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The rise of the Argentine Nuclear Program and the thwarted dream of industrialization (1950-1984)

MILAGROS ROCÍO RODRÍGUEZ (Universidad de Buenos Aires)

https://orcid.org/0000-0001-8879-5298 | mily_89r@hotmail.com

ABSTRACT

The rise of the Nuclear Program in Argentina took place during the second stage of the process of Import Substitution Industrialization, which encourage local industry and the development of metalworking and electronics. In this context, one of the central aims of the National Atomic Energy Commission (CNEA) was to improve the domestic industry of goods and services in order to supply future nuclear power plants and promote technological autonomy. However, this philosophy began to struggle with the neoliberal reforms that were implemented after 1976.

The primary objective of this work is to draw and analyze the main strategies implemented by CNEA to promote local industry. In this sense, this paper will be focus in the creation of the Metallurgy Department (1955), the Technical Assistance Service to Industry (1962), the National Industry Group (1965) and the creation of an Industrial Architect, ENACE SA (1980).

KEYWORDS: Argentina Nuclear Program; Economic Development; Nuclear Industry; Technological Autonomy; State

JEL CODES: N76; O14; 033; H00

1. Introduction

Following the end of World War II, the leading states involved in nuclear programs, including the United States, France, and the United Kingdom, assumed a pivotal role through the establishment of public agencies such as the US Atomic Energy Commission, the Commissariat à l'énergie atomique, and the United Kingdom Atomic Energy Authority, respectively. These agencies were responsible for various aspects, including personnel training, radiation safety, and the development of nuclear applications. However, it became evident that the active participation of industries, along with other actors such as universities, was crucial for the successful advancement of nuclear technologies. The generation of nuclear power entails a broad range of industrial activities, both nuclear-specific and conventional, which are not readily available even in highly industrialized countries (Frewer and Altvater 1977). Only in regions where there was a fluid collaboration between the state, industry, and the research and development (R&D) sector, was nuclear energy able to expand effectively. The interplay between these actors facilitated the necessary infrastructure, technological advancements, and expertise required for the development and operation of nuclear power plants.[1]

Several developing countries recognized the potential of nuclear programs as a cornerstone of their industrialization strategies. The appeal extended beyond the provision of abundant electricity and modernization; it encompassed the consolidation of capital goods industries as well (Rubio Varas and De la Torre 2017, pp. 13). Several developing countries recognized the potential of nuclear programs as a cornerstone of their industrialization strategies. Argentina, Brazil, Mexico, and Spain, despite their distinct circumstances, shared a common vision of the nuclear industry as a means to overcome underdevelopment.[2] In the case of Latin American nations, it also served as a catalyst for the deepening of the import substitution industrialization model. While similar intentions existed in other developing countries before the 1970s, such as India, a notable distinction lies in the fact that the Ibero-American countries did not pursue the production of atomic bombs.[3]

By the 1970s, Spain, Brazil, Mexico, and Argentina had each experienced varying degrees of integration between their nuclear programs and national industries. In Spain, the involvement of private electricity companies and banks in nuclear power dates back to 1960, leading to the monopolization of commercial activities (De la Torre and Rubio Varas 2015; 2018; Garrués-Irurzun and Rubio-Mondéjar 2017; 2018; Romero de Pablos 2012). In Brazil, nuclear policies aimed at rapid export-led growth and macroeconomic stability, resulting in limited space for national private industrial and technological resources due to a reliance on state entrepreneurship and foreign technology (Ribeiro de Andrade 2006; 2012; Solingen 1996; Spektor 2016). In the case of Mexico, the consolidation of a local nuclear industry was hindered by the commercial influence of the United States, a fragmented decision-making process, and an import-oriented equipment policy (Vera 2018; Mumme 1991; Azuela and Talancón 1999; Sarquis 2013).

It has been noted that the Argentine Nuclear Program achieved better outcomes in the development of the nuclear industry compared to Brazil and Mexico, although it lagged behind the Spanish case (Cabral 1991; Rodríguez 2021; Solingen 1996). Argentina took an early lead in 1950 with the establishment of the National Atomic Energy Commission (CNEA), and the Nuclear Program was consolidated as a state monopoly with substantial

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[1] In the field of Social Studies of Science and Technology there are several theoretical models that analyze the nature of this link, such as the 'Sabato triangle' (Sabato and Botana 1968), the 'Iron Triangles' (Balogh 1991) or the 'Triple Helix' innovation model (Etzkowitz and Leydesdorff 2000).

[2] Following Hurtado and Romero de Pablos, the nuclear development of Argentina, Brazil and Mexico are often compared in studies that consider Latin America as the unit of analysis (2012). The inclusion of Spain in this trend can be justified by affinities in the dynamics of technological development and it allows to highlight some political and economic determinants typical of Latin America. For a comparative study between Mexico, Brasil and Argentina see Cabral (1991) and Luddeman (1983). For a comparative study between Brasil and Argentina, see Adler (1987), Hagood (2006), Poneman (1982) and Soligen (1996). For a comparative study between Spain and Argentina see Rodríguez (2021).

[3] As Sarkar pointed out, the leaders of the Indian nuclear program saw in nuclear fission the possibility to augment geopolitical goals of the territorial state as well as the technopolitical goals of the developmentalist state, leading to a large dual-use enterprise, simultaneously serving military and civilian ends (2022: 2).

funding.[4] Unlike other scientific institutions, CNEA received support from every government between 1950 and 1984, enjoying full autonomy in setting its objectives.[5] This way, by 1984, Argentina had two operational nuclear power plants, Atucha I and Embalse de Río Tercero, which accounted for 15% of the country's total electricity generation. Construction was underway for Atucha II, and numerous facilities associated with the nuclear fuel cycle were scattered throughout the nation (Figure 1).

The emergence of the Argentine Nuclear Program took place within the framework of the Second Stage of Import Substitution Industrialization between 1955 and 1976.[6] This period witnessed the strengthening of the metal-mechanic and electronic industries through foreign investment, as part of the broader objective to promote economic development and reduce dependency on central countries, a viewpoint advocated by many Latin American intellectuals (Dagnino, Thomas, and Davyt 1996).[7] During this time, a philosophy or "institutional mystique" known as "technological autonomy" emerged within CNEA. According to Jorge Sabato, this notion referred to the acquisition of knowledge and skills through practical problem-solving. The goal was to enhance decision-making capacity regarding local development and production, as well as the importation of technologies. The focus was not on achieving technological autarky but rather on defining sustainable technological packages that could be adapted to existing economic and social conditions, whether they were imported or developed domestically (Sabato 1983).

The pursuit of technological autonomy also required the support of a capable local industry that could provide high-quality supplies and services. Given the limitations of Argentine manufacturing, it was crucial for the innovation processes at CNEA to spill over into the private sector through various mechanisms. As Evans (1995) suggested, when private capital lacks vitality, the state can play a "midwifery" role by encouraging the emergence of new business groups or motivating existing ones to venture into riskier areas. At CNEA, this strategy materialized in a comprehensive policy of technological spillover aimed at stimulating national industry and the private sector.

[4] It should be noted that, until the end of the 80's, 98% of the total energy generated in the country was managed by public companies (FIEL, 1987).

[5] Juan Domingo Perón (1946-1955, Justicialist party); the 'Liberating Revolution' (1955-1958, de facto military government); Arturo Frondizi and José Maria Guido (1958-1962, Intransigent Radical Civic Union party); Arturo Illía (1963-1966, People's Radical Civic Union party); the 'Argentine Revolution' (1966-1973, de facto military government); Héctor Cámpora and Raúl Lastiri (1973, Justicialist Front for National Liberation party); Juan Domingo Perón and Isabel Perón (1973-1976, Justicialist Front for National Liberation party); the 'National Reorganization Process' (1976-1983 de facto military government).

