HYBRID ENERGY STORAGE FOR MICROGRID PERFORMANCE IMPROVEMENT UNDER UNBALANCED AND NON-LINEAR LOAD CONDITIONS

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Abstract - Energy storage system (ESS) is usually wont to manage the intermittency of renewable energy sources (RESs). one among the important issues in micro-grids, is to provide top quality powers to consumers. This project proposes the utilization of hybrid energy storages to enhance the facility quality under unbalanced load conditions for micro-grids applications. Battery and Super capacitor (SC) are used as hybrid energy storages systems (HESSs) that provide low and high power frequency respectively. The proportional resonance (PR) and fuzzy controllers are, respectively, wont to regulate the AC load voltage and DC bus voltage controller. the most advantages of the proposed energy management scheme are to scale back battery power fluctuations, better DC bus voltage regulation for generation and cargo disturbances, improvement of the system performance under unbalanced load conditions, reduced rate of charge/discharge of battery current, improved power quality feature under unbalanced load and transition conditions. The performance of the proposed method and control strategy is verified by using simulation studies within the MATLAB software environment.

Keywords: Micro grid, Charging and discharging control, Bidirectional dc-dc converter,solar Battery.

I. INTRODUCTION

MICROGRID is a promising concept to meet the challenges of integrating various distributed generators (DGs) and energy storage systems (ESSs) into the electricity network . Micro grids can operate in both grid connected and islanded modes. In islanded mode, the key questions are how to ensure the supply–demand balance within the micro grid and how to achieve this in the most cost-effective way.

Wind and solar power are among the most promising renewable power supply alternatives due to their abundance, cleanness, and free primary energy source. However, the intermittency of wind and solar power supply poses new challenges to the operation and control of autonomous micrograms, especially under high penetration levels. Installing and operating ESSs such as batteries. They can be utilized as buffer to absorb excessive power during peak generation periods, compensate the insufficient power during peak load periods [8], and they can also balance short-term variations in total net load. The frequency of the micro grid may change rapidly and frequently due to the intermittency of the renewable generation and low inertia present in the microgrid. The battery ESSs (BESSs) is a power electronic-based device and has a fast response time [8]. Therefore, the active power imbalance of an islanded microgrid caused by the integration of intermittent RG sources can be minimized when BESSs are introduced and innovative cooperative control methods are implemented.

The major cooperative control strategies can be classified into three categories. The first strategy is to implement a centralized control scheme through a central controller which coordinates all BESSs [10], [11]. This kind of strategy requires communication between the central controller and every single component in the microgrid to collect information globally and a powerful central controller to process large amountsof data [12]. Thus, these solutions are costly to implement and susceptible to single-point failures. The second is a fully decentralized control strategy which is based on local information only, such as droop control proposed in [13]. This type of control strategy is robust and less expensive in the sense that no communication is required. However, due to the lack of broader available information, it may not be effective to utilize all available resources in the network in an optimal way [14]. The third approach is a distributed control strategy, which only requires information exchange among components through a local communication network. As the components within a microgrid could be diverse and distributed, the control and management solutions should be as efficient and costeffective as possible for the microgrid to be economically viable. Since well-designed distributed control strategies can be flexible, reliable, scalable, and low-cost to implement [12], they are considered as a promising option for the control and operation of micro grid.

“ For a micro grid to work autonomously, the key problems are to maintain the active power balance to stabilize system frequency and regulate the reactive power to keep the voltage magnitudes in allowable ranges. There are many previous studies on control and optimization of ESS for grid frequency support [15]–[18]. References [15], [16] propose an optimization method for dimensioning BESS based on the state-of-charge (SOC) limitation to regulate the primary frequency.

ESS to support grid frequency and reduce the impact of intermittent renewable generations. To improve the performance of conventional droop control, Lu et al. [18] propose an adaptive droop control for balancing the SOC of the distributed ESS in a micro grid. However, all these studies are carried out based on the assumption that the charging/discharging efficiency remains the same for different charging/discharging rates. References [19] and [20] show that the charging efficiency has a no negligible dependence on the charging rate because of the internal battery resistance. References [21] and [22] show that the charging efficiency of a BESS decreases almost linearly with the charging rate. Also, the efficiency shows a certain dependence on the current SOC, which may drop to 50% for lead–acid batteries as reported in extreme cases in [23]. To control and operate the distributed ESS in an autonomous microgrid in a cost-effective way, the charging/discharging efficiency needs to be taken into consideration.

