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Mitigation of Electricity Theft at Low Distribution Voltage End Using Matrix Converter

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Abstract*—This study demonstrates the use of a matrix converter to reduce electricity theft at the low distribution voltage end. Residential users' meter bypassing energy theft causes electric power distribution businesses in poor nations like Nigeria to lose a considerable amount of money. Direct tapping on distribution lines remains a persistent problem that needs to be utterly eliminated, even though smart metering systems have solved concerns linked to power theft at the meter. Because there is no need for a large, bulky dc link electrolytic capacitor that increases system complexity, an indirect matrix converter is utilized because it ensures compactness and reliability. Design and simulation of the proposed system are based on the low voltage distribution network's frequency variation (10 Hz to 20 Hz). For the converter's design, a frequency of 10 Hz was used to produce a worst-case Total Harmonic Distortion (THD) of 204.99 %.

Keywords — Electricity theft, low voltage distribution, indirect matrix converter, THD

I. INTRODUCTION

Electricity theft is one of the main problems impeding the growth of the power sectors in developing nations like Nigeria. Over the years, utility providers have been quite concerned about this issue since the losses result in a significant strain on the distribution network. The utility companies suffer severe functional and financial losses as a result. An enormous amount of electricity is lost illegally in Nigeria each year [1]. These include bypassing the energy meter and tampering with the distribution network. Energy theft has been studied extensively, and there is a wealth of literature on the subject. The authors of [2] described encrypting power signals to stop power robberies in distribution systems. The three phases (Red, Yellow, and Blue) and neutral are passed through a semiconductor-based switching mechanism, which is used at the secondary side of the distribution transformer. A microcontroller produces a bit sequence in order to switch system. In order to prevent unauthorized distribution line taping in power networks, an encrypted power signal that cannot be utilized to power household appliances travels over the power line between the distribution transformer and the energy meter. Additionally, the researchers in [3] created a circuit that will stop energy theft if it is discovered along the distribution line by cutting off the consumer's electrical supply, in order to be reconnected to the main supply, consumers must inform the electrical board.

Technical and engineering solutions as well as managerial methods were suggested as two ways to avoid electricity theft in [4]. He worked on meter tampering using the technological approach and offered tamper-proof meters. In order to prevent tampering, the meter will be securely sealed. A monitoring and inspection strategy was included in managerial practices, and in some cases, power system reorganization was as well. Significant advances might be attained by fusing robust technology advancements with a clever and proactive anti-theft approach. To reduce electricity theft in the distribution system, regular inspections and monitoring of power customers are needed. To determine the general location and an estimate of energy theft at that place, the authors in [5] employed a conceptual approach. It transmits data across power lines using high frequency carriers. The communicated information has no impact on the AC power signal. The data sent by a distant sender is filtered by a receiver. Additionally, a proposal for enhanced metering infrastructure that includes power line communication capability via dedicated transmitter and receiver is made.

The real-time identification of power theft is also presented in [6] using data on all lawful consumers' energy consumption and information from transformer energy meters on outbound distribution. Additionally, it worked to regulate an electrical theft prevention system utilizing a fuzzy inference-based approach that was created in Lab View to prevent hook line activity. Inappropriate voltage is produced across unlawful consumers, which interferes with the proper operation of their appliances. This is done to prevent power theft. The consumer care unit's (CCU) interlocking with the system to prevent power theft keeps the supply voltage at the end of the line for authorized consumers at the regular level.

And [7] according to the study, the distribution line's current approach stops illicit electrical power theft. With this technique, the distribution transformer's output is encoded before being sent to the consumers. By including a decoding circuit in the smart meter, decoding is then performed at the consumer end as well. In order to prevent unauthorized distribution line tapings, encoded power signals that can't be used to power household appliances pass across the power line between the distribution transformer and the energy meter.

In addition, [8] the authors employ an online method for performing theft detection and employ an electricity

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