Actual Situation and Perspectives on Wind Energy Usage in Banat Region

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Abstract: - This paper presents synthetically some of the actual trends in the unconventional energy resources in case of non-polluting wind energy. There are presented the worldwide efforts engaged on the increase of the wind energy usage and particularly in the Banat Region, Romania. There is presented the experience of the researchers from Banat Area and their most important achievements. There is highlighted the importance of the induction generator in the wind energy conversion systems and there are stated conclusions based on practical implementations regarding the optimization of the operation of induction generators through terminal voltage control. There are identified the potential participants and the existing legal regulations regarding the wind energy utilization program and the potential investors. There are stated objective conclusions regarding the problematic of the wind energy usage in Romania.

Key-Words: - wind energy usage, wind energy conversion systems (WECS), induction generator, synchronous generator, wind aggregates, legal regulations, wind programs

1 Introduction

Nowadays, there are significant concerns regarding the importance of reducing the carbon-dioxide emissions that pollute the atmosphere, phenomena that critically disturb the world climate.

There are periodically worldwide scale meetings, planned by several organizations (such as the United Nations).

Their topics are mainly dedicated to the problematic of our planet’s climatic changing. The participants are usually diplomats, government’s officials, environment lobbies and business groups, specialists in energy, etc.

There are studied, analyzed, discussed the above mentioned major issues.

In this paper, the authors are submitted only to the issue of the use of renewable energy resources such as the wind energy.

There are several organizations that dealing with and promoting the above presented problematic of the large scale wind energy usage.

One of the most important at international level are the EWEA (European Wind Energy Association) and the AWEA (American Wind Energy Association). [1][2]

At local area, in Timisoara, Banat Region, there is collective involved in research of wind energy usage, the authors of the present paper being members of this large interdisciplinary research team.

2 Actual situation and perspectives regarding the wind energy usage

There has been esteemed that until year 2017, the windmills installed capacity, should cover up about 10% of the planet’s electrical energy needs.

The EU (European Union) prepares the document entitled “The White Paper” which states out the future directives for the member countries (differentiated by each country’s non-polluting energy potential) – consequently that until 2022, about 15% of the energetic requirements to be contended by non-polluting renewable resources such as: wind, solar, micro-hydro, etc.

In Denmark, this directive/recommendation has been already reached. Germany has the supremacy regarding the windmills installed capacity in Europe (appreciatively about half of the total Europe's installed capacity), and further one of the Nordic lands, Schleswig-Holstein, the wind energy represents already 13% of the consumed energy. [2][3] Germany is followed by Denmark (about 50% of Germany's windmills installed capacity). Spain has about 25% of Germany's windmills installed capacity, Holland, Great Britain, Sweden, Italy, Ireland, Portugal, Greece, France, etc. Romania is rated on 21st place in Europe. It is obvious in the case of non-member EU states, those who want to become EU member states, have to take into consideration the directives that are stated by the EU states.

Therefore other non-member EU states must align their energy politics to the EU requirements and standards.

The studies conducted in Romania are estimating a wind potential of 95.000 TJ/year (T W*s) – which means about 14% of the Romania's energy, requirements reported to year 1989. [4]

Although in Romania existed preoccupations and were constituted a research, project and production nucleus ("Politehnica" University of Timisoara, ICEMENERG Bucharest, HIDROTIM Timisoara, ICSITMUA Brasov, IAEM Timisoara, ELECTROMONTAJ Timisoara, UCMR Resita, ELECTROPUTERE Craiova, ELECTROTEHNICA Bucharest, etc.), Romania is rated in Europe on 21st place with about 1MW installed capacity. [4]

Presently, the trends in the wind energy aggregates are mainly focused on:

a) The enhancement of wind aggregates:

- Efficiency raise and the reduction of the generated electrical energy costs
- Improvement of the electrical energy distribution parameters – the reduction of excessive fluctuations of the generated energy (due to the significantly wind speed variations), that presents negative consequences on the mechanical and electrical windmill's components
- The increase of components reliability, service, short duration revisions, easy maintenance in order to assure a higher availability degree of the windmills

b) The reduction of the installing time frame:

- Mainly by considering a modularization of the construction elements

c) The optimal grid integration into the distributed wind farms or of the individual aggregates into power energy distribution grid:

