

ASPECTS OF THE GENERATION AND TRANSMISSION SERVICES IN THE PERUVIAN POWER SYSTEM UNDER DEREGULATION

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Abstract – In this paper is described and analyzed some aspects of the deregulated Peruvian electric sector with emphasis on the generation and the remuneration for the transmission services. After Chile in 1982 and Argentina in 1992, Peru began the reform of its electric sector enacting the Electric Concessions Law (LCE) in 1992 and its regulations in 1993. The new structure separates the activities of the electric sector in generation, transmission and distribution, establishing a competition among the generation utilities while the transmission system is defined as a regulated monopoly based on the concept of economically adapted system. Under this new deregulation framework, the remuneration by the use of the secondary transmission systems may generate controversial situations among the participant agents of the electricity market and the regulatory entities may face difficulties to solve them with the current legal rules. These and other cases that recently have originated enhanced rules are discussed and reported in this work.

Keywords: *Electric power systems, deregulation of power systems, transmission system, electric markets*

1 INTRODUCTION

Before 1988 the vertical organization of the electric power utilities was the predominant structure model in which one controlling authority operates the generation, transmission and distribution systems [1]. Electric power systems (EPS) around the world have gradually adapted to new legal rules prompted by the growing world globalization [2, 3]. For example in South America, Chile, in 1982, was the pioneer country to adopt new rules due to the privatization of its electric companies and consequent electric power reorganization, resulting in the deregulation of its electric power systems [4, 5, 6]. It is accepted that the structural organization of modern power systems usually considers the separation of the generation, transmission and distribution activities.

Transformation of the traditional electricity markets based upon monopoly structures has originated several laws and regulations and they are not usually perfect, showing some deficiencies reflected in the occurrence of different interpretations of the legal rules among the concessionaires which participate in the electric markets. This may lead to the rising of certain conflicts among the participant electric companies, and, accordingly, the involved agents and the ruling entities could face situations where with the legal existing tools is very difficult to solve discrepancies involving in most

cases some payment or remuneration [7]. In spite of generation would seem to be the sector with more difficulties due to the imposed competition, the transmission system is a propitious environment to the rising of divergences and conflicts. Also some troubles in the transmission system management including problems such as congestion, transmission tariffs and transmission losses have been identified [8, 9, 10]. In this context the problem of compensation imputable to the use of transmission systems has not been solved completely, but there have been proposed some advances on the topic with very good results, like for example the pools Pennsylvania-New Jersey-Maryland (PJM) and Ontario [11, 12]. These cases have been considered in a deregulated free-competition system, in which the market rules have the primacy [13].

In South American countries, problems caused by the lack of clarity and transparence of the legislation ruling the payment for transmission services, have caused conflicts among the concessionaires as well as between concessionaires and the ruling entities, which are difficult to solve under the present legal frames [5]. The lack of a simple, complete and transparent legal frame in countries such as Colombia, Peru and Chile, has led to think in changes in their electric sector laws [7]. Currently the government entities are putting in practice partial changes to those legal rules that have been insufficient tools to solve controversial situations.

In this paper is discussed a set of aspects related to the generation and transmission services payments in the deregulated Peruvian power system, in particular identifying those cases that may cause controversy between generation utilities and/or consumers and the transmission company. Some definitions in the current Peruvian legal frame have originated different interpretations among the agents of the electrical sector arising difficulties for the determination of transmission payments. Perhaps these problems indicate the need of a transformation from a cost-based regulated structure to a more market-based less regulated system.

