Study on Micro Grid and Compensation Parameters with Solar/Hydro DGs

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***Abstract*: Hydropower energy is one of the most suitable and efficient sources of renewable energy which depends on the energy of flowing water. The power capacity and facility are two criteria required for the classification of the hydropower plants. The first one consists of five technologies: dammed reservoir, run of river, pumped storage, in-stream technology, and new technology gravitational vortex. The other one is classified according to the power scale is Large, Small, Mini, Micro, and Pico Hydropower. Nowadays most of the rural areas in developed and developing countries use the hydropower plant for producing electricity, it is cheap and effective. This paper gives a review of hybrid system i.e. micro hydropower technologies and solar energy, it is focusing on the categories and performance of hydropower systems and the most suitable solar energy which can be used.**

Keywords: Pump, solar energy, hydropower, hybrid system.

I. INTRODUCTION

Nowadays, researchers are showing interest in the importance of sustainable energy and, in particular, it has been discovered that fossil fuels are expensive and have a negative impact on the environment. Renewable energies are the most appropriate solution for establishing a good connection between renewable energy and sustainable development. The role of renewable energies has been defined of great importance for global environmental concerns. Hydroelectricity is an effective example of renewable energy and its potential application for future electricity production should not be underestimated. Therefore, hydroelectric power plants do not cause emissions into the atmosphere, but in most cases they have a negative impact on water quality and wildlife habitats and prevent the migration of fish. Recently, however, new technologies such as the gravitational water vortex system have been able to solve this problem. Hydroelectricity is currently the safest, most efficient and most reliable renewable energy source, based on over one hundred years of professional experience [1]. World production of hydroelectricity is increasing, which, in the latest statistical data, corresponds to 20% of world electricity production. Hydroelectricity is generated by the energy extracted from the water which moves higher and lower locations.

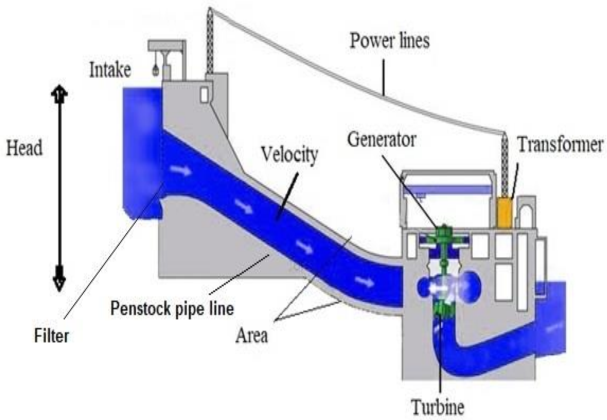

Fig. 1 Hydroelectric power generation diagram [1]

II. LITERATURE REVIEW

NandKishoret al. [2] in this review article, the authors attempted to divide previous research into several sections based on the development of hydroelectric models and the design of their controller. A considerable amount of relevant research can be found on plant modeling, on the design aspects of control methods and on their performance study.

Mohamed Walid et al. [3] this document provides an overview of hydroelectric technologies and turbines. It focuses on the categories and performance of the most suitable hydroelectric systems and turbines that can be used.

Chiyembekezo S. Kaunda et al. [4] Expert knowledge is used in this study. The authors also examined magazines, conference articles, reports and some documents in detail to provide secondary information on the subject. The document examined the global energy scenario and the question of how hydropower can be used as a solution to the global challenge of sustainable energy. Issues related to the availability of hydroelectric resources, technology, the environment and climate change were also discussed.

Carlos Platero et al. [4] this article presents a new operating method for hydroelectric power plants, which is based on controlling the opening time of the injectors or evil doors based on the upper level of the tank. In this way, a faster power injection can be obtained depending on the current water level in the upper tank. If this value is higher, the opening time may be shorter. As a result, hydroelectric ramps could be steeper.

