New Aspects on the Implementation of Wind Farms in Romania and Greece

Marius-Constantin Popescu and Nikos E. Mastorakis

Abstract**—**Presently, the wind energy utilization devices approach is changed from individual isolated equipments, designated to a singular application, to compel wind farms connected to the electrical network. Supported by a favorable legal frame, they become competitive actors on the energy market, challenging traditional actors, like thermal or hydro power stations. Romania and Greece has good wind resources, mainly on the Black Sea and Mediterranean coast and in mountainous areas. The paper presents a computer modeling of such a farm, continuing with a study of balance of a turbine, by a MATLAB simulation of the resulting transfer functions.

Keywords**—** Transfer functions, Simulation and modeling, Components balance, Stability System, LabView interface.

I. Introduction

A wind turbine is a device that converts kinetic movement of a propeller blade in mechanical energy [19].

If this mechanical energy is transformed into electricity and then we are dealing with a wind generator powered/wind energy converter. But appropriation is time to *"wind turbine"*. In wind power location we take into account the amount of wind in the area, land price, visual impact on surrounding structures and nearness of current distribution network.

Production of electricity using wind energy is achieved by means of a synchronous generator (synchronous machine with magnet or with rotor) or asynchronous. The design of large pallets requires a speed of rotation of its axis very low (few tens of rounds per minute). If synchronous machine has a large number of poles where this will lead to realizing a large diameter generator (Fig. 1).

Types of wind turbines. Horizontal axis turbines - power generator rotor and are positioned to be aligned on top of the tower and wind direction. Small turbines are targeted with a wings and large using sensors and actuators to align the wind direction. Most turbines are horizontal axis and a gearbox that converts the rotating movement of the blades in one slow faster, needed to increase efficiency power generator. Since the tower produces turbulence behind its aerodynamic rotor is positioned in front. Turbine blades are resistant to not be folded and pushed into the tower that is installed by strong winds. Besides the tower and the blades are slightly angled apart. There are horizontal axis turbines with rotors placed behind the tower. Such turbines have the advantage that the propeller blades can bend, reducing the surface that opposes wind speeds and not are oriented in the wind, making it automatically due to construction [3].

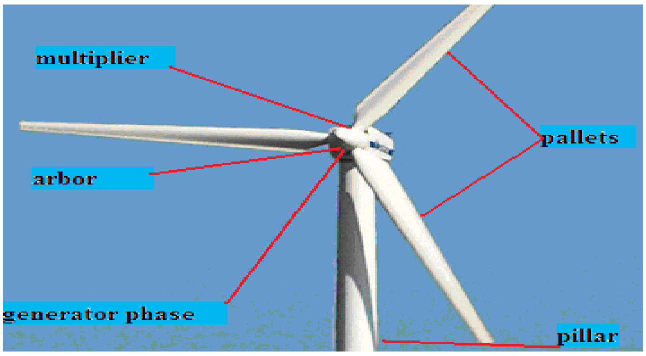

Fig. 1: Typical wind turbine with horizontal axis.

In turmoil but most horizontal axis turbines have rotor placed in front of the tower. Vertical axis turbines - more sophisticated generator and all components are placed in the bell tower, thus easing installation and maintenance. The main types are: Darrieus, Gorlov, Giromill and Savonius. Depending on the location of the turbines they can be categorized in offshore turbines and turbines placed in Offshore.

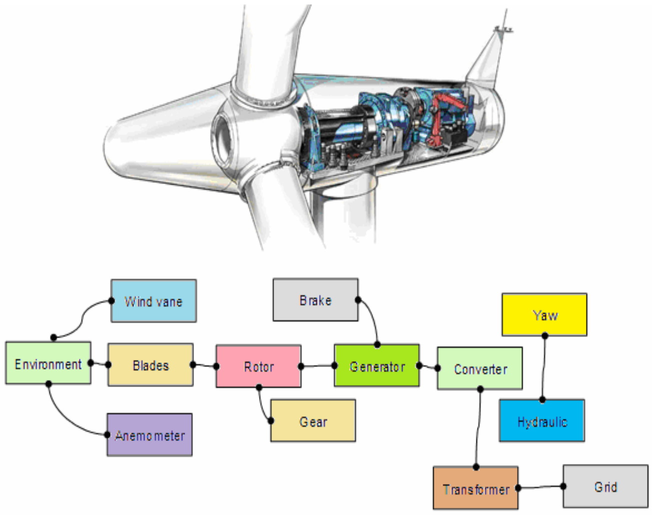

Fig. 2: Wind Turbine Components.

Marius-Constantin Popescu is currently an Associate Professor at the Faculty of Electromechanical and Environmental Engineering, Electromechanical Engineering Department, University of Craiova, ROMANIA, e.mail address popescu.marius.c@gmail.com.

Nikos Mastorakis is currently a Professor in the Technical University of Sofia, BULGARIA, Professor at ASEI (Military Institutes of University Education), Hellenic Naval Academy, GREECE, e.mail address mastor@wseas.org

A wind turbine system consists of several components including the rotor, gear, converter, and transformer used to convert kinetic wind energy to electricity (Fig. 2).

II. Description of the Situation in Romania and Greece

At the same time, within the national R&D program, several favourable sites for wind farms were investigated and Pre-feasibility studies were carried out (the Semenic Mountains, the Black Sea coast and off shore, the Sub-Carpathians areas). Four experimental 300 kW wind turbines were assembled on location in the Semenic Mountains. Two of the wind turbines never became operational because of lack of funding [18]. The first set is still operating, but it has to be dismantled because it is in an advance stage of wear. The set belonging to Electrica has fallen into disrepair because of a broken blade. The hesitant and slow wind energy development in Romania is contradictory to the European energy policy and to the Romanian clear commitment to adopt the European acquis. So, in this critical point, the SWOT analyzes of wind energy development in Romania is most welcomed. Analyze this also may be symptomatic for other CEE countries as well.