- The reactive energy compensation issue (technical issues require a power factor as much as possible closer to the 1 value)
- The rejection of current harmonics introduced in the grid - basically a lower value for the THD (total harmonics distortions) factor
- The prediction on short/medium/long term of wind speed evolution on site, fact that involves an advanced and improved power energy system management. [5]

Presently, the above mentioned desiderates are based on the main following research, development and implementation guidelines:

a) The usage of a variable speed induction generator with winded rotor and frequency static converter in the rotary circuit:

- Leads to the reduction of the generator's dimensions and weight
- The optimal reactive energy distribution between the stator and rotor in order to minimize the losses and the avoidance of overloading some machine's components
- The optimization of the interaction between the grid and generators in the nominal functioning regimes and in the case of failure regimes (through power converters)

b) Direct turbine coupled generators, in order to eliminate the mechanical transmission and therefore the functioning at reduced speed and frequency that requires the usage of frequency converters as an interface between the network power grid and the generator:

- The elimination of the mechanical transmission disadvantages (wearing parts, attrition, and lubricant periodic replacement, high production cost that reaches sometimes can reach up to 50 % from the total windmills cost)
- The usage of adequate generators (synchronous conventional or synchronous with permanent magnets, squirrel cage induction generators, other special types of generator – with compensation windings, double fed, etc)

c) The usage of the modern modeling and computer aided simulation methods:

- Simulation of the wind aggregates in different specific functioning regimes
- Wind aggregates controller's synthesis and validation
- Selection, based on simulation results of the optimal control structures and control methods

d) The usage of adequate control systems for variable speed wind aggregates:

- Field oriented control (FOC) methods
- Advanced control methods based on neural networks and fuzzy logic [7]
- Wind prediction based methods
- Control methods based on H^{∞} theory

- Other optimized control methods: Hill Climbing Control (HCC), etc

There are known, presently, a large number of structure variants for induction machine field-oriented control.

In the following, for presentation, it is considered as an example the case of the induction machine air-gap magnetic field oriented control system structure. (Presented in Figure 1) [5]

The structure is identical as in the case of electrical drives, in which appear: transducers /estimators, controllers and field oriented method specific calculator blocks (phase number transformers TS, TS-1, field orientation block FOB and its elements, phase analyzer PHA, axes transformers AT, AT-1), frequency converters, excepting the Preset Turbine – Generator, Rotor Speed Calculator, Preset Voltage Calculator and Wind Turbine, Induction Generator Group. [4]

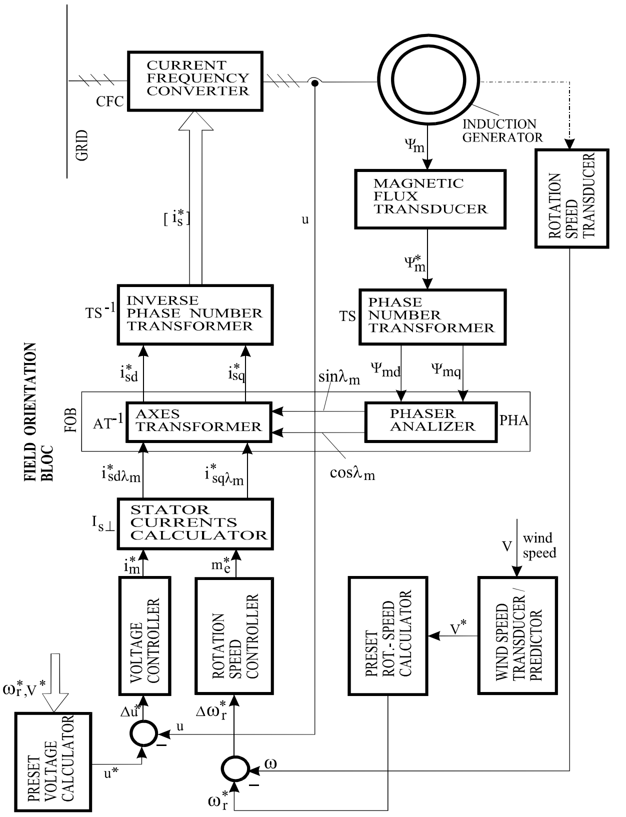

Figure 1. Induction machine air-gap magnetic field oriented control system structure. [4]

Thus the mentioned facts prove that there have been achieved outstanding progresses in the domain of wind energy usage, the research domain still remains attractive and open to new ideas and solutions.