III. HYDRO POWER TECHNOLOGY SYSTEMS

Electrical capacity and power plant (technology) are two criteria for classifying hydroelectric plants. The first consists of four technologies that have accumulated in the tank, in the flow, and in the pumped storage, in the current technology, and in the new technology, the gravitational energy of the vortex. The performance scale is large, small, mini, micro and Pico. See the fig. 2

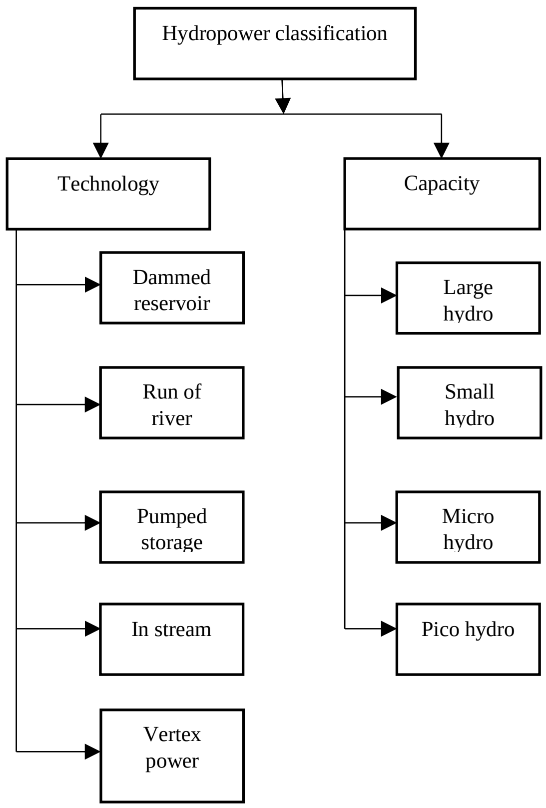

Fig. 2 Hydropower categories (a) facilities (technologies) (b) power capacity

IV. HYDROPOWER TECHNOLOGY

In engineering, performance is the rate in terms of working hours. The job can take the form of mechanical, electrical or hydraulic work. Forces within or through a system are involved in every work process, in which a system is defined as a limited amount of matter. Hydroelectricity is the speed with which hydraulic energy is extracted from a certain amount of water that falls due to its speed or position, or both. The rate of change in the amount of angular movement of the falling water or its pressure, or both, on the surfaces of the turbine blades creates a differential force on the turbine rotor, causing rotation. Water in a hydroelectric plant is not used as a workplace and is therefore available for other purposes [5].

Hydropower can be used to power machinery or generate electricity or both simultaneously. The mechanical application is mainly applied to small hydroelectric plants, where the electricity produced is used to operate small mechanical tools and machines for pressing, milling, grinding and cutting. In some cases, the output shaft of the small hydroelectric turbine is extended in both directions to make room for both mechanical power and energy generation [6].

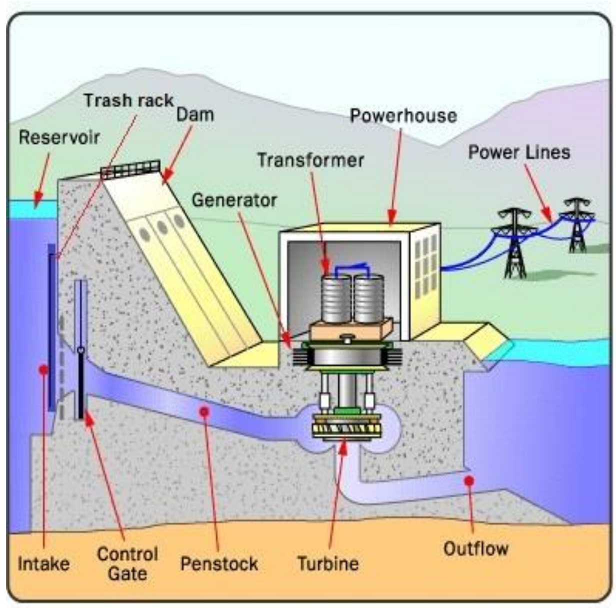

Fig. 3 Schematic view of a hydropower station and its basic parts, adapted from International Energy Agency

Large hydroelectric power plants are generally used to generate electricity. The block diagram of a hydroelectric power station is illustrated in Figure 3. The turbine output shaft is coupled to the generator to generate electricity. The generator consists mainly of an electromagnetic rotor located in a cylinder (called a stator) containing a winding of electric wires (called a conductor). During operation, the rotor rotates in the stator and generates electricity according to the principle of electromagnetic induction. The electricity produced is transmitted to the charging points through a transmission system made up of components such as switchboards, transformers and transmission lines.

