Impact of Electric Bus Charging on the Power Distribution System a Case Study IEEE 33 Bus Test System

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Abstract - **Electric buses (Ebus) have become increasingly used, especially in the metropolitan area, to reduce pollution from carbon monoxide and dust. However, the use of an Ebus requires charging from the power distribution system, which may affect the stability of the system. This paper is a study of the impact of electric bus charging on the power distribution system a case study IEEE 33 bus test system. The study also included Ebus charging integrated with distributed generation (DG) system to improve voltage level. The power flow was calculated using the Newton-Raphson method and the size and location of DG calculated by the voltage deviation index (VDI). The simulation results show the impact of Ebus charging on the system. The fast charging of 6 minutes at 300 kW power, system voltage dropped 0.8139 p.u., mean voltage 0.9014 p.u. The voltage improvement by installing DG on buses 18 and 33 at 1.0 MW and 1.4 MW respectively. The results show that the system voltage increased to 0.9533 p.u., the voltage means 0.9735 p.u. The Ebus charging causes the voltage drop on the power system, which affects the reliability of the system. It is a larger load than the charging of electric vehicles. The installation of DG into the system makes it possible to adjust the voltage level to the standard value.**

Keywords - **Distributed Generation, Electric Bus Charging, Power Distribution System**

I. INTRODUCTION

At present, air pollution caused by the use of internal combustion engines is increasing, which affects the lives of people in health. It also affects the environment causing global warming. In recent years this has begun to develop electric vehicles, which can help reduce greenhouse gas emissions and make the city a better environment [1].

The bus began operating in 1826, the Omnibuses, built by Stephen Bureau. He wants to transfer employees in the company [2]. In the early 19th century, technological advances in the development of electrochemical batteries, electric motors and generators made it the first start of electric motor vehicles. It has led to a revolution in urban transport, with the public bus being the Trams and Trolleybuses as shown in Fig. 1 [3], [4].

Public transportation in the form of an electric vehicle is a technological breakthrough that happened long ago. However, on the railways, it may be considered a modern development, but the problem of changing this to a larger vehicle. One of the reasons for this is the battery problem, so it can last longer and have a faster charging. The battery is efficient in electric bus operation, which consists of a large battery pack that provides all-day power for service, or at least one point at which the bus can stop charging. Korea's electric bus is said to be the first car in the world to be used for the Beijing Olympics [5]. Build Your Dreams (BYD) is the largest rechargeable battery supplier in the world. BYD K9 is featuring the most extended drive range of 250 km using LiFePO4 batteries, capacity 90 kW [6]. Proterra is an American company that manufactures electric bus batteries that have a quick charge. This bus battery can be charged in less than 10 minutes [7].

Fig. 1. Trams on the left [3] and Trolleybuses on the right [4].

A fast-charging hybrid plug-in Ebus was tested in Umea, Sweden, the automatic charger was placed at one end of an electric bus route. The bus can only operate in electric mode and is equipped with a 400 V, 100 W charger. It takes about 30 minutes to charge. These bus tests demonstrate a 100% electric operation that can be performed in this way for a 14 km circle route [8]. Electro-magnetic charging systems for electric buses are evaluated for their performance. The analysis results show the energy efficiency is 1.34 kWh/km [9]. Study of power quality problems of the fast-charging stations for public transport. The fast-charging stations have a power level of 120 kW, developed for electric buses. Power quality problems that can happen is a matter of a battery, charging, an infrastructure of electric charge, and the route of the Ebus [10]. The loads of charging stations, charging fast, resulting in an increased demand for electricity, reduce the electricity reserve, voltage uncertainty, and reliability issues. The strategy for positioning of Ebus charging stations in distribution networks is significant for stability, voltage stability, reliability, and power loss on the power distribution system [11].

This paper presents a study on the effect of electric bus charging on the power distribution system. The IEEE 33 bus test system is used to connect the Ebus charging system. The mathematical model of the Ebus charging