Xournals

Academic Journal of Material Sciences

ISSN UA | Volume 01 | Issue 01 | January-2019

Energy Storage System and Their Technologies

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Available online at: www.xournals.com

Received 18th September 2018 | Revised 16th October 2018 | Accepted 24th December 2018

Abstract:

Immediate response of electricity generated from renewable sources can rarely be provided because these supplies cannot deliver regular supply to consumption need. Greater network load stability is this decentralized production and it needs energy storage, which normally uses lead batteries as a potential solution. Lead batteries cannot reserve great quantities of energy in minor volume and also cannot resist high cycling rates. Therefore, various different kinds of storage techniques are being created and applied. This paper highlights the need of the storage of energy to make the power networks strengthened and to make the load levels maintained. Many kind of storage methods are discueesd here among which some are still under the development. Different techniques of electricity storage and their application are also discussed in this paper.

Keywords: *Renewable Energy, Storage Compressed Air, Batteries, Thermal Energy Storage*

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Introduction

Electrical energy is readily available energy at the lowest price and is an invisible, omnipresent product and has been considered as common consumer goods. The making of electricity is vastly consolidated at present time and its end users are unable to get this. Daily and seasonal needs of the electricity determines the loads leveling at the initial stage but also by the insufficient production due to the involvement of secondary modes like as thermal and hydraulic plants. Stored energy also used by these plants such as water is used for the pumped storage plants and fossile fuels are used for the thermal plants. The difficulties of alleviating the power linkage is increased because of the delocalized electricity production and by introducting the variables, fluctuating sources such as renewable energy (wind turbines solar etc.), it is mainly decreased because of the demand supply difference. It is thus appropriate to produce energy by transmitting, converting and storing it. But it is problematic to store because storage requires huge, expensive apparatus although it becomes a need. It is important to know that the centralized making of electricity promotes the growth of a complicated arrangement of energy production transmission. The enrgy content, transformation approaches for the storage of alternate current was unreliable, very expensive and were not in trend in the pre 1980. The thought that electricity cannot be stored is brought about by the datum that electricity is produced in bulk, transferred and used in alternative current. But now it is declared that the electricity can be stored even in indirect storage.

Technical and Financial benefits of Energy Storage

Electricity storage becomes as an interesting venture by the main economical advantages which are described as follows:

1. Energy transfer:

The conversion of a very cheap primary energy source which are used in normal power plants yields the intermediary energy. It can be stored and utilized as an additional for the costly power which is used in most of the load power stations or can be utilized for the virtual energy at an appropriate time. The two means of energy generation for which storage is very essential are as follows:

- First mode of energy production is conventional energy production which can compensate the temporary production loss of generating unit. It avoids penalties by fulfilling the commercial obligation of pre-sold energy supply.

- Second is renewable energy production, which makes this type of predictable energy and its storage enhances the worth to the generated power. Only a fraction of the minimal production ability can be satisfied by the stored power although energy should be made available due to the contractual compromise.

2. Network savings:

A number of production units, different stages of conduction and dissemination lines, linked stations and substations and innumerable consumers with extensively ranging power necessities are included by the power networks. Inequality and fluctuation characterizes the power consumption by users which means that the lowest consumption is approximately half of a highest peak. In peak and average power levels ratio, end user demand is often have the value of 10 which causes the extra dimensioning of power generation and diffusion gear which is not created for average daily consumption but only for function of peak in demand. Fluctuation can be reduced to a minimum by the load levelling which makes the supply more predictable and also the prevailing conduction and dissemination conveniences for a number of years. Reduction of the installed power and to get the most from the existing network, is helped by the smoothing of consumption at the concluding dispersal stage.

3. Kinetic advantages:

Instant response to demand can be provided by the suppleness of forthcoming storage and repossession sysems, it also adds the suppleness to the linkage in terms of load levelling. Impermanent production shortage causes network inequity which can be predicted possibly. The need of the production could also be the cause of failure of the production.