2 STRUCTURE OF THE PERUVIAN ELECTRIC SECTOR

The main objective reformation target of the Peruvian electric sector was to establish the basis for an efficient electric system, capable of ensuring the society with a reliable and adequate service. Under these premises it was enacted the Electric Concessions Law (LCE)

on 6 November 1992, and its regulations on 5 February 1993. Both granted the necessary legal frame to carry out all activities related to generation, transmission, distribution and commercialization of electric energy [5, 14, 15]. Until 1992 the Peruvian electric sector was structured under a vertical state monopoly. The new structure puts apart the activities of generation, transmission and distribution into independent companies, establishing competition among the generation utilities. (See Figure 1)

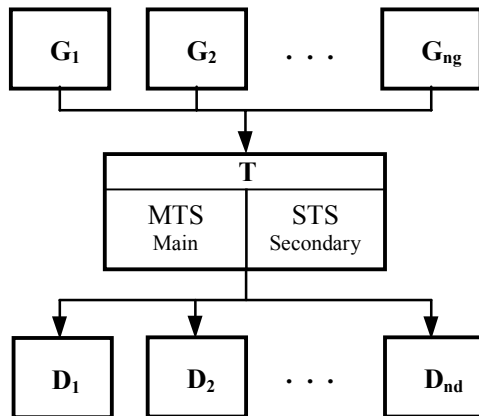


Figure 1: The structure of the deregulated Peruvian power system. (G, T, D = generation, transmission, distribution)

Institutions in charge of the legal handling, regulation, controlling and coordination, are respectively the Ministry of Mines and Energy (MEM), the Energy Tariffs Commission (CTE), the supervisory body for the Investments in Energy (OSINERG), and the Committee for the Economic Operation of the System (COES). The MEM defines the sector policy and enacts this sector's norms. The entity in charge of the regulation, controlling and publishing of the regulated tariffs is CTE. COES is in charge of the system operation planning [5, 16, 17, 18].

Under this model the generation is decentralized and deregulated, subject to free competition, with a national transmission system that will allow free access to a regulated toll system and distribution per area in a regulated natural monopoly regime, with prices regulation based on the computing of marginal costs [14, 15].

According to the LCE and its regulations, the electric market is composed of free clients (CL) whose contracted capacity is larger than 1 MW, regulated clients (CR) whose contracted capacity is equal or lower than 1 MW, intergenerators market and the opportunity market (spot). Agents of Peruvian electric market are shown in Figure 2.

3 THE PERUVIAN GENERATION SYSTEM

The installed electric generation capacity of Peru (2001) is about 5900 MW, of which 47% is hydroelectricity and 53% mainly diesel and fuel oil. The electricity generation of Peru was 20.7 billion of kWh in 2001, up from 19.9 billion of kWh in 2000. [19]

Information collected from Internet sites of COES-SICN and COES-SUR indicates that maximum load demand of the SICN power system for year 2000 was 2620.7 MW and for SIS was 473.6 MW (for SEIN it was 3094.3 MW).

The total power capacity of the SICN and SIS for year 1998 was 4206.8 MW, of which 2297.3 MW (54.6%) was hydroelectricity and 1909.5 MW (45.4%) from thermoelectric plants. The effective power (i.e. the dispatched power) was 3852.2 MW of which 2096.5 MW (54.4%) corresponded to hydroelectric plants and 1755.7 MW (45.6%) to thermoelectric plants. [16, 20]

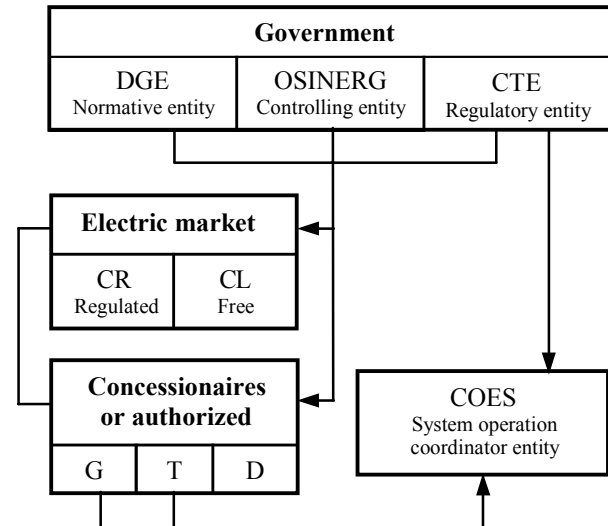


Figure 2: Schematic diagram showing the participant agents in the Peruvian electric market (G, T, D = generation, transmission, distribution).

