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A FUZZY BASED WIND-HESS SYSTEM CSSONTROL METHOD TO SUPPRESS WIND POWER FLUCTUATION WHILE CONSIDERING THE OPERATING STATES OFHESS.

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ABSTRACT

The guideline objective of this paper is A FUZZY based Wind-Hess structure control method tosmother wind control change while contemplating the working area of HESS. This paper has proposed a fleecy based breeze HESS systemcontrol method to smother wind control instabilitywhileconsidering the working states (SoC level) of HESS. Thekey motivation behind thecontroller is to dole out wind fluctuationswith unmistakable repeat gatherings to thesupercapacitor and thebattery by dynamically changing the time steady of primaryanddiscretionary channel channels. The suitability of the proposed method has been appeared for a real power system.A feathery based breeze HESS structure controller is proposed to smother thebreeze control instabilities. The proposed controller abuses the complimentary traits of thesupercapacitor and battery with the supercapacitor and battery responsible for high and focusrepeat portions of wind changes, independently. In this endeavor PV structure is related withbattery for better performance.The capability of the proposed arrangement in the paper for wind.

Index Terms—Hybrid Energy Storage System (HESS), Wind power, Optimal storage sizing, Fuzzy base control, grid frequency deviation, Differential Evolution.

1. INTRODUCTION

One of the principle concerns is the matrix recurrence deviation when the level of wind control infiltration is high. Particularly in a low latency network, speed governors and rotor dormancy of synchronous generators (SGs) will most likely be unable to oblige the breeze control fluctuation to keep the recurrence deviation inside the prerequisite of Matrix Code. Thus effect of wind control vacillations on network recurrence dependability has been a point of examination sought after by numerous analysts as of late. Strategies dependent on time-area recreations and Time-Recurrence Change have been connected and proposed in the

2581-4575

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examination to survey the effect. Contrasted and the single vitality stockpiling framework (ESS), the HESS is made out of a high-vitality stockpiling (ESS-E) and a powerful capacity (ESS-P) where the ESS-E meets the moderate, long haul vitality varieties and the ESS-P manages the pinnacle and quick transient power. A half and half vitality stockpiling framework (HESS) can join the specialized benefits of various sorts of ESSs and accordingly give wanted execution of intensity and vitality abilities. Different examines have been made as of late with the point of dealing with the power and vitality stream between ESS-E and ESS-P. Creators have made a definite survey of the best in class control procedures for HESS with sustainable power source incorporated. The control systems of vitality administration of HESS can be arranged into two classifications which are established control technique and keen control procedure.

The established control procedures incorporate Principles Based Controller (RBC) and Filtration Based Controller (FBC) and both are generally utilized in vitality administration of ESS because of the effortlessness and less computational endeavors. The RBC control the power set purposes of the HESS dependent on pre-characterized rules and the FBC receives the channel (e.g. low-pass channel, moving normal channel and wavelet change) to break down the lopsidedness control into high-recurrence and low-recurrence parts. In any case, the established control techniques are pre-set and inflexible which are hard to adjust to ongoing framework conditions. In this manner, canny control systems, for example, counterfeit neural system, fluffy rationale controller, which are more powerful and effective when contrasted with established control procedures, are acquainted with deal with the vitality stream of HESS. In this paper, the proposed control technique depends on the FBC strategy and furthermore receives the wise control strategy to consequently modify the channel parameters with the end goal to adjust to the genuine framework conditions. In term of ESS to help recurrence steadiness, numerous examinations have been directed on the recurrence controller outline.

A recurrence area based methodology was proposed to measure a solitary ESS and battery-supercapacitor HESS framework for keeping up lattice control balance when entrance of wind age is high, with the end goal to keep up the matrix recurrence deviations inside as far as possible. In any case, the ideal measuring calculation does not consider the control system of the HESS, which will constrain its genuine applications. To check the issue of recurrence deviation caused by wind control variances, vitality stockpiling frameworks (ESSs) can be utilized to remunerate the breeze changes or to give additional capacity of recurrence reaction. In the advancement of ESSs, two key elements to be inspected are the ESS constant activity methodology and estimating. As they are diverse issues about specialized and monetary parts of ESSs, up until this point, they have been considered and inspected independently.