To address the above problems, this paper proposes a cooperative control strategy of multiple BESSs to maintain the active power balance and minimize the total active power loss associated with BESS charging/discharging inefficiency. The proposed strategy is based on a multiagent system (MAS) framework. According to the MAS-based control solution presented in this paper, an agent is assigned to each node in the microgrid. The agent with no BESS connected to its node just participates in discovering optimal incremental cost and net active power. The agent with BESS connected to its node has two control levels. The upper control level is a consensus-based optimization algorithm which adjusts the local BESS charging/discharging rate reference to minimize the total power loss from charging/discharging the BESS while maintaining the supply–demand balance. The lower control level is responsible for controlling the BESS to track the power output reference. To solve the above issues, in this paper, a power allocation strategy for the HESS group under the unbalanced load and nonlinear load conditions is proposed. The proposed HESS adopts dual inverter structure, including a battery PCS (BATPCS) and an ultracapacitor PCS (UC-PCS). In the strategy, the power allocation between the two inner PCSs, and the power sharing among HESSs are both studied. The BATPCS, as the main unit in the HESS, adopts the droop control method to ensure active power sharing among HESSs; the UC-PCS, as the auxiliary unit, works in compensation mode,

Outputting reactive, negative sequence and harmonic powers. During load or generation variations, the UC-PCS will extra provide high-frequency active power to make up for the low power density of the BAT-PCS.

II. DROOP CONTROL IN NETWORKED MICROGRID

Coordination of various distributed generation (DG) units is important to satisfy the increasing demand for electricity. Many control strategies, like droop control, master-slave control, and average current-sharing control, are extensively implemented worldwide to work parallel-connected inverters for load sharing in DG network. Among these methods, the droop control technique has been widely accepted within the scientific community due to the absence of critical communication links among parallel-connected inverters to coordinate the DG units within a microgrid. Thus, this study highlights the state-of-the-art review of droop control techniques applied currently to coordinate the DG units within a micro grid.as show in below figure1

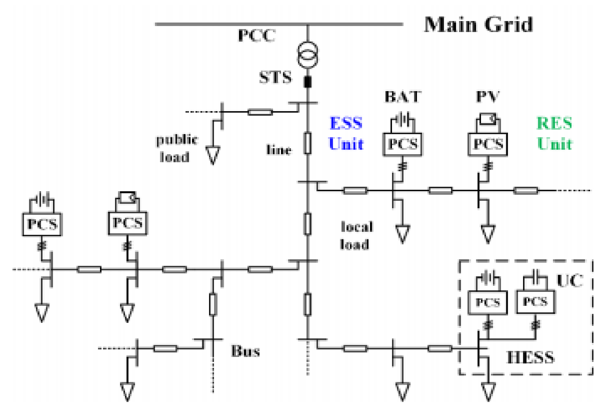

Fig 1: Illustaration of DC Micro Grid

To solve the facility sharing issue in islanded micro grid, the traditional droop control method is typically applied to the BAT-PCS, and its control expressions are as follows:

f*=$f_{o-D_p\,P}$--→1

E*=$E_{o-D_Q\,Q}$−−→2

Where f_o and E_o are initial values of the frequency and voltage magnitude of the DG unit, respectively; P and Q are the measured active and reactive powers after the first-order low-pass filtering (LPF), respectively; Dp and Dq are the active and reactive power droop slopes, respectively. When SOC is not considered, they are normally associated with the power rating of the DG unit, which can be defined as

$$D_P = \frac{f_{max} - f_{min}}{P_{max}} \dashrightarrow 3$$

$$D_q = \frac{E_{max} - E_{min}}{Q_{max}} \dashrightarrow 4$$

where fmax and fmin are the upper and lower bounds of the micro grid frequency, respectively; Emax and Emin are the upper and lower bounds of the microgrid voltage, respectively; Pmax and Qmax are the active and reactive power ratings of the DG unit. With the derived frequency and voltage magnitude, the instantaneous voltage reference of the DG unit are often obtained accordingly.

