CENTENA

Centro Tecnológico Nuclear e Ambiental

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CENTRO TECNOLÓGICO
NUCLEAR E AMBIENTAL

Introducing the CENTENA

CENTENA (Nuclear and Environmental Technological Center) will be a complex dedicated to technological development in the area of waste management and environment, with the double goal of low and intermediate-level radioactive waste disposal and research development. CENTENA´s concept follows all relevant international safety criteria and standards.

When fully implemented, CENTENA will be the solution for the back-end of the cycle of use of the nuclear energy and the radioisotopes diverse applications in Brazil, optimizing storage space in the user´s facilities and in the centralized deposits, thus enabling the growth and sustainability of the sector, while also fulfilling national and international legal commitments.

The project to implement the CENTENA facility is developed by the National Nuclear Energy Commission (CNEN). In order to follow the best international practices, as those promoted by the IAEA, the French National Agency for Radioactive Waste Management (ANDRA) was contracted to help in the development of the CENTENA´s conceptual and basic design.

Mission, Vision, and Values

Mission

To promote nuclear energy sustainability through the radioactive waste disposal and the development of technologies in radioactive waste management, ensuring the advancement of nuclear energy and the safety ofthe public and the environment.

Vision

To be a global reference center in waste disposal and in the technological development in radioactive waste management.

Values

- Safety
- Quality
- Transparency
- Ethics
- Care
- Sustainability

Guiding principles of radioactive waste management

- Non-generation
- Volume reduction
- Protection of workers, the public, and the environment
- Respect for future generations

Sustainable Development Goals (SDGs) - CENTENA's contribution:

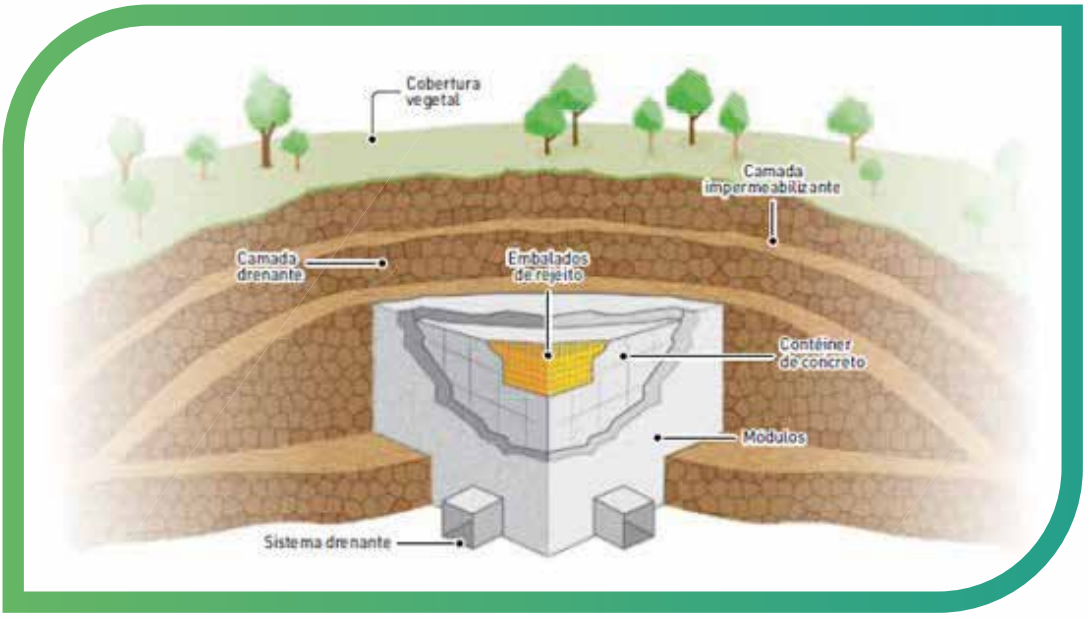
The implementation of CENTENA contributes to the United Nations' Sustainable Development Goals (SDGs), which are part of the global agenda adopted during the United Nations Summit on Sustainable Development in 2015. When operational, CENTENA will take care of the wastes generated in practices related to the following SDGs:

- **Goal 2:** Zero hunger (Nuclear techniques for pest control)
- **Goal 3:** Good health and well-being for all at all ages (Nuclear medicine)
- **Goal 6:** Clean water and sanitation (Aquifer quality control by isotopic techniques)
- **Goal 7:** Ensure access to affordable, reliable, sustainable, and modern energy for all (NPP with zero emission)
- **Goal 8:** Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all (Affordable energy, like nuclear, supports economic growth)
- **Goal 9:** Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation (Industrial processes control by nuclear techniques)
- **Goal 11:** Make cities and human settlements inclusive, safe, resilient, and sustainable (Modern energy supports clean communities).
- **Goal 12:** Ensure sustainable consumption and production patterns (Nuclear energy is crucial for waste reduction).
- **Goal 13:** Take urgent action to combat climate change and its impacts (Electricity generation with zero emission).