[6] The First Stage of Import Substitution Industrialization in Argentina began after the Great Depression (Belini, 2017).

[7] The Latin American Thought in Science, Technology and Development, grouped together intellectuals such as Jorge Sabato, Oscar Varsavsky, Amílcar Herrera, Osvaldo Sunkel, Enrique Oteiza, Francisco Sagasti, Máximo Halty Carrere, among others.

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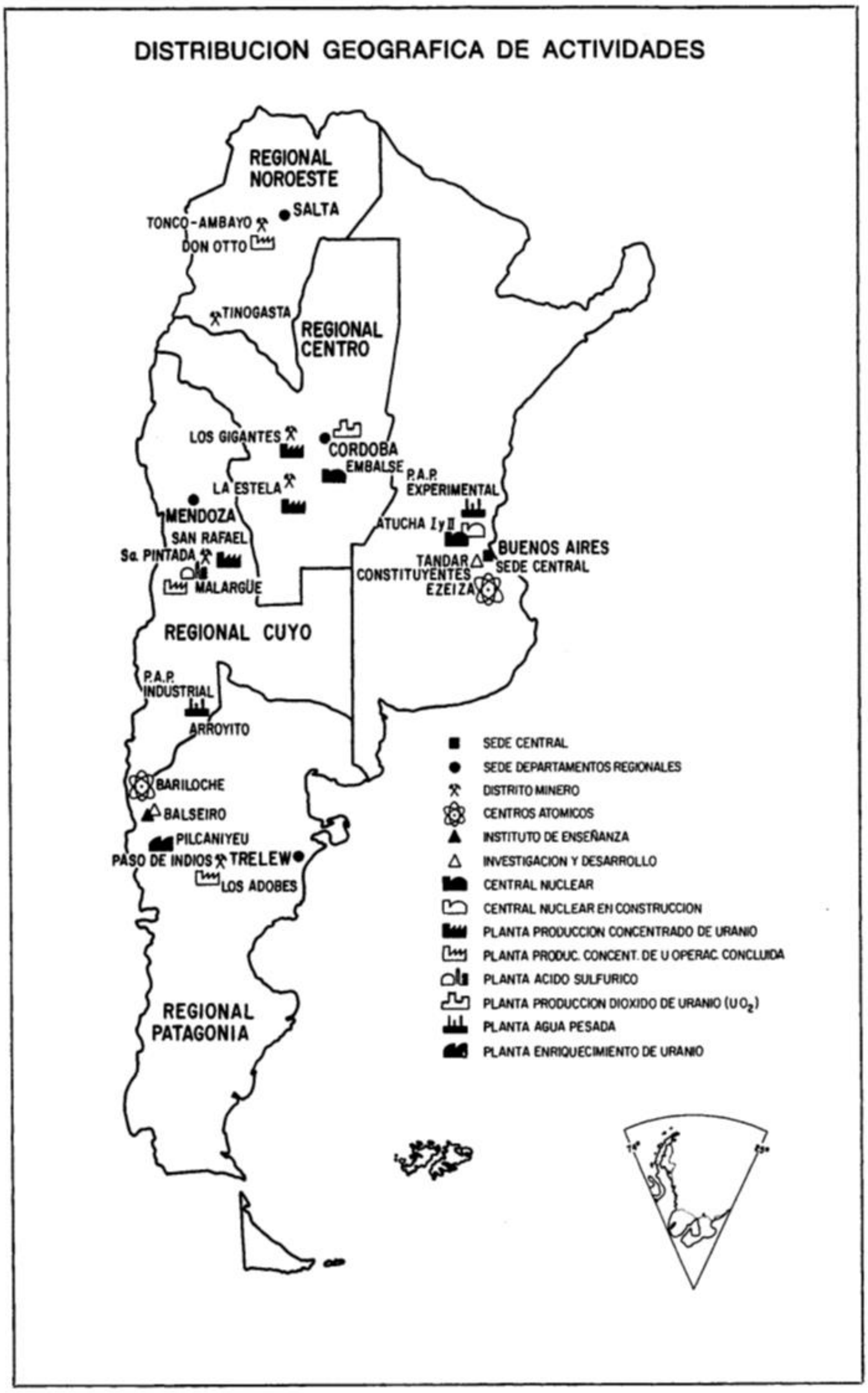
FIGURE 1. Geographical distribution of CNEA's nuclear facilities



Source: CNEA (1985).

This paper will focus on four milestones that contributed to the crystallization of the technological autonomy philosophy within the Argentine Nuclear Program: (1) the establishment of the Metallurgy Department in 1955, (2) the creation of the Technical Assistance Service to Industry (SATI) in 1962, (3) the construction of nuclear power plants based on the "opening of the technological package" model, and (4) the genesis of the Industrial Architect (IA)[8] as a joint venture between CNEA and Siemens KWU, leading to the formation of Empresa Nuclear Argentina de Centrales Eléctricas SA (ENACE) in 1980.[9]

Despite the geopolitical significance of the nuclear power sector, its history in Argentina remains limited, primarily within the field of Social Studies of Science and Technology. Only recently has a national history of the sector started to take shape, but economic history has played a minor role in its development.[10] Studies that link nuclear power to the industrial sphere are scarce, and more importantly, there are no official statistics available on the nuclear or conventional industries involved in the Argentine Nuclear Program. This deficit is not surprising considering that the historiography of the local industry lags behind studies conducted in central countries. The deindustrialization process that commenced in Argentina after 1976, and intensified during the 1990s, shifted the focus away from this topic. Only in recent years has the subject regained attention as researchers seek to understand the reasons behind the failure of the local industrialization process.

This study aims to examine the four milestones mentioned earlier, with a particular focus on the public policies implemented by CNEA to promote local industry. On one hand, this analysis will shed light on why a peripheral and developing country like Argentina chose to pursue a nuclear program. On the other hand, it will underscore the challenges and limitations of these policies, contributing to an understanding of the shortcomings in the local industrialization process. It will be argued that despite CNEA's efforts, private companies benefited from this process but never assumed a leading role in the nuclear program. In the conclusion, key elements will be provided to stimulate further discussion and debate in the future.

2. A Nuclear Program in Argentina

The origins of the Argentine Nuclear Program stepped into history by the 'Richter's affair', a scandalous episode that took place during the government of Juan Domingo Perón (1946-1955).[11] But, usually, this bizarre experience tends to obscure that interest in atomic technology can be found even before Peron's government. After the explosions in Hiroshima and Nagasaki (1945), nuclear investigations and its energy potential aroused the interest of the Argentine Armed Forces. Thus, in October 1945, a new decree (*Decreto del Poder Ejecutivo*, hereafter DPE) prohibited the export of uranium minerals under the premise that these minerals could be used to produce energy in the future (DPE

[8] The IA of a Nuclear Power Plant is the organization aimed at planning, engineering, and management of the Project.

[9] A last strategy could be mentioned, regarding the creation of *joint ventures* linked to the fuel cycle, but for reasons of extension this milestone will not be included in this work. See Rodríguez (2019).

[10] An approach from the Social Studies of Science and Technology can be found in Fernández (2010); Hurtado de Mendoza (2005; 2009; 2012; 2014), Marzorati (2012). For an Economic History perspective, see Lugones (2020) and Rodríguez (2014; 2015; 2019; 2020; 2021).

