Faculty of Electrical Engineering

MODELING OF ISLANDING DETECTION METHODS FOR MICROGRID

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MODELING OF ISLANDING DETECTION METHODS FOR MICROGRID

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DECLARATION

I declare that this thesis entitled "Modeling of Islanding Detection Method For Microgrid" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality for the award of Master of Science in Electrical Engineering.

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Date :

DEDICATION

To my beloved mother and siblings

ABSTRACT

The increase in world demand for energy as well as environmental concern over scarce and limited fossil fuels has significantly triggered the search for environmentally friendly and renewable energy resources. In Malaysia, the system maximum demand in Peninsular has increased 4.65% from the year 2012 to 16,562 MW which has been recorded in May 13, 2013. Hence, to meet future energy requirement, some proactive measures of alternatives or renewable sources of energy must be established. In this context, the Micro-Grid (MG) concept is the potential solution to the issue of scarce natural resources. However, one of the major challenges associated with implementation of MG is to design an appropriate protection scheme which can protect MG in both grid and islanded mode. Considering this, a MG microswitch-based OUV and OUF IDMs through passive, Non-Intelligent IDM techniques was modelled and simulated. Microswitch-based performance testing has been carried out on both grid-connected and island modes, and considering the active power flow between the two systems and accompanying with different faulty conditions on each case and tested it five simulation cases based on the IEEE Standard 1547.4 test systems. These models were also tested with two fault of conditions in IEEE 15-bus radial distribution test system. The investigation from both test systems shows that, the proposed microswitch-based is effectively to perform in grid-connected and islanded modes. It also could import, export and isolate the active power flow without any serious effect in feeding the Unintentional Islanding Test Load and it function effectively under different faulty. Finally, the implemented concept of microswitch-based on MG is recommended to represent actual Malaysian distribution network model and parameters.

ABSTRAK

Peningkatan terhadap permintaan tenaga dunia telah menjadi satu kebimbangan terhadap alam sekitar dimana bahan api yang terhad telah mencetuskan usaha untuk mencari tenaga yang lebih mesra alam dan sumber tenaga boleh diperbaharui. Di Malaysia, kehendak maksimum pada sistem grid di Semenanjung menunjukkan peningkatan sebanyak 4.65% berbanding pada tahun 2012 iaitu sebanyak 16.562 MW yang telah direkodkan pada 13 Mei 2013. Oleh itu, untuk memenuhi keperluan tenaga untuk masa hadapan, beberapa langkah proaktif telah diwujudkan bagi mencari alternatif lain untuk sumber tenaga yang boleh diperbaharui. Dalam konteks ini, konsep MicroGrid (MG) adalah satu penyelesaian yang berpotensi dalam menangani isu sumber semula jadi yang terhad. Walau bagaimanapun, salah satu cabaran utama yang berkaitan dengan pelaksanaan MG adalah mereka bentuk sistem perlindungan yang mempunyai keupayaan untuk melindungi MG dalam mod sambungan pada grid dan mod pengasingan dari grid. Sehubungan itu, suis-mikro MG berasaskan teknik pasif OUV dan OUF, bukan pintar telah dimodelkan dan di simulasikan. Pengujian prestasi suis-mikro telah dijalankan pada kedua-dua keadaan mod sambungan pada grid dan mod pengasingan dari grid, dan mengambil kira tentang aliran tenaga yang aktif antara kedua-dua sistem dan disertakan keadaan kegagalan yang berbeza untuk setiap kes telah dijalankan dengan lima kes simulasi berdasarkan sistem ujian IEEE Standard 1547.4. Suis-mikro model ini juga turut diuji dengan dua keadaan kegagalan pada Sistem Ujian Pengagihan Jejari 15 bas. Dari pengujian dari kedua-dua sistem ujian ini menunjukkan bahawa, suis-mikro berkesan untuk beroperasi dalam mod sambungan pada grid dan mod pengasingan dari grid. Malah, dalam kes mengimport, eksport dan mengasingkan aliran kuassa aktif, tiada kesan yang serius dalam proses membekalkan tenaga walaupun di bawah keadaan kegagalan yang berbeza. Akhir sekali, konsep suis-mikro yang dilaksanakan pada MG adalah disyorkan untuk diguna pakai di rangakaian pengedaran Malaysia yang sebenar.

