THE IBERIAN ELECTRICITY MARKET – MERGING TWO COMMERCIAL OPERATION MODELS INTO AN INTEGRATED MARKET STRUCTURE

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ABSTRACT:
After some years of independent development of their liberalization processes, Portugal and Spain decided to create the Iberian Market for Electricity (MIBEL), to start in 1 January 2003. Although the final organization is still to be approved from the governments, it is already possible to describe the main lines of the proposed model, as developed by the regulators of both countries.
The paper reviews with some detail the present situation of Portugal and Spain regarding the electricity sector organization, and discusses the fundamental issues associated to the development of the new integrated market. The main obstacles for integration are identified, and solutions to specific issues (like renewables) are addressed.

Keywords: Electricity Markets, Iberian Electricity Market, Pool, TSO, ancillary services, Renewables, Congestion, Guarantee of Capacity.

I. INTRODUCTION

When the governments of Portugal and Spain decided to create a unified electricity market in the Iberian Peninsula (MIBEL), to be started by January 1, 2003, it became necessary to construct a new market model, integrating two initial different models of commercial operation. This task was mainly committed to the Regulators of both countries, with the collaboration of the main agents (TSO, GENCO, DISCO, etc.) of the two countries. The authors had the opportunity to collaborate, in different degrees, in the process.

The current portuguese commercial model of operation is such that it includes two coexistent systems:

- a public electricity system (SEP), where the activities of generation, transmission and distribution are performed under the framework of a regulated public service model, with uniform tariffs for the clients;
- an independent electricity system (SEI) that includes a non-regulated sector (SENV) and also generation under a special regime, PRE. SENV is operated under market rules, and it includes generation companies, non-regulated distribution companies and eligible consumers. SENV consists mainly of small hydro stations embedded in distribution networks and that, in fact, is paid according to same rules as PRE.

The Portuguese power system is characterized by an annual generation amount of about 40 TWh (including cogeneration and small renewables), approximately one fifth of the Spanish main production. In 2001, 84% of the Portuguese demand was supplied by SEP generators, 14% (including self consumption) came from PRE and only 2% from SENV. Generation under the SEP is remunerated through long-term Power Purchase Agreements (PPA), with the ownership of the generation companies being characterized by a large concentration.

SEP operation is centrally optimized through a single buyer agent that makes the communication with the system operator and a market operator, which also tackles the SENV energy transactions.

In Spain all the generation is operated under market rules, either from bilateral contracts or from a centralized pool. There is a complex day-ahead pool market for energy, controlled by a market operator that defines the hourly marginal price for energy and a market for ancillary services, managed by the system operator that also validates the generation program coming from the market operator.

The generation activity in Spain is remunerated through the marginal price obtained in the pool, plus a compensation associated to a transient mechanism that pays the stranded costs of the generation companies.

The distribution activity is performed under a regulated environment both in Portugal and in Spain, with differences regarding the type of remuneration of the activity. A commercialization activity exists for retailing in Spain, while in Portugal the commercial activity is performed by the regulated distribution company.

Under the proposed integrated market model, a single market operator will be created, while two system operators will keep the control over two control areas (Portugal and Spain).

For commercial purposes, the interconnection capacity between the two countries has the average value of 600 MW. Reinforcement of this interconnection capacity has already been decided and will start taking place soon.

This paper initially describes the present situation in the electric power systems of the two countries regarding their composition, regulatory issues and commercial relations. Several issues are presently under discussion and the alternative scenarios that may result from these decisions need to be discussed in detail. This paper also includes a discussion about these problems, namely the ones that may happen during the transition to the new model of operation.

II. THE PORTUGUESE AND THE SPANISH SYSTEMS

A. The Portuguese Electricity Sector

In 1975 the Portuguese electricity industry was nationalized and was organized in terms of a vertically integrated utility, EDP, including generation, transmission and distribution. The first change in this structure occurred in 1988, when a law was passed [1] aiming at encouraging new investments in small hydro (under 10 MVA), wind parks, and the use of resources coming from agriculture, industry and urban waste. The application of this law was very successful, since the installed capacity under this special regime – PRE, Special Regime Generation – corresponds currently to about 14% of the total installed capacity. This was the consequence of a very attractive tariff system and the fact that the public utility was obliged to accommodate all the energy coming from PRE. Thus, these resources are non-dispatchable stations.