Generation utilities may develop electric trade among them as follows:

- Power and energy transfers at a short-term marginal cost. COES determines the marginal cost from results of economic dispatch studies according to procedures established by the regulation.
- Generators may sale power and energy to the regulated market at regulated tariffs to distribution utilities.
- Sale of power and energy to the free market at free prices to generation or distribution companies and free clients.

For calculation of electric tariffs, the CTE remunerates the investments in the electric system with an interest of 12 %. This percentage only may be modified by the Ministry of Mines and Energy, from a study conducted by a consultant designed by the CTE. The LCE defines penalties for generators and distributors in case of some service failure.

Buses tariffs (generation tariffs) are regulated in a semester basis and occur in the months of May and November of every year. The transmission tolls (transmission tariffs) are regulated in an annual basis in the month of May. Tariffs formulae for regulated clients are regulated every four years in the month of November.

4 PERUVIAN TRANSMISSION SYSTEM

In Peru, the transmission network is formed by two big interconnected systems and by small regional systems. The big ones are the central northern interconnected system (SICN) and the southern interconnected system (SIS). The SICN has the largest installed capacity, it is constituted by 220 and 138 kV transmission lines in the area located over most of the cities of northern and central Peruvian regions. In Fig. 3 is shown a diagram that represents the important SICN transmission system. Companies in charge of the transmission system are ETECEN (Central North Electric Transmission Company) and ETESUR (South Electric Transmission Company) in the SICN and SIS, respectively.

The SICN is interconnected to SIS since September 2000 when it began to operate the 220 kV, 600 km transmission line Mantaro–Socabaya (LMS) creating thus the national interconnected system (SEIN). LMS is to be operated by Transmataro Consortium for a 30 years concession period.

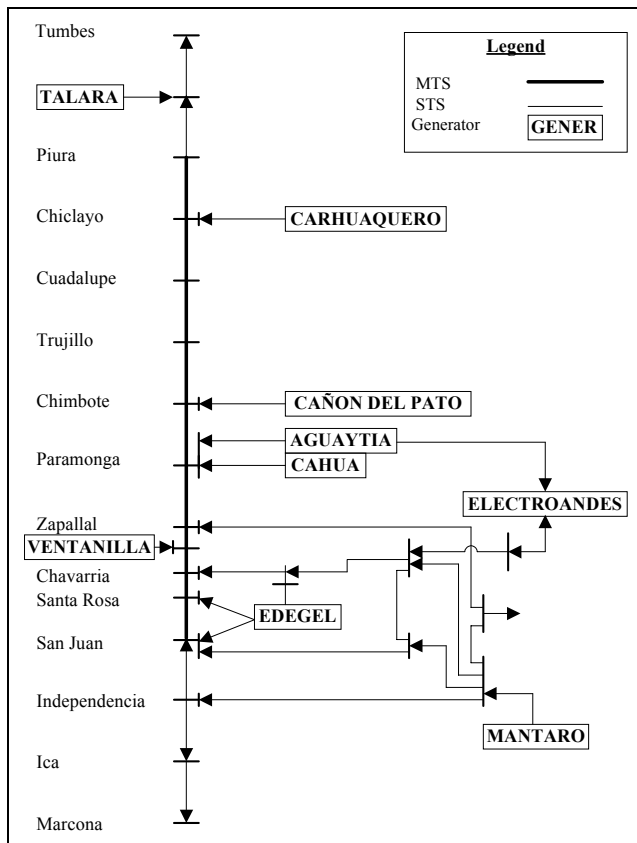


Figure 3: Diagram of central northern interconnected system (SICN). [21]

SICN and SIS interconnection has originated the occurrence of some electromechanical and voltage oscillations mainly in the SIS subsystem. These oscillations are typical in electrical power systems with longitudinal structure and when they operate under high load conditions. SEIN has clearly a longitudinal structure.

