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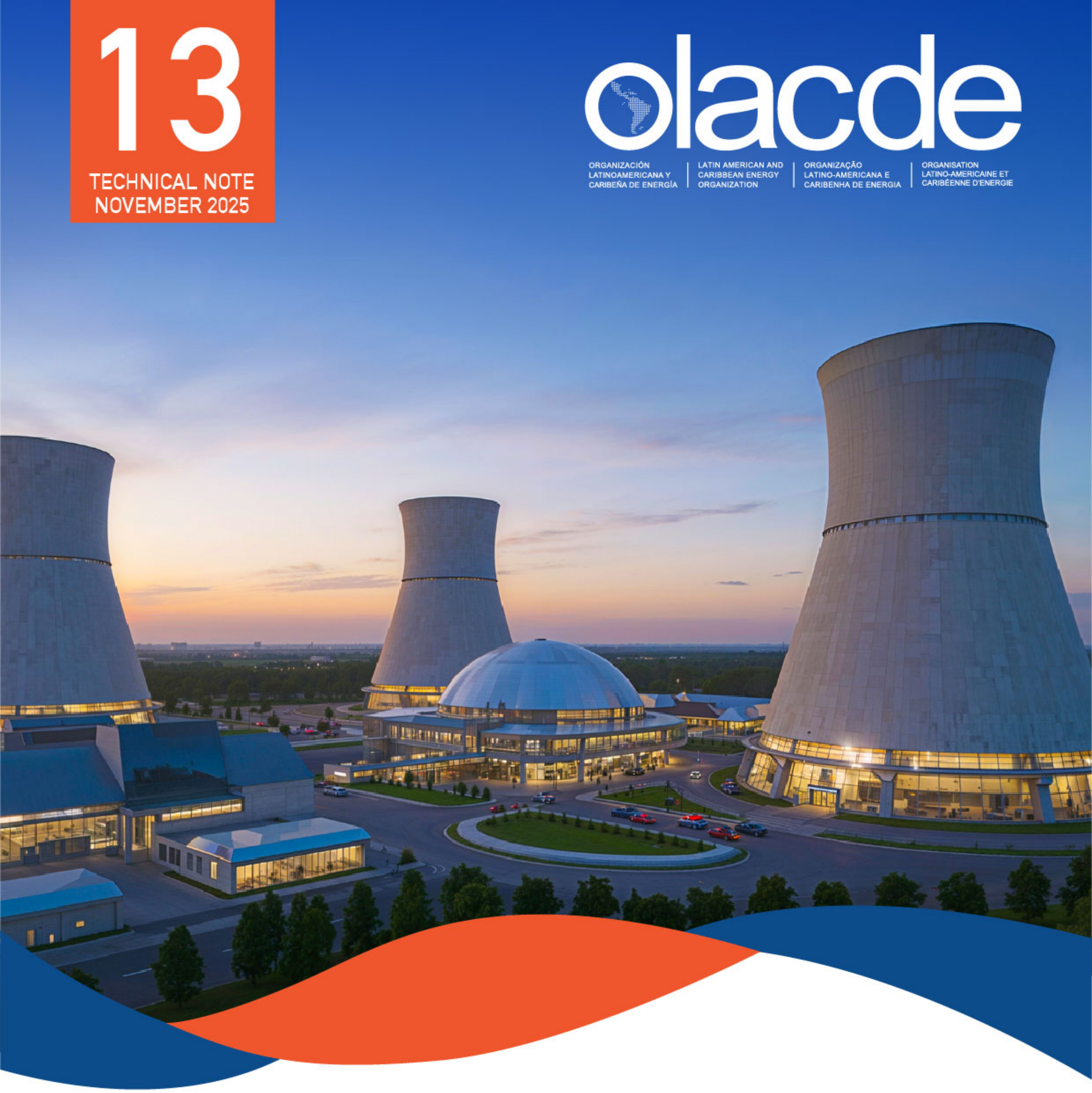
TECHNICAL NOTE
NOVEMBER 2025



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TECHNICAL NOTE Nº 13

AN OUTLOOK ON NUCLEAR ENERGY IN LATIN AMERICA AND THE CARIBBEAN AS A SOURCE OF FIRM ENERGY FOR ENERGY TRANSITION

Energy joins us

AN OUTLOOK ON NUCLEAR ENERGY IN LATIN AMERICA AND THE CARIBBEAN AS A SOURCE OF FIRM ENERGY FOR ENERGY TRANSITION

Technical Note No.13

This document was prepared under the direction of the
Latin American and Caribbean Energy Organization (OLACDE)

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Acknowledgement

To the Ministry of Mines and Energy of Brazil for its valuable support in the review of the information for the nuclear power plants of this country.

November 2025

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AN OUTLOOK ON NUCLEAR ENERGY IN LATIN AMERICA AND THE CARIBBEAN AS A SOURCE OF FIRM ENERGY FOR ENERGY TRANSITION

1. Introduction

Since the adoption of the Paris Agreement in 2015, many countries in the region have set their Nationally Determined Contributions (NDCs), establishing targets to reduce greenhouse gas emissions. To achieve these goals, countries have enacted policies and regulations with the aim of implementing energy transition processes. The most tangible results can be seen in the increase in the share of non-conventional renewable energy sources, mainly wind and solar, in their electricity generation matrices, reaching 17% of total generation in 2024 and an estimated 19% at the end of 2025.

However, as electricity demand increases due to the increased electrification of energy end uses including transportation, process digitization, the proliferation of data centers, and the green hydrogen industry. In addition, the participation of intermittent and unmanageable energy sources is increasing in the electricity generation *mix* , so it is increasingly evident the need to have sources that provide firm energy to the system, which for now is the function, in most countries, of regulatable hydroelectric plants and thermal plants that operate based on fossil fuels; and in only three countries in the region (Argentina, Brazil and Mexico), also of nuclear power plants.

The high costs of implementing nuclear power plants, their long construction periods and other gaps in the scientific, technological and social fields, explains that only the three largest regional economies have ventured into the use of this technology, however, currently, thanks to technological advances worldwide that have made it possible to significantly reduce construction costs and time, as well as increase the safety levels of the facilities, other countries in the region are beginning to consider nuclear energy as a good alternative to replace the use of fossil sources in the supply of firm energy for electricity generation.

