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Efficient AC Power Transmission with Low Frequency at Steady State Strategies

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ABSTRACT: The main motto of this application is to diminish the power variations and results in a more stable voltage and a higher stability margin for the low frequency AC (LFAC) system. As well as to achieve the Voltage regulation, based on multi-area distribution scheme apart from the past scheme. Steady State Power Transmission is a major concern in electrical domain, which reduces the power variations while transmission with low frequency. In this system, the steady-state scheme is proposed to analyze the performance of low frequency AC (LFAC) is analyzed clearly for bulk power transmission. An existing power system can increase its power transfer capability by up to more than eleven times if it operates on minimum frequency. Maintaining or Sustaining the stable state of power is highly concentrated in this approach and concentrating highly on low frequency AC power transmission strategies. Voltage Regulation is a major concern in interactive residential entities or end power units. This provides better match the load profile of each entity internally as well as externally. In this system we manipulate the power with five different entity levels via AC Bus System.

KEYWORDS: Power Optimization, Low Frequency AC Transmission, LFAC, Skin Effect, Voltage Stability Margin.

I. INTRODUCTION

Conventional transmission systems utilize either high-voltage AC, operating at 50 or 60 Hz, or high-voltage DC (HVDC) to transfer bulk power. The high voltage AC system is designed to operate at a high voltage level to reduce losses and increase bulk power transfer. This method is limited, however, by the constraints of installed transmission overhead lines, such as voltage level and power transfer capability. In contrast, the HVDC system can handle a large amount of power on the transmission line by utilizing DC current instead of AC. The HVDC system has no limitation in transmission line length for power transfer; however, it requires a high initial cost for converter stations and specialized protection systems.

Moreover, another disadvantage is that the HVDC system is a point-to-point connection, and thus not flexible for multi-terminal connection. The low frequency AC transmission system, first introduced in earlier systems, is another solution for bulk power transmission that inherits advantages from both high voltage AC and HVDC systems. The primary advantage of LFAC is that by operating the system at a frequency lower than 50 or 60 Hz, the transmission line reactance can be significantly reduced, thus extending power capacity. Further advantages include multi-terminal connections, distance protection using alternating-current based circuit breakers, and improving power transfer capability close to that of an HVDC system. LFAC transmission has been the focus of recent research due to potential benefits for interconnection between new wind power installations and the grid.

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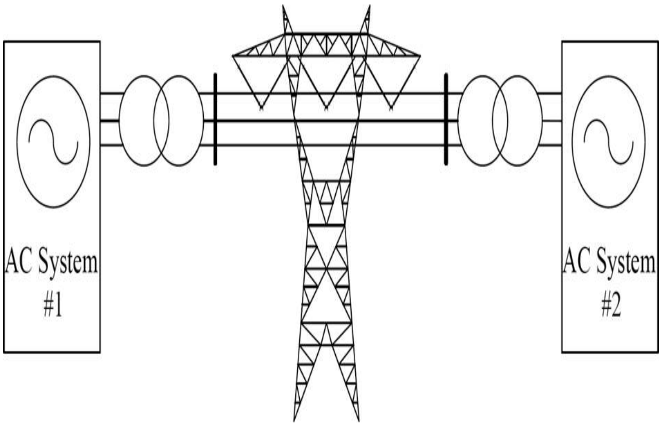

Fig. 1. AC Power Transmission Line System.

The increase of wind power penetration has necessitated transmission lines to be capable of handling large amounts of power as more generation is injected into the grid. In an on-shore or off-shore wind farm where the transmission line length is less than 500 km, for example, the LFAC system offers benefits over the HVDC system. The advantages of utilizing LFAC transmission for wind power over conventional 60 Hz in terms of power capability are described in earlier systems. Many alternative configurations for low frequency transmission in wind farms are introduced in earlier systems with detailed consideration of optimal voltage level, cost, and power transfer capability. The previous investigations have not, however, considered the system steady-state performance, especially voltage stability, when a transmission system operates at a low frequency. In addition, the response of the transmission network for frequencies lower than 20 Hz has not been demonstrated due to the limitations of the cyclo-converter employed in previous research. However, studies in earlier systems have shown that the lower limit of operating frequency is 0.1 Hz. Space charge accumulation in the overhead line occurs when the frequency is lower than 0.1 Hz. The upper limit of frequency if utilizing a cyclo-converter is 1/3 of the source frequency because of output voltage and current quality. With the development of power electronics, however, the source frequency can be converted into any desired value without harmonic issues. Therefore, our motivation in this paper is to examine the steady-state performance of the LFAC system under various operating frequencies. Specifically, the impact of skin effect on the transmission line parameters is investigated to see if any line model corrections are needed.

