Impasses and controversies of hydroelectricity

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In view of electricity generation from fossil fuels (oil by-products, mineral coal and natural gas), hydroelectricity that uses water as its "fuel" is presented as a "clean, renewable and cheap" energy source. In Brazil, hydroelectricity accounts for about 76.6% of the generation installed capacity in the country, and for 82.8% of all electricity consumed (ANEEL, 2007).

The use of water for electricity generation found, in the Brazilian territory, an important field for the development and consolidation of the national engineering.

Among the approximately 157 hydroelectric enterprises (with power higher than 30,000 kW) currently operating in Brazil, it is possible to find real "works of art". Some of them make the qualification of the Brazilian civil engineering evident, in terms of project conceptions, arrangements, development of damming techniques and of hydraulic systems.

In that sphere some companies also stood out as great public construction undertakers, in the execution of civil constructions and electromechanical assembly in hydroelectric enterprises, as a rule alongside overbillings, expedients often identified but never investigated as they should be.

Hydroelectricity is an alternative to obtain electricity from the use of the hydraulic potential of a certain portion of a river, often ensured by the construction of a dam and the consequent formation of a reservoir.

Only in the periods of heavy rain, when there is a greater water flow, as well as a higher waterfall, due to the increase of the height above datum of the reservoir, it is possible to obtain more power. For that reason, the function of the reservoirs is to store water, regulating the flow, in order to guarantee greater energy availability for a longer period of time.

In the hydroelectric enterprises there is always the idea of the so-called "comparative advantages" provided by the great hydroelectric projects, pointed out as a renewable energy supply alternative.

From the point of view of the use of the hydric resources, the electricity generation in Brazil has been considered a priority, despite an old legislation that has already defined the principles of the multiple uses of the waters, such as the Code of the Waters of 1934. Law n. 9,433, of January 8th, 1997,

which establishes the National Policy for Hydric Resources and the tools of the National Management System for Hydric Resources, only reiterates those principles, without making their execution effective.

Two governmental agencies compete to regulate the implementation of the hydroelectric enterprises. On the one hand, the National Electricity Agency (ANEEL), created by Law n. 9,427, of December 26th, 1996 to replace the old National Department of Waters and Electricity (DNAEE) that became extinct in the restructuring process of the Brazilian electric sector. On the other hand, the National Agency of Waters (ANA), created by Law n. 9,984 of 2000. The superposition of competences between both agencies was only partially solved with Resolution n. 131, of March 11th, 2003, which defined as competence of ANA the Hydric Availability Reservation Declaration (DRDH), imposing on ANEEL the responsibility for its previous obtainment, as a pre-requisite for the concession bidding or authorization of the use of hydraulic potential.

More recently, a new support organ to the Ministry of Mines and Energy was created, the Energy Research Company (EPE). Its attributions were defined by Law n. 10,847 of March 15th, 2004. They consider the promotion of the energy potential studies, including the inventory of hydrographic basins, and the promotion of the technical-economic and the social and environmental feasibility studies of hydro power plants, as well as the obtainment of the Previous Environmental License for hydro power plants.

Hydroelectric potential

The installed capacity of the hydro power plants currently in operation (about 74 thousand MW) represents not more than 28.4% of the total hydroelectric potential in Brazil, estimated to be 260.1 thousand MW.[1] That situation is used as an argument for the advocates of a more vigorous expansion of the projects of hydro power plants in Brazil.

The possibilities for the expansion of the hydroelectric capacity to be installed in Brazil, however, face many problems.

Almost half of that potential (50.2%) is located in the Amazon region, mainly in the Tocantins, Araguaia, Xingu and Tapajós Rivers. The social and environmental consequences of the possibility of implantation of the hydroelectric enterprises predicted for the region, involving issues such as those related to reserves within indigenous lands or the maintenance of the biodiversity, demand attention and care that go much beyond the rhetoric of the official documents.[2]

The hydroelectric potential to be used in the Paraná and Uruguay River basins is also significant, representing about 29% of the total. In those regions of the South of the country, characterized by a high population density in the rural areas, the process of "compulsory displacement" of those riverside

people for the formation of the reservoirs of the predicted hydroelectric enterprises also requires all the attention and care, to avoid the repetition of the problems that took place in the recent past.

As for the other hydrographic basins, it is worthy to point out the limited hydric availability for new hydroelectric plants in the East Atlantic, São Francisco, Southeast Atlantic and South Atlantic basins.