4. Electricity storage systems:

It can be attained meritoriously. Electricity storage must be first converted into another form of storable energy and also must be transformed reverse as per the need. For storing every forms of energy such as chemical, thermal, and mechanical, there are many possible techniques. According to the applications of storage techniques, it can be categorized into four groups which are:

A. Less power application in remote areas which is essential to feed transducers and emergency terminuses

B. Moderate power application in inaccessible areas

C. Network association application with peak levelling

D. Power quality regulating applications

Here in initial two classes, energy can be stored as chemical energy, kinetic energy, compressed air, in supercapacitors or hydrogen as these are for small scale systems. In three and four classes, energy can be stored as thermal energy, gravitational energy, compressed air, or chemical energy as these are for large scale systems. Category four is further divided into many types which are as follows:

1. Pumped Hydro Storage (PHS):

This technique is easily can be achieved and it is the main advantage of this technique. It uses the highly concentrated renewable energy source that is power of water. This technique is most applicable to high power applications. In this technique, water drifts outside of the upper reservoir to activate the turbines and generating the high value electricity for peak hours as per the high demand, while during the low demand these station pumps the water from lower reservoir to the upper reservoir using electricity. Height of the waterfall and the volume of water are the two parameters on which storage capacity is based on.

2. Thermal Energy Storage (TES):

Depending on the use of latent or sensible heat, thermal energy storage system is divided into two: Latent – fussion – heat TES and Sensible heat thermal storage, where latent heat storage uses the liquid – solid transition of a material at continual temperature and heating a bulk material yields the sensible heat thermal storage. The stored energy by this system is 40,000kWh of the thermal energy which is equal to almost 1 day of sunlight.

3. Compressed Air Energy Storage (CAES):

This technique is dependent on the comparatively mature technology having numerous high power projects in place. Nearly two third of the power is used by the power plant with typical gas turbine to compress the combustion air. High pressure (40-70 bars) and near ambient temperature is needed to achieve compressed air energy storage. The geological criteria will be eliminated by this method and it make the system calmer to handle and function.

4. Small-scale compressed air energy storage (SSCAES):

It will be good to use compressed air storage under high pressure in cylinders for small and medium scale applications. It is for the purpose of recharging and discharging power. The number of cycles are chiefly restricted by the mechanical weariness of the cylinders. United States has been proposed this type of installation as temporary network support.

5. Energy storage coupled with natural gas storage (NGS):

Coupling of the underground natural gas storage with electricity is done by this technique. The consumtion of energy for compression which could be unconstrained in the form of electricity is caused by the pressure dissimilarity between high pressure gas storage in reservoirs and gas inoculated with a maximum service pressure of 60-80 bars.

6. Energy storage using flow batteries (FBES):

Two electrolyte sytems in which the chemical compound used is in liquid state with the electrolyte for energy storage is called flow batteries. This is the sytem which restricts the capability of typical batteries and also overcome the restrictions of normal electrochemical accumulators hence called limited mass system. Large quantities of energy can be stored by using massive reservoirs and coupling a huge number of cells, and then electrolyte is pumped into the reservoirs to release it.

7. Energy storage in supercapacitors:

In this technique, both the features of capacitors and electrochemical batteries are involved in the components increasing the capacity of cycling. Here insulating material is interchanged by electrolyte ionic conductor where ion motion is parallel to the conducting electrode with a huge specific surface this is the exception in its principle other than the capacitors. These are generaly very durable and persist for 8-10 years with 95% efficiency.

8. Flywheel energy storage (FES):

This include massive and compound flywheel attached with a motorgenerator and unusual brackets. High capacity flywheels are needed for storing the energy in an electrical power system. It is not feasible to store the enrgy for long term by this apparatus because of the friction losses of 200 tons flywheels which are estimated at about 200 Kw.