3 Romanian researches regarding the windmills

There can be stated that the Romanian research, until the 1989 year, have been in concordance with those on international level. The preoccupations regarding the issue of wind energy usage started at at ICEMENERG Bucuresti Institute, with two wind aggregates of small nominal power (one within the institute and other on the Petriman Mountain). In year 1983, the next windmill, the SAG 01-100KW, researchers from Technical Institute from Timisoara, proposed and equipped the windmill with an induction generator with variable speed, interfaced with a power converter produced by ELECTROTEHNICA Bucuresti: CCTR-380-12/50, this being the actual trend on international level, the solution is used by ENRON WIND, VESTAS, NORDEX, FUHRLANDER, etc. In 1983, at Timisoara there were realized the experimental aggregate AAETO-L1/AEROTIM L1 (installed power 30 KW), as depicted in figure 2.

Figure 2. Experimental windmill AEROTIM L1 at Polytechnic Institute from Timisoara [4]

Figure 3. AEROTIM L1 experiments control room.

Afterwards, there was build the AAETO M2/30 Kw prototype from the Research center in Technology and Hydromechanics Equipments (CCSITEH), Timisoara Branch. (presented in figure 3). Also, under the supervision of Polytechnic Institute from Timisoara, there was design and build the AAETO-MD/33 Kw windmill, which was placed on Semenic Mountain site. The windmill was build by Bocsa factory and erected on site by ELECTROMONTAJ Timisoara Branch. (Figures 4, 5 and 6), and other on Moravita site (Figure 7) [4][6]

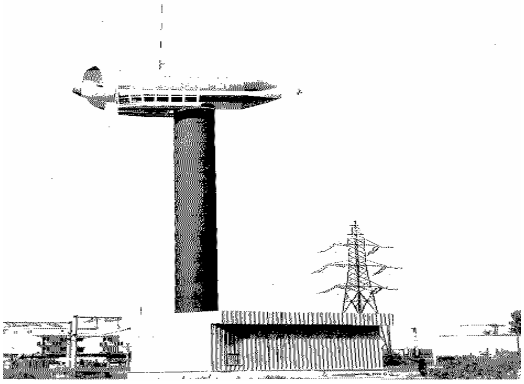

Figure 4. Windmill prototype at CCSITEH, Timisoara Branch. [4]

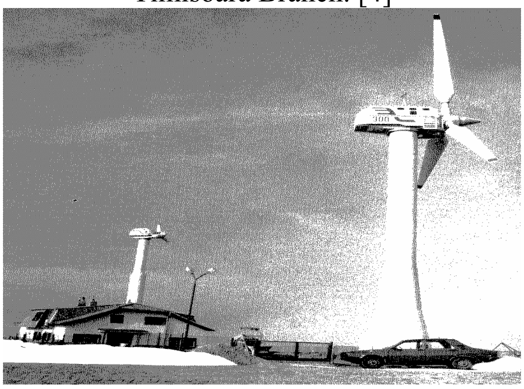

Figure 5. AAETO-MD/300 Kw, Semenic site. [4]

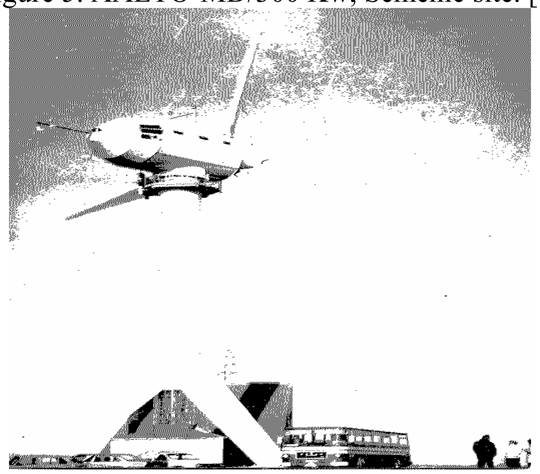

Figure 6. Variable speed-constant frequency Scherbius cascade induction generator windmill at SEMENIC Wind-farm.

Figure 7. Variable speed D.C. generator windmill at Moravita site (Romania)

4 The induction generator prevalence on the problem of increasing the efficiency of classical and new energy sources exploitation

Energy World Conferences (starting with Montreal Canada, 1979, 1989, 1986, etc.) insisted on two following aspects in connection with the problem of so called “exhaustion of planet energy resources”:

- spare the existing big but exhausting classical energy resources,
- efficiently to exploit the “small” but un-exhausting energy resources or the so called renewable energies of biomass, wind, sea and ocean tides, waves, currents and heat, earth heat, sun rays, small river courses etc.;
- complementary to exploit both as classical as new energies.