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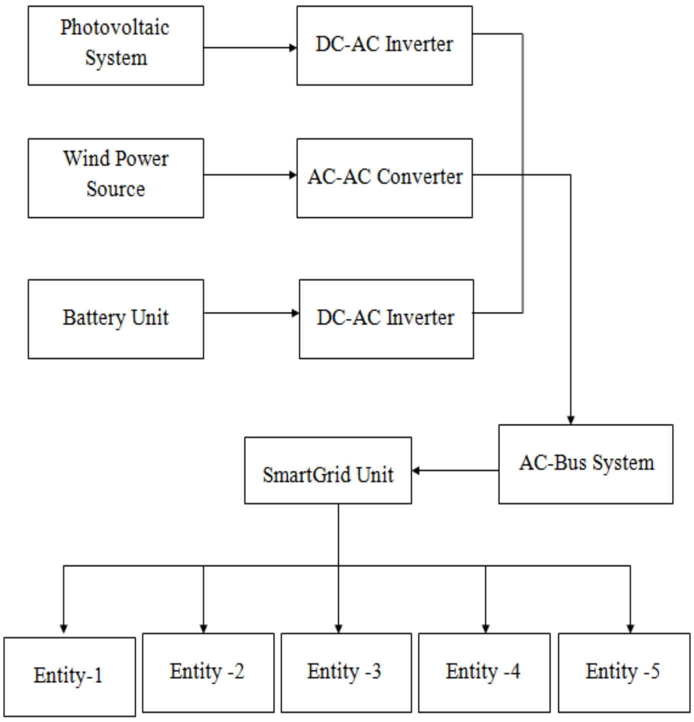

Fig.2 Proposed Block Diagram

III. PROBLEM DESCRIPTION

(i) Existing System

The past analysis results such as increase its power transfer capability by up to more than eleven times if it operates at 5 Hz. In low operating frequency conditions, the transmission overhead line reactance is significantly lowered and thus results in less voltage drop along the line. Due to the power variation the loads connected in the destination end are highly affected and its lifetime is reduced fastly. Single entity power source scheme causes power based issues in while power distribution model. Production level of power is too low and it is fluxuated. Existing methodology uses homomorphic single grid based power management procedure to support interactive buildings, so that the efficiency is too low and lots of power failures occurs. The past researches contain lots of disadvantages, which are listed below: (a) Poor in Performance, (b) Power Fluxuation cause severe harm to power distribution model, (c) Cost and Circuit complexity is too high in practical implementations and (d) Single entity power source doesn't have ability to support numerous intelligent buildings or industries, so power optimization is not possible in it.

(ii) Proposed System

In the proposed approach, We present a Steady-State power management system with low frequency AC (LFAC). Each destination entity is working based renewable power maintenance system such as wind, battery and solar resources. This system contributes to demonstrate the advantages of AC Power Transmission with a set of power sources by exploiting uncertainties of renewable sources and demands. In addition, the energy consumed in each entity is constrained by a certain level of acceptance that is the bounds which the decision maker (DM) is satisfied with the help of Voltage Regulation Principles. In the proposed approach, We present a global energy management system for cooperative/optimized entities such as buildings or industries. Each building has a Renewable Energy Source (RES) based power maintenance system such as wind, battery and solar resources. Multi-Source Power variation is considered here and manipulate all these via SmartGrid architecture and AC Linear Power Distribution Model. The Proposed

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system contains lots of advantages, which are listed below: (a) Multi-Power Source based Voltage Regulation System Performance is comparatively good in working with earlier Single entity systems, (b) Power Fluxuation is highly reduced and Voltages are properly regulated, (c) Power optimization is achieved via LFAC architecture and (d) Cost and Circuit complexity is too low and it is more efficient for practical implementations.

(iii) System Summarization

Input of the system is raised via three power sources such as PV-Panel, Wind and Battery Units. The output of PV and Battery is DC and we interconnect this DC output with DC to AC Converter and the finalized output of AC is passed to AC-Bus System. And the Wind mill output is AC, which is passed to AC to AC converter to purify the fluxuated AC to normal AC. All these output will be connected with AC-Bus System and that will passed to SmartGrid model, that will switched over to five different entities such as buildings or industries with regulated manner, and we need to prove the Voltage Regulation System is more better than past analysis. All these are done under 3-Phase Power Circuit nature.

