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Analysis on New Methods for Hardness of Power Grids and Energy Storing Using Capacitors and Batteries in Handling Electromagnetic Frequency

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Abstract- This paper concentrates on analysis and handling of electromagnetic frequency control using the science of enriching and compacting energy. In fact, systems get weak facing these disturbances, this is because of photovoltaic solar and wind resources in energy generation. In this sort of energy generation in power systems, the type of wind farm or number of turbines next to each other has great percentage of energy which is generated using hardness-less generators. The frequency varies while using these generators. This is because when using hardness-less generators, it reduces frequency fluctuations. In these conditions, automatic programming is essential. This will even result in blackout. By the way, using much automatic load elimination is for having back the power balance and it also prevents frequency failure, simultaneously, it will carry multiple consequences. Storing energy in cells results in a great decrease in other types of energy such as photovoltaic solar cells and wind turbine. And with the usage of renewable energy resources, the vitality of the usage of cells for storing energy will be considered significant. From these cells or the other storing resources, storing capacitors can be remarked which play a significant role. Experiments and other results disclose the on-time and right operation of capacitors and the necessity of their use well. In other approach, it is illustrated that this can be performed with a less percentage of trust on other energy storing resources and methods and opts for appropriate choice after comparing their dynamic operations.

This paper investigates the storing and energy using capacitors and supporting the handling of electromagnetic frequency in Khuzestan, Iran. In further part of the paper, load reduction factors and the utilized structure "Rocof" and the usage of energy storage, will be discussed.

Keywords- *Reactive Power, Rocof Voltage Sag, Photovoltaic, Power Grid Stability*

I. INTRODUCTION

Wind turbine-based power plants connected to grid separately:

The connection of renewable energies generation resources has 2 methods:

A- Separated B- Connected to power systems

In this paper, separated method is important to us. Our objective of distributed generation is reactive power supply. And its position must be near the load or connected to the grid which the most prominent application is to cut down on transmission loss or putting off current costs and huge investments on transmission system, distribution system, or over-distribution system, which in this debate some topics are prominent that will be pointed out further.

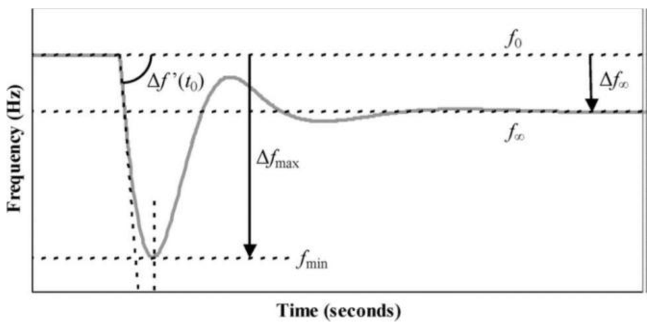

Figure 1. The result of simulation

II. WIND ENERGY

In wind turbines that cannot absorb wind energy only the effect of wind energy on the turbine is transformed into mechanical movement and then into electrical power. In wind turbines blades are circular so that their reactions before the wind touch and after that are different and this is prominent.

$A = \pi r^2$

$\rho_{wind} = \frac{1}{2}\rho a v^2$

Figure 2. 199 KW wind turbine

III. SPEED DIFFERENCE

The fluctuations of wind and fluctuations of wind turbine are called speed difference which the wind power absorbed by turbine if it is more than %60 is called 1/3 of wind power absorbed.

$$\rho_{turbine} = \frac{1}{2}\rho \mathrm{A} v^3 - \frac{1}{2} A v_0^3$$

$$\rho_{wind} = \frac{1}{2}\rho \mathrm{Av}.v^3 = \frac{1}{2}\rho A v^3 \left(\frac{1+\frac{70}{7})(1-\left(\frac{70}{7}\right)^2)}{2} \right)$$

$$\rho_{wind=\frac{1}{2}\rho Av.v^3 CP}$$

IV. AIR DENSITY

The wind fluctuations in different heights in a way that the height is more above the sea level are called air density.

$$\rho = \frac{\rho}{RT}$$

$$\rho = \rho_0 - \frac{1}{194} \times 10^{-4} \times h$$

These points in wind turbines should be taken into consideration and beside these the steps of making power plant and factors like the first step: Law-related factors and the 2nd step finding an appropriate land; the 3rd step morphology with geographical position; the 4th step wind measurement; the 5th step determination of the required capacity and the number of turbines and the 6th step; opting for the type of required wind turbine in comparison with other renewable energy resources is more beneficial because:

1. The price of wind turbine is less in comparison with other types of energy

2. Job opportunities and living resources for people

3. Reactive and active power controllability

4. Ease in utilized methods

In these turbines wind energy is transformed to the turbine by blades and then to the generator and eventually will result in energy generation. These types of turbines are classified into 3 categories:

A. *Small turbine (type A)*

These types of turbines generate energy up to 10 KW and these turbines are utilized in impassable and mountainous areas which are distant from power plants or are at the energy generation place in an islanding way.