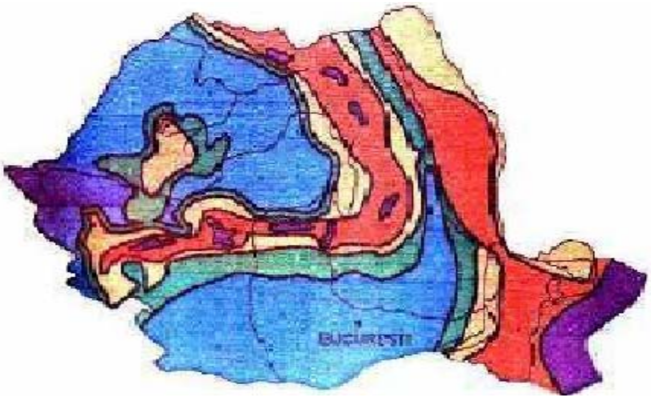

Fig. 3: The wind potential map of Romania [11], [18]:
purple - *high,* red - *moderate,* green - *low,* blue - *very low.*

Positive factors:

– New energy laws have been passed and is now in force accounting for energy market liberalization.

– The absorption of the EU *acquis* is an immediate policy goal for Romania. The promotion of renewables is a priority for the EU energy policy (see the Directive on renewables and the Green Paper Towards a European Energy Strategy [13]). Romania has to comply with this option [9].

– Other political commitments (e.g. the Kyoto Protocol, ratified by Romania, sets the target to reduce GHC emissions by 8% during the first commitment period), favour the development of renewables. Use of the Kyoto flexible financial mechanisms (joint implementation and emissions trading in particular) can also provide an additional financial input for the development of renewable sources, especially wind power.

– The Romanian power and heat regulatory agency (ANRE) has established rules to guarantee equal treatment of actors on the energy market. ANRE produced a clear regulatory framework for IPPs to operate according the regulated Third Part Access (rTPA) principles.

– The cross subsidies for electricity were removed. The tariffs, based on transparent methodologies, reflects the actual electricity costs.

– The Romanian industrial sector has the proven capability to transfer and implement modern technologies for manufacture wind turbine components, i.e. towers, nacelles, Gearboxes, Generators.

– Good wind energy resources.

– Quite good own R&D experience. There are various centres in Romania, where extensive research in the field of renewable energies, particularly wind energy, has been performed. Sound knowledge and professional skills are available from the group (albeit a rather small one) of qualified local experts.

– The development of remote rural areas where connection to the grid is not possible or is too costly calls for decentralized power generation solutions. Renewables provide such environment-friendly alternative solutions.

– Many companies that have considerable electricity bills and own sites with good wind potential is interested to become self-producers.

Policy barriers:

– In spite of the fact that promotion of renewables is stated as a policy goal in all official documents governing the energy legislation and regulatory framework, no specific legislation has been enacted yet and no well-defined mechanisms have been put in place to provide meaningful incentives for the implementation of projects in the area of renewable energy resources.

– No connection is being made between the political commitment to the Rural Electrification and the opportunities provided by renewables as a viable solution.

– Nuclear power production is seen as a priority for the national energy strategy in order to meet the rising electricity demand. Since no electricity shortages are foreseen in the medium term, there is no particular pressure to develop environmentally clean alternative resources.

– The slow pace of translating new energy laws and national strategies into a well-functioning energy market with free access for all investors.

– The existing large hydro sector, once included in the renewables category, is perceived as covering the "clean energy" and other political commitments [2], [16].

– There is a lack of operational experience with Independent Power Producers in Romania. Because of this identified barrier there has been only limited API activity in the country.

Financial barriers:

– The relatively high initial capital costs of renewables jeopardize the ability of such units to compete in a free energy market. Unregulated liberalization of the market could result in lower electricity prices in conventional generation units, thus undercutting the progress of renewables. There is no financial mechanism in place yet to reallocate the quota of electricity sales to renewables activities.

– Competition for capital investment in Romania is substantial, and the absence of a history of commercially operating renewable energy projects results in limited availability of investment capital.

– Persistence of still low energy prices. Today the average regulated electricity prices are \$ 38 to \$ 49 per MWh, on medium or low voltage.

– Romanian overall economic performance has been poor especially in the past four years, the situation was compounded by the shortage of investment capital.

– Existence of excess electricity generating capacity to meet the energy demand dwindling.

Institutional barriers:

– Renewables is dealt with by various decision-making bodies: Ministry of Resources and Industry, Ministry of Waters and Environmental Protection, ANRE and ARCE. No clear delimitation between their responsibilities and no agreed co-ordination mechanism seem to exist.

Technical barriers:

– There is no precise knowledge of the wind power potential, since no substantial wind audit has been conducted in the country. Only a general analysis was attempted during the 1990's.

– There are no meaningful national capabilities, so far, for the design, manufacturing and testing to enable the local production of wind turbines with a capacity of 600 to 750 kW to be used for electricity generation in wind farms and for stand-alone systems. Such wind turbines will have, therefore, to be developed and produced through technology transfer, provision of expertise, training and supply of related equipment.

– There are no specific Romanian norms and standards relating to wind energy.

Information, awareness and human resources barriers:

– Earlier in the area of demonstration applications using exclusively Romanian wind power equipment and know-how undermined the credibility of the new technology as a result of their poor performance due to inadequate materials and maintenance.

– No convincing demo application using commercially available proven technology has been installed wind energy in Romania yet. Although there were attempts in the past to produce wind turbines for electricity generation, they were unreliable and inefficient.