In any case, ESS control methodology may drastically influence the measuring results. Additionally, capacity estimating limit can't be

2581-4575

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checked through the constant activity , in the event that it is analyzed independently. Thus if those two key components can be researched together, a more profound knowledge into the issues and better technique can be gotten. Creators of introduced the estimating and control systems for a battery based ESS to repay wind control conjecture mistakes. A structure for ideal measuring and vitality administration of shrewd home with battery vitality stockpiling framework (BESS) and photovoltaic (PV) control age is proposed for the objective of augmenting home economy, while fulfilling home power request utilizing raised programming (CP) and randomized calculations. In any case, the work that has been done on ESS control and measuring, just thinks about a solitary kind of ESS. This paper proposes a streamlining technique and fluffy based control methodology for a breeze HESS framework to ideally decide the extent of the HESS to meet the prerequisite of breaking point on network recurrence deviation.

Fundamental commitments of this paper are as per the following:

1) A fluffy based control methodology for consolidated breeze cross breed vitality stockpiling frameworks (HESS) considering the diverse SOC levels (typical, cautioning and alert state) is proposed in the paper to alleviate network recurrence deviations by smoothing the variances of wind control age. The proposed technique can maintain a strategic distance from the ESS over-charging hazard and in the meantime keep the ESS from working near the over releasing zone, which enhances the cycle life of the HESS.

2) An ideal estimating technique dependent on differential advancement (DE) is produced to measure the negligible limit of HESS to meet the lattice recurrence deviation constrain, while likewise evaluating the effect of control methodology on measuring results.

2. LITERATURE SURVEY

2.1Assessmentof frequency and harmonic distortions during wind farm rejection test

This paper proposes a new application of the self-tuning least squares (STLS) estimation algorithm for understanding transient processes during a rejection experiment at a wind farm site in Denmark. The problems of simultaneous estimation of frequency and harmonic distortion in a wind farm are investigated. An adaptive and robust application of the STLS algorithm is proposed to estimate the unknown parameters during the dynamic changes due to forced islanding conditions. Equipped with a self-tuning procedure, the algorithm is resistant to noise which significantly improves its accuracy.

The system frequency is considered as an unknown model parameter and estimated simultaneously with fundamental and harmonic components. The outcome is an estimation method which is not sensitive to variations of system frequency. To demonstrate the efficiency of the proposed algorithm, a number of computer simulated tests are also presented. Several interesting results can be observed during the rejection experiment: the large deviations of three phase voltages and currents, the changes of total harmonic distortion, and variations of power system frequency.

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2.2Frequency deviation of thermal power plants dueto wind farms

This paper presents the results of a study on the frequency deviation of the utility grid due to wind power fluctuations. The deviation is estimated by a deterministic method based on the transfer functions of system components. As the grid frequency is regulated, the deviation can limit high wind power penetration. The research identifies speed governors as one key component in enabling high wind penetration and there is need to factor their increased wear and tear into the ancillary services cost. It also raises the question as to whether the existing standards set for frequency deviation, which have to be complied at the points of connection of wind energy providers, are adequate to promote high wind penetration

2.3Method for Assessing Grid Frequency Deviation Due to Wind Power Fluctuation Based on Time-Frequency Transformation

Grid frequency deviation caused by wind power fluctuation has been a major concern for secure operation of a power system with integrated large-scale wind power. Many approaches have been proposed to assess this negative effect on grid frequency due to wind power fluctuation. Unfortunately, most published studies are based entirely on deterministic methodology. This paper presents a novel assessment method based on "Time-Frequency Transformation" to overcome shortcomings of existing methods. The main contribution of the paper is to propose a stochastic process "simulation" model which is a better alternative of the existing dynamic frequency deviation simulation model. In this way, the method takes the stochastic wind power fluctuation into full account so as to give a quantitative risk assessment of grid frequency deviation to grid operators, even without using any dynamic simulation tool. The case studies show that this method can be widely used in different types of wind power system analysis scenarios.

2.4 Hybrid energy storage systems and control strategies for stand-alone renewable energy power systems

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. A hybrid energy storage system (HESS) is a better solution in terms of durability, practicality and cost-effectiveness for the overall system implementation. The structure and the common issues of stand-alone REPS with ESS are discussed in this paper. This paper presents different structures of stand-alone REPS with HESS such as passive, semi-active, and active HESS. As there are a variety of energy storage technologies available in the market, decision matrixes are introduced in this paper to evaluate the technical and economic characteristics of the energy storage technologies based on the requirements of stand-alone REPS. A detailed review of the state-of-the-art control strategies such as classical control strategies and intelligent

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control strategies for REPS with HESS are highlighted.
The future trends for REPS with HESS combination and control strategies are also discussed.