Literature Survey

In the year of 2012 the authors "T. Funaki and K. Matsuura" proposed a paper titled "Feasibility of the low frequency AC transmission" in this they described such as: It has become hard to establish new overhead transmission lines for many reasons, and underground power cables will be adopted more in the future. A power cable has a difficulty of limitation in transmission length when it is operated in conventional AC system. An HVDC transmission can solve this problem for DC is free from charging current problem. XLPE cable is being more widely used at each voltage level instead of of cables and the other types, because it has many advantages. But XLPE cable has a difficulty of operation in DC, because space charge accumulates in the XLPE dielectrics. The authors propose a low frequency AC transmission (LFAC) to a power cable system. The proposing LFAC system uses the power electronics apparatus of AC/AC converters at the terminals. From the frequency characteristics of the space charge behavior in XLPE dielectrics, the power cable operation in higher frequency than 1 Hz can be admitted. The presenting LFAC transmission can use the conventional AC XLPE cable by operating higher than this frequency. In the system, the authors describe other merits and demerits of the proposed LFAC transmission compared to the conventional AC transmission and an HVDC transmission. Finally, the authors present the simulation results of the simplified LFAC system model by using EMTP.

In the year of 2014 the authors "W. Xifan, C. Chengjun, and Z. Zhichao" proposed a paper titled "Experiment on fractional frequency transmission system" in this they described such as: The fractional frequency transmission system (FFTS) is a very promising long-distance transmission approach, which uses lower frequency (50/3 Hz) to reduce the electrical length of the ac power line, and thus, its transmission capacity can be increased several fold. This system introduces the experimental installation of FFTS and primary experiment results. The experiment uses the phase-controlled cycloconverter as the frequency changer, stepping up 50/3 Hz electricity to 50 Hz electricity and supplying it to the utility grid. Thus, a new flexible ac transmission system device is successfully established in this experiment. The synchronizing process of 50/3 Hz transmission system with 50 Hz utility system is introduced in this system. The experiment results show that a 1200 km/500 kV transmission line can transmit more than 2000 MW electric power when employing the FFTS. The experiment also illustrates that there is no essential difficulty to realize FFTS in engineering practice.

In the year of 2013 the authors "H. Chen, M. Johnson, and D. Aliprantis" proposed a paper titled "Low-frequency AC transmission for offshore wind power" in this they described such as: This system presents a low-frequency ac (LFAC) transmission system for offshore wind power. The LFAC system is interfaced with the main power grid with a cycloconverter. The wind power plant collection system is dc based, and connects to the LFAC transmission line with a 12-pulse thyristor converter. A method to design the system's components and controls is set forth. Simulation results are provided to illustrate the system's performance.

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IV. EXPERIMENTAL RESULTS

The following figure shows the resulting scenario of the proposed system.

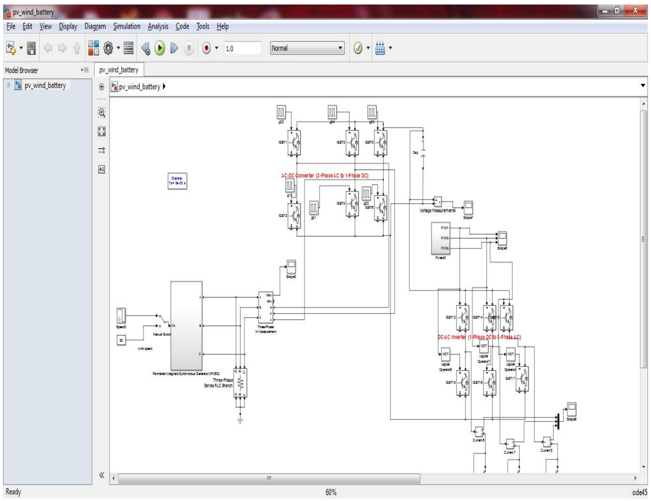

Fig.3 Circuit Design

The following figure shows the Windmill Scope view of the proposed system.