[11] A complete analysis of 'Richter's affair' can be found in Mariscotti (1987).

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2285/45).[12] The legislation, drafted by General Manuel Savio[13], started uranium prospecting in the national territory through the Dirección General de Fabricaciones Militares, which Savio directed since its creation in 1941 (Mundo Atómico 1955a).

Why were the military forces concerned about the energy issue in Argentina? To get a proper answer, it is necessary to follow some of the economic problems in the country during the 30's and 40's. In those years, the Armed Forces began to perceive that national defense must necessarily include the promotion of local manufactures and power generation, which would reduce imports and ensure the supply of critical goods and services (Gerchunoff and Llach 1998; Rougier 2013; Solberg 1986). For these reasons, some nationalist slogans, such as 'economic liberation' and 'national autonomy' had long spread in society. The military coup of 1943, called 'The 1943 Revolution', consummated the power of certain pro-industrial sectors and consolidated this trend.[14]

However, the shortage of fuel and electrical energy became a major dilemma to solve. Even though the dictatorial government made several efforts in terms of regulation and control, the dependence on imported fuels ─especially, US oil─ continued to increase, adversely affecting the trade balance. In 1953, 23% of Argentine imports corresponded to liquid fuels, which represented about 55 million dollars (Gadano 2006, pp. 642).[15] Combined with the falling of currency reserves and the deterioration of the terms of trade after 1949, fuel imports become a major macroeconomic problem.

The provision of cheap energy was essential to promote the Import Substitution Industrialization process. In this sense, the policies outlined by the governments of 1943 Revolution were reinvigorated after the election of General Juan Domingo Perón, who ruled between 1946 and 1955. Through the Five-Year Plans, efforts were aimed at creating new industries, encouraging existing ones and increasing the added value of exports. More specifically, the second Five-Year Plan of 1952 was oriented to the development of basic industries such as steel, metallurgy, aluminum, chemical, metalworking, machinery, and equipment. These transformations led to the decrease of the traditional industries (food, beverages, tobacco) and the advance of intermediate and basic industries (vehicles and machinery, electrical appliances, metals, rubber, and oil). However, it is important to emphasize that this progress was far behind the developed

[12] '[…] es previsible el empleo de dichos minerales en la obtención, dentro de un plazo que puede ser relativamente breve, de energía industrialmente aplicable'. (DPE 22855/45). The early nationalization of uranium deposits can also be traced in the Spanish and Mexican case (Rodríguez 2021; Vera 2018).

[13] Manuel Savio was a military officer and engineer who played a central role in the dawn of industrialization in Argentina, particularly in relation to the mining and steel industry.

[14] On June 4, 1943, the United Officers Group, a secret society that grouped colonels and lieutenant colonels of the armed forces. carried out a coup to the de facto government of Ramón Castillo with the aim of maintaining neutrality during the World War II and preventing the advance of communism. Until the democratic elections of 1945, the government was in charge of General Pedro Ramírez (1943-1944) and Edelmiro Farrell (1944-1946).

[15] Current dollars amounts were calculated on the exchange rate extracted from Officer (2020).

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countries, and had some structural limitations based on the lack of equipment and technology (Belini 2017, pp. 255).

In this context, after de end of the World War II, the government of Juan Domingo Perón made significant efforts to attract German scientists to achieve technological transfer and acquire know how. However, this strategy was only viable in cases where engineers had not been required by the occupying forces (Stanley 2004, pp. 30). Through a secret mission, some specialists were brought into the country between 1947 and 1949, including Kurt Tank and Ronald Richter.[16] Richter was an Austrian physicist who had worked with Manfred Von Ardenne in Berlin and, after some negotiations, agreed to travel to Argentina without signing any contract. During the meeting with Perón, Richter claimed to be capable of producing cheap and unlimited energy through nuclear fusion, a process that even then was not considered feasible by developed countries. Perón, who was politically isolated from the scientific community, supported this ambitious utopia with enthusiasm. Shortly after, Richter settle in the island of Huemul, located in Bariloche, with a huge laboratory at his disposal and was entrusted with presidential authority. Still, he was reluctant to bring local scientists into the project (Mariscotti 2018).

After a year of work, and the import of several equipment, the physicist notified the success in the task. The new was announced by Perón himself to the international media, causing concern in the nuclear countries and skepticism from the global academic community. However, the absence of convincing explanations in the months that followed the event, added to Richter's refusal to repeat the experiment, led to the formation of a scientific commission who investigated the island. The final report was astonishing: Richter's findings were not only due to instrumental error, but to misinterpretation of the results. In other words, the experiment was a fraud. In November 1952, the Huemul Project was dismantled, thus closing one of the most infamous and scandalous episodes of scientific development in Argentina.

Even so, the 'Richter affair' did not mean the end of nuclear aspirations: from then on, it was clear that atomic technology already had a place on the public agenda. Beyond failure, the Peronist government clearly perceived the relevance that atomic research had in the developed world and made great efforts to achieve the mastery of that technology. In this sense, the National Atomic Energy Commission was created during Richter's years but, paradoxically, its initial organization has little to do with its later trajectory. The original entity did not aim to form personnel but rather to grant an administrative framework to Huemul, whose budget depended on the National Directorate of Migration (Mariscotti 2018, pp. 111). However, this milestone was also decisive in officializing the project and putting an end to the policy of secrecy. The institution was in charge of coordination, control and stimulation of research, radiological defense, and advice to the Executive Power. All pre-existing and future research related

[16] Kurt Tank was a was a German aeronautical engineer and test pilot who came to Argentina in 1947. He worked in the Military Aircraft Factory and developed several airplanes prototypes, such as the Pulqui I and II, the Huanquero, and the Cóndor.

to the atom had to be reported immediately to CNEA, which would hold federal control of nuclear activities.[17] Entity direction would remain in the hands of the Armed Forces, although the decree stated that Argentina had no offensive intention (DPE 10936/50).[18]

Nevertheless, it is important to note that the original CNEA was not allowed to train specialized personnel. For this reason, a National Atomic Energy Directorate (DNEA) was organized independently of Huemul, and its main function would be to train technical personnel in atomic issues, produce and commercialize uranium and radioisotopes, establish a radiological safety system, disseminate scientific facts, and organize a specialized library (DPE 9697/51).

The existence of DNEA explains why the closure of Huemul did not imply the end of nuclear aspirations, and it is in this sense that these institutions became the key from which the Nuclear Program could be 'relaunched': less grandiloquent, perhaps, but professionalized. The epicenter of the atomic investigations moved to Buenos Aires and the training of personnel occupied a privileged place. It was decided to hire young professionals and advanced students, who were trained by specialists from other universities and sent to laboratories in Europe or the United States. Additionally, DNEA hired international specialists to teach intensive courses in the country, including different disciplines such as medicine, radiological defense, metallurgy, nuclear chemistry, and nuclear reactors.[19] By those years, the research focused on basic sciences allowed CNEA to participate at the first Geneva Conferences (1955), in which Argentine scientists presented 37 papers (Iraolagoitía 1955).

3. 'A window into reality': The Department of Metallurgy and the SATI

The CNEA achieved institutional consolidation between 1955 and 1966, in a scenario of exceptional stability. Unlike what happened in other Argentine institutions, after the fall of Perón, the CNEA not only continued to carry out its activities normally, but also received the active endorsement of the governments that followed until the 80's. In fact, the management of the entity was almost uninterruptedly under the presidency of Rear Admiral Oscar Quihillalt.[20] The sole significant change was the merge of DNEA into CNEA in 1956 (DPE 384/55; Decreto Ley 22499).

