RES INTEGRATION IN ROMANIA

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In the last 20 years the Romanian economy has registered radical structural changes passing from a predominant energy intensive industry to an economy based on small and medium size enterprises, and small light industries, and keeping one steel producing large plant and cement industry privatized and fully rehabilitated. Since 2010, the installed and operational capacity of wind power plants has been constantly increasing, and this year installed capacity reached 2967 MW, most of the wind power plants (80 %) were concentrated in the Dobrogea region. In this paper is analysed the legislative framework in Romania concerning renewable energy and also it is determined the limit of wind power plants that can be installed in the Romanian system taking into account the tertiary reserve.

Keywords: RES, WPP, energy, power, transmission.

1. Energy Legislative Framework in Romania

Romania as one of the State Members has to fulfill its obligations related to EU's targets in terms of RES (renewable energy sources) integration. The incentive support scheme for RES has been enacted by Law no. 220/2008 for establishing the promoting scheme for energy produced out of RES, Law no. 139/2010 (modifying Law 220/2008) and a series of four governmental orders dated November 2011, and Governmental Decision no. 57/2013 [1], [2], [3].

RES promoting scheme has been established by Law no. 220/2008, modified by Law no. 139/2010 and Law no. 134/2012. Each produced MWh is given a certain number of green certificates according to the specific primary resource (i.e. wind, solar) as a result of different prices for generating technology. In the frame of green certificates market, green certificates (GCs) are sold by producers that are entitled to receive GCs and electricity suppliers are obliged to buy green certificates so that quotas established by law to be fulfilled. Mandatory quotas of electricity that should be produced by RES that benefit from promoting scheme for 2010 – 2020 time interval are: 2010 - 8,3%; 2011 - 10%; 2012 - 12%; 2013 - 14%; 2014 - 15%; 2015 - 16%; 2016 - 17%; 2017 - 18%; 2018 - 19%; 2019 - 19,5%; 2020 - 20%. According to the amount of consumption that is supplied, each supplier has to buy a certain number of green certificates.

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GCs price on the market can vary between 27 Euro/MWh and 55 Euro/MWh so that to protect electricity consumers on one side and on the other side to protect generating companies. Setting of minimal value for transaction of green certificate is intended to protect producers and enable them to prepare minimal business plan. Setting of maximal value for transaction of green certificate is intended to protect electricity consumers, to avoid that high price of green certificates to become a burden.

All producers will receive GCs if they are enabled by national regulatory, but the obligation to buy these GCs is only for suppliers so that to fulfil mandatory quotas. In case the number of GCs on the market is bigger that requests there are two implications:

- the GC price will go down up to the minimal price;
- some GCs will remain unsold.

In case electricity suppliers are not able to fulfil quotas, penalties are imposed, suppliers being obliged to pay double the maximal price of GCs. With the amount of money that is collected by transmission system operator, development fund is established with the purpose of funding small RES projects (installed power less than 100 kW) [4].

Very important statements are included in the Governmental Decision no. 57/2013 about the promotion scheme.

Beginning 1st July 2013 the promotion scheme for granting the number of GC is temporarily postponed for each MWh produced and delivered by the producers of electricity from renewable sources as follows: one GC for new hydro power plants with installed capacity of more than 10 MW, one GC for wind power plants, for two green certificates for solar power plants.

Postponed green certificates will be recovered from 01.04.2017 for hydro and solar projects and from 01.01.2018 to 31 December 2020 for wind power projects. Basically, instead of suddenly received two GC, the investor in wind power plants would receive only one; the other will be recovered in 2018.

In solar, investors would receive 4 GC instead of 6, the other two will be recovered in 2017.

Also when issuing of the technical permits, network operators have the right to request the establishment of financial guarantees [3].

2. RES integration challenges

As a result of the supporting scheme mainly based on green certificates, since 2007, the National Grid Company received a large number of applications for integration of WPP projects in the National Power System. Most of this large WPP are located in Moldova (1), Banat (2) and Dobrogea (3) areas as in Fig. 1 [5].

