A Novel Technique of short Transmission line for Low-Frequency

Siddharth Verma [1], Chetan Praveer [2]
M. Tech. (Electrical Engineering) [1], Asst. Prof. Dept. Of Electrical Engg. [2]
CBS Group of Institutions, Jhajjar-Kosli [1,2]

Abstract : Now a day renewable energy is widely used such as wind energy and solar energy, due to their extreme abundance. So they should be properly interfaced with the power grid with suitable devices. In this paper a system of offshore wind with low-frequency ac (LFAC) transmission system which increases the power capacity and transmission distance is proposed along with a photovoltaic integration on the offshore itself results more stability in the power system. A cyclo converter is designed for the low frequency transmission and also to interface with the main power grid. The wind power plant collection system is dc based, and connects to the LFAC transmission line with a 12-pulse thyristor converter. Simulation results are observed to analysis the output voltages and currents of the two renewable sources and to illustrate the performance of the system.

Key Word: Low-Frequency AC (LFAC) Transmission, Thyristor Converter

1. Introduction

Offshore wind power plants are expected to represent a significant component of the future electric generation portfolio due to greater space availability and better wind energy potential in offshore locations. The integration of offshore wind power plants with the main power grid is a subject of ongoing research. Presently, high-voltage ac (HVAC) AND high-voltage dc (HVDC) are well established technologies for transmission. HVAC transmission is advantageous because it is relatively straightforward to design the protection system and to change voltage levels using transformers. However, the high capacitance of submarine ac power cables leads to considerable charging current, which, in turn, reduces the active power transmission capacity and limits the transmission distance. HVAC is adopted for relatively short (up to 50–75 km) underwater transmission distances.

Two classes of HVDC systems exist, depending on the types of power-electronic devices used: 1) line-commutated converter HVDC (LCC-HVDC) using thyristors and 2) voltage-source converter HVDC (VSC-HVDC) using self-commutated devices, for example, insulated-gate bipolar transistors (IGBTs). The main advantage of HVDC technology is that it

imposes essentially no limit on transmission distance due to the absence of reactive current in the transmission line. LCC-HVDC systems are capable of handling power up to 1 GW with high reliability. LCCs consume reactive power from the ac grid and introduce low- order harmonics, which inevitably results in the requirement for auxiliary equipment, such as capacitor banks, ac filters, and static synchronous compensators. On the other hand, VSC-HVDC systems are able to independently regulate active and reactive power exchanged with the onshore grid and the offshore ac collection grid.

The reduced efficiency and cost of the converters can be identified as drawbacks of VSC-HVDC systems. Power levels (typically on the order of 300–400MW) and reliability are lower than those of LCC-HVDC. HVDC is applied for distances greater than 100 km for offshore wind power transmission. Besides HVAC and HVDC, high-voltage low-frequency ac (LFAC) transmission has been recently proposed. In LFAC systems, an intermediate-frequency level is used, which is created using a cyclo converter that lowers the grid frequency to a smaller value, typically to one-third its value. In general, the main advantage of the LFAC technology is the increase of power capacity and transmission distance for a given submarine cable compared to 50-Hz or 60-Hz HVAC. This leads to substantial cost savings due to the reduction in cabling requirements (i.e., less lines in parallel for a desired power level) and the use of normal ac breakers for protection.

In this paper, a novel LFAC transmission topology is analyzed. The proposed system differs from previous work in that the wind turbines are assumed to be interconnected with a medium-voltage (MV) dc grid, in contrast with current practice, where the use of MV ac collection grids is standard. DC collection is becoming a feasible alternative with the development of cost-effective and reliable dc circuit breakers, and studies have shown that it might be advantageous with respect to ac collection in terms of efficiency and improved production costs. The required dc voltage level can be built by using high-power dc–dc converters and/or by the series connection of wind turbines. For example, multi-MW permanent-magnet synchronous generators with fully rated power converters (Type-4 turbines) are commonly used in offshore wind plants. By eliminating grid-side inverters, a medium-voltage dc collection system can be formed by interconnecting the rectified output of the generators. The main reason for using a dc collection system with LFAC transmission is that the wind turbines would not need to be redesigned to output low-frequency ac power, which would lead to larger, heavier, and costlier magnetic components (e.g., step-up transformers and generators). The design of the dc collection system is outside the scope of this paper.

At the sending end of the proposed LFAC system, a dc/ac 12-pulse thyristor-based inverter is used to generate low-frequency (20- or 16 2/3-Hz) ac power, as shown in Fig. 1. At the onshore substation (the receiving end), a thyristor-based cycloconverter is used as an interface between the low-frequency side and the 60- or 50-Hz onshore power grid. Thyristor-based converters can transmit more power with increased reliability and lower cost compared to VSC-HVDC systems. However, large filters are necessary at both ends to suppress low-order harmonics and to supply reactive power. Furthermore, the system can be vulnerable to main power grid disturbances.