In 1995, a whole set of new laws was passed [2] that drastically changed the organization of the electricity sector, in fact anticipating in some years the EU 96/92 Directive on the internal electricity market [3]. This legislation organized the National Electricity System (SEN), in two main systems: the Public Electricity System (SEP), and the Independent Electricity System (SEI).

SEP includes generation companies, the transmission company and distribution companies. The generation companies are linked to the transmission company by Power Purchase Agreements (PPA), that remunerate both the installed capacity (in terms of investment) and the energy (in terms of the used resources, the number of start-ups, etc.). On their side, distribution companies are obliged to buy all the required energy to the transport company, except a percentage of 8% that they can eventually buy from other producers (in SENV or abroad).

SEI includes the PRE generation (small hydro under 10 MVA, wind parks, solar, photovoltaic, cogeneration, …) and the Non Binding Electricity System, SENV. SENV includes generation companies, distribution companies and eligible consumers that have purely market relations, mainly in terms of bilateral contracts. The PRE tariff system is based on avoided energy and power costs, plus a payment related with avoided emissions that depends on the technology.

Also in 1995, the vertically integrated utility, EDP, was reorganized in terms of an holding company and a number of child companies. The most important of them were devoted to large hydro and thermal generation, to distribution and to the transmission (the operation of the 400/220/150 kV grid and of the control center). Although the initial idea was to privatize the child companies, the final decision was to privatize the holding company. Thus, in this moment, there is a majority private company largely dominating the generation and the distribution sectors.

Meanwhile, by June 2000, the transmission company (REN - Rede Eléctrica Nacional) was isolated from EDP. This company holds and operates the 400/220/150 kV grid, is responsible for managing the PPA agreements and for selling electricity to the distribution companies. REN is in some way a TSO that still has some commercial functions, not so usual in the most typical and well developed market structures.

In 2000, the Portuguese generation system comprised about 10500 MW of installed capacity:

SEP – Public Electricity Sector:
- hydro – 3903 MW
- thermal (coal) – 1776 MW
- thermal (fuel oil) + gas turbines – 1852 MW
- thermal (fuel oil/natural gas) – 236 MW
- thermal (natural gas) – 990 MW

SEI – Independent Electricity Sector:
- SENV – 272 MW
- PRE – about 1500 MW

This means that about 40% is related to hydro stations. PRE stations are mainly connected to the distribution network, although new investments in large wind parks connected to the main grid were started recently.

Most of the hydro stations (large and small) are located in the north and central regions of Portugal, while thermal plants are located mainly in the center and south. This means that in typical wet winters there are strong flows from the north to the south and in dry summers the opposite situation occurs. The system includes a number of interconnections with Spain:
- two 400 kV interconnections, one in the north and one in the center. A third one is planned in the south to start in 2003;
- three 220 kV interconnections in the north.

The transport grid and the public generation system is operated by the TSO (REN). This entity is responsible for:
- daily planning and operation of the system;
- buying electricity from generation companies under the PPA agreements;
- developing long term operation planning studies, in order to optimise the use of the water;
- establishing the required levels of ancillary services. These services are bought by REN from the generation companies holding PPA agreements. The cost of these services is paid by all consumers through the Tariff for the Global Use of the System;
- developing six year expansion planning studies of the transmission network. These plans, updated every two years, are submitted to ERSE (the portuguese Regulatory Authority) and, upon approval, are remunerated by the Tariffs for Use of the Transmission Network;
- developing long term generation expansion planning studies, in order to organize tender processes to build and connect new stations to the public system.

In 2001, the peak power was 7143 MW and the generation was 40022 GWh. From these, 2561 GWh (about 7%) came from PRE stations. The demand has been increasing at around 5% each year.

Under the legislation of 1995, the first regulatory period included the years 1999-2001. During this period, the eligibility level (that allows a client to choose his provider) corresponded to annual consumptions higher than 9 GWh, representing about 25% of national demand. After the revision of the regulations in September 2001, this level was changed, so now all clients except low voltage consumers are eligible. This represents about 18000 clients and 45% of the total demand. In June 2002, there are about 650 clients (about 7% of the demand) that hold contracts out of the public system.

