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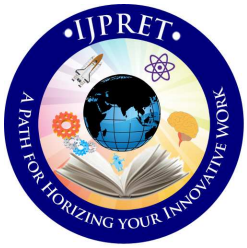

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CONNECTION CRITERIA OF WIND FARMS INTO TRANSMISSION SYSTEM

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Abstract

In this paper work the connection of wind Farms of larger sizes than 30 MW into high voltage (110 kV) transmission system is addressed. Taking into consideration the construction and application submitted to ERO for decision making of construction authorization. Given interest in construction and applications submitted in ERO for issuing the permits, it is necessary that Kosovo should complete connection regulations of Wind Farms in transmission and distribution system. In this paper are addressed the connection criteria of Wind Farm in transmission system into high voltage (110 kV) and sizes above 30 MW. In order to forecast the condition under which the technical condition will approach, the theoretical study has been performed taking into consideration current relevant regulations of Grids for Wind Farms in Europe, results of which are presented in this paper.

INTRODUCTION

With new laws within EU for renewable energy, the production of wind energy has been increased. Therefore, the new requirements relating to management of power system are based on conceptual solution of system organisation in the near future. Based on examples of managing with systems it is possible to foresee the development prediction of technical and regulatory rules related to connections of Wind Farms into transmission grid by analysing some planning aspects of the system. Among requests submitted by Energy Corporation, the same rules should be included also when it comes to the Wind Farms operators. Taking into account the assessment of wind potential in Republic of Kosova and extensive requirements for investments in this field, it is necessary as soon as possible to compile the technical conditions of Wind Farms connection in transmission system. Kosovo has a good potential of renewable energy sources. According to the preliminary results of modelinf wind power in Republic of Kosovo there are many places with average wind speed of 6 m/s.

RENEWABLE ENERGY IN KOSOVO

In March 2007, the Heads of States and Governments of the 27 EU Member States adopted a binding target of 20 % renewable energy from final energy consumption by 2020. Combined with the commitment to increase energy efficiency by 20 % until 2020, European political leaders paved the way for a more sustainable energy future for the European Union and for future generations. Based on this, the strategic aim of Kosovo Policy is also to achieve these goals.

Plans for generation capacities from renewable sources are promoted and supported by Ministry of Economic Developments, respectively by Government of Kosovo Program for a clean and efficient energy. In this program are also determined the indicative targets for energy amount which should be generated from renewable energy. It is foreseen to be build a large number of small Hydro Power Plants (>16) with a capacity of 140.3 MW up to 2020.

The amount of consumption from renewable energy until 2016 is determined in the document “Administrative Direction.

No. 06/2007 on indicative targets for consumption of Electric Energy and Heating from the Renewable sources and co-generation", issued from the Ministry of Energy and Mines. These indicative targets may be seen in table 1.

Following the document in question, in 2016 is foreseen a consumption of 230. 39 GWh energy generated from Hydro Energy. Significant participation in generation of the energy from renewable sources is foreseen to be from wind generators, while by the end of 2020 is planned to be installed up to 141 MW wind generation capacity with estimated average load factor of 0.25.

In 2010 in Kosovo, Golesh hill, are installed first three wind turbines with an old technology (ansicron generators with a constant speed). These turbines are connected to the 10 kV voltage level and each of them has an install capacity of 0.45 MW. On the basis of forecast production that has been given, those three units can generate about 2.59G Wh / year, resulting in a load factor of about 0.22.

In Kosovo, there is no special institute for wind measurement, but there were willingness of potential investors to make the measurement of wind potential in certain areas of Kosovo.

Construction of Plants that will use biomass and urban waste as a fuel is projected to occur by 2012, with the progressive development of capacity to 16.5 MW in 2020. While lower development is anticipated in the electricity produced by solar panels as a result of the high cost of this technology. Figure 1 shows the share of categories or types of renewable energy sources to total production from these sources. The average energy production by renewable technological species for the period 2015-2020 is presented as follows:

- 60 % from small HPP, 30 % from Wind,
- 9.8 % from biomasa, and
- 0.2 % solar pannels.