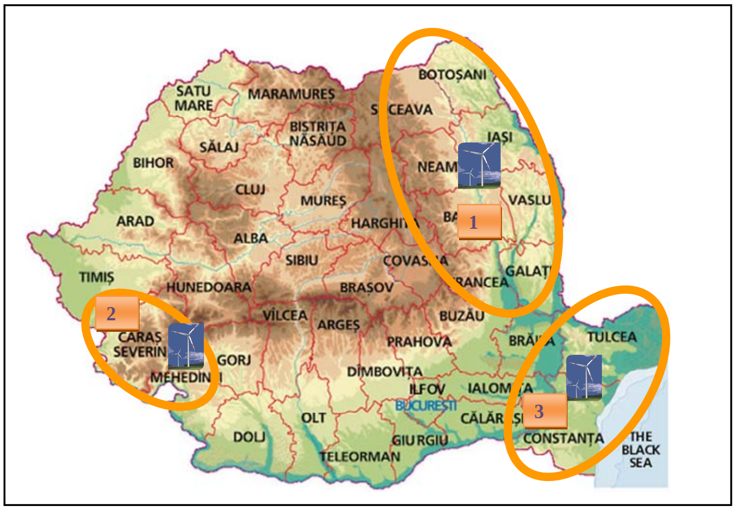

Fig. 1. Areas with large wind power projects in Romania

This concentration of interest from the private investors coincides with the wind potential map as in Fig. 2 [6].

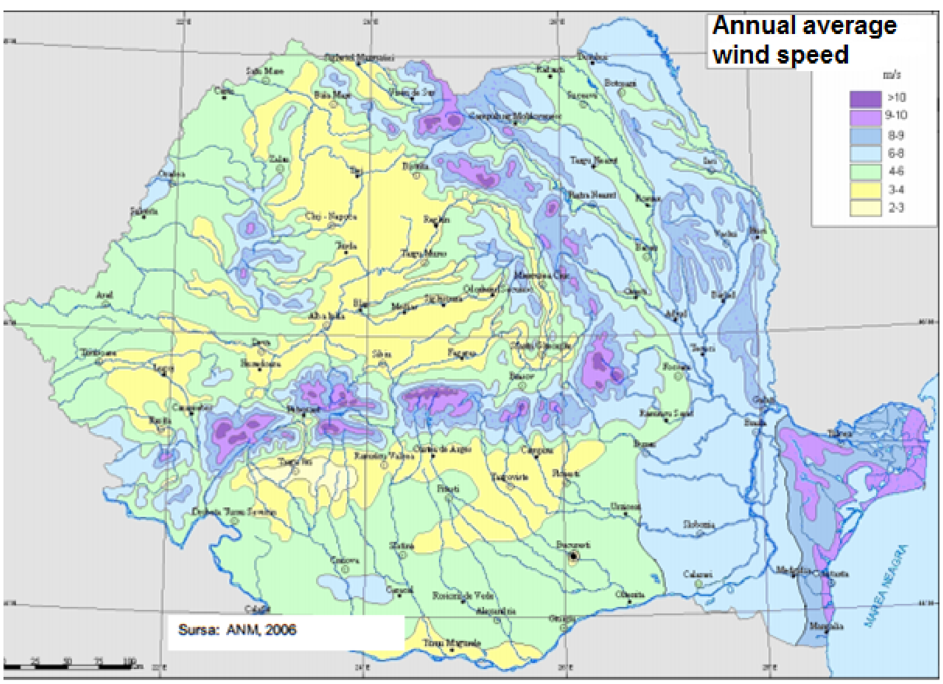

Fig. 2. Wind potential in Romania

During 2014, a large number of contracts and permits were signed for the connection of wind power plants (9772 MW). The situation for photovoltaic power plants is of 1245 MW installed. To those is added a large number of technical permits and contracts signed in the transmission and distribution network (3210 MW).

This year installed capacity in wind power plants reached 2967 MW; most of the wind power plants (80 %) were concentrated in the Dobrogea region.

The impact of the onshore wind power production on the operating system involves at least the following aspects [6]:

1) Big concentration in windy areas leads to large amount of power flows on transmission and distribution network elements from the areas of production to electricity consumption areas. As a consequence the transmission and distribution capacity reserve of the network elements decreases and N-1 security criterion is not fulfilled. Also such concentration of WPP in certain areas (i.e. Dobrogea) causes large fluctuations and need to balance these fluctuations quite fast. Therefore, system reserves have to be available and affordable for TSO.
2) It increases the grid losses in the transmission and distribution network, that implies an uneconomical operation mode and the losses must be offset by additional production whose cost are to be paid by the transmission and distribution network companies.
3) The congestions frequency in the transmission and distribution network increases and determines expensive costs of production generated by the necessity to reschedule the generation units. This is followed by the deviation from the order of merit of dispatchable units, which generates additional costs to eliminate possible congestions.
4) It is necessary to increase the fast tertiary reserve in the National Power System. The European experience shows that for 1 MW installed in wind power plants is necessary to increase the fast tertiary reserve power in flexible generation units by approx. 0,6 to 0,9 MW [11].
5) The operation at minimum/ shutdown of conventional generators, mainly for the coal fired power plants units, implies significant negative economic effects on the conventional generation.
6) Technical problems raised from the operation of transmission and distribution networks implies strengthening of the networks, requires installation of new flexible generation capacities to ensure the necessary level for fast tertiary reserve and this requires additional financial efforts and long time for implementation.
7) Uncertainties for transmission network planning regarding precise location and size of the plants. Out of experience, building new transmission infrastructure takes more than building wind power plants. The other