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LIST OF ABBREVIATIONS

AFD	Active Frequency Drift
AI	Artificial Intelligent
ANN	Artificial Neural Network
APS	Automatic Phase Shift
ARPS	Adaptive Reactive Power Shift
CERTS	Consortium for Electrical Reliability Technology Solution
CFC	Chloro-Fluro-Carbons
COP	Change of Output Power
COROCOF	Comparison of Rate of Chane of Frequency
CO_2	Carbon Dioxide
CHD	Current Harmonics Detection
CHP	Combined Heat & Power
DER	Distributed Energy Resources
DG	Distributed Generation
DISF	Detection of Impedance at Specific Frequency
DR	Distributed Resources
DP	Disperse Power
DT	Decision Tree
EMD	Empirical Mode Decomposition
EPS	Electric Power System
f	Frequency

FB	Frequency Bias
FJ	Frequency Jump
FL	Fuzzy Logic
FiT	Feed-in-Tariff
GDP	Gross Domestic Product
GEFS	General Electric Frequency Schemes
GWh	Giga Watt Hour
Hz	Hertz
II	Impedance Insertion
IM	Impedance Measurement
IDM	Islanding Detection Method
IEEE	Institute of Electrical and Electronic Engineers
KF	Kalman Filter
kW	kilo Watt
LL	Line-to-line
LN	Line-to-Neutral
LV	Low Voltage
MG	MicroGrid
MWh	Mega Watt Hour
MV	Medium Voltage
NJSMS	Nonlinear Jumping Slip Mode Frequency Shift
NDZ	Non-Detection Zone
NOX	Nitrous Oxide
NSCI	Negative-Sequence Current Injection
PCC	Point of Common Coupling

PF&VU	Positive Feedback and Voltage Unbalance
PJD	Phase Jump Detection
PLCC	Power Line Carrier Communication
PLS	Power Line Signaling
PMU	Phasor Measurement Unit
RE	Renewable Energy
RI	Reactance Insertion
RMS	Root Mean Square
ROCOF	Rate of Change of Output Frequency
ROCOFOP	Rate of Change of Output Frequency Over Power
ROCOP	Rate of Change of Output Power
RPBAM&ANN	Reactive Power-based Active Method and Artificial Neural Network
RPEED	Reactive Power Export Error Detection
SCADA	Supervisory Control and Data Acquisition
SEDA	Sustainability Energy Development Authority
SFS&Q-f	Hybrid Sandia Frequency Shift & Q-f
SMS	Slip Mode Frequency Shift
SOM	Self-Organizing Map
SO_2	Sulphur Dioxide
SPD	Signal Produced by Disconnect
ST	S-Transform
SVS	Sandia Voltage Shift
TNB	Tenaga Nasional Berhad
TTS	Transfer Trip Scheme
UFT	Unstable Frequency Trip

UOV	Under / Over Voltage
UOF	Under / Over Frequency
V	Voltage
VC&RPS	Voltage Change and Real Power Shift
VHD	Voltage Harmonics Distortion
VMV	Voltage Magnitude Variation
VOC	Volatile-Organic compounds
VPFC	Voltage and Power Factor Change
VS	Vector Shift
VSR	Vector Surge Relay
VU	Voltage Unbalance
V_g	Voltage at grid
V_{LL}	Voltage Line-to-Line
V_{LN}	Voltage Line-to-Neutral
WT	Wavelet Transform

LIST OF SYMBOLS

Δf	Frequency Difference
ΔV	Voltage Difference
$\Delta \Phi$	Phase Difference
Δ	Delta
Y_g	Wye-Ground