This note includes a brief overview of the historical and current situation of nuclear energy for electricity generation both globally and in the Latin America and the Caribbean region.

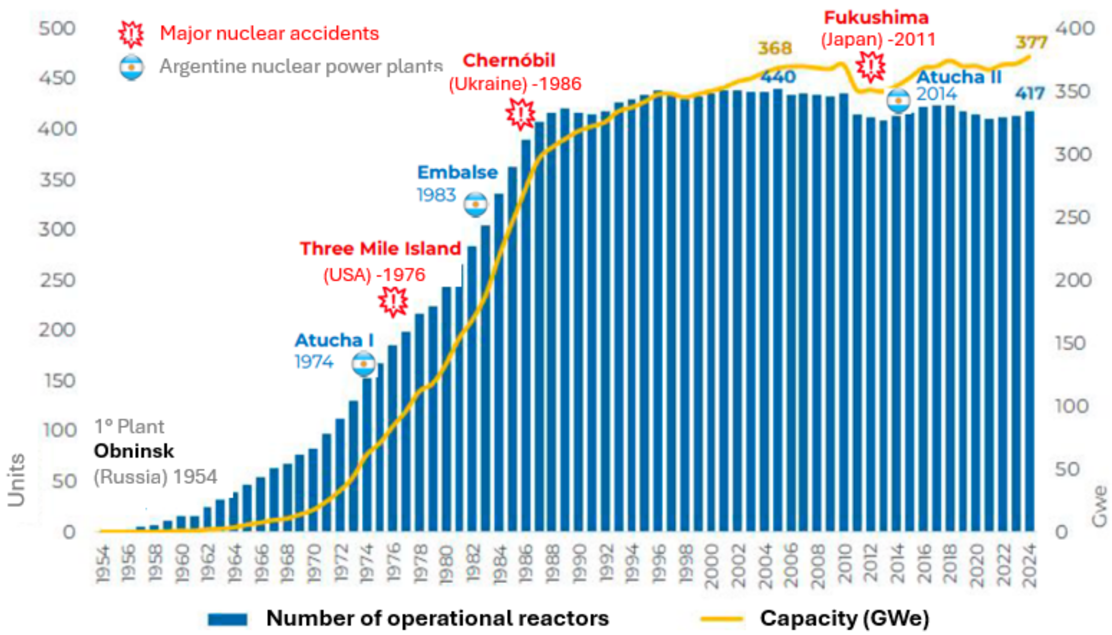
2. Nuclear energy in the global context

After the discovery of nuclear fission in 1938 and the end of World War II in 1945, with the beginning of the cold war, the great powers of the world began nuclear weapons programs, mainly the United States and the then Soviet Union; and it was not until the early 1950s that the first civilian applications of this new technology began to emerge, specifically in the field of electric power generation. Between 1954 and the end of the 1980s, the construction and implementation of nuclear power plants boomed, reaching over 400 units worldwide and about 340 GW of installed capacity.

The Chernobyl nuclear power plant accident in Ukraine in 1986 marked the beginning of the slowdown in nuclear power expansion in the world, starting in 1990 with a decrease in the number of reactors in operation and although there was then a slight growth, both in units and in installed power, to reach 440 active reactors and 368 GW of installed capacity in the mid-2000s, the growth of the global nuclear power park began a slowdown process ending in 2024 with 417 reactors in operation and 377 GW of installed power. This is largely due to nuclear accidents in Ukraine and Japan, but also to high construction costs. See Figure 1.

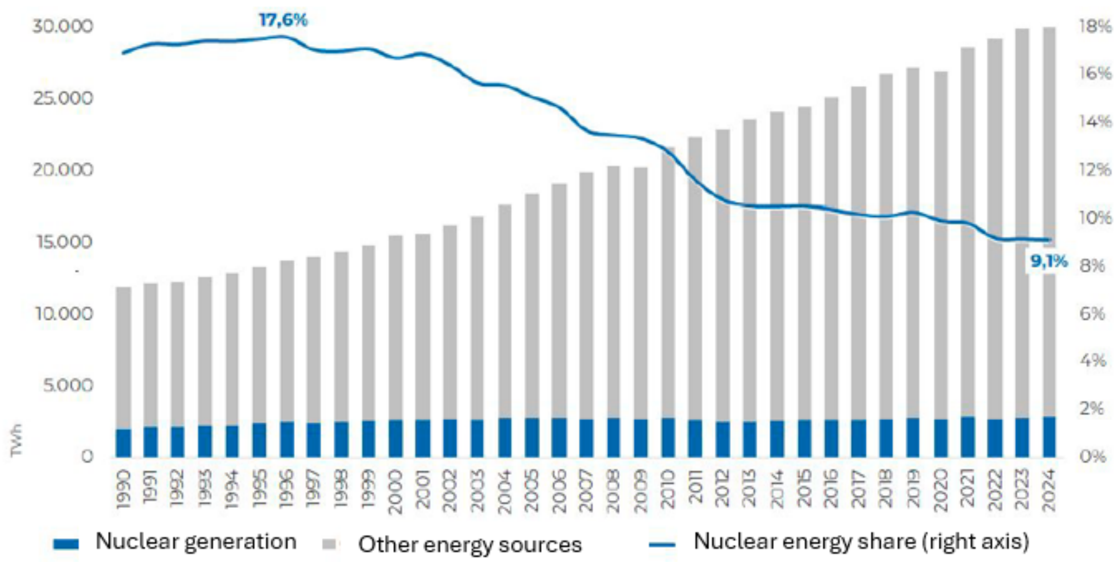
Globally, approximately 9.1% of total electricity generation is produced with this energy source while for LAC in 2025 it is 2.7%.

Figure 1. Operational nuclear reactors in the world. Quantity and power (GWe)



With the proliferation of other clean electricity generation technologies such as hydroelectric, solar and photovoltaic; and also in the face of the accelerated penetration of natural gas generation, nuclear energy has been losing share in the global generation matrix, falling from 17.6% reached in 1996 to only 9.1% in 2024. However, with respect to the total electricity generated with clean energy in the world, currently 25% corresponds to nuclear power. See Figure 2.