III. PROPOSED SYSTEM

The main circuit of the HESS is shown in Figure 4. The BAT-PCS and UC-PCS have their respective control chips, and therefore the frequency of the BAT-PCS is shipped to UC-PCS through local communication link. the 2 PCSs have an identical structure: the primary stage may be a bidirectional buck boost converter, and therefore the second stage may be a three-phase half bridge inverter. In discharge state, the energy flows from the primary stage to the second stage, and therefore the bidirectional buck-boost converter works in boost mode. While responsible state, the energy flows from the second stage to the primary stage, and therefore the bidirectional buck-boost converter works in buck mode

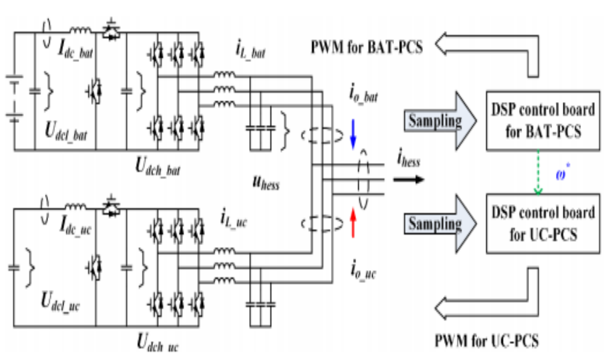

Fig 2: Main circuit of the proposed HESS

B.Control strategy of HESS:

The power allocation strategy within the single HESS has been introduced above. When the micro-grid contains several such HESSs, they have cooperate together to take care of the voltage and frequency of the micro-grid and also share the load demand. So, the networking strategy is required.

To adapt different requirements, the HESS is meant to possess several external coordination strategies. The HESS can operate in either master and slave mode or peer to see mode. In master and slave mode, one HESS with large capacity is about because the master unit, working in VF mode. The others add PQ mode. In peer to see mode, all the HESSs add Droop mode and support the micro grid voltage together

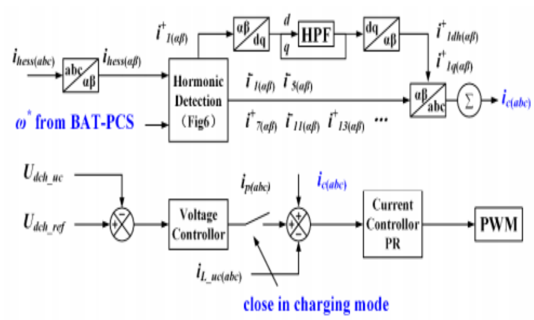

Fig3: Control strategy of the BAT_UC

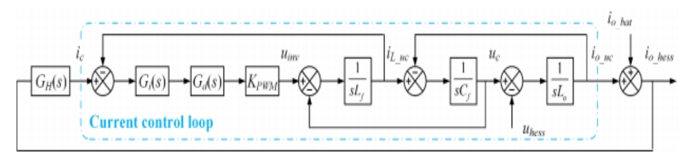

Fig 4:Model of the UC-PCS with the current compensation control method

IV. SIMULINK DESIGN AND RESULTS

A micro grid model is designed in Matlab/Simulink to validate the proposed coordination control strategy. As shown in Figure 5 the simulated microgrid is composed of three identical HESSs and several loads .In the below intially designed by a PV Module which is connected with a boost converter,Here the boost convereter will boost up the input voltage more than the input voltage, to get the maximum voltage at output end of dc dc converter here we used a Perturb & Observe based Maximum power tracking Algorithm.

After words from Ultra capacitor which is generating a dc voltage connected to bidirectional DC-DC Converter which will act as step up and step down dc dc converter from secondary side A Li-ion type of battery which is having a 24v connected to bidirectional DC DC converter

All three solar based dc dc converter ultra capacitor based bidirectional dc dc converter and battery with bidirectional DC DC converter all are connected to a linear load.

