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**Koordinasi Optimal Active Power Control (APC), Reactive Power Control (RPC), dan Remote Controlled
Switches (RCS) untuk Peningkatan Hosting PLTS**
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ABSTRAK

Peningkatan penetrasi Pembangkit Listrik Tenaga Surya (PLTS) pada jaringan distribusi modern menimbulkan berbagai tantangan operasional, terutama kenaikan tegangan, *reverse power flow*, dan keterbatasan *hosting capacity*. Penelitian ini mengembangkan kerangka *Active Distribution Network* (ADN) terkoordinasi untuk meningkatkan regulasi tegangan dan *hosting capacity* PLTS melalui integrasi *Active Power Control* (APC), *Reactive Power Control* (RPC), dan *Remote Control Switches* (RCS). Kerangka yang diusulkan mengombinasikan pengendalian berbasis inverter dengan rekonfigurasi jaringan sehingga injeksi daya dan topologi feeder dapat dikendalikan secara terkoordinasi untuk merespons perubahan kondisi operasi akibat penetrasi PLTS tinggi. Permasalahan diformulasikan menggunakan *Mixed-Integer Convex Programming* (MICP) yang mempertimbangkan variabel kontrol kontinu dan keputusan *switching* diskrit dengan tetap mempertahankan struktur radial jaringan distribusi. Selain itu, simulasi monte carlo digunakan untuk merepresentasikan sifat stokastik lokasi dan kapasitas PLTS sehingga analisis mampu menggambarkan berbagai kemungkinan kondisi operasi sistem. Dengan mengombinasikan analisis probabilistik dan pengendalian jaringan terkoordinasi, metode yang diusulkan memberikan pendekatan yang lebih realistis dan praktis dalam evaluasi serta peningkatan *hosting capacity* pada jaringan distribusi modern dengan penetrasi PLTS tinggi. Hasil simulasi menunjukkan bahwa koordinasi APC, RPC, dan RCS dapat meningkatkan kemampuan jaringan dalam mengakomodasi penetrasi PLTS. Pada kondisi tanpa ADN (skenario *baseline*), *hosting capacity* jaringan hanya mencapai 10%. Penerapan pengendalian inverter melalui APC dan RPC meningkatkan *hosting capacity* menjadi 14%. Peningkatan yang lebih signifikan diperoleh ketika APC dan RPC dikombinasikan dengan rekonfigurasi jaringan menggunakan RCS, yaitu hosting capacity meningkat hingga 70%. Selain itu, pada penetrasi PLTS 70%, metode APC, RPC, dan RCS dapat menurunkan tegangan maksimum sistem dari 1,0850 p.u. menjadi 1,0498 p.u. Hasil tersebut menunjukkan bahwa integrasi pengendalian daya aktif, daya reaktif, dan rekonfigurasi jaringan merupakan strategi yang efektif untuk meningkatkan *hosting capacity*.

Kata kunci: *Hosting capacity*, *Active Distribution Network*, *Active Power Control*, *Reactive Power Control*, *Remote Controlled Switches*.

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ABSTRACT

The increasing penetration of photovoltaic (PV) systems in modern distribution networks introduces significant operational challenges, particularly related to voltage rise, reverse power flow, and limited hosting capacity. This study presents a coordinated ADN framework designed to improve voltage regulation and increase PV hosting capacity by integrating Active Power Control (APC), Reactive Power Control (RPC), and Remote Controlled Switches (RCS). The proposed framework combines inverter-based control with network reconfiguration so that both power injection and feeder topology can be adjusted in a coordinated manner. Through this approach, the system is able to respond more effectively to changing operating conditions caused by high PV penetration. To determine the optimal operating strategy, the problem is formulated using a Mixed-Integer Convex Programming (MICP) model that simultaneously considers continuous control variables and discrete switching decisions while maintaining the radial structure of the distribution network. In addition, monte carlo simulations are employed to represent the stochastic nature of PV placement and sizing, allowing the analysis to capture a wide range of possible operating scenarios. By combining probabilistic analysis with coordinated network control, the proposed method provides a more realistic and practical approach for evaluating and improving hosting capacity in modern distribution systems with high PV penetration levels. Simulation results show that the coordinated implementation of APC, RPC, and RCS enhances the network's capability to accommodate higher photovoltaic (PV) penetration levels. Under the baseline condition without Active Distribution Network (ADN) control, the network hosting capacity is limited to 10%. The application of inverter-based control through APC and RPC increases the hosting capacity to 14%. A more substantial improvement is achieved when APC and RPC are combined with network reconfiguration using RCS, resulting in a hosting capacity increase to 70%. Furthermore, at a PV penetration level of 70%, the APC, RPC, and RCS strategy reduces the maximum system voltage from 1.0850 p.u. to 1.0498 p.u. These results demonstrate that the integration of active power control, reactive power control, and network reconfiguration is an effective approach for enhancing hosting capacity while maintaining voltage regulation within acceptable limits.

***Keywords** : Hosting capacity, Active Distribution Network, Active Power Control, Reactive Power Control, Remote Controlled Switches*