Characteristics of Energy Storage Techniques

Energy storage methods can be categorized as per some criterias like as the kind of application (permanent or portable), storage period (short or long term) and the kind of generation (maximum power needed). The fundamental characteristics of the storage systems needs to analyze critically for establishing the comparison criteria of technology. There are some features of the storage systems for the selection principles are listed below:

- Storage capacity
- Available power
- Depth of discharge or power transmission rate
- Discharge time
- Efficiency
- Durability
- Autonomy
- Costs
- Feasibility and adaptation to the generating source
- Self-discharge
- Mass and volume densities of energy
- Monitoring and control equipment
- Operational constraints
- Reliability
- Environmental aspect

Review of Literature

SOCACIU, (2012) overview on the storage of solar heat gathered in summer for space heating in winter. They require to discover an enhanced means to utilize energy, especially in the area of energy storage as the global warming is becoming one of the most critical complications in the world. She classified the solution into the sensible, latent and thermochemical heat stores. If the resultant of the reaction can be well separated, the storage mediums will be very stable this is the amin advantage of the technology and suitable for long term storage.

Chopade, Kauthalkar and Shrama, (2013) dealt with the storage of solar thermal energy in supplies which undergoes phase change. It smoothens the output and improves the energy systems and reliability. Developing inexpensive and efficient storage devices is as significant as emerging new sources of energy. Heat supply and compactness at a stable temperature is the chief advantage of heat storage in phase change material. Procedures of including PCMs into other lightweight building materials like as ceiling, floor tiles and plywood also, being the topic of research.

Khare et al., (2013) demonstrated the use of material selection software package and also identified appropriate sensible heat storage amterials for high temperature system. To find out an appropriate material is a difficult and time consuming process. It is found that the common material like as silicon carbide, alumina, and high temperature concrete, steel, cast iron and graphite, is more effective and suitable for the sensible heat storage. High alumina concretes and alumina silicate geopolymers were found as a promising group of sensibke heat storage media as they are high temperature composite materials.

Luo *et al.*, (2014) provides a widespread and vibrant picture of the state of the art technologies obtainable and where they would be suitable for incorporation into a distribution system and power generation and also overviewed of the economic performance, operation principles, technical performance demonstrates also the development and current research in the vital electrical energy storage techniques, which are based on the kinds of energy stored into six main categories. They made clear that there is no apt commercialized expertise for seasonal energy storage at existing times.

Boda, Phand and Kotali, (2017) presented the examination and investigation of thermal energy storage combining without or with Phase Change Material (PCM) for use in solar water heaters. Phase change material has low range of temperature and high energy density of melting and solidification as compare to the sensible heat storage. In this paper, assessments of preceding work on the latent storage has been discussed and provided an awareness to current efforts for developing fresh programs of phase change materials.

Meena and Choudhary, (2017) reviewed on the thermal energy storage in sensible materials. Pebble bed system is simpler and economical in design and development to store solar energy in sensible heat storage materials as compare to the latent or thermo chemical energy storage. The study thows that pebble bed thermal energy storage predicts the behaviour of porous media for heat transfer and energy storage the result of which is well in experimental data.

Sarbu and Sebarchievici, (2017) focusses on thermal energy storage techniques providing a method of valorizing solar heat and reducing the energy demand of buildings. It is the technology which stores the thermal energy by cooling or heating a storage medium for further use of the stored energy. In this review several values of energy storage techniques and calculation of storage capacities are defined. Accumulation and discharge of heat and cold can be done by the thermochemical reactions as per the demand and humidity also can be control in a variety of applications by the use of different chemical reactants.

Conclusion

This study reviewes the accessible energy storage technique which are valid for electrical power systems. By careful studying the objective, we found that it needs enhancement and optimization of power electronics in the field of storage techniques and it is often used in the conversion of electricity into storable energy. Optimization of the methods in terms of efficiency, cost, reliability, maintenance, environmental and social impacts, etc. will be promoted by the study of complete system. Storage is a fundamental element for the development of renewable energies. If the source of energy is associated to the distribution network, the storage will not be a necessity.

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