The above problems may be solved only by increasing exploitation efficiency of energy resources by new means, methods and techniques.

A good example may be found in [4] concerning a new operating method of hydro-electrical groups working at variable hydraulic head: operation at variable rotation speed. It is shown that the operation at variable controllable speed, in the considered case of - 25% to +10% variations of the hydraulic head, may determine a turbine efficiency increase of 3 * 10%, as well as the decrease of the vibrations and cavitations.

The functioning at variable rotation speed is also desirable for wind generators. Many technical literature and research studies demonstrate the wind generators operation efficiency at variable controllable rotation speed.

An alternative to solve the problem of functioning of energetically groups at variable controlled rotation speed may be the use of the induction generator (double feed induction machine, induction machine cascades, etc.).
The above mentioned possibility of using the induction generator as well as many other positive features of that machine make it of considerable importance for unconventional energetic.

5 Rehabilitation of the Induction Generator

The first commercial power station, built by Thomas Edison in 1882 in New York, in the southern part of Manhattan, was equipped with 4 direct current generators.
In 1882, Nikola Tesla and independently of him Galileo Ferraris discover the rotating magnetic field. In 1884 Nikola Tesla comes from Yugoslavia to New York,, bringing with him new ideas about the alternative current energetic systems. In 1885, based on his licenses, there are installed two synchronous generators of 3725 kW each; at the Niagara Falls hydropower station. The balance between the direct current and alternative current is soon inclined towards the last. In the power stations the victory belongs to synchronous generators which still dominate the energetic.
In the field of electric motors, on the contrary, those of alternative current couldn't eliminate the direct - current motors, which dominate in the domain of electric drives, being more controllable. However, in the last years, the alternative current motors gain here, too more and more ground in the competition with the direct current motors.
Among the direct current motors, the induction motors impose themselves more. The three phase induction machine, invented by G. Ferraris in 1887, as a 3W laboratory apparatus, will know, after its construction in an usable industrial form, by Dolivo Dobrowolski, a great success. Now, the induction machine is produced in a wide range of powers from a few watts up to 5MW and even more (20 MW).
The use in energetically systems of the induction machine as generator was not of interest almost until the present. This is mainly explained by the disadvantage of this machine, against the synchronous, to absorb reactive energy from the system, respectively not to be able to supply the necessary reactive energy into the system (mostly for induction motors), which in the conditions of less developed energetic systems, is a prohibitive disadvantage.
In isolated networks (autonomous), too the induction generator hasn't imposed itself because it isn't easy to control the step - by - step connection of excitation condensers, respectively the low quality of the supplied energy (voltage harmonics in case of saturation coil control, etc.).
Only major changes in electroenergetics, new possibilities and new developments could determine the reorientation towards the use of the induction generator, in case that it would present, in changed conditions, advantages against the synchronous generator.
The above mentioned favorable conditions for the utilization of the induction generator appeared gradually:
1. Big energetic systems which can ensure the reactive power of relative small power induction generators for hydraulic power stations (and others), the induction generators offering in exchange the possibility of more simple total automation of micro hydropower stations, together with an increased reliability.
2. The energetic orientation towards the utilization of new energy sources, requiring non - conventional approaches both of energetically equipment's and the operation mode (ex: operation at variable speed, a mode which is required also by the use of wind energy, etc.).
3. Development of devices and circuits with power and control semi - conductors, permitting a more simple solving of some principles (for ex. the use in the rotor circuit of the Scherbius static cascade instead of the one realized with commutation machines of complicated construction and difficult to control, with low reliability and a high cost, which hindered the idea's promotion); the higher controllability of the circuits with power semi - conductor elements is also a favorable factor for new developments with higher technical and economic performances.
4. The development of control engineering, which using technical means not subjected to human physiologic limits action, makes possible processes which could not be realized without it ; so, the quick control of reactive excitation power of an induction generator, by start of an induction motor supplied by the generator, is not possible without the quick automatic collection of information and the proper quick automatic intervention.
The operation of induction machine as a generator, parallel with a constant frequency and voltage grid, is generally known, being considered in the electric machines handbooks, side by side with the operation as motor, with the same mathematics models, the same equivalent circuit, the same circular diagram,

etc., the difference being in the slip values, positive for motor and negative for generator operation. This operation and its characteristics being well known, the present work shows only the peculiarities which can be noticed in such use, and some solutions for solving the problems occurred by the use of induction generators.
There will be presented mainly less known operation regimes as generator and especially those to the study of which the author has contributed.

