

The role of dams and hydropower in Argentina

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In 2010 Argentina will complete two centuries of life as a country. During the first 100 years, the primary focus was on securing territorial borders and establishing national institutions. The last 100 years were characterized by strong social and economic growth. Since the mid-20th century, dams have played an important part in the development of regional economies, and in national integration. The current international economic crisis underlines the challenge of strengthening the participation of this sector in the national economy.

With a continental surface area of 2.78×10^6 km², Argentina is the eighth largest country in the world. By 2010 its population will have reached approximately 40 million. The majority live in urban areas, with more than one fourth being concentrated in Buenos Aires and its surrounding municipalities.

The National Constitution of 1853 established a representative democratic, republican and federal system. The reformed Constitution of 1994 assigned natural resources (including water) as the property of the 24 Argentine provinces.

According to the parameters established by the World Bank, 66 per cent of the country is arid or semi-arid. In this immense area of territory, only a small number of rivers drain more or less from West to East, determining the valleys in which development is possible. That is why the country needs utilities to control water and allow for the generation of irrigated zones and electric power, among other benefits.

The total surface water resources in Argentina have an average flow of 26 000 m³/s, of which 22 000 m³/s flows within just 24 per cent of the country's territory. For the most part, this concentrated flow is in the Argentine part of the Río de la Plata river basin. This eastern section of Argentina has a particular need for dams, to take advantage of water surpluses at rainy times of the year, and also to control floods which from time to time cause catastrophes with an associated loss of life and infrastructure.

Major national companies

The conditions which have been described, together with the political and social context, have led to the creation of large state companies responsible for territorial development and the provision of the necessary infrastructure for human, agricultural and industrial needs. In 1947, the national company Agua y Energía Eléctrica S. E. (Water and Electric Power) was created, with jurisdiction over the whole of Argentina. In



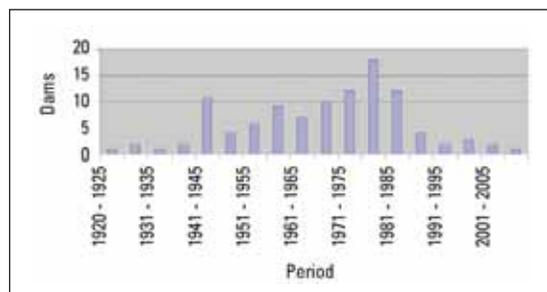
Aerial view of the Alicura project.

1967 Hidronor S.A was established, with exclusive jurisdiction over the major non-shared basin, the Río Negro river basin. In the period between 1945 and 1995, these companies constructed 80 per cent of large Argentine dams. During that time, important agreements were signed with the Republics of Paraguay and Uruguay for the construction of two bi-national hydropower plants: Yacyretá (3200 MW) on the Paraná river, and Salto Grande (1890 MW) on the Uruguay river.

These dams and hydro plants have played an important role in national development and land use, incorporating areas for irrigation and providing electricity for growth. The power was initially for local grid systems, and, since the mid-twentieth century, form an important interconnected electrical system.

Privatization and the standstill in dam construction

In the early 1990s, the neoliberal economic model found one of its firmest followers in Argentina. State companies were liquidated, and water and electric power companies were privatized. Hydropower plants were taken over by private companies and the State abandoned its pioneering role. The optimisation of benefits took priority over strategic development, favouring the installation of thermal plants (generally combined cycle plants), instead of hydropower plants which were not considered to be economically feasible. Only a few provinces continued to develop hydraulic projects, mainly in the form of water man-



Trends in the construction of large dams in Argentina.

Type of dam	Number	Per cent
Concrete arch	12	11
CFRD	2	2
Concrete buttress	11	10
Rockfill embankment	10	9
Concrete gravity	22	21
RCC	1	1
Earthfill embankment	49	46

agement schemes for irrigation and domestic water supply. The result was a sharp decline in the construction of new dams.

