RESEARCH PAPER | Engineering | Volume : 5 | Issue : 7 | July 2015 | ISSN - 2249-555X

Reliable Energy Storage System for Advanced Power Systems & Distribution

KEYWORDS: Power systems, Energy Storage systems, flywheel energy, HVDC, FACTS, Power electronics, super capacitors.

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ABSTRACT *Energy storage technology do not represent energy sources they provide valuable benefits to improve stability power quality & reliability of supply Battery technologies have improved significantly to meet the challenges of practical electric appliances. Flywheel technologies are now used in advanced no-polluting uninterruptible power supply. Advanced compensators are being considered as energy storage for power quality applications. Super conducting energy storage systems are still in their prototype stage but receiving attention for utility applications he latest technology developments seeks performance analysis & cost considerations are addressed. This paper concentrates on the performance benefits of implementing energy storage to power electronic compensators for utility applications.*

I.INTRODUCTION

Electric power systems are going through various changes in operational requirements as a result of regulations. Continuing electric load growth and higher regular power transfer in a huge interconnected network leads to complex and less secure power system operation. Power generation and transmission facilities have not growth to meet these new demands as a result of economic, environmental, technical and governmental regulation constraints. The growth of electronic loads has made the quality of power supply. Power system engineers are facing these challenges. This problem seeks solution to allow then to operate the system in a controlled manner.

Whenever power system disturbance once, synchronous generators are not always be able to respond rapidly to keep the system stable enough to operate. If high-speed real or reactive power control is available load shedding or generator dropping may be awarded during the disturbance. High speed reactive power control though power coming from the same line or in some cases form adjacent lines facing the same substation However a better solution would be to have the ability to rapidly vary real power without impacting the system through power circulation.

Recent developments and a Vance's in energy storage and power electronics technologies a viable solution for modern power applications. Viable storage technologies include batteries, flywheels, ultra capacitors & superconducting energy storage systems. Through several of these technologies were initially envisioned for large-scale load-leveling application energy storage is now seen more as a tool to enhance system stability aid power transfer & improve power systems.

II. ENERGY STORAGE SYSTMES FOR TRANSMISSION & DISTRIBUTING APPLICATIONS

Electrical energy in an AC system cannot be stored electrically. However, energy can be stored by converting the AC electrically and storing it electromagnetically electrochemically, kinetically r as potentially.

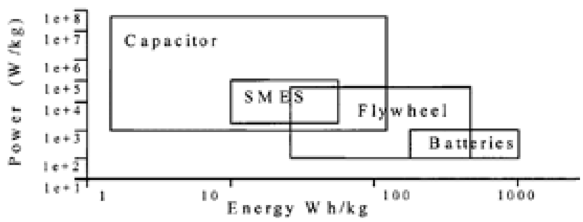

Fig. 1. Specific power versus specific energy ranges for near-to-midterm technology.

There are four major technologies by which will can store energy for power systems & its distribution or applications these are as follows:

1. Superconducting Magnetic Energy Storage (SMES).
2. Battery Energy Storage Systems (BESS).
3. Advanced Capacitors.
4. Flywheel Energy Storage (FES).

A Superconducting Magnetic Energy Storage (SMES)

SMES systems have attached the attention of both electric utilities and the military due to these fast response efficiency (almost – 95%) possible applications include load leveling, dynamic stability, transient stability, voltage stability, frequency regulation, transmission capability enhancement, and power quality improvement.

An SMES unit is a device that stores energy in the magnetic field generated by the DC current flowing through a superconducting coil. Thus inductively stored energy (E in joules) and the rated power (P in welts) are commonly given specifications for SMES devices, and they can be expressed as follows:-

$$E = \frac{1}{2} LI^2 = LI\frac{dI}{dT} \quad = \quad P = \frac{dE}{dt}$$

Where L is the inductance of the coal, I is the DC current flowing through the coil, and V is the Voltage across the coil, since energy is stored as circulating current energy

Volume : 5 | Issue : 7 | July 2015 | ISSN - 2249-555X

can be drawn from an SMES unit with almost instantaneous response with energy stored or delivered over periods ranging from a fraction of a second to several hours.

The schematic diagrams that contains respective components of a typical SMES system is as under

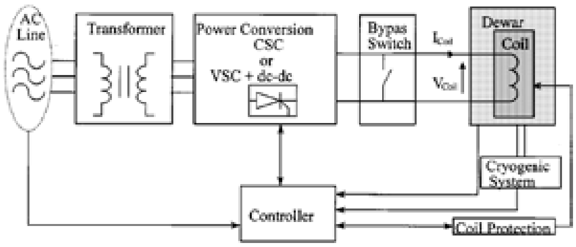

Fig. 2. Components of a typical SMES system

B. Battery Energy Storage System (BESS)

Batteries are one of the most cost effective energy storage technologies available with energy stored electrochemically. A battery system is made up of a set of low voltage/ power battery modules connected in parallel and servers to achieve a depend electrical characteristics. Batteries are "Charged" when they undergo an internal chemical reaction under a potential applied to the terminus.

