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Research Of Operating Parameters Of Alternative Power Sources Taking Into Account The Power Category Of Electric Circuits

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Abstract - *This article is devoted to the study of the operating modes of renewable energy in the energy sector of the world. The article proposes the most effective method for managing the energy parameters of alternative sources of electricity, and also considers the constructive and technological scheme of alternative sources in different climatic conditions. Also, the advantages and disadvantages of the energy parameters of non-traditional sources of electricity have been thoroughly studied, taking into account the category of supply of mechanical and light energy per year. Finally, the performance of unconventional sources of electricity in the energy schedules of electricity loads has been clarified.*

Keywords - Active power, reactive power, full power, electric power, renewable power, unconventional, alternative, source.

1. INTRODUCTION

The great technological breakthrough of humanity at the beginning of the 20th century entailed a large amount of energy consumption. At that time, hydrocarbons were the only source of energy. In the following decades, the consumption of hydrocarbons increased dramatically and continues to grow to this day. This leads to a large amount of emissions of harmful substances into the atmosphere, as well as a huge amount of CO emissions leads to the greenhouse effect, which will further lead to global warming. The states of all countries are trying to limit greenhouse gas emissions into the atmosphere as much as possible, and are increasingly turning to alternative energy sources [1, 2].

The main source of wind energy on earth is the sun, its radiation, heating the planet unevenly, creates zones of different pressure in our atmosphere. Air masses tend to move from a high pressure zone to a low pressure zone, thereby forming wind. Wind power can be attributed to an alternative source of energy. It is an energy industry specializing in converting kinetic wind energy into electrical, mechanical, thermal or any other form of energy suitable for human use [3, 4].

Such conversion can be carried out by a wind generator (for generating electricity), a windmill (for converting into mechanical energy), a sail (for use in shipping), and others. Wind power is the fastest growing industry on earth. The largest manufacturers of turbines for wind turbines are the USA, Germany and China. The undoubted disadvantage of wind energy is the inconstancy of the weather and, as a consequence, the absence of wind. To convert wind energy into electricity, a wind speed of over 5 m / s is required [5-7].

Of all natural forms of energy, the most powerful is solar. One of the methods of converting light energy into electrical energy was invented in Spain, where 600 mirrors focus solar energy on a water tank located on a tower 120 meters high and heating it to 500 degrees converts' water into steam, which drives turbines to generate electricity. But this method of generating energy has the same disadvantage as that of a wind generator it is completely dependent on the weather. Solar panels are more widespread in the world; in large quantities they can provide entire cities with energy [8].

Today, hydropower provides about 80% of renewable and up to 25% of all electricity on earth. The first hydroelectric power plant was built in 1882 on the Fox Revere in the United States in Appleton. And by 1989 there were more than 200 of them in the USA and Canada. Widespread hydro-construction in China began in the early 2000s, for which hydropower is the main source of electricity. Located in China is the world's largest hydropower plant Three Gorges with a capacity of 22,500 MW. Hydropower has a number of advantages, such as the low cost of electricity generated, the absence of harmful emissions into the atmosphere, and climate mitigation near large reservoirs. The disadvantages include flooding of arable land, unregulated water releases harm the ecosystem of rivers and adjacent forests [9, 10].

2. RESULTS AND DISCUSSION

World experience shows that one of the main directions of increasing the energy efficiency of the economy is the development of alternative energy. This implies a wider use of renewable energy sources and the use of modern efficient technologies for the generation of electric and heat energy. The use of renewable energy sources, their active introduction into life is becoming more and more serious every year. By 2020, the European Union plans, in accordance with its 20-20-20 energy strategy, to increase the share of renewable energy sources in the total fuel balance to 20%, which, according to the Europeans, will make it possible to reduce the specific demand for traditional energy resources by 20%. This will allow the countries of the European Union to increase the gross national product by 79% by 2030, while reducing energy consumption by 7%. In the future, European states will receive from renewable sources at least a third of their energy consumption. United States, the world's premier importer of hydrocarbons, also develop their strategy in this direction. In the United States, funding for renewable energy and energy efficiency from the federal budget is comparable to spending on nuclear energy and radioactive waste management. According to the plans of President Barack Obama, by 2012 in the country, the share of energy obtained from renewable sources should reach 10%, and by 2025 25% [11].

For foreign politicians and businessmen, renewable energy has long become one of the promising areas that contribute to overcoming the crisis, solving environmental and climatic problems caused by technological processes of obtaining energy from traditional fuels. The development of alternative energy in Russia in the coming years will allow. In the largest in area subject of the Russian Federation, the Republic of Sakha, approximately 75% of all utility costs in 2006 fell on the share of fuel supplies. The cost of its transportation in 2007 was estimated at 1.2 billion rubles. This is especially true for the northern and equivalent territories. Over the past 10 years, the number of settlements not connected to public networks has increased dramatically due to the destruction of power lines; those settlements that received energy from diesel power plants often remain without electricity due to the failure of diesel generators and the impossibility of replacing them. We are talking here about the living conditions of 20-30 million people;

To increase the reliability of power supply to power-deficient regions of the Russian Federation, although they are covered by centralized power supply, but which have limitations in terms of power or types of energy. Connecting new consumers to power grids in these areas is very expensive, and connection refusals have become widespread;

To release in the structure of the country's energy balance the volumes of traditional energy resources necessary for the fulfillment of agreements under long-term contracts for the export supply of oil and natural gas to developed foreign countries.