B. *Huge turbines (type B)*

These turbines are from those grid-connected turbines which consist of several turbines such as over-beach wind farms with a power more than 250 KW.

C. *Average turbines (type C)*

These turbines are utilized for commercial purposes, factories, agricultural usages and houses with a power of 15 to 30 KW.

V. SOLAR CELL POWER PLANTS (PV)

In industry, solar cell is modeled like a diode. Each solar cell is almost some centimeter in some centimeters with a power of 1 KW. The output voltage is DC and the material is silicon.

In solar power plants, there is some equipment that energy is collected with their aid and a high temperature is created with concentration of them. This energy with a temperature converter, generator turbine, or steam motor is converted into energy. In this procedure, some points are vitally important.

A. *The Strength of Sunlight*

The most generated current in 1sun is called the strength of sunlight and with decrease of the strength of sunlight current will get reduced, but voltage will almost remain constant and in cloudy weather the current will be half and power will be zero.

B. *The Degree of Sunlight*

The degree of sunlight depends on the degree of shining and the magnitude of light absorbed by solar cell. Supposing light shining crooked to the solar cell, in this case it will be $02\theta 2$.

C. *Temperature*

In solar cells, sunlight is demanded, but unfortunately with increase in temperature, light will increase as well which this increase in temperature causes sags in the efficiency of voltage, in a way that with every increase of 2 centigrade degrees in temperature, the temperature and efficiency will decrease approximately %1 and with increase in temperature $\boldsymbol{I_{sh}}$ will increase but $\boldsymbol{V_{oc}}$ will drop. For following the power points generated, voltage must decrease.

$$P = VI = V_0 I_0 (1 + \alpha DT)(1 - \beta \Delta T)$$

$P = \rho_0(1 + (\alpha + \beta)\Delta T - \alpha\beta\Delta t^2)$

It is notable in solar cells that the load magnitude for each type of turbine is of great importance indeed, since for using the maximum power of PV the magnitude of utilized resistor for a cell should be selected. Thus, PV diagram for each power, for instance P2, two points cross each other. This means there is a balance in 2 points from which one of them is balanced.

$$P = Load\ with\ constant\ power = VI = I = \frac{P}{V}$$

$$[\frac{\mathrm{dP}}{\mathrm{dV}}]_{\mathrm{Load}} > [\frac{\mathrm{dP}}{\mathrm{dV}}]_{\mathrm{Source}}$$

Another prominent and noteworthy debate in solar cell is solar tracking; in a way that the sun rises from east in the morning and sets in west in the evening. In different seasons of a year also, there are noticeable fluctuations. Therefore, for maximum efficiency of the solar cell, it should turn 24/7.

Figure 3. Linear 259 KW parabolic power plant

This is divided into a couple of sections:

1- Single-axis

2- Double-axis

For the systems, double-axis is suggested since it circulates for east, west, north, and south. These circumstances increase the output in comparison to when there is no sun tracking.

VI. THE METHOD OF MAXIMUM POWER POINT TRACKING (MPPT)

For receiving more output, the PV voltage has to be maintained constant on the $V_{max}.V_{max}$, on the other hand, it varies with fluctuations in temperature, load, sunlight, etc. Thus, a controller is needed. This controller controls DC/AC. In order to not staying on the maximum point after disturbance, voltage difference has to be zero: $\Delta V = 0$

$$\Delta P = P_{new} - P = \Delta VI + I\Delta V$$

$$\Delta P = 0 = \frac{\Delta V}{\Delta I} = -\frac{V}{I}$$

$$\frac{V}{I} = -t_{so}$$

It can be depicted that this state takes place when in knee point of the diagram.

VII. THE METHOD OF MAXIMUM POWER TRACKING

There are 2 solutions in this method:

1- Elite systems that can be a function of an hour, a day before, a year, or a series of sunlight.

2- Time-based series: Wind speed is considered for an hour and applied to the formula:

$$\Delta V = 5V = -\frac{\Delta V}{\Delta I} \times I$$

VIII. "ROCOF" LOAD SAG

Structure of power systems will face disturbance because of presences of continuous disturbances. This is of the major responsibilities and promises of power companies and in some cases will result in decreases in value of their stock and credit in markets and the stock system of that specific country. On the other side, it will cause instability in power systems that will be applied to the customers with a lower ratio.