The SEIN has been defined considering regulated wheeling costs and a distribution by area within a regu-

lated monopoly regime and prices based on marginal costs. The LCE and its rules point out that power transmission activities are characterized to be an open access system, where the compensations due to the use of transmission network are already regulated. To accomplish a proper regulation, the LCE indicates some definitions related to the payment by the use of the transmission system.

4.1 Main and Secondary Systems

To put apart the responsibilities by the use of the transmission system, LCE divides it into two: main transmission system (MTS) and secondary transmission systems (STS). In Figure 4 is shown a schematic division of the Peruvian transmission system.

The MTS is the part of the interconnected system with high and very high voltages, where the power flow is bi-directional and it is not possible to establish specific responsibilities to each generator and client. In this way it is allowed to the generators the power and energy commercialization in any bus of such systems.

The STS is constituted by those parts of the interconnected system in which is possible to determine a predominant power flow direction and, in such a way, to establish specific responsibilities for one or more generators or clients, allowing to the generators to connect to the main system or to commercialize power and energy in any bus of these secondary systems [5, 22].

In Figure 3 it is shown the SICN diagram in which it is indicated the main buses and generation utilities and the configuration of the main and secondary transmission systems.

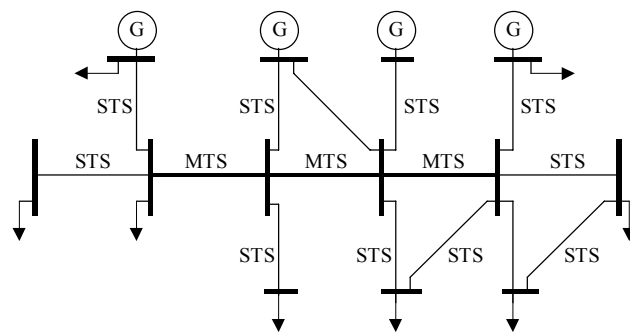


Figure 4: Diagram of the structure of the Peruvian transmission system.

In spite of the expected benefits of the SICN and SIS interconnection, some problems have not been solved. Thus, for example, during the restructuring process there were also congestion problems after the interconnection of one of the generators (of a generation utility) to the MTS of SICN. The interconnection of this generator unit to the secondary transmission system of another generation and transmission utility it caused conflicts between these concessionaires. The origin of the problem was the transmission service payment by the use of a secondary transmission system [21]. Apparently the CTE has not solved that discrepancy.

On the other hand, new difficulties among the participant agents of the electric market may arise due to the SICN and SIS interconnection. It is not very clear the definition of MTS and STS systems because of the LMS interconnection will affect the power flows direction in the secondary transmission systems of SICN and SIS, and provoking in this manner that some generation utilities may demand some evasion for the payment of its STS. In other words, it is possible that some subsystems of the STS may be redefined as part of the MTS and vice-versa.

Definitions given by the LCE on the qualification criteria, whether a transmission system is main or secondary, may be a controversial question for the transmission concessionaire company. These criteria or rules do not have the sufficient economical principles supporting such division and the decision, to certain extent, may be considered arbitrary.

Moreover must be indicated that currently Peru and Ecuador are analyzing and coordinating the option of interconnection of their electric systems.

4.2 Economically Adapted System

The LCE establishes the concept of an economically adapted system (EAS), and when it is applied to the transmission has the following characteristics: the electric transmission network is dimensioned according to demand requirements, inefficient nor redundant electric facilities are not considered, under market prices the facilities will be valued as if they were new. Once the economically adapted system is an ideal model, the existing networks cannot be incorporated into such a concept. The attainment of a system economically adapted leads to a dilemma when seeking the solution for the optimization problem [5, 23].

4.3 New Replacement Value

The new replacement value (NRV) is the cost credited to the renewal of constructions and equipment, where take part the engineering, a power system ideally conceived assigned to offer the same service parallel to technology and market current prices. This value includes financial expenses at the time of construction based upon the interest rate fixed by LCE, expenses in studies and control, considering a transmission system technical and economically adapted to specific load conditions.