[17] Regardless of Huemul, there were isolated groups or individual scientists who had been working on atomic technology. This is the case of the group of radiochemicals lead by Dr. Seelmann Eggebert or the 'Grupo de Buenos Aires', which was formed at the University of La Plata to investigate physical aspects of radioactivity (Radicella 1999).

[18] '[Argentina], despreocupada de toda intención ofensiva, puede trabajar con […] elevado sentido de la paz en beneficio de la humanidad' (DPE 10936/50).

[19] Some of the specialists who visited the country were: Aten from Holland (chemistry and radiochemistry), Bouissières and Travers from France (chemistry and radiochemistry), Götte from Germany (chemistry and radiochemistry), Maddock from England (chemistry and radiochemistry), Dole from the U.S. (chemistry and radiochemistry), Marchetti from Italy (chemistry and radiochemistry); Hittmail and Beck from Austria (physics); Cahn of England (metallurgy). In CNEA (1956).

[20] The only exception was a brief interregnum of a year and a half in which Admiral Helio López was appointed to the charge.

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Those years were also the scene of several industrial transformations. Since the mid-50’s, the economy has moved towards a second stage of Import Substitution Industrialization, also known as the ‘complex phase’, based on intermediate and capital goods. However, the chronical lack of currency and the fall in the terms of trade, hindered basic imports to complete this transition. From the standpoint of Argentine developmentalism, this obstacle could only be overcome with the investments of foreign capital, which were settled in sectors such as transportation, chemical industries, and machinery (Basualdo 2007; Belini 2017; Gerchunoff y Llach 2018).

While the energy issue was still a major problem, power reactors were set as a long-term goal in Argentina. In this context, the need for industrial development was early perceived by CNEA scientists as a difficult obstacle to solve. In 1954 the CNEA hired Jorge Sabato, from the Metallurgical Investigations company (IMET), to provide advice on metallurgy of the fuel elements. The following year the Metallurgy Division was created, and Sabato became its full-time director. Moreover, the entity acquired a very particular characteristic: at the request of Sabato, the Division obtained an important autonomy to set its own goals aside from CNEA.

At that time, although a few metallurgists could be found in the country, there was no university degree in engineering or metallurgical physics and no specific local courses were dictated on these subjects. In other words, the professionals in the sector had empirical knowledge but did not had training in basic sciences (Sabato 1962). Instead of creating a division that would only attend Nuclear Metallurgy issues, Sabato decided to establish a space to solve general problems related to the industrial sector. In this way, the Division could help to improve the quality and efficiency of all local goods and promote the professionalization of the discipline. To achieve these goals, he pointed that it was necessary to build a broad base of scientific-technical knowledge that could solve specific problems with ‘an open mind’ (Sabato 1973a).

In those years, a group of graduates from engineering, aeronautics, mechanics, physics, and chemistry received instruction in modern metal physics. The original 20 members, nicknamed ‘La Murga’, were trained in the most important centers of the world: Birmingham, Stuttgart, Paris, Illinois, among others. Sabato himself stayed between 1957 and 1958 in the Birmingham laboratory to study the crystallization of uranium under pressure under the direction of Professor Robert Cahn (CNEA 1957). In parallel, the CNEA organized courses with local and foreign experts. As a result, in 1960 the Division was transformed into a Metallurgy Department and had 25 professionals, 50 technicians and several facilities (Sabato 1962).

The ‘baptism of fire’ of this strategy came soon after. In 1957 Quihillalt, director of CNEA, traveled to the Argonne National Laboratory in Chicago to see a small reactor that was put into operation some weeks before. It was the *Argonaut*: a cheap, low-power

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machine, useful for the training of human resources and the production of radioisotopes.[21] After that visit, Quihillalt was convinced that the reactor could be built in Argentina with local technology and estimated that the cost could not exceed the amount of USD 100,000. He traveled back to Washington and meet John Hall, US AEC external relations officer, who gave his approval for Quihilallt to acquire the blueprints. In addition, CNEA was allowed to send three technicians to visit and train in the laboratory (Hurtado de Mendoza 2014, pp. 82). Hall's willingness was based on the technical assistance agreements signed between the US and Argentina during the early years of the Atoms for Peace program (Mundo Atómico 1955b).

It was, however, a complex task. Velia Hoffman, a civil engineer who participated in the project, pointed out:

> "But let me be clear that the blueprints were only… the blueprints. A sheet of paper with sketches. […] Now, how is the container made of these alloys built? How thick? Who knows how to weld it? What tolerance do you have to have in the measurements to be exactly half a centimeter more or half a centimeter less? How much of that can disturb? […] Well, all of that had to be absolutely developed in here".[22]

Through this decision, CNEA could select those components that were manufactured locally and encourage the participation of Argentine science and technology. This modality was later baptized by Sabato as 'opening the technological package' (Sabato 1973a). The fuel elements were developed by the Department of Metallurgy, and in 1957 some samples were sent to Chicago for testing. The response was surprising: Argentine fuel elements were superior to those manufactured in the United States (CNEA 1958b). The technology was patented shortly after and sold to a West German company (Degussa).

The construction of the first experimental reactor, called RA-1, became a central milestone in CNEA. Not only the modality of 'opening the technological package' was institutionalized but also the policy of promoting local industry was made explicit as a strategic goal. Contrary to the general macroeconomic trend, in which foreign companies had major role, several components of RA-1 and all the fuel elements were developed in the country with the participation of 32 Argentine industrial companies (Hurtado de Mendoza 2012, pp. 167).[23] Following Quihillalt, CNEA only imported the enriched uranium, nuclear-grade graphite (France), and some electronic materials. After nine months of works, the RA-1 reached criticality on January 17, 1958, and was originally

[21] The original *Argonaut* (Argonne Nuclear Assembly for University Training) was built at Argonne National Laboratory and went critical for the first time on February 9, 1957. Although many have been built throughout the world, over a wide range of power levels, the original reactor was rated for 10 kilowatts.

[22] Interview conducted by the author to Velia Hoffman in June 1, 2013. Hoffman started her career in CNEA in 1955 and worked on de division of Nuclear Reactors. She actively contributed to the commissioning of the RA-1. Author's translation.

[23] The 20% of enriched uranium was leased to the United States under the Cooperation Agreement signed in 1955 (CNEA 1958a).

rated for 10 kilowatts. It was the first research reactor in Latin America and was also the first time that the United States had exported uranium without including fuel elements (CNEA 1958a, pp. 11). This experience was followed by others, the RA-0 (1960), RA-2 (1966) and RA-3 (1967), all of them with a gradual increase of the participation of local suppliers.