In order to maintain stability and the rate of customer pleasure with the distribution and generation companies, the stability of the grid has to be maintained. Thus, the factors creating instability in the grid should be identified and prevented at the first step for maintaining grid stability to prevent local blackouts, transient flickers, and fluctuations on distribution system and eventually to prevent blackout in power system and in unpleasant conditions, to prevent system failure (generators drop). And in case of incident, it should be prevented from spreading. One of the reasons of instability in voltage is overload on grid, load drop in grid, entering and leaving of great loads in grid, transient short circuits, collision of the birds in between the lines, and the existence of induction motors in power systems that result in disconnection of other lines in the grid. More lasting of the overload causes more disconnection of lines and total blackout in the grid. Therefore, something should be done to sort this problem out. Maintenance of stability in power systems and preventing serious drops in frequency and voltages of the buses is of the vital issues engineers of electrical engineering have always been dealing with and seeking about. Thus, instantly of the voltage in addition to applying humorous damaged to power grid, makes the power grid into several parts. Voltage drop in buses, also, creates the possibility of voltage failure in power grid. So, a reasonable solution for voltage drop and preventing the power grid from breaking into several parts should be devised and implemented, respectively. This is essential if this process causes disconnection of many consumers and blackout of theirs. Relatively, in case of such a fault, the whole power grid will get out of control. Thus, disconnecting some consumers is more economic. Elimination of loads is in order to disconnect some consumers of power system for maintenance of synchronization in power system.

This is in order to prevent damages to the equipment of power system and frequency and voltage control. The thoroughly clear point is consequences of elimination of loads cause the displeasure of consumers and a considerable drop in economic incomes. Therefore, the last solution for control of power system must be implemented. In such conditions that security and maintenance of grid stability is of great importance, it is definite that it affects the above points. And elimination of loads becomes logic and one of the surest and most constant methods for grid stability is load elimination. On the other hand, in isolated systems, it should be remarked that these systems themselves provide security and reliability and electricity saving; thus, this task should be implemented regardless of installation so that more attention of devising load elimination is needed.

Some factors imply load elimination for us:

1. Sudden or gradual increase of grids load:

Nowadays, because of the usage of distributed generation sources in low-power grids that are autonomous systems, frequency maintenance is of great importance. For improving and correcting traditional methods of load elimination, many efforts have been made in order to use frequency flow as a criterion for determination of power decrease amount in power grids. Simultaneous use of amount of frequency fluctuations rate along with momentary measurement of frequency in frequency-based load elimination methods has noticeably increased the usage of theirs in determination of amount of care in power decrease and will improve the system. Frequency-based load elimination methodologies which are considered are:

- Old methodology
- Half-comparison-based methodology
- Comparison-based methodology

A. *Traditional methodology:*

In this methodology, when the frequency decreases, it will reach the first allowed amount; the first load elimination step is performed then. In case this frequency decrease still goes on, the system finds out the amount of load that it has eliminated was not sufficient so that there must be another load elimination and the frequency reaches the previous amount. If the frequency decrease still carries on, then the next level of load elimination will be performed as well as long as the frequency goes back to its nominal amount.

Half-comparison-based load elimination methodology is close to the traditional load elimination methodology. In this method, the amount of load that will be disconnected will be determined through the measurement of frequency fluctuations rate (ROCOF).

Comparison-based load elimination methodology is an optimized and logical algorithm of load elimination in which the fluctuation equations are utilized in order to demonstrate the extra load amount. The load that is proposed due to comparison-based methodology can be determined with a higher accuracy.

2. Cut in transmission lines (short circuit between the power plant and substation):

Supposedly a new power plant is generating energy and transmits it to the substation through lines which is in star model; suddenly a cut takes places in one the lines. In this state, the received load will remain constant and the generation will still carry on; therefore, the balance between generation and consumption will demolish which causes the generated power to be spread out on other lines and the right consumption of the other lines will not be performed properly as well which leads in impact upon the generating generator. Under such circumstances, load elimination proves required and essential and aids the grid and equipment.

IX. CONCLUSION

This paper proposes a methodology to control, analyze, and manage the electromagnetic frequency. It creatively suggests utilizing the methods of the science of compacting and enriching energy. Since with the presence of DG in the procedure of energy generation the distribution system faces various issues and disturbances, the hardness-less generators have been utilized to diminish the frequency fluctuations. Energy storing capacitors being considered vital with the presence of renewable energy resources, proved that they have the highest reliability when it comes to proper and on time operation of energy storing resources.

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