aspect is related to connection type. Base on the type of connection that is applied (deep or shallow) investors are more or less encouraged to invest in RES.

8) “No limit” approach in terms of installation of RES can be dangerous for TSO, investors and society. First, TSO should avoid investment that is needed only few hours a year and paying too much for congestions. Second, investors have problems in being able to prepare a bankable business plan. Third, electricity consumers may not be able to sustain green energy. Residential consumers may shift from electrical heating to other less expensive ways and industrial consumers may relocate their business to other countries where electricity is cheaper.

As these wind farms are concentrated especially in Dobrogea, Moldova and Banat, for their connection in the Power Grid, the electricity grid operators must develop the transmission and distribution network to avoid congestions that may occur at the tripping or withdrawal from operations of network elements. Depending on new planned investment projects, in many cases, in order to avoid overloading the network elements, it will be necessary to reduce the power produced by the renewable sources at disposal of the National Dispatching Centre. This is clearly stated in GD no. 33/2012 [7].

Also due to the frequency control needs and thus maintaining continuously an acceptable level of fast tertiary reserve, it was calculated a limit at about 3000MW for the possible power likely to be installed in wind power plants. In this sense, the National Authority approved the procedure that sets the way installed capacity of WPP is acceptable based on system flexibility and the level of power reserve that is needed for security of supply.

And for this reason in some cases the power produced in wind power plants will be reduced or even disconnected.

3. Limit integration of WPP in the network

To determine the fast tertiary reserve at pick load the groups with reservoir and the spinning reserve generating units are considered. To determine the tertiary reserve at off pick, are taking into account only the hydro power plants with reservoir and thermal groups that do not work with cogeneration, up to the technical minimum power. For hydro power plants, the technical minimum power is considered equal to zero.

The programmed tertiary reserve is calculated as the available tertiary reserve value in the previous year. According to the Commercial Code in force, [10] the energy market participants are required to submit to the TSO for each dispatching interval (h), the available active power ($P_{available}$), the technical minimum power (P_{min}) and physical notification (P_{PN}) for each dispatchable unit.

Based on these values , notified by the producers in the previous year, the tertiary reserve is calculated at pick ($RTR_{prog + h}$) and at off-pick ($RTR_{prog - h}$), by summing these values for each time interval, for each dispatchable unit i (n is the number of the dispatchable units):

$$RTR_{prog+h} = \sum_{i=1}^{n} \left(P_{available_i} - P_{PN_i} \right) \tag{1}$$

$$RTR_{prog-h} = \sum_{i=1}^{n} \left(P_{PN_i} - P_{min_i} \right) \tag{2}$$

Then, the ranked curves of tertiary reserves scheduled for pick and off-pick, are plotted according to Fig. 3 and 4.

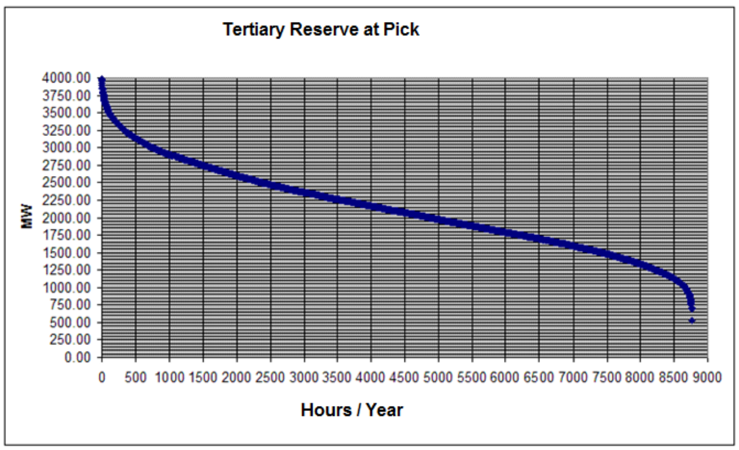

Fig. 3. Ranked curve of the tertiary reserve at pick for the previous year (2014)

