The Impact of Photovoltaic Power Plant Penetration on the Submarine Cable Power Loading of Ternate-Tidore Interconnected Power System

Agus **SETIAWAN**, Universitas Indonesia, PLN (Indonesia), aguspkl@gmail.com
Devni **SYAFRIANTO**, PLN (Indonesia), devni.syafrianto@pln.co.id
Herry **NUGRAHA,** IT PLN (Indonesia), herry.nugraha@pln.co.id
Iwa **GARNIWA**, Universitas Indonesia (Indonesia), iwa@eng.ui.ac.id

ABSTRACT

Ternate-Tidore power system is dominated by fossil power plants and interconnected by submarine cable. Since electricity in Indonesia adopts Energy Transition as mandatory, the renewable energy mix must be increased. This study investigates the impact of Photovoltaic Power Plants (PVPPs) penetration on the submarine cable power loading of the Ternate-Tidore Interconnected Power System. The simulation that is conducted using a DigSILENT Power Factory software simulation model show that the integration of PVPPs may reduce the loading on the cable. This finding indicates that the optimized allocation of PVPPs may be integrated without exceeding the submarine cable's loading limit.

KEYWORDS

Interconnected Power System, Energy Transition, Submarine Cable, Energy Transition, Photovoltaic Power Plant Penetration, Loading Limit.

INTRODUCTION

The Ternate-Tidore power system is a small power system located in the North Maluku province of Indonesia. The power system primarily relies on fossil power plants for power generation and submarine cable for interconnection. The mandatory of Energy Transition in electricity of Indonesia then encourages the rise of renewable energy utilization. Since solar energy is the most widely distributed and abundant source of energy in Ternate-Tidore, utilization of photovoltaic power plants determines to the increase of renewable energy mix.

The integration of PV power plants into the power system may have impact on the submarine cable loading, which can affect the reliability of the power system. First, it can cause the submarine cable to overheat. When a submarine cable overheats, it can become damaged, and this can lead to power outages. Second, the increase in submarine cable loading can cause voltage instability in the power system. Voltage instability occurs when the voltage in the power system fluctuates, and this can lead to power outages. Third, the increase in submarine cable loading can cause an increase in the cost of electricity, as the cost of maintaining the cables also increases.

This paper focusses on investigating the impact of photovoltaic power plants penetration on the submarine cable power loading of the Ternate-Tidore interconnected power system. The investigation will feed policymakers, system operators and investors to make informed decisions regarding the integration of photovoltaic power plant can lead to several issues. The feeding may mitigate the effect of PV power plant penetration on submarine cable loading in the Ternate-Tidore power system by increasing the capacity of the submarine cables. This mitigation may raise the capacity transfer of electrical power and reduce the risk of damage due to overloading.

LITERATURE REVIEW

Several studies have been conducted on the integration of PVPPs into power systems and their impact on submarine cables.

1. Cabrera-Tobar et al. (2016) [1] conducted a study on the impact of PVPPs on the stability of a power system, and they found that the integration of PVPPs can lead to voltage instability due to their intermittent nature.
2. Dakic, Jovana, et al. (2020) [2] proposes an optimization model for PV integration in an offshore wind power plant with AC subsea cables. The results show that the optimal PV integration strategy can help to reduce the submarine cable loading and improve the overall performance of the power system.
3. Al-Shetwi, Ali Q., et al. (2020) [3] investigated the impact of PVPPs on the power quality of a power system, and they found that the integration of PVPPs can lead to harmonic distortion and voltage fluctuations.
4. Mendoza-Vizcaino et al. (2017) [4] investigated the impact of PVPPs on the reliability of submarine cables, and they found that the integration of PVPPs can increase the likelihood of cable failure due to the increased loading on the cable.
5. Lehtinen, Oula (2020) [5] found out impact of high PVPPs penetration levels on submarine cable loading in an offshore wind power plant" by - This study investigates the impact of high levels of PV penetration on the loading of submarine cables in an offshore wind power plant. The results show that the addition of PV systems can increase the submarine cable loading and that the impact can be mitigated by advanced control systems.
6. Yang et al. (2017) [6] analyses the impact of distributed PV generation on submarine cable systems and proposes a control strategy to mitigate the impact. The results indicate that the proposed control strategy can effectively reduce the impact of PV generation on submarine cable loading.

Briefly, the literatures suggest that the integration of PVPPs into power systems can have a significant impact on the stability, reliability, and power quality of the system, as well as on the submarine cable power loading. Therefore, the assessment on impact of photovoltaic power plant penetration will confirm the loading capacity of submarine cable.