Figure 2. Share of nuclear power in global electricity generation (TWh)

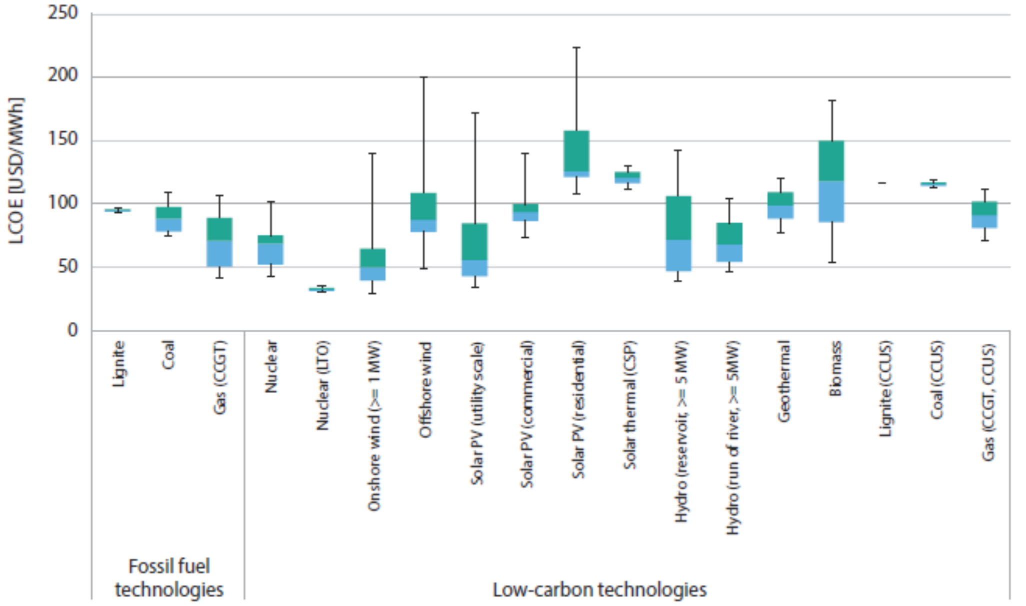


Source: Ministry of Economy of Argentina/National Directorate of Regional Studies and Value Chains. 2025 Nuclear Energy Electrical Generation.

With technological advances and the reduction of construction costs and times, both for the implementation of new plants, as well as for the repowering and extension of the useful life of existing nuclear power plants, nuclear energy presents good prospects of regaining prominence in the global electricity generation matrix, especially if the small modular nuclear reactors (SRM) industry for civil applications is consolidated. It should be noted that, in 2024, there were 62 nuclear reactors under construction in the world, with a total of 64 GW of electrical power.

Although the investment costs for the construction of conventional nuclear power plants may still be relatively high compared to other electricity generation technologies, the levelized cost of electricity from nuclear origin turns out to be very competitive, since as seen in Figure 3, it is in lower ranges of variation than that of carbon electric, combined cycle gas plants, offshore wind and other technologies.

Figure 3. Levelized Costs by Power Generation Technology



Note: Values at 7% discount rate. Box plots indicate maximum, median and minimum values. The boxes indicate the central 50% of values, i.e. the second and the third quartile.

Source: https://www.oecd-nea.org/jcms/pl_51126/low-carbon-generation-is-becoming-cost-competitive-nea-and-iea-say-in-new-report

3. Nuclear energy in Latin America and the Caribbean

As for Latin America and the Caribbean, nuclear energy as a source of electricity generation has had a development focused on the largest regional economies such as Brazil, Mexico and Argentina, which began in the mid-twentieth century, after the end of World War II, when US President Dwight D. Eisenhower promoted nuclear cooperation agreements with countries in the region.

Following these agreements, institutions dedicated to promoting nuclear research and development were established in these countries, such as the National Atomic Energy Commission (CNEA) in Argentina in 1950; the *Comissão de Energia Atômica* in 1950 and the *Institute of Atomic Energy* in 1962, now IPEN, in Brazil; and the National Commission for Nuclear Energy in Mexico in 1961. Currently, nuclear power generation in the three countries that use it represents 7% of the total electricity generated in Argentina, 2% in Brazil and 3% in Mexico.

Although, based on international commitments to mitigate climate change, most of the countries in the region have focused their energy development policies on the greater use of non-conventional renewable energy sources for electricity generation, mainly in wind energy and solar energy, as these intermittent production technologies have been gaining ground in the generation matrix, there has been a need to look for an alternative of a firm energy source that allows reducing the dependence on thermoelectric plants that operate based on fossil fuels and that is why some countries in the region that do not currently have nuclear energy in their electricity matrix, are considering this technology in their medium and long-term expansion plans.

4. Nuclear energy in Argentina

In Argentina, nuclear activity was formalized through Decree No. 10.936 of May 31, 1950.

ATUCHA I Nuclear POWER PLANT

The Atucha I Nuclear Power Plant, began construction on June 1, 1968, has been providing energy to Argentina since 1974 and is the first nuclear power plant in Latin America.

It is located 100 km from the Autonomous City of Buenos Aires, in the town of Lima. It has a gross electrical power of 362 MW and uses a mixture of natural uranium (0.72%) and uranium slightly enriched to 0.85% as fuel.

The Power Plant is cooled and moderated with heavy water (D20), and belongs to the PHWR type of reactor - pressurized heavy water reactor -.

The reactor core is composed of 252 positions with cooling channels. Within each of them, the fuel elements are housed in the form of sintered uranium dioxide (UO2) pellets.

Nucleoeléctrica is currently carrying out the Atucha I Life Extension Project, which, once completed, will allow the plant to operate for an additional twenty years at full power.

Table 1. Technical characteristics of the Atucha I nuclear power plant - Argentina

REACTOR TYPE	SIEMENS PRESSURE VESSEL
THERMAL POWER	1,179 MWt
GROSS/NET ELECTRICAL POWER	357 MWe
MODERATOR AND COOLANT	Heavy water (D20)
FUEL	Natural uranium or slightly enriched uranium (0.85%)
STEAM GENERATOR	Two Uprights, Incolloy 800 U-Tubes
TURBINE	One high pressure stage, three low pressure stages. Speed: 3,000 rpm
ELECTRIC GENERATOR	Two voltage poles 21 kV, 50 Hz

Source: https://www.argentina.gob.ar/economia/energia/energia-electrica/nuclear/centrales

Figure 4. Photo of the Atucha I nuclear power plant

Source: https://www.lanacion.com.ar/sociedad/que-es-y-donde-esta-ubicada-atucha-1-la-central-nuclear-que-provoco-un-corte-de-luz-masivo-nid01032023/

EMBALSE Nuclear Power Plant

The Embalse Nuclear Power Plant is the second to be built in Argentina. Its construction began on May 7, 1974. On January 20, 1984, it began its commercial operation and ended its first operating cycle on December 31, 2015.