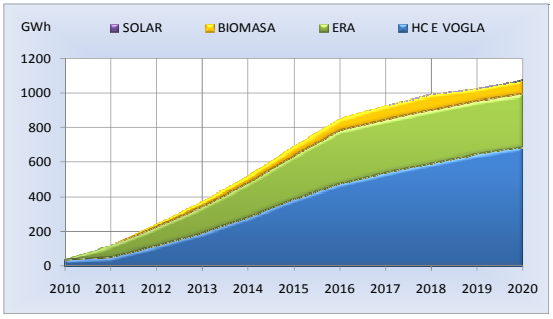

Figure 1 Participation according to type of renewable sources

APLICATIONS FOR CONSTRUCTION OF NEW GENERATION CAPACITIES FROM RENUWABLE SOURCES IN KOSOVO

The table below shows that there exists a huge interest for construction of new generation capacities from renewable sources. From the Applications, there are Companies interested in building of renewable capacities of 158.25 MW.

According to the measurements performed in some locations in Kosovo in construction of renewable sources (Bajgora area), there is an optimal wind speed for Wing Farms. The preliminary measurements are also taking in other areas in Kosovo as: Krajkovo, Skenderaj, Kamenica and in Novoberdo (in the souranding of Prishtina). All this means that we should be prepared for a greater penetration of Wind Farms in distribution and transmission system in the near future.

NEEDS FOR NETWORK CODE FOR WIND FARMS IN TRANSMISSION SYSTEM

Network codes are mostly sufficient for implementation in most cases related to the power system. Among others, to describe technical obligations of generators connected to the system.

Network codes have been developed taking into account the dominant types of generators in the system, i.e. for synchronous generators which are used in TPP's and larger and large HPP. While network codes, in general, are not designed in that way to exclude or discriminate against any type of generators, their rules are usually defined taking into account the power plants and conventional HPP. Given the recent filing of requests for connection of Wind Farms in transmission system is evident that existing general network codes are not adequate for many reasons which will be explained in the following:.

There are two aspects in analysing of this problem. First, there exists the need of providing of the new criteria corresponding connections that define the technical aspects of Wind Farms connection in the transmission system.

Second, there is a need for the new certain criteria of connection that defines the technical aspects of Wind Farms in transmission system. Afterwards, those new

Criteria should be compliant to the context of wider application of existing network codes. Established criteria should enable the operation system to fulfil its obligation and duties defined during issuing of licences for performance of its activities. From the changes are expected to be defined some basic direction:

• Be consistent with the main goal for a open access of the transmission system;

• To be created a constructive technical basis for connection and guidance of Wind Farms without unnecessary obstacles; and

• To avoid discrimination against users of transmission system.

Up to now is clear that the requests that require current network codes have some disadvantages in terms of connection and guides of Wind Farms:

• Lack of requests required by producers with asynchronous output;

• The failures of the Wind Farms are not possible due to their construction plan;

• The technical data of Wind Power will have large impact in working security of entire Energy System;

• Allowing connections on an individual basis is not transparent; it is potentially discriminatory and may cause inconsistency in approach;

• Without imposing the minimum technical requirements will be presented obstacles of asynchronous resources due to the necessity of maintaining the required level of security and stability.

Wind Generators are different from synchronous generators for why it was passing through the network codes audit period. Has come to a gap between, on the one hand, the expectations of operators and planners what can make in the future of Wind Farms and the other hand the meaning of Investors for the needs of the system operator and planners. In resolving these problems the network codes for wind power are planning the important roll.

Usually are developed two types of network Codes for Wind Farms: one type has to do with the inclusion of Wind Farms in transition system (nominal voltage ≥ 110

kV), and the other kind of distribution network (nominal voltage ≤ 35 kV). Nowadays requirements for Wind Farms network codes found under a permanent (continuously) revision. Wind Farms with larger size (e.g. 50 MW) today directly involved in the transmission network (nominal voltage ≥ 110 kV). Connection criteria's of Wind Farms in transmission system in the form of codes actually represent network transmission system preparations for the arrival of larger Wind Farms.

In applications which arise in this field should also be seen as a precedent because of which comes to a change of network codes. Bringing special treatment Wind Farms in terms of network codes can cause the occurrence of other groups demands of system users (existing and new) to bring changes in the existing network codes in order to adapt their individual needs. It will be very difficult to explain other specific users that Wind Farms should be treated in another way. Some examples have been noted in European practice where some user groups have sought to take into account their requests as "special" requirements.