It is also important to emphasize the primary character of the notion of "hydroelectric potential" of the watercourses, in contrast with other possible "potentials" – fishing; irrigation; touristic; cultural; biodiversity. In that measure, the priority of electricity generation in view of the other uses of the waters is highlighted.

Hydro power plants and the environmental issue

Hydroelectric enterprises have often proved to be unsustainable, both internationally and specifically in Brazil. That unsustainable character may be established from criteria that identify the physical-chemical-biological problems decurrent from the implantation and the operation of a hydro power plant and from its interaction with the environmental characteristics of the place where it is built.

Among the main environmental problems in hydro power plants, the following ones can be pointed out:

- Alteration of the hydrological regime, jeopardizing the activities downstream of the reservoir;
- The low quality of the waters, due to the still water character of the reservoir, making the decay of the wastes and effluents more difficult;
- The wearing away of the reservoirs, due to the lack of control in the territorial occupation pattern in the headwaters of the reservoirs, subject to processes of deforestation and removal of the riparian forest;
- Greenhouse gases emission, specifically methane, decurrent from the decay of the vegetable covering definitely submerged in the reservoirs;
- Increase of the water volume in the reservoir, with the resultant overpressure on the soil and subsoil due to the weight of the water mass penned up, in areas with unfavorable geological conditions (for example, karst plots), leading to induced earthquakes;
- Public health problems, due to the formation of the still waters in the reservoirs and the consequent proliferation of vectors that transmit endemic diseases;
- Difficulties to ensure the multiple use of the waters, due to the historical character of priorization of the electric generation instead of the other possible uses such as irrigation, leisure, fishing, among others.

Social issues in the hydroelectric enterprises

As far as the social aspects are concerned, specifically in relation to the riverside people affected by the undertakings, they are always disregarded before the perspective of the irreversible loss of their production and social reproduction conditions, established by the formation of the reservoir.

The hydro power plants built so far in Brazil resulted in more than 34,000 km^2 of flooded lands for the formation of the reservoirs, and in the discharge – or "compulsory displacement" – of almost 200 thousand families, all of which were directly affected riverside people.

The construction of a hydro power plant has often represented the destruction of the life projects for those people. It imposed their discharge from the land without presenting compensations that could at least ensure the maintenance of their reproduction conditions in the same level as before the implantation of the enterprise.

In the relationship of the companies of the Brazilian electric sector with those people, the "consummate fact" strategy prevailed in almost all the enterprises. While the hydroelectric alternative was always presented as a "clean, renewable and cheap" energy source, and each project was justified on behalf of the public interest and the progress, the fact is that the material and cultural bases for the existence of the riverside people were violated. The undertakings caused the compulsory displacement of those people, along with ridiculous or inexistent financial compensations; the resettling process, when there was any, didn't ensure the maintenance of the life conditions that existed before. Several public health problems occurred in the dam areas, such as the increase of endemic diseases, the jeopardizing of the water quality in the reservoirs, which affected activities such as fishing and agriculture, and problems related to the security of the people, with the increase of the risks of flood below the reservoirs, decurrent from operation problems. Besides, a great quantity of productive lands was submerged and, in many cases, the biodiversity loss was irreversible.

Historically and coincidentally, many hydro power plants are installed in social spaces originally conceived by riverside people and for them to produce their forms of subsistence through fishing and agriculture. The projects for the construction of hydro power plants end up occupying the spaces for social/cultural reproduction of land owners and non-owners alike (sharecroppers, tenants, holders, wage earners, etc.) and determining the beginning of conflicts. The essence of which, according to some people, is the seizure of the geographical space as a form of specific commodity for hydroelectric power generation; and, according to others, the social and socio-cultural reproduction use as a way of life.

On the one hand, the entrepreneurs try to hide or muffle conflicts, trying to go on with their projects and using essentially economic criteria. On

the other hand, the affected people, along with religious and environmental authorities, try to make the conflicts evident, showing that certain rights are not being considered. They use essentially environmental, social and humanitarian criteria (Rezende, 2003, p.23).