6 The Use of Induction Generators for Wind Generators Connected to the Network Grid

At the present time, it is estimated [4] that the wind potential of Romania is comparable with the hydroelectric one, of some milliards of kWh/year.
Beginning from 1979, Electrical Energy Board raised the question of the centralized use in Romania of wind generators connected to the public grid.
Inside ICEMENERG - research institute of the Board, a research group for wind energy use was set up. Universities and research institutes from Timisoara, Bucharest, Brasov and Bocsa-Resita obtained notable results for wind energy equipment. First, a few 10-30 kW (Fig. 8, 9) units were tested, and then experimental vertical axis units of 100 kW and horizontal axis units (Fig. 9) of 300 kW were constructed. The studies localized sites where hundreds of MW can be installed, in favorable economic conditions (see Table 1).

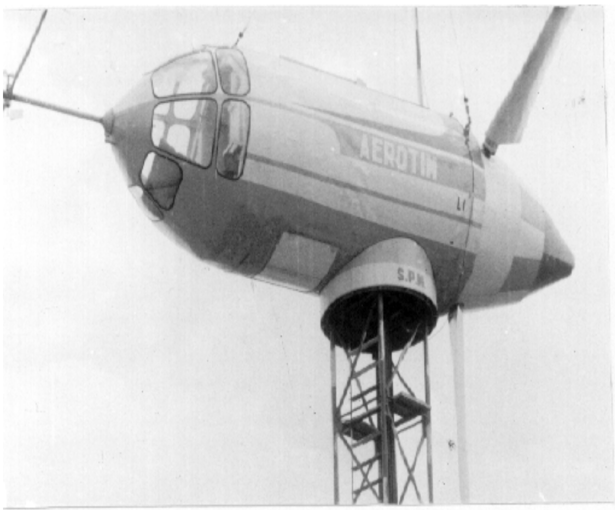

Figure 8. AEROTIM 30KW, Polytechnical University from Timisoara

Table 1. Favorable sites for wind generators

Areas	Average wind speed (m / s)	Potential kW/Km^2 .10^3	Existing wind energy % of Romania's total energy	kWh / Km^2 / year .10^6
Mountain ridges above 1500 m	6-10	5.63	1.3	11.41
Mountain massifs above1000 m, exclusive ridges	4-6	1.10	24.5	2.13
Black See Coast and Danube Delta	4-7	1.27	9.1	2.45
Continental platform of Black Sea till 20 m depth	5.7	2.98	13.0	5.57
The rest of territory	4	0.30	52.1	0.61
Average per country		0.41		0.82

Figure 9. EOLTIM 300, Semenic Mountain Platform

The Semenic Mountain Platform site was chosen for installation of a wind-farm with 8-12 units of 300 kW each, later following the development up to 300 units.
For the Romanian windgenerators to operate in parallel with the national electric system, realized or to be realized in the future, the solution with induction generators was exclusively adopted.
The specific of induction generator operation at wind generators (available wind energy and random wind speed, low speed of wind turbine) determines only some constructive and operation peculiarities

of existing machines (use of machines with two synchronism speed, use of two generators of different speeds, low speed generators, generators operating at variable speed).

The theoretical problems of the connected to the grid generator operation are well known in technical literature. To illustrate the specific induction generators' constructive problems to be used at windmills, in Tables 2 and 3 are given the solutions adopted by the Technical University of Timisoara and Hidrotim SA Timisoara specialists for some wind generators, implemented or in implementation stage [4].