They deliver absorbed energy, or "discharged", whey they reverse the chemical reaction. Key factors of batteries for storage applications include:

High energy density, high energy capability, round trip efficiency, cycling capability, life spam & initial cost BESS have recently emerged as one of the more effective with respect to storage technologies for power applications offering a wide range of power system applications such as area regulation, area protection.

Several BESS units have been designed and installed in existing systems for the purpose of load leveling, stabilizing & load frequency control. Optimal installation site and capacity of BESS can be determined depending upon its application these have been done for load leveling applications. Also, the integration of battery energy storage with a FACTS power flow controller can improve the power system operation & control.

C. Advanced Capacitors

Capacitors store electric energy by accumulating positive & negative charges separated by an insulating di-electric. The capacitance 'C' represents the relationship between the stored charge 'Q' and the voltage between the plates 'V' the capacitance depends on the permittivity of the dielectric 'E' the area of the plates 'A' & the distance between the plates 'D'. The Energy stored on the capacitor depends on the capacitance and on the & quire of the voltage. Following equation explains better mathematically:

$Q=CV$

$C=\dot{\varepsilon}A/d$

$E=1/2CV^2$

Note: C_{TOTAL} & R_{TOTAL} are the result from a combined series/ parallel configuration of a capacitor cells to increase the total capacitance and the voltage level. The product R total C_{TOTAL} determines the response time of the capacitor for charging or discharging.

Several varieties of advanced capacitors are there:

a) Ceramic hyper capacitors
b) Ultra capacitors
c) Super capacitors etc.
d) Flywheel Energy Storage (FES).

Flywheels can be used to store energy for power systems when the flywheel is compiled to an electric machine. In most cases power converted is used to drive the electric machines to provide a under operating range. Stored energy depends on the moment of Inertia of the motor & the square of the rational velocity of the flywheel. The moment of inertia (I) depends on the radius, mass, & height (length) of the motor.

Energy is transferred to the flywheel when machine operates as a motor; charging the energy storage device. The flywheel is discharged when the electric machine regenerates through the driver slowing the flywheel.

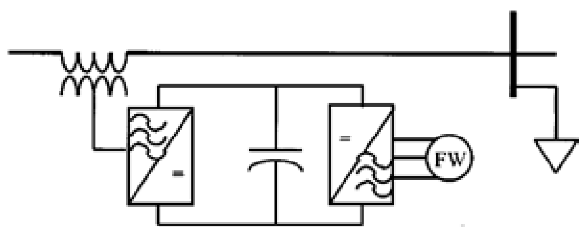

Fig. 3. Flywheel energy storage coupled to a dynamic voltage restorer.

The energy storage capability of flywheels can be improved either by increasing the moment of inertia of the flywheel or by lenity it a weightier rotational velocities.

These are two strategies by which we can utilize the use of flywheels

1. Increase moment of inertia with the help of large radius – UPS (uninterrupted Power supply).
2. Design flywheels with less weight motor which gives 60% more rotations.

III. POWER SYSTMS APPLICATIONS

There are mainly three categories that comes under this section

1. Integration of Energy Storage Systems into FACTs Devices.

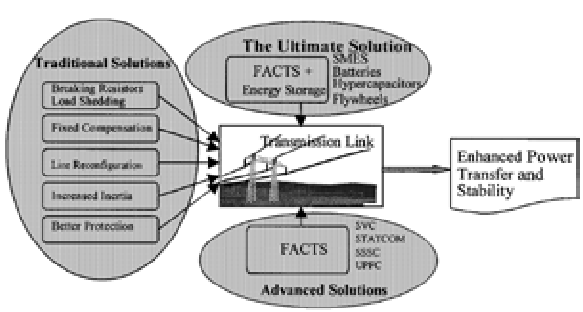

Fig. 4. The ultimate solution: FACTS+ESS.

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2. H V D C transmission & Distribution Applications.
H V D C systems operate at high voltage levels to reduce resistive losses the systems use- line- commutated the register-based converters and have a simple point-to-point layouts with a single rectifies.