It is a logic that invades regions that are not totally included in the market economy and that supposedly need incentives for their inclusion. "The hydroelectric enterprises are directed towards the development of extensive territorial areas that have not been included in the market economy yet" (Waldman, 1990, p.42). Besides, the same logic will only be conceived when the invaded space offers conditions for capital reproduction and exploitation of the natural space as a commodity: "The projects identify entire regions, very extensive basins, rich meadows transformed in energy mines" (Vainer & Araújo, 1992, p.71). As a rule, the regional development programs presuppose that the region has some kind of ability for hydroelectric installation to become feasible.

There is a great range of issues that involve hydroelectric projects. Another aggravating factor is the difficulty of participation of those interested in the decision making process about the installation of the undertaking or not. The involvement of society in the issues related to hydroelectric installation is limited, when it exists at all.

Such issues were examined by the World Commission on Dams (WCD), created in April, 1997, for an evaluation of the dams built in the world. With twelve members, WCD involved the participation of representatives from the equipment industry, from governments, scholars, environmentalists and social movement leaderships.

In its final report called "Dams and development – a new structure for decision making", elaborated from the reaching of a consensus. It considered the several social players involved and was published in 2000. WCD stated the following:

> The participation in the planning processes of large dams and their transparency are often neither comprehensive nor open [...] The participation of the affected people and the evaluation of the environmental and social impacts often occur only late in the process and have limited reach.

It's important to note that the Universal Declaration of Human Rights was included in Annex VI of that document, which constituted a pathetic way of exposing the need to consider the people affected in the hydroelectric enterprises.

The predominance of a reductionist and hegemonic conception determines that the ways of life and the forms to use natural resources act according to the market logic and that they prevent the communities affected by dams from being acknowledged as "subjects that are active and have discussion and deliberation margin" (Zhouri et al., 2005, p.98-9).

The non-identification of the subjects and their interests, their histories and cultures by the investing agent actually constitutes a previously defined element to conceive the invisibility phenomenon for riverside people. "For the government, the multilateral Banks, the construction companies and the consultants that elaborate Environmental Impact Studies, they don't exist" (Leroy, 2002, p.9), and, since they don't exist, they are not considered in the decision making process, and their interests and proposals are not taken into account. Using the invisibility strategy means denying rights and duties of the investing agent himself in relation to families and riverside communities and cities. Operating the invisibility resource means not to observe the existence of subjects, cultures, developed social organization, building and being rebuilt in the identified area while fit to receive the hydroelectric plant. It ends up favoring the involuntary displacements of people and the withdrawal of families from agricultural work to try to encourage the regional development.

"The current energy policy is fundamentally directed towards the profit of the private agents" (Carvalho, 2002, p.112), while the social and environmental effects that result from the installation of the industrial hydroelectric plant are costs that reduce the speed of the return rates of the hydroelectric projects. "The dam projects are guided by the market logic. Other costs that result from the undertaking, such as the ecological ones and the personal damages are not taken into account in their estimates" (Rezende, 2003, p.22). For the investing agent of the electric sector, the issues that deal with society and environment are high costs that make the investments more difficult and extend their return times.

Using invisibility as a tool to control the costs of investments and non-acknowledgement of the social groups historically constituted in a certain region reduces the range of politics as a field for the negotiations and possibilities, although it doesn't mean the non-existence of both social and environmental problems.

Democratic management of the hydric resources

The actual participation of the people affected by hydroelectric enterprises in the decision process of those undertakings is the main challenge and presents difficulties that are hard to overcome.

The quest for legitimization seems to guide the participation mechanisms and procedures. The democratic set of ideas that supports it also imposes some limitations. They refer to the majority principle as a democratic decision procedure, used to represent the desire of a majority instead of the others, identified as minorities.

Such themes as ecology, energy policy, urban sanitation, policies for women and the family are political areas characterized by the fact that they depend on decisions made "by everyone" (in a mediate way, for example,

by representative democracy), but their costs and effects affect more or less clearly defined population categories. In such situations, the majority decision principle doesn't ensure its democratic character (Offe, 1984, p.314-54).

The need to develop consensus in situations such as those related to the energy issue is endorsed here. The establishment of a consensus means the acknowledgement of the divergent interests that must be considered and incorporated into the negotiation process.

In fact, the search for consensus imposes the need for a greater time to make a decision, which makes this procedure hard to accept when the situations (and the interests) impose the need for quick decisions. For example, the decisions that refer to the construction of electricity generation plants have often been exposed to the perspective of a supposed increase of power deficit risks, supported by the blackout syndrome. In those situations, the persistence of affected people to acknowledge their rights is seen as an action that goes against the desire of a "majority who wants power".