– The population has no recent experience with wind energies The population has no recent experience with wind energy. It is, therefore, necessary to overcome the lack of knowledge about the availability of alternative renewable energies, particularly wind, and to educate the population, at all levels, by providing tangible demonstration that such alternative technologies could offer real solutions. It is, therefore, necessary to overcome the lack of knowledge about the availability of alternative renewable energies, particularly wind, and to educate the population, at all levels, by providing tangible demonstration that such technologies could offer real alternative solutions. Available realistic potential (i.e. taking into account both resource and site restrictions) can be estimated at 2.000 MW producing over 4.000 GWh/year.

The target established for Greece under the European Union's Renewable Energy Directive, Directive 2001/77/EC, is that at least 20% of electricity supply should come from renewable sources by 2010 [13], [14]. Although this seemed an ambitious target, the approval of the Specific Framework of Planning Design and Sustainable Development for the Renewable Energy Sources (from the Ministry for the Environment, Physical Planning and Public Works) will enforce the development of renewable energy sources (RES) in Greece.

Wind energy represents an enormous opportunity to attract foreign investments into Greece and is also a challenge for the country's business world. In the last decade, interest has increased among, mainly, construction companies and individual investors for wind energy–related projects. Wind energy deployment has become a challenging area for development all over the country—especially in areas having poor infrastructure, in which some of the most promising sites for wind energy development can be found. Although manufacturing of wind turbines has not been established in Greece, there is considerable domestic added value in connection with infrastructure works, for example, grid strengthening, tower manufacturing, road and foundation construction, civil engineering works, and so on. In addition, new jobs are created related to maintenance and operation of the wind farms in mainly underdeveloped areas. An expanding network of highly experienced engineering firms has been created and is currently working on all phases of the development of new wind energy projects. Thus, wind energy is gradually becoming a considerable player contributing in the development of the country. The distribution of installed wind farms throughout Greece is depicted in Fig. 4 [6], [10], [17].

Fig. 4: Distribution of installed wind farms in Greece [6], [17].

Greece participates in Tasks 11 and 20. Task 11, Base Technology Information Exchange, promotes wind turbine technology understanding through cooperative activities and information exchange on R&D topics of common interest among member countries. Extra emphasis has been given through the years, especially at NTUA and CRES, to the development of aerodynamic models of wind turbines, an activity that is supported by the involvement in the activities of Task 20, HAWT Aerodynamics and Models from Wind Tunnel Measurements.

The Ministry for Development promotes all R&D activities in the country, including applied and basic R&D as well as demonstration projects. Key areas of R&D in the field of wind energy in the country are wind assessment and characterization, standards and certification, wind turbine development, aerodynamics, structural loads, blade development, noise, power quality, wind desalination, and autonomous power system integration. There is limited activity in Greece concerning offshore deployment [17].

Last, the Specific Framework of Planning Design and Sustainable Development for the Renewable Energy Sources is expected to decrease the difficulties of land selection and to lessen bureaucratic bottlenecks.

During 2008, four large wind farms were installed, having capacities in the range of 15 MW to 24 MW each. The total installed capacity of wind generators reached 990 MW.

III. Mathematical Modelling of Wind Farms

A. *Modelling of the Aero-generator*

It is considered a speed multiplier located between the blades and generator axis. In this configuration the generator will be a permanent magnet synchronous machine (Fig. 5).

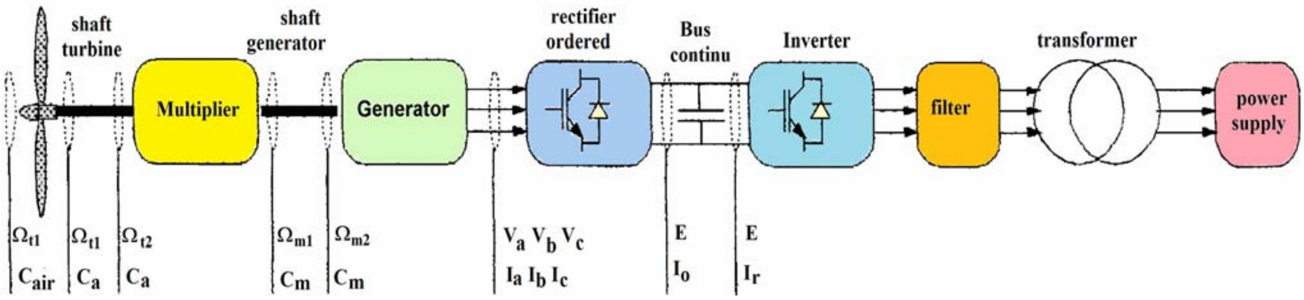

Fig. 5: The principle scheme of an aero-generator connected to the electricity grid.

Recovered by the turbine power: wind power comes from the kinetic energy of air mass due to wind. If it is considered an air mass m moving with speed *m*, corresponding kinetic energy will be [8]

$$E_c = \frac{1}{2} m v^2 \tag{1}$$

During a second, on a surface *S* and could recover strength, given by:

$$P_c = \frac{1}{2} \rho S v^2 , \tag{2}$$

where, ρ is air density.

Airspeed behind aero-generator is null and because this power can never be achieved. It defines a power coefficient of wind as

$$P_e = C_p . P_c , \tag{3}$$

where P_e is the effective power transmitted by the wind blades.