The LCE considers the settlements of the transmission system as permanently new, being susceptible of rewarding indefinitely. The NRV concept is not clear because no project is built to last forever. In such a project there is an amount of investment, and the investors expect to get adequate profits at the end of the term.

4.4 Operation and Maintenance Costs

The Electric Concessions Law establishes the concept of operation and maintenance costs (OMC) which are considered efficient for the system economically adapted, and comprehend the following items: staff, maintenance, fuel and lubricants, yearly fixed capital (buildings, plants, machinery, parts, and other equip-

ment), safety of the installations, materials, other operation expenses.

This concept of OMC cannot be applied, once the LCE asks for the operation and maintenance calculus of fictitious assets, in other words, of non-existent ones.

4.5 Tariff and Toll Revenues of the Main Transmission System

Compensation for the main transmission system usage is done separately through one of two concepts: tariff income and toll per connection. Tariff income is calculated in function of the power and energy delivered and removed in buses, valued according to their corresponding bus tariffs, which is the difference between the value of the power and energy removed from the output point towards the client, and the prices of the power and energy delivered at the injection point. Equations (1) and (2) define the terms for the calculation of total transmission cost and tariff income. [24, 25, 26]

$$TC = YNRV + OMC \quad (1)$$

$$TI = (Po * Cpo + Eo * Ceo) - (Pi * Cpi + Ei * Cei) \quad (2)$$

Where:

TC, TI : Total transmission cost, total tariff income.

$YNRV$: Yearly replacement value of the EAS.

OMC : Operation and maintenance effective costs.

Po, Pi : Output and input power, respectively.

Eo, Ei : Output and input energy, respectively.

Cpo, Cpi : Prices of Po and Pi , respectively.

Ceo, Cei : Prices of Eo and Ei , respectively.

Tolling for the wheeling transaction is the difference between the total transmission cost and tariff income (see Figure 5). This collected toll is used to pay transmission expenses that have been not covered by the tariff income, as given in equation (3).

$$Toll = TC - TI \quad (3)$$

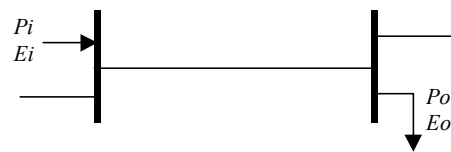


Figure 5: Schematic one-line diagram of the tariff income.

In order to fix the toll prices, the CTE computes the total transmission cost, and considers the expected tariff income provided by the COES.

Connection toll is the amount charged in favor of the main transmission system and is paid by the generators interconnected to the system proportionally to their firm electric powers. Payment of this fee permits to generator selling the energy, without additional tolls, to its final clients located at any point of the main system.

Compensation for the usage of MTS covers the total transmission cost, which is constituted by the annuity of the investment and the effective operation and maintenance cost of the economically adapted system. Annuity of the investment is calculated considering the new replacing values of the facilities, their life term (30

years) and an actualization fee that considers the investment risk in the country (12%), which is paid monthly to the transmission system owners, including both, the toll and the tariff income.

4.6 Compensation for the Usage of Secondary Transmission Systems

Unlike MTS, if a generator supplies power in buses located in the SST or by using the facilities of a distribution concessionaire, compensation on this described usage should be defined under agreement within owners. In some cases this could be done by negotiation. In other negotiations without any agreement between partners, the CTE may act as breaking off referee.

5 CURRENT VIEW OF THE PERUVIAN POWER SYSTEM

The present transmission regulation framework in the Peruvian power system is not perfect and in specific situations may allow to some participants of the market (generators and/or consumers) to evade their payment obligations for investments made by the transmission company in transmission projects. Those evasions occur generally after the corresponding transmission projects are put in service. It may be noted that investments in local generators and load management made by the evader company may facilitate the payment evasion.