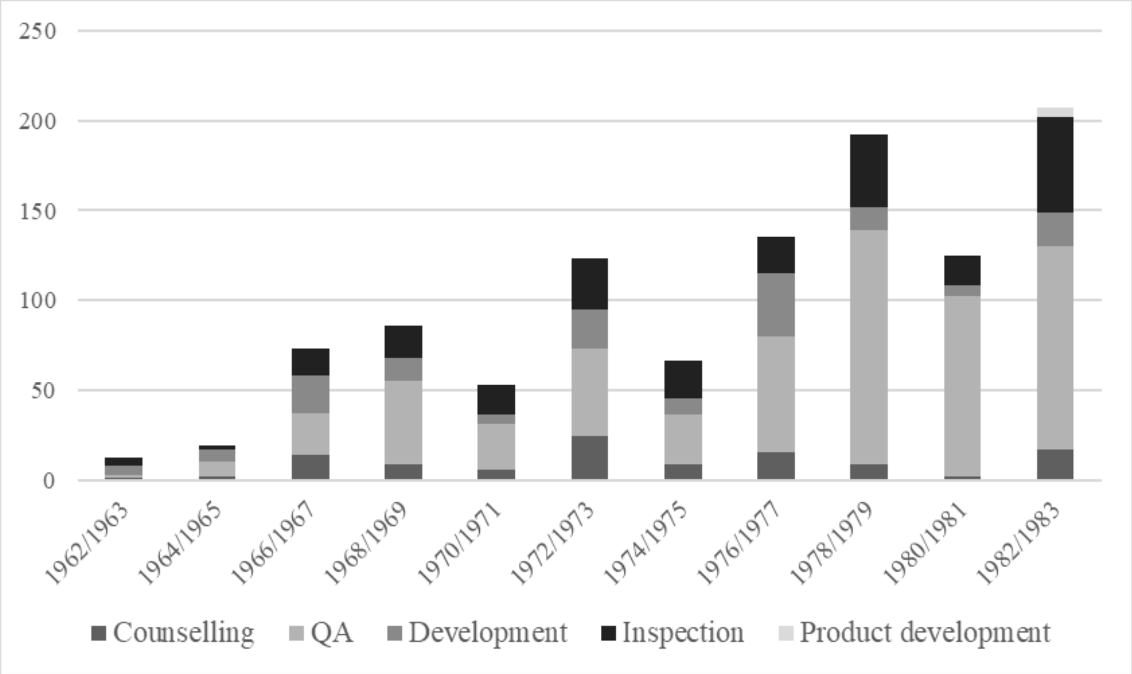
Those were certainly years of institutional consolidation. On one hand, metallurgy training became a major goal in CNEA. In 1955 the specialization degree in Physics of Metals was created at the Balseiro's Institute (Bariloche) (CNEA 1963, pp. 9). In 1962, the Training Program extended its action to the rest of America through the Pan-American Metallurgy Courses.[24] Thus, it is estimated that between 1955 and 1980, 600 professionals were trained in the region (Sabato and Tanis 1983).

On the other hand, the seek for development of the national industry was formalized with the creation of the SATI. Through an agreement between the CNEA and the Association of Metallurgical Industries of the Argentine Republic (AIM), celebrated in March 1961, a scientific-technological assistance and advice service in metallurgy for Argentine industry was established. The entity was financed by the AIM as a nonprofit organization that would depend on the CNEA Metallurgy Department and would contribute to the technical training of industrial personnel (CNEA 1961). The SATI's *modus operandi* was organized into two types of services: counselling and problem solving. In the first case, the entity would provide bibliographic information, given that CNEA Library was one of the most complete in the country. Additionally, the agency could carry out a technical and economic evaluation. In the second case, the SATI would solve the problem through a work plan and an estimated budget.

The results are noticeable. During its first three years of life (1961-1964) the SATI received 280 inquiries from different sectors of the metallurgical industry, most of which were small and medium-sized companies. Additionally, it provided training for about 70 technicians (Sabato 1962). It is estimated that between 1960 and 1983, SATI carried out a total of 1,092 assistance services. As can be seen on the Figure 2, an important section corresponds to the type of 'quality control' (QA) and the peaks of work are associated with the installation of the nuclear power plants after the 60's: Atucha I (1966-1974), Embalse (1972-1983) and the first stage of Atucha II (1979-1983).

[24] Pan-American courses were jointly organized by CNEA, the Organization of American States and the International Atomic Energy Agency in Buenos Aires for 20 students who also received a scholarship (Sabato 1962).

FIGURE 2. Assistance Services provided by SATI, by type (1962-1983)



Source: CNEA (1985).

Both the Metallurgy Department and SATI constituted not only a first stage of dialogue between the CNEA and the industrial sector, but also, according to Sabato, they would be 'a kind of window into reality' (1973a). Both experiences allowed to learn about the real state of the technological development of the industry and, consequently, its possibilities of participation in the Nuclear Program. As we will see shortly, this knowledge was essential to articulate the goals of the next stage: the nuclear power reactors.

4. The rise of nuclear energy: Atucha I nuclear power plant

After 1964 the generation of nuclear power was included among CNEA's short and medium-term objectives with the aim of achieving an increasing participation of national industry in nuclear program (CNEA 1965, pp. 5). The goals that had been pursued as an 'implicit' policy were formalized in the 'Argentine Nuclear Program 1967-1977' (Sabato 1973b). The ten-year plan included the start-up of at least one nuclear power reactor, the achievement of radioisotopes'self-sufficiency and the development of the entire fuel cycle.

At that time, economic growth provided a favorable context for large electrical ventures. The *de facto* government of the 'Argentine Revolution' (1966-1969) developed public works in strategic areas –such as roads, bridges, dams, houses and schools- that would strengthen the alliance between the State and its contractors of goods and services (Basualdo 2013, pp. 60). On the other hand, between 1964 and 1974 there was an unprecedented process of continuous growth, based on the maturation of foreign investments, public spending, and salary increasement. During this period, it is estimated that employment grew at a rate of 2% per year and production at a rate of 5.9% per year (Belini 2017). The sectors that leaded the expansion were the automotive, metalworking, iron and steel, chemical and petrochemical industries.

In the context of a sustained increase in electricity consumption, the feasibility study for the first Argentine nuclear power plant was made official (DPE 485/65). Between 1965 and 1966, two types of reactors —natural and enriched uranium— were analyzed at two power levels —300 MW and 500 MW— determined by the capacity of the network in north Buenos Aires (CNEA 1966, pp. 160).[25] In this sense, the pursuit of technological autonomy guided the debate on two central topics: (1) which actors would intervene in the construction of the plant and under what type of contract and (2) what kind of reactor would be used. Regarding the first question, opinions within CNEA were divided into two groups. On the one hand, there were a few scientists that supported the development of an intermediate prototype 'made in Argentina' that allowed to later jump into scale production. The promoters of the 'linear model', purely based on local technology, included Dan Beninson (Safety and Inspection Manager) and Celso Papadópulos (Energy Manager). On the other hand, some members of CNEA considered that it would be wiser to shorten the path by purchasing a turnkey plant, like another peripheral countries usually did. However, to promote technology transfer and self-decision-making, the CNEA would carry out the feasibility study and ensure the participation of local industry by opening the technological package. As had happened in the past, this strategy would guarantee national contribution in less complex areas, such as civil engineering, auxiliary services, and some components (Fernández 2010, pp. 15). This approach, led by Sabato (Technology Manager), finally prevailed.

The second topic of debate was related to the type of fuel that the plant would use. This issue was particularly relevant, due to the investment needed to supply fuel to a plant throughout its useful life is equivalent to the cost of installation (APCNEA 1972). For this reason, the feasibility of producing fuel elements locally or importing them became an aspect of great economic impact, although limited by two options: the use of enriched uranium-light water or enriched uranium-heavy water. While the former worked with a modern, smaller, and cheaper design, the supply was a complicated matter. Producing enriched uranium in the country was not viable, not only because the technology would take years to develop and required large capital outlays, but it was also subject to the safeguards system. Finally, opting for enriched uranium meant strengthening dependence on the only feasible supplier: the United States. In those years, foreign relations with North America had become a thorny issue because of Argentina's refusal to sign the Non-Proliferation Treaty (1968), and the country was excluded from Exim-Bank financing.[26]

[25] The region was chosen because it represented the largest part of the national electricity demand and had an electrical system capable of supporting the contribution of the future plant.
[26] After China's nuclear detonation in 1964, the Nuclear Non-Proliferation Treaty (NPT) was promoted by the United States and the Soviet Union. The member countries would be divided into two groups and would have different obligations: on the one hand, those nations that had not developed nuclear weapons would be prohibited from manufacturing, acquiring or storing them, and the access to fissile material was restricted; on the other hand, those countries that already possessed explosive weapons – United States,

Natural uranium, on the other hand, required a considerable increase in installation costs, but with the advantage that it could be mined and packaged locally.