For a radius *R* of the blade, resulting

$$P_e = \frac{1}{2} C_p \rho \pi R^2 v^3 . \tag{4}$$

According to aerodynamic laws, the maximum coefficient of power is limited. If the air is considered incompressible, the maximum coefficient C_p corresponds to the limit of *Betz* [7], C_{pmax}=16/27=0.593. In a facility, the coefficient C_p varies depending on wind speed and rotor, and is expressed in terms of specific speed coefficient λ given by

$$\lambda = \frac{R \Omega_p}{v} . \tag{5}$$

Coefficient λ is a dimensionless number expressing the ratio between the tangential velocity of the end blades and wind speed. For the wind to set the relationship:

$$C_p = 0.536 \sin(0.1836 \lambda) - 0.004 \lambda . \tag{6}$$

Calculation of power factor: for a given wind speed, wind turbine has a speed Ω_{t1}, previous relations allow calculation of the coefficient of power as block diagram below (Fig. 6):

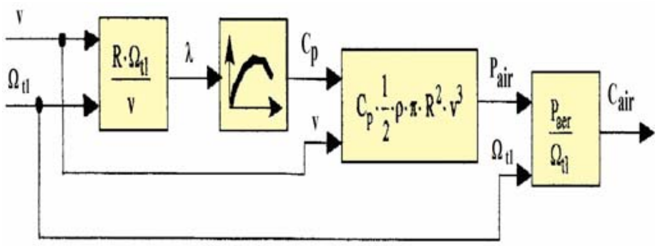

Fig. 6: Block diagram for calculating the coefficient of power.

Modelling of turbine-shaft gear assembly: the wind turbine forward a couple aero (Fig. 6), and flexibility of blades and the connecting shaft are detected by stiffness k_t. If friction is neglected fluid inertia can be considered pallets J_t. Dynamic equations of elasticity are

$$\Omega_{t1} = \frac{1}{J_t} \int (C_{aer} - C_a) dt \ , \ C_a = \frac{1}{J_t} \int (\Omega_{t1} - \Omega_{t2}) dt \ . \tag{7}$$

Modelling multiplier: it use the principle scheme illustrated in Fig. 7. Without neglecting inertia and mechanical losses resulting multiplier relations:

$$C_{m0} = \frac{C_a}{G}, \qquad \Omega_{t1} = \frac{\Omega_{tm}}{G}. \tag{8}$$

Taking into account the inertia and friction on the speed of output:

$$\Omega_{m1} = \frac{1}{J_m}\int (C_{m0} - C_m - f_m\Omega_{m1})dt. \tag{9}$$

Mechanical modelling engine shaft and its inertia (Fig. 8). As before, the relations of elasticity and the resulting dynamic

$$C_m = k_a \int (\Omega_{m1} - \Omega_{m2})dt. \tag{10}$$

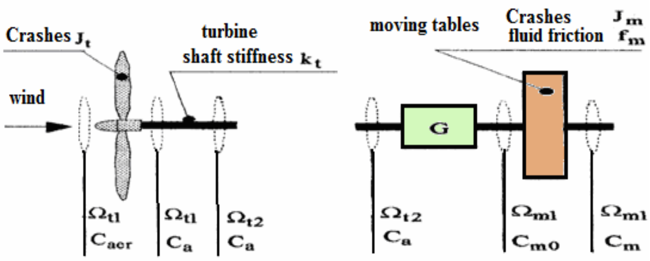

Fig. 7: Scheme turbine and the multiplier.

For alternative is noting with inertia *J,* friction fluid with f_a, and C_{em} electromagnetic torque [1]:

$$\Omega_{m2} = \frac{1}{J_a}\int (C_m - C_{em} - f_a\Omega_{m2})dt. \tag{11}$$

Aero-generator modelling mechanical parts: last 5 equations translate into the following simulation scheme (Fig. 9). Size which would be set rotational speed of the turbine is denoted by Ω_{t1}. Wind turbine torque C_{air} to regulate speed Ω_{t1} this torque can be considered as a random disturbance. Express speed Ω_{t1} depending on the torque and torque alternator aero.

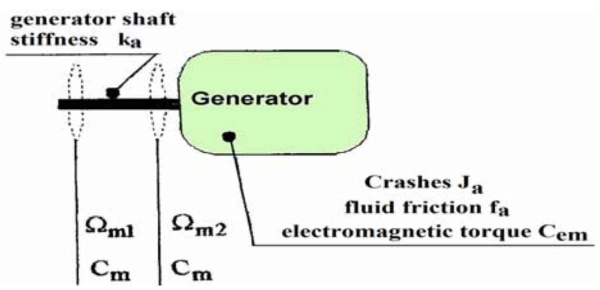

Fig. 8: Schema generator.

An approximate calculation will lead to

$$\Omega_{t1}(S) = G_1(s)\, C_{air}(s) - G_2(s) C_{em}(s) \tag{12}$$

with

$$G_1(s) = \frac{c_0 + c_1 s + c_2 s^2 + c_3 s^3 + c_4 s^4}{d_0 + d_1 s + d_2 s^2 + d_3 s^3 + d_4 s^4 + d_5 s^5}$$

and

$$G_2(s) = \frac{c_0}{d_0 + d_1 s + d_2 s^2 + d_3 s^3 + d_4 s^4 + d_5 s^5} \tag{13}$$

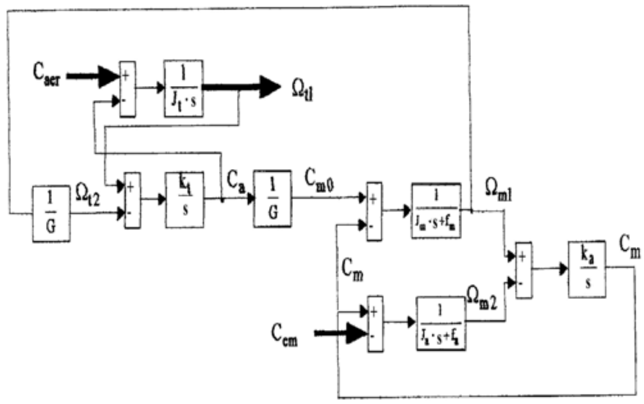

Fig. 9: Structural block diagram of mechanical assembly aero-generator.