Among them are:

• Co-generation sources (CHP);

• Very small generation sources;

• Nuclear generation sources, and

• New conbinated generation Units (gas and steam combined cycle units). (CCGT).

Mainly requests for special treatment of a certain type of producers related to achieving competitive advantage and reducing production expenses. Then it is necessary to analyze a system operator can take advantage of the rules of the Network Codes in order to distribute a portion of its expenditures in other utilizes. Bringing continual changes and additions to the rules of the Network Codes and its process of electricity market liberalization makes it difficult to compare or evaluate already complex connection rules. Requirements in Network Code regarding connection of Wind Farms in transmission system are demonstrated in the following chapters will be shown in summary form that based on available documents.

Summary is obtained based on the award of European systems operator's requirements as ESBNG (Republic of Ireland), TSO Scotland (Scottish Power and Scottish Southern Energy), NGC (England and Wales), ELTRA (Denmark), Eesti Energia (Estonia), MEAGE and leads NETZ (Germany). Numbering requirements above are the most serious and distinguished by all who are watching during the writing of this article. Comparison of existing Network Codes for Wind Farms network can be useful in the accomplishment of the following tasks.

- Choosing or reduction of speculation regarding connections of Wind Farms which on the one hand appear to investors (or their representatives) and the other to the system operator.
- Help Producers of Wind Farms for better understand of the existing rules, in order to develop new strategies of management and hardware selection.
- Explanation of the relevant issues in those countries, regions which are still in the design phase of the criteria for connection of Wind Power in transmission network in order to harmonizes the international criteria.
- Understanding the differences between national codes regarding the connection, and this can help to harmonize the criteria in European leve.

CONNECTION CRITERIA OF WIND FARMS

All connected Wind Farms should fulfil requirements set by Network Code. Network Codes were originally created in template form which treates exclusively synchronised generators. Because Wind Turbines does not fulfil ërkesat e Kodeve të rrjetit. Due to the fact that Wind generators do not have the same features as synchronous generators, it is necessary to create a new set of technical criteria for connection of Wind generators in transmission system. So, the primary goal is to create numerous technical rules which Wind Generators must meet in order to be connected in the transmission system (≥ 110 kV voltage level). The group must contain the minimum criteria set by system operator to the producers of those generators.

Hence, this paper has attempted to initiate compilation of technical criteria proposal for connection of Wind Generators to the transmission system. Further, it is necessary that professional coordinated activities within the topic raised that initial proposals should be agreed between the parties and to design adequate standard which will enter into service in Kosovo's power system in the way it sees system operator. Proposal and eventual standard criteria should be drawn up in accordance with the existing Network Codes.

The aim of Technical criteria is to maintain the most important features of the SEE work, as security of supply, reliability and quality of electricity supply in both short as long term. Along with common network codes should contribute criteria optimal allocation of resources. This among other things introduces the need to balance demands that occur before producers from various generation sources. Idea of the criteria is to create the necessary conditions that will enable the use of some characteristics of Wind Farms in order to contribute to maintaining the security of the whole system. How and to what extent can use those features and what are the consequences in terms of the economic side, there are questions about the next stage of study of this issue on which attention should be paid to various aspects of leadership of the whole system. It is important to pursue the development of those Wind Generators features which supposedly contribute to the reliability of the power system work. Such requirements will probably be contribute to compatibility of power system and this will allow a greater penetration of Wind Farms in SEE.

Building large aeroelektranave probably would dramatically change the properties of the SEE. Major expansion, so far, partly unfamiliar technologies in small systems, will result in a greater number of requests and will be a challenge for the leadership of the working of the system with sufficient certainty. It's hard to find a similar expansion of experiences which will be used in SEE. These criteria are therefore based on models and applications limited experiences so far. It is expected that the criteria will change a lot based on the speed of technology development in the field of Wind Energy. Also, it is necessary to expect

that the features of the power system will change, so will raise the level of knowledge that is gained experience under major expansion of larger Wind Generators. In many countries with a Wind Generators are usually involved in the transmission system (110 kV), with which may have relatively small power of short circuit. When planning the development of Wind Farms in such broadcast systems is necessary to analyze some important issues. Among them are, for example, practice of connection to the transmission system, system integration, strengthening the system for about the construction of the equipment necessary to command the system stability. Small Wind Farms usually do not participate in frequency and voltage regulation, but in the event of the occurrence of the disorder most often stop and then connected again after creating the conditions for normal operation.