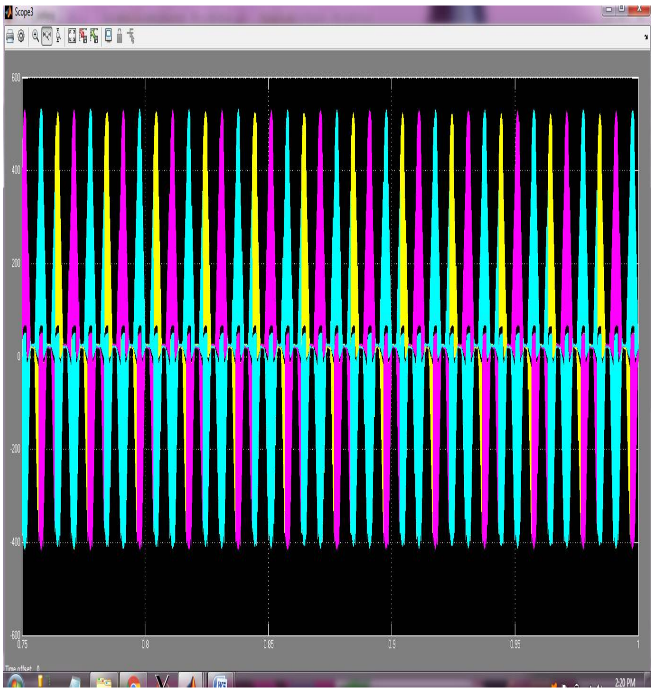

Fig.4 Windmill Scope view

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The following figure shows the AC-DC Converter scope view of the proposed system.

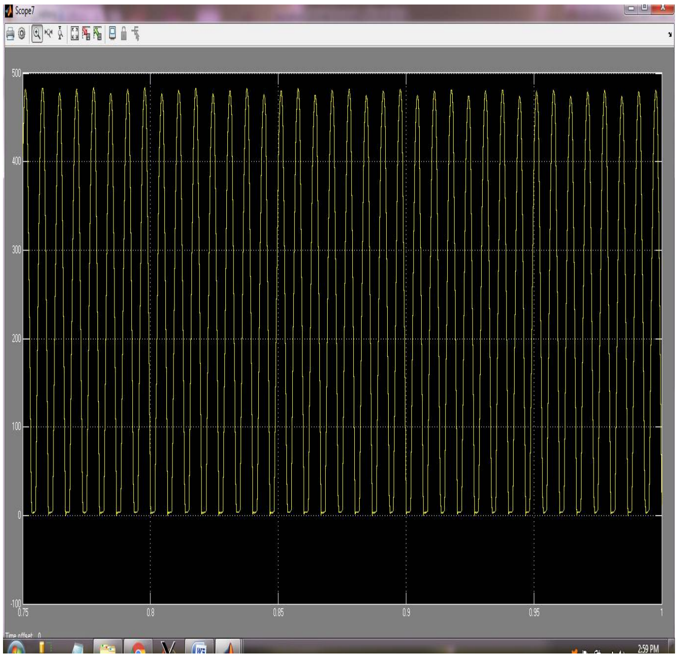

Fig.5 AC-DC Converter Result

The following figure shows the 3-Phase AC result view of the proposed system.