It is located on the southern coast of the Tercero River Reservoir, in the province of Córdoba, 665 metres above sea level. La Central is located 110 km southwest of the City of Córdoba and 700 km from the City of Buenos Aires.

The Nuclear Reservoir is of the CANDU type (Canadian Uranium Deuterium), it belongs to the type of pressure tube plants, which uses natural uranium as fuel and its coolant, and moderator is heavy water.

The energy provided by the Embalse Nuclear Power Plant is delivered to the national grid, that is, to the Argentine Interconnection System (SADI).

Table 2. Technical characteristics of the Embalse nuclear power plant - Argentina

REACTOR TYPE	Pressure tubes (CANDU)
THERMAL POWER	2,109 MWt
GROSS/NET ELECTRICAL POWER	648 Mwe
MODERATOR AND COOLANT	Heavy water (D2O)
FUEL	Natural uranium
STEAM GENERATOR	Two Uprights, Incolloy 800 U-Tubes
TURBINE	One high pressure stage, three low pressure stages. . Speed: 1,500 rpm
ELECTRIC GENERATOR	Four poles. Voltage 22 kV, 50 Hz

The life extension project of the Embalse nuclear power plant was carried out over three years, coming into operation in 2019, and starting its second life cycle for a period of 30 years. In addition to updating the installation, one of the most relevant tasks that have been developed has been to increase the power of the reactor.

Table 3. Extension of the Embalse nuclear power plant - Argentina

THERMAL POWER	2,064 MWt
GROSS/NET ELECTRICAL POWER	656 Mwe

Source: https://www.argentina.gob.ar/economia/energia/energia-electrica/nuclear/centrales

Figure 5. Photo of the Embalse nuclear power plant

Source: https://www.foronuclear.org/actualidad/noticias/la-central-nuclear-argentina-embalse-preparada-para-operar-30-anos-mas/

ATUCHA II Nuclear POWER PLANT (CNAII)

The Atucha II Nuclear Power Plant is a nuclear power plant with a gross power of 745 MW, based on natural uranium and heavy water. It is in the same complex as the Atucha I Nuclear Power Plant.

The cornerstone of the Atucha II Nuclear Power Plant was laid in 1982, between 1994 and 2006 it was paralyzed, until the relaunch of the Argentine Nuclear Plan, promoted by the National State that same year; it entered service in 2014.

Like Atucha I, it also uses a pressurized heavy water reactor (PHWR), but with more advanced technologies and an improved design.

From the point of view of design and construction, it is a modern plant that has updated security systems; with the concept of defense in depth with successive barriers; containment sphere; physical separation between security systems, and an in-service surveillance program.

Table 4. Technical characteristics of the Atucha I nuclear power plant - Argentina

REACTOR TYPE	Pressure Vessel
THERMAL POWER	2.175 MWt
GROSS/NET ELECTRICAL POWER	745/692 MWe
MODERATOR AND COOLANT	Heavy water (D2O)
FUEL	Natural uranium
STEAM GENERATOR	Two Uprights, Incolloy 800 U-Tubes
TURBINE	A high-pressure stage. Two low pressure stages. Speed: 1500 rpm.
ELECTRIC GENERATOR	Four poles. Generation voltage 21 kV. 50 Hz

Source: https://www.argentina.gob.ar/economia/energia/energia-electrica/nuclear/centrales

Figure 6. Photo of the Atucha I nuclear power plant

Image 03: ATUCHA II nuclear POWER PLANT

Source: https://www.na-sa.com.ar/es/centrales-nucleares/atucha-2

The CAREM project (Central Argentina of Modular Elements)

The Argentine Modular Elements Power Plant (CAREM) is the first nuclear power reactor designed and built entirely in Argentina by the National Atomic Energy Commission (CNEA). It is a smaller nuclear power plant than the traditional ones, with an integrated design and a high level of safety.

This first Argentine nuclear power reactor advances in the construction of 32 MW of electricity, with 65% progress, which places it among the few small modular reactors (SMR) in the world that are materializing.

It belongs to the category of small modular reactors (SMR), characterized by their simplicity of design, possibility of being manufactured in series and transported to the installation site, lower initial cost and rapid return on investment.

The CAREM project integrates its main components into a single pressure vessel, reducing complexity and size, and incorporates passive safety systems that operate without external power or human intervention, making it safer.

In addition to electricity generation, it can be used to supply isolated areas, industries, desalination or hydrogen production plants, and heating systems, constituting a complementary base energy source to renewables and a clean alternative to fossil fuels.

Figure 7. Photo of the progress in the construction of the CAREM project in the Atucha complex

Source: National Atomic Energy Commission (2023).

Although its power will be able to supply about 120 thousand inhabitants, the main objective of the prototype is to validate the design and systems of the reactor and then develop commercial modules of 120 MW electricity.

The advanced development of CAREM positions Argentina as a leader in SMR technology, with the potential to export nuclear reactors and generate billions of dollars, according to international organizations such as the IAEA and the OECD/NEA.

Finally, its compact, safe and adaptable design makes it especially attractive for countries seeking to introduce nuclear energy as a clean alternative to fossil fuels, reinforcing energy sovereignty and opening niches of cooperation and technology transfer led by Argentina.

5. Nuclear energy in Brazil

At the United Nations Climate Conference (COP28) in Dubai, United Arab Emirates, a group of 22 countries pledged to triple nuclear power generation by 2050. This effort aims to contribute to decarbonization and mitigate climate change, since nuclear energy is considered clean due to the absence of greenhouse gas emissions from power plants.

Brazil is not a signatory to the COP28 agreement but plans to increase its nuclear capacity with the construction of the Angra 3 plant, located on the southern coast of Rio de Janeiro. Angra 3, which will not be operational before 2030, is expected to have a capacity of 1,405 megawatts (MW) and generate more than 12 million megawatt-hours per year, enough to satisfy the consumption of 4.5 million people.

