RENEWABLES - IMPORTANT CHALLENGES FOR TRANSMISSION SYSTEM OPERATORS

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Promotion of renewables in electricity production introduces new challenges to the sector. Procurement, installing and connection to the existing grid of thousands of MW in a short period of time represent a real challenge to the Romanian electricity system. This new challenge makes more actual the question if the electricity only market forces could normally lead the system to a medium term security/adequacy. New developments regarding to the definition of necessary reserves, their level and the economical impact on the electricity system from the perspective of wind energy are presented considering the level of installable wind power.

The paper will contain a short description of the present situation of the Romanian electricity system, the actual regulatory framework focused on capacity mechanism (obstacles and results) and new developments of the regulatory framework regarding to the definition of necessary reserves, their level and the economical impact on the electricity system from the perspective of wind energy. The dimension of the installable wind power has to be determined based on the installed and new coming capacity qualified for ancillary services in the electricity system, the instantaneous, not average, available ancillary services, the characteristics of the existing and new coming wind farms (installed power, simultaneous power, wind potential and its characteristics), network congestion etc.

Key words: *renewables, network investment, security of supply, capacity markets*

1. Introduction.

The activity of the electricity market started in Romania in the year 2000, when the Romanian Energy Regulatory Authority (ANRE) regulated the trading relations between the electricity producers and suppliers and when the first electricity sale/purchase contracts between them were signed. Since its establishment, the electricity market has recorded a continuous progress both in increasing its opening degree and in the increasing of the participant numbers, but also by the diversification of the contract types.

The electricity system is organized today in production companies (the biggest is SC Hidroelectrica SA, followed by SC Nuclearelectrica SA (2x700 MW) etc.), one transport and system operator (TSO) National Company Transelectrica SA, eight major electricity distribution companies (five of them privatized with foreign investors) and more than 150 suppliers and 150 small distributors of electricity. The State owns about 75% from the TSO, the rest being owned by different funds and private investors. The company for construction of another two nuclear units (2x700 MW) is operational, where the State owns 51%.

Even the electricity market opening degree is 100%, not all of it is used. In fact, the electricity market has two parts: the regulated one with regulated quantities and prices on portfolio contracts for households and assimilated consumers, and the competitive side.

The provisions concerning the electricity strategy from the Electricity Law no. 318/2003 are maintained into the Electricity Law no. 13/2007. According to the Electricity Law, the Ministry of Economy is responsible to issue the long-term development strategy of the electricity system, the TSO to issue the 10 years development plan of the transmission network which has to be endorsed by ANRE and approved by the Ministry of Economy. As an EU member, at present, apart of the provision of the tender procedure for new capacity given by the EU Directive 54/2003, the secondary legislation doesn't consider a medium term capacity mechanism.

In this context, can be assured the capacity adequacy of the electricity system by electricity market only? And more, should we let only electricity market to assure, on medium term, both, electricity and capacity? Normally, the electricity market forces should lead the electricity system to a medium term security/adequacy. There are concerns however, especially after several relevant recent events happened in the recent past, that in real life, the electricity only market cannot assure the adequate capacity for both reliability and effective competition at all moments. Just on average it is not enough to assure them.

Promotion of renewables in electricity production introduces new challenges to the sector. Procurement, installing and connection to the existing grid of thousands of MW (12000 MW) in a short period of time represent a real challenge to the Romanian electricity system with an existing total generation capacity of 17000 MW. Not only new high voltage lines (400 kV) and substations are needed, but also new regulation regarding to the definition of necessary system reserves and their level.

The Romanian Energy Regulatory Authority developed in July 2007 a regulatory framework for a capacity mechanism as a first step in order to ensure a more specific signal, to ensure on medium term the adequacy of the system and reward all generators which contribute to effective competition or to system reliability. The time horison is less than a month for the mechanism in force.

2. Energy wind potential in Romania

Five wind energy zones have been identified according to the geographic and environmental conditions and the wind velocities above 50 m of height.