A. *Micro-hydro power plant*

Hydroelectricity is based on the principle that flowing and falling water is associated with a certain kinetic energy potential. Hydroelectricity is created by converting the energy of running water into useful mechanical energy using a water wheel or turbine. This energy can then be converted into electricity using an electric generator. The energy from running / falling water can be used directly by suitable machines to avoid loss of generator efficiency. Recently, small water systems have sparked great public interest as a promising renewable source of electricity for families, farms and remote communities. Hydroelectric microsystems refer specifically to systems that generate electricity in the range from 5 kW to 100 kW [7].

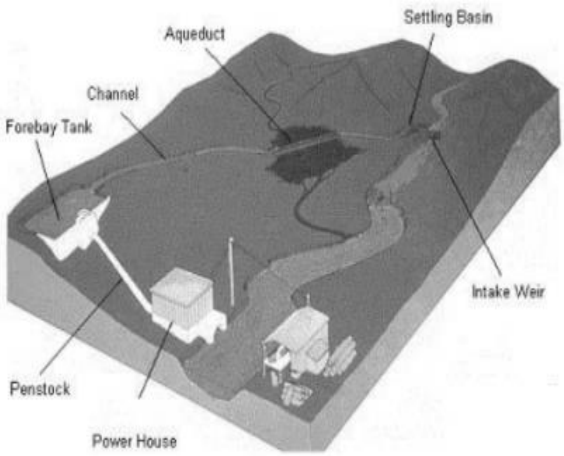

Fig. 1. General components of micro-hydro power plant [7]

The micro-hydraulic system includes a water turbine that converts the energy of the flowing water into mechanical energy. This mechanical energy drives a generator that generates electricity. The efficiency of the entire system is generally in the order of 50% of the theoretical power associated with the energy of the running water, taking into account the friction losses caused by the pipes and the turbine breakdowns. Micro-Hydro has been used in many applications for many years. The turbine varies from place to place depending on the head and the flow rate indicated in each position [7].

V. HYBRID ENERGY SYSTEM

Hybrid energy systems combine two or more forms of energy generation, storage, or end-use technologies, and they can deliver a boatload of benefits compared with single source systems. The option of having variety in our day-to-day life could be considered as the spice of life; therefore, why limit ourselves to just one energy source or storage option? In these cases, hybrid energy systems are an ideal solution since they can offer substantial improvements in performance and cost reduction and can be tailored to varying end-user requirements. The energy storage system (ESS) in a conventional stand-alone renewable energy power system (REPS) usually has a short lifespan mainly due to irregular output of renewable energy sources. In certain systems, the ESS is oversized to reduce the stress level and to meet the intermittent peak power demand.

VI. SOLAR ENERGY

Solar energy, solar radiation that can generate heat, cause chemical reactions or generate electricity. The total amount of solar energy that falls to the earth far exceeds the current and expected energy needs of the world. When used appropriately, this highly widespread source has the potential to meet all future energy needs. In the 21st century, solar energy is expected to become increasingly attractive as a renewable energy source due to its inexhaustible supply and its ecological character unlike finished fossil fuels of coal, oil and natural gas [8]. The sun is an extremely powerful source of energy and sunlight is by far the largest source of energy received from the earth, but its intensity on the earth's surface is actually quite weak. This is mainly due to the huge radial spread of radiation from the distant sun. A relatively small additional loss is due to Earth's atmosphere and clouds, which absorb or disperse up to 54% of incoming sunlight. The sunlight reaching the ground is made up of almost 50% visible light, 45% infrared radiation and a smaller amount of ultraviolet radiation and other forms of electromagnetic radiation.