However, overall growth of Wind Farms construction affects the behaviour of the whole power system hardening significantly leadership under the command system work only with large manufacturing resources. Clearly, the rate of Wind Farms which comes not to influence the behaviour of the overall power system is significantly dependent on the characteristics of each system separately which are assessed according to the level of short circuits, and the ability speed command with the active and reactive power output monitoring level and delivery system. Therefore, in planning of larger Wind Farms construction attention should be paid to the study of detailed analysis of the system and study designs in order to find technical and economic solutions to those problems.

System operators more often specify functional requirements which wind Farms need to meet. In some countries, such requirements are already specified in its entirety including the definition of response in active and reactive power control, in terms of possible failures. Some of the requirements can be very difficult or very costly to construct the larger Wind Farms. However, for security reasons, those criteria should be taken into account during the construction, replacement or expansion of those Farms.

Properties which will be saved with the implementation of these criteria is

necessary to be inspected and maintained properly throughout the life of Wind Farms. The following are given the criteria which should be applied:

- Wind Farms connected to the transmission system.
- Wind Farms which are connected to the grid but are larger than are described before.

Taking into consideration the rapid development of wind utilization, from Wind Farms is expected their support to transmission system. Wind Farms connected so far is based on the idea that if it comes to transmission system disorder (e.g., voltage depressions), with be immediately stopped. In this case, in a wide area of the transmission system (caused e.g. by short circuit) can cause stoppage of all Power Farms in the region. This means that in extreme cases can quickly lose hundreds of MW of active power from Wind Farms. In such extreme cases it is possible to present the phenomenon of supply shortage to customers throughout the region which has affected disorder. New requirements intended to avoid such negative scenarios. It is necessary to establish criteria taking into account the different technology and wind energy utilization characteristics, problems associated with modelling in system stability studies, and finally the problems that are associated with the properties of Wind Farms.

Technical criteria of Wind Farm connection in the networks should be based on existing experience and regulatory obligation in different countries. They are known five main fields of technical criteria should be included with a purpose of integration of Wind Farms connection in transmission system:

- Requirements in terms of frequency,
- Requirements in terms of voltage,
- Requirements regarding passage throughout fault condition,
- Requirements regarding quality of delivered energy, and
- Requirements regarding signalisation, communication and command.

These five key criteria are considered as key areas in which the submission of Wind Farms differs greatly from submission of

other network users. In addition to the five main areas mentioned is likely that there will be need (if not must) be set criteria for some areas such as verification and testing of Wind Farms before commissioning or setting minimum size of Wind Farms for which will be necessarily applied. During establishing of detail rules for SEE planning may need to define requirements related to computer modelling of Wind Farms and include standard package modelling for system analysis program.

Some system operators have already prepared new technical criteria for connection Wind Farms in the transmission system, and that consultation with manufacturers, and measurement and organization institutes. Wind Farms manufacturers have already begun applying those criteria measures. Although in some cases it is necessary to make changes in electrical parts of Wind Farms, some manufacturers have already announced that their Wind Farms meet new requirements for connection. European systems operators have gone very far in the preparation and application of technical criteria. Below is given the comparison with the existing bilateral technical criteria for connection of Wind Farms in the transmission system. Advantages of comparison of specific criteria are required to be used for the purpose of establishing initial technical criteria that must be developed and applied in the Republic of Kosovo.

REQUIREMENTS OF EUROPIAN OPERATORS REGARDING FREQUENCE

Key elements in the field of frequency / active power that appear in terms of connection aeroelektranave in the system are:

- The range of frequency generation during normal operation and during disturbances;
- Wind Farms features in the entire band of frequency changes in the system;
- Participation of Power Plants in order to regulate the frequency and command with active power;
- Change speed of power generation of Wind Farms; and
- Providing back-up power by Wind Farms.