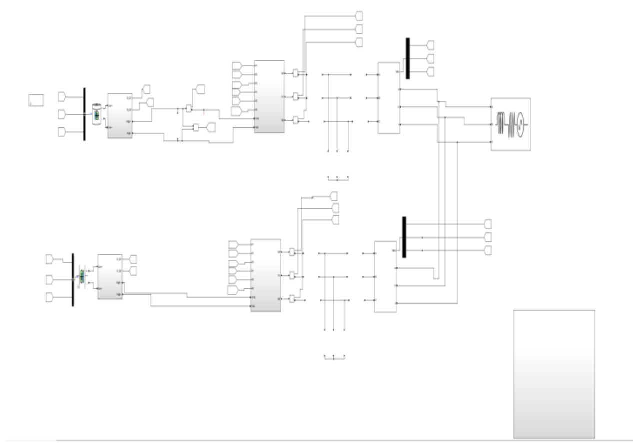

Fig 5: Proposed Control Strategy Of HESS (Battery+Ultracapacitor) Grid system

A Proposed Control strategy of HESS (Ultra Battery) based Grid connected inverter system which is applicable medium and high power voltage applications, First here parallel interconnected two Grid inverters are implements with rating by synchronizing with grid system. The UC-PCS only compensates the high frequency active current. At the beginning, only Load 1 is connected. According to the characteristics of the droop control, the three BAT-PCSs output the same active current but different reactive current. The simulated currents of the BAT-PCSs and UC-PCSs

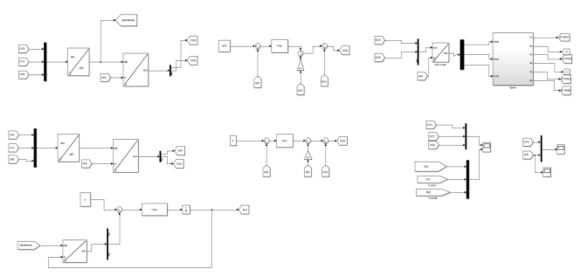

Fig 6 : Simulink Design of Proposed Controller

However, as only the high frequency active current is compensated, and the reactive current is ignored, the currents of the BAT-PCSs still change rapidly. On the other hand, in the whole simulation process, the power sharing of BAT-PCSs has not been realized

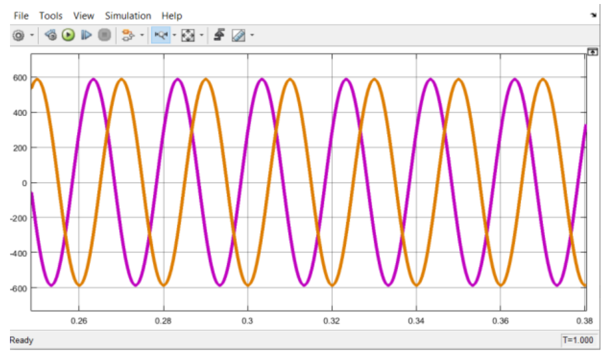

Fig 7: Voltage waveforms Va&vb Inveter

The currents of the inverters 1 and 3 using the conventional droop control method Due to the different feeder impedances, the two inverters output different currents at the beginning. From the comparison of the voltage, it can be seen that the currents contain reactive components. When inverter 2 and 4 start the compensation, the currents of inverter 1 and 3 become equal

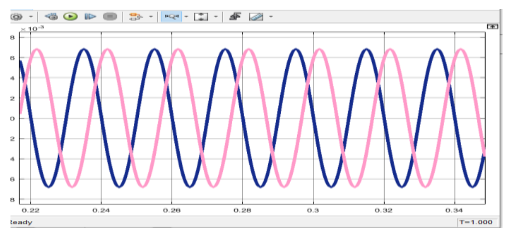

Fig 8:Current waveforms of Battery Connected Grid Inverter Ir+Iy

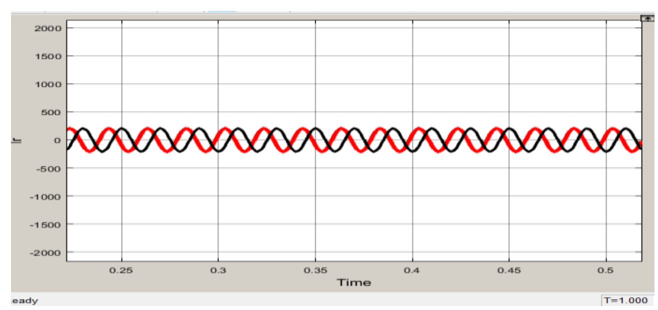

Fig 9: Output waveforms (Ir+Iy) of Current Grid inverter

By connecting parallel inverter circulating will produce so by applying co ordinate control stargey for dc link capacitors we are minimizing the ripples of dc link voltage by minimizing the ripples of dc link capacitor while we are converting dc to Ac we will get more harmonics but here we are minimizing the harmoinic reduction hence here we are minimizing circulating currents equal to zero.