Many decision instances in which society has some space to express interests that are divergent from or contrary to the enterprises are currently subject to the principle of the majority vote as a democratic expression of the decision process. This is just an apparent expression if we consider that the decisions are actually made after counting votes of a forum whose composition already reveals the prevalence of a majority position that favors the government or the entrepreneur. The Basin Committees already created are examples of those difficulties to ensure the independent character of their decisions.

Next, a case study is presented: the project of Tijuco Alto Hydro Power Plant Power Plant, which illustrates the impasses and the controversies mentioned above.

The case of Tijuco Alto Hydro Power Plant

The project of Tijuco Alto Hydro Power Plant, proposed to the federal portion of the Ribeira de Iguape River, between the States of São Paulo and Paraná, with the expected installed capacity of 144 MW, a 56.5 km2 reservoir and a 142 meter high dam, has as its investing agent the Brazilian Aluminum Company (BAC), which is part of Votorantim Group.

In December 2006, the project reached seventeen years of history, all of which trying to obtain the necessary licenses for electricity generation. The social movement that is the history of the popular battle against the installation of the Tijuco Alto project reached the same seventeen years.

The first attempt to obtain the licensing occurred in 1989. BAC registered documents in the state environmental licensing agencies – Secretariat of Environment (of the State of São Paulo) and Superintendence of Water Resources and the Environment (Surehma) (of the State of Paraná), petitioning for environmental licenses for the Tijuco Alto Hydro Power Plant project. The preliminary licenses were granted on 6.14.1994 by Consema/

Sema of São Paulo and on 2.22.1995 by the Environmental Institute of Paraná (EIP) that substituted Surehma.

Later, the licensing was nullified by a Public Civil Action, supported by a mobilization that involved congressmen, environmental agencies, community leaderships of the Vale do Ribeira region and lawyers. In the judicial decision of 12.10.1999, the Public Ministry decided that the licensing couldn't be on a state level, defining the competence of licensing to the Federal sphere – Brazilian Institute for the Environment and Renewable Resources (IBAMA).

Meanwhile, a new licensing petition, this time in the Federal agency IBAMA, began in 1997. In 2003, the petition was denied once again due to insufficiencies in the Environmental Impact Study presented.

In August 2004, BAC hired the National Association of Consultant Engineers (CNEC) and got a new Reference Term issued by IBAMA authorizing the restart of the studies. On 2.10.2005 a new licensing process was started and on 10.11.2005 both the Environmental Impact Studies and the Environmental Impact Report were presented to IBAMA, which is currently analyzing them (February 2007).

Throughout the history of Tijuco Alto Hydro Power Plant, BAC began to buy lands expecting the approval of the environmental licenses. In the properties bought, productive activities were developed both by land owners, who had the right for compensation and by non-owners, who didn't have that right.

The result of the buying of the land properties generated an involuntary population displacement process and the break in the community economic dynamics.

The hydrographic basin of the Ribeira de Iguape River

Ribeira de Iguape is the main river of its hydrographic basin. It runs for 470 kilometers – 350 kilometers in the State of São Paulo, 120 kilometers in the State of Paraná and 90 kilometers in the border between both states. The basin is located in the Southeast region of the State of São Paulo and in the Northeast region of the State of Paraná, comprising 23 municipalities in the State of São Paulo and seven in the State of Paraná, for a total of 432,966 inhabitants, according to data by IBGE (2000).

The Ribeira Valley region is renowned for the dichotomy that exists between a magnificent environmental patrimony and numbers that classify it as one of the poverty areas of the country. The scenario is one of scarce productive infrastructure and low economic development in a physical space renowned for one of the richest and more threatened biomes in the planet: the Atlantic Rainforest.

The municipalities of Cerro Azul (PR), Adrianópolis (PR), Doutor Ulysses (PR), Itapirapuã Paulista (PR) and Ribeira (SP) will be affected by

the reservoir of Tijuco Alto Hydro Power Plant if the project is implemented. As for the number of families affected, the estimate made by BAC in the first EIA/Rima elaborated by the company under the technical responsibility of the Intertechne/Engemim/IPEC Consortium (2nd version, December 1991) affected 740 families. At the time, the Movement of People Affected by Dams (Moab) in the Ribeira Valley region indicated that more than 1,200 families were already under pressure to sell their properties and to transfer their rights on the land.

