CHAPTER

5

PASSIVE POWER QUALITY MONITORING FOR DISTRIBUTED GENERATION

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5.1 INTRODUCTION

Power quality measures the perfection of an electrical voltage at any given time or point between the power supplier and the end-user. Today, with the end users' expectations and environmentally friendly concerns, utilities need to reduce consumers' electricity bills and connect green power generation to the conventional power generation grid networks. Along with this, it is well known that increasing demand is overloading today's grid, and conventional solution techniques are increasing the complexity of current smart grid systems (Kitamura et al., 2015; Naderi et al., 2018). Sustainable energy supply system is recommended to ensure socio-economic development. Therefore, the impact of providing energy from renewable energy resources (RERs) as an alternative to fossil fuel production technology on socio-economic development is more important (Kumar et al., 2020). Renewable energy is the energy generated from naturally replenished and non-depleting energy sources such as the sun and wind. Renewable energy can be used for power generation, heating and cooling of space and water, transportation, and agriculture.

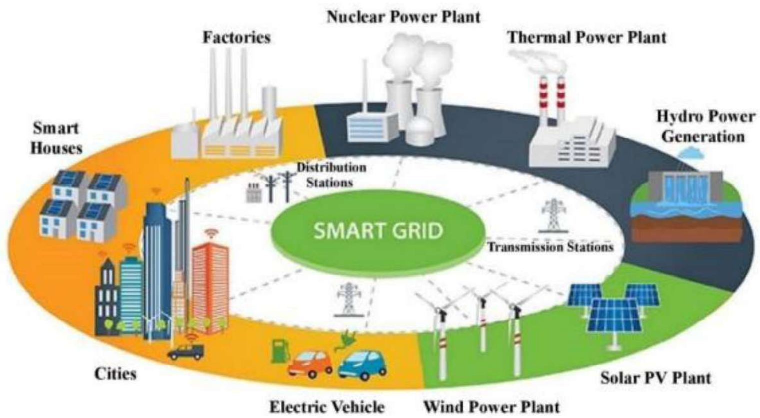

Figure 5.1 Illustration of the modern grid network integrating conventional and renewable energy sources within a smart grid system

In addition, optimal placement of distributed energy resources (DERs) can be defined as high potential to improve transmission efficiency in the distribution networks and lead to a sustainable energy supply on smart grids (Xu et al., 2021).

In recent years, photovoltaic (PV) distribution systems offer an attractive solution to potential conflicts between the rapidly growing ground-mounted solar power plants and agricultural production, and landscape ecology. Additionally, PV can be used to improve plant resilience to increased vulnerability to climate change, such as excessive heat stress and drought, especially in hot and dry climates (Feng et al., 2022; Fu & Zhou, 2023).

Due to the increasing use of renewable energy sources, distributed generation (DG) is managing energy and power quality monitoring primarily on the supplier and consumer sides due to new types of failures caused by uncontrolled connections in the power grid. Faced with evaluation challenges (Wu et al., 2021). The number of non-linear, impulse, and asymmetric loads connected to the network significantly reduces the power quality of the network (Bajaj et al., 2020).

5.2 POWER QUALITY MONITORING FAILURE

The quality of energy obtained from renewable DG systems depends on environmental regulations and the control of power electronics. The number of non-linear, impulse, and unbalanced loads connected to the network significantly reduces the power quality efficiency and reliability of the network. Power quality refers to the magnitude and frequency rates of the sinusoidal voltage and current waveforms of the system. Power quality management refers to the control of the voltage waveform, as variations in voltage can be more effectively managed compared to the current waveform. Power quality classifications, which are consistent with IEEE 1159 standards, are illustrated in Figure 5.2, which shows the classification of PQ disturbance based on seven types. The evaluation process of the power quality problem is shown in Figure 5.3. The first stage of this assessment involves identifying the problem category. Furthermore, additional standard requirements are defined by the Computer and Business Equipment Manufacturers' Association (CBEMA) curve, as illustrated in Figure 5.4.

Previous research activity has focused on the development of monitoring and mitigation of the power quality system. The assumption that the current waveform follows the applied voltage waveform does not hold for non-linear loads, which lack consistent current-processing characteristics. Although equipment exists to monitor power quality (PQ) events and disturbances in DG systems, there is still a lack of effective monitoring and mitigation techniques, especially for disturbances caused by non-linear load connections within the network. As the integration of power electronic components in modern power systems continues to grow, the non-linear loads also increase. These loads are a major source of harmonic distortion, leading to significant PQ issues. In this study, the proposed monitoring performance was evaluated and compared with benchmark PQ monitoring methods, demonstrating superior effectiveness.