Some investments of the transmission company apparently did not take in account a detailed risk analysis that may guaranty an adequate investment recovery. One of the reasons for this was that new projects were done inspired only in the social benefit and they did not consider the appropriate negotiation between investors and future clients.

On the other hand, under the current environment there is not an appropriate congestion management that should be explicitly considered in the LCE. Generators have to purchase more expensive power to fulfill their electricity supply contracts as a consequence of some congestion cases.

Definitions such as *new replacement value*, *main transmissions system*, *secondary transmission systems*, *economically adapted system*, all present in the LCE and its Rules, may lead to a lack of objectivity and transparency, given place to differences between some generation companies and the ones in charge of the transmission. Those problems apparently are impossible to be solved under the current legal frame.

One of the oldest disputes in the Peruvian power system is that of ETECEN (transmission company) and Mantaro (generation company) from the year 1998. The problem is the payment for the transmission service that Mantaro has to give to ETECEN for the use of a secondary transmission system. ETECEN interprets the LCE and it concluded that Mantaro has to pay to ETECEN some millions of dollars. On the other hand Mantaro interprets the LCE and concludes that it should pay only the third part of that calculated by ETECEN. Both proposals are based on the interpretation of the concept of

economically adapted system and for coincidence the two companies seem to be correct in their interpretations of the LCE. At present the CTE entered as mediator and has decided that ETECEN calculates the distribution factors in the facilities that are in confrontation in order to proceed to calculate the responsibility of the participants.

The present compensation pattern of the Peruvian power transmission system fails to handle properly questions such as congestion of the power transmission network, inclusion of bus prices, advantages of a better location for new investments in generation or load.

Due to the privatization process is not concluded, under the current legal framework some agents may have access in the new privatizations of the remaining public concessionaires and they may generate verticality, in other words, to generate a monopoly in the electric sector in such a manner that the involved agents may control the generation and distribution in the SEIN and avoid the competition in the electric market and enabling the possibility to influence in the electric tariffs. These problems are being discussed currently.

6 MODIFICATION TO THE ELECTRIC CONCESSIONS LAW

Because of the problems arise in the remuneration due to the use of the secondary systems facilities, and mainly in response to the occurrence of some conflicts among utilities, the Peruvian government enacted on December 1999 the "Law that modifies several articles of the Electric Concessions Law", assigning to CTE the regulating function of the compensations by the use of the secondary transmission system or distribution system. This legal measure confirms the supposition that there are deficiencies related to market economic aspects of compensation for the transmission system use.

For those reasons the CTE in the use of its attributions may propose the privatization of the specific transmission lines involved in the conflict.

Since the identification of main or secondary transmission system is more based on physical and technical criteria and not in economical principles, and remembering that the MTS and STS definition originated many problems, the CTE suggests the reclassification of the transmission lines in : a) part of the *common system* (CM), or b) a *connection system* (CN). The common system includes those transmission lines and facilities which are used to interconnect the generation system and the loads. The CN is needed for the connection of a generator or load to the common system.

7 CONCLUSIONS

The restructuring of the Peruvian electric sector began with enacting of Electric Concessions Law in 1992. The LCE and its rulings define the legal framework to adjust all the activities related to generation, transmission, distribution and commercialization of electricity.

This new structure of the electric sector did not introduce a set of rules backed by a solid economical support for transmission services regulation. Moreover, transmission companies willing to pay electric services to the country did not analyze the new investments under the economic point of view of the owner and future users, over the payment of the investments already done.

In spite of the success of the restructuring of the Peruvian electric sector, in the LCE it is defined a set of concepts such as new replacement value, main and secondary transmission systems, economically adapted system, and others, which gave rise to different interpretation because of the lack of clarity, leading to discrepancies among some agents of the electric market.

Inclusion in the LCE of technical aspects in some economic definitions, together with the lack of an adequate legal handling of the problems caused by the restrictions in the transmission capacity and some rules vaguely defined on the transmission rights, makes it very difficult to obtain any viable agreement to assume the payment of those investments.

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