Table 2 contains comparative values of the range of frequencies which are given expected working condition of Wind Farms in those European countries in which exists network rules for Wind Farms. In England, Wales and Scotland frequency range in which the normal work required for Wind Farms is very similar. Requirements of Network in Ireland for Wind Farms differ very little. System on the continental part of Europe range of the frequency is slightly smaller than the British, and is to be expected considering that the system frequency deviation on the continental part of the Europe is not as great and frequent as in Britain. In Scotland by Wind Farms also required to contribute to the reduction of the frequency when they rise above 50.4 Hz. These requirements are independent of the requirements set out in frequency regulation cases that must be met at all times.

In Table 3 are given the requirements which are given regarding in the regulation of frequency and active power production in some European countries system. Although in the current condition, from Wind Farms are expected a limited response to frequency, Wind Farms in Scotland and Wales this condition meet since 2006. In Scotland and Germany, over a certain frequency generators required generators of Wind Farms automatically reduction of output power with the aim of helping to reduce high frequency. In Scotland this condition came after 2004. And for all Wind Farms above 30 MW. In Ireland and continental countries (Germany, Denmark and the Netherlands), is also required response from Wind Farms to change the frequency. Ability of Wind Farms to keep responding frequency performance but is applied to Wind Farms which are involved recently in Europe.

REQUIREMENTS OF SYSTEM OPERATORS REGARDING VOLTAGE

The main requirements related to voltage transmission system in which key Wind Farms dealing with deviations and voltage changes, automatic voltage regulation and reactive power production capacity. The system operator forms Wind Farms recommendations taking into account all the aspects mentioned. In addition, set the demand for elevator transformers which are located in Wind Farms connection with

transmission system, i.e., the maximum permissible voltage change. Wind Farms generators should also contribute to the regulation of system voltage. Requirements laid twofold: on the one hand, taking into account certain voltage deviation which must be held in connection node Wind Farms in the system and on the other hand taking into account the level of fixed compensation of reactive power, i.e. the exchange of its system. Claims submitted by the states analyzed in terms of reactive power compensation are defined with distortion and power factor are shown in Table 4. In most of the applications submitted, power factor is defined or its registration capacity of Wind Farms or within the deviation of total power production. Ireland requirements specify that the same reactive power output (MVAR) Wind Farms which deals with registered capacity should be available under the registered capacity. Mutual comparison of the requirements of which are set out in terms of reactive power results in the knowledge that they Wind Farms as more resemble conventional power plants (large number of construction and connection to the transmission system) they are required to work in a greater range power factor.

REQUIREMENTS OF EUROPIAN SYSTEM OPERATOR REGARDING TRANSFER OF WINT FARMS INTO FAILURE SITUATOION

Farms in case of occurrence of disturbances / failures in the system are extremely important because it is necessary to know the impact of large Wind Farms connection in the transmission system, as well as their behaviour during disturbances how short links in the system. With increasing Wind Farms sizes increases the importance of their ability to pass through the state of corruption in the system (without disconnection) in a similar way as synchronous generators that are replaced. For this reason should be defined enough skills of Wind Farms so that it does not have a negative impact on transmission systems and other users. Ability required by Wind Farms in terms of presentation of the break in transmission system commonly called Wind Farms crossing skills through the transmission system fault condition. Stability work of Wind Farms, protections systems, modelling preconditions of Wind

Farms in transmission situations, behaviour of Wind Farms in transitional situations failures are just some of the reasons due to which system operators shall submit their requests.

Ability of Wind Farms crossing through external fault condition in the system is an aspect which should be taken into account when defining the inclusion criteria. So, it is necessary that the network code of Wind Farms include written conditions enduring failures in the transmission system. Without this ability to come to the increased risk of disconnection of customers in a wide area after a breakdown or would come to a serious restriction building the Wind Farms in the future in the same area.

European Operator's requirements are presented in Table 5 in terms of passing ability of Wind Farms through fault condition. It is very important to note that different operators run different systems and the requirements of each of them are set taking into account their system.