The discussion took place within CNEA, and included other actors, such as the CNEA Professionals Association (APCNEA), created in 1966, the Ministry of Energy, and local companies. Despite a clear preference for the natural uranium line, the tender initiated in 1967 did not restrict any options. According to Sabato, this method would be useful to compare the final cost of both options and to determine a 'reasonable price' (Sabato 1970, pp. 69). However, some aspects of the decision were prioritized: the financing method offered; the participation of the local industry; the acceptance of the feasibility study carried out by CNEA; and a delivery period of 48 and 52 months (Sabato 1973b, pp. 123).

After the deadline, 17 offers were made, and the project presented by Siemens AG was finally chosen by decree in 1968 (DPE 749/68). It was a natural uranium nuclear power plant with a net power of 319 Mw. Despite it was West Germany's first experience as an exporter of reactors, and the design was the only one of its kind, the firm agreed the participation of the local industry. In fact, it was negotiated that there would not be reserved domains and CNEAs technicians could travel to Siemens to acquire the know-how of the technology. Regarding financing, the company would take over 100% until the first six months of commissioning and operation of the plant, and the total amount would be repaid in 20 years at a 6% interest rate. The total cost, excluding the first load of fuel and heavy water, was estimated at 280 million marks. Within that budget, CNEA secured a surcharge of 6 million marks due to delays in the local production of certain components, that is, a total of 286 million marks or 72 million dollars (Fernández 2010, pp. 25). Additionally, Siemens included the financing of the pilot heavy water plant for 35 million dollars.[27] It was clear that the concessions granted in terms of financing and technology transfer responded to the intentions of Federal Germany to position itself as exporter of reactors in the periphery. Also, Siemens had full support from its government (Sabato 1973b, pp. 129).[28]

Regarding the participation of the national industry, the Law 18,875 called 'Buy National' was approved in 1970. This policy was extended to all sectors of the economy and institutionalized the opening the technological package. In the nuclear sector, it allowed Argentine products to be more competitive regarding to Germans because CNEA subsidize local contractors in a 20% (Sabato 1970, pp. 75). Additionally, certain benefits were granted, such as reimbursement or exemption from taxes for those materials required by the local industry that were not manufactured in the country (Báez et al 1973). The

Soviet Union, United Kingdom, France and China – were compromised to promote peace and reach and, eventually, a general disarmament (Castro Madero and Takacs 1991, pp. 32). The inclusion of uranium enrichment technology in the NPT generated a heated debate, given its proliferating potential. This issue has been analyzed by local historiography as one of the main conditioning factors of Argentine nuclear policy in the 70's. See Castro Madero and Takacs (1991); Hurtado de Mendoza (2009; 2012; 2014).

[27] Current dollars amounts were calculated on the exchange rate extracted from Officer (2020).

[28] A complete analysis of the cooperation between Argentina and the German Federal Republic can be seen at Castro Madero & Tacacks (1991), Sabato (1973b) and Rodríguez (2020).

'Buy National' policy became another 'window' that allowed an overlook of the existing industrial capacities in the country. Two years later, the panorama was completed with the constitution of the Argentine Association of Nuclear Technology (AATN), an entity that brought together scientists, professionals, and businessmen to promote nuclear applications.

At the administrative level, the 'Committee of Nuclear Power Plants' was created with the objective of assisting the president of the CNEA in all technical, economic, financial, social and security matters regarding nuclear power plants. To carry out the tasks of the Atucha I Project and facilitate the acquisition of know-how, the agency appointed an Executive Member, a technical secretariat, two Liaison Offices — one at the plant and the other in the city of Erlangen, Federal Germany—, a 'National Industry Group' and a person in charge of the training of personnel (CNEA 1971, pp. 17). The National Industry Group played an important role in linking the project with the national industry since its mission was to ensure the national supply of 71 items.

Another relevant chapter of the Atucha I experience was the development of fuel elements.[29] In the absence of local companies that could face the challenge, the Fuel Department of CNEA oversaw manufacturing a prototype that also included the local development of fuel pods.[30] In this way, although the first reactor charge had been provided by West Germany, it was gradually replaced by uranium rods developed in Argentina.[31] Heavy water, on the other hand, had to be purchased from the United States since at that time Canada had technical difficulties in providing the supply (Sabato 1970, pp. 77).

Even though the contract stipulated that the plant had to be delivered on June 15, 1972, there were two inconveniences, one in the design and the other in the civil works, which delayed the commissioning to January 13, 1974. Finally, 24 years after the failure of Huemul, Argentina had its first nuclear power plant, and it was Peron himself who, after returning to government a few months earlier, inaugurated it. The role played by local industry —originally estimated at 35%— represented a 40% of the total amount of works, while the number of local items was increased to 96 (Báez et Al. 1973, pp. 6).[32] The success of the project also demonstrated that, even during political turmoil, the nuclear

[29] The fuel production process -pure natural uranium- can be distinguished from the fuel element manufacturing. The second includes the container where the uranium is placed in the reactor. In 1970, the natural uranium costed around 25 dollars per kilo, while the whole element cost 80 dollars (Sabato 1970, pp. 78).

[30] Initially, CNEA had an agreement with the company SIAM Electromecánica to develop fuel based on the design provided by Siemens (Sabato 1973b, pp. 2). However, the experience was ultimately frustrated due to the agony the company went through and disagreements with CNEA regarding Siemens' involvement (Quilici 2010, pp. 25).

[31] According to Sabato, it would take 4 years to replace imported fuel pods for Argentine made fuel pods (1970).

[32] The main supplies awarded locally included heat exchangers for heavy water; ventilation system for nuclear and conventional facilities; water treatment equipment; mechanical cleaning system and chemical treatment of cooling water; transformers; main and secondary refrigeration circuit piping, among others (Báez et Al. 1973, pp. 7).

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sector had received active support from the seven governments of different political backgrounds that followed each other from 1964 until 1974.

5. Embalse de Rio Tercero nuclear power plant

By then, it was clear that nuclear energy was already emerging as an alternative to the traditional energy mix. While the discussions regarding the technological choice of Atucha I was set, the Córdoba Provincial Energy Company (EPEC) requested CNEA to carry out a pre-investment study in 1969. The goal was to install a nuclear power plant in the province of Cordoba, an area that had grown substantially in recent years because of the development of the Import Substitution Industrialization policies. During the brief transition to democracy (1972-1974), industrial expansion continued under a new protection program for local industry that once again privileged national capital over foreign capital. Through specific promotion policies, the State managed to stop the denationalization process that the sector had been experiencing since the 60's (Belini 2017, pp. 323).

In this context, the discussion regarding the type of nuclear power plant to be installed, once again, went beyond the technical level to focus on political and strategic considerations. While defenders of enriched uranium argued that it was a safer line, supporters of natural uranium emphasized the issue of technological dependence, the participation of the national industry and the management of the fuel cycle within the country. Despite the intransigence of both positions, the bidding process was similar to Atucha I, and no technological line was restricted. However, bidders had to draw up a 'positive list' and a 'probable list' of supplies that could be purchased locally. Additionally, it was stipulated that CNEA should have a major participation in engineering (Quilici 2008, pp. 8).

