DISTRIBUTED GENERATION, CONDITION FOR USING WIND ENERGY IN THE SOUTHERN KHORASAN PROVINCE, MAINTAINING AND CONVERTING WIND TO THE COMPRESSED AIR

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ABSTRACT

Restructuring in Iranian Electric Power Systems has been caused focusing on Renewable Energy Sources in these systems more than before. Distributed Generation (DG) units may have various effects on the Electrical Power Systems according to their specifications, conditions of operating, and the location of installing. What declares nowadays in this field, is finding the correct location, method of generating power, and the way to connect DG units to the National Grid. In this research, an introduction of DG, its advantages, and the conditions for using DG units in Iran has been discussed and also a survey on Wind Energy in the Southern Khorasan Province and subsequently the usage of Compressed Air in storing Wind Energy have been discussed and analyzed.

INTRODUCTION

DG is generally stated as generating electricity in the regions which are near to the customers, but sometimes technologies that use Renewable Energy Sources are called DG as well. The utility of these kinds of energy considering the environmental factors, using in different conditions, variety, and being near the consumers have caused the increasing growth of these energy sources by the energy deliverers. Wind energy is one of the sources that can be found in most of Iranian areas in some seasons or in the whole year.

PROBLEM DEFINITION

The definitions presented for the DG is somehow different. IEEE has defined the DG as the power generators which are smaller than the central power plants and can be installed near the consumers. According to IEA, DG units are the power generators near the consumers or inside the distribution networks that deliver the power directly to the local grid. CIGRE adds the condition of non-dispatching for these kinds of generators that is called to the generating units which deliver a power less than 10 megawatts and can be connected directly to the distribution networks or to the customer units.

Advantages of using DG units

Using DG units may have not economical benefits in some situations, but other factors rather than economical factors are important in utilizing this kinds of energy sources so that they can justify the essential of applying this types of energy sources. Some advantages are as follows: emergency electrical power generation, power quality and reliability, Combined Heat and Power (CHP) units, peak clipping, environmental and ecological issues, and so on.

DG technologies via renewable sources

Technologies such as wind turbine, solar cells, fuel cells, tide energy, and geothermal are used for generating power in DG units.

Considering the existing potentials, and the reason for notice to DG technologies in Iran

Like other countries around the world, Iranian government has intended to invest in the field of research, commissioning, and installing DG units in order to fulfil its long term plans. The most important reasons and essentials for this idea are as follows:

a) the increasing growth in energy consumption and lack of extra energy sources for adding
b) necessity of investment in energy sector by private companies in order to decentralize the governmental directing
c) essentials of competitions in the Market
d) low liquidity for investing in new sources
e) focus on environmental issues in the future decades and improvement in power quality and industrial productivity
f) notice to the variety of energy consumption in energy generating sources
g) using the existing capacities in different sections
h) decreasing losses in transmission and distribution networks

Potentials for DG sources in Iran

Table1 shows the existing potentials for some of DG sources:

Table1 – the existing potentials for DG Sources

No	Sources	Existing Potentials
1	Solar Energy	2000 Kwh/m^2 per year
2	Wind Energy	6500 Megawatts
3	Biomass Energy	33052 Giga watt hours (22000 thermal Megawatts)
4	Geothermal Energy	7400 Megawatts
5	Hydro power plant	4200 Megawatts
6	Tide Energy	Not considerable

WIND ENERGY

There are different climate regions in Iran and also there are seasonal winds in some areas of the country. Fortunately, the Southern Khorasan Province is one of the regions influenced by the winds in the period of 120 days in every year (called 120 Day Sistan Wind). Also wind blows in the aforesaid region during 250 days of a year. On the other hand, the far distance between the consumers and the existing power plants and also the plenty of deserts with the cheapest land price are the main factors of focusing on DG units.