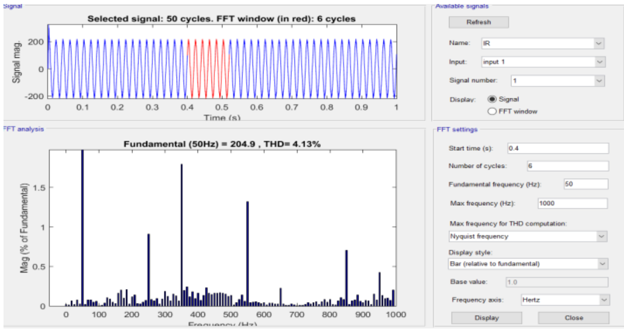

Fig 10 :Total Harmonic distortions of Grid Current 4.13%

V. CONCLUSION

In this venture, a coordination control procedure is proposed for the HESS made out of BAT-PCS and UC-PCS. Contrasting and the typical procedure, the proposition further examinations the office assignment issue under uneven and nonlinear burden conditions. The system principally has two focal points. Right off the bat, the static and dynamic presentation of the framework is improved gratitude to the responsive, negative arrangement and symphonious force remuneration part of the UC-PCS. Furthermore, precise force sharing among BAT-PCSs is acknowledged in arranged microgrids; and correspondence is just utilized inside HESS. In addition, the twin inverter structure of HESS is favorable for the updating of existing gear. Reproduction and trial results have confirmed the adequacy of the proposed coordination system. inside the recreation, both the static and dynamic framework exhibitions are introduced. because of the pay function of the UC-PCS, the BAT-PCS just need yield low-recurrence dynamic force, even in unequal or nonlinear burden conditions. At the point when a few HESSs work together, each BAT-PCS has an identical force yield. Be that as it may, the technique just explains the office sharing issue for the BAT-PCSs, the circling flows actually exist among HESSs, which can cause pointless line misfortune. inside the future, the office sharing issue of the HESS will be concentrated to upgrade the proposed control methodology; then, financial activity will be considered to frame the BAT-PCS yield more adaptable.

VI. REFERENCES

[1]. M. A. Zamani, T. S. Sidhu and A. Yazdani, "Investigations into the control and protection of an existing distribution network to operate asa micro grid: a case study," IEEE Trans. Ind. Electron., vol. 61, no. 4, pp. 1904-1915, April 2014.

[2]. I. Chung, W. Liu, D. A. Cartes, E. G. Collins and S. Moon, "Control methods of inverter-interfaced distributed generators in a microgrid system," IEEE Trans. on Ind. App., vol. 46, no. 3, pp. 1078-1088, May 2010.

[3]. Y. Xu, W. Zhang, G. Hug, S. Kar, and Z. Li, ''Cooperative control of distributed energy storage systems in a micro grid,'' IEEE Trans. Smart Grid, vol. 6, no. 1, pp. 238–248, Jan. 2015.

[4]. M.E. Choi, S.W. Kim, and S.W. Seo, "Energy management Optimization in a battery/supercapacitor hybrid energy storage system," IEEE Trans. Smart Grid, vol. 3, no. 1, pp. 463–472, Mar. 2012.

[5]. M. G. Molina and P. E. Mercado, "Power flow stabilization and control of microgrid with wind generation by superconducting magnetic energy storage," IEEE Trans. Power Electron., vol. 26, no. 3, pp. 910– 922, Mar. 2011.

[6]. U. Akram, M. Khalid and S. Shafiq, "An innovative hybrid wind-solar and battery-supercapacitor microgrid system-development and optimization," IEEE Access, vol. 5, pp. 25897-25912, 2017.

[7]. A. V. Savkin, M. Khalid, and V. G. Agelidis, ''A constrained monotonic charging/discharging strategy for optimal capacity of battery energy storage supporting wind farms,'' IEEE Trans. Sustain. Energy, vol. 7, no. 3, pp. 1224–1231, Jul. 2016.

[8]. M. Khalid, A. Ahmadi, A. V. Savkin, and V. G. Agelidis, ''Minimizing the energy cost for micro grids integrated with renewable energy resources and conventional generation using controlled BA.