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Alternative Energy Storage

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Every year, human needs increase, and the rate of consumption increases constantly. All this leads to necessity for huge amounts of energy production. Due to these factors, there is an increasing interest in solving the energy storage problem.

This article will discuss various ways to solve the problem of energy storage, there will be given an assessment to efficiency, will discuss advantages and disadvantages of technologies, and describe the principles of operation of devices. The technologies to be discussed in the article are the following: hydro-accumulator, compressed air, the molten salt, floating chemical battery, super-flywheel [1].

With the development of energy, people faced the problem of how to preserve excess energy effectively for a subsequent use. This problem has a harmful influence on the development of renewable energy methods such as hydropower, solar, wind, etc. The problem is that such methods cannot ensure the supply of energy to consumers due to daily, seasonal or poorly predicted changes in their capacity. That is why today the solution to this problem is of an increased interest. Efficient energy storage will allow to equalize load peaks, to reduce the cost of electricity during peak consumption hours and use renewable energy sources efficiently [2]. Scientists all over the world try to find new technologies, devices that could accumulate energy, store it and use it if necessary. Today many projects are being developed and find their application, scientists suggest various ways to solve this problem. However, this issue remains unresolved. At the moment, there are many ways to

store energy, each of them has its own advantages and disadvantages [3].

Hydraulic accumulator. Hydraulic accumulator is the oldest, most sophisticated and common technology for storing energy in large volumes. The principle of operation is quite simple: two water tanks are located one above the other. When the power demand is small, energy is used to pump water into the upper tank [4]. During the peak of electricity consumption, water from the upper tank drains down, where the turbine, which spins by water movement, is located, and the generator produces electricity. Then water flows into the lower tank and can be used many times again. Advantage of this technique is that water can pass a large number of cycles and the efficiency is in the order of 75-85%. From several disadvantages can be distinguished the following: the installation of hydraulic accumulators is expensive and requires special geographical conditions. The installed capacity of all hydraulic accumulators in the world is about 140 GW. Nowadays, projects of hydraulic accumulators develop in Germany, where they will be placed inside unused mines, as well as on the ocean floor in specially created spherical storage tanks [5].

Compressed air. This technique is thus: accumulated energy is supplied to the electric motor which drives the compressor. Compressed air is cooled and stored at 60-70 atmospheres. Then, if necessary, air is extracted from the accumulator, heated and supplied to the gas turbine, where energy gets compressed and heated. Air rotates the turbine, and the generator supplies power system with electricity. The disadvantage is low efficiency - no greater than 55% [6]. The reason is that the part of energy in the gas compression is converted into a thermal form. Installed capacity in the world does not exceed 400MW. There is a promising direction CAES for improving efficiency. It allows to retain and store the heat, which is released during compressor operation at the stage of air

compression and cooling and so to use it again at cold air reheating. Nowadays a new Energy Bag system is being tested, which is the storage of compressed air in polymer accumulators at depths of several hundred meters. This system allows to provide the efficiency of 75-85% [7].

The molten salt. The molten salt has the property of holding the heat for a long time. The salt can be heated and melted by solar infrared radiation. The principle of operation of tower solar power plants is the following: many reflectors direct solar energy to a tank with salt, which is installed on the top of the tower, which is in the center of the station. The molten salt can be stored for several hours and used, for example, for house heating in the evening, or immediately by means of a steam generator and turbine to generate electricity [8]. One of the advantages is that the molten salt can function at high temperatures – more than 500 °C, which contributes to the efficient operation of the steam turbine. Such a project is located in a solar park in the Arab Emirates [9].

Flowing chemical battery. The principle of operation of the flowing battery is the following: two liquids, which act as electrodes, flow through the fuel cell with the membrane, in which ionic interaction of liquid electrodes and generation of charges of different signs take place. Fixed electrodes, which are used to supply accumulated electric energy, are installed in the cell. This process takes place without mixing liquids. That allows liquid electrodes to be used many times. The advantage of this type of battery is thus: it is reliable, easy to operate and has a long-lasting performance. Efficiency is about 70-80%, but it can vary depending on needs [10]. The main disadvantage is the low density of stored energy. At present, Germany plans to install underground tanks with electrolytes, namely vanadium, salt water, chlorine or zinc solution, and to build a 700 MWh flow battery in local caves. The main concern of the project is to balance the distribution of renewable energy within 24 hours in

order to avoid electricity disruptions caused by lack of wind or overcast weather [11].

Super-flywheel. This kind of energy accumulation is based on accumulation of kinetic energy and its conversion into electric energy if necessary. This accumulator is a cylindrical reservoir, inside which a super-flywheel is suspended on active magnetic bearings. Super-flywheel is made of a huge number of layers of carbon fibre composite. Rotor of motor-generator is installed on a fly-wheel shaft, which spins fly-wheel when power is received and generates current when load is connected. The application of super-wheels can range from small autonomous uninterrupted power sources for private farms to large industrial installations. The main advantage is that the massive fly-wheel is able to convert the accumulated kinetic energy instantly into electrical energy, thus, providing the consumer with necessary power. It can work as a buffer to compensate for sharp peaks and downturns in consumption for 24 hours. Also the main advantages of super-wheels are the following: long-service life, which is more than 10 years, 90% efficiency, ease of maintenance and no need for a regular maintenance, its safety for the environment, minimum operating costs, a high degree of automation. The German company ATZ produces 20 MJ drives today, capable of giving up to 250 kW of power to the load, equipped with a system of synchronization with the network. The American company Beacon Power produces cylindrical drives for 6 kWh and 25 kWh, which can be used in clusters to ensure the stability of current parameters in the industrial electricity networks of the country [12].

To sum up, it can be said, that today there is no single ideal way to store energy. Each way has its own pros and cons in different areas. However, the problem of energy storage is not completely solved. Many projects are either under development or have already been realized and are being used actively.

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