REQUAREMENTS OF EUROPIAN OPERATOR SYSTEM TAKING AS A BASE SHORT CIRCUIT AND QUALITY OF SUPPLIED ENERGY

Quality of electricity supply which is assessed on the basis of short circuit calculated in connection noodles of transmission system is a particularly important aspect of the connection and operation of Wind Farms. It is important to realized that Wind Farms have a impact on the system users (especially those who are near) which should be supplied with energy. For this it is necessary to establish which steps to avoid the deterioration of quality in the transmission system after connection at Wind Farms. Evaluation of the quality of energy supply is based on many aspects of which the most important are:

- Voltage disturbance in the lower frequencies.
- Rapid Shifts voltage (or fluctuations): Quick single financial changes effective voltage value at which these changes have an extension (e.g. notified during connections of Wind Generators
- Quality assessment of energy supply is performed based on many aspects from which the most important are:
- Flicker Emissions: voltage disorder in low frequency areas.

- Rapid voltage changes (or fluctuation): quick single changes of voltage effective values tension it during which these changes have extension (e.g. announced during operation with Wind Farms generators),
- Harmonics: periodical disorder of voltage and current with frequency of 50Hz (n full number).

Scotland and Denmark (ELTRA and ELTRA&ELKRAFT) establish rules regarding quality requirements at 50-60 kV systems in which the voltage change must be <3% of the nominal voltage at the connection point of aeroelektranës in the system. Danish ELTRA also represents additional demand rapid changes in terms of frequency of voltage changes (for frequencies up to 10 times per hour <2.5% for frequencies up to 100 times <1 .5%). According to the ELTRA & ELKRAFT rules required the definition of special requirements regarding Flickers emissions and harmonics in the short and long time periods.

Swedish Requirements respond Danish rules DEFU who like VDEW German rules include requirements and limit values which must be met in connection in Wind Farms in the system. Danish rules, however, require the use of quality characteristics according to IEC 61400-21. Unlike VDEW rules, DEFU Danish rules do not require measuring quality by an independent institute. Relevant information provided by the manufacturers of equipment of which also depends on the choice of method of determining the quality of its aeroturbinës generator. Ideally, the quality is measured according to IEC rules taking into account the requirements of the regulations by DEFU. Then, the equipment manufacturer can use data from those measurements for quality assessment. Similar to German regulations,

IEC61400-21 present Wind Generators quality parameters that should be measured by measurement methods. IEC also requires measuring flikerëve, harmonics, and apparent power, power factor during normal operation as well as power fluctuations and flickers during operations. In case it is necessary to make a final choice, most often proposed to be followed IEC rules than German regulations. Although the methods of measurement and

evaluation according to IEC rules are similar to those in Germany, results may vary significantly. To some extent this comes because of the use of different extensions of periods and evaluation method which in some cases have significant impact on results.

REQUIREMENTS OF EVROPIAN OPERATOR SYSTEMS REGARDING INFORMATION SIGNALS, DATA COMMUNICATION AND CONTROL REQUIREMENTS OF WIND FARMS

Technical connections of Wind Farms in transmission system includes also signal, communication and control be foreseen that communication system should be performed for each Wind Farm. The owner of Wind Farm is responsible r çdo aeroelektranë veç e veç. Wind Farms owner is responsible for the provision of signals necessary for the operation of the power system. In addition to active and reactive power can be sought other signals as status of Wind Farms and wind speed at the location of its construction. Questions dealing with signals, communications, and control for Wind Farms connection to the transmission system are:

- Command signals from the system operator in direction of Wind Farms;
- Active power production forecasts - statement.

Unlike other aspects which were discussed earlier, the requirements regarding communication aeroelektrana are very similar in all documents reviewed. All rules require the availability of signals voltage, active power, reactive power, and status work aeroelektranave. Scotland, Denmark (ELTRA) and Ireland (ESBNG) also require the availability of wind speed signal. As additional signals, Scottish rules seek direction signal in real time wind speed and frequency control status (connected / disconnected), as well as information on disorders that cause stopping and releasing back Wind Farms within 15 minutes. Similar rules Scottish, Irish rules require wind direction and temperature and air pressure in real time. Swedish rules (SVK) require aeroelektranat information for regulatory capabilities. Ireland (ESBNG) and Germany (EON NETZ) require information about the position of the tap of the transformer through which Wind Farms is connected to the transmission system. Besides the

mentioned signals, which are sent by Wind Farms, according to some rules also set requirements regarding the ability of Wind Farms command from outside.