Table 2. Electrical generators of windmills elaborated at the Technical University from Timisoara and Hidrotim SA Timisoara

Wind generator	Electrical generator	Justifying considerations
1. AEROTIM 30 kW	Two induction generators with phase - wound rotor and static Scherbius cascade in the rotor circuit **1.** NR. 1 Generator P_N = 6 kW n_o = 650 rpm n = 650-1300 rpm **2.** NR. 2 Generator P_N = 15 kW n_o = 1500 rpm n = 1500-2250 rpm	Allows the operation at variable speed and the study of cascade solution
2. AAETO M1 30 kW	Induction generator with Scherbius rotor static cascade P_N = 18 kW n_o = 1500-2250 rpm	Allows the operation at variable speed and the study of cascade solution
3.EOLTIM 300 kW/1	The induction generators with Scherbius rotor cascade **1.** NR.1 Generator P_N = 55 kW n_o = 500 rpm n= 500-1000 rpm **2.** NR. 2 Generator P_N = 250 kW n_o = 1000 rpm n = 1000-1400 rpm	Allows the operation at variable speed and the study of cascade solution
4.EOLTIM 300 kW/2	Induction generator with phase-wound rotor and resistors in the rotor circuit P_N = 315 kW n_o = 1500 rpm	Allows the operation in a larger variation field of speed and thus, better conditions of turbine operation (shock damping)
5.	Induction generator with two rotation speed P_N = 5 / 7 kW n_o = 750 / 1500 rpm	Allows the starting and operation at lower wind speeds
6.	Two rotation speed induction generator P_N = 22 / 30 kW n_o = 750 / 1500 rpm	Allows the starting and operation at lower wind speeds
7.	Two rotation speed induction generator P_N = 35/50 kW n_0 = 750/1500 rpm	Allows the starting and operation at lower wind speeds
8.	Induction generator with Y /Δ connection of windings at low wind speeds respectively high wind speeds	Greater power factor (cos φ) at low wind speeds

Table 3. Blade position drive and control systems

Wind generator	Drive and control systems	Critic issues
1. AEROTIM 30 kW	With blade drive c.c. motor supplied by a static voltage converter; the motor is located in the cowling being supplied through a brush-ring system	The system eliminates the contactors and allows a linear control. . The presence of commutator c.c. motor and converter reduces the feasibility and increases the complexity

		and price
2. EOLTIM 300/1, EOLTIM 300/2 5/7 kW, 22/30 kW, 50 kW	With drive induction motor located in the cowling supplied through a brush-ring system	The contactors and brush-ring system reduce the feasibility
3. EOLTIM 300/3	With drive induction motor located in the nacelle, supplied from a frequency converter ; the motor is rotating continuos in a single direction , the drive direction and control speed depending on the difference between the motor and turbine speeds	The system eliminates the supply system through brushes and rings as well as the contactors. Assures a higher quality of the control

7 Operation Optimization of Parallel with the General Electrical System Induction Generators, by Terminals Voltage Control

Theoretical [4] and experimental studies, as well as recent achievements of some manufacturers, underline the effect of voltage control at the terminals of induction machines supplied from the grid (motor regime) or which deliver energy in the grid (generator regime) with equipment connected between the induction machine and grid. The proper control of voltage can have remarkable efficiency. The SABINA Company achieved the LOADSTAR SOLID STATE AC MOTOR STARTER 5-100 HP equipment having the schematic diagram in Fig.10.

The process has as effect, at subnominal loads, the improvement of power factor, reduction of currents, losses in copper and iron and as a consequence, improvement of the machines efficiency and reduction of losses in the grid.

To illustrate the effect of power factor improvement and reduction of the induction machine current at under rated loads, by voltage control, in Fig.11. there are presented the simplified circular diagrams of the machines for $U = U_N$ and $U = 0.5\ U_N$ and corresponding stator currents at the same load (electromagnetic moment).

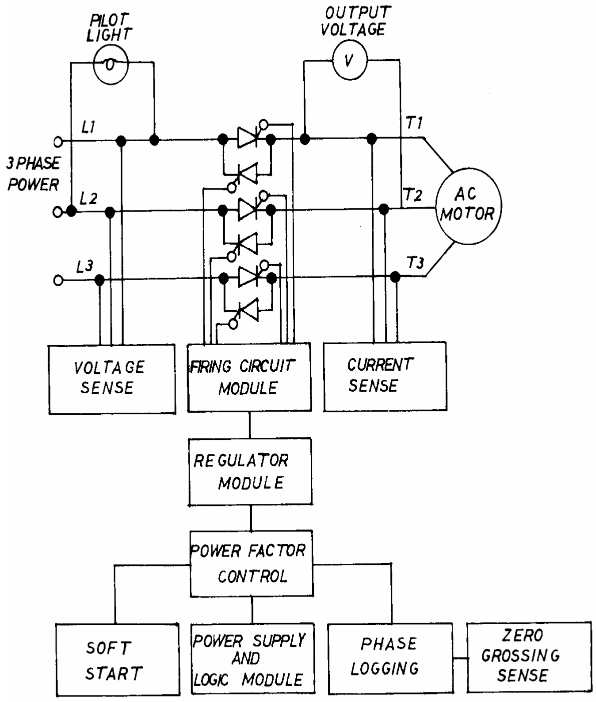

Figure 10. Schematic diagram of a terminals voltage control system for optimization of induction machines operation (ex SABINA Electricand Engineering Company).