The active and reactive power flow can be calculated as follows [12-14]:

$$P_i = P_{i+1} + P_{L,i+1} + R_{i,i+1}\left(\frac{P_i^2 + jQ_i^2}{|V_i|^2}\right) \tag{1}$$

$$Q_i = Q_{i+1} + Q_{L,i+1} + X_{i,i+1}\left(\frac{P_i^2 + jQ_i^2}{|V_i|^2}\right) \tag{2}$$

The voltage at receiving bus can be calculated using (3).

$$V_{i+1}^2 = V_i^2 - 2*(R_{i,i+1} * P_i + X_{i,i+1} * Q_i) + (R_{i,i+1}{}^2 + X_{i,i+1}{}^2) * \left(\frac{P_i^2 + jQ_i^2}{|V_i|^2}\right) \tag{3}$$

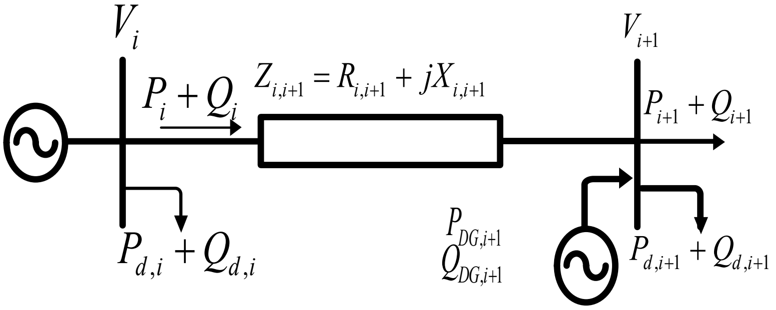

Fig. 1. Equivalent circuit of active, reactive resistances of alternative and traditional sources of electricity.

The active and reactive power losses between buses *i* and *i+1* can be expressed as follows:

$$P_{loss(i,i+1)} = R_{i,i+1}\left(\frac{P_i^2 + jQ_i^2}{|V_i|^2}\right) \tag{4}$$

$$Q_{loss(i,i+1)} = X_{i,i+1}\left(\frac{P_i^2 + jQ_i^2}{|V_i|^2}\right) \tag{5}$$

The main objective function is the minimizing total active power losses that can be given as follows:

$$F_{obj} = minimize(P_{loss}) \tag{6}$$

where, P_{loss} is the total power loss.

The above objective function is subjected to some constraints such as DG size, bus voltage, and branch current.

2.1 Equality constraints

The generated power must be equal to the demand loads and power losses as [10]:

$$P_{swing} + \sum_{i=1}^{N_{DG}} P_{DG}(i) = \sum_{i=1}^{L} P_{Lineloss}(i) + \sum_{k=1}^{N} P_d(k) \tag{7}$$

$$Q_{swing} + \sum_{i=1}^{N_{DG}} Q_{DG}(i) = \sum_{i=1}^{L} Q_{Lineloss}(i) + \sum_{k=1}^{N} Q_d(k) \tag{8}$$

where, P_{swing} and Q_{swing} are the active and reactive powers of swing bus, N_{DG} is the number of DGs, and L is the number of transmission lines.

2.2 Inequality constraints

- Voltage limitation

The bus voltages must be within the minimum voltage value ($V_{\min}$) and the maximum voltage value ($V_{\max}$)

$$V_{\min} \le |V_i| \le V_{\max} \tag{9}$$

- The limits of power generated from DG

The DG's installation capacity in the network is limited. Therefore, it must not exceed the power provided by the substation [11] to prevent reverse power flow.

$$\sum_{i=1}^{N_{DG}} P_{DG}(i) \le \frac{3}{4} * \left[\sum_{i=1}^{L} P_{Lineloss}(i) + \sum_{k=1}^{N} Pd(k) \right] \tag{10}$$

$$\sum_{i=1}^{N_{DG}} Q_{DG}(i) \le \frac{3}{4} * \left[\sum_{i=1}^{L} Q_{Lineloss}(i) + \sum_{k=1}^{N} Qd(k) \right] \tag{11}$$

$$P_{DG}^{\min} \le P_{DG}(i) \le P_{DG}^{\max} \tag{12}$$

$$Q_{DG}^{\min} \le Q_{DG}(i) \le Q_{DG}^{\max} \tag{13}$$

where, $P_{DG}^{\max}$ and $P_{DG}^{\min}$ are the maximum and minimum active powers generated by DG unit, $Q_{DG}^{\max}$ and $Q_{DG}^{\min}$ are the maximum and minimum reactive outputs of DG unit.

- Transmission line current limitation

The maximum transmission line current must meet the following constants [12].

$$I_k \le I_{\max,k} \tag{14}$$

where $I_{\max}$ is the maximum allowed current through the branch *k*.

3. CONCULISION

For example, the Japanese government is going to allocate more than 300 million for the development of solar energy in the developing countries of Asia, Africa and the Middle East. The goal is clear: to stake on the market of developing countries and a considerable share of the world market for the products of Japanese firms. At the same time, Japan intends to provide and install equipment free of charge within the framework of the anti-crisis program.

Russia has the necessary natural resources for the development of alternative energy sources. According to available estimates, the potential of renewable energy sources in Russia is about 4.6 billion tons of fuel equivalent. That is, five times the volume of consumption of all fuel and energy resources of Russia. Renewable resources include the energy of the Earth, sun, wind, sea waves, biomass, etc. It cannot be said that these resources are present in abundance and evenly distributed over the territory, but they exist and are able to solve such problems as increasing reliability power supply, creation of reserve capacities, compensation of losses, supply of electricity to remote areas. The most significant for Russia in terms of their industrial applications are biomass, wind and solar energy.

Within the framework of this article, the largest sources of alternative energy were considered. In fact, now there are many more of these sources and progress is not standing still. At the moment, we can safely say that alternative energy technologies are rapidly developing and there is a demand for them. Well, we can only hope that in the future we will be able to produce for ourselves as much energy as necessary, while carefully preserving and not polluting our planet.

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