The reform process initiated in Argentina at the beginning of the 1990s ended in 2001 with a phenomenal economic and social crisis. Between 2002 and 2008, the internal gross product increased at a continuous pace, which was unprecedented in the country's history. This brought about a recovery in the levels of electrical demand which put the electrical system on the verge of crisis. As a result of these new developments, hydroelectric projects again became a competitive and strategic alternative to thermal based production.

Argentine dams

In Argentina there are more than 120 large dams and a large number of small dams, including all types of structures. Of the registered dams, 20 per cent are have more than 60 m high. The distribution according to type is as shown in Table 1.

At 170 m, Piedra del Águila dam on the river Limay is the highest. It is a gravity dam with a volume of $2.78 \times 10^6 \text{ m}^3$, a maximum reservoir capacity of $12.400 \times 10^6 \text{ m}^3$ and a maximum spillway capacity of 10000 m^3/s . Details of the country's five highest dams are shown in Table 2.

Five major reservoirs impounded by dams are shown in Table 3

Most dams in Argentina have been constructed to fulfil more than one purpose. Table 4 summarizes the distribution of their uses. (The first five categories have been calculated without taking into account whether these are exclusive uses).

Today, 25 per cent of dams and hydropower plants come under national jurisdiction and are operated by private companies under licence. Two utilities are bi-

Dam	River	Type	Height (m)	Crest length (m)	Volume(10^3m^3)
Piedra del Águila	Limay	PR	170	820	2780
Los Reyunos	Diamante	ER	131	266	3220
Alicurá	Limay	ER	130	880	13 000
Futaleufú	Grande	ER	130	600	6000
Agua del Toro	Diamante	VA	120	309	320

Dam	River	Type	Height (m)	Reservoir volume (10^6m^3)
Loma de la Lata	Neuquén	Rockfill	16	27.770
El Chocón	Limay	Rockfill	86	22.000
Yacyretá	Paraná	Rockfill	43	21.000
Planicie Banderita	Neuquén	Rockfill	34	13.800
Piedra del Águila	Limay	Gravity	170	12.400

Use	Number	Percentage of total	ICOLD abbreviation
Irrigation	68	64	I
Water supply	25	23	S
Flood control	39	36	C
Hydropower	50	47	H
Navigation	2	2	N
Multipurpose	57	53	M

national, some of them are private, and the provinces operate the remainder.

Hydroelectricity

The hydroelectric theoretical potential of Argentina is 354 TWh/year. The technically feasible potential is 130 TWh/year, of which approximately 24 per cent is developed. If a comparison were done with regard to the theoretical available potential, there would be a proportion of less than only 9 per cent in use.

In 1950 3.2 per cent of the energy in Argentina was generated by hydropower. By 1995, that figure had increased to 45 per cent. Strong economic growth in the last six years has generated a significant increase in electrical demand, because of growth in economic activity and also the increase in per capita consumption.

The total installed capacity in Argentina is 26 244 MW, which is likely to diminish for lack of availability and obsolescence. The hydropower capacity accounts for 38.7 per cent (10 156 MW) of the total. Because of the lack of significant investment in the construction of hydropower plants, the major demand produced by growth in the internal gross product between 2002 and 2008 was absorbed by an increasing share of thermal power and a consistent decrease in hydroelectric power generation as shown in Table 5.

The share of hydroelectric power decreased from 50.5 per cent in 2002 to 34.4 per cent in 2007, marking a constant and consistent negative trend.

Considering the volatility of the fossil fuel market, the heavy reliance on thermal energy creates an equally heavy financial drain and makes it increasingly difficult to meet the growing demand for electric energy.

Dam safety

Until the early 1990s, dam safety in relation to the national hydropower plants was in the hands of Water and Electric Power and Hidronor. From 1993, the private companies which began to operate the dams



The bi-national Yacyretá scheme.



Aerial view of the Vertedero scheme.

assumed responsibility over dam safety from the State.