Currently, Brazil has two nuclear power plants in operation: Angra 1 and Angra 2, located at the Almirante Álvaro Alberto Nuclear Power Plant in Angra dos Reis, on the Costa Verde of Rio de Janeiro. Both are operated by the state-owned company Electronuclear.

Brazil has two uranium fission reactors: Angra 1, which began operating in 1985, and Angra 2, which began operating in 2001. Together they can generate up to 1,990 megawatts (MW). And, if completed, Angra 3 alone could generate 1,405 MW and could generate more than 12 TWh per year: enough energy to supply the cities of Brasilia and Belo Horizonte.

Angra 1

Angra 1, a Westinghouse pressurized water reactor with 640 MWe of power, reached criticality in 1982 and began commercial operation in 1985. Together with Angra 2 (1,275 MWe, operational since 2001), the plant is a key piece of the Brazilian nuclear program. The license renewal process began in 2019 and included comprehensive technical assessments, International Atomic Energy Agency (IAEA) missions, and a Comprehensive Implementation Plan for safety improvements.

Angra 1 generated 4.78 million MWh in 2023 and has had a load factor of 88.24% for the last five years. It supplies enough energy to power a city of two million people. The plant has renewed its operating license for another 20 years, extending its activity until December 2044. This license expired in December 2024.

Angra 2

Brazil's second nuclear power plant began commercial operations in 2001. With a capacity of 1,350 megawatts, Angra 2 is capable of supplying the energy needs of a city of 2 million inhabitants, the same size as Belo Horizonte.

The plant has a pressurized water reactor (PWR) of German Siemens/KWU technology (currently Areva NP), the result of a nuclear agreement between Brazil and Germany signed in 1975. The construction of Angra 2 began in 1981, but slowed down from 1983 due to the economic crisis that hit the country at that time, completely stopping its operations in 1986. The unit was restarted in late 1994 and completed in 2000.

The plant's performance has been exemplary since its inception. At the end of 2000 and the beginning of 2001, its implementation made it possible to save water from Brazilian hydroelectric reservoirs, thus mitigating the consequences of energy rationing, especially in the southeast region, the largest consumption center in the country.

The construction of Angra 2 facilitated the transfer of technology to Brazil, propelling the country towards its own technological development, which resulted in the mastery of virtually all stages of nuclear fuel manufacturing. In this way, Eletrobras Eletronuclear and the national nuclear industry now bring together qualified and up-to-date professionals at the forefront of the sector.

This plant has been in operation for 24 years, with an estimated useful life of 40 years and the possibility of an extension of another 20 years.

Angra 3

Currently under construction, Angra 3 will be the third plant of the Almirante Álvaro Alberto Nuclear Power Plant (CNAAA). With a capacity of 1,405 megawatts, the new unit will be able to generate more than 12 million megawatt-hours per year, enough to supply 4.5 million people. In this way, nuclear energy will generate the equivalent of 60% of the consumption of the state of Rio de Janeiro and 3% of the consumption of Brazil.

Construction, suspended in 2015 due to a funding review, resumed in 2022. The Agis consortium, formed by Ferreira Guedes, Matricial and ADtranz, won the tender to restart the construction of Angra 3 and provide services within the framework of the unit's Critical Lines Acceleration Plan.

The National Energy Policy Council (CNPE) is expected to return to address the resumption of construction at its next meeting in December. At its last meeting, held in October, the CNPE (National Energy Policy Council) determined the need to update the studies on the economic and financial viability of the completion of Angra 3.

According to Eletronuclear, updated studies indicate that the completion of Angra 3 has an estimated cost of R$23.9 billion, while abandoning the project would require expenditures of between R$21.9 billion and R$25.97 billion. If construction continues, the plant is expected to commence commercial operations in March 2033.

Angra 3 will diversify the electricity grid and reduce the overall costs of the National Interconnected System (SIN), since it will replace the more expensive thermal energy that is frequently dispatched by the National Electricity System Operator (ONS). Its proximity to the main consumption centers of the country helps avoid congestion in the interconnections between subsystems.

6. Nuclear energy in Mexico

Current situation

The Laguna Verde Nuclear Power Plant, located in Alto Lucero de Gutiérrez Barrios, Veracruz, is owned and operated by the Federal Electricity Commission (CFE). It has two reactors, called Laguna Verde I and II, both of the BWR (Boiling Water Reactor) type of General Electric technology, which constitute the only nuclear facility in operation in Mexico. In 2024, the total installed capacity was 1608 MW and generated about 3% of the national electricity.

History and development of the Laguna Verde power plant

Mexico's nuclear interest was formalized in 1956 with the creation of the National Nuclear Energy Commission (CNEN), in charge of the country's nuclear activities, while the Federal Electricity Commission (CFE) assumed the role of future nuclear generator. Investigations to locate suitable sites began in 1966, and in 1976 the CFE officially began construction of the Laguna Verde Nuclear Power Plant in the municipality of Alto Lucero de Gutiérrez Barrios, Veracruz, next to the Gulf of Mexico, equipped with two General Electric BWR reactors.

Although the domestic industry did not manufacture the main components, Mexican companies executed the civil works, and local personnel were trained to operate the plant. In the following years, CNEN evolved into various specialized institutions: INEN, ININ, Uramex and CNSNS, leaving nuclear management under the Ministry of Energy since 1985. The Unit 1 reactor starts commercial operation in 1990, followed by Unit 2 in 1995. Subsequently, between 2010 and 2013, the CFE, together with Iberdrola Engineering and Alstom, executed a modernization project for 605 million dollars, which increased the power of each reactor by 138 MW and extended its useful life to 40 years.

Figure 8. Photo of Laguna Verde Nuclear Power Plant in Alto Lucero, Veracruz, Mexico

Source: https://www.sociedadnuclear.mx/la-central-nucleoelectrica-de-laguna-verde-pilar-de-la-energia-en-mexico/

SHELF-LIFE EXTENSION

In 2020, Unit 1 received authorization to operate until July 2050, and Unit 2 until April 2055, after complying with the safety assessments of the National Commission for Nuclear Safety and Safeguards (CNSNS).