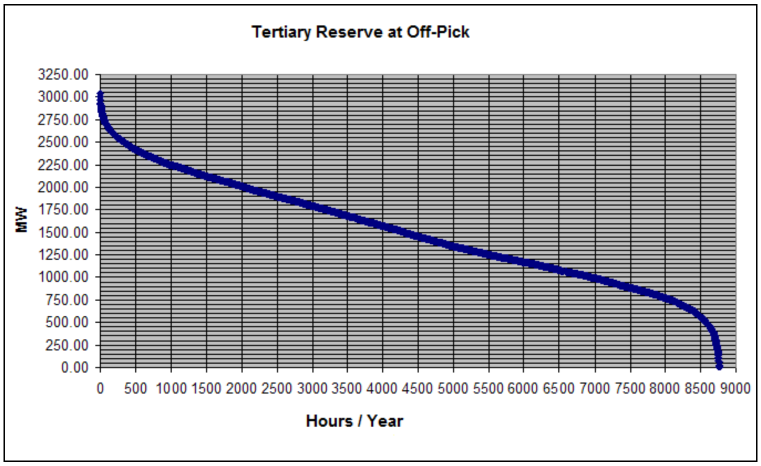

Fig. 4. Ranked curve of the tertiary reserve at off- pick for the previous year (2014)

For the next year, the scheduled tertiary reserve for each hour h (RTR_{progh}) is equal to the minimum value of tertiary reserve at pick or at off-pick, observed between the same hours of preceding calendar year:

$$RTR_{progh} = \min\left(RTR_{prog+h}, RTR_{prog-h}\right) \tag{3}$$

The available fast reserve in the network was established to be the maximum value that was available in the previous year - 8322 hours (representing 95% of 8760 hours). Is clear that the all production of the system provides the necessary reserve for the good functioning of WPP (the average work is about 30 % of the installed power) for 95% of time during the year, for 5% of the time being possible to limit the WPP production because of the reserve failure.

Annually the maximum WPP installed power is determined, acceptable in terms of availability of fast tertiary reserve existing in the power system;

$$P_{i\max CEE} = \frac{RTR_{available}}{k} \tag{4}$$

where k = utilisation factor of WPP,

$RTR_{available}$ = tertiary reserve available.

The fast tertiary reserve must cover the greatest power that can be shut-down quasi-simultaneously from the system, plus the maximum allowable imprecision consumption forecast (estimated). It follows that the need for fast reserve in Romania, until WPP integration is about 800 MW (calculated to cover the onset one unit of Cernavoda NPP, plus 100 MW of consumption forecast imprecision). Since the volume of installed capacity in wind power plants for which the expressed intentions are much higher than available reserve in the system, the fast tertiary reserve is the criterion to limit the WPP amount to be installed.

The maximum installed capacity in wind power plants it is determined as the maximum estimated power that can be turned off / turned on simultaneous in WPP ($P_{simul\tan eousWPP}$) can be compensated by uploading / downloading available tertiary reserve.

$$P_{simul\tan eousWPP} = RTR_{available} \tag{5}$$

As an example, for a fast tertiary reserve equal with 900 MW, having a utilization factor for WPP of 30% of the installed power, the maximum power installed is 3000 MW, according to (4). Of course that this limit can be exceeded by installing generating units fast and flexible.

4. The transmission grid planned development projects

The latest analysis developed in perspective, highlighted a number of important trends, namely:

- the transmission network development is not specifically generated by increased consumption, but by the investors intention to achieve numerous renewable, mainly wind and photovoltaic power plants;
- there is a pronounced trend to invest in renewable sources especially, wind and photovoltaic;
- in both cases the new generation facility location is not consistent with the needs of the system, but with opportunities and primary energy resources offered (in case of conventional power plants) and with atmospheric conditions for renewable power sources.

It resulted necessary to develop the eastern part of the entire National Power System (Dobrogea, Moldova), as a result of requests for nuclear new units (Units 3 and 4 at Nuclear Power Plant Cernavoda) new TPP (880 MW Thermal Power Plant Braila, 800 MW Thermal Power Plant Galati) and especially wind power plants, totaling over 9772 MW with connection contracts and permits in the region.

