UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ASSESSMENT ON THE IMPACT OF DISTRIBUTED GENERATION TO THE LINE LOADABILITY FOR URBAN RAIL APPLICATION

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

by

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I hereby, declared this report entitled ASSESSMENT ON THE IMPACT OF DISTRIBUTED GENERATION TO THE LINE LOADABILITY FOR URBAN RAIL APPLICATION is the results of my own research except as cited in references.

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Date: 15/2/2021

APPROVAL

This report is submitted to The Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Tenaga elektrik adalah sumber utama sistem elektrik elektrik arus terus (AT). Pencawang kuasa tarikan disambungkan ke grid kuasa utiliti elektrik untuk tujuan operasi dan kuasa. Ketidakseimbangan daya sering berlaku di rangkaian kereta api voltan tinggi kerana beban sistem daya tarikan. Kuasa penyampaian mestilah boleh dipercayai, cekap dan kos rendah, oleh itu tujuan projek ini adalah untuk mencari kesan penjanaan pengedaran untuk beban talian dalam sistem rel bandar. Terdapat dua kes simulasi yang berbeza. Output yang perlu dipertimbangkan adalah profil voltan, kehilangan kuasa dan kos penjanaan. Semua output ini telah dianalisis oleh manajemen daya yang berbeza yaitu jarak antara penjana kuasaan terdistribusi dan beban dengan berbagai jenis penggunaan penjana kuasaan terdistribusi. Simulasi tersebut dianggap membuktikan kesan positif generasi yang diedarkan untuk beban garisan dalam sistem rel bandar.

ABSTRACT

Electrical energy is another main source of Direct Current (DC) railway electrification system. Traction power substations (TPS) were connected to the electrical utilities power grid for operating and powering purposes. The power unbalance frequently occurs in the high voltage railway network due to the load of the traction system. The power that delivery must be reliable, efficient and low in cost, thus the aim of this project is to find the impact of distribution generation for line loadability in urban rail system. There two different cases of simulation. The output that need to consider is the voltage profile, power losses and generation cost. All this output had been analyze by different power management which is distance between distributed generation (DG) and load with a different types of DG use. The simulation was considered to prove the positive impact of distributed generation for line loadability in urban rail system.

DEDICATION

I dedicated my dissertation work to my beloved family especially for my lovely parent with deepest gratitude because without their encouragement I was not able to complete this final year project and their prayers have always been a source of strength for me

ACKNOWLEDGEMENTS

This final year project is a research conducted on finding a suitable power dispatch method toward line compatible line loadability in railway distributed generation system. At the time preparing this paper, I am gone through IEEE publication paper industrial website and business website which help me to obtain lot of information with new topic. It was almost five month I spend the time and energy to complete this final year project. When I was started, I had to face some difficulties and a lot of challenges. As it turned out I sure needed help and very grateful for the support that I receive. First, I wish to express my sincere appreciation to my supervisor Mr Adlan bin Ali for his guidance in carrying out this project. I also would like to thank to my co-supervisor Mr Irianto for helping me accomplish my final year project. Lastly sincerely thanks to my family and member of Universiti Teknikal Malaysia Melaka who rendered their help during the period of my project. I also thank the University for providing me the opportunity to embark in this project

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TPS	Traction power substations
PF	Power Flow
ED	Economic Dispatch
OPF	Optimum Power Flow
DG	Distributed Generation
PV	Photovoltaic
WT	Wind Turbine
PM	Power Management
RE	Renewable Energy
AC	Alternate Current
DER	Distributed Energy Resources
RES	Renewable energy System
FC	Fuel Combustion
HV	High Voltage
AGC	Automated Generation Control

CHAPTER 1

INTRODUCTION

1.1 Project Overview

In the modern world, electricity has become the main source of traction power. In some other countries, no electricity such as diesel and a coal-driven train is still be used but they may be often restricted to long-distance commutation and/or freight transportation. The electric traction system is that the most effective traction system. It offers many advantages over alternative systems, including fast start and stop, very efficient, pollution-free, easy to handle, and simple speed management. Traction power substations (TPS) such as in Malaysia, located at the end of lines are connected by a 33KV power line to the nearest Malaysia National Grid of 132 kV. Mostly for urban rail (750 – 1500 Vdc), TPS positioned with several kilometres range to 2- 10 KM depending on the traffic intensity with the type of vehicle used. On the other hand, for the railway operate higher voltage (1500 - 3000 Vdc), the average distance of TPS is about 15-20 KM. These distances may be reduced due to intense traffic, or in case of high power consumption, such as required for high-speed lines. The power delivery from the grid is essentially the most important part. Due it supplies a public utility service thus it must ensure that the best quality of service. The challenge to obtain the quality of service of power delivery in the railway industries involves the higher operating cost with the power stability issue. In order to deliver suitable power to consumer (railway operator), the method of power dispatch with distributed generation have to be identified.

