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Before starting, I'd like to personally acknowledge Mr. Sylvain Saint Pierre and, through him, the World Nuclear Association, for its constant devotion and for giving us the possibility to share our visions with the international community and industry leaders.

Perspectives on Nuclear Energy and Radioprotection in Argentina. The industry vision.

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1. Argentina's Profile

Argentina is a very large country with a small population. It occupies an area of 2,800,000 km² (the world's eighth largest country) and it has a population of somewhat less than 40,000,000 inhabitants.

Argentina is an emerging country: it has not still reached the degree of industrialization of the new industrial countries (Japan, China, Korea, etc.).

Argentina is essentially a large exporter of agricultural products and it has limited oil, gas and uranium surpluses. Its energy resources are enough for supplying the domestic demand and it also has exportable surpluses, even in high-growth periods like the current one.

It is also worth highlighting that the country is insufficiently explored in terms of new energy reserves, especially in the Andean region and the offshore area.

A unique characteristic of Argentina, which stands out in the region, is its education model. With a history of over 150 years, this model has made it possible for the country to rapidly adjust to new and diverse international technological advances. Argentina's industries satisfy the domestic demand, from the production of commodities to cellular phones, and now they record high export growth.

2. Argentine Energy Plan

Since 2003, Argentina's GDP has grown at an 8.8% annual rate, accompanied by a 7% electric power demand growth.

Energy production, including electric power generation and distribution, has been transformed and privatized since 1991, except for the Nuclear System, which is considered strategic for the State. This new management system of electric power generation and distribution has proved to be highly competitive, with investment growing until 2001.

Due to the serious economic crisis undergone by the country during 2001 and 2002, the Argentine government decisively intervened in the regulation of all the energy systems' rates. As a result of this intervention, rates could be stabilized and, consequently, there was also a significant reduction in private investment in this sector. Most growth plans are currently being financed with public investment or a mixture of public and private capital.

Considering the total power generation, the nuclear sector, which has not attracted investment for 20 years, has reduced its share from 15.5% in 1990 to 6% nowadays.

Projections of Argentina's power demand for the next 20 years show that it is absolutely necessary to use all the available resources and provide the necessary incentives for adequately exploring and tapping them.

Energy Plan Objectives

Some considerations

- 1) It is estimated that, considering today's world consumption, available oil reserves are sufficient to satisfy global oil consumption for the next 40 years, and if difficult-access reserves are included, this period of time extends to 80 years (World Energy Technology Group). At the same time, new estimations forecast millions of oil barrels in the Artic platform.*
- 2) In order to continue growing globally, it will be necessary to consider all the energy sources, including clean coal, solar energy, hydrogen, wind, biomass, waste and biofuels.*
- 3) Energy savings will be part of the solution.*
- 4) As for nuclear energy, the development of the closed uranium cycle will be a valuable contribution to the intensive use of uranium resources.*
- 5) Argentina has all the resources and they will compete based on their technological accessibility and price.*
- 6) For us, the only musts for nuclear industry continuance are singularity, competitiveness and creativity. The opportunity is now.*

Authorities have formulated the basic premises which must be fulfilled in the future for the electric power market:

- 1) Ensure reliable and high-quality power supply to the entire population.*
- 2) Ensure power supply capacity: at competitive prices for industries and at affordable prices for the population, depending on the different social segments.*
- 3) Ensure that energy policies common to the different sources safeguard the safety and preservation of the environment at sustainable levels.*
- 4) Promote new investment in power generation and facilitate the profitability of the nuclear system's companies through the new industrial consumption generated by free agreement of rates between demand and supply (Energy Plus Plan).*

3. Today's Nuclear Argentina

Argentina has a long nuclear history. It started its activities in the nuclear field in 1950, with the creation of the National Atomic Energy Commission.

Since 1997, the Nuclear Regulatory Authority (NRA) has been the agency responsible for establishing, developing and enforcing a regulatory system applicable to all nuclear activities carried out in Argentina. Prior to 1997, the National Atomic Energy Commission had been the agency in charge of this paramount function since its creation in 1950.

Since then and over the following forty years, many actions have been taken along five strategic axes:

Research & Development

Nuclear Power & Related Supplies, including the nuclear fuel cycle.