Romania belongs to a temperate-continental climate area, with a high energy potential both on the Black Sea coast (gentle climate) and the alpine peaks and valleys (severe climate). Preliminary evaluations estimate that the annual wind energy potential of Romania is about 23000 GWh, with an installed rating of 14000 MW. On the Black Sea Coast the installed capacity could be estimated at 2000 MW, suitable to produce 4500 GWh/year.

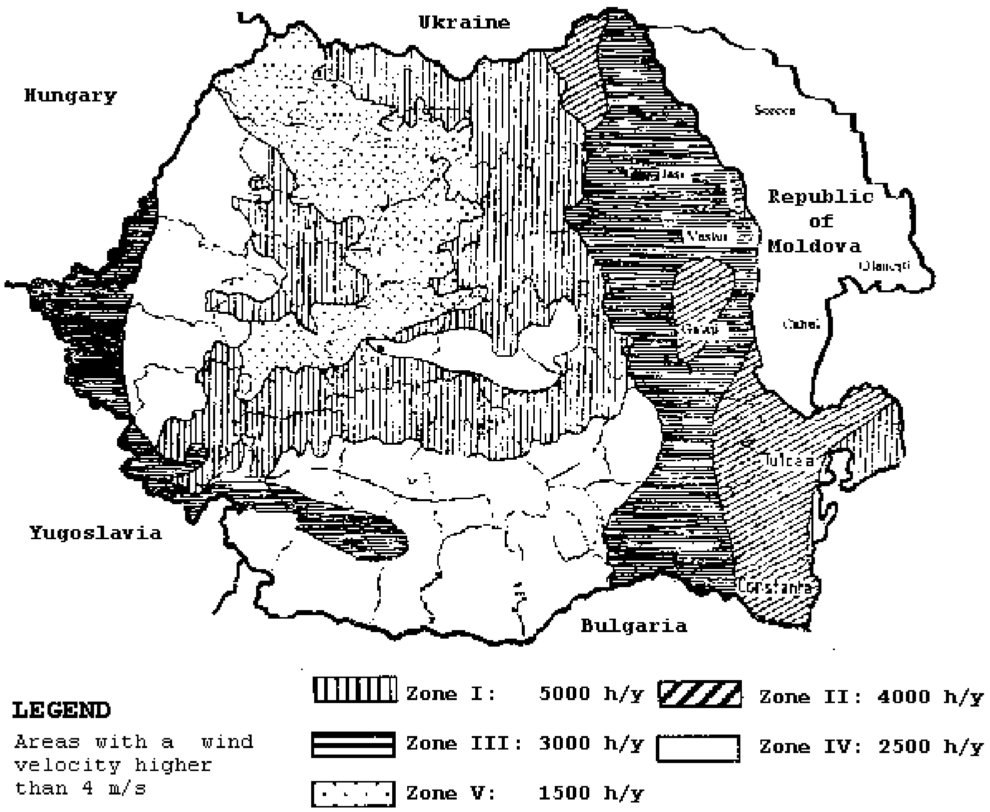
The five wind zones of our Country and their wind potential limits are represented in Table 1. (Ambros, 1999).

Table 1. Technical elements for the wind potential exploitation in Romania

Zone / velocity/ capacity	High mountain (m/s; *W/m²*)	Sea Offshore (m/s; *W/m²*)	Sea Coast (m/s; *W/m²*)	Plains (m/s; *W/m²*)	Hills (m/s; *W/m²*)
I	>11,0; *>1800*	>9,0; *>800*	>8,5; *>700*	>7,5; *>500*	>6,0; *>250*
II	10,0 - 11,5; *1200 – 1800*	8,0 - 9,0; *300 - 800*	7,0 - 8; *400 - 700*	6,5 - 7,5 *300 - 500*	5,0 - 6,0; *150 - 250*
III	8,5 - 10,0; *700 – 1200*	7,0 - 8,0; *400 - 600*	6,0 - 7,0; *250 - 400*	5,5 - 8,5; *200 - 300*	4,5 - 5,0; *100 - 150*
IV	7,0 - 8,5; *400 – 700*	5,5 - 7,0; *200 - 400*	5,0 - 6,0; *150 - 250*	4,5 - 5,5; *100 - 200*	3,5 - 4,5; *50 - 100*
V	<7,0; *<400*	<5,5; *<200*	<5,0; *<150*	<4,5; *<100*	<3,5 ; *<50*