3. MODELING OF HYBRID ENERGY STORAGE SYSTEMS

A generalized reduced order model of energy storage systemis adopted in this paper, which is shown in Fig. 1.The differences between supercapacitor and battery storagein this generalized model are the response time. Normally,the response of supercapacitor is faster than the battery (i.e.T_{ess};sof supercapacitor is larger than T_{ess};b of battery). Thecharging input of ESS is limited by the current SoC and theESS power rating. The general mathematical model ofESS is defined as follows:

$$\mathrm{SoC}_{t_1}\% = \mathrm{SoC}_{t_0}\% + \frac{1}{E_{ess}\cdot h}\cdot \eta \cdot \int_{t_0}^{t_1} P_{ess}dt$$

where, E_{ess} is the energy rating of the ESS. h is chosen tobe 3600 due to the 1-second time resolution of the input data.

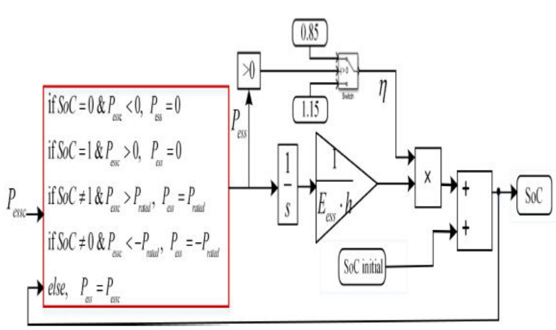

Fig. 1. Generalized reduced-order model of ESS including converter (left side) and battery (right side) model.

4.FUZZY BASED WIND-HESS SYSTEM CONTROL

This section presents a brief description of the fuzzy basedwind-HESS system (FWHS) control theory. As shown in Fig.2, the supercapacitor and battery are connected to the commonDC link. The Voltage Source Converter (VSC) is used tocntrol the power flow from the supercapacitor and battery by
the control reference signal from proposed FWHS system

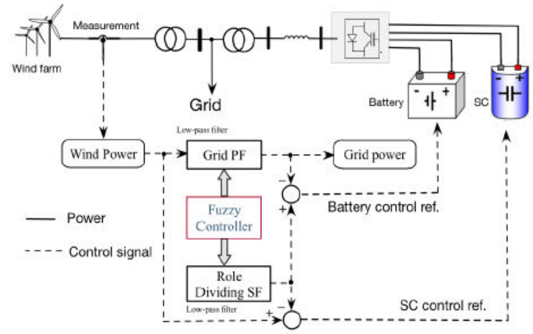

Fig. 2. The control scheme of fuzzy based wind-HESS system.

4.1Wind-HESS System Smoothing Control Strategy

As being illustrated in Fig. 3, randomly variable wind powerfluctuations can be decomposed into three components: high frequency variation, middle-frequency component and lowfrequency variation [23], by defining two different cut-offf requencies fH and fL. Different variable components of wind
power fluctuation can be accommodated by relevant storagetechniques.

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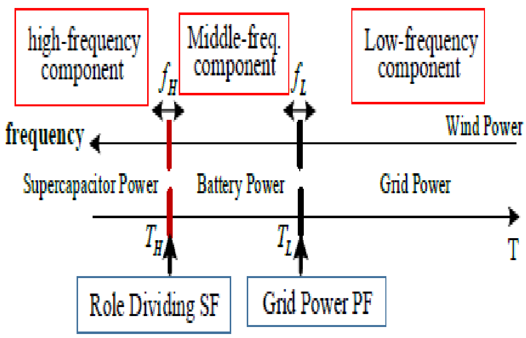

Fig. 3. Illustration of wind-HESS Smoothing principle.

4.2. Grid Power Primary Filter

Grid power primary filter, which is controlled by a timeconstant TL, is adopted to determine how much power ofHESS has to take charge of. Equation (3) represents thetransfer function of the grid power primary filter:

$$G(s) = \frac{1}{1 + sT_L}$$

The time constant TL is dynamically determined by thefuzzy-based controller. As shown in Fig. 5, the inputs ofthe grid power fuzzy controller are: 1) sum of battery andsupercapacitor charging power; 2) combined SoC level ofHESS. A combined SoC equation of the HESS is proposed toevaluate the SoC level of HESS, which is shown as follows:

$$SoC_{com}\% = \frac{E_{rated,s} \cdot SoC_{sc}\% + E_{rated,b} \cdot SoC_{batt}\%}{E_{rated,s} + E_{rated,b}}$$

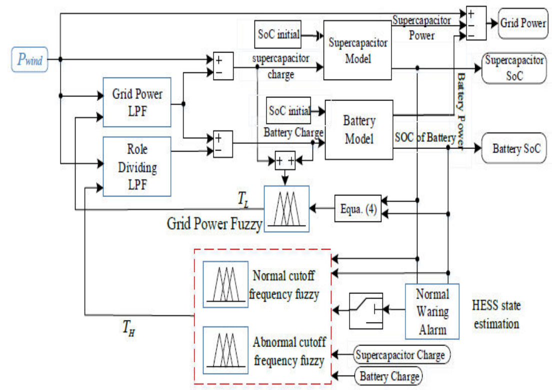

Fig. 4. Fuzzy based wind-HESS smoothing control diagram, including grid power primary filter (time constant is decided by grid power fuzzy) and role