Finally, the offer made by the Italo-Canadian consortium Atomic Energy of Canadá Limited (hereafter AECL) and Italimipianti for a 600 MW Canadian Deuterium Uranium (hereafter CANDU) reactor based on natural uranium and heavy water was approved. Industrial participation was initially estimated at a 50% and promoted the formation of two consortia to facilitate the learning process: Nuclar and Argatom. The objective of both associations was to bring together companies that could carry out technical assistance, engineering, construction, assembly, and commissioning services (Bertoni 2012, pp. 9). In the long term, the goal of this strategy was to form a major firm that could compete internationally by providing services as an industrial architect. In parallel, CNEA organized a 'Manufacturing Coordination', focus on determining local manufacturing capacities, weaknesses and addressing possible solutions. The analysis of 40 companies revealed that 132 items had a positive response, 36 partial, 44 probable, and 13 unlikely (Pagani 1985).

The contract was signed in April 1974, days before the inauguration of Atucha I.[33] However, during the following years the project would be affected by two major drawbacks. First, the Indian detonation (1974) —made with plutonium supplied by a Canadian reactor— would dramatically change the outlook for Argentina. From then on, the Canadian policy would tighten the conditions for nuclear exports and renegotiated the Embalse contract (Hurtado de Mendoza 2014, pp. 156). Secondly, the local economic context would experience severe changes after the implementation of the economic policies of Minister Celestino Rodrigo during the government of Isabel Perón. In June 1975 inflation soared and climbed to 30% per month. This situation implied a notable disadvantage for AECL, since the financing of national supplies had been foreseen with a maximum ceiling of 25%. In January 1976, CNEA was forced to renegotiate the contract, becoming the main subcontractor of the project, a fact that would allow Argentina to increase its participation to 67% in the future (Table 1).

TABLE 1. Percentage of national participation in Atucha I and Embalse, by item

Ítem	Atucha I	Embalse
Engineering	0%	33%
Civil Work	90%	100%
Assembly	50%	90%
Electromechanical Components	13%	33%

Source: Rodríguez (2020).

6. ENACE and the technological autonomy

The last step towards technological autonomy was set in the years of the Argentine dictatorship (1976-1983) which, paradoxically, coincided with the 'peripheral privatization'[34] process and the destruction of local industry (Belini and Rougier 2008; Canitrot 1980; Schvarzer 1987). These guidelines emerged from a critical diagnosis about the Import Substitution Industrialization. In this sense, inflation and government deficit were identified as the main obstacles to economic growth, and both state intervention and industrial promotion policies were seen as the cause of inefficiency.

Despite the official discourse and the implementation of neoliberal measures, the dictatorship established a close alliance with two economic actors through a broad policy of public works. On the one hand, large business groups that benefited from the contracts with the State; on the other hand, a faction of the Armed Forces that considered the promotion of infrastructure as a priority in terms of national defense (Castellani 2009 147). Therefore, the government supported the Nuclear Program in three aspects; (1) regarding international affairs, the dictatorship continued to reject the signing of the Non-Proliferation Treaty in defense of technological autonomy; (2) in terms of planning, the

[33] A complete analysis of the cooperation between Argentina and Canada can be seen at Castro Madero & Tacacks (1991).

[34] The 'peripheral privatization' process refers to the sale of all public companies that were not considered as strategic.

first Nuclear Plan was officialized and (3) the budget of CNEA grew uninterrupted: in 1983 it represented 1,17% of Argentina's GDP and 3,96% of public administration budget (Castro Madero and Takacs 1991, pp. 135).

The first Argentine Nuclear Plan was approved in 1979 (DPE 302/79). The document made official the objectives that CNEA had planned since the previous decade: the installation of four 600 Mwe nuclear power plants based in natural uranium technology, an extensive program of exploration and exploitation of uranium resources in the country and the achievement of autonomy in all stages of the fuel cycle (Rodríguez 2014, pp. 32). In addition, the 1979 Nuclear Plan identified two strategic objectives: the participation of national industry and the strengthen of science and technology. Regarding the first goal, four future power plants would be schedule in stages to increase local participation (Table 2).[35]

TABLE 2. Nuclear Power Plants connected and planned in Argentina (1984)

Central	Atucha I	Embalse	Atucha II	Central IV	V Central	VI Central
Condition	Connected	Connected	Projected	Projected	Projected	Projected
Start up	1974	1984	1987 *	1991 *	1994 *	1997 *
Location	Buenos Aires	Córdoba	Mendoza	Northwest	Buenos Aires	Buenos Aires
(*): Projected						

Source: own elaboration from CNEA (1980).

The second goal was aimed at strengthening scientific and technological capacities in nuclear matters, as well as maximizing the use of the country's natural resources. For this reason, the program regulated the promotion of research and development, the exploration of uranium resources, and the scientific exchange with the rest of the Latin American countries.

However, the Nuclear Plan did not specify the mechanisms to acquire the know-how from the supplier. At this point, some scientists and technicians in CNEA supported the creation of an Industrial Architect, a main contractor that would manage engineering, construction and commissioning (Bertoni et. Al 2004). Even though a few projects were disputed, in 1979 the decision was settled: CNEA would create a joint venture with the foreign company that wins the bidding of the first nuclear plant. The Industrial Architect would have a 75% stake in favor of CNEA and a 25% acquired by the offeror. In these terms, CNEA could ensure a major participation of local companies and the acquisition of engineering, design and know how (Bertoni 2012; Cosentino 1983, pp. 43).

[35] However, given the size of the local nuclear sector, local participation could not exceed 80% because the internal market was not large enough to justify the production of highly complex components related to the nuclear island, such as the containment vessel of the nuclear reactor or certain electromechanical components.

The tender for the first of the four nuclear power plants programmed in the 1979 Plan took place in the second half of 1979. The bidding process faced the CANDU model from AECL (Canada) and a prototype designed by Siemens KWU (Federal Republic of Germany).[36] Political considerations had a major role in the debate, even above economic and technological matters. Although CANDU's model allowed a broader participation for local industries, the Canadian government required Argentina to sign the NPT to conclude the deal. That is the reason why, on October 1979, the Executive Branch announced the election of Siemens KWU to provide the technology.

In this context, ENACE SA was created on November 3, 1980, with a shareholding of 1,600 million of pesos (BORA 1980). The purpose of ENACE was to manage engineering and, eventually, would assume the functions of main contractor, planning and design. In other words, through this experience, CNEA would integrate the necessary knowledge to replace the original designer in fifteen years. That's why Siemens KWU's participation in ENACE would be reduced to 20% in 1985, to 10% in 1988, and finally in 1992 CNEA would acquire 100% of the shares (Backhaus 1985, pp. 186). Technology transfer would operate through the exchange of technical commissions made up of Argentine and German personnel.

The National Industry Group created for Atucha I was now incorporated into ENACE as the Industrial Promotion Directorate. Its objective was to qualify the companies, as well as managing the contracts signed with Siemens. The entity became central to ensure the technology transfer process, which would operate mainly through: (1) the transfer of manufacturing licenses and technology; (2) the purchase and installation of equipment; and finally (3) training personnel in critical tasks, such as welding. In this sense, there were no universities in the country that offered systematic training. To resolve this problem, in 1981 ENACE organized, together with the German Welding Institute, a course in Duisburg (Federal Germany). The policy was complemented with the First Welding Science and Technology Course held at CNEA the following year.

During the first years of the Nuclear Plan several firms committed to nuclear power activities. As can be seen in Table 3, many private companies considered project Atucha II as an opportunity to acquire know how from CNEA and compliance with international quality standards. In fact, companies that benefited from the welding courses achieved insertion in other large projects (Bertoni 2012, pp. 9).