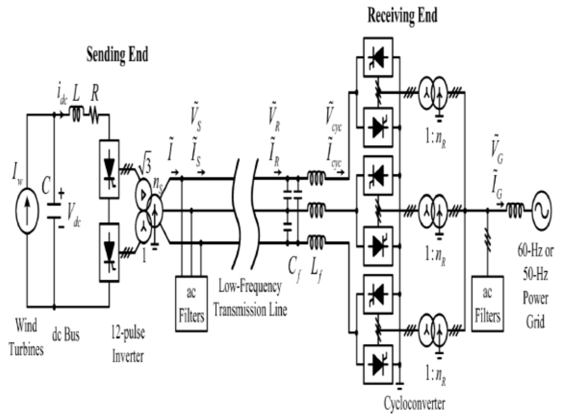

Fig1: Configuration of the proposed LFAC transmission system.

The proposed LFAC system could be built with commercially available power system components, such as the receiving-end transformers and submarine ac cables designed for regular power frequency. The phase-shift transformer used at the sending end could be a 60-Hz transformer derated by a factor of three, with the same rated current but only one-third of the original rated voltage. Another advantage of the proposed LFAC scheme is its feasibility for multi terminal transmission, since the design of multi terminal HVDC is complicated but the analysis of such an application is not undertaken herein. In summary, LFAC transmission could be an attractive technical solution for medium-distance transmission (i.e., in between HVAC and HVDC). The expressions for ac voltage and current and thereplacing the conventional gap-typepower equations in terms of A,B,C and DSilicon Carbide arresters, for both considerations of each line when the resistive drop in lightning and switching-surge duty. transformer winding and in the line conductors due toi .Shunt reactor compensation and use of dc current are neglected can be written as n series capacitors, resulting in possible sub-synchronous resonance conditions and Sending end voltage

$V_S = AV_R + BI_R$(1)
high short circuit currents.

2. Literature Survey

In **[1]** This report explain the two major source of loss in high voltage. AC transmission lines: resistive loss and corona loss. The first loss occurs due to non-zero-zero resistance of the wire. Corona loss occurs because of the ionization of the air that occurs when the electric fields around a conductor exceed a specific value. The amount of resistive loss in a system can be calculated by using corona free transmission line equation to find the amount of power delivered to any point along the wire and subtracting the initial amount of power. Corona loss is occurred due to the ionization of air molecules near the transmission line conductors. Corona loss only occurs when the line to line voltage exceed the corona threshold.

In[2] In this paper an analysis of lumped- distributed branch – line couplers for coplanar waveguide(CPW) branch line couplers suitable for GaAs MMIC design is given. In this paper the author consider the degree of coupling, impedance transformation and the level of miniaturization in order to provide greater design flexibility for integration with unipolar monolithic circuits. The results shows that an amplitude balance of 4.7×0.3 dB, Input and output return losses of better than 12 and 15dB respectively, and an isolation of better than 20 dB over the range of 14-16 GHz.

In[3] For the various non-uniform transmission lines, the exponential line and the binomial line's analysis based on the rigorous solution of the telegraph equation. Up till now, there is no systematically solution for the binomial line. So, in this paper, the rigorous solution of telegraph equation for 2^{nd} order binomial lines is derived and its equivalent circuit is constructed by a cascade connection of uniform distributed parameters lines, lumped reactance elements and the ideal a high pass filter consisting of the series lumped capacitance and uniform distributed- parameters line is constructed by the quadratic lines and lumped capacitance.

In[4] silicon Radio Frequency Integrated Circuits (SiRFICs) have matured greatly over the past five years and are now found in multimode of commercial products. The use of silicon Radio frequency integrated circuits is to reduce the insertion loss and decrease the circuit size. The author performed the experimental measurements and use the Finite Difference Time Domain (FDTD) analysis are used to show that embedded inverted micro strip lines are not suitable for use above a few GHz.

In[5] In this paper a new method for the simulation of fast transmission line is given. The method is based on the method of characterization of partial equation theory.

This method include resistive losses and the wave speed variations. For this purpose, we have to proposed a Norton equivalent for transmission line. At any given time, the Norton equivalent of each transmission line end is independent of the line's interior behavior at that time, therefore the model can readily be included into any electrical network transients simulation program. The author apply this method to two problems. The first one consists of analyzing the effects of non-uniformities caused by the sagging of conductors on an aerial line. The second of application consist of the simulation of a fast impulse propagating along a transmission tower modeled as a network of vertical and horizontal transmission lines.