The basic principles of setting TL value are:
1) HigherTL value (yellow area in Fig. 5): As the larger
the time constant TL value is, the more wind power willget delivered to the HESS, the higher TL value existsin the following three scenarios: a) SoC level is in thenormal state and charging input is lower (middle yellow area in Fig. 5); b) ESS is in the fully charged state (SoCis higher) and charging input changes to discharge (negative,wind power starts decreasing). In this situation, asthe HESS is full, it has great ability to discharge. Thuswe chose higher value of TL to let the HESS uptakemore power; c) ESS is in the fully discharged state (SoCis lower) and charging input changes to charge (positive,
wind power starts increasing);2) median value (cyan area in Fig. 6): SoC level is in thenormal state and absolute value of the charging input islarger than 5;3) lower vale (blue area in Fig. 6): SoC level is higher andESS is in the charging state; SoC is lower and ESS isin the

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discharging state.The above-mentioned principles are the same as the designed results, as shown in Fig. 6. The fuzzy sets and membershipfunctions for inputs (SoC level and Charge input) andoutput (TL) are designed according to their characteristic, asshown in Fig. 5 and 6.

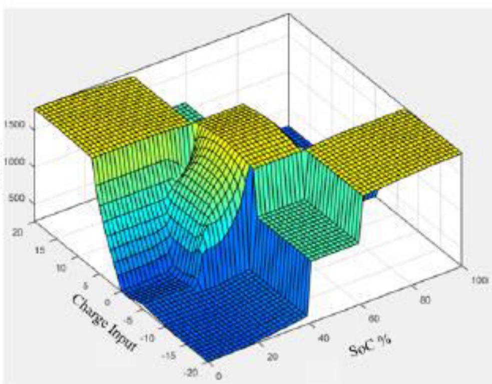

Fig. 5. Fuzzy surface of the grid power primary filter.

4.3 Role dividing secondary filter

The function of Role dividing secondary filter is to determinethe role of supercapacitor and battery. The transferfunction of the role dividing secondary filter is the same asequation (3), except that the time constant of secondary filteris TH. There are two switchable fuzzy-based controller usedto determine the value of TH, which are called normal andabnormal cut-off frequency fuzzy controller, as shown in Fig. 4. The principle of the switching is based on the module ofHESS state estimation.The logic of HESS state estimation to determine the normal and abnormal lev el of the HESS is based on the SoC level of individual ESS, as shown in Fig.The state level of HESSis classified into three states:

1) Normal: the SoC of Two ESS are in the range of 20%–80%;
2) Warning (Abnormal): Either the SoC of battery or supercapacitor is in the range of 10%–20% or 80% – 90%;
3) Alarm (Abnormal): Two ESS are in the range of 10%–20% or 80% – 90% or one ESS is in the range of 0%–10% or 90% – 100%.

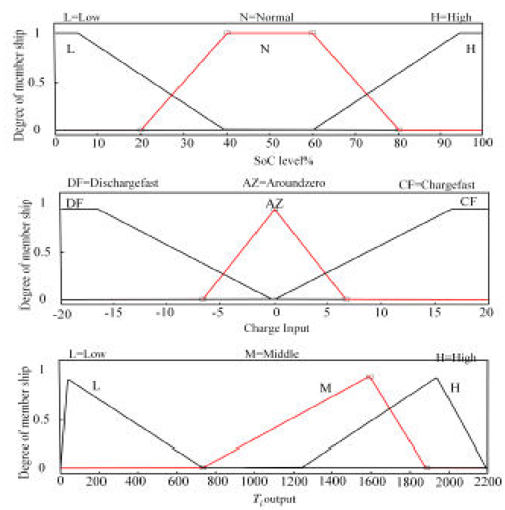

Fig. 6. Fuzzy membership function of the grid power primary filter.