Resources

Mexico has estimated resources of 2,500 tons of uranium, according to the Mexican Geological Survey (SGM). These reserves are located mainly in the states of Chihuahua, Sonora, Durango, Oaxaca and Baja California Sur, although so far they have not been commercially exploited. The nuclear fuel, owned by the State, is managed and supervised by the National Commission for Nuclear Safety and Safeguards (CNSNS) and the Ministry of Energy (SENER).

Legal framework and international commitments

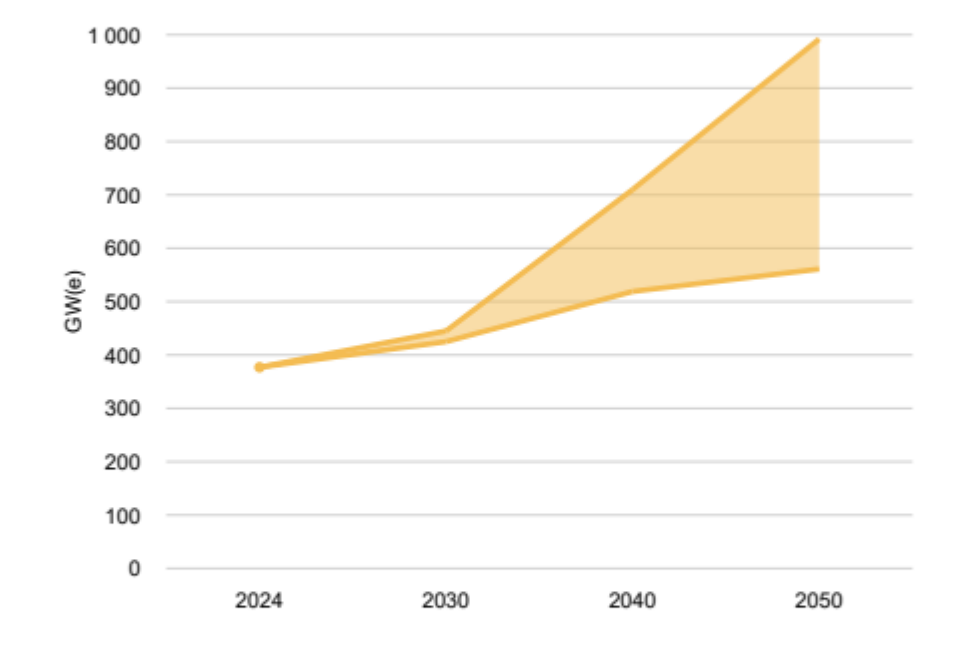
The Mexican Constitution establishes that nuclear energy may only be used for peaceful purposes, and this is reiterated in the 1984 Law on Nuclear Activities.

Mexico signed a Nuclear Non-Proliferation Treaty (1969, 2004). It is a party to the Convention on the Physical Protection of Nuclear Material (1979, 1988) and depositary of the Treaty on the Prohibition of Nuclear Weapons in Latin America (Treaty of Tlatelolco, 1967).

7. Projection of installed nuclear power capacity in the world and LAC

According to data from the IAEA, published in its report ***Energy, Electricity and Nuclear Energy, Estimates for the period 2050***, it is projected that in an optimistic scenario the installed capacity for global electricity generation will increase by approximately 17% by 2030 and will double by 2050; while nuclear electricity generation will increase by 18% by 2030 and will increase by 2.6 times the capacity of 2024 by 2050, that is, the share of nuclear energy will increase by almost one percentage point by 2050.

Figure 9. Nuclear power generation capacity worldwide

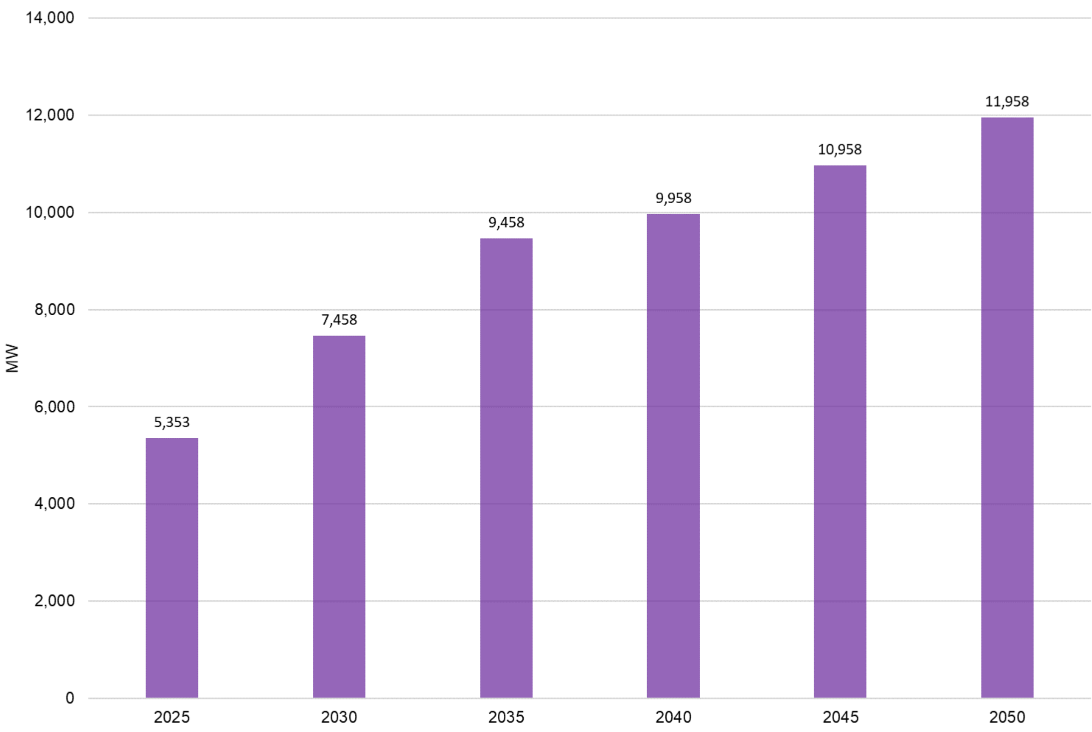


Source: https://www-pub.iaea.org/MTCD/Publications/PDF/p15942-25-02880E_RDS-1-45_web.pdf

Likewise, it is estimated that, in the most optimistic scenario, the useful life of most nuclear reactors will be extended, so that only 81 GWe of nuclear power generation capacity will be withdrawn from 2024 to 2050 and this is expected to result in a net increase in nuclear power capacity (new facilities minus withdrawals) of 615 GWe by 2050.