The map with the Romania wind energy potential, computed by the UE WASP Programme, is shown in figure 1. In Dobrogea Region the wind blows with a velocity higher than 4 m/s during a 4000…5000 hours/year period.

Figure 1. Wind velocity zones in Romania



2.1. Wind distribution in the Black Sea Area

Due to the connection between the spatial air pressure and the air-mass circulation, the wind in the Black Sea has the main characteristics:

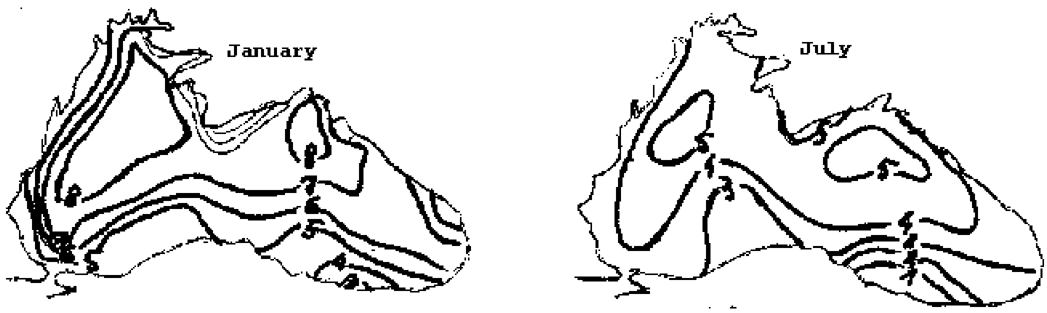
- During winter, because of the depression zone and the dorsal Siberian anticyclone influence, Black Sea is under the action of Northern winds, very powerful near the coast and weaker off-shore. The Northern winds frequency represents about 44% of all other cases (N, NW and NE). These winds have also the highest average velocities in comparison to other sectors. Thus, the average wind velocities from the Northern sector are between 3,4 m/s (Mangalia) and 4,9 m/s (la Sulina), while on the other directions their values are between 2,7 m/s (Mangalia) and 3,4 m/s (Constanta).
- Starting April, the wind-flow directions change. During summer, due to the influence of the Azoric maximum, the main air circulation is from West.

Table 2 and Figure 2 reveal that the average wind velocity on the Romanian Black Sea Coast is about 8 m/s during winter and 5-6 m/s during summer.

Table 2: Average velocities (m/s) of the Western and Northern sector of the Black Sea

Sector / Month	VIII	IX-X	XI-II
West	6	7	8
North-East	5	6	8

Figure 2. Average wind velocity distribution on the Black Sea during January and July

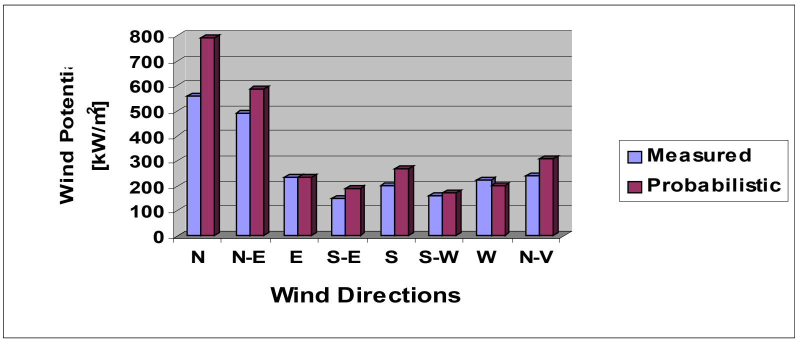


Besides the main continental air circulation, at the frontier between land and sea appears a local circulation due to the thermal properties of the bellow surface, so-called breeze. The breeze generation mechanism is next explained: during winter, when sun radiation is strong, the soil temperature is much higher than the sea one, generating pressure gradients (in the day-time from the land to the sea, and in the night-time from the sea to the land). These pressure gradients cause a wind that begins to blow at 9 AM from the sea to the land, reaching is maximum at 3-4 PM. After 7-8 PM, the breeze changes its direction and blows from the land to the sea.