STEPS OF WIND FARM DESIGN

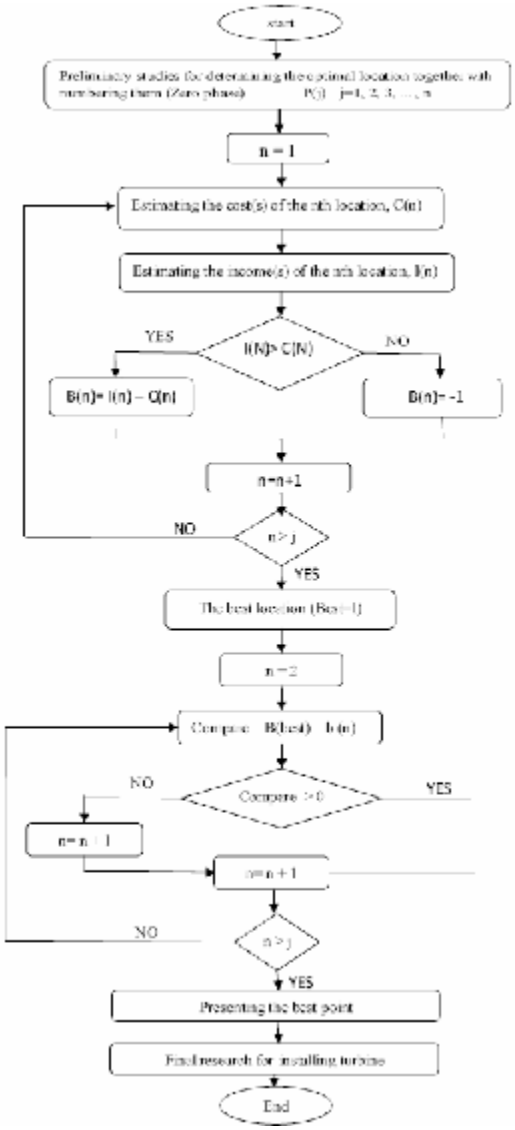
The factor of wind production is an important issue in installing a wind farm. Since turbines are rotating by wind in a wind farm which has a stochastic characteristic, the behaviour of DG units in general is different from the ordinary and popular power plants and it will have different impacts on the power systems. Thus, the study of wind at the Southern Khorasan region together with the turbine type, its connection to the network, economical factors, etc. must be considered in the design and study steps that are described in the following sections:

Finding suitable location

One of the suitable systems for finding the optimal location of the wind power plants is using GIS system. Thus, the GIS software is one of the important software installed in the subsidiaries of the Southern Khorasan Electric Energy Distribution Company (SKEDC) and there's the possibility to perform the location finding and power plant design steps according the algorithm shown in figure1. For optimal location and possibility of erecting wind power plants, the following steps must be carried out:

1. Having access to the preliminary studies: for this reason, the various diagrams for wind, Medium Voltage networks, existing roads, topography of the region, etc. must be considered and then some optimal points as an input for the software must be selected.
2. Estimation of required cost for erecting the wind power plant including research cost, infrastructure, turbine installation, connecting the turbine to the network, and maintenance costs must be suitably estimated and stored for further calculations.
3. Estimating the incomes originated from the power plant operation
4. Comparing the incomes and costs for obtaining the loss and profit function and decide if erecting a wind power plant has economical justification.
5. Iterating the above steps for predicted points and further comparisons.

Figure1. The algorithm of feasibility study for wind power plant using GIS software



Using the GIS software facilities and utilizing the above algorithm, the acceptable findings for erecting wind power plants in the Southern Khorasan region is obtained and shows the profit after 8 years with suitable function in most days of the year.

The pattern of wind velocity

Wind as an important factor for energy supply in different points and months of the year has various conditions and speed and thus a complete information form the related organizations like climatology bureaus in a multi-year period is needed and it must analyzed correctly in order to achieve an appropriate output. The information obtained in the Southern Khorasan indicates the powerful wind that is

suitable for erecting wind power plant in the Southern Khorasan.