Swedish rules (SVK) and Danish (ELTRA, ELTRA & ELKRAFT) file additional requirements in terms of command ability. Wind Farms with larger size than 20 MW requires local control functional ability manual or remote command within 15 minutes after the occurrence of the failure in order to enable the system sharing, connection and command system with active and reactive power output. ELTRA and ELTRA & ELKRAFT require the realization of the possibility of connection / trip Wind Farms from external system.

REQUIREMENTS OF EVROPIAN OPERATOR SYSTEMS REGARDING COMPTER MODELING OF WIND FARMS

Forecast of interactions between Wind Farms and power system in terms of the appearance of faults in the system, usually is done by making computer simulations. In order to create the necessary prerequisites for performing simulation Wind Farms owners require system operators to provide adequate models of Wind Farms which are necessary for numerical analysis. Control device Wind Farms model by recording the responses feature of Wind Farms in network disturbances should also be installed.

Scottish and Danish (ELTRA) rules require detailed documented models for Power Plants which are consistent with the results of similar power plants testing prototypes. ELTRA plus requires models for each Wind Turbine if Wind Farms contains different types of Wind Farms. Scottish and Danish (ELTRA) rules in order to verify the model requires the installation of equipments for recording quick response in terms of failures. Variables, which is necessary responses are recorded according to Danish rules (ELTRA) are voltage, active power / reactive power, frequency and current at the connection point of Wind Farms in the transmission system and voltage, active power / reactive power and speed for each wind generator installed aeroturbinave in Power Plants. Variables, the answers of which shall be recorded by Scottish rules are current through all phases, voltage phase and wind speed. Swedish rules (SVK)

require data documented technical details. Since in this field in accordance with the rules Irish (ESBNG) mainly apply the same requirements to Wind Farms as conventional power stations, modelling aspects of Power Plants in Ireland are not yet worked out in detail. Rules Danish (ELTRA & ELKRAFT) and German (EON NETZ) also do not treat Power Plants modelling although it is expected in future revisions.

CONCLUSION

Most set requirements can be met with less improvement of Wind Turbines, regulatory program support systems and eventually electronic circuits (hardware). In addition, most of the costs related to the development for why it was made irrelevant in the context of serial production. The hardware of interest has to do with communication system within Wind Farms and that in terms of the system operator and mobile system. Part requiring foremost has to do with keeping the angle and voltage stability in transitional periods and electromechanical aeroturbinave manufacturer required extra effort. The duration of the fall of pressure is one of the critical issues for which the operators of the system must be very careful when submitting claims. Wind Turbines constant speeds of rotation have technical deficiencies, but it seems that they will be able to meet the requirements as to add auxiliary equipment inside Wind Farms. In fact their technical deficiencies can be turned into an advantage in terms of cost. Therefore, it is best to specify the technical system operators rather than production technology.

It is not reasonably to be requested to be fulfilled all mentioned of smaller Wind Turbines respectively by Turbine Units. In particular it has to deal with system requirements (e.g. frequency regulation and shift speed of generation power). From system operator can be to accept smaller Wind Farms (under a certain size) that do not meet the requirement until their size does not exceed certain power. Existing power plants should belong to this group.

Wind Farms functions with an application of which they lose a certain amount of generation power is economically reasonable to be applied in some other energy sources making the last Wind Farms

in the series where the producers will apply. System Operators can request the establishment of the controlling system of the Wind Farms from the HQ or other places with excellent communication with Wind Farms. Smaller projects are not obligatory to have direct remote control.

Many of the previous functions cannot be tested in the location of the building in the manner already used by the system operator upon connection of conventional manufacturing. This is partly due to the specific conditions of the air and partly because Wind Farms consists of a large number of generators turbines which is necessary to test each individually. Is more reliably than the typical tests will be entrusted to third parties for some of these functions. If this does not require the system operator, it is certain that these requirements will require and complete construction by producer in order to avoid any risk of non-compliance with regulations and codes.

As conventional sources productive aeroelektranave owners are required to submit aeroturbinave model and regulatory systems in use of the system operator which requires making various System simulations of the entire system. Specifically for the application requirements of the break, the system operator must compare with simulations of a power behaviour normal conditions. If normal behaviour of Wind Farms differs considerably from the forecast, Wind Farms owner may have financial consequences and Wind Farms can be disconnected from the system. With this purpose, the system operator can install equipments for recording of behaviour in terms of the disorder.