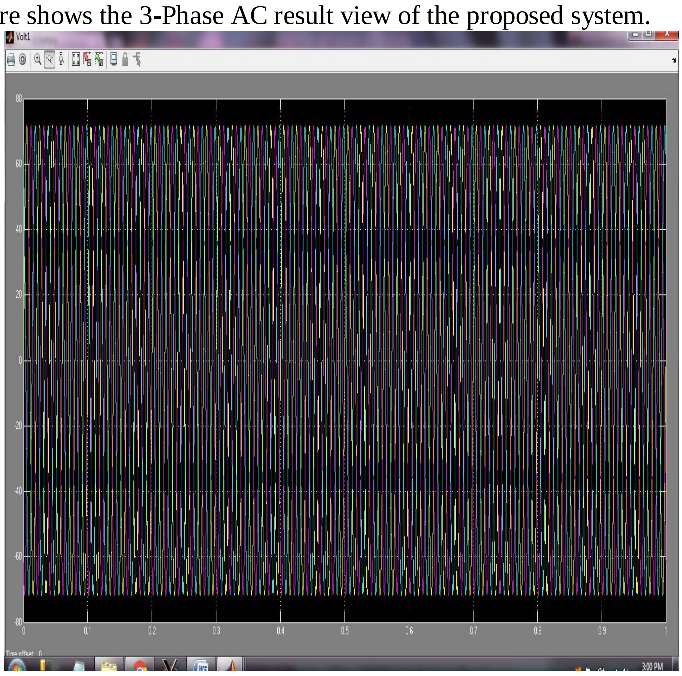

Fig.6 3-Phase AC Result

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V. CONCLUSION

The proposed system clearly shows, that the significant reduction in reactance power at a low frequency, the transmission line system has more capability to transfer power. More importantly, the system has a superior voltage profile due to a lower voltage drop along the line, and is close to that of an HVDC system if the operating frequency is low enough. The system stability has also been extended with less dependence on power variation. Finally, a practical transmission line project case study has been investigated to give a clear example of the benefits of LFAC systems. In conclusion, the low frequency system is a promising candidate for AC power transmission. In this system, the advantages of regulation and optimization among a set of entities are demonstrated by exploiting fluctuations of the stochastic local renewable sources and loads. For all the entire system depicts a global power system management scheme for cooperative entities.

REFERENCES

[1] T. Funaki and K. Matsuura, "Feasibility of the low frequency AC transmission," in Proc. 2000 IEEE Power Eng. Soc. Winter Meeting, 2000, vol. 4, pp. 2693–2698.
[2] PSERC, Low Frequency Transmission, PSERC Publication, 2012 [Online]. Available: http://www.pserc.wisc.edu/documents/publications/reports/2012_reports/Meliopoulos_PSERC_Report_S-42_Oct_2012_ExSum.pdf
[3] C. Mau, K. Rudion, A. Orths, P. B. Eriksen, H. Abildgaard, and Z. Styczynski, "Grid connection of offshore wind farm based DFIG with low frequency AC transmission system," in Power Proc. 2012 IEEE and Energy Soc. General Meeting, Jul. 2012, pp. 1–7.
[4] Y. Cho, G. Cokkinides, and A. Meliopoulos, "LFAC-transmission systems for remote wind farms using a three-phase, six-pulse cycloconverter," in Proc. 2012 IEEE Power Electronics and Machines in Wind Applicat. (PEMWA), Jul. 2012, pp. 1–7.
[5] W. Xifan, C. Chengjun, and Z. Zhichao, "Experiment on fractional frequency transmission system," IEEE Trans. Power Syst., vol. 21, no. 1, pp. 372–377, Feb. 2006.
[6] H. Chen, M. Johnson, and D. Aliprantis, "Low-frequency AC transmission for offshore wind power," IEEE Trans. Power Del., vol. 28, no. 4, pp. 2236–2244, Oct. 2013.
[7] N. Qin, S. You, Z. Xu, and V. Akhmatov, "Offshore wind farm connection with low frequency AC transmission technology," in Proc. 2009 IEEE Power Energy Soc. General Meeting (PES '09), Jul. 2009, pp. 1–8.
[8] J. Zaborszky and J. W. Rittenhouse, Electric Power Transmission: The Power System in the Steady State. Troy, NY, USA: The Rensselaer Bookstore, 1977.
[9] J. Traphoner, "Evaluation of impedance parameters in transmission lines," Master's thesis, Univ. Texas, Austin, TX, USA, 2014.
[10] R. E. Collin, Foundations for Microwave Engineering. New York, NY, USA: Wiley-IEEE Press, 2001.
[11] J. Glover, M. Sarma, and T. Overbye, Power System Analysis and Design. New York, NY, USA: Cengage Learning, 2011.
[12] P. Kundur, Power System Stability and Control. New York, NY, USA: McGraw-Hill, 1994.
[13] A. Bergen and V. Vittal, Power System Analysis. Englewood Cliffs, NJ, USA: Prentice Hall, 2000.
[14] H. Le and S. Santoso, "Analysis of voltage stability and optimal wind power penetration limits for a non-radial network with an energy storage system," in Proc. 2007 IEEE Power Eng. Soc. General Meeting, Jun. 2007, pp. 1–8.
[15] PUCT, CREZ Transmission Projects, 2014 [Online]. Available: http://www.texascrezprojects.com/
[16] EPRI, Transmission Line Reference Book 115–138 kV Compact Line Design. Palo Alto, CA, USA: Electric Power Research Institute, 1978.
[17] EPRI, Transmission Line Reference Book 345 kV and Above. Palo Alto, CA, USA: Electric Power Research Institute, 1982.