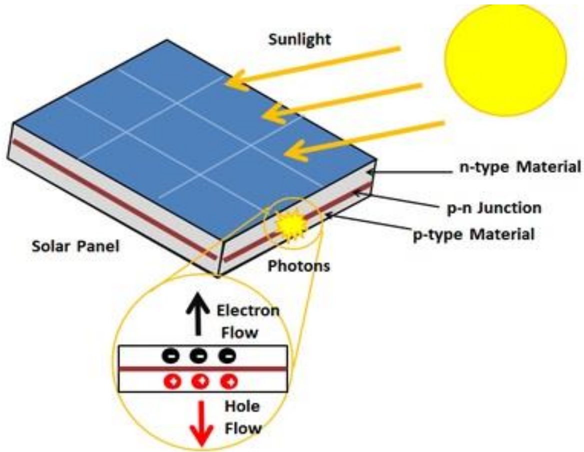

Fig. 4 Internal of Reaction of Solar energy [9]

VII. UNIFIED POWER FLOW CONTROLLER

A unified power flow controller (UPFC) is an electrical device for providing fast-acting reactive power compensation on high-voltage electricity transmission networks. It uses a pair of three-phase controllable bridges to produce current that is injected into a transmission line using a series transformer [10]. The controller can control active and reactive power flows in a transmission line.

Unified Power Flow Controller (UPFC), as a representative of the third generation of FACTS devices, is by far the most comprehensive FACTS device, in power system steady-state it can implement power flow regulation, reasonably controlling line active power and reactive power, improving the transmission capacity of power system, and in power system transient state it can realize fast-acting reactive power compensation, dynamically supporting the voltage at the access point and improving system voltage stability, moreover, it can improve the damping of the system and power angle stability [11].

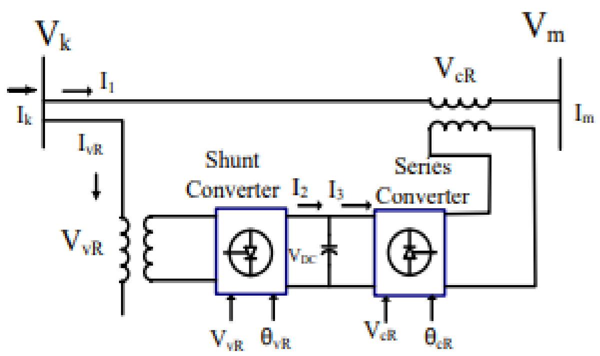

Fig.5. UPFC Schematic diagram [12]

VIII. RAINWATER HARVESTING

Rainwater collection is the method by which rainwater that falls on a roof surface is collected and sent to a warehouse for later use. As shown in Fig. 6, rainwater collection systems (RWH) are a collection of many components and processes, including (but not limited to) a feeding area, a transport system, filtration before storage, a container storage, a pump and a post-storage filtration / treatment and post-distribution system. In most systems, precipitation falls on the roof, is collected via gutters and transported to the storage container through a network of pipes. Pre-storage filtration is often used to prevent sediment, leaves and debris from entering the storage container. A network of pipes then directs the water to the tank.

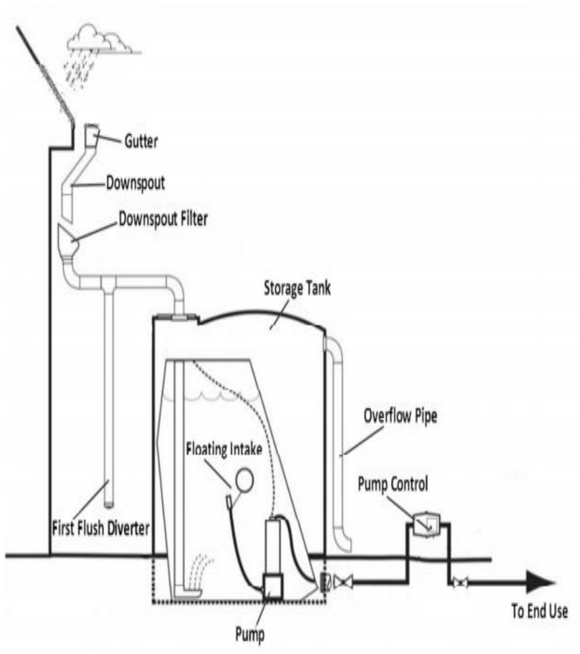

Fig. 6. Example of an above-ground rainwater harvesting system

A first rinse valve can be installed in the drain line to direct the dirtiest drainage water from the tank, thus maintaining the quality of the water collected for later use of the tank. The water flows by gravity or is pumped to the point of use. Depending on the quality of the water collected and the quality required for certain uses, post-treatment is sometimes included in the RWH system.