While for LAC, according to projections made by OLACDE, the installed capacity for nuclear power generation will grow by 2050 by approximately 2.3 times compared to 2025 due to the entry of new generation plants or the increase in power in existing plants in countries that already have this energy source.

Figure 10. Nuclear power generation capacity for LAC



Source: OLACDE, own elaboration.

8. Perspectives of nuclear energy in other Lac countries

Colombia

Given that in Colombia much of the generation depends on hydroelectric plants (vulnerable to droughts) and greater firmness (constant production capacity) is sought, nuclear energy appears as an option with low CO_2 emissions and high installed power.

The country has made legislative progress. For example, the bill ("Nuclear Law" or related bill) to establish the regulatory framework, and the initiative to create a nuclear safety authority (National Nuclear Safety Authority), are underway. (Trade 2025).

The possibility of using small modular reactors (SMR) as the most viable strategy for the country is explicitly studied: smaller dimensions, shorter construction times, more modular scale.

There is already an estimate of incorporating nuclear energy into the matrix from 2035. The Energy Mining Planning Unit (UPME) establishes in its plan that the installed nuclear capacity could be between 1,200 and 1,884 MW by mid-century.

Ecuador

The government has announced that it intends to diversify the energy matrix, incorporating, in addition to renewable sources, nuclear energy as a basic option. Through the Ministry of Energy and Mines of Ecuador, it signed a memorandum of understanding with the International Atomic Energy Agency (IAEA) to explore the peaceful use of nuclear energy.

The first unit - a small modular reactor - is expected to have a capacity of ≈300 MW, in the medium term (2034).

In the long term, a plant of ~ 1,000 MW (1 GW) is projected that could contribute around 20% of the country's maximum demand (~ 4,950 MW) according to government data.

El Salvador

In 2023, a memorandum of understanding was signed with Thorium Energy Alliance to explore nuclear technology with thorium as fuel.

In March 2024, the Salvadoran Government submitted to the International Atomic Energy Agency (IAEA) the legal instruments required for the peaceful use of nuclear energy.

In the same year, the "Nuclear Energy Law" was enacted, which regulates the design, construction, operation and dismantling of nuclear facilities, and creates the corresponding regulatory bodies.

Candidate sites for nuclear facilities are being evaluated: for example, departments such as San Vicente and Chalatenango were identified as potential locations for the nuclear plant.

Also in 2024, the country signed a program framework with the IAEA for technical cooperation in five priority areas, including "energy and industry". (IAEA.ORG, 2025)

9. Requirements for the implementation of a nuclear power program in LAC countries

As can be seen in the previous paragraph, some Lac countries that do not currently have nuclear power generation capacity are taking their first steps towards the implementation of this type of technology for the medium and long term. For this type of initiative to be consolidated, it is necessary to structure an ecosystem for the development of nuclear energy. This ecosystem should cover the following areas:

I. Legal and regulatory framework

A country that wants to develop nuclear energy must have:

- Specific laws regulating nuclear generation, transport and handling of radioactive materials.

- Independent nuclear regulatory authority, responsible for supervision, inspection and licensing.
- Compliance with international treaties, such as:
    - Nuclear Non-Proliferation Treaty (NPT)
    - Nuclear Safety Convention
    - IAEA safeguards and controls agreements
    - International norms and standards, such as those of:
    - IAEA (IAEA)
    - WANO
    - ASN/US NRC according to the adopted model
    -

II. Institutional infrastructure

This requires:

- A national nuclear energy program with clear objectives.
- Institutions dedicated to:
    - Nuclear and radiation safety
    - Radioactive Waste Management
    - Training and education
    - Research and Development
    - A robust emergency response system
    -

III. Technical and physical infrastructure

- Suitable site that meets criteria of:
    - Seismicity
    - Hydrology
    - Accessibility
    - Environmental assessment
    - A licensed commercial nuclear reactor.
- Systems of
    - Physical Restraint
    - Cooling
    - Radiological monitoring
    - Electrical networks capable of integrating large base plants.

IV. Radiation safety and protection

There must be a framework of:

- Nuclear safety programs
- Physical protection against intrusion and sabotage (nuclear security)
- Safeguards to prevent diversion of material (safeguards)
- Ongoing training of operators and technical staff
- Robust nuclear safety culture across the organization

V. Fuel and radioactive waste management

Includes:

- Clear policies for the nuclear fuel cycle (acquisition, use and return or storage).
- infrastructure for:
    - Dry or pool storage of used fuel
    - Safe and traceable management of radioactive waste
- Long-term plans for permanent storage.

VI. Public participation and transparency

- Public Communication Programs
- Environmental impact assessments with citizen participation
- Periodic and accessible reports on safety and operation

VII. Human resources training and development

- Training of engineers, technicians, operators, regulators and support staff.
- Cooperation with international organizations and educational centers
- Technology Transfer Programs

VIII. Financial and economic viability

- Analysis of construction, operation and dismantling costs.
- Financing models (public, private or mixed).
- Study of energy demand and long-term planning.

IX. 9. Plan for decommissioning

From the beginning there must be:

- Strategy and funds for the decommissioning of the plant.
- Management of waste generated during this process.
- Site Restoration

10. Challenges faced by countries in the region to boost nuclear energy

The main challenges of LAC for the implementation of nuclear energy include the need for financial investments, the creation of sound regulatory and safety frameworks, training of professionals, management of nuclear waste, and gaining social and political acceptance.

10.1 Financial and Infrastructure Challenges

High upfront costs: The construction of nuclear power plants requires high investment, which represents a major difficulty for emerging countries.

Funding Need: Increased support from multilateral banking is required to fund nuclear projects.

Shortage of trained personnel: The region needs to develop a skilled nuclear engineering workforce to design, build, and operate the facilities.

10.2 Regulatory and safety challenges

Strong, independent regulations: Strong, independent nuclear regulators are critical to ensuring plant safety.