The terms of transfer coefficients of these functions are the following:

$$c_0 = k_a k_t,\; c_1 = G^2 f_m k_a + f_a (G^2 k_a + k_t),$$
$$c_2 = G^2 f_m f_a + G^2 k_a (J + J_m) + k_t J,$$
$$c_3 = G^2 (f_m + f J_a J_m),\; c_4 = G^2 J J_m$$
$$d_0 = G^2 k_t k_a (f_a + f_m). \tag{14}$$

Aero-generator simplified model: if a transmission is considered rigid when the dynamic system of equations aero-generator, multiplier and the generator is simplified considerably (Fig. 10).

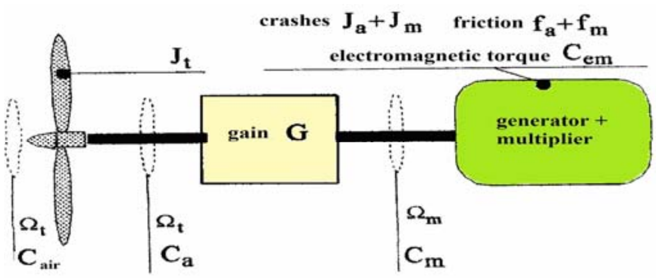

Fig. 10: The simplified aero-generator.

Assuming a rigid transmission resulting

$$\Omega_t = \Omega_{t1} = \Omega_{t2}, \quad \Omega_m = \Omega_{m1} = \Omega_{m2}.$$

If write equations system and the overall dynamic turbine generator and multiplying the result of:

$$\Omega_{t1}(s) = G_{1s}(s)\, C_{air}(s) - G_{2s}(s) C_{em}(s) =$$

$$\frac{C_{aer} - G C_{em}}{\left[G^2(J_m + J_a) + J_t\right]s + G^2(f_a + f_m)}. \tag{15}$$

B. Modelling Static Converters

A larger network can be regarded as frequency and voltage are required [12]. To achieve an efficient transfer between wind energy and turbine speed must be adapted, what leads to getting out of a variable frequency generator [5]. To transfer electricity is inserted a continuous bus (Fig. 11). Adjust speed helios power is achieved by maintaining constant voltage *E* on the bus is continuously and adjusting the power factor of the network. To obtain the electromagnetic torque and speed regulation aero generator insurance, current loop reference voltage required by the pulse width modulation PM1 [4]. On the continuous *bus*, in addition to the electromagnetic torque is required and current I_0. With the inverter, the modulator PM2, and maintaining constant voltage *E is* the *bus's* continuously ensure the best transfer of power to the network.

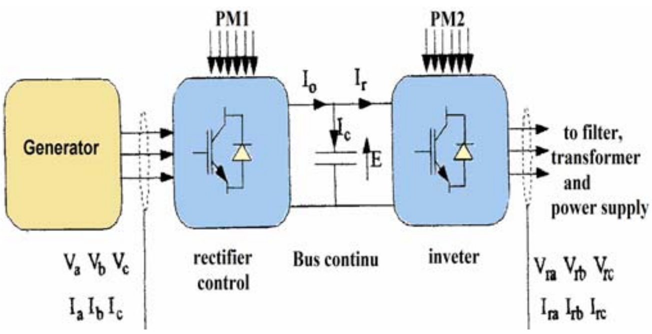

Fig. 11: The principle scheme of the electronic device power.

IV. The Study of Wind Power Stability

The main sizes of mechanical parts helios power modelled in the previous paragraph are given in Tab. 1.

Tab. 1: Parameters of wind power

a) the parameters of the turbine and transmission shaft elastic

V	*Wind speed m/s*	*R=4 m*	*Radius blades in m*
C_p	*Coefficient of power*	λ	*Specific speed*
Ω_p	*Blade speed*	C_{aer}	*Static torque carried by the wind turbine*
Ω_{t1}	*Turbine speed*	C_a	*Turbine torque transmitted through the reducer*
Ω_{t2}	*Speed entry into multiplier (reducer)*	ρ	*Air density (kg/m³)*
J_t	*Turbine inertia (kg.m²)*		

b)the parameters of the gearbox and the turbine shaft

G=18	*Multiplier*	C_m	*Torque transmitted from the multiplier to alternative (Nm)*
Ω_{m1}	*Speed the output multiplier*	$k_a=10^5$ *Nms/rad*	*Shaft stiffness relation between multiplier and alternative (Nms/rad)*
Ω_{m2}	*Rotational speed of the alternator*	$f_m=2$ *Nms/rad*	*Fluid friction multiplier out*
$J_m=2$ *kgm²*	*Exit reducer inertia kg.m²*		

c) the parameters of the alternator

		C_{em}	*Electromagnetic torque of the alternator (Nm)*
$J_a=0,6$ *kgm²*	*Inertia alternator out (kg.m²)*	$f_a=2$ *Nms/rad*	*Fluid friction alternative*

d) the parameters of the gearbox and the turbine shaft

P_{aer}	*Wind power transmitted the turbine* $P_{aer}=\Omega_{t1}\, C_{aer}\,(W)$	P_m	$P_m=\Omega_{m1}\, C_m$ *Reducing power transmitted (W)*
P_{fm}	*Losses due to fluid friction reducers* $P_{fm}=\Omega^2{}_{m1}\, f_m\ (W)$	P_{fg}	*Losses due to fluid friction the generator* $P_{fm}=\Omega^2{}_{m2}\, f_a\ (W)$

Turbine speed command. The alternator will be equipped with 2 pairs of poles and will likely be the following: Ω_{m2} =150 rad/s, P_e=300 kW rated one involving a nominal torque C_{em}=2000 Nm. The process of associating block calculating power factor control has a size which is noted here with the electromagnetic torque C_{em} and a disturbance of wind speed *V.* The size of the output is the speed controller blades Ω_{t1} .