In[6] In this paper a fast analysis of aperture- coupled reflect arrays is given in terms of transmission line model. The circuit approach is used to drive the phase design curve as a function of the current flowing on the equivalent impedance of the single radiating element. Computational cost is suddenly reduced as compared to the standard full wave methods. Numerical and experimental calculations are based on slot coupled reflectarry configurations which is working at different operating frequencies.

In[7] In this paper the author combined the hybrid finite-element/ boundary –integral method (FEBI) with the multilevel fast multiple algorithm (MLFAI) and applied it to the three dimensional scattering problems of inhomogeneous media. Numerical results show that the proposed method can greatly improve the efficiency of (FEBI) for scattering problems of inhomogeneous media. The finite element method (FEM) is a very successful method with the wave transmission problems owing to its strong ability for simulating arbitrary geometric structures and in homogenous media.

3. Simulation Results and Discussion

Simulation is performed by MATLAB/SIMULINK 10b version to verify the proposed solar and wind hybrid power with low frequency transmission. In this chapter simulation results of variable output results are discussed.

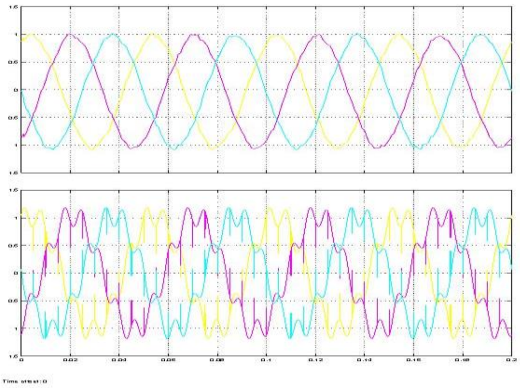

Fig 2 Simulation Results:

Fig above input voltage and current waveform at sending end fig shown is input volatge and current wave forms in sending end side with ripple content. Figure above shown gives the information of voltage and current are filtered through active filters & supllied to marine cables.

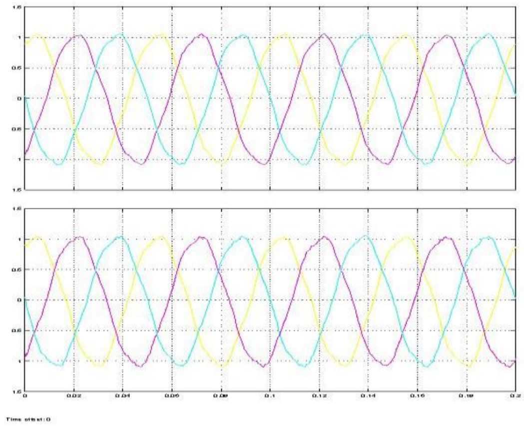

Fig 3 voltage and current wave forms at receiving end

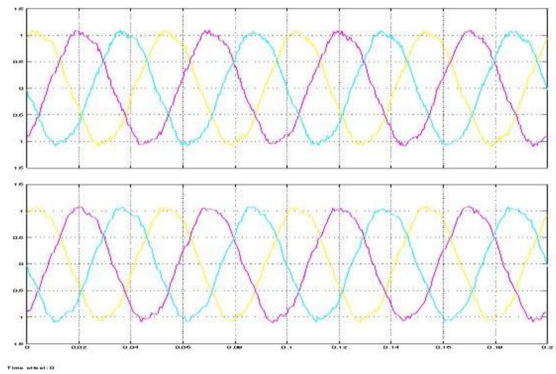

FIG 4 input and output waveforms of cyclo converter 20Hz Fig 4depicts the hormonic content at cycloconverter from available input i.e supplied from Lfac cables.

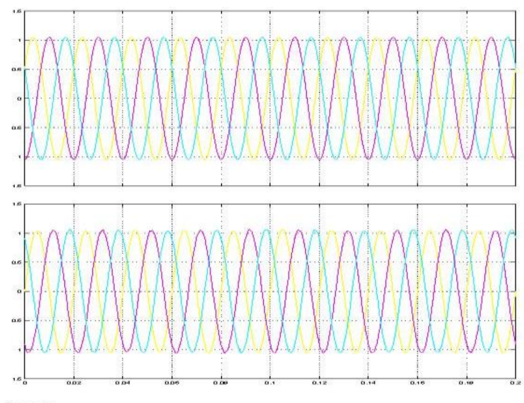

Fig 5 voltage and current waveforms at 60 Hz power grid

Fig 5 depicts the converion of 20hz frequency to 60 hz by cycloconverter and smoothning of voltage and current waveforms using active filters. And gives sinusoidal wave forms of constant magnitude.

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