Nuclear safety: Safety protocols must be improved, and technologies must be innovative to address safety concerns.

Radioactive waste management: A long-term solution must be found for the safe management of radioactive waste, which has remained hazardous for thousands of years.

10.3 Social and political challenges

Public Acceptance: A "social license to operate" is necessary, which requires a genuine, long-term commitment to local communities.

Public perception: Nuclear energy often generates concern and mistrust due to the risks associated with accidents and hazardous waste.

10.4 Implementation Challenges

Lack of knowledge and capacities: Lack of technical knowledge and institutional capacities can hinder the development of nuclear projects.

Preparation for new technologies: Countries should prepare for the incorporation of technologies such as small modular reactors (SMRs), which offer modularity and firmness to complement renewables

11. Conclusions

The use of nuclear energy for electricity generation in the Latin American and Caribbean region is currently concentrated in only three countries in the region: Argentina, Brazil and Mexico, with a total combined capacity of 5,353 MW, of which 1,755 MW are in Argentina, 1,900 MW in Brazil and 1,608 in Mexico, respectively representing 4%, 1% and 2% of the total installed capacity of these countries and altogether 1% of the total installed capacity of the region.

The three countries with nuclear power capacity in the region have plans to increase their installed capacity of this technology in the medium term and other countries in the region that do not yet have this technology are beginning to show interest in integrating it in the future into their generator park.

With the reduction of costs and implementation periods of nuclear power plants, the increase in safety levels and the future massification of the supply of small modular reactors (SMR), nuclear energy can become one of the most viable alternatives to replace conventional thermoelectric plants and the use of fossil fuels, reducing the carbon footprint of the regional electricity generation matrix.

South-South cooperation is important in the field of Latin America and the Caribbean to take advantage of the expertise and lessons learned from the three countries in the region that have already traveled the path of the implementation of thermonuclear power plants in their respective territories, such as Argentina, Brazil and Mexico.

It is essential for countries interested in exploring the use of nuclear energy for electricity generation to start organizing and developing the right ecosystem for advancing this technology. This involves engaging government institutions, academia, the private sector, the financial sector, and civil society.

12. Bibliographic References

- Ministry of Economy of Argentina (consulted in 2025). Nuclear Energy, Generating sustainable, clean and safe energy for a developing country. https://www.argentina.gob.ar/economia/energia/energia-electrica/nuclear
- World Nuclear Association. (2025). Nuclear Power in Argentina Nuclear Power in Argentina - World Nuclear Association
- Nuclear Forum. (2019). The Argentine Nuclear Power Plant Embalse, prepared to operate for another 30 years. Source: https://www.foronuclear.org/actualidad/noticias/la-central-nuclear-argentina-embalse-preparada-para-operar-30-anos-mas/

- Nuclear Forum. (2024). The Brazilian nuclear power plant Angra 1, authorized to operate for another 20 years. https://www.foronuclear.org/actualidad/noticias/la-central-nuclear-brasilena-angra-1-autorizada-para-operar-20-anos-mas/

- Nucleoeléctrica Argentina. (consulted in 2025). Reservoir https://www.na-sa.com.ar/es/centrales-nucleares/embalse

- Nucleoeléctrica Argentina. (consulted in 2025). Atucha 1 Source: https://www.na-sa.com.ar/es/centrales-nucleares/atucha-2

- Nucleoeléctrica Argentina. (consulted in 2025). Atucha 2 Source: https://www.na-sa.com.ar/es/centrales-nucleares/atucha-2

- Sol Pedre/IGN. (Accessed in 2025). The CAREM Project https://www.ign.gob.ar/odc-13-pedre

- **World-Nuclear.org. (**Accessed in 2025**). Nuclear power in Mexico.** https://world-nuclear.org/information-library/country-profiles/countries-g-n/mexico

- **Government of Mexico (**Accessed in 2025**). Uranium in Mexico.** https://www.sgm.gob.mx/Web/MuseoVirtual/Aplicaciones_geologicas/El-uranio-en-Mexico.html

- Agencia Brasil. (2024). Brazil wants to expand the use of nuclear energy https://agenciabrasil.ebc.com.br/es/economia/noticia/2024-07/brasil-quiere-ampliar-el-uso-de-la-energia-nuclear

- Geological Survey of Brazil. (2025) An overview of critical and strategic minerals potential of Brazil. Critical and Strategic Mineral Potential of Brazil 2025_.indd

- Electronuclear. (Accessed in 2025). Angra 2 https://www.eletronuclear.gov.br/Nossas-Atividades/Paginas/Angra-2.aspx

- Electronuclear. (Accessed in 2025). Angra 3 https://www.eletronuclear.gov.br/Nossas-Atividades/Paginas/Angra-3.aspx#

- Nuclear Energy Agency -NEA. (2020) Low-carbon generation is becoming cost competitive Source: https://www.oecd-nea.org/jcms/pl_51126/low-carbon-generation-is-becoming-cost-competitive-nea-and-iea-say-in-new-report

- International Trade Administration. (2025). Colombia Nuclear Energy https://www.trade.gov/market-intelligence/colombia-nuclear-energy?utm_source=chatgpt.com

- Bancolombia (2025). Nuclear energy: growth, challenges and opportunities in the world and Colombia https://www.bancolombia.com/empresas/capital-inteligente/actualidad-economica-sectorial/por-que-colombia-no-tiene-energia-nuclear?utm_source=chatgpt.com

- Cicion PRW (2025). El Salvador and Thorium Energy Alliance Sign MOU for Civilian Nuclear Deployment. https://www.prweb.com/releases/El_Salvador_and_Thorium_Energy_Alliance_Sign_MOU_for_Civilian_Nuclear_Deployment/prweb19233545.htm?utm_source=chatgpt.com

- Library of Congress No. (2025) El Salvador: Law on Nuclear Energy Enacted https://www.loc.gov/item/global-legal-monitor/2025-01-10/el-salvador-law-on-nuclear-energy-enacted/?utm_source=chatgpt.com

- IAEA (2025). El Salvador Signs a Country Programme Framework (CPF) for 2024–2029. https://www.iaea.org/newscenter/news/el-salvador-signs-a-country-programme-framework-cpf-for-2024-2029?utm_source=chatgpt.com

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