In this project, the method have been approached which is power flow load study for conventional urban rail distribution system with urban rail distribution system connected with DG. Power flow defines a steady-state analysis whose target is to determine the voltages, current, and real and reactive power flow in a system under load condition. The load flow study most basic and commonly use for electrical study including railway electrical distribution system. Distributed generation (DG) is a design system that operate a generation on the distribution system or near the load. The DG contribute huge impact on power flow thought the power system, voltage condition at bus and switch gear fault rating. DG can also contribute in reduce CO2 emission by increasing focus on renewable generation such as Solar or wind generation.

There are many things that have to be considered regarding evaluating the suitable method of power dispatching in the railway distributed generation system. A condition of Power Management (PM) is required for excellent operation in the railway distributed generation system. The purpose of applying PM is the distance between DG with the load due to long, medium or short distance of the transmission line affect the power quality to the railway system. Lastly, PM that use is the type of different DG used in the railway DG system the different types of DG allocates different power output levels. For example, is fuel (coal or diesel generation) draws a high output power compared with PV and WT. Through this project, the impact of the DG to the loadability of urban rail system can be determine.

1.2 Problem Statement

In modern countries, the promotion of the development of renewable energy (RE) in railway electrification rapidly increases. The use of DG in the railway system places the positive impact of power quality and stability during the process of power dispatching. The performance of power during high traffic intensity or during the peak hour of a railway operation causes the changes in power dispatch quality to the electrification railway system. This is because of the railway electrification load factor that depends on train frequency and usage. This type of load cause the excessively high investment cost for the railway operation

1.3. Project Objective

1. To identify the effect of voltage profile of urban rail distribution system connected with distributed generation using suitable simulation software.
2. To analyse the power losses condition for urban rail distribution connected distribution generation
3. To evaluate the total generation cost of the urban rail distribution connected with distribution generation.

1.4 Project Scope

This project mainly focusing on impact of the distributed generation of the urban rail distribution system. The scope of ths project by analysing the voltage profile, power losses and generation cost starting from primary input line to TPS

CHAPTER 2

LITERATURE REVIEW

2.1 DC Railways Electrification System

Based on (Press and Perez, 2018), the authors describe DC railway electrification is electric transport network that employs DC traction which the energy needed to power the electrical drive system is driven by a three-phase distribution network then rectified to DC by the rectifier located at TPS. DC railways line are powered by TPS located within an appropriate proximity in order to obtain best power performance and safety reason. To ensure the adequate power is obtainable for traction plant, the choice of a final location must be take the nearness to primary grid transmission or distribution stations into the design. These are following main criteria for set up a grid connection strategy:

1. Size of the plant.
2. The plant location toward the network and the presence, within the interested area, of installation or production facilities and lines as well as primary and secondary stations.
3. Network operational factors related to the connected plant.
4. Probability of extending the stations, primary and secondary stations. In simple word it can be describe as the possibility of expansion the network
5. The existence of protection and automation equipment on the network.
6. Quality and redundancy of service requirement.

The system reliability is the most important factor. Not only the relation to empower the actual train, thus it also for all power supplies to distributed to the security, safety, and emergency system, such as signaling tunnel lighting, remote control ventilation and telecommunication infrastructure.

Based on (Stuart-smith, 2014), it stated that the actual voltage level of the connection is usually set by the network voltages used based on the particular standard that been set by a country. The 11 or 22 kV is most suitable at the power levels to power up light rail while 33 kV is most suited to heavy rail system. On the other hand, for the longer distance, the 66 kV with small conductor can be a good choice other than installing the transformers to provide 33 kV supplies.

The verdict of the railway operator to invest in high voltage network infrastructure can be state in several factors;

1. The reliability of the available high voltage host network
2. The potential safety impact of a loss of supply
3. The political acceptability of service disruption

The construction of tunnel and viaduct contributes to potential safety impact factor. The safety impact can be function of ambient condition, temperature, and the ease of passenger go through the exit way when detrained. Figure 2.1 show the detrained passenger (Stuart-smith, 2014).

