OPTIMAL PLANNING OF PHOTOVOLTAIC DISTRIBUTED GENERATION CONSIDERING UNCERTAINTIES USING MONTE CARLO - PDF EMBEDDED MVMO-SH

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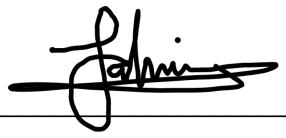

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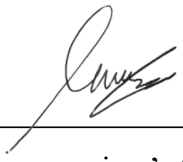

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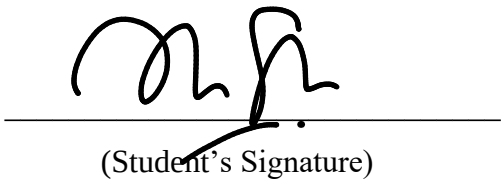

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ABSTRAK

Dengan peningkatan integrasi tenaga solar di dalam rangkaian sistem kuasa, kajian ketidakpastian penghasilan tenaga solar perlu diambil kira di dalam perancangan, pengoperasian dan pengawalan penjanaan teraruh fotovoltan tersambung grid. Ini kerana ketidakpastian penghasilan tenaga solar ini boleh mengganggu operasi rangkaian sistem kuasa. Kaedah kebarangkalian merupakan kaedah paling berkesan untuk memodelkan ketidakpastian sinar solar. Berdasarkan data meteorologi, permodelan berasaskan simulasi Monte Carlo dibangunkan menggunakan kebarangkalian pengaruhan beta untuk memodelkan pembolehubah rawak berterusan yang terdapat di dalam sinar solar. Permodelan ketidakpastian sinar solar diperlukan bagi mengoptimalkan perancangan integrasi sistem penjana teraruh fotovoltan di dalam rangkaian sistem kuasa tersambung grid. Tambahan pula, kajian ketidakpastian sinar solar berdasarkan cuaca tropika di Malaysia tiada di dalam kajian-kajian literasi bagi tujuan perancangan penjana teraruh fotovoltan di dalam rangkaian sistem kuasa. Maka disertasi ini akan memfokuskan kajian untuk membangunkan system kerangka optimasi baharu berdasarkan Monte Carlo – MVMO-SH bagi mengoptimalkan lokasi dan saiz penjana teraruh fotovoltan dengan mengambil kira ketidakpastian tenaga solar dan beban berdasarkan keadaan tropika di Malaysia. Bagi kajian permodelan aliran beban, permodelan berasaskan simulasi Monte Carlo – Gaussian dibangunkan mengambilkira beban domestik (kediaman), perniagaan (perdagangan) dan beban industri. Algoritma optimasi berasaskan populasi - stokastik iaitu MVMO-SH dibangunkan bertujuan mengoptimalkan lokasi dan saiz penjana teraruh fotovoltan bagi meminimumkan indek kehilangan kuasa (APL). Sistem pengujian pengagihan kuasa sejajar digunakan untuk menguji keberkesanan model yang dibangunkan. Kehilangan kuasa dan profil voltan boleh diperbaiki sekiranya saiz dan lokasi penjanaan teraruh fotovoltan dioptimalkan di dalam rangkaian sistem kuasa. Permodelan ini dibangunkan sebagai data masukan kepada analisis aliran beban. Corak aliran kuasa akan terganggu apabila permodelan ketidakpastian diambil kira di dalam analisis aliran beban. Maka, kaedah matematik aliran kuasa perlu diperbaiki dan dibangunkan dengan mengambil kira simulasi Monte-Carlo berdasarkan ketidakpastian penghasilan kuasa solar dengan menggunakan model fungsi kebarangkalian pengaruhan beta untuk ketidakpastian penghasilan kuasa fotovoltan dan fungsi kebarangkalian pengaruhan Gaussian untuk kajian permodelan kebarangkalian beban. Algoritma yang dibangunkan adalah penting di dalam perancangan integrasi penjanaan teraruh fotovoltan di dalam sistem penghantaran kuasa. Hasil keputusan kajian menunjukkan model Monte Carlo – PDF adalah kurang dari 15% pelencongan jika dibandingkan dengan hasil permodelan yang dibangunkan oleh SEDA. Keputusan mengoptimumkan perancangan integrasi penjana teraruh fotovoltan akan mengurangkan kehilangan kuasa di dalam rangkaian sistem kuasa. Keputusan kajian bagi kaedah MVMO-SH – Monte Carlo PDF juga didapati menurunkan kadar indeks APL lebih baik berbanding PSO dan GA. Permodelan ketidakpastian didapati sangat mempengaruhi perancangan integrasi sistem penjana teraruh fotovoltan di dalam rangkaian sistem kuasa.

ABSTRACT

In recent years, photovoltaic distributed generation (PVDG) has seen rapid growth due to its benefits in supporting the power system network, enhancing the transmission and distribution of power, and minimizing power congestion. PVDGs are connected directly to the load and produce power locally for the users, thus help to relieve the entire grid by reducing the demand especially during the peak load. Due to the random nature of the weather and occurrences of uncertainty, the planning and optimization of PVDG in the power system network with predicted uncertainty in photovoltaic generations and load variations are of crucial importance to minimize power losses. Thus, this research aims to develop a new optimization framework based on Monte Carlo embedded hybrid variant mean – variance mapping optimization (MVMO-SH) for the planning of PVDGs by considering these uncertainties. In this work, the probabilistic method in managing the risk of solar irradiance uncertainty with load variability is prepared. Uncertainty management is focused on the Malaysian tropical climate. Using meteorological data for one reference year, the Monte-Carlo simulation is performed in the Beta probability density function (PDF) to model continuous random variables of solar irradiances. For the load modelling studies, the Monte Carlo simulation is performed in Gaussian PDF to develop a probability model of various types of loads. The urban residential, commercial and industrial load profiles for one reference year are used for the load modelling. The probabilistic values of PV generation and load models are employed as the input data to the load flow analysis for the radial distribution network. The load flow patterns will significantly have affected when uncertain PV generation – load models are considered into the power flow algorithm. A new method of probabilistic backward – forward sweep power flow (BFSPF) based on Monte Carlo – PDF is developed as the fitness evaluation for the PVDG planning. A hybrid population – based stochastic optimization method named MVMO-SH algorithm is proposed to optimize PVDG locations and sizes in the grid system network. The objective function is to minimize the active power loss (APL) index. The proposed algorithm is applied to the standard radial test system to examine the usefulness and effectiveness of the proposed method. The impacts of PVDG on the power system network have been examined. As the results of the study, the uncertainty model of solar irradiance in Monte Carlo – Beta PDF has shown an almost similar pattern with less than 15% deviation as compared to the model from SEDA. The reductions in the power system's total power losses have been shown with appropriate planning of PVDG in the power system network considering uncertainty in PV generation and load variations based on the Malaysian Tropical climate. When probabilistic BFSPF is optimized by MVMO-SH embedded Monte Carlo – PDF under uncertainties, the results show a better APL index compared to utilizing PSO and GA. The results also revealed that the uncertainties had the greatest influence on the optimal planning of PVDG in the power system network.

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