2.2. Wind energy potential of the Black Sea Coast

Wind energy potential estimation has been done both on the 5 years experimental tests basis and Raleigh probabilistic model (Degeratu, 2003). The velocity measurements have been recorded at a standard weight of 10 m. The results of these estimations are represented in figure 3. It is possible to remark a very good concordance between model and measurements on the East and South-West directions, a good one on the North-East, South-East, East, West and North-West directions and an acceptable ratio on the North and South wind blowing directions.

Figure 3. Measured and estimated wind velocities on the Black Sea Coast



3. Regulatory framework in force concerning capacity mechanism

According to the Directive 2003/54/EC of the European Parliament, “security” means both security of supply and provision of electricity, and technical safety. Article 4, Monitoring of security of supply, highlight the monitoring activity including “covering the supply/demand balance on the national market, the level of expected future demand and envisaged additional capacity being planned or under construction,…, measures to cover peak demand and to deal with shortfalls of one or more suppliers”. Article 28, Reporting highlights that “**special attention** will be given to measures taken in Member States to cover peak demand…”. Article 7, Tendering for new capacity, specifies in accordance with Article 9 (Tasks of Transmission System Operator TSO – “responsible for: ensuring the long – term ability of the system to meet reasonable demands for the transmission of electricity, contributing to security of supply through adequate transmission capacity and system reliability, etc.”), that the TSO may be designated as the body responsible for organizing, monitoring and controlling the tendering procedure for new capacity”. At least in one of the proposals to update the Directive on Security of Electricity Supply was considered “to complete the process” and maintain adequate margins in both power transmission and generation.

The present commitment to assure the security is very strong, especially after all events happened in the recent past. These lessons showed that even liberalization requires adequate reserve margins and as it was expected, they decrease after liberalization process. There are voices which expect that competitive markets will provide adequate levels of security (eg many in UK), but also others considers that markets are unlikely to provide enough adequacy in “real life”. So, both the quantitative, but also qualitative aspects have to be considered when we discuss about security of supply and capacity.

Apart of the provision of Directive no 54/2003 regarding to the Tendering for new capacity on long term and the provisions of Hourly Electricity Balancing Market, in between, the only mechanism in place at the disposal to the Romanian TSO to ensure the quantitative and qualitative generation capacity to the system, are ancillary services. Their horizon is less than a year. For the capacity reserve the horizon is a month. Totally different than the balancing market, the ancillary services represent a market bigger than 300 mil Euro per year.

The components of the ancillary services are: secondary reserve, tertiary reserve (fast and slow), U/Q reserve, cogeneration capacity reserve and capacity reserve. Secondary reserve, fast tertiary reserve, U/Q reserve and cogeneration reserve are regulated 100%, both, hourly prices and quantities. Slow tertiary reserve is regulated only 50% and the rest of the necessary reserve is procured by TSO from seven suppliers on the market.

The capacity reserve has been implemented starting from 1st of August 2007 as a result of approval and published of a certain methodology by ANRE. It represents an ancillary service which has the goal to assure of adequacy in the National Power System. The Methodology for establishes, implementation and use of ancillary services capacity reserve was approved by Order no.19/2007 and published in Official Gazette of Romania no.507/30th of July 2007. The capacity reserve is an additional power reserve requested by TSO, assured by power units which can start and upload in a shorter time than 72 hours to assure power consumption in special conditions.