The Brazilian Aluminum Company (BAC)

BAC, located in the municipality of Alumínio (SP), is an integrated aluminum industry whose productive process is electro-intensive to the extent that each ton of primary aluminum produced consumes between 15 thousand and 16 thousand kWh. In 2006, it had an annual installed capacity of 345 thousand tons of primary aluminum, with an expected increase to 470 thousand tons in 2007. CBA produces about 60% of the electricity that the company consumes, in the self-production regime. Tijuco Alto Hydro Power Plant project falls within its expansion perspectives.

According to Bermann, the issue of self-production is also controversial (2004b).

The figure of the self-producer was defined by Decree n. 2003, of 9.10.1996. Article 27 indicates that the granting of concession or authorization to self-producer is conditioned to the evidence, before the regulating and inspecting body of the granting authority, that the electric energy so produced shall be destined to self-consumption, *present or projected*.

The self-production regime considers the energy generation not as a commercial merchandise (independent producers), but as an input for the self-producers' activity, since they produce for their own consumption. Therefore, according to the principle on which it is based, the self-producer would stop consuming the energy from the public system and the latter would have a break. That would be a way to increase the supply without using public resources.

However, ANEEL, by means of Decree n. 2003 mentioned above, actually attributed to the self-producer an excessive benefit. According to Article 30 of that decree, upon grounded request by the interested party, the granting authority may declare the public utility of lands and improvements, for purposes of expropriation or institution of administrative easement, in order to allow the performance of works and services necessary to the implementation of hydraulic utilization or thermoelectric power plant, and the independent producer or self-producer shall be incumbent to effect, amicably or in court, pursuant to the legislation in force, the formalization of the act and pay the indemnification due.

That obligation of the granting authority had already been defined by Article 29, paragraphs VIII and IX, of Law n. 8,987, of 2.13.1995, but only Article 10 of Law n. 9,648, of 5.27.1998 established that the Brazilian Electricity Regulatory Agency (ANEEL) is responsible for declaring areas of public utility for the purposes of expropriation or establishing an administrative right of way as required to implement the facilities of the electricity concessionaires, permit-holders and authorizees.

The legitimacy of the expropriation for the purposes of activities considered to be private, both as an independent producer and for exclusive consumption, must be questioned. The argumentation used to justify such measure has to do with the understanding that the implantation of electricity generating units, regardless of its exploitation regime, leads to the increase of the capacity to meet the national demand, attending, therefore, the public interest involved. In the specific case of self-production, the new generating units would represent the availability of quantities of energy that would necessarily be destined to meet the needs of those interested industrial segments. Besides, the public interest would also be observed by means of the increase of the public revenues, the generation of jobs and the improvement of the people's life quality.

However, the enterprises in the self-production regime, specifically the Tijuco Alto Hydro Power Plant project, are shown to be enterprises that only ensure the increase of the production capacity of each of the electro-intensive companies involved. Thus, the celebrated break for the public system doesn't exist. On the contrary, the hydro power plants auctioned for the self-production regime actually take away from the public system the desirable increase of the supply.

In that sense, the current legislation permits the public good represented by the river to be expropriated to meet the private needs, in the strict sense of the term.

The companies and the government must respect the rights of the affected people, not using pressure or constraint, to compel the families to leave the lands or to accept the negotiations. This is about guaranteeing the rights of the affected people to ensure the reconstruction of their life conditions.

The social issue at Tijuco Alto Hydro Power Plant

In a recent study, Jeronymo (2007) evaluated the social and economic liabilities that result from the BAC actions with a view to make the Tijuco Alto Hydro Power Plant project feasible. In the fieldwork that took place, the owner and non-owner families of the lands bought by BAC were identified.

The BAC entrepreneur tried to exempt himself from the responsibility concerning the situation of the non-owners who left the rural real estates bought without any compensation, claiming that the owners were responsible

for the compensation of share-holders and tenants. In some cases, the holders only received the value of the improvements (cutting of trees, clearing of stumps, roads and paths, houses).

Many families that were displaced in a compulsory manner were only able to settle in peripheral neighborhoods, in which the public power has a very limited performance in the supply of the public services.

