NON-CONVENTIONAL ENERGY BASED POWER GENERATION UNITS FOR MICRO-GRID SYSTEM

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ABSTRACT: Micro-grid is currently an optimal solution for satisfy the responsibility of reliable power delivery future Power Systems. Renewable power sources, for example, wind and hydro offer the best potential for outflow free power for future micro-grid systems. This paper presents a miniature network framework dependent on wind and hydro power sources furthermore, delivers issues identified with activity, control, and steadiness of the framework. The micro-grid system examined in this paper speaks to a contextual analysis carried for this research. It comprises of a little hydro age unit and a wind ranch that contains nine variable-speed, twofold took care of acceptance generator based wind turbines. Utilizing MATLAB Simulink, the network is demonstrated and reproduced to recognize the specialized issues associated with the activity of a micro-grid system dependent on inexhaustible force age units. The operational modes, specialized difficulties and a concise blueprint of calculated ways to deal with tending to a portion of the specialized issues are introduced for additional examination.

Index Terms- Micro-grid, Renewable power generation, Distributed generation, MATLAB

I. INTRODUCTION

The interest for more force joined with interest in clean advancements has driven analysts to create disseminated power age frameworks utilizing environmentally friendly power sources [1-3]. Then again, the reconciliation of an enormous number of dispersed generations into conveyance network is confined because of the limit restriction of the conveyance organizations and their unidirectional force stream conduct [2, 4, 5]. Such obstructions have propelled scientists to locate an option applied answer for upgrade the circulated age joining into the appropriation organizations. An elective methodology called "Micro-grid" was proposed in 2001 as a methods for coordinating more appropriated ages into the dissemination networks [5]. Disseminated age in miniature matrix activity gives advantages to the utility administrators, disseminated age proprietors furthermore, purchasers as far as dependable force gracefully, transmission misfortune pay, decrease in transmission framework extension furthermore, improvement of sustainable force entrance. An audit of the current writing uncovers that the first miniature matrix design was proposed by R. H. Lasseter[5, 6], and called CERTS miniature framework. The CERTS microgrid by and large accepts converter-interfaced conveyed age units dependent on both inexhaustible and non-sustainable power sources. Barnes et al [8] additionally

proposed a miniature framework framework under the casing of the European venture "Miniature matrices". The European miniature matrix engineering consists of two PV generators, one wind turbine, battery stockpiling, controllable loads and a controlled interconnection for the nearby low voltage network. The NEDO in Japan proposed three miniature network ventures in 2003 [9, 10]. The primary NEDO miniature network (1.7MW) framework includes various types of power modules for example, MCFC, PAFC, SOFC, and photovoltaic (PV) framework and battery stor-age.The second NEDO miniature lattice (610kW) setup comprises of PV, WT, biomass and battery stockpiling. The third NEDO miniature framework (750kW) framework comprises of PV, WT, MCFC, biogas and battery bank, which has exceptionally low rate (13 percent) of sustainable energy age. Miniature network research in Canada has begun in colleges with the collaboration of the CANMET energy innovation focus at Varennes [9]. This exploration bunch has identified industry cases, for example, the secluded Rameawinddiesel miniature matrix framework, and the Fortis Alberta lattice tied microgrid framework for examination. Canada's miniature network research and advancement additionally developed to build up a proving ground for industrialgrade model testing and execution assessment [9]. An examination of miniature lattice dynamic