Management of Radioactive Waste at CENTENA

- Segregation, characterization, and treatment of radioactive waste occur under the responsibility of the waste-generating facility.
- Transportation to CENTENA is also a generator´s responsibility.
- Upon arrival at CENTENA, the documentation is checked, and initial acceptance tests are conducted. The cargo is then directed to temporary storage, and a sample of the packages is sent for radiochemical analyses.
- For the disposal process, the waste package is placed in concrete containers according to a predetermined cargo composition. These containers are filled with mortar and placed in the disposal modules.
- Finally, when the module capacity is complete, the module is sealed with mortar and a slab, according to the multi-barriers concept.

Safety (Multi-barriers concept)



Following the internationally accepted practices for radioactive waste repositories and considering the interdependence between the various stages of waste management, the safety measures at CENTENA are based on the concept of multiple barriers. The successive barriers ensure sufficient isolation of the waste from the environment and limit potential releases of radioactive materials in the event of a failure or combinations of failures. The engineering barriers are designed to provide the complete confinement of the radionuclides present in the waste for a long period of time, in the order of hundreds of years.

Benefits from the implementation of CENTENA

Technological Benefits

- R&D in new materials and processes for radioactive waste management
- R&D in new nuclear technologies
- R&D in long-term storage and disposal of other hazardous wastes
- Services in the area of radioactive waste

Economic Benefits

- Investment of approximately USD 50 millions for the CENTENA´s implementation.
- Expected financial return of over USD 100 millions in the first five years.
- Regional benefits such as tax revenue, royalties, creation of direct and indirect job positions, local economic growth, and improved infrastructure.
- Enabling the future operation of Angra 3 NPP, whose licensing is tied to the existence of the CENTENA facility.

Social Benefits

- Creation of lasting and well-paid jobs for people from diverse educational backgrounds.
- Enabling the sustainability of the nuclear practices in Brazil, by providing a safe disposal of the generated wastes in e.g.:
    - Nuclear medicine.
    - Pest control by Sterile Insect Technique.
    - Use of radiotracers in environmental studies and in agriculture.
- Strategic role of nuclear generation for the country in terms of technological development and national sovereignty.

Environmental Benefits

CENTENA will provide safety through the emplacement of wastes in a facility designed for appropriate levels of containment and isolation.

- The site for CENTENA covers an area of 300,000 square meters, making it the first technological development center for nuclear and radioactive waste deposition in Latin America.
- Unified solution for radioactive waste generated in the country.
- Nuclear Energy is the only proven, scalable, and reliable low-carbon energy source.
- A key role in reducing dependence on fossil fuels and addressing climate change and chronic air pollution worldwide.
- Fulfilling international commitments - Joint Convention on the Safety of Radioactive Waste Management (IAEA).

What are radioactive wastes?

Radioactive waste is any material resulting from human activity, which contains radionuclides in quantities exceeding the exemption limits specified by the Brazilian regulatory body, for which reuse is inappropriate or not foreseen.

And where are they generated?

The main activity generating radioactive waste in Brazil is the operation and maintenance of nuclear power reactors, and in the future, their decommissioning. Waste is also generated during the manufacturing of fuel elements, in R&D activities carried out in research institutes and universities, and in the applications of radioisotopes in medicine, agriculture, industry, and the environment.

Types of radioactive wastes

Radioactive waste can be generated in different operations of the nuclear energy cycle, as mentioned above. Wastes can be classified according to their physical form. Some examples are:

Solid: filters, papers, plastics, scrap, aprons, personal protective equipment, fabrics, contaminated needles, and vials.

Liquid: decontamination solutions, turbine evaporator concentrates, and scintillation liquids used for agricultural analysis.

Gaseous: vapors and gasses released mainly in the processes of nuclear fuel or radiopharmaceuticals manufacturing.

How are these wastes currently stored?

Currently, low and medium-level radioactive wastes are kept in storage facilities located in the units where they are generated, or transferred to centralized storage facilities located in CNEN's institutes. Although these facilities can store their wastes under high level security, they have limited storage capacity.

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MAIN CHARACTERISTICS & FEATURES

1. Subsurface facility.
2. Safety of disposal provided by multiple barriers.
3. Only wastes meeting acceptance criteria are received.
4. Safety analysis for licensing.
5. Long-term performance study of barriers.
6. Radiological and environmental control.
7. 300-year institutional control.
8. Opportunities for nuclear and environmental R&D to ensure the protection of the present and future generations.