Based on the application of 46 questionnaires (63% with owners and 37% with non-owners), one could attest that only 23.5% of the people interviewed claimed that their life quality improved after the displacement, while 47% said there was no change and 29.5% believe that their life quality worsened. As for the income, 35% (owners and non-owners alike) stated that there was an improvement, while 24% of the owners declared that there was no change and 41% declared that their income went down. As for the non-owners, 35% declared that there was no change and 30% declared that their income went down.

The results demonstrate that the alleged improvement for the people and for the region with the implantation of the enterprise must be seen with extreme caution.

Conclusion: For a non-demonization of hydroelectricity

The evaluation of hydroelectricity as a generation alternative in Brazil should not be understood as an absolute restriction. In view of the issues discussed here, this is not about condemning the hydroelectric enterprises, but about pointing out social and environmental restrictions that are present and that must be actually considered so that the expansion of hydroelectricity in Brazil takes place in a socially just and environmentally sustainable manner.

Thus, some possibilities for the exploitation of the hydric resources for the generation of electricity in Brazil can be pointed out:

The repotentialization of the plants

The repotentialization of the hydro power plants with over twenty years of operation could increase the hydroelectric generation capacity in the country by 12%. A study carried out by IEE-USP for WWF (Bermann, 2004a) indicates that repotentialization undertakings in 67 plants in those conditions would have increased capacity potential reaching 868 MW for the minimum repotentialization, 3,473 MW for the light repotentialization and 8,093 MW for the heavy repotentialization. This is about optimizing the potential of the existent plants and about increasing efficiency in the generation.

The motorization complementation

Another option, which represents a gain of installed power without building new plants is to complement the motorization of some hydro power

plants. Porto Primavera Hydro Power Plant (SP), for example, has a capacity for eighteen turbines, but only ten are in operation. Itaipu Hydro Power Plant also doesn't have its entire capacity installed, since two turbines of 700 MW could add 1,400 MW to the 12,600 MW currently installed. That is also the case of Xingó and Itaparica Hydro Power Plants, both located in São Francisco River. Xingó Hydro Power Plant was projected to have ten turbines of 500 MW, so it would have a total installed capacity of 5,000 MW. However, today there are only six turbines installed. Therefore, 2,000 MW could be added if the other four turbines foreseen were installed. Itaparica Hydro Power Plant also has similar conditions. Initially projected to have ten turbines of 250 MW, it currently has only six turbines, for a total of 1,500 MW. Another 1,000 MW could be added if the remaining turbines were installed.

As for the two hydro power plants in São Francisco River, São Francisco Hydroelectric Company (Chesf) claims that there has been an over-dimensioning in both projects and that there is not enough water to put into effect the motorization complementation of both hydro power plants. In that case, the issue leaves the technical sphere and reaches the judicial one, since it has to do with investigating the responsibilities of those who approved the projects and managed the undertakings of both plants.

Small hydro power plants as an alternative

ANEEL Resolution n. 394, of 12.4.1998, defines as a small hydroelectric plant (SHP) the plants with total installed potency of up to 30,000 kW (30 MW) and maximum flooded reservoir area of 3 km^2. The regulatory agency granted some benefits to encourage electricity generation from the SHPs, such as the concession of a 50% discount in the tariffs for the transportation of electricity generated by them.

Since they are enterprises that, in general, try to meet the demands next to the loading hubs, in areas outside the transmission system, the SHPs play an ever more relevant role to foster the development of the generation distributed in Brazil. According to data by ANEEL (December 2006), a total of 63 SHPs were under construction, with a potency of 1,061.49 MW.

Most of the small hydroelectric plants in operation are located in the South and Southeast regions, in the Paraná and the Atlantic Southeast basins, near the great electricity consumption hubs. The Center-west region, where most of the remaining plants are located, concentrates the greatest potential for the new projects.

Official data by the Hydroelectric Potential Information System (Sipot) (ELETROBRÁS, 2005), obtained by ELETROBRÁS, indicate the existence of a potential for 9,800 MW in Brazil that could be reached with the construction of 924 SHPs. If we consider the plants with potency between 30 and 50 MW to be installed, the estimated potential may add another 4,700 MW, involving other 120 hydro power plant projects. Currently, about 277 SHPs are in

operation, with a total installed potency of 1,580 MW, which represents 1.64% of the Brazilian generation capacity (data by ANEEL for February 2007).