The methodology is applied by TSO for: determination of requested quantity for capacity reserve (700 MW in year 2007, 400 MW at present), selection of dispatchable power units for this service, nominalization of suppliers for this service, using the service of capacity reserve, ending of service. It is implemented also by the suppliers running power units qualified for capacity reserve and used by ANRE to approve tariffs and regulated quantities for capacity reserve.

Based on a procedure endorsed by ANRE, TSO estimates, using computation methods for every next year, gross electricity consumption (for each month), maximum number of hours for not supplied electricity, capacity reserve (for each month).

There are defined two stages in implementing the capacity reserve. The 1st stage started from August 2007 and ends on June 30, 2009. The characteristics have to be defined for the 2nd stage of this market.

For the first stage of this market, the power units are selected by TSO based on a certain criteria as: the unit is off running and has no contract for ancillary services or for power, the unit has no environmental restrictions, the unit is not restricted to power flow, the unit is not in rehabilitation or retrofitting program, the unit has proved its availability, the supplier proved fuel availability, the period for which the unit can supply this ancillary service, geographical area of the unit, the period of time necessary from the appointment of the unit till to available status of the unit for this ancillary service.

Based on TSO's information and calculation and suppliers offers, ANRE approves the maxim price and the requested quantities of capacity reserve. The appointment of the units is settled based on the bidding price, no higher than the maximum price approved by regulator, if the offer of the supplier for capacity reserve is greater than the requested quantity. The appointment of the units is settled based on a regulator ordinance, if the offer of the supplier for capacity reserve is smaller than the requested quantity. The suppliers are paid by the bidding price, no higher than the cap price.

TSO and the capacity reserve suppliers settle dispatchable power units based on a contract. The use of capacity reserve is possible only through dispatch order for a period no less than three days. Capacity reserve is rebuilt in no more than two weeks from the starting point of running this ancillary service.

On the balancing market, the units will be paid with maxim price in the first three days and in the following days, they will be paid as a result of the bids on the balancing market. The power bidding on the day ahead market of these units is forbidden.

Ending of service for capacity reserve before the contract period is allowed in specified conditions: force majeure, TSO requirement and regulatory approval if the power unit has not achieved contractual tasks at least one time after penalty payment, when the power units is above the maximum level allowed, when the license of the supplier was suspended or retracted, in other cases including contract suspended but only with regulator approval.

4. Proposals for new developments of the regulatory framework

Procurement, installing and connection to the existing grid of thousands of wind MW (12000 MW) in a short period of time represent a real challenge to the Romanian electricity system with an existing total generation capacity of 17000 MW. Not only new high voltage lines (400 kV) and substations are needed, but also new regulation regarding to the definition of necessary system reserves and their level. About 3000 MW in wind farms received approval for connection to the grid and about 700 MW of them have already connection contracts. They are mostly located in the south – east of Romania, near the Black Sea coast where new two nuclear units are planned to be installed at Cernavoda Power Plant. The most important problem raised by the TSO related to wind farms is the reserve needed to cover the power when the wind doesn't blow. This new challenge makes more actual the question above. We need to make transparent the difference between capacity and energy, and deeper, the request of different type of capacity.

The signal given by a high electricity price could have different roots as a lack of producing capacity by requested type, energy resources or network congestion. A more dedicated signal, led by market forces, should be developed on different types of medium term requested capacities.

A mechanism to *ensure today enough proper capacity for medium term (about 4 years)* and to put on market basis this managing activity of the surplus capacity could be more appropriate, together with redesign of the actual technical procedures to determine the necessary system reserves. It is sustainable for the society to ensure a market mechanism, which provides the financial resources for units offering proper medium term adequacy of the electricity system in order to let the in-efficient units which can provide adequacy, not to operate. In order to maintain a capacity reserve, the present regulatory framework promotes the un-efficient units to operate through portfolio contracts.