Medical & Industrial Applications

Waste Management

Human Resources Training

The following achievements accomplished from the beginning of nuclear activities to the 90's are worth highlighting:

- *In 1974, "Atucha I" Nuclear Power Plant (PHWR 350 MWe) began its commercial operation.*
- *The second Nuclear Power Plant, "Embalse", has also been operating since 1984. This is a CANDU-6 reactor (600 MWe).*
- *In 1980 the construction of a third reactor (780MW PHWR) called Atucha II was begun. Construction works were delayed many times and it has not been finished yet.*
- *Between 1999 and 2002, Atucha I Nuclear Power Plant replaced core fuel elements by substituting natural uranium with 0.85% U235 slightly enriched uranium (SEU). The result of such change was that burn-up increased from 5,900 to 11,000 Mwd/tU. Similar alternatives for Embalse Nuclear Power Plant are now being analyzed.*
- *Uranium exploration studies started to be carried out in the mid 50's. Then mining began and uranium had been extracted by the year 1997.*
- *In the 80's, Argentina installed and started operating:*
 - *the uranium dioxide conversion plant (Dioxitek S.A.)*
 - *the fuel element fabrication facility (CONUAR S.A.)*
 - *the zircaloy tube fabrication facility (FAE S.A.)*
 - *the industrial heavy water plant (ENSI).*
- *A pilot uranium enrichment facility was designed and built at Pilcaniyeu Technological Center.*
- *At the same time, the following facilities and applications were either developed or put into operation:*
 - Reactors and Cyclotrons for radioisotope production*
 - Hot cells for encapsulation & production of Sealed Sources*
 - Radiotherapy – Nuclear medicine*
 - Food and equipment sterilization facilities*
 - Applications in agriculture & industry*
 - In the particular case of radioisotope production, Argentina produces, inter alia, Co 60 from the irradiation of Co sources at Embalse Nuclear Power Plant.*
- *Argentina designed, built and sold research reactors to Peru, Algeria, Egypt and Australia.*
- *High class universities were created for human resources training and support to all the nuclear activities, such as the Balseiro Institute and the Sábato Institute.*

Nuclear projects have not achieved significant progress since the 90's.

4. Argentine Nuclear Plan

The Argentine Government has adopted a strategic stance on nuclear activity.

This plan is based on a Vision of the future in which:

Research, development and the application of environmentally-friendly peaceful nuclear technology uses shall be consolidated and enhanced, significantly contributing to the economic development, well-being and continuous improvement of the population's standard of living and that of future generations.

Based on that, the following undertakings have been decided for the near future:

- *Complete the construction of Atucha 2 Nuclear Power Plant (700 MW PHWR) by 2010. The costs of finishing this nuclear power plant are significantly lower than those of building a new reactor, including any additional safety requirement imposed by the Nuclear Regulatory Authority (ARN)*
- *The life of Embalse NPP (CANDU 600) is being extended. The current operation license expires in 2011 and a 30-year life extension is planned.*

The implementation model for these projects provides incentives for the local industry to be involved in the nuclear activity, creating new jobs and permitting the local development of updated production and management technologies. This growing national involvement will make it possible to reach new design and construction levels and alternatively plan the autonomous construction of a NPP in the short term.

Furthermore, the Plan promotes:

- Completing the CAREM reactor's construction (Nuclear Power Plant prototype). This is a Low Power NPP (25 MW) with a new-generation inherently safe innovative design, which will make it possible to develop this reactor to its maximum possible power.*
- Resuming the uranium enrichment process. At an initial stage, the facility located in Pilcaniyeu will be put back into operation.*

Industry Vision

Argentina has been using nuclear energy in its energy matrix for more than thirty years. Its second-generation reactors and the Nuclear Fuel Cycle have operated under strict environmentally-friendly safety conditions, without generating environmental damages.

Industrywise, the decisions to finish Atucha II Nuclear Power Plant, extend the life of Embalse NPP and start the feasibility studies for the construction of two new CANDU reactors are based on an advantageous strategy which makes the most out of:

- Proven knowledge of CANDU reactor construction and licensing times.*
- Personnel with over twenty year experience in operation and capable of quickly training new operators.*
- Local manufacture of Fuel Elements at competitive prices and proven performance for more than 20 years.*
- A known maintenance system with common spare parts.*
- The economical and competitive use of this facility, facing the urgent need to meet the boom in electric power demand, which came as a result of exceptionally favorable economic conditions.*

For this reason, Argentina has ruled out the idea of building third-generation reactors at this stage, waiting until it is more mature in terms of technology and performance, in order to be able to evaluate their application to the Argentine market.

As for the future, I think that, apart from taking the above-mentioned decisions, Argentina should clearly evince its future interest in fourth-generation reactors, particularly high temperature ones (HTR and VHTR) devoted to hydrogen production or hydrogen/electricity cogeneration.

The use of hydrogen as fuel for means of transport would complete the energy matrix and Argentina could be the regional leading country in this system regarding any of the projected fuel distribution models for hydrogen, given its long experience in safely using natural gas in vehicles and supporting the favorable experiences which it previously had.