To encourage the use of alternative energy sources, Law n. 10,438 of 4.26.2002 created the Program for the Incentive to the Alternative Electricity Sources (Proinfa), which foresaw the installation of 1,100 MW up to December 2006 by means of SHPs.[3] However, the results reached were well under what had been initially predicted. Of the 65 SHP projects contracted, representing 1,189.58 MW, only nine were in operation in December 2006 (13.8% of the projects contracted), with 154.84 MW or 13.8% of the potency initially contracted.

Difficulties to obtain funding, insufficient quality of the proposed projects and problems of land availability for the implantation of the enterprises are some of the reasons that hindered the consolidation of Proinfa. The Federal government, in turn, eventually postponed the initial goal of the program to December 2008 (Bermann, 2007).

From the social and environmental point of view, the construction of small hydroelectric power plants must also be conceived with the same cautions that should be observed in the great hydroelectric power plants. Ortiz (2005) points out that

> It is obvious that an SHP can cause less impact than a large hydroelectric power plant. However, within the social and environmental specificities of a region, it can cause very serious and irreversible impacts on a certain biome and on the people who live in it and depend on it to survive.

In the recent history of the hydroelectric generation, there are many examples of SHPs that caused great impacts. SHP Fumaça (10 MW), built in the municipality of Diogo Vasconcelos (MG) by Novellis do Brasil (the former Alcan Alumínio), displaced in a compulsory manner two hundred families when it began to operate in April 2003. People who depended on the riverside to survive and who maintained a complex relationship with nature – shareholders, pan-makers (craftsmen who used soapstone), gold or diamond prospectors, daily workers and farmers – still face compensation problems.

In turn, the project of SHP Aiuruoca (16 MW), proposed by Eletroriver in Rio Grande River basin (MG), foresees the formation of a 16 hectare reservoir, that will suppress an important and unique portion of Atlantic Rainforest responsible for connecting the forests of Serra do Papagaio State Park and those of Itatiaia National Park. That plant, that will have a run-of-river operation, will jeopardize the sanitation conditions of the urban nucleus of Aiuruoca, located downstream from the damming (portion with reduced flow), since the sewage (both domestic and hospital) of the city is thrown directly into the river (Zhouri, 2004).

Even if the implementation of SHP doesn't solve the electricity generation needs in the country, it is undeniable that Brazil may increase its

generation capacity by means of the SHPs, favoring generation projects for isolated systems and giving priority to the assistance of the communities and the non-powered rural estates.

Hydroelectricity may continue with the role of ensuring the energy needs of the country if the social and environmental problems pointed out here are actually considered and overcome. The public service character as the destiny of the electricity production must be emphasized, in such a way as to prioritize the attendance of the residential and of public services demand whose average consumption (kWh/inhabitant) is still limited.

Notes

1 The hydroelectric potential refers to the information by ELETROBRÁS (2005). Available at: <http://www.eletrobras.com.br/EM_Atuacao_SIPOT/sipot.asp>. Access on: 2.12.2007. The data on the installed capacity refer to the Generation Information Bank (BIG) of ANEEL for February 2007. Available at: <http://www.aneel.gov.br/aplicacoes/ capacidadebrasil/capacidade brasil.asp>. Access on: 12.2.2007.

2 See the article by J. G. Tundisi in this issue.

3 Proinfa considers energy generation projects from the winds (aeolic power), small hydroelectric power plants (SHP) and sugar cane bagasse, rice straw, wood splinter and biogas from sanitation embankment (biomass), for an expected total of 3,300 MW. Up to December 2006, which was the initially expected date for the goal to be reached, only 771.4 MW had been installed, which represented only 23.4% of the total contracted. The number of enterprises represents coarse 16.6% of the total of projects contracted.

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ABSTRACT – This article assesses hydroelectricity in Brazil according to its importance as one of the country's main energy sources and also to its social and environmental impasses and controversies derived from the implantation and operation of hydroelectric

undertakings. In order to illustrate the questions related to large power plants that are brought up along the article, two case reports are presented: Tijuco Alto Hydroelectric Power Plant, which is going through Ibama's (Brazilian Institute for the Environment and Renewable Natural Resources) environmental license process; and Barra Grande Hydroelectric Power Plant, whose environmental license process has been affected by several irregularities. Finally, possible alternatives for hydroelectric production are pointed out, particularly power plant re-potentiation and a greater incentive to undersized hydroelectric plants.

KEYWORDS: Energy and environmental policy, Hydroelectricity and environment, Hydroelectricity and society, Social conflicts, Anti-Dam movement.

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