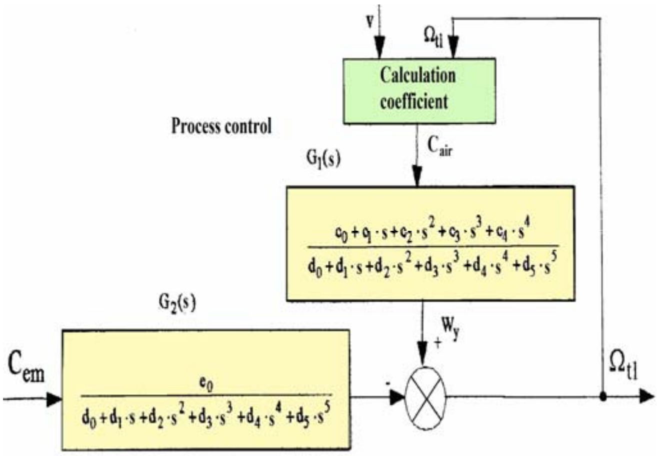

Fig. 12: Block diagram of the process the order.

Equations of mechanical parts can be put in the form of two matrices Transmittance $G_1(s)$ and $G_2(s)$ (Fig. 12). To obtain a high yield can set specific speed coefficient the optimal value (with features power coefficient C_p). The principle scheme of control is illustrated in Fig. 13.

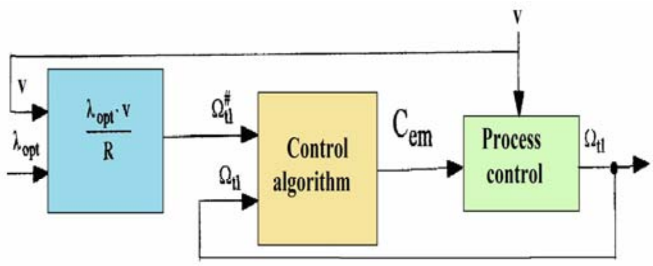

Fig. 13: Control Scheme provides an efficient power transfer.

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Clear, ka=100000; kt=150000;
c0=ka*kt, fa=2, fm=2, G=18;
c1=(G^2)*FM*ka+fa*((G^2)*ka+kt), Ja=0.6;
 Jm=0.2, c2=(G^2)*FM*fa+(G^2)*ka*(Ja+Jm)+kt*Ja;
 c3=(G^2)*(fa*fm*Ja+Jm),c4=(G^2)*Ja*Jm;
d0=(G^2)*ka* kt*(fm+fa),Jt=10;
 d1=kt*((G^2)*fa*fm+ka*((G^2)(Ja+Jm)+Jt));
 d2=(G^2)*FM*(ka*Jt+kt*Ja)+...
fa*(kt*Jt+(G^2)*(ka*Jt+kt*Jm));
d3=(G^2)*fa*fm*kt*Ja*Jt+Jt+(G^2)*...
(ka*Ja*Jt+ ka*Jm*Jt+kt*Ja*JM);
 d4=(G^2)*Jt*(fm*Ja+fa*JM);
 d5=(G^2)*Ja*Jm*Jt, e0=G*ka*kt;
 numG1=[c0 c1 c2 c3 c4];
 denG1=[d0 d1 d2 d3 d4 d5];
 numG2=[e0]; denG2 = [d0 d1 d2 d3 d4 d5];
z1=roots(numG1),r1=roots(denG1),r2=roots(denG2);
 G1=tf(numG1,denG1), G2=tf(numG2, denG2);
 pzmap(G1), pause;
pzmap G2)
 z1= r1= r2=
 -0.0043+0.0414 I-0.2077-0.2077
 -0.0043-0.0414-0.0000+0.0080i-0.0000+0.0080i
 -0.0000+0.0012I-0.0000-0.0080-0.0000-0.0080
 -0.0000-0.0012-0.0000+0.0012i-0.0000+0.0012i
 0.0000-0.0012-0.0000-0.0012
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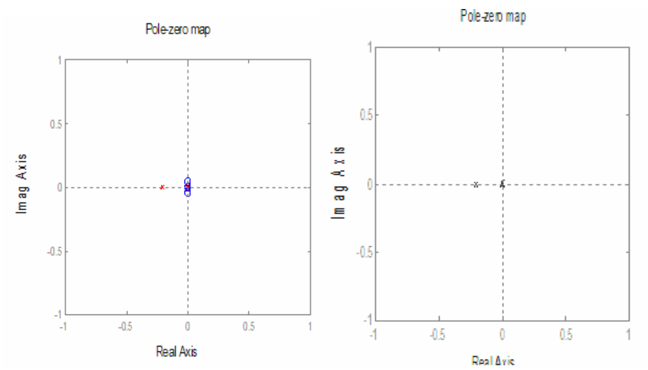
To pass parameters, and zeros pole function G_1 (Fig. 14a) and poly function G_2 (Fig. 14b), are placed in the complex plane as illustrated in Fig. 14.



a) b)

Fig. 14: Location of poles and zeros of functions: a) G_1; b) G_2.

V. The Control System Software

The control system interfaces with these components through hundreds of I/O signals and multiple communication protocols. The most complex part of the control system is the embedded control software executing the control loops. Because our software developers regularly release a new software version for the controller, we need to test the software to verify that these releases will execute reliably in the wind park's conditions. With every software release we perform factory acceptance testing before the software can be used in the field [15].

A. A Flexible Real-Time Test System Architecture.

The new test system simulates the behavior of the real wind turbine components by running simulation models for these components in the LabView Real-Time system to supply simulated signals to the system under test [20].

