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Remarks to the 46th Annual Meeting on Nuclear Technology

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Argentina: Nuclear Power Development and Atucha 2

Mauro Nogarin

In 2002 the per capita consumption of electricity in Argentina was 2,000 kWh/year and had increased by 2007 to 2,600 kWh/ year, a plus of about 30 %. Gross electrical energy production in 2007 was 115,000 GWh, made up of the following sources: 54 % thermo-electric, 27 % hydro-electric, 9.4 % generated from oil, 2.2 % generated from coal and 6.3 % generated by nuclear power.

In 2014, nuclear energy generated about 5,257 GWh of electricity or a total share of 4.05 % of the total electrical energy of about 129,747.63 GWh kWh produced in Argentina and there has been a trend for this production to increase. Argentina currently has a nuclear production capacity of 1,010 megawatts of electrical energy. However, when the *Atucha 2* nuclear power plant is completed and starts commercial operation, it will add an additional 745 megawatts to this electrical production capacity.

Argentina's nuclear energy policy relies mainly on the use of heavy water nuclear reactors which may utilize raw or very low enriched uranium as fuel. Such is the case of the *Atucha 1* nuclear power plant, which originally used natural uranium as fuel. Today slightly enriched (about 0.9 %) uranium is used, which doubled the burn-up from 6 to about 13 GWd/t. The *Atucha 1* nuclear power plant is located in the city of Lima, which is located 115 kilometers north-west of Buenos Aires and has a total capacity of 745 MW. The construction of *Atucha 1* started in 1968 and the plant was first commissioned in 1974; it was the first nuclear power plant in Latin America.

Besides *Atucha 1* there is also a nuclear reactor near the city of *Cordoba,* a CANDU-6 built by the *Atomic Energy of Canada Ltd. (AECL)*. Thanks to the transfer of nuclear technology from Canada, the *Embalse* nuclear power plant was constructed and went into operation in 1984. In 2010, the government of Argentina signed an agreement to renovate and expand the plant for another 25 years of operation. The *Embalse* nuclear power plant currently operates at 80 % capacity to limit neutron damage to the pressure tubes.

The *Atucha* nuclear project was originally conceived to have multiple reactors in 1968, but the construction of *Atucha 2* was delayed. In 1979, the Argentine government formulated a plan to build four more additional plants designed by *Siemens* of Germany, which would come on line between 1987 and 1997. Construction of *Atucha 2* began in 1981 but advanced slowly due to funding and was suspended in 1994 when the plant was 81 % built. In 2003, new plans were approved to complete the *Atucha 2* reactor which would generate about 692 MW net and 745 MW gross. The construction was completed under a contract with *AECL*.

The *Atucha 2* reactor uses materials manufactured in the country and regulated by the *National Atomic Energy Commission* (CNEA in Spanish). It utilizes uranium ore or slightly enriched uranium (0.85 % of U-235) made in Argentina. The local manufacturer of enriched uranium has years of experience based on supplying the other two nuclear power plants, *Atucha 1* and *Embalse,* which have been operational since 1974 and 1984 respectively.

| Positioning of the first fuel element into the reactor of Atucha 2. (Courtesy: NA SA)

The six hundred tons of heavy water required for the initial loading of the reactor and heat extraction system were produced at the *Arroyito* plant, located in the province of

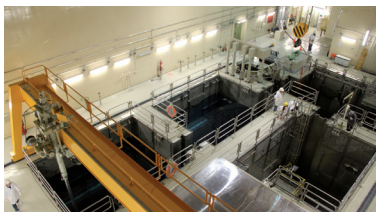
| Upper view of the reactor head of Atucha 2. (Courtesy: NA SA)

Neuquén, Argentina. The heavy water, which transports the heat generated by the reactor and comes out at 314 °C and 115 kg/cm^2, serves to transmit thermal energy to the steam generators, in which the heavy water exchanges heat with a secondary circuit of light water from the condenser of the turbine, which transforms it into 3,600 t/h of steam at 268 °C and 54 kg/cm^2 which powers the turbo-generator. The turbine condenser, in turn, is cooled by an open circuit of river water drawn from the Parana River at a flow rate of 40 m^3/sec. That is returned to the river after having been cooled in the condenser. This water in turn, returns some of the energy that was used for pumping it by activating a hydraulic turbine located in the flow of the discharge which generates an additional 8 MW.