IX. CONTROLLING TECHNIQUES

A. Adaptive Neuro Fuzzy Inference Controller (ANFIC)

To overcome the disadvantages of fuzzy ANFIS, [13] - [14] is used. ANFIC is based on the first-class Takagi-Surgeon model and only allows one exit. ANFIC was used to train the gain programming controller for a power supply system [15]. Five Linear Quadratic (LQR) controllers have been developed and the ANFIC controller is trained to select the most suitable controller based on the operating point of the current system. To form ANFIC, you need to generate two datasets: the input data and the corresponding output data. The training input data are two vectors of the deviation of the active power and of the deviation of the reactive power in the area of the obtainable system. The training output data are the two components of the corresponding series-connected voltage.

The main advantage of ANFIC is the reduction of the interaction between active and reactive power flow, since changes in active and reactive power are presented simultaneously to the controller.

B. Particle Swarm Optimization (PSO) Algorithm

Particle swarm optimization (PSO) is a calculation method that optimizes a problem by trying iteratively to improve a candidate solution with respect to a certain quality measure [16].

This algorithm has been simplified and has been observed to perform optimization. PSO gets better results faster and cheaper than other methods. Only a few parameters need to be adjusted. PSO does not use the problem gradient to be optimized, which means that PSO does not require that the optimization problem be differentiable. The PSO hypothesizes little or nothing that the problem to be optimized could seek very large areas of candidate solutions. PSO is also used for optimization problems that are sometimes irregular, noisy, modified over time, etc. This new approach offers many advantages. It is easy, fast and easy to code. The required memory is also minimal.

Furthermore, this approach is advantageous in many respects compared to evolutionary and genetic algorithms. First of all, PSO has memory. This means that each particle remembers its best solution and the best solution for the group. Another advantage of the OSP is that it maintains the initial population of the OSP and therefore no operator should be applied to the population, which takes time and memory.

In addition, PSO is based on “constructive cooperation” between particles, in contrast with the genetic algorithms, which are based on ”the survival of the fittest”.

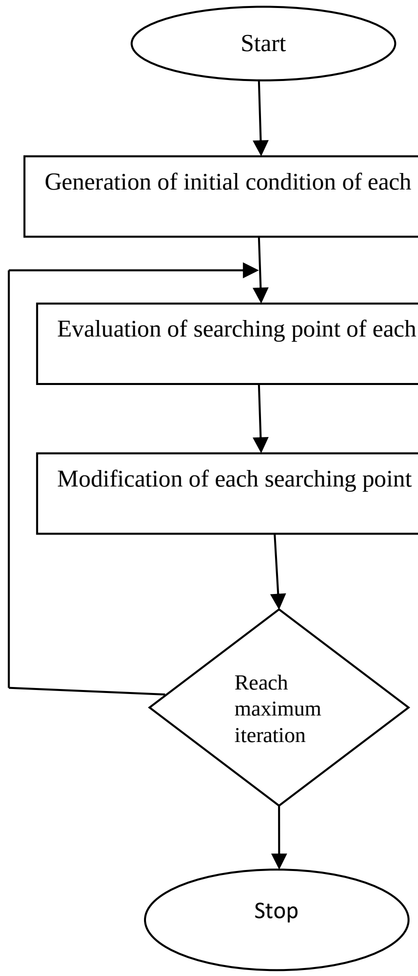

Fig. 7 Flow Chart of PSO

X. CONCLUSION

This article has focused on water micro-systems and hybrid solar energy fields. Hydropower has proven to be a cornerstone of the power plant, which is of great importance for global economic, economic and ecological concerns. On the other hand, this article provides an overview of hydroelectric technologies, hybrid systems and solar energy. It focuses on the categories and performance of hydroelectric systems and the most appropriate solar energy. This article showed different types of hydroelectric systems; it contains a general description of hydroelectric turbine systems and their various components and performance. The use of efficient micro-hydroelectric technology in hybrid with the solar system can be an effective choice as a branch in small areas.

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