In 1999, the National Government created the Dam Safety Regulator Organization (ORSEP) by Decree No. 239/99. This Institution is responsible for technical regulatory functions, and for the supervision of structural safety at all national dams and reservoirs. The operation and maintenance responsibilities are contracted out to private consortia in the form of concessions. The concessionaires are responsible for monitoring and inspecting the dams and for implementing an emergency action plan. Annual reports on dam safety monitoring and technical documents are submitted to ORSEP.

ORSEP is the official agency responsible for enforcing compliance with structural norms and standards, as determined by the concession contracts drawn up by the Federal Government. The private concession contracts require each concessionaire to implement a specific emergency action plan in accordance with civil defence.

Dams in the provinces are under provincial government supervision. There is no regulation for these dams. ORSEP provides technical assistance on dam safety issues to some of the provinces, under requirement and specific agreements.

There are no specific guidelines or norms relating to dam safety in Argentina, and there is no system of dam classification at present.

Criteria for basic decisions are based on ICOLD guidelines, and it is usual to follow the practices of institutions such as the Corps of Engineers, the Bureau of Reclamation, or FEMA-FERC in the USA.

Recently, the Argentine Government began work on promoting a Federal Dam Safety Law to cover all large dams in the country, as well as new projects

Some of the new projects already in progress in Argentina are as shown in Table 6.

Current situation

After the political and economic crisis in Argentina at the beginning of the millennium, growth of the internal gross product generated the expectation of new hydroelectric projects going ahead, including the construction of new dams. This situation marks the beginning of a slow recovery process for dam-specific engineering, which now involves new challenges, such as environmental issues, financial and social sustainability, the development of new construction technologies and more.

In general, new projects are to be constructed and operated on the basis of concessions. Financing is achieved through a system of public - private associa-

Year	Thermal	Hydropower	Nuclear	Imported	Total
2002	32 642	41 090	5393	2210	81 334
2003	49 399	38 717	7025	1234	86 442
2004	39 466	35 133	7313	1441	93 286
2005	51 351	39 213	6374	1222	98 160
2006	53 928	42 987	7153	559	10 4627
2007	61 012	37 290	6721	3459	108 482

Project Name	Status
Chihuido I	Bidding process
Condor Cliff	Bidding process
Cordón de Plata	Under project
Corpus Christi (Binational with Paraguay)	Under project
Garabí (Binational with Brasil)	Under project
La Barrancosa	Bidding process
La Elena	Feasibility level
Las Tunas	Under construction
Los Caracoles	Due for commissioning in August 2009
Los Monos	Feasibility level
Portezuelo del Viento	Under project
Potrillos	Recently commissioning
Punta Negra	Review of the project to restart the construction
Saladillo	Under construction
San Francisco	Under construction

tion, whereby the investor assumes the principal costs and proposes variants to state participation, such as tax exemptions, different periods of grants from the commission, economic contributions of the State during construction, and so on. Likewise, the State must update its participation, assuming the role of regulator-initiator.

The current international crisis will certainly affect Argentine development. Nevertheless, the needs of the new millennium will direct efforts toward hydropower.

Today more than ever, Argentina needs to establish clear rules for investors, to strengthen the regulatory role of the State. It is also necessary to define alliances between the private and public sectors, to make their interests compatible and to revitalise a strong investment in hydroelectric projects. There are hopeful signs already. ◇

Ernesto Ortega graduated as Civil Engineer from the National University of Buenos Aires, Argentina, in 1973. During his career he has worked with Water and Electric Power S.E., Hidronor S.A. and various national and international consulting companies. He has developed expertise in the construction of large dams and energy projects. In 1994 he joined the Planning Area of the Dam Safety Regional Organisation of Comahue Region in Argentina, specializing in dam safety, with special emphasis on Emergency Action Plans. Since 1999 he has been Technical Secretary of Dam Safety Regulatory Organization (ORSEP). From 2005 to 2008 he was President of the Argentine Committee of Dams and he is currently its Secretary.

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