UNIVERSITI PUTRA MALAYSIA

MODELLING OF STAND-ALONE HYBRID MICROGRID WITH DEMAND- SIDE MANAGEMENT

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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May 2014

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Faculty: Engineering

The future of power system will be highly influenced by Microgrid with renewable energy resources. Stand-alone Microgrid is widely proposed for any kind of grid-off community and rural electrification. Due to lack of established standards in Microgrid industry, designing a Microgrid seams ambiguous. The first part of this study tries to fill this gap by acquiring and addressing the relevant standards. The design starts by feasible study based on location and potential renewable energy resources. Based on load data, the supply capacity and storage backup are calculated. It was shown that solar and wind energy are suitable Renewable Energy Sources (RES) for tropical area such as Malaysia. In this study, solar energy, wind energy and battery backup are sized and modeled based on relevant standards. Three controllers are modeled and simulated for Maximum Power Point Tracking (MPPT), DC/DC converter and DC/AC inverters for proposed plant. Mathematical model of each individual elements of proposed Microgrid are modeled in MATLAB/Simulink software. The simulation results of main components are validated by manufacturer's datasheet. Due to uncertainty and intermittency in Renewable Energy (RE) Generation, a smart Demand Side Management (DSM) controller is proposed to smoothing demand control and increase system efficiency. The existing DSM functions are mostly suitable for utilities and grid-connected Microgrid. Proposed DSM is adjusted to meet vulnerable stand-alone system requirement. The simulation results show DSM controller will supply sensitive load longer and will increase system efficiency. Different scenarios for sun irradiance, wind speed and temperature are simulated to test DSM controller in different situation and the result shows DSM controller is successfully implemented. For future study, an intelligent load pattern recognition will improve the proposed DSM function for each load will be

recognized by DSM wherever they plugged in the supply. Finally, an experimental work on this study also is recommended.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia Sebagai memenuhi keperluan untuk ijazah Master of Sains

PEMODELAN HIBRID MIKROGRID BERDIRI SENDIRI DENGAN PERMINTAAN DARI PENGURUSAN

Oleh

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Masa depan sistem kuasa sangatlah dipengaruhi oleh grid mikro berserta sumber tenaga boleh diperbaharui. Grid mikro berdiri sendiri dicadangkan secara meluas bagi apa-apa jenis masyarakat grid-tutup dan elektrik luar bandar. Oleh kerana kekurangan piawai yang diiktiraf dalam industri grid mikro, mereka bentuk grid mikro masih kabur. Bahagian pertama kajian ini cuba untuk mengisi jurang ini dengan memperoleh dan menangani tahap yang ditetapkan. Reka bentuk ini bermula dengan kajian dilaksanakan berdasarkan lokasi dan potensi sumber tenaga boleh diperbaharui. Berdasarkan data beban, bekalan dan penyimpanan dikira. Ia menunjukkan bahawa solar dan tenaga angin sesuai sebagai sumber tenaga boleh diperbaharui (RES) bagi kawasan tropika seperti Malaysia. Tenaga solar tenaga angin, bateri sandaran dikenal pasti saiznya dan dimodelkan berdasarkan piawai. Tiga pengawal dimodelkan dan simulasi dijalankan untuk maksimum penjejakan kuasa titik (MPPT), penukar DC/DC dan pengawal tersongsang AC/DC bagi loji yang dicadangkan. Model matematik bagi setiap elemen di dalam cadangan grid mikro dimodelkan menggunakan perisian MATLAB/Simulink. Keputusan simulasi komponen utama disahkan oleh lembaran data dari pengeluar. Disebabkan oleh ketidaktentuan dan ketidakteraturan dalam penjanaan tenaga boleh diperbaharui (RE), pengawal pintar permintaan dari pengurusan kawalan (DSM) dicadangkan untuk melicinkan kawalan permintaan dan kecekapan peningkatan sistem. Fungsi DSM sedia ada kebanyakannya sesuai untuk utiliti dan grid mikro grid-sambungan. DSM yang dicadangkan akan diselaraskan untuk memenuhi keperluan sistem yang berdiri sendiri terdedah. Keputusan simulasi menunjukkan DSM pengawal akan membekalkan beban sensitif lagi panjang dan akan meningkatkan kecekapan sistem.

Simulasi bagi senario yang berbeza untuk sinaran matahari, kelajuan angin dan suhu dilakukan untuk menguji pengawal DSM dalam keadaan yang berbeza dan hasilnya menunjukkan pengawal DSM berjaya dilaksanakan. Untuk kajian masa depan, pengecaman corak beban pintar akan meningkatkan fungsi DSM yang dicadangkan untuk setiap beban akan diiktiraf oleh DSM di mana sahaja mereka dipasang bekalan. Akhir sekali, kerja eksperimen kajian ini juga adalah disyorkan.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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