Figure 2.1: Detrained passenger

In designing the high voltage power supply arrangement, several parameter are identified and can be choose:

1. System topology.
2. Type of construction either (overhead or underground), and.
3. Protection scheme.

2.2 High Voltage Railway Network Topologies

TPS obtain several common basic network connection arrangement include:

1. Radial
2. Open and Close ring

2.2.1 Radial Connection

According (Stuart-smith, 2014) stated, radial connection could be an exclusive feeder from a zone substation or a simple one tee-off from a distribution feeder serving the area around the TPS. If other TPS are been fed from the same distribution feeder or the one or the same zone substation busbar, the system will be inefficient than other TPS that was fed from the independent sources. The zone substation that fed from the same sub transmission are no resist with any power disturbance and there is always possibility of power disturbance occur. The radial connection are the suitable choice for light rail system because the sophisticated connection that generally occur when lower power level of light rail system were been used. Thus it can also cause inappropriate costly. Figure 2.2 and 2,3 shows the simple dedicated radial from single bulk supply substation and radial feed from a tee from a distribution feeder (Stuart-smith, 2014)

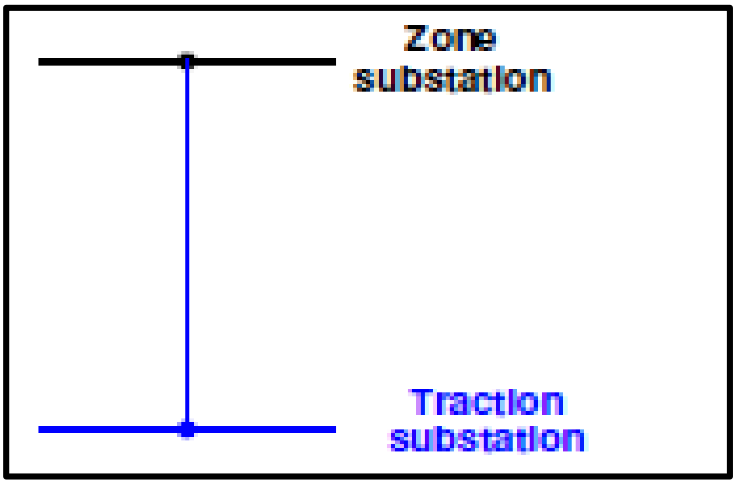

Figure 2.2: Simple Dedicated Radial from Single Bulk Supply Substation

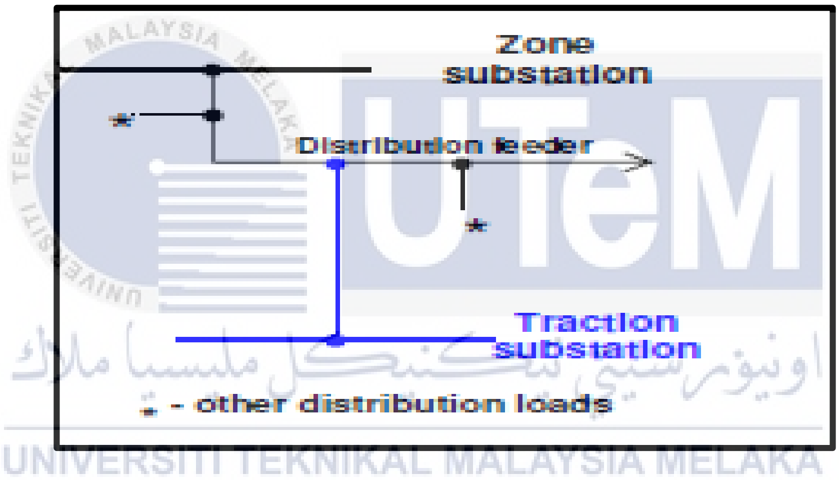

Figure 2.3: Radial Feed from a Tee from A Distribution Feeder

2.2.2 Ring Configuration

Refer to (Stuart-smith, 2014) , the ring configuration fundamentally provide two incoming supplies to each TPS with high voltage connection between substations. The end of each TPS were connected with the same bulk supply can be called as the closed ring. Basically, when the ring traverse, two bulk supply points carry significant circulating current between the supply points. In spite of, it is