The host computer has an intuitive LabView GUI that users can easily adapt by moving the components in the panel. The Windows OS application also communicates with two external instruments that were not real-time compatible. The software on the host computer communicates with the LabVIEW Real-Time target in a PXI-1042Q chassis over Ethernet. LabView Real-Time runs simulation software that typically consists of 20 to 25 simulation DLLs executing in parallel. This solution can call user models built with almost any modeling environment such as the NI LabView Control Design and Simulation Module, The MathWorks, Inc. Simulink software, or ANSI C code. A typical execution rate of our simulation loop is 24 ms, leaving plenty of processing capacity to meet future expansion needs.

B. FPGA Boards for Custom Wind Turbine Protocols and Sensor Simulations.

There are a lot of custom communication protocols used in wind turbines because of the lack of existing standards. Using an NI PXI-7833R FPGA-based multifunction RIO module with the LabView FPGA Module, we can interface with and simulate these protocols. In addition to protocol interfacing, we are using the device to simulate magnetic sensors and for accurate three-phase voltage and current simulations. The

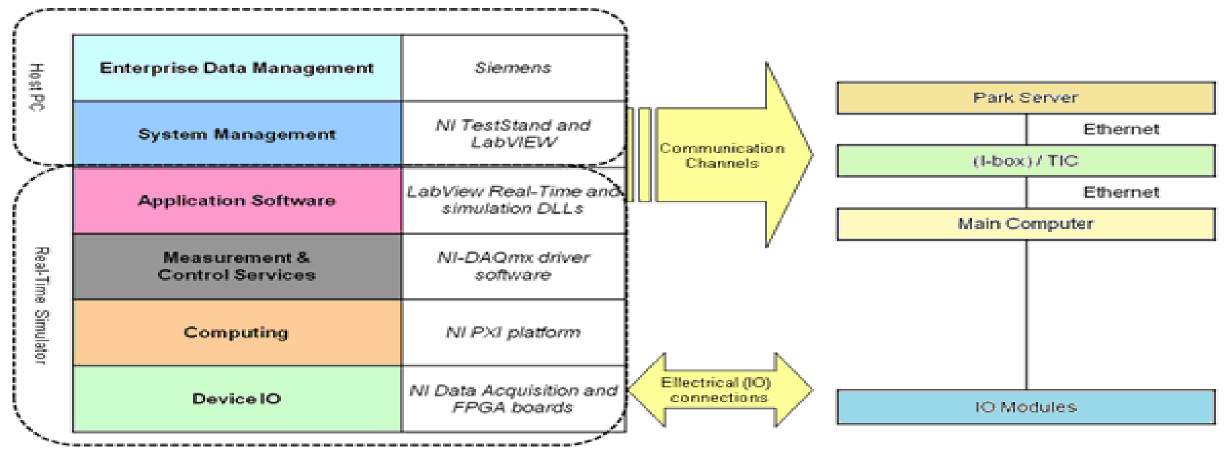


Fig. 15: The principle scheme of a unit of energy system.

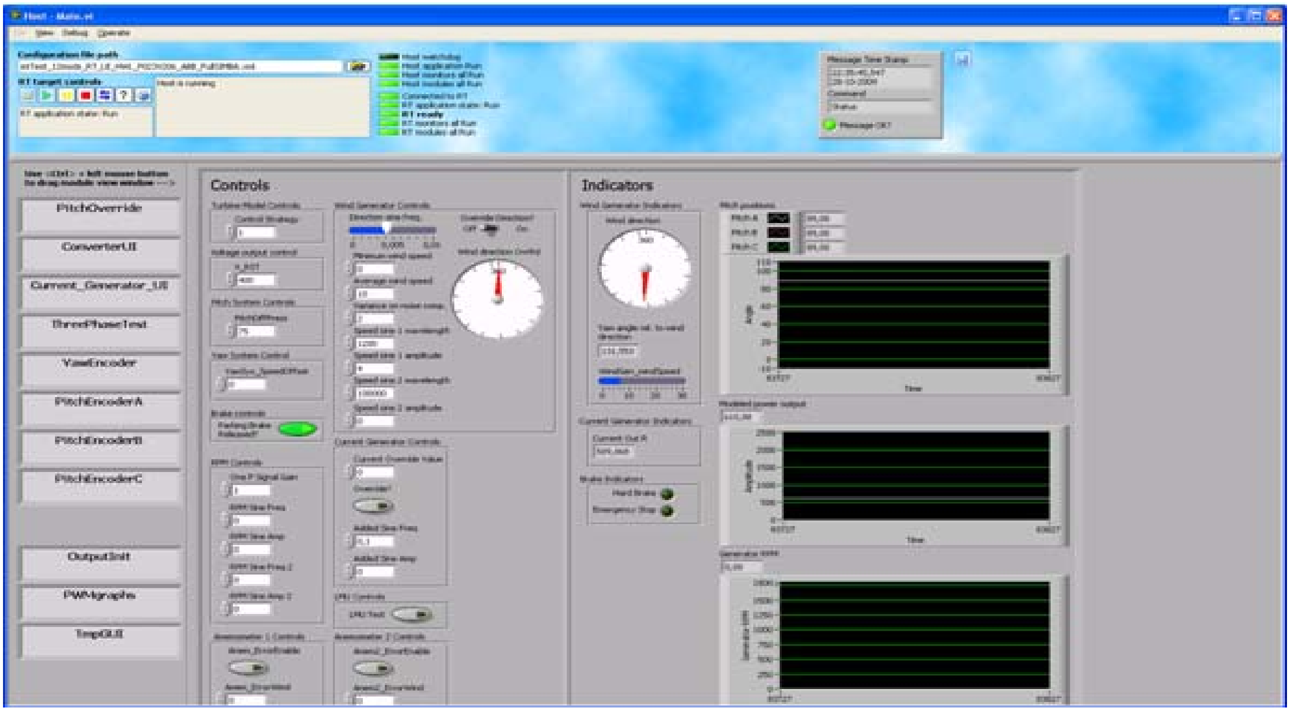


Fig. 16: The host computer has an intuitive LabView GUI.