A final word to the degree of concentration of the ownership of the system [4]:

- Generation – 70% of EDP Generation, 10% of Turbogas, 6% of Tejo Energia and about 14% from PRE;
- Distribution – 99,7% of the clients are served by EDP Distibution.

B. The Spanish Electricity Sector

Till 1995 the Spanish Electricity Sector was organized in terms of a set of vertically integrated utilities, each one operating in a specified geographic area. This means that, despite having more than one utility, there was no competition and the clients were physically and commercially bounded to the same company. In 1995 new legislation was passed, under which it was created the Regulatory Board, *Comision Nacional de Energia*, CNE, and the sector was organized in terms of an integrated system and an independent one. This model was very much contested, so that in November 1997 a new law was approved, *Ley del Sector Electrico* [5], that introduced radical changes:

- the integrated and the independent systems were abolished and purely market driven procedures were adopted to link generation and demand;
- a market operator was created to organize and run the pool day-ahead market. This function is currently assigned to OMEL, *Companhia Operadora do Mercado Eléctrico Espanhol*, the Spanish market operator, MO;
- a system operator was created to operate the transmission grid. This function is assigned to REE, *Red Eléctrica de Espana*¸ the Spanish TSO.

Regarding the Pool market and the process of detecting and solving congestion problems, Figure 1 details the steps under which it is organized [6].

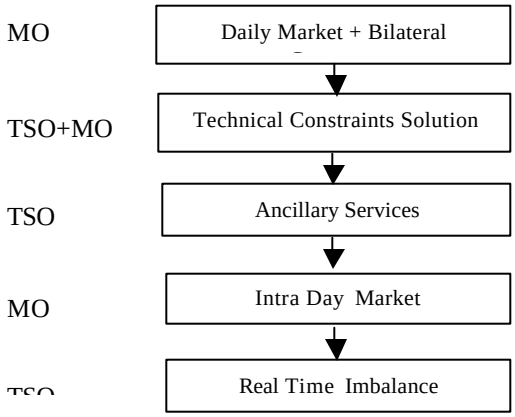

Figure 1 – Operation organization of the Spanish System.

The Day Ahead Market is run by OMEL. Each participating agent – generation companies, distribution companies, qualified consumers and buying/selling external agents – sends its buying/selling orders until 10 am each day. The selling bids include available quantities and price for each hour of the day, as well as a complexity constraint regarding the minimum amount of revenue each company wants to receive all along the day. OMEL runs the market, performs the matching of the bids and identifies the market clearing price and quantity for each hour of the day. These prices do not consider network constraints, but they correspond to the market prices for the whole day: prices received by generation companies and paid by the demand.

OMEL also receives information about physical bilateral contracts and sends all this information to the System Operator that will identify possible network congestions. If there is no congestion, this is the final dispatch. If congestion occurs, the SO and the MO select other bids according to their merit order, testing new combinations of generation dispatches, until congestion is solved. Once this is accomplished, the Technically Viable Daily Dispatch is published. The next step involves fixing the required levels of ancillary services. Some of them are mandatory – reactive/voltage control and primary reserve must be supplied by generation companies as a condition to participate in the market. On the other hand, secondary and tertiary reserves are subject to auction mechanisms and their costs are included in the tariffs.

In the next day, that is the day on which the above decisions are implemented, the SO runs several sessions of the Intra-Day Market in order to allow participants to buy or sell extra quantities of energy, in order to cope with mismatches between forecasted and close to real time operation demand. Currently, the SO runs 6 of these markets, each one having a time horizon of 4 hours. This means the first one is run at 8 pm of the day before, and the next 5 ones at 0.0 am, 4 am, 8 am, 12 am and 4 pm. Finally, the Real Time Imbalance Process solves real time mismatches between load and generation. Currently the day ahead market dispatches about 500000 MWh per day [4] and in 2001 the average daily price varied from 4 c€/kWh to 7 c€/kWh. In December 2001 there were several price spikes with prices almost getting to 12 c€/kwh. These spikes must be understood considering that currently there is no capacity payment in the Spanish system nor any reference generation expansion plan, since the generation activity is completely liberalized. In recent years, the number of additions to the generation system has been very modest, while the demand increased by around 4%.