However, starting from 1984, it became evident that ENACE had fallen short of achieving its long-term objectives. This can be attributed to various factors that contributed to the gradual decline of the Argentine Nuclear Program between 1980 and 1990, ultimately leading to the abandonment of the pursuit of technological autonomy. A significant factor was the diminishing prominence of nuclear energy in the periphery. It is important to note that this decline was not solely a result of the Three Mile Island and Chernobyl accidents,

[36] A complete analysis of the negotiations between Argentina, West Germany and Canada during 1979 can be seen at Rodríguez (2020).

but rather a consequence of the economic recession and a decrease in energy consumption. The Latin American debt crisis of 1982 compelled regional governments to implement budget cuts, which inevitably led to the postponement of large-scale public projects. In Argentina, this trend was particularly pronounced, and it accelerated the process of deindustrialization, reaching its peak during the neoliberal government of Carlos Menem (1989-1999).

TABLE 3. Private companies benefiting from ENACE technology transfer (1985)

Company	Activity	Licensees	Equipment	Training
Industrias Pescarmona S.A.	Nuclear Steam Supply System (NSSS)	X	X	X
Sociedad Técnica de Construcciones Metalúrgicas S.A.	Thermomechanical Installations / Cranes	X	X	X
Zoloda S.A.	Instrumentation and control		X	
Gases Industriales S.A.	Bottled Industrial Gases and Thermal Installations	X	X	X
CIMSA S.A.	surface treatment	X		X
Tool Research S.A.I.C.	Thermomechanical Installations	X	X	
Elcomat S.A.	Industrial electronics	X		X
Techint S.A.	Technical assistance, engineering and nuclear assembly	X	X	X
Salcor Caren S.A.	Boilers	X		X
Consorcio Nuclar S.A.	Technical assistance, engineering and nuclear assembly	X		X
Consorcio Argatom S.A.	Technical assistance, engineering and nuclear assembly	X		X
Astra Evangelista	Technical assistance, engineering and nuclear assembly	X		X

Source: own elaboration from Consejo para el Proyecto Argentino (1985) and Quilici (2008).

By 1994, Atucha II, the first nuclear power plant envisioned in the 1979 Nuclear Plan, had not yet been commissioned and was plagued by a seven-year delay. In that same year, construction activities were definitively halted in order to facilitate the privatization of the entire sector, and CNEA was separated from its involvement in electricity production. However, the intended privatization never materialized, leaving the Nuclear Program in a state of abandonment for several years and effectively erasing the concept of technological autonomy from the national agenda.

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7. Conclusions

The central issue of state planning in the early stages of Nuclear Programs has been a focal point of discussion and analysis. In Argentina, following the Richter affair, public decisions were made through CNEA, an autonomous entity that successfully fostered the development of a nuclear scientific community. This achievement was made possible by the strong political support for CNEA, which allowed the formulation of policies that extended beyond technical considerations. As a result, the concept of 'technological autonomy' emerged as a broader philosophy aimed at overcoming underdevelopment, promoting industrialization, and facilitating technology diffusion. This notion materialized through the milestones mentioned and contributed to significant local development.

However, the emphasis on industrial policy design reveals the weakness, if not the absence, of local private companies in Argentina's Nuclear Program. Unlike the Spanish case, Argentinean companies were unable to play a leading role in the program. The 'midwife' role of the state, which endorsed and financed the national industry through different policies, suggests that local industry was not prepared to face the nuclear challenge without public aid. This trend can be explained by structural limitations, including insufficient industrial development and the absence of a capital market focused on expanding infrastructure. Moreover, the deindustrialization model implemented after 1976 constrained CNEA's 'industrial spill' project, leading many large business groups investing in nuclear to shift their focus to the financial sector.

On the other hand, the lack of official statistics and quantitative sources hinders a deeper analysis of the outcomes of these policies and their continuity over time. However, from a qualitative perspective, some conclusions can be drawn. Firstly, the development of a Nuclear Program in Argentina during the 1950s and 1960s was driven by strategic interests. In the short term, it presented an opportunity to foster the R&D sector, train a new generation of specialists, and position Argentina among prestigious newcomers in the field. In the medium and long term, nuclear power had the potential to improve the trade balance by reducing fuel imports and exporting complex goods and services. Lastly, the sector was viewed as a unique type of industrializing industry that could reinforce the Import Substitution Industrialization process and stimulate the development of local industries.

Lastly, the concept of technological autonomy played a pivotal role in the adoption of natural uranium and heavy water reactor designs. During the 1960s and 1970s, this approach offered an alternative for peripheral countries seeking independence from US supply and aiming to move away from turnkey purchase arrangements. In Argentina, this decision was reaffirmed at each mentioned milestone and eventually became an official policy by the late 1970s. It is in this context that Argentina successfully integrated the local industry into the nuclear program, achieving better results compared to Brazil or Mexico.

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El sorgiment del Programa Nuclear Argentí i el somni frustrat d'industrialització (1950-1984)

RESUM
El sorgiment del Programa Nuclear a Argentina va tenir lloc durant la segona etapa del procés d'Industrialització per Substitució d'Importacions, que va fomentar la indústria local i el desenvolupament del sector metalmecànic i electrònic. En aquest context, un dels objectius centrals de la Comissió Nacional d'Energia Atòmica (CNEA) fou l'estímul del desenvolupament de béns i serveis produïts localment per tal que poguessin subministrar a les futures centrals nuclears i promoure l'autonomia tecnològica. Tanmateix, aquesta filosofia va començar a patir contratemps després de la implementació de les primeres reformes liberals posteriors a 1976. L'objectiu central d'aquest treball és dibuixar i analitzar les principals estratègies implementades per la CNEA en la promoció del desenvolupament de la indústria local. En aquest sentit, el paper es centra en la creació del Departament de Metal·lúrgia (1955), el Servei d'Assistència Tècnica a la Indústria (1962), la construcció de centrals nuclears sota la modalitat "d'obertura del paquet tecnològic" (1965) i la creació d'ENACE, SA com a arquitecte industrial (1980).

PARAULES CLAU: programa nuclear, indústria nuclear, desenvolupament econòmic, autonomia tecnològica, Estat, Argentina

CODIS JEL: N76; O14; 033; H00

El surgimiento del Programa Nuclear Argentino y el sueño frustrado de industrialización (1950-1984)

RESUMEN
El surgimiento del Programa Nuclear en Argentina tuvo lugar durante la segunda etapa del proceso de Industrialización por Sustitución de Importaciones, que fomentó la industria local y el desarrollo de los sectores metalmecánico y electrónico. En este contexto, uno de los objetivos centrales de la Comisión Nacional de Energía Atómica (CNEA) fue el estímulo del desarrollo de bienes y servicios producidos localmente para que pudieran abastecer a las futuras centrales nucleares y promover la autonomía tecnológica. Aun así, esta filosofía empezó a sufrir contratiempos después de la implementación de las primeras reformas liberales posteriores a 1976. El objetivo central de este trabajo es trazar y analizar las principales estrategias implementadas por la CNEA en la promoción del desarrollo de la industria local. En este sentido, el papel se centra en la creación del Departamento de Metalurgia (1955), el Servicio de Asistencia Técnica a la Industria (1962), la construcción de centrales nucleares bajo la modalidad "de apertura del paquete tecnológico" (1965) y la creación de ENACE SA como arquitecto industrial (1980).

PALABRAS CLAVE: programa nuclear, industria nuclear, desarrollo económico, autonomía tecnológica, Estado, Argentina

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