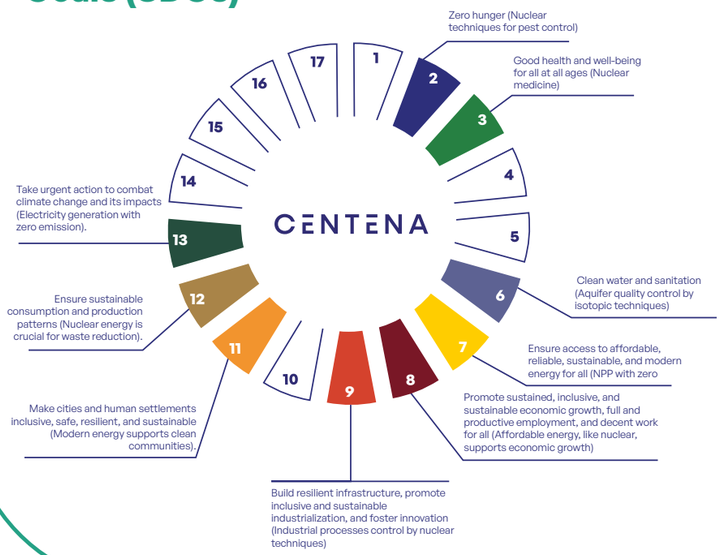
OBJECTIVE

The objective of the CENTENA project is to design, construct, and commission the first nuclear and environmental technology facility for the disposal of low level radioactive waste in South America.

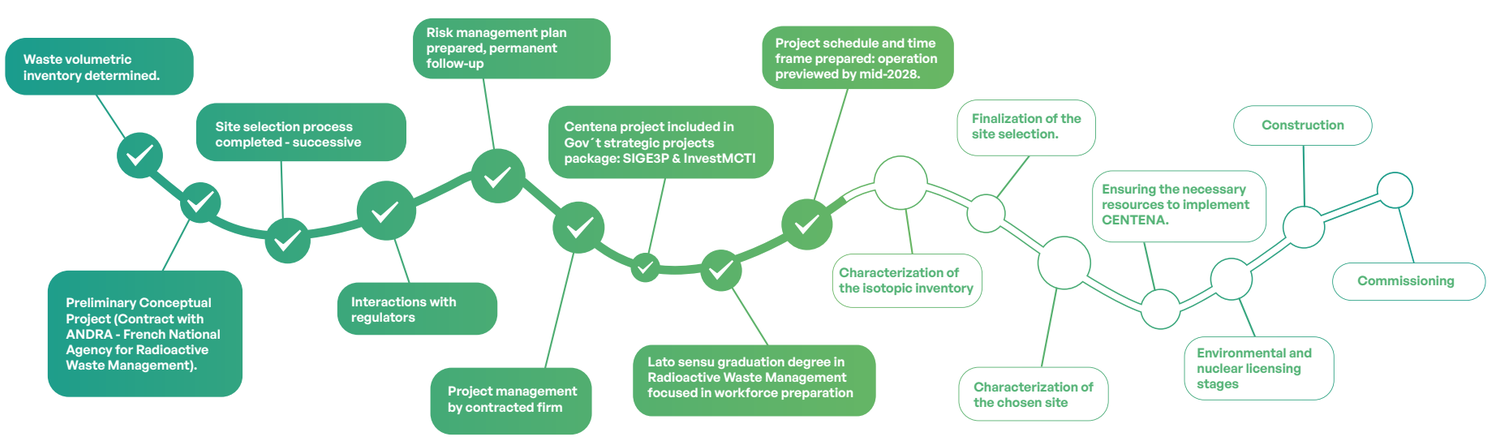
WHY TO DO IT?

1. Angra NPP storage capacity almost exhausted.
2. Centralized solution for radioactive waste disposal using up-to-date techniques.
3. Compliance with national and international obligations - e.g. the IAEA Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management.
4. Compliance with legal aspects and guidelines of the Brazilian Nuclear Program.
5. Fulfillment of Sustainable Development Goals.
6. Aiding to ensure the sustainability of the nuclear sector.
7. Enabling nuclear energy contribution to the growth of various economic sectors.

Sustainable Development Goals (SDGs)



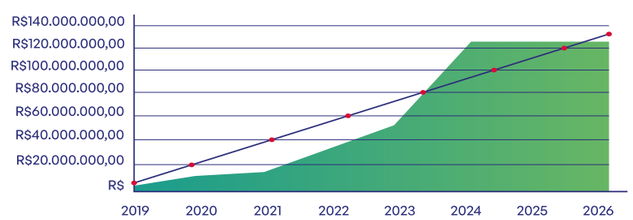
Where are we?



What if not implemented?

Non-compliance with a court ruling.

Project cost X If not implemented cost



Impairment of Angra 3 operation: No generation of 12 million megawatt-hours per year, enough energy to supply the cities of Brasília and Belo Horizonte or the equivalent of 50% the State of Rio de Janeiro consumption.

Frequently Asked Questions About the CENTENA

1 - What is a repository for radioactive waste?