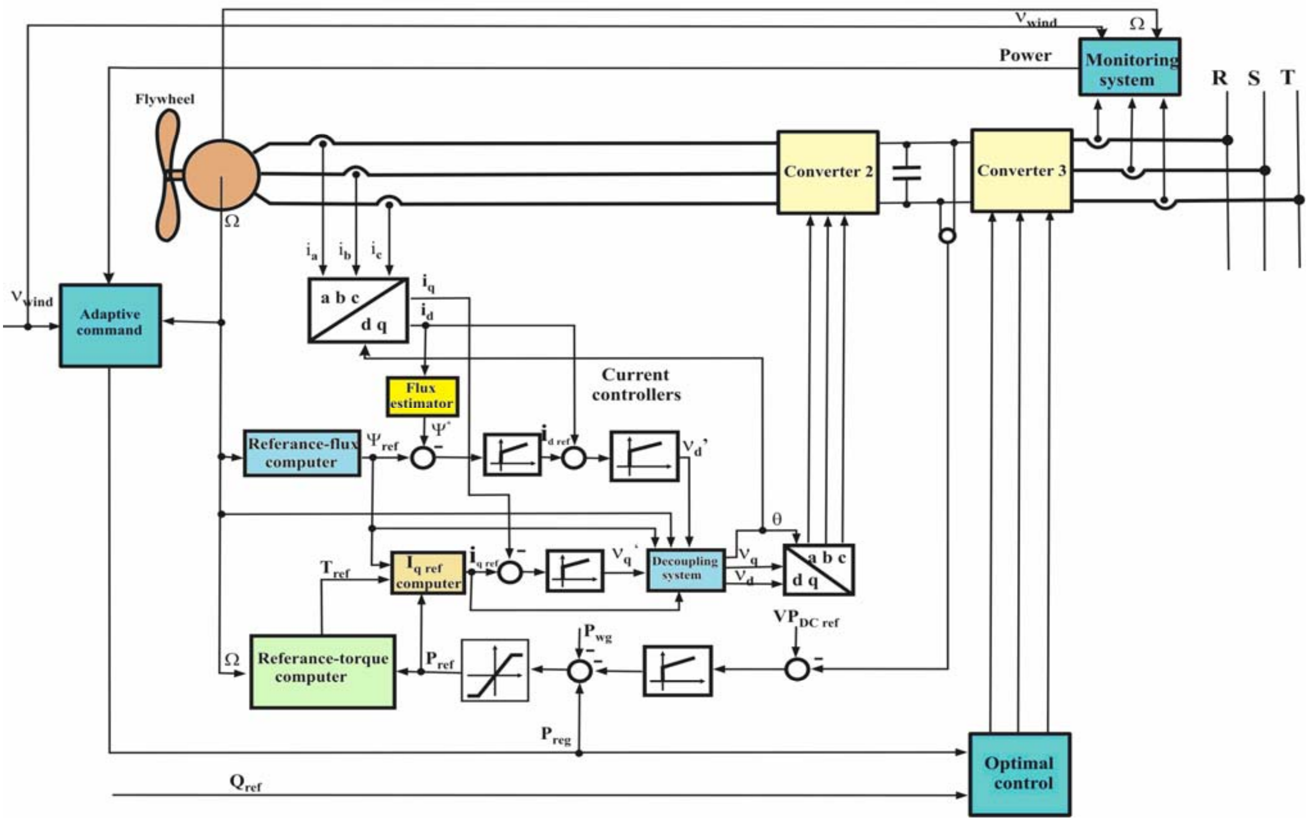


Fig. 17: The principle scheme of a unit of energy system.

other FPGA board is connected to an NI 9151 R Series expansion chassis to further increase the system channel count.

The structure will contain the converter (Fig. 17): electric generator, a converter 2 for converting AC power to DC power fluctuated, a converter 3 to obtain AC power transfer network, an adaptive control block take account of wind speed, turbine speed and power transferred to the network, an optimal control block, a block of energy transferred in network monitoring, real time processing of data on wind speed, the integration into a single system wind farm [16].

VI. Conclusion

The analysis of the paper is on the following:

It is noted that the function has 5 poles and 4 zeros. A pole is real and 4 poles are complex conjugates with negative real parts (for the parameters considered), so the system is stable - in fact the limit of stability (a calculation can be done in MATLAB with `roots(denG1)` - see file *eolian_1.m).* zeros are complex conjugate (the values considered), two having negative real part. The function has 5 poles, one real pole and 4 pole complex conjugates having zero real part (for the parameters considered), so the system is at the limit of stability.

It is clear that, without addressing the above-mentioned barriers, it will be difficult to promote sustainable wind energy alternatives and open the market. In this context, ENERO is committed to contribute, according to its objectives and resources, to the wind energy development in Romania. Identifying the barriers is a first, necessary, step.

The promotion of national land planning currently under way is expected to further facilitate investments in renewable energy systems. However, reaching the targets set for 2010 is still uncertain, unless additional measures and policies are undertaken, both institutional and technological. The institutional measures are expected to be implemented in the new legal framework, while technological actions such as the interconnection of the Northeastern Cyclades islands complex with the interconnected system are still to be decided and implemented.

The new Siemens Wind Power test system has several benefits over the previous generation solution. Because of the modularity of the system, it is easy to improve, adapt, and further develop. The system under test can be quickly replaced without any changes in the test system architecture. Remote control capability and simple replication of the system gives us the flexibility to copy the system to other sites as our operations expand.

The modular architecture allows us to scale-up the system to meet the growing requirements of rapidly evolving wind energy technology. We envision dividing the simulation to multiple LabView Real-Time targets to meet our future testing needs. We are also going to use NI TestStand to further automate test execution.

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