5. SIMULATIONRESULTS

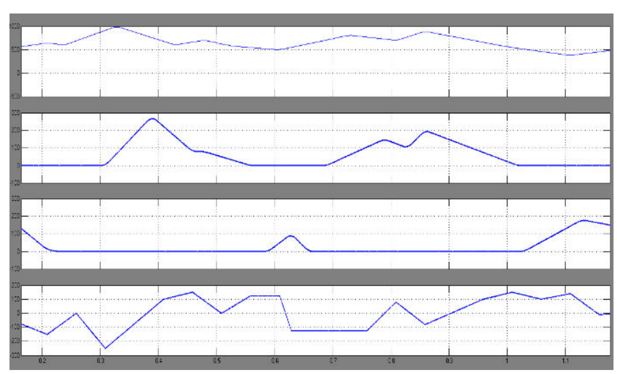

Fig7. Active power from various sources

2581-4575

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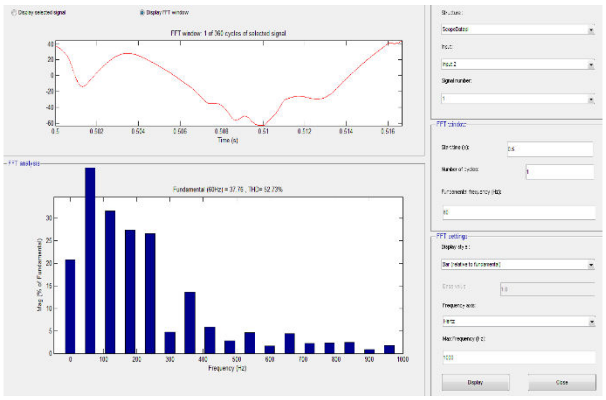

Fig8. THD percentage of Ig is 52% with PI controller

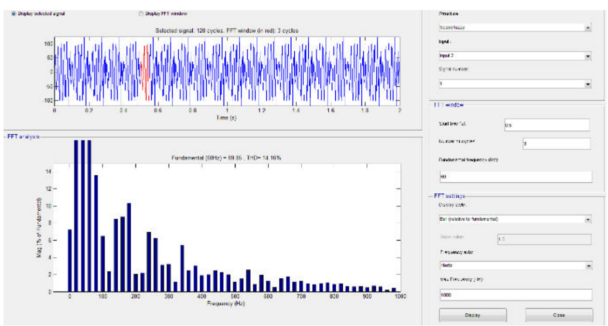

Fig9. THD percentage of Ig is 14% with fuzzy controller

6.CONCLUSION

This paper has proposed a fuzzy based wind HESS framework control technique to smother wind control vacillation while thinking about the working states (SoC level) of HESS. The key purpose of the controller is to designate wind fluctuations with various recurrence groups to the supercapacitor and the battery by powerfully changing the time consistent of essential and auxiliary channel channels. The adequacy of the proposed strategy has been exhibited for a genuine power framework. To keep the framework recurrence deviation inside the allowed limit, an on the whole investigation of ideal stockpiling estimating and control of wind-HESS framework has been directed in this paper. Aftereffects of the reenactment have demonstrated that the ideal measuring and control techniques could help limit the span of HESS and furthermore enhance the cycle life of the HESS.

REFERENCES

[1] H. Novanda, P. Regulski, V. Stanojevic, and V. Terzija,“Assessmentof frequency and harmonic distortions during wind farm rejection test”IEEE Trans. on Sustain Energy, vol. 4, no. 3 pp. 698-705, 2013.

[2] C. Luo and B.-T. Ooi,“Frequency deviation of thermal power plants dueto wind farms” IEEE Trans. on Energy Conversion, vol. 21, pp. 708-716,2006.

[3] L. Jin, S. Yuan-zhang, P. Sorensen, L. Guo-jie, and G. Wengzhong,“Method for Assessing Grid Frequency Deviation Due to WindPower Fluctuation Based on Time-Frequency Transformation,” IEEETrans. on Sustain. Energy , vol. 3, pp. 65-73, 2012.

[4] Lee Wai Chong, Yee Wan Wong, Rajprasad Kumar Rajkumar and DinoIsa.“Hybrid energy storage systems and control strategies for stand-alonerenewable energy power systems,” Renewable and Sustainable EnergyReviews, vol. 66, pp. 174-189, Aug. 2016.

[5] Quanyuan Jiang and Haisheng Hong, “Wavelet-Based Capacity Configurationand Csoordinated Control of Hybrid Energy Storage System forSmoothing Out Wind Power Fluctuations,” IEEE Trans. on Power Syst.,vol. 28, no. 2,.pp.1363-1372, Sep., 2012.

International Journal For Recent Developments in Science & Technology
2581-4575
Crossref
A Peer Reviewed Research Journal

[6] Garca P, Garca CA, Fernndez LM, Llorens F and Jurado F. "ANFISBasedcontrol of a grid-connected hybrid system integrating renewableenergies, hydrogen and batteries," IEEE Trans. Ind. Inform, vol. 10, No.2, pp. 11071117, May. 2014.

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