Some materials used in the process of nuclear energy generation or in radioactive activities in medicine or industry end up being contaminated and need to be specially packaged for disposal to prevent contamination of the environment or people. Since these materials can remain radioactive for long periods of time, there is a need to store them in specially constructed facilities called repositories.

2 - What is the CENTENA project?

The Nuclear and Environmental Technology Center (CENTENA) is the national repository for low and intermediate-level radioactive waste. The project involves the construction of a repository capable of permanently and safely storing the radioactive waste of these categories produced in Brazil. In addition to centralizing the storage of this radioactive material, CENTENA will also have operational support buildings and facilities for research and technological development, as well as for the dissemination of nuclear sector activities and training.

3 - Why is Brazil building a permanent waste repository?

The 50 years of nuclear technology use in Brazil have accumulated a sufficient amount of low and intermediate-level waste to justify the construction of a permanent repository for these materials. The existence of a repository capable of safely storing a large volume of such waste is a requirement in the environmental licensing process for the Angra 3 nuclear power plant. It is also a requirement for the implementation of the Brazilian Multipurpose Reactor (RMB), a nuclear reactor for research and production of radioisotopes.

4 - What kind of material will be stored in the repository?

Low and intermediate-level waste will be stored. These are materials contaminated during the operation of nuclear power plants, such as clothing and instruments used during daily operations. Also included in this category are sources used in medicine and industry with a radioactive half-life limited to 30 years. The safe storage of these wastes is done worldwide with repositories built near the surface, where the pieces are immobilized, monitored, and contained with engineering barriers to ensure their isolation for a long period. Another category consists of high-level waste. These are materials generated during the fission of uranium inside nuclear power plant reactors. Due to intense contact with nuclear fuel, they remain radioactive for a long period. Their storage requires the construction of repositories at great depth - about 500 meters below the surface - in geologically selected areas to be permanently isolated from the environment.

5 - How long do these materials remais emitting radiation?

Materials with a radioactive half-life limited to 30 years are considered to be low and intermediate-level waste.

6 - What is the cost of constructing this facility?

The estimated cost of constructing the repository facilities is approximately R$ 130 million.

7 - Where will the repository be installed?

The choice of the location for the repository construction is the result of a careful selection process carried out by the National Nuclear Energy Commission (CNEN) over the past years. It takes into consideration the distance from the facilities of the main generators of radioactive waste in the country, as well as the distance from major urban centers. In addition, the analysis of geological and meteorological criteria ensures the stability and safety of the facilities.

8 - Will it be a safe facility?

Yes. The construction of a repository is primarily guided by safety. The construction of the permanent repository was planned based on successful international experiences, with the French technology serving as a basis. Its preliminary design involved the participation of Andra, the French agency responsible for coordinating the storage of radioactive waste in that country, which is an international reference in the management of radioactive material. Therefore, the construction of the facilities does not pose risks to the local population or the environment.

9 - Who will manage this facility?

The National Nuclear Energy Commission (CNEN) will be responsible for managing the repository. The control of the facilities will be carried out through the Environmental Monitoring Program (PMA) of CNEN. This is an ongoing program based on radiological monitoring and analysis of water, soil, vegetation, and sediment samples collected in the repository area.

10 - How does Brazil currently store low and intermediate-level radioactive waste?

Currently, low and intermediate-level waste is stored in initial deposits located within the units where they are generated, or transferred to intermediate deposits under the guardianship of CNEN.

11 - Why can't the waste remain where it is at the moment?

Storing this waste in a single permanent repository will facilitate the management and control of this material, providing more reliability and support for the expansion of the nuclear sector in the country. It will also generate cost savings for both CNEN and other actors producing radioactive waste.

12 - Does Brazil already have another repository of this kind?

Yes. To permanently house the waste generated in the Cesium-137 accident in Goiânia in 1987, the Abadia de Goiás repository was built. Today, the facility is part of the Central-West Nuclear Sciences Regional Center (CRCN-CO), located within the Telma Ortegal State Park.

13 - How is the control and surveillance of the Abadia de Goiás repository done?

In Abadia de Goiás, the surveillance of the repository is ensured by the Environmental Police Battalion of the Military Police of Goiás, which has installations in the region. The control of the repository is the responsibility of CNEN.

14 - Is there a difference between the Abadia de Goiás repository and the one being designed?

Yes. Although both structures are designed as repositories for low and intermediate-level activity materials, there are differences due to the type of material to be stored. The Abadia de Goiás repository only stores Cesium-137. The new repository is being designed to safely store other elements generated in the operations of nuclear power plants in Brazil, as well as activities in the medical and industrial fields.

15 - How is communication and interaction with society carried out within the process of building a waste repository?

The community participates in the licensing process for the construction of the repository through public hearings convened by the licensing agencies.