The characteristics of wind turbines

The characteristics of wind turbines are different from the popular power plants. The output of wind turbines is a function of wind velocity and there's a non-linear relation between these factors. The relation between the outputs of wind turbines and the wind velocity may be calculated by the following formula called power-velocity curve:

$$pwt = \begin{cases} 0 & x<V_{cin} \\ P_r \,.\, (A+Bx+cx^2) & V_{cin}\leq x<V_{co} \\ p_r & V_r\leq x<V_{co} \\ 0 & x\geq V_{co} \end{cases}$$

In the above mentioned design, wind turbines are constructed so that they start generating when the wind velocity reaches to V_{cin} and the generation reaches to the nominal amount when the velocity is equal to V_r. If the increase in wind velocity will be continuous, until the wind velocity reaches to the amount of V_{co}, the output of these turbines will be constant to the extent of P_r and after that it will alter by increasing the wind velocity to the amount greater than V_{co}, These turbines will be locked to prevent any mechanical damages. The factors A, B, and C are constants and they substitute in the formula based upon the turbine characteristics.

The characteristics of wind farms

The wind farms usually contain some wind turbines. These turbines may be the same or different types. The output power of the wind farm equals the sum of output power of the turbines. If all turbines are the same type and the output power of each turbine is equal to x, the output of wind farm will be $P=Ax$ where A equals the number of turbines. A correlation coefficient must be considered according to the generator configuration that is often considered equals 0.95 and thus, the output power can be stated as $P=0.95Ax$.

STORING WIND ENERGY USING COMPRESSED AIR

What described above shows that using wind energy depends on the different conditions and also wind velocity in different moments. On the other hand, using wind energy may be impossible at peak or other required times. For solving this problem and possibility of using wind energy in all daytimes and different time intervals in the year, the method for converting wind to the compressed air is offered. For this reason, Walsch method is recommended as shown in Figure2 and Figure3:

Figure2. Using wind for compressed air system

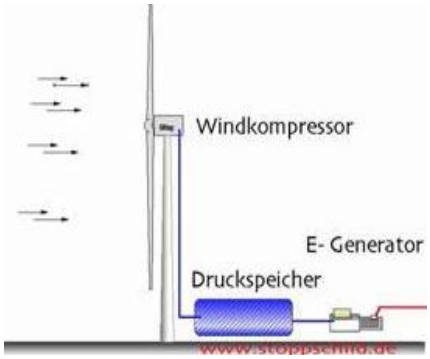
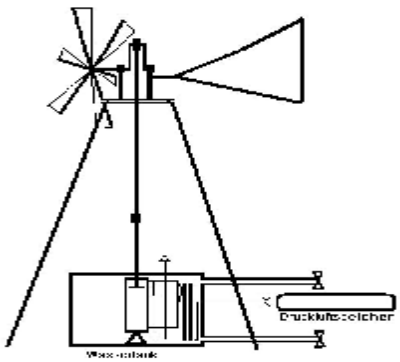


Figure3. Compressing air using wind at the capsule



In addition, for converting wind to the compressed air, using vertical axis turbines is highly recommended. In Figures 4, 5, and 6 some models of these turbines have been shown:

Figure4. A wind turbine modelled by Savino

Figure5. A multi-blade wind turbine

Figure6. A Vertical Axis wind turbine

Producing compressed air through wind energy is being used not only for generating electricity with constant voltage and frequency, but also it can be used for energy carriers, breathing, cooling, nitrogen production, automobiles, etc.

CONCLUSION

Nowadays, using renewable energies are highly used all over the world. Thus, it's recommended that all information about usage conditions and the variety of energy in different geographical locations are presented so that the researchers can reach them easily and try to use them for utilizing these kinds of energies around the world. The results of this paper can present the feasibility of using wind energy in the Southern Khorasan Province using GIS software meanwhile a method for storing wind energy and converting it to the compressed air has been also described.

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