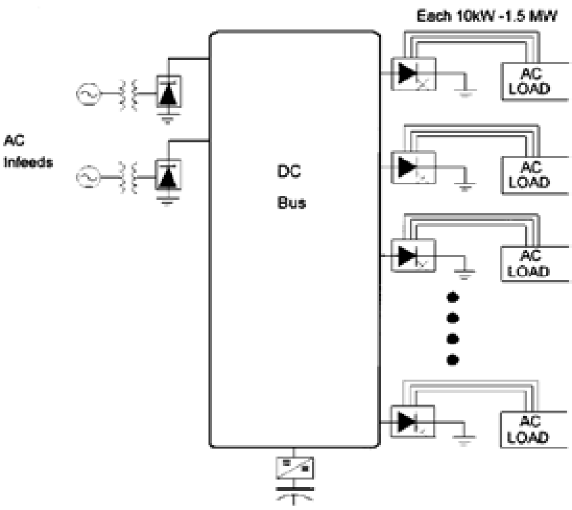

Fig. 5. DC system with capacitive energy storage added to the DCsystem through a DC-to-DC converter.

3. Power Quality Enhancement with Energy Storage.
The dynamic voltage restores (DVR) is a pulse width-modulated (PWM) converter in series with lines, having a DC link stabilized by an energy storage element, usually a large capacitance. The DVR is explained by having a DC energy source DC capacitors.

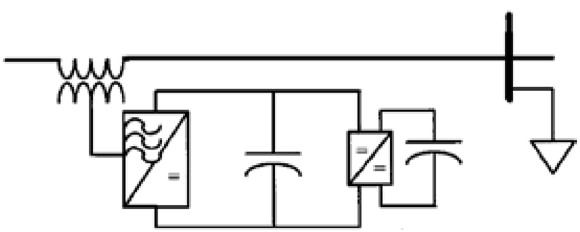

Fig. 6. Dynamic voltage restorer (DVR) with capacitor storage.

IV. COST ESTIMATIONS
To establish real cost estimates, the following steps are accountable

- Indentify the system issues to be accounted.
- Select Basis system characteristics
- Define basic energy storage, voltage & current requirement of the system
- Determine utility & financial Benefits from the operation of system
- Compare and analyse deferent energy storage systems performance & costs

SYSTEM	COST (INR)
1.UTILITY APPLICATIONS	5-8Lac/MJ.
2. SUPPORTING SYSTEM	1-5Lac/MJ.
3.CONVERSION SYSTEM POWER	10-15 Lac/KW.
TOTAL	25-30 Lacs.

V. CONCLUSION
As the potential performance benefits produced by advanced energy storage systems are improved with system reliability dynamic stability, enhanced power quality, transmission capacity enhancement, and area protection an energy storage device that can have a positive cost & environmental impact.

FACTS devices which handle both real and reactive power to achieve improved transmission system analysed performance are multi MW proven electric devise now being introduced in the utility industry. The paper show the energy storage devices can be used to power electronic converters to provide power system stability, enhanced transmission capability & improved power quality, adding energy storage to power electronics compensators not only enhances the performance of the device, but can also provide the possibility of reducing the MVA ratings requirements of the font-en power – electronics conversion system. This is an important cost/benefit consideration when considering adding energy storage systems.

REFERENCE
[1] J. Mc Dowell, “conventional battery technologies – present and future in proc. 2000 IEEE power engineering society summer. Meeting, vol 3 July 2000, PP 1538-1540. | [2] E. Scheme PP. & W. D. Jackson, “systems considerations in capacitive engineering conf, vol 2 Aug. 1996. PP 666 – 671. | [3] H. Akagi, “Active filters and energy storage systems operated under non periodic conditions”, in Roe. 200 IEEE power engineering Society summer meeting vo. 2 July 2000 PP 965-970. | [4] K. K. Leung & D. Sutano, “A storage power flow controller (SPFE) using battery storage, in IEEE 1999 int. Power electronics & Drive systems. Hong Kong, July 1999. | [5] A. B. Arsoy, “Electromagnetic transient & dynamic modelling and simulating or a statcom – SMES compensator in power systems”, PhD dissertation, Black sburg, VA, 2000. | [6] L. Weimers, “New markets need new technology”, in powercom 2000 comf, Dec 2001. | [7] P. F. Rigeiro, Brain K J Dhnson, Mareisa Lcrow, A Yson Arsoy, Yilu Lui, “Energy storage systems for Advenced power Applications”, IEEE conf 2008. | [8] Ravi Gupta, NK, Sharma P Tiwari,, Actha Gupta, Nitsha Nigam Anubha Gupta, International Journal of engeerning sceemce & technology vol 3. No 1 2011 PP. 289-297. |