Though the above considerations are referring to the motor regime of the induction machine, they remain valid for the generator regime, too.

Corresponding to the above-mentioned effects, the rapid amortization of the control equipment cost is estimated. So, the amortization of costs is obtained only in a few months, in some cases as:

- 2 hours/day at 80 % of rated power and 14 hours/day at 25 % of rated power,
- 6 hours operation daily at 95 % rated power and 4 hours / day at 25 % rated power. [4]

We also can mention the extremely favorable effect on the grid connection process of the windmills equipped with induction generators and the considered voltage control devices - elimination of mechanical wear of contactors, avoiding of current and mechanical shocks (in the cinematic elements of transmission).

But we can observe that the considered devices, of voltage control, implemented by thyristors have the disadvantage of an important distortion of absorbed current (current harmonics) or of discharged current (as generator) in the grid.

To reduce the distortion effect of the voltage control device, we proposed (at Hidrotim Timisoara) another mode to realize the voltage control device, using magnetic power amplifiers, as shown in Fig.12.

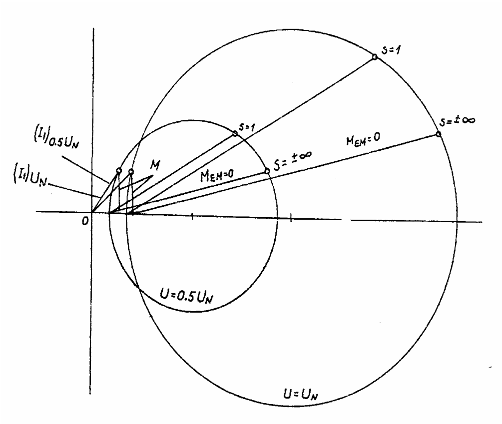

Figure 11. Simplified circular diagrams of an induction machine operating at UN and 0.5UN voltages.

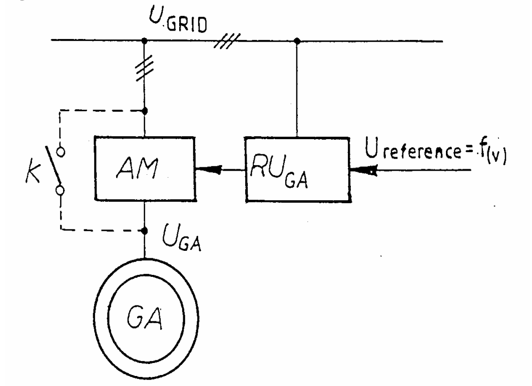

Figure 12. Schematic diagram of Hidrotim voltage control device for wind unit induction generators.

As it can be noticed (Fig.12.) the voltage controller RU_{GA} has as input variable the wind speed, the prescribed voltage following its evolution and so that of the available power. The dependence of the input variable U_{ref} on the wind speed can be find by calculation, considering the characteristic of wind turbine power (Fig.13.) and on the other hand, the equivalent circuit of induction generator (C. Knowing the nominal power of turbine $(P_T)_N$, the nominal wind speed v_N and considering

$$P_T = K_T \cdot v^3, \tag{1}$$

results the turbine power at different wind speed values

$$P_T = \left(\frac{v}{v_N}\right)^3 (P_T)_N \tag{2}$$

For each wind speed and, correspondingly for each power value of the generator (at the shaft)

$$(P_1)_{GA} = P_T, \tag{3}$$

$(I_1)_{GA}$ is calculated, for different voltage values at the generator terminals (in the interval $U_{GA} = 0 - U_N$), retaining the voltage for which $(I_1)_{GA}$ has the minimum value for considered $(P_1)_{GA}$. The calculations were performed by using a corresponding program.