A *medium term* capacity market could give the correct signal for new efficient units in order to assure the medium term adequacy of the system and also it could give the surety on an adequacy of the system from capacity point of view. It recognizes in time the potential capacity shortfalls (or surpluses) before they actually occur, thereby facilitating the capacity investments that would avoid the price volatility that results when electricity supply becomes limited.

TSO should determine the necessary capacity (including the type) for each year of the near future period of time based on the estimated demand received from suppliers and long term system and generation planning studies. This period of time should be about 4 years in order to allow the building of new capacity. A longer period would bring the estimation errors and stranded cost in unneeded capacity. TSO could awards certificates for each capacity available in the target year according to the net available long term/peak capacity, differentiated by various categories of reserves/plants, in order to be used on the market by each production company.

The market mechanism should require to each supplier to medium term secure or contract for sufficient proper reserve capacity to match his customer profile according to the system operator specification, bilaterally/ offers to the capacity market operator/ via auction. Those consumers who need higher power reserve should buy more reserves, of different types. We can talk about capacity markets for different type of capacity. The money would be paid in the year in which capacity is appointed. A penalty system has to be considered for both demand side and supply side of capacity.

In the other hand, taking into account the huge present possibility, from the technical point of view, to efficiently use the renewables potential, especially wind, to produce electricity, the redesign of the necessary system reserves has to make a step further than the variation of the load

over prognoses and the biggest capacity connected directly to the system (biggest installed unit or sum of units connected together to the grid).
Having in mind that the fast tertiary reserve is dimensioned based on the disconnection of the biggest capacity connected directly to the system and a suddenly consumption variation of 100 MW (in Romanian system), the installable wind power has to be determined considering the size in MW of the request for wind power connection and their location versus the same wind. In case of regulated monopoly of electricity transmission and distribution service, the most transparent approach for the common welfare of the society is to design the network having in mind the wind power potential in an area, not only the present request for connection. In this way of thinking, the use of renewables for electricity production is promoted together with an efficient transmission of electricity where the necessary reserves can remain at the existing level.
Against of different proposals, we consider that, for the next year, the dimension of the installable wind power has to be determined based on the installed, decommissioning and new coming capacity qualified for ancillary services in the electricity system. The variation of consumption has not to be forgotten. The installable wind power has not to be reduced considering that the entire wind power can be lost simultaneously, but, based on the location of the installed and planned to be installed wind farms with the characteristics of the wind and its potential in the respective locations. It is unacceptable the proposal that only 30% from the installed wind power to be considered as a possible lost power when the installable wind power is determined, without looking to the locations and the wind characteristics.
A supplementary cost occurs when the instantaneous wind power which can be lost is greater than the biggest capacity connected directly to the system. In this situation, TSO has to cover the supplementary fast tertiary reserve which has to be procured from the system. This cost, regulated or established by market, has to cover the wearing of the units used to cover the lost power. This supplementary cost has to be considered also in designing the grid. At present regulated prices, for the about 3000 MW in wind farms which received approval for connection to the grid, we are talking about 150 mil Eur/year.
The 3rd Legislative Package offers to the society, through the 10 year development plan of the network the opportunity to promote the use of renewables and the efficient development of the network for the welfare of the society. According to the Regulation (EC) of the European Parliament and of the Council on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003, “the network development plan shall include the modelling of the integrated network, scenario development, a European generation adequacy outlook and an assessment of the resilience of the system”.

5. Conclusion

A mechanism to ensure today enough proper capacity for medium term (about 4 years) and to put on market basis this managing activity of the surplus capacity could be more appropriate, together with redesign of the actual technical procedures to determine the necessary system reserves.
New developments of the regulatory framework regarding to the definition of necessary reserves, their level and the economical impact on the electricity system from the perspective of wind energy has to be implemented.
The dimension of the installable wind power has to be determined based on the installed and new coming capacity qualified for ancillary services in the electricity system, the instantaneous, not average, available ancillary services, the characteristics of the existing and new coming wind farms (installed power, simultaneous power, wind potential and its characteristics), network congestion in order to promote the use of renewables for the welfare of the society.