I want to highlight that, in order to generate sustained growth of investment in new reactors, it will be necessary to generate attractive conditions for private investment in all the Projects. These conditions shall include, as mentioned before, competitiveness vis-à-vis other generation sources and its related profitability, as well as safety conditions and limited risks, which will make it possible to reach a favorable economic and financial equation, so that new players are willing to take them.

Nowadays, there is international and local consensus regarding these nuclear projects, due to their characteristic of contributing to the fight against the greenhouse effect, thus, complying with the policy adopted by Argentina in terms of the Kyoto Protocol.

5. Regional Integration

In today's vision, Argentina hopes to share its objectives with the other countries in the region, in order to accompany a sustained integration of energy projects within the MERCOSUR policy framework and the new alliance of countries manifested through the UNASUR treaty.

Brazil and Argentina signed a Joint Statement including Nuclear Cooperation in 2008; this Statement focuses on:

- The development of a new nuclear power plant for power generation, supplying energy to both countries.
- The creation of a binational uranium enrichment company.
- The generation of scientific and productive integration plans regarding the fuel cycle.

Brazil and Argentina have been working together for quite a long time: they have created and applied a joint Safeguard System through the Agencia Brasileño-Argentina de Contabilidad y Control (ABACC) (Brazilian-Argentine Accounting and Control Agency).

Both countries have made important scientific, technical and human capital investment and they already have the necessary nuclear infrastructure for ensuring the joint development of nuclear projects with regional scope.

Now, it is necessary to agree on regulations and standards common to all MERCOSUR countries, in order to create a competitive nuclear market based on the already available infrastructures and permit the free generation of nuclear projects, as well as their free trade in the region.

It is worth highlighting that the nuclear sector must also consider the need for a Dissemination Policy and systematic action from the educational viewpoint, making it possible that society as a whole keeps pace with its implementation and the attainment of its goals.

6. Radioprotection, Now and Ahead

Argentina has proved to be reliable in every nuclear safety and radioprotection aspect, according to the strictest international criteria. It could obtain such positive results because it has the necessary control, management and education infrastructure.

The most important goal common to all the nuclear industry's organizations is that their members share the vision needed to follow the procedures protecting individuals and the Environment and that these procedures are followed even under production pressure.

Very early in our nuclear fuel manufacturing experience we realized that, in order to build a safety culture, it was, and it is, necessary to be committed at board, managerial and individual level and have clear responsibilities, among others. Moreover, it has been very important to promote a questioning attitude regarding the slightest deviation from safety-

At Conuar, we have formed a team comprised by our specialists in Safety and Radioprotection and union representatives who have a proven vocation for safety. This Committee has the mission of auditing overconfidence attitudes, looking for better practice improvements and checking the feedback of implementation results.

Nevertheless, industries perceive that important changes must be generated in terms of control and management requirements, in order to maintain and improve the results obtained in the past.

Conuar has closely followed up research done on the stochastic effects caused by low doses arising from manipulating natural uranium materials. The probabilistic nature of the stochastic effects makes it very difficult to clearly distinguish between 'safe' and 'dangerous', thus causing troubles in terms of explaining radiation risk control.

To solve that, we try to apply ICRP recommendations regarding the need to look at the three main components of a basic system of protection: the justification of a practice, the optimization of protection and the use of dose limits, which imply an adequate standard of protection. The major policy implication of a non-threshold relationship in the case of stochastic effects is that some finite risks must be accepted at any level of protection.

On the other hand, the IAEA is promoting the application of Integrated Management Systems in the facilities. The IAEA GS-R-3 Standard defines the requirements for a Management System integrating safety, health, environmental, security and economic elements, particularly the economic ones if they introduce or mitigate potential risks. For the IAEA, safety is the fundamental principle upon which the management system is based. In Argentina, the Nuclear Regulatory Authority has instructed the application of this IAEA standard in our Nuclear Fuel Facility (CONUAR S.A.).

CONUAR/ FAE is a CNEA Group's mixed-capital (private/state-owned) company, devoted to the manufacture of nuclear fuel elements, main components of Argentine reactors and zircaloy, titanium alloy and incoloy tubes. It has supplied fuel elements to Argentine nuclear power plants for the last 26 years.

Over 20 years ago, CONUAR S.A. incorporated the application of Management Systems into its strategic decisions as an improvement tool. In 1995, the necessary elements to obtain the certification of its Quality Management System designed in accordance with ISO 9001 requirements were incorporated into its original Quality System designed in accordance with IAEA 50-C-QA Standard. This certification was awarded by TÜV Cert (Germany). In 1999, TÜV Cert certified that CONUAR's Environmental Management System complies with every ISO 14001 requirement and later, in 2001, it also certified that it complies with OHSAS 18001, regarding the aspects related to Safety and Occupational Health.