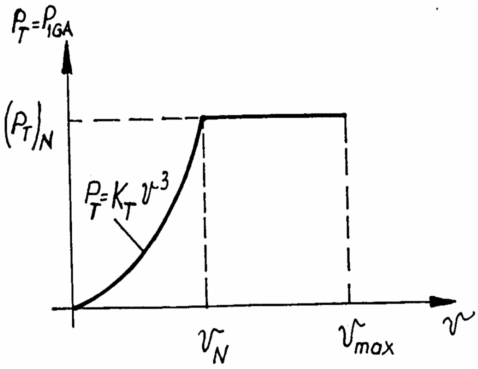

Figure 13. $P_T = f(v_{wind})$ characteristic for controllable wind turbines.

By the experimental Danish wind generator FOLKECENTER – 500 kW, the power of thyristor equipment for voltage control at induction generator terminals at start and small values of the wind is about 100 kVA.

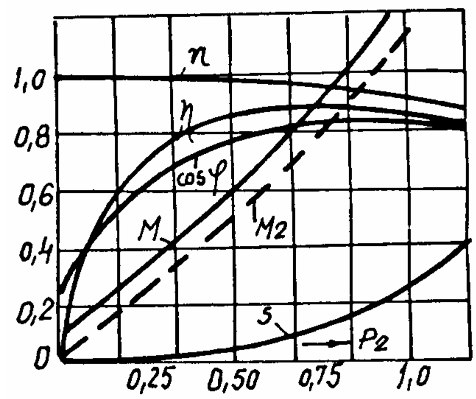

Figure 14. Operation characteristics of an induction machine (motor regime) in relative units.

The power factor value variation and, as consequence the variation of efficiency with load, is important in the range of relative power of 0 ÷ 0.4 (Fig.14.), that is why the discussed voltage control equipment is necessary namely in this power interval.

8 Issues above legal regulations

Regarding the lawful regulations of unconventional energy promotion, we present some ideas and approaches reported by prestigious technical journals and magazines: [1], [2]

· In USA, starting with 1980, there have been granted important subventions for the investors and for the producers for the delivered energy (bonus funds/KW), etc.

· In Germany is stated a fixed price that covers up the difference of electrical energy cost price for coal based energy plants meant to stimulate the investors in renewable energy.

· In Czech Republic is granted a subvention up to 40% of the investment's costs.

· The new EU's directives will set up for the member states, differentiated, precise regulations for the generation of electrical energy out of renewable primary energy resources – the so called "green", "clean" energies at guaranteed prices.

· The same directives will oblige the distribution association's to deliver to the consumers the renewable and non-polluting energy, and to take over the task of necessary transmission lines construction and other related tasks.

Of course, the local governments and private associations could implement other facilities for the investors in wind energy production such as:

- fee-free benefits on certain time periods,
- rent exemption for construction lands required for plants in mountain areas,

In Romania, currently, there are the following regulations regarding the problematic of the wind energy usage:

- The Electrical Energy Law No. 138, approved by the Romanian Parliament in year 2003, which dedicates the 5th Chapter to the "Renewable Energy Sources", published in the Official Romanian Monitor, part I / 16.07.2003
- The HG 1535/2003, Romanian Government Resolution - "Resolution Regarding the Approval of Valorization Strategy of Renewable Energy Sources", published in the Official Romanian Monitor, part I/07.01.2004. This resolution established the following valorization of the renewable resources:

a) Wind energy sources, 120 MW (installed power) between 2003-2010 and 280 MW between 2011-2015

b) Hydro energy sources, 120 MW between 2003-2010 and 120 MW between 2011-2015

- The HG 540/2004, Romanian Government Resolution regarding the approval of "Rules for the License and Authorization Granting in Electrical Energy Sector", published in the Official Romanian Monitor, Nr. 399/ 05.05.2004.

9 Potential investors in the wind energy usage programs

The potential investors may possibly be:

- Families and individuals. As an example, at the biggest wind energy plant in Friesland, Germany, which is constituted from 34 wind aggregates of 1,5MW, some of them were the private property of about 300 local families, while other aggregates are the property of some local regional companies.
- The banks could become also investors.
- Private associations and companies. In Spain, as an example the Cabanillas Plant, with an installed capacity of 30 MW constituted of 50 aggregates of 600KW.

10 Conclusions

As already stated, Romania has a great wind energy potential that needs to be exploited, taking into consideration the global trend in usage of renewable, nonpolluting energies.

The authors are conducting researches regarding wind generators equipped with different type of generators, such as low speed induction generators and with high quality advanced method controlled power frequency converters, doubly fed induction generators, synchronous generator, permanent magnet synchronous generators, etc.

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