By now many systems operators have adopted different sets of technical requirements for connection of Wind Farm known as “Network Regulations for Wind Farms”. Network Regulations can be divided into three groups. First should be compiled the technical condition for connection of smaller Wind Farms in distribution system (35 kV), and then for larger Wind Farms in transmission system (110 kV). And at last technical conditions for operation with system in terms of high penetration of Wind Farms.

No.	Energy Sources	Indicative targets for energy generated from renewable sources (GWh)									
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	Hydro	125.84	134.56	145.03	156.31	167.01	178.40	190.50	203.18	216.67	230.39
2	Wind	0.00	0.00	0.00	32.56	68.73	108.51	151.89	199.80	252.14	309.94
3	Solar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	Biomass	0.00	0.00	0.00	0.00	11.63	17.45	19.77	23.26	29.08	29.08
TOTAL		125.84	134.56	145.03	188.87	247.37	304.36	362.16	426.24	497.88	569.40

Table 1

Table 2

Requirements of some Europian countries taking into account the range of frequency deviation

Country	England/Wales	Scotland	Ireland	Germany	Denmark	The Netherland
Frequency Range	47, 0-47.5 Hz -20 sec. 47.5-52 Hz frequently	47-47, 5 Hz 20 sec. 47,5-50,4 Hz frequently 50,4-52 Hz reduce the minimum speed power up 2% of the power output of the AE from 0.1 Hz frequency deviation over 50 Hz system	47-47, 5 Hz - 20 sec. 47,5-52 Hz 60 min. 49,5-50,5 Hz frequently the power should be stored in changing power system frequency to 0.5 Hz	47,5-51,5 Hz frequently	47-47,5 Hz 20 sec. 47,5-48 Hz 5 min. 48-49 Hz 25 min. 49-50,3 Hz frequently 50,3-51 Hz 1 minute Mbi 53 Hz disconnection	48-51 Hz frequently

Table 3
Requirements for participation of Wind Farms in regulating frequency / active power in Europe

Country	England/Wales	Scotland	Ireland	Germany	Denmark	The Netherland
Frequency regulation	Full capability of Wind Farms response to requests for frequency	Ability of response to the condition of frequency: AE 30 - 100MW since 2004 On the frequency 50.5 Hz power output must be reduced statistically by 10%	Frequency response capability required by reducing active power production and power curve adjustment and frequency category aeroelektranat> 5Mwdhe > 10 MW	Limited work of Wind Farms based on frequency 50.25 Hz frequency of Wind Farms should be included in discharge mode statically 40% (from 2002)	The working skills of Wind Farms are required in terms of frequency	The contribution of the primary control of Wind Farms required limitations present leadership strategy and wind conditions.

Table 4
Power factor requirements of Wind Farms in Europe

Country	England/Wales	Scotland	Ireland	Germany	Denmark	The Netherland
Range of power factor	Power factor connection point in the network Cap. -0.95 0.95 ind	0.95 cap.- 0.85 for all types of Wint Farms	The same amount of MVAr reactive power to produce and spend between minimum and maximum load before than be restricted on the basis of power factor	0,975. cap. up to 0,975 ind in connection point	Neutrality in terms of reactive power connection node (zero reactive power exchange)	0,8 kap- 0,85 ind in connection point

Table 5.

Requirements for ability of Wind Farms passing throughout failure situation in Europe

Country	England/Wales	Scotland	Ireland	Germany	Denmark	The Netherland
Ability of passing through the fault condition	Wind Farms must remain on the operation in terms of short circuits in three phase solid 400 kV and 275kV for the time up to 140 ms. Productive the power must not fail the Wind Farms	Wint Faults should resists the faults in the transmission system 123 kV and higher which courses voltage decrease 0%	Wind Farms should be able to operation for voltage decrease from 15% in time up to 625 ms and to stay in direction of improvement of voltage up to 3000 ms	Wind Farms should be able to operation for voltage decrease from 15% from nominal value for at least 680 ms and to stay in direction of improvement of voltage up to 3000 ms	Wind Farms should stay in operation during transition process of three and two phase connection with inability to be reconnected in failure situation	Wind Frame may not be able to be disconnected at 0% in a time of 100 ms

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