The turbo-generator has a three stage condensation turbine: one high, one low and the third uses double flow. The turbine rotates at 1,500 rpm and is directly coupled to an 840 MVA generator cooled by hydrogen which generates a terminal voltage of 21 kV, which rises in transformers at a rate of 500 kV for delivery to the national electrical grid. This unit will be the largest generator in the national interconnected system at 2,000,000 HP, a position currently held by the generator at the *Embalse* nuclear plant in *Cordoba.*

The construction and startup of the *Atucha 2* nuclear power plant is being managed by *Nucleoeléctrica Argentina S.A. (NA-SA),* a state-run company responsible for the operation, and construction of all nuclear power plant in Argentina. *Atucha 2* is similar in civil construction to the nuclear power plants built in Spain, *Trillo* and the newest nuclear power plant in Brazil and *Angra II*, which are both equipped with pressurised water reactors. The *Atucha 2* nuclear power plant has the latest state-of-the-art safety systems built into its design and construction. These safety features include the concept of defense in depth barriers, successive containment spheres, physical separation between security systems and surveillance program service, among other concepts. Notably *Atucha 2* was built and will be operated according to building permits, rules and a timely inspection program arranged by the *Argentina Nuclear Regulatory Authority (ARN)*. Security systems have been designed and built with rules similar to those of the more than four hundred second-generation nuclear power plants currently in operation worldwide.

In conclusion, *Atucha 2* required 4,000 tons of piping, 16,000 valves, 700,000 welding joints, 3,000 km of cable, 1,000 connection points, 12,000 instruments, 1,600 displays, and 32.000 m^3 of concrete.



| Fuel element storage tanks. (Courtesy: NA SA)

Argentina has only 15,000 tU of confirmed uranium reserves as listed in the OECD-NEA/IAEA *Red Book*. Even though *CNEA* estimates that possible reserves may be as much as 55,000 tU. Argentina undertook an exploration for uranium in the 1950s, and a few small mines were operational, but the last one closed in 1997 due to economic reasons. However, there are currently plans by the *CNEA* to re-open the *Sierra Pintada* mine near *Mendoza,* which has been closed since 1997 and which is located in the central west part of the country. In 2007 the *CNEA* reached an agreement with the provincial government of Salta, in the north of the country, to re-open a uranium mine called *"Don Otto",* which had operated intermittently.

Since April 1997, the National Nuclear Activity Act assigns responsibility for the *CNEA* for the management of radioactive waste.

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DAtF Notes

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60 Years of the Peaceful Use of Nuclear Energy – Anniversary of the First Geneva Conference

The German Atomic Forum is commemorating the 60th anniversary of the first Geneva Conference (International Conference on the Peaceful Uses of Atomic Energy) which took place from 8 to 20 August 1955 under the leadership of the United Nations (UN).

The conference was dedicated entirely to the peaceful use of nuclear energy. Under this overall concept, participants discussed a wide range of topics, including reactor research and technology, health and safety aspects and the global requirements for the energy supply, and the contribution that nuclear energy can make towards it. Not only did the 38 governments submit over 1,000 papers for the first nuclear conference; with more than 1,400 participants it was also one of the UN's largest events at the time.

The conference had considerable consequences in Germany, where prospects for nuclear research only emerged after the declaration on renunciation of nuclear weapons in the Paris Agreements of 1954 and integration with the West. Given the technical and scientific backlog in nuclear technology, science and politics were strongly motivated to catch up and to use the technology peacefully also in Germany. The result was the beginning of an impressive industrial success story for nuclear technology in Germany. 5,000 TWh of electricity, which is available for base load around the clock, had been generated from nuclear energy by October 2014. It also constitutes a substantial contribution to climate protection: Considering the German production structure from 1961 to the present, this has prevented the emission of around five billion tonnes of CO_2 into the atmosphere.

The nuclear conference in 1955 was also a response to the "Atoms for Peace" speech given by US President Dwight D. Eisenhower in front of the UN in 1953 in which he explained his ideas and plans for the peaceful use of nuclear energy. The main focus was on the goal of making nuclear energy available in the fields of agriculture, medicine and electricity production. For this purpose, President Eisenhower proposed the creation of joint cooperation structures under the umbrella of an international atomic energy agency. In 1954, the UN General Assembly adopted a decision which provided for the establishment of the International Atomic Energy Agency (IAEA) and the implementation of an international technical conference, the first Geneva Conference.

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