Development of improved MPPT methodologies for Grid integration of Wind-PV hybrid distributed generation system

Abstract: Renewable energy systems are likely to become widespread in the future due to adverse environmental impacts and escalation in energy costs linked with the exercise of established energy sources. Solar and wind energy resources are alternative to each other which will have the actual potential to satisfy the load dilemma to some degree. However, such solutions any time researched independently are not entirely trustworthy because of their effect of unstable nature. In this context, autonomous photovoltaic and wind hybrid energy systems have been found to be more economically viable alternative to fulfill the energy demands of numerous isolated consumers worldwide. It is also found that PV–Wind–Battery hybrid system is the most optimal solution regarding cost and emission among all various hybrid system combinations. Many remote communities around the world cannot be physically or economically connected to an electric power grid. PV and wind system, both depending on weather condition, individual hybrid PV and hybrid wind system does not produce usable energy throughout the year. For better performance of the standalone individual PV combination or wind combination need battery backup unit for reliable power supply to load. In this When there is surplus of power battery will charge and during scarcity in power battery will tend to compensate the interruption of power supply.

Hybrid energy has disadvantages due to the unstable nature of solar and wind energy. It is well known that solar energy is not constant throughout the day and also the wind speed is unpredictable. Interharmonics is one of that major problem which is mostly focused sector for researchers. The PV based inverters with oscillating input and non-ideal switching can lead to the generation of harmonics into the system. The harmonic cushioning techniques are already available to counter this problem. Along with harmonic content, it observed that Inter-harmonics also induced in the PV-grid integration system. Inter-harmonics has a similar effect to that of harmonics, but some of the impacts like flickering can be higher in Inter-harmonics. This flickering results in sudden isolation of the PV system without any fault condition due to the unwanted triggering of the protection system.

These Interharmonics mainly caused by the MPPT scheme employed in the system. The inter harmonic modelling and analysis of grid-connected PV system already done, the effects of MPPT on Inter-harmonics are analysed. The Mitigation of Inter-harmonics is still a burning research topic for modern researchers. Although very few pieces of literature are available for the reduction of Inter-harmonics in the PV-grid integrated system, most of the existing schemes do not address the MPPT efficiency and drifts due to sudden change in irradiation. Interharmonics observed under a more moderate power condition because, under quiet power operation, the inter harmonic components becomes comparable with the fundamental frequency component.

Under more moderate power conditions, it is observed that CV MPPT reducing lower-order Inter-harmonics considerably under uniform irradiation case. But fails to explain about maintaining maximum efficiency and also the case of a sudden change in irradiation. In case of Wind energy, Interharmonics related to MPPT were not studied. From this discussion it is clear that, it is required to establish a perfect MPPT technique for PV case such that interharmonic reduction is established while maintaing maximum efficiency. Coming to wind energy case there is no proper literature available for the interharmonic issue related to MPPT. In this proposed work it is focused about the reliable supply to load and also over the reduction of Interharmonics by establishing modification in existing techniques. In this work, INHARE MPPT scheme is developed as an improved version of ARV MPPT, where memory unit usage is removed by employing simple mathematical formulation. Moreover, PI controller is used to tune the steady state oscillations.

An improved weather Adaptable P&O (WA-P&O) scheme is introduced as an improved version of INHARE MPPT, where the PI controller gain values are updated unlike INHARE MPPT scheme. This will further improve the steady state characteristics under sudden change in irradiation. The WA-P&O scheme displays improved dynamic characteristics compared to existing conventional and adaptive PI and PID controller-based schemes.

For partial shading situations, three different MPPT schemes are implemented. Where two of them are depending on the operating points. The remaining one depends on the operating characteristics. Based on the operating point strategy, dummy peak elimination algorithm is proposed. The peak detection mechanism in DPE assists P&O algorithm in tracking global maximum successfully. The proposed DPE scheme has been implemented for series

configurations, shown satisfactory results. The DPE MPPT is modified further to operate for series-parallel configuration.

The modified DPE MPPT scheme is further named as fast global peak estimation technique. The proposed DPE and FGPE methods displays better dynamic characteristics and can be employed successfully in reducing inter-harmonics. A slope-based scheme is proposed in this research work, where the operating characteristics are employed to find the nearest MPP. The SB MPPT is based on the slopes of the PV characteristics, resulting in faster and accurate detection of MPP.

In case of wind energy, an SSM-PSO based MPPT scheme is developed for the improved dynamic MPP tracking characteristics. The proposed scheme focuses at minimizing the searching space for MPP detection. By using a wind speed sensor, the area of particle placement in case of PSO is minimized. Therefore, the tracking time in detecting peak point reduced further in case of PSO.

Finally, a hybrid system is proposed, where PV, wind and battery co-ordinate each other to feed the load. Moreover, evolved MPPT schemes ae employed in case of wind and PV systems to improve the MPP characteristics. It is further noted that, the proposed schemes able to overcome inter-harmonics issue effectively compared to existing conventional based schemes. As a future work the focus is towards reducing the sensor usage in proposed schemes.

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