CONUAR advanced with the innovative integration of its Management Systems and in 2002, TÜV-Cert (Germany) certified that CONUAR and FAE have an Integrated Management System which complies with all the requirements of ISO 9001 (Quality), ISO 14001 (Environmental) and OHSAS 18001 (Occupational Health and Safety).

Our short-term growth projection shows that we face new different challenges. CONUAR is doubling its production volumes and this implies recruiting new personnel, requiring the incorporation and training of a significant number of new staff members in its facilities.

Our industry's stand-by situation for almost 20 years has also created a generation gap between old and new employees. This has never happened before and, therefore, new strategies are required.

Personnel recruiting, induction to their workplace and specific training shall be accompanied with rigorous monitoring of new cultural profiles.

One of the new challenges is:

How can we prevent the risks related to such a wide generation gap between old and new employees?

Historically, our industry recruited personnel who gradually got trained under the guidance of older employees. The frequent fears of working with radioactive material gradually disappeared, not only due to formal training in radioprotection issues but also, and largely, due to the informal exchange of experience and trust among "old" and "new" employees.

New employees come from a post-Chernobyl's accident culture, which modified the public's optimistic and trusting perception of nuclear activities. Such perception changed into a fearful and distrusting vision of the risks related to any nuclear activity. Young nuclear industry workers have grown up under this cultural perception and many of them also have this groundless apprehension of ionizing radiation. Such fears can make the industry less attractive and demand new educational methods for avoiding risks at the workplace.

Moreover, it is verified that, in the new generations and especially in urban areas, there are new risks related to the increase of addictions, epidemic caused by new social origins, terrorism and new cultural behavior among young people. These risks introduce new aspects to be considered when recruiting, monitoring and training employees, especially in an industry which demands new and higher safety standards.

Based on the consideration of these new elements, Conuar has developed new personnel recruitment, induction and training models.

They include:

- Knowledge Management Programs, which permit to preserve and share the knowledge of top performers.*
- Creativity Programs, which foster the creative involvement of old and new personnel.*
- Continuous Improvement Programs, which promote the personnel's active, attentive and committed involvement, ensuring compliance with new requirements and the innovative preservation of the already acquired expertise.*

We have observed that the IAEA has also been promoting the application of Safety Culture Standards. It is very important to create an integrated culture of standards (Safety, Quality, Security and others) in the industries, in order to prioritize and clearly define the objectives of the staff responsible for their compliance.

Throughout the years, we have seen that much research has been done in terms of the basis of Radioprotection and that such basis has extended. This made it possible that radioprotection methodologies for risk prevention improved and that outstanding results were obtained.

We want to put these new situations forward for consideration, in order to contribute to the establishment of a sustainable safety culture.

Finally, another new aspect which has been increasingly considered by some stakeholders in the nuclear industry is the emphasis put on radiological environmental protection.

For the public opinion, Environmental Protection has displaced occupational safety from the center of attention.

Reflecting this, local environmental regulations are constantly and exponentially increasing. Radioactive materials are the object of regulations by the Nuclear Regulatory Authority and also the Environmental Authorities, generating new and greater challenges for the industry.

Radioprotection has been the guarantee for the people and the communities that nuclear organizations are operating responsibly. For this reason, the public must be aware of radiological protection.

The media has become a social reference of what is "true" or "false".

The entire industry has to lead the battle against the greenhouse effect and, jointly with governmental institutions as regulatory and controlling bodies, they must build awareness and trust based on scientific knowledge and the verification of what appears in the media as facts.

Looking ahead, a sustainable nuclear market will need to be reliable and competitive.

Reliability is essential for stakeholders to promote its growth and facilitate the access to financing for new projects.

Competition will make it possible that private investment crowds out or partners with governmental organizations to generate new projects.

7. Conclusions Argentina's Key Targets

Safety culture is the new paradigm which is the basis for the nuclear industry of the future.

It is essential that we make society and the communities aware of the unique advantages of nuclear energy, and that we convince them that we are leaders in the battle against climate change.

A realistic vision of the new generations will let us adjust training, recruitment and monitoring programs to new nuclear industry professionals and technicians, developing a new creative culture.

Competitiveness will be essential for sustained growth in the industry, attracting regional and international investment and allowing for the construction of new nuclear power plants.

Industry growth must be stimulated by sharing the available nuclear infrastructure in the region, in order to reduce the barriers to new entrants and build a regional nuclear power market with free competition.

Lastly, a nuclear green bond, representing the battle against the greenhouse effect and promoting investment in new NPP, should be created.