In Banat region, in the South-Western part of the country, there are also a large number of projects for wind power plant (about 1500 MW) with reduced possibilities for connection due to the lack of transmission network in the area.

In the Power Transmission Grid Perspective Plan, the Romanian TSO, as the transmission grid development planner, identified and proposed some transmission lines projects for the developing the grid.

Another examined development proposal are adding Phase Shift Transformers on existing interconnections lines with Bulgaria, as well as building new pumped storage hydropower plants, developing the smart grids, etc [8].

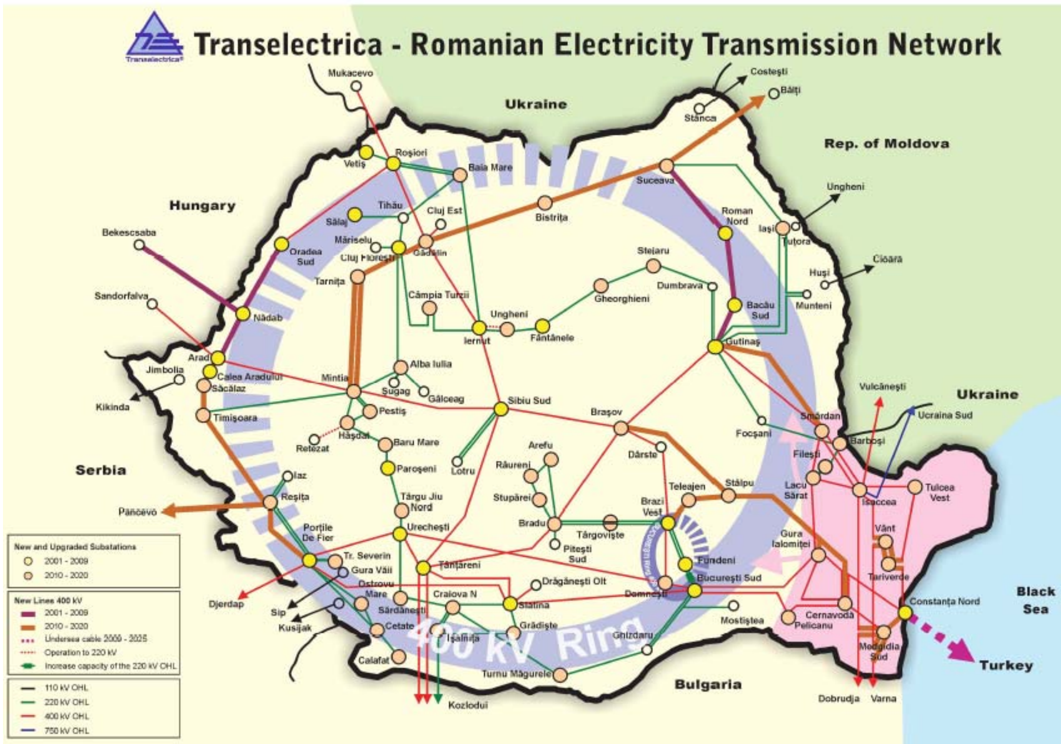

Fig. 5. The Romanian Electricity Transmission Network developments from the Power Transmission Grid Perspective Plan [9]

The TSO elaborated the Power Transmission Grid Perspective Plan based on considering ahead the development needs and financial possibilities that the company holds. If the speed of onshore wind power plants installation is quick, then a part of the investment may be needed sooner than foreseen for financial reasons in the plan. It is necessary to develop the existing regulation framework in order to enable investors to participate in financing the development of National Power Grid.

5. Conclusions

This paper analyzed the challenges that the Romanian Transport System Operator have to deal with in the transmission network planning process and the projects for developing the grid that could be taken into account.

In the last two years encouraged by the renewable energy promotion Law issued by the Parliament in 2008 and updated several times, the National Transmission Company faced an important development of large photovoltaic plants, recording an increased number of grid connection applications for such new generation units.

It is analysed the Energy Legislative Framework in Romania with the latest updates, insisting on the promotion scheme for renewable energy producers.

It also determined the necessity to revise and complete the existing regulatory framework in order to create the conditions for the TSO to develop the grid at the required level generated by the impetuous development of the renewable energy sources.

It was calculated maximum amount of WPP to be installed in the system according to the available tertiary reserve. It is clear that for the moment, no more than 3000MW can be integrated. Of course that this limit can be exceeded by installing generating units fast and flexible.

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R E F E R E N C E S

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