On the Spanish system, the law accommodates Special Regime Generation in a way similar to Portugal. Also as in Portugal, the share of the installed capacity is around 14%. Currently, PRE is paid an average value of the system market clearing price with a surplus depending on the technology.

In this moment the electricity industry is dominated by 4 industrial groups, as follows [4]:

- Generation – 40% of ENDESA, 25% of IBERDROLA, 13% from PRE, 12% from Union Fenosa, 7% from HidroCantabrico and 3% others;

- Distribution (number of clients) – 41% from ENDESA, 38% from IBERDROLA, 15% from Union Fenosa and 6% from HidroCantabrico.

The *Ley del Sector Eléctrico* [5] recognized the existence of transition stranded costs, called *Costes de Transicion a la Competencia*, CTC. Under this procedure, the Spanish government recognized that generation companies are due to recover a specified amount in the period from 1998 until 2010 considering the difference between estimated revenues under the previous regulatory organization and revenues obtained after 1998. The yearly recoverable amount is fixed and is decreasing during the above referred period. This amount also includes a payment to thermal plants using Spanish coal giving that its extraction costs are very high.

In terms of retailing, the liberalization process moved faster than what it was originally required by the EU 96/92 Directive. In 1998 the eligibility level was fixed in annual consumptions higher than 15 GWh, and this level was expected to low to 9 GWh in 2000, to 5 GWh in 2001 and to 1 GWh in 2004, so that a fully liberalized retailing market would be implemented in 2007. However, a faster liberalization process was adopted, in the scope of which at the moment all clients except low voltage consumers are eligible and a full liberalization is expected by 2003. Currently, 58% of the demand is eligible, and from this demand, 32% has already changed supplier.

III. THE PROPOSAL FOR THE MIBEL MODEL

Since there is a set of natural complementarities between the two electricity systems in the Iberian Peninsula, it was considered of mutual interest to go ahead with the creation of a common electricity market – MIBEL. This initiative will also contribute to the development of the internal electricity market in the European Union.

The proposal of a model for MIBEL was lead by the Regulators of Portugal and Spain and developed in several stages, in a very open and transparent way. The process involved:

- preparation, by the Regulatory Authorities, of a position paper to trigger the discussion about the main issues of concern;
- reception of suggestions and comments about the structure of the market and the system operation sent by generation companies, by the two TSO, by distribution companies, eligible consumers and associations of consumers;
- integration of the conclusions of the European Council of Barcelona regarding the internal market of electricity and recommendations from CEER;
- identification of consensus issues and aspects requiring harmonization;
- definition of a proposal for the model of the market and the operation of the integrated system.

The main characteristics of the proposed model are briefly presented in the next sections.

C. General Aspects

The organization of the model suggested for MIBEL was based on the main following principles:

- freedom and equality of access of all agents to the different energy negotiation platforms;
- transparency and liquidity of the negotiation on the pool platforms;
- stability of the market;
- concerns with the security of supply;
- implementation of mechanisms to recover recognized stranded cost, that result from the elimination of PPA in Portugal and CTC in Spain. These mechanisms should be designed in a way so that they avoid, at the same time, the introduction of distortions in the market behaviour.

These concerns, together with the need of assuring a soft transition to an open market environment lead to an integrated model, based on a single market operator and two system operators for the two control areas of Portugal and Spain.

In this model, the activities of transmission, distribution, System Operation control and Market Operation management will be subject to regulation by the Regulatory Authorities of both countries. Since it is expectable that, during the first stages of the operation of MIBEL, a large amount of consumers will not select, at the beginning, a commercialization company, regulated commercialization companies will be created for that purpose. This issue will be crucial to assure the transition to the open market model.

B. Negotiation Platforms

A mixed system was suggested regarding the acquisition of energy, such that the following negotiation platforms would be available:

- Bilateral negotiation between commercialization and generation companies;
- Day ahead and adjustments pool markets;
- Short and medium term future contracts for physical trading of standardized packages of power quantities for a given period of time.

The pool daily markets and the futures energy trading are expected to be managed by a common market operator acting in the Iberian peninsula.

In the bilateral negotiation, either commercializing agents or generation companies can sell energy to other generation companies or external agents. The external agent is assumed to be a foreign electricity trading company that is qualified to buy or sell energy in the Iberian market.

The day-ahead market would be based on an independent negotiation for each of the 24 hours of each day, using simple offers, expressed in terms of quantity and price. These bids can be aggregated in terms of *portfolio* for each agent. The clearing quantities in the pool market are determined adopting an algorithm based on marginal cost evaluation. If necessary, a market splitting mechanism is used to manage the interconnection congestion.

An adjustments market should also be considered to help managing short term forecasted deviations to contracted programs of generation/consumption. This mechanism is needed because sudden generating outages or other events may occur, leading to the need for corrections and

compensations in the daily contractual programs defined in the other negotiation platforms.

The market operator should communicate the result of the daily pool to both system operators. The system operators will also receive information from the agents responsible for bilateral contracts. This information should be disaggregated by physical units. System operators are then responsible for the validation of the generation program checking and solving eventual network constraints.

The commercialization companies will not have the possibility of celebrating bilateral contracts, being obliged to buy their energy needs in the daily markets and through the short and medium term futures negotiation platform. This will create enough liquidity in the pool.

A set of *ex-ante* and *ex-post* measures are foreseen to assure transparency and control to the operation of the market. Among those it is important to mention the following ones:

- the obligation of generation companies to make public an aggregated value of the prices adopted for different bilateral contracts in order to assure transparency, liquidity and competition among platforms of negotiation. This also minimizes the possibility of small agents operate under disadvantageous conditions;
- the limitation on the duration of the bilateral contracts to a maximum of two years to avoid long duration contracts that would close the market to new competitors;
- if necessary, the introduction of limitations on trading amounts regarding companies of the same group, in order to increase the liquidity of the whole system;
- the definition of maximum limits in energy prices or presentation of price declarations when the service is provided under no competition conditions.

D. Ancillary Services

The management of ancillary services will be a responsibility assigned to each System Operator, in such a way that the level of services required for each control area will be defined and contracted by the corresponding TSO. Harmonization of mandatory and non-mandatory ancillary services, remuneration and assignment procedures are under development.

In each control area, the corresponding TSO will operate as a single buyer following the definition, for each hour of the day ahead, of the required amounts. These will be defined according to UCTE criteria or other specific criteria that may result for instance of the integration of larger shares of PRE.

The formulation suggested is such that:

- Primary reserve is a mandatory service, non remunerated, according to what is presently being already followed in the two systems;
- Secondary reserve is to be considered a non-mandatory service subjected to market mechanisms inside each control area;
- Tertiary reserve should also be considered as a non-mandatory service to be managed under a market approach, taking into account the reserve margins defined by the system operators for each control area. Interruptibility contracts will be managed under this umbrella and also adopting market rules;
- Reactive power allocation to each generating unit should also be managed under market rules, following the same type of conceptual procedures to be adopted for secondary reserve. However, due to security reasons, a minimum requirement level of reactive support will be defined to be delivered in a mandatory way and without remuneration.

The operation procedures to be adopted in the future by the two TSO are presently being studied and developed by common task forces. It is also supposed that both TSO will revise the ancillary services requirements, in each area, according to the increases foreseen for the interconnection capacities between Portugal and Spain.

Deviation margins regarding the generation/consumption programs should be defined for ordinary generation and commercialization companies and penalties will be applied whenever these deviations are larger than tolerance margins to be defined.

E. Guarantee of Capacity

The security of supply in the Iberian Peninsula is considered to be one of the most crucial issues for the success of the implementation of the MIBEL. For that purpose, a capacity tariff to be paid by all consumers will be added to other tariffs. Although this procedure constitutes a strong incentive to the construction of new power plants, it does not imply that the necessary reserve margin will be attained. Therefore, the implementation of a monitoring scheme of the reserve margin of the Iberian System is of utmost importance to the guarantee the supply of electricity in short and long terms. It is important to mention that the specificity of the Iberian electricity system requires this approach since there will be an important share of production coming from large hydro plants and PRE, that are characterized by a large variability along the year and from one year to another. Therefore, the operation of such a system involves a significant risk, worsened by the limitations of the interconnection with France.

This approach will be implemented in MIBEL such that when the reserve margin is found to be insufficient a tender process is activated to build new production facilities. The implementation of this approach requires the definition of criteria to recover the costs resulting from these decisions.

F. System Operation and Transmission Congestion

The operation of the entire system is performed by the two existing TSO, one controlling the Portuguese area and the other the Spanish one. These two entities are responsible for the operation of each system and for the coordinated operation of the interconnections. Under this scope there are some important issues to agree on and to harmonize:

- evaluation of the commercial interconnection capacity. This implies harmonizing security criteria and scenarios adopted to evaluate the capacity reserved for security purposes and the amount available for commercial trade;
- Congestion – it can correspond to inner area, inter area or outer area congestion:
    - inner area congestion - each TSO is responsible for its solution by introducing changes in the market

driven dispatches, preferably achieved using market procedures;

- inter area congestion – the operation model should comprise transmission capacity auctions as well as market splitting procedures in order to cope with the mix bilateral contract/centralized pool to be implemented;
- outer area congestion – it results from the interconnections Spain/France and Spain/Morocco. In this case, an agreement between the Spanish, French and Morocco TSO has to be obtained. These agreements should be approved by the Spanish regulatory board in order to ensure that the available capacity is allocated in a transparent and non-discriminatory way.

G. Participation of Special Regime Generation

Having in mind the foreseen increase of the Special Regime Generation, PRE, in the Iberian Peninsula, special care needs to be taken regarding the participation of these generating units in the operation of the system.

In order to enable an efficient technical management of the Iberian system, the PRE generation facilities should be classified in *controllable* and *non-controllable* according to their capability of being dispatched. The controllable installations should be the ones where it is possible to control the active power generation. These generation facilities can participate in the market using the available negotiation platforms directly or through aggregating agents.

One of the concerns regarding the technical implementation of the market is related with the need of forecasting, as accurately as possible, the generation from the *non-controllable* PRE sources for each period of 24 hours, in order to use this information in the daily pool.

It should also be pointed out that the possibility of PRE generation facilities delivering ancillary services is under study. This includes the possibility of delivering primary reserve, secondary reserve (shut down), voltage control and reactive power.

H. Concentration on the Resulting System

Under MIBEL the degree of concentration both at generation and distribution levels will be lowered (with reference to the present values in the two countries), hopefully increasing the competition in these two areas:

- Generation – 34% of ENDESA, 21% of IBERDROLA, 11% from PRE, 10% from EDP Generation, 10% from Union Fenosa, 24% others;
- Distribution (no. of clients) – 36% from ENDESA, 30% from IBERDROLA, 19% from EDP Distribution, 10% from Union Fenosa and 5% from others.

IV. CONCLUSIONS

Integration of the different commercial structures of the present Portuguese and Spanish electricity sectors is a challenge to regulators and politicians, namely because technical issues strongly constrain the possible solutions for an integrated market in the Iberian Peninsula. The model developed by the entities in charge (with the collaboration of the main agents and research institutions) seems to address all the issues in a transparent way. The next step is the approval by the Governments of Portugal and Spain, followed by implementation, when new challenges will certainly emerge.

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VI. BIOGRAPHIES

João Peças Lopes is an Associate Professor with Aggregation in the Faculty of Engineering of University of Porto. He obtained an Electrical Engineering degree (5 years course) in 1981 from University of Porto and a PhD. degree in Electrical Engineering from the same University in 1988. In 1996 he got an Aggregation degree. He is presently adjoint Coordinator of the Power Systems Unit of INESC Porto and a senior member of the IEEE. He was responsible of several EU research projects and contracts in the field of renewable energy sources grid integration and projects related with regulatory issues. He served as a consultant in the Portuguese regulatory agency for the development of the Iberian Electricity Market.

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João Tomé Saraiva was born in Porto, Portugal in 1962. In 1985, 1993 and 2002 he got his degree, PhD and Agregado degrees in Electrical and Computer Engineering from Faculdade de Engenharia da Univ. do Porto (FEUP) where he is currently Professor and teaches graduate courses on market issues and EMS/DMS systems. In 1985 he joined INESC where he is research manager. He was head researcher or collaborated in several projects related with the development of DMS systems, quality in power systems in the scope of re-regulation and tariffs due for the use of transmission and distribution networks.

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