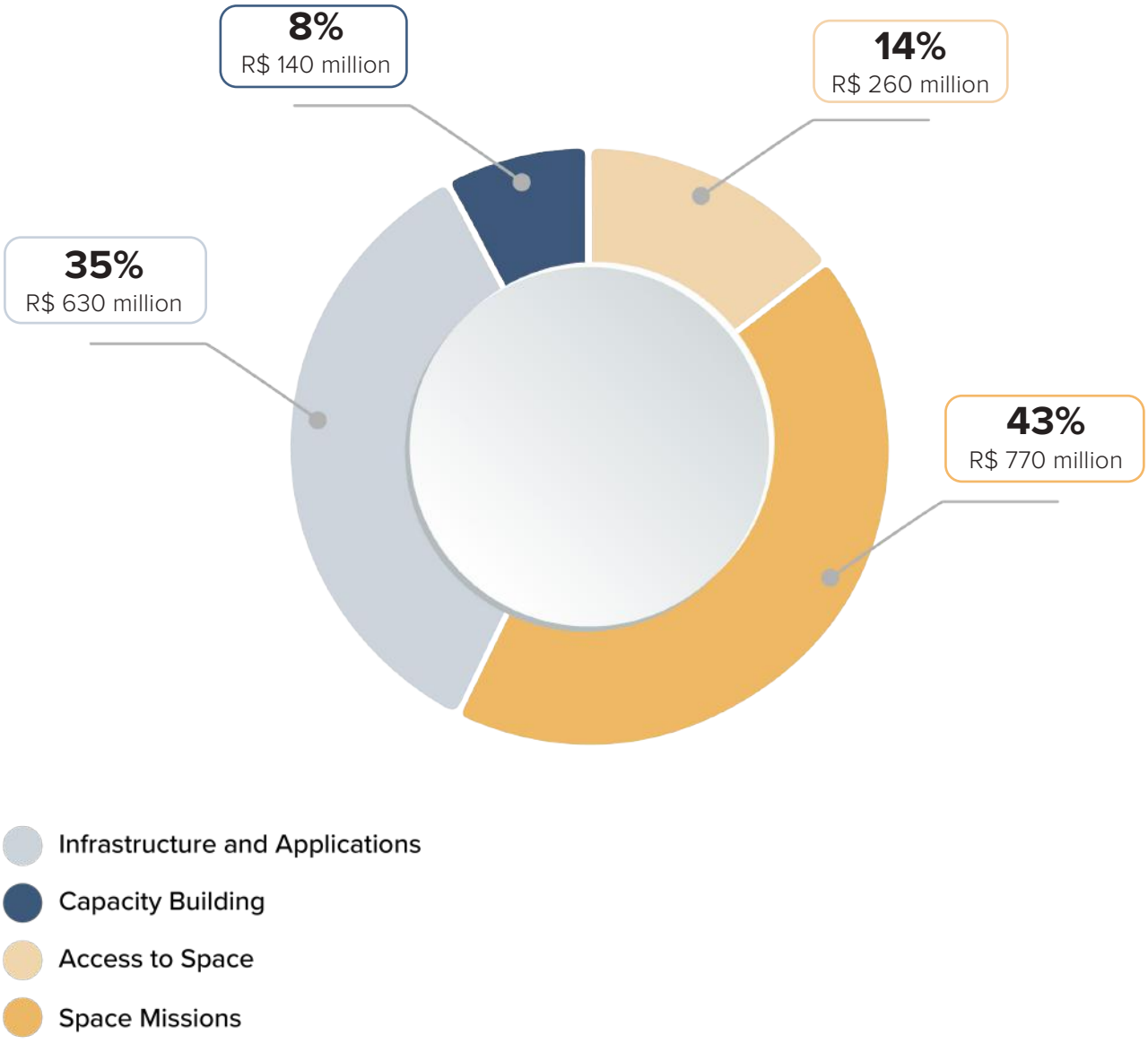
Scenario 0

Scenario 50

In *Scenario 50*, there is an increase in the 10-year investment capacity of the PNAE to a level 50% higher than in *Scenario 0*. As a result, it reaches a potential investment of about R$1.8 billion over the decade.

In a complementary manner to what *Scenario 0* leads to, space missions are expanded, with a greater number of proposals likely to be executed. Access to space is consolidated and continues its development chain with a national vehicle to launch minisatellites. The national space infrastructures adapt to this need, just as the actions for the capacity building.

The figure *Scenario 50* presents the distribution of investments for *Scenario 50*.



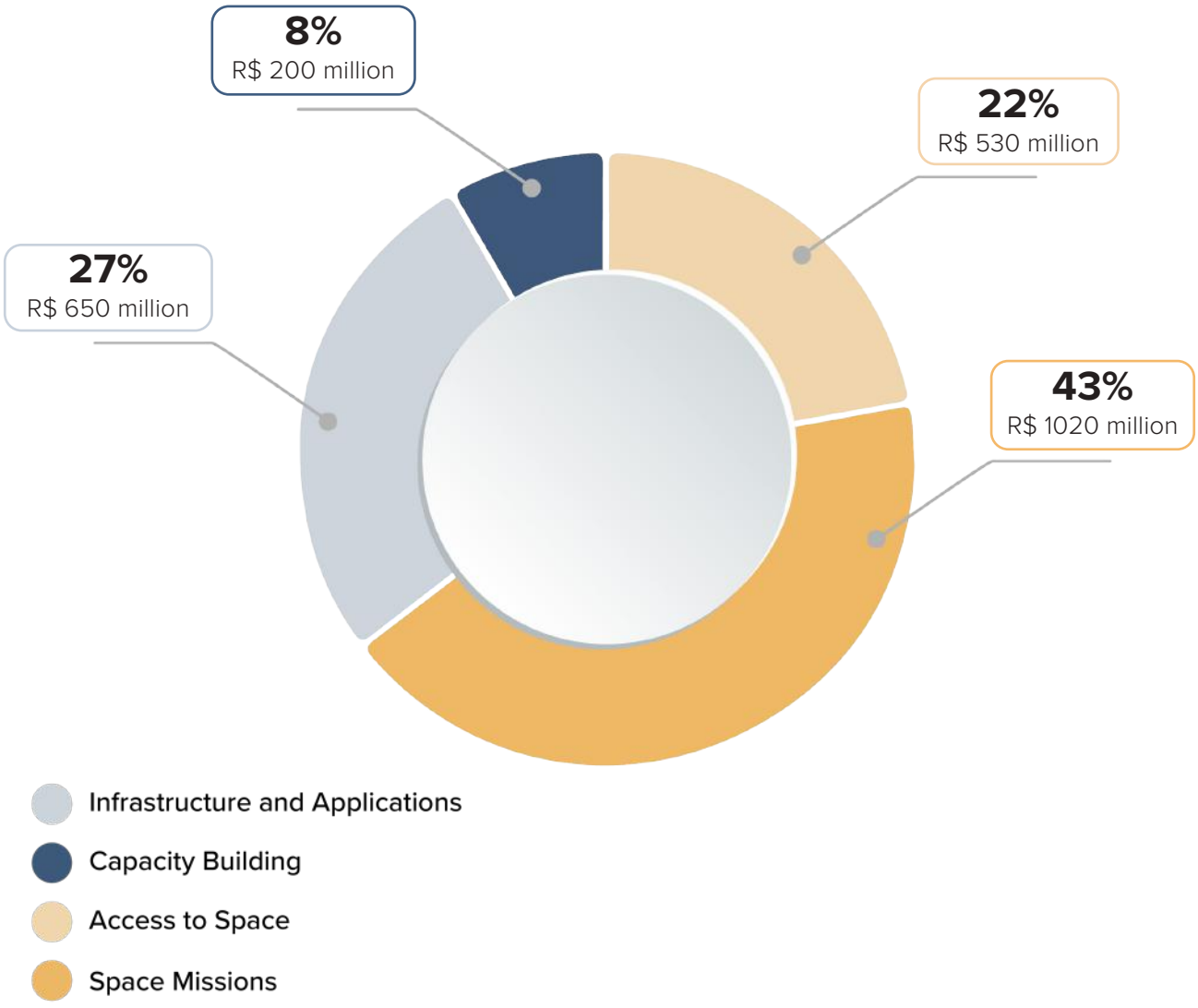
Scenario 50

Scenario 100

In this scenario, the investment capacity of the PNAE is 100% higher compared to *Scenario 0*. Thus, an investment potential of about R$ 2.4 billion is expected over the decade.

Complementary to *Scenario 50*, the capability to provide more complex space missions, which include remote sensing and synthetic aperture radar, is achieved. Access to space is consolidated and continues its development chain with a competitive minisatellite launch vehicle. The national space infrastructure adapts to this need, as do the capacity building capabilities.

The figure *Scenario 100* presents the distribution of investments for *Scenario 100*.



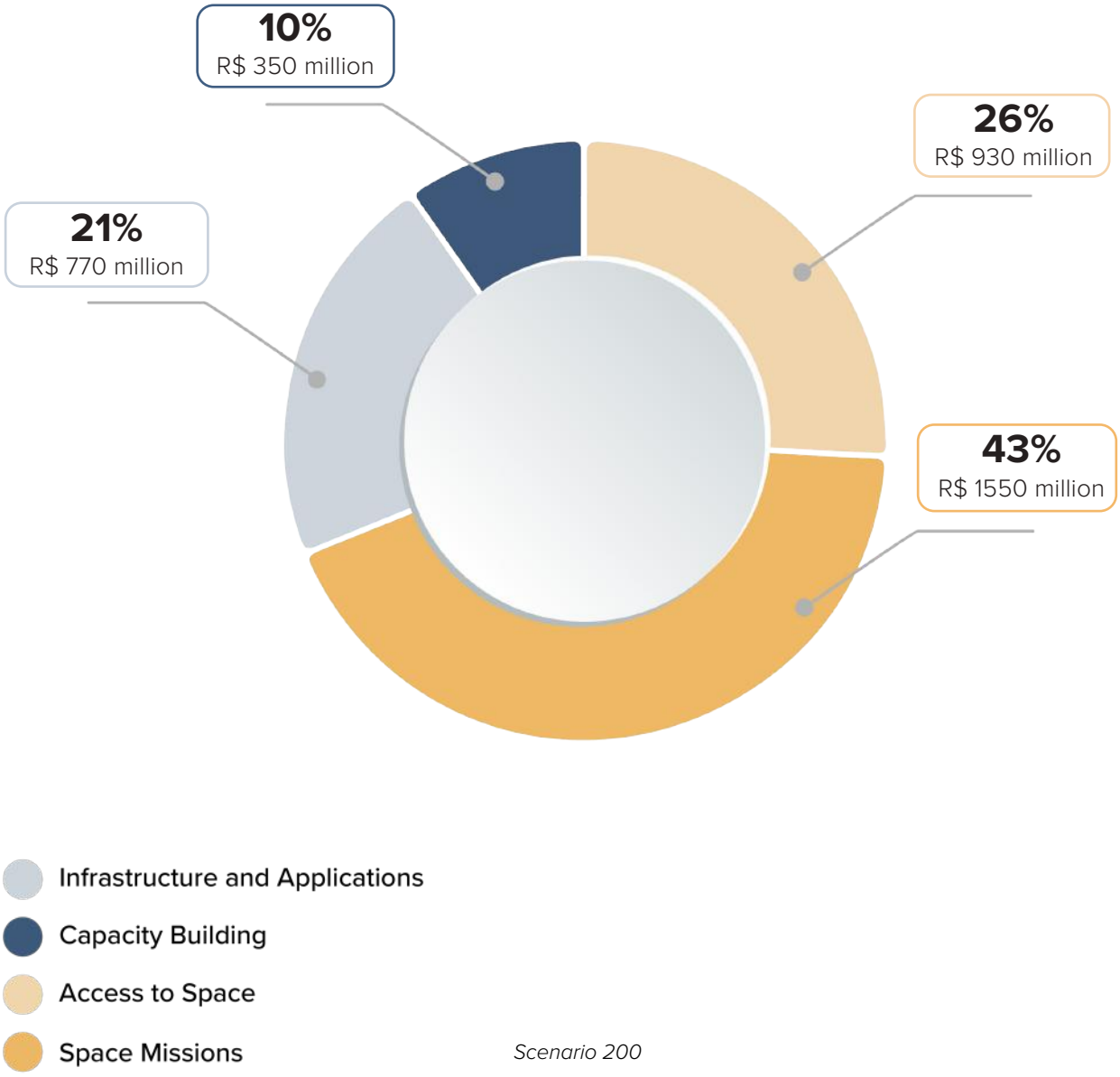
Scenario 100

Scenario 200

In this scenario, the investment capacity of the PNAE is expanded to the necessary level to meet the projects, space missions and initiatives that the planning instruments of the Brazilian Space Sector pointed out in 2021. It is expected, therefore, an investment potential of about R$ 3.6 billion over the decade.

In addition to the investments that relate to *Scenario 100*, the country expands its capacity for complex space missions, with the inclusion of sub-meter remote sensing satellites among deliveries. Access to space continues its development chain, with a competitive vehicle to launch minisatellites into polar orbits. National space infrastructure adapts to this need, as do capacity building capabilities.

The figure *Scenario 200* presents the distribution of investments for *Scenario 200.*



Scenario 200

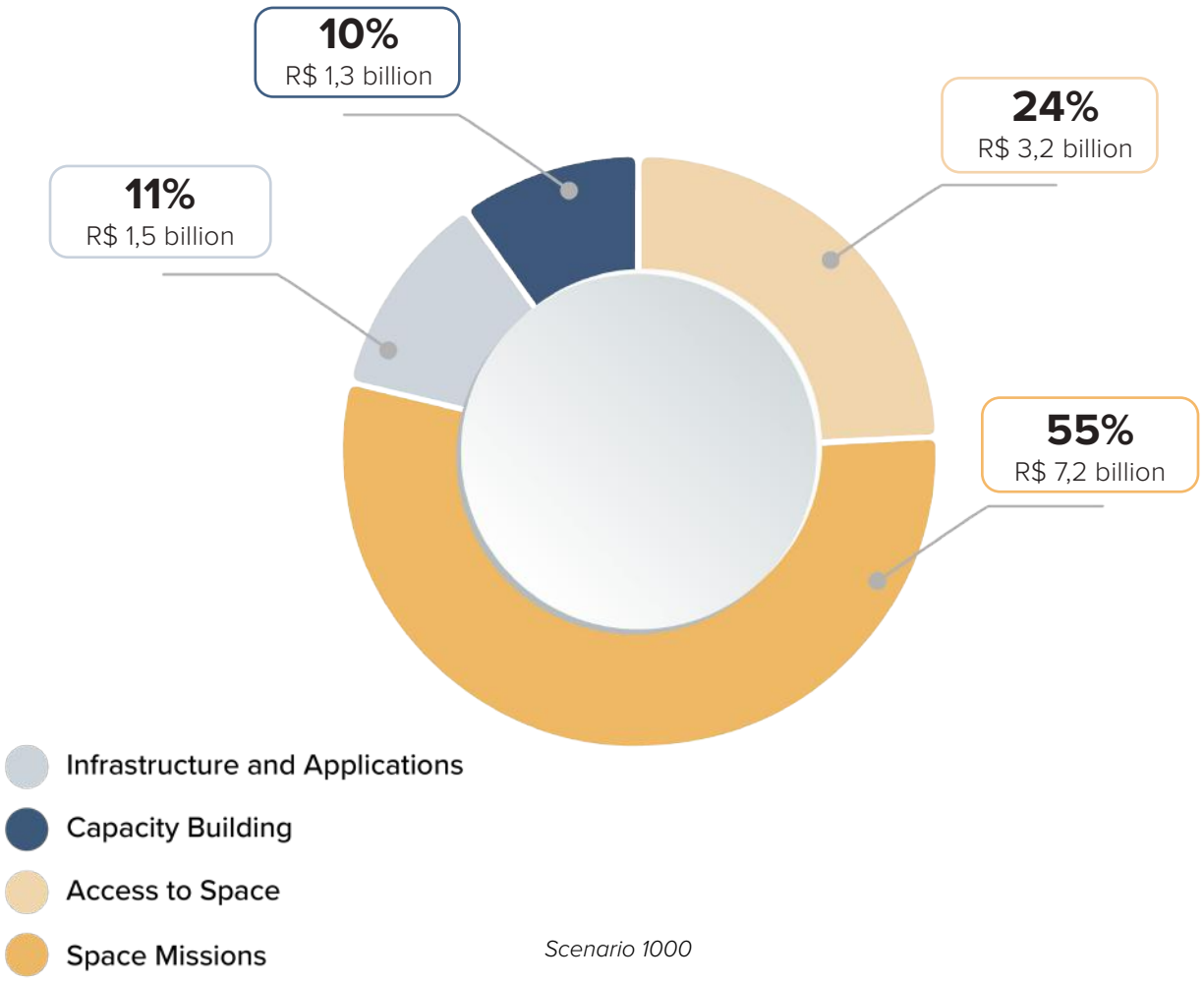
Scenario 1000

In this scenario, the investment capacity of the PNAE converges to a level 11 times higher than the level of *Scenario 0*. Thus, an investment potential of about R$ 13.2 billion is expected throughout the decade. Consequently, Brazil achieves the Vision of Future of the PNAE 2022-2031, which is ***"to be the leading South American country in the space market".***

The *Scenario 1000*, in addition to the results that relate to *Scenario 200*, contemplates additional deliverables in all investment strands. As a consequence, the Brazilian Space Sector consolidates itself as an inducer of national development, in order to enable sustainable businesses, with a protagonist space market that generates jobs, income and tax collection for the country. In this process, international partnerships catalyze the construction, in a coordinated way, of the accesses Brazil needs to consolidate itself as the definitive leader of the space market in South America and to attract foreign investment to the country.

Space missions are expanding with the development of large satellites for low orbit and geostationary satellites. Access to space is complemented by the increased use of liquid propulsion, which provides recurrent launches of national launch vehicles for low orbit. The country's infrastructure contemplates the needs presented by national launch vehicles. In addition, local capabilities for production, integration and testing of geostationary satellites are being completed. The investments in capacity building meet the country's needs for human and technological resources that will allow it to maximize the benefits of the PNAE investments.

The figure *Scenario 1000* presents the distribution of investments for *Scenario 1000.*



Scenario 1000

Execution
Portfolio

The Execution Portfolio comprises ongoing projects in the AEB's budgetary context. They represent investments that are part of space initiatives and missions that expand the country's technological and space capacity.

In this edition of the PNAE, the projects in the Execution Portfolio include three categories: *Space Missions in Operation, Nanosatellite Missions,* and *Access to Space. Space Missions in Operation* represent the continuity of investments that the 2012-2021 PNAE contemplated. The *Nanosatellite Missions* present new initiatives in the context of national space infrastructure. *Access to Space* commits to the delivery of VLM-1 and its development chain.

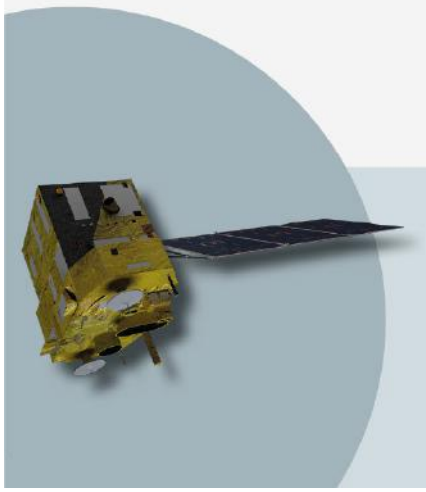
The following are the projects in the Execution Portfolio at the time of the PNAE 2022-2031. During this period, it will evolve to include other space missions, through ProSAME, as well as other Space Access projects.

Space Missions in Operation

The *Space Missions in Operation* include the maintenance of space missions that already have satellites in orbit and that require funding for operation and applications. They fit, therefore, in the investment segment of Infrastructure and Applications.

CBERS-4

CBERS-4 is an Earth observation satellite resulting from an international partnership with Chinese institutions that went into operation in 2017. Its name stands for *China-Brazil Earth Resources Satellite*. It carries on board two Brazilian cameras - MUX and WFI - and two Chinese cameras - PAN and IRS. The MUX camera has a spatial resolution of 20 meters, 26-day revisit and four bands in the visible and near-infrared spectra, producing high quality RGB color images. The wide-field 900 km WFI camera has a spatial resolution of 63 meters, RGB color imaging, and 5-day revisit. The Chinese PAN camera has 10-meter RGB resolution and 5-meter panchromatic resolution. The IRS camera has bands in the mid and thermal- infrared.



Payload: Remote sensing and environmental data collection
Operation: INPE
Operation deadline: december 2022
OEEs attainment: OEE2, OEE3, OEE5 and OEE6

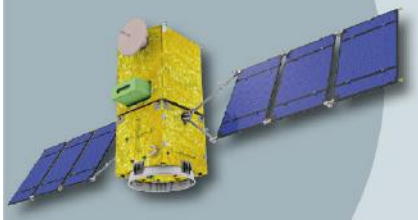
CBERS 04A

CBERS 04A is an Earth observation satellite resulting from an international partnership with Chinese institutions. It started operating in 2020 and it flies in heliosynchronous orbit, at an altitude of 628.4 km. It has three different optical sensors. The Brazilian MUX camera has a spatial resolution of 16 meters and a revisit time of 31 days. The WFI camera, also Brazilian, has a spatial resolution of 55 meters and a revisit time of 5 days. The Chinese WPM camera has a resolution of 2 meters in panchromatic mode and 8 meters in RGB. Thus, *CBERS 04A* meets the demands for medium resolution images and also a relevant portion of the national demands for high resolution.

Payload: Remote sensing and environmental data collection
Operation: INPE
Operation deadline: december 2023
OEEs attainment: OEE2, OEE3, OEE5 and OEE6

Amazonia 1

Amazonia 1 is the first Brazilian Earth observation satellite with a completely national project and system engineering. It started operating in 2021 and qualified in orbit the *Multimission Platform* - PMM. It is a medium size satellite operating in polar orbit and provides images of the Earth through a wide-view optical viewer, with three frequency bands in the visible spectrum and a *Near Infrared* (NIR) band. It can observe a range of approximately 850 km, with 64 meters of space resolution.



Payload: remote sensing
Operation: INPE
Operation deadline: december 2025
OEEs attainment: OEE2, OEE3, OEE5 and OEE6

Nanosatellites Missions

Several national institutions are developing space missions based on nanosatellites. These are academic and operational initiatives that deliver value to the Brazilian Space Program.

This section explores the initiatives that receive AEB's budget support and are, therefore, in its Execution Portfolio at the time of editing this PNAE 2022-2031.

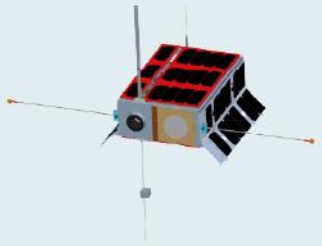
NanoMirax

The NanoMirax is a scientific artifact for X-ray astrophysics investigations. It aims to act in the detection and positioning of cosmic explosions. In addition, it may contribute to gravitational-wave localization.

Platform: Cubesat 2U
Payload: LECX - Cosmic Explosion Tracker
Institution in charge: INPE
AEB's role: budgetary support
Completion: december 2022
OEEs attainment: OEE2 and OEE5

SPORT

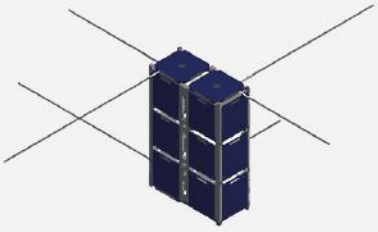
The *Scintillation Prediction Observation Research Task Mission* – SPORT aims to contribute to the understanding of the effects of the ionosphere and the South Atlantic magnetic anomaly on aerospace communications.



Platform: Cubesat 6U
Payload: Scientific instruments for measuring the Ionosphere
Institution in charge: ITA, NASA, INPE and US universities
AEB's role: Institutional support and technical capacity building
Completion: june 2022
OEEs attainment: OEE2 and OEE5

ITASAT2

The *ITASAT2* complements *SPORT* in a space weather mission for ionosphere and geolocation studies.



Platform: 3 cubesats in formation flight
Payload: Scientific Space Weather Monitoring
Institution in charge: ITA, FINEP, Fundação Casimiro Montenegro Fillho and AEB
AEB's role: budgetary support
Completion: december 2025
OEEs attainment: OEE2 and OEE5

GOLDS-UFSC

The *GOLDS-UFSC* is a technological development mission consisting of the launch and operation of a nanosatellite for environmental data collection. It seeks, among its goals, to validate in orbit a standard 2U CubeSat platform being developed by the Federal University of Santa Catarina - UFSC from the FloripaSat nanosatellite flight heritage. Furthermore, it aims at qualifying in space, and in a relevant environment, the *Environmental Data Collector* - EDC payload, under development by INPE's Northeast Space Coordination - COENE/INPE. The EDC is compatible with the Brazilian System for Environmental Data Collection - SBCD. The mission's name results from the junction of the term *Global Open Collecting Data System* - GOLDS - and the acronym UFSC. Its technological legacy will contribute to the development of nanosatellites of the *Catarina Constellation*.

Platform: Cubesat 2U

Payload: Environmental Data Collection

Institution in charge: UFSC and INPE

AEB's role: procurement of components and subsystems, launch and technical follow-up of the mission

Completion: december 2022

OEEs attainment: OEE2, OEE3, OEE5 and OEE6

Catarina Constellation

The Catarina Constellation fits as a Sectorial Program in this PNAE context. It is a set of space systems based on the use of nanosatellites to provide data collection services on environmental, atmospheric and Earth observation. Its systems complement each other through the collaborative sharing of space infrastructures, either of knowledge, data, services and space applications.

It serves, primarily, the national agriculture and civil defense sectors. However, the applications can be extended to othersectors, in order to contribute to the sustainable socio-economic development agenda of the country.

The manufacturing and supply of Catarina Constellation space systems should foster the national space market. Consequently, it should **expand private agents' activities in the Brazilian Space Sector.**

Product: Catarina Constellation Sectorial Program - AEB Ordinance Nº 590/2021 and revisions

Investment Segments: Capacity Building and Infrastructure and Applications

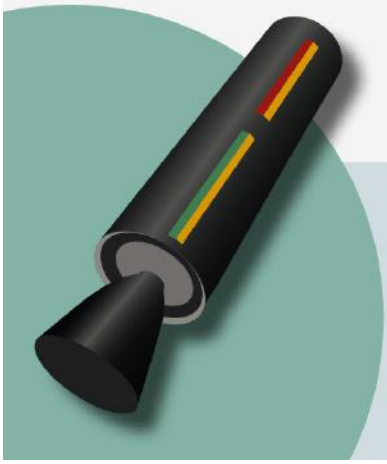
Fleet 1 Completion: december 2023

OEEs attainment: OEE2, OEE3, OEE4, OEE5 and OEE6

Access to Space

Access to space, as an activity, takes place through the structuring of launch centers and the construction of launch vehicles and their component parts. The deliverables of the PNAE 2022-2031 that relate to launch centers are found in the Structuring Initiatives. As far as the launch vehicle development route is concerned, the initiatives under execution in the context of the PNAE 2022-2031 are the following.

S50 Rocket Motor



The *S50* is a solid propellant-based rocket motor. It uses approximately 12 tons of propellant, which qualifies it as the largest rocket motor ever produced in Brazil. Its envelope, with a length of 5.3 meters and a diameter of 1.5 meters, is structured in carbon fiber. As a result, there are benefits in terms of mass and performance. It produces 450 kN of thrust, in a firing time of 82 seconds. It is the main engine for the *VS-50 Suborbital Vehicle*. It will also be part of the first and second stages of the *VLM-1 Microsatellite Launch Vehicle*.

The manufacture of the S50 engine was contracted from the national industry.

Completion: december 2022
Mission: Operação Acre
OEEs attainment: OEE2, OEE3, OEE5 and OEE6

Suborbital Microgravity Platform

The *Suborbital Microgravity Platform - PSM* is a payload transport module for missions in a microgravity environment. It is used in experiments in the scope of AEB's *Microgravity Program*. It will allow Brazil to enter the international market by providing services of this nature. The platform provides all the necessary support for the execution of experiments: structural protection, power, telemetry channels and launch indications, microgravity and service remote control.

Completion: june 2022
Mission: Operação Santa Branca
OEEs attainments: OEE3, OEE5 and OEE6

VS-50 Suborbital Vehicle

The *VS-50* Suborbital Vehicle is a two-stage vehicle capable of providing up to 15 minutes of flight time in a microgravity environment for up to 500 kg of payload. It is the intermediate and structuring vehicle ofthe *VLM-1*. Thus, all systems, subsystems and components that *VS-50* develops, tests and qualifies will be used in the *VLM-1*.

Completion: august 2023
Mission: Operação Santa Maria
OEEs attainment: OEE2, OEE3, OEE5 and OEE6

VLM-1 Microsatellite Launch Vehicle

The *VLM-1 Microsatellite Launch Vehicle* is an orbital vehicle designed to launch microsatellites and payloads with a mass of at least 30 kg into a low earth orbit of 300 km altitude and low inclination. It consists of three solid-propellant stages. Its first two stages are based on *S50* rocket motors. The third stage consists of an *S44* motor, which is responsible for injecting the payload into orbit.

Completion: june 2025
Mission: to be determined
OEEs attainment: OEE2, OEE3, OEE5 and OEE6

Space
Missions

Based on the **Strategic Space Goals** and their unfolding, in compliance with the **Brazilian Space Program Priorities**, it becomes possible to select the space missions that the PNAE 2022-2031 will deliver to society throughout its term.

To achieve this, the PNAE 2021-2031 uses the Procedure for the Selection and Adoption of Space Missions-**ProSAME**, which is structured based on technical and programmatic criteria, around the adoption and execution schedules of missions. These schedules foresee time intervals for the adoption and execution of space missions, according to the investment capacity of the PNAE for the period – **the Mission Slots**.

The investment capacity is related to the **2022-2031 Scenario** in effect. By conjugating the constraints, the most suitable proposal to fill a given Mission Slot is identified, with consequent adoption by AEB. **Scenarios with investment capabilities lower than *Scenario 0* make the adoption of any mission unfeasible**.

The ProSAME approach to selecting PNAE space missions is based on the following goals:

- Formalize calendars that guide the short, medium and long-term planning for the Brazilian Space Sector
- Select space missions in a meticulous way, aiming at the efficient use of public resources and the effectiveness of the Brazilian Space Program
- Enable a space mission bundle that is feasible in the AEB's budget context
- Provide a balanced flow of space missions, so as to avoid scenarios of inactivity or excessive overload
- Ensure adherence of space missions to the planning instruments of the Brazilian Space Sector
- Encourage healthy competition in the Brazilian Space Sector
- Propose increasing scientific and technological challenges to the institutions of the Brazilian Space Sector, with the stimulus of integration among the teams of industries, as well as research and development institutions
- Provide the insertion of Brazil as a relevant agent in the international space activities contextinternacionais



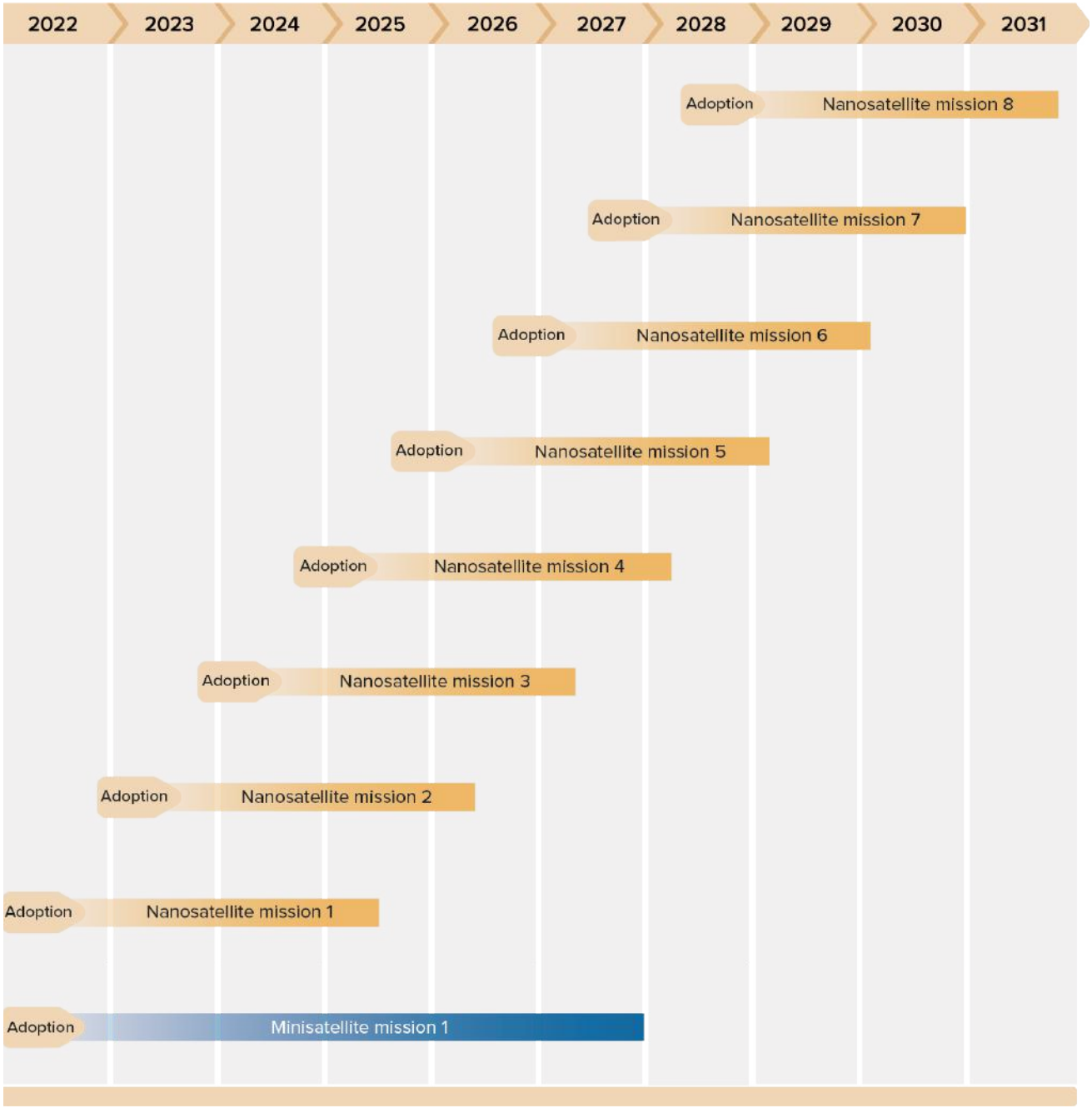


Mission Scenarios

The following are the Mission Slots for the period of the PNAE 2022-2031, according to the **Scenarios for 2022-2031.**

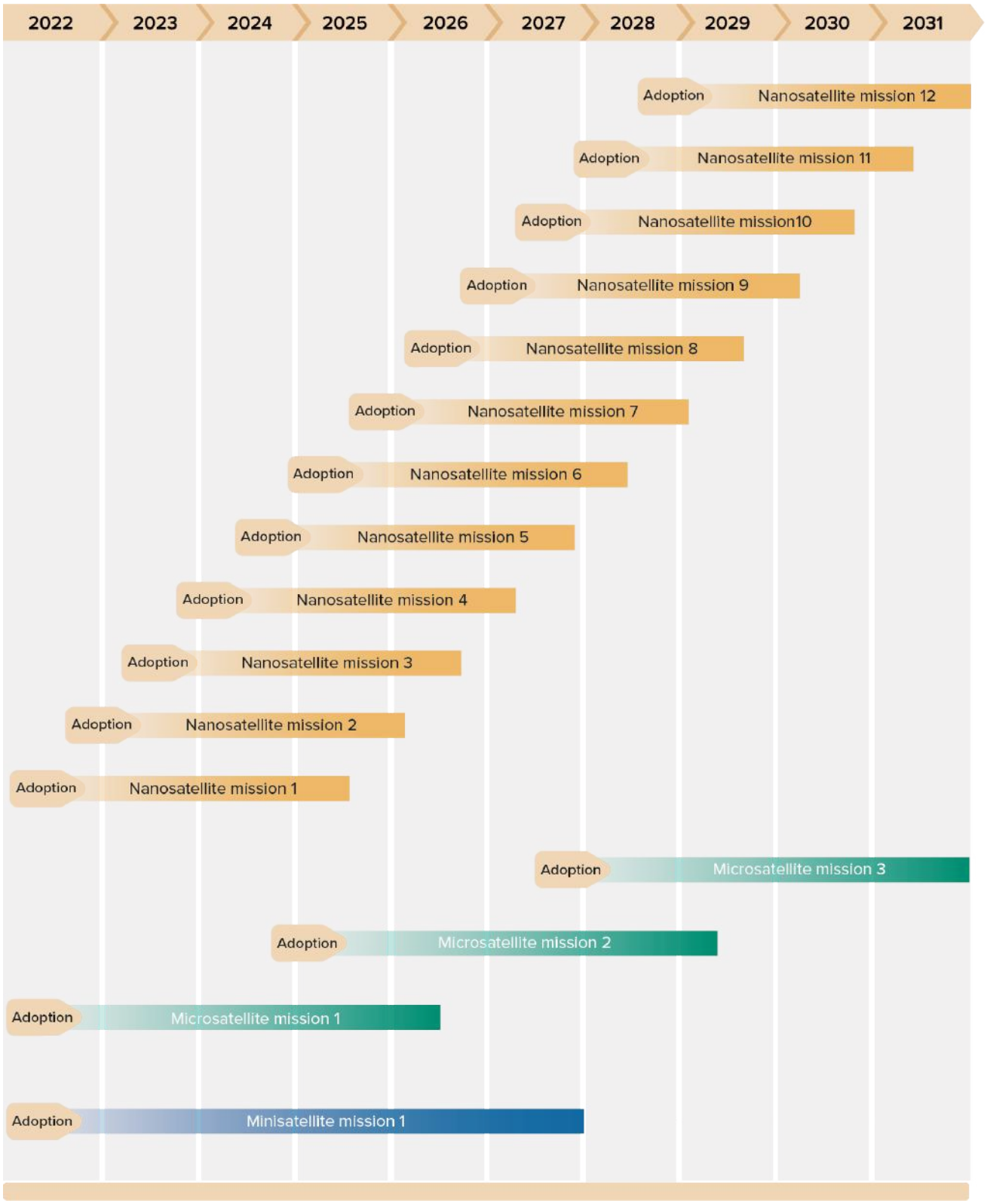
Scenario 0

Investment capacity: 40% of R$ 1.2 billion: R$ 480 million



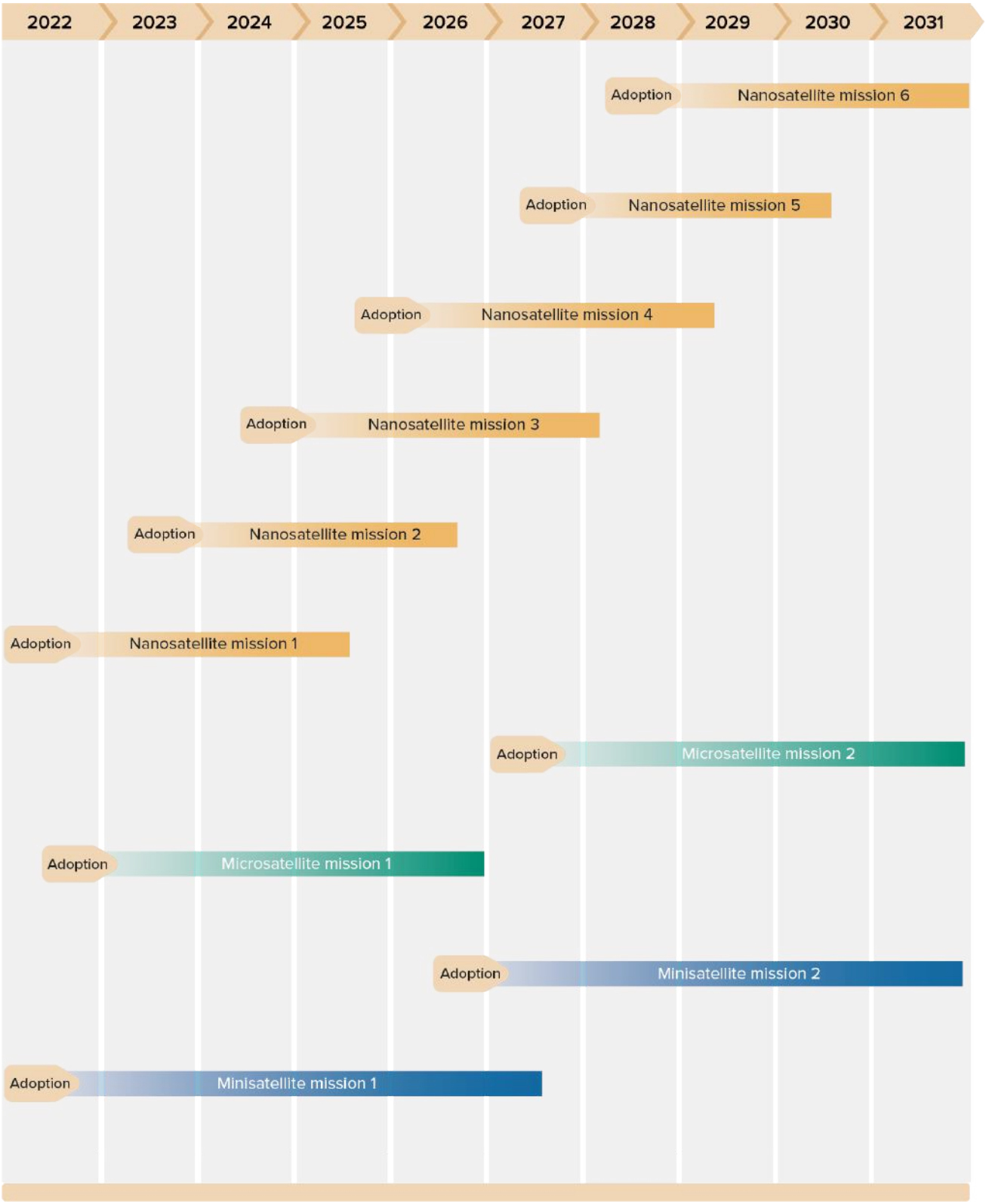
Scenario 50

Investment capacity: 43% of R$ 1.8 billion: R$ 770 million



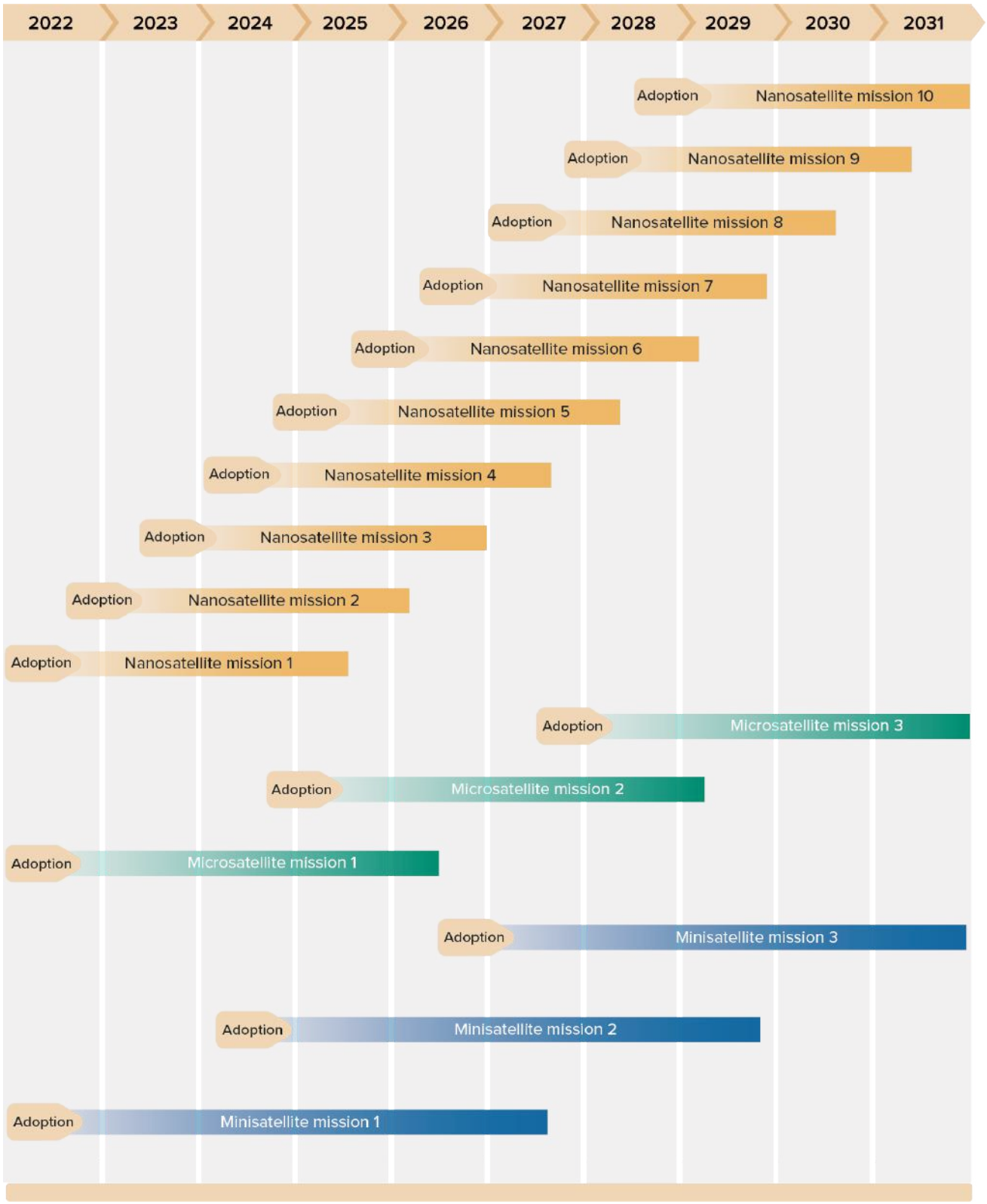
Scenario 100

Investment capacity: 43% of R$2.4 billion: R$1,020 million



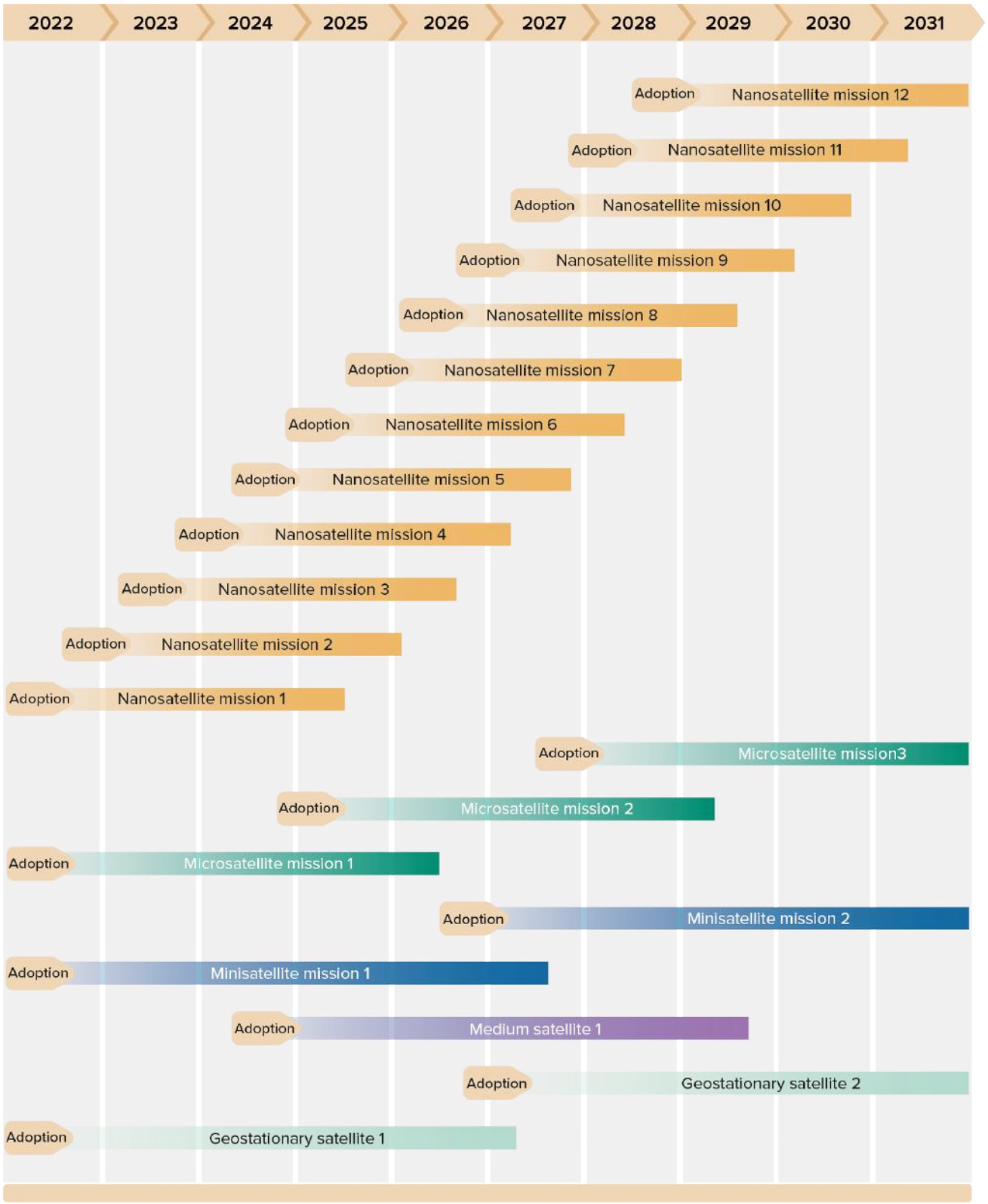
Scenario 200

Investment capacity: 43% of R$3.6 billion: R$1,550 million



Scenario 1000

Investment capacity: 55% of R$13.2 billion: R$7,260 million



Admission Portfolio

The Admission Portfolio is the gateway for new proposals for space missions to the PNAE. It hosts proposals in the early stages, which are submitted to the AEB to get started in the ProSAME. However, the permanence of a proposal in the Admission Portfolio does not guarantee its adoption.

To qualify for adoption, the proposal must evolve in its definitions and the construction of its technical, programmatic, and budgetary viability. It is from the Admission Portfolio that AEB selects, at the appropriate time, the candidates for this process.

The Brazilian Space Program should be a continuum. Therefore, initiatives that were discussed during the PNAE 2012-2021 are incorporated into the initial version of the PNAE 2022-2031 Admission Portfolio. Thus, the initial composition of the PNAE 2022-2031 Admission Portfolio is established based on proposals from the following planning instruments:

- PNAE 2012-2021
- Final Reports of the Technical Groups of the Brazilian Space Program Development Committee - CDPEB, which was established by Decree No. 9,839, of June 14, 2019
- Final Report of the GT-MAPSAR Working Group, as set forth in AEB Ordinance No. 46, dated March 8, 2019
- Final Report of the GT-SabiaMAR Working Group, according to the AEB Directive nº 691, of August 17th 2021
- Planning documents of the GT-PNAE Working Group, according to AEB Ordinance No. 107 of May 13, 2019
- Multiannual Plan PPA 2016-2019
- Multiannual Plan PPA 2020-2023

The updated content of the Admission Portfolio can be accessed on the Prosame website: https://observatorio.aeb.gov.br/prosame.

Afterword

The PNAE 2022-2031 inaugurates a new stage of the Brazilian Space Program. It presents itself as an effective tool for society and, consequently, as a protagonist for the achievement of national public policies.

Its construction relied on the contributions and work of nearly 200 professionals from various public and private institutions in the country. Throughout almost three years of uninterrupted activities, more than 6,000 pages of studies and technical material were created, which made up more than 500 support and complementary documents.

Coordinating a work of this magnitude represented a challenge for AEB. But it showed how strong our institutions are and how much we can deliver for the country.

PNAE 2022-2031 is not yet a perfect tool. However, it represents what can be envisioned for our next decade. It should lead the Brazilian Space Sector to establish Brazil as the leading space market in South America!

In order to do so, the sector must maintain cohesion and act in an integrated and synergistic way.

The Brazilian State assigns AEB the task of coordinating space activities in the country. Therefore, it is increasingly necessary for AEB to be strong and well positioned, with capabilities to lead the Brazilian Space Sector towards the future that our society demands.

To the Brazilian Space Sector, we say *thank you very much*, for this PNAE that we have delivered, together, to the Country!!!

Let's walk towards a more spatial future for our Brazil.

Under the auspices of the Brazilian Space Sector, the PNAE 2022-2031 takes full force and strength to fulfill its duty.

Cristiano Augusto Trein

Technologist
Coordinator of the GT-PNAE

Version control

Version	Content	Date
0.91	Approval of the contents for the Compact Version of PNAE 2022-2031	05/08/2022
0.92	Approval of the translation for the compact version of PNAE	22/05/2023


BRASIL

PROGRAMA ESPACIAL BRASILEIRO

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MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO

GOVERNO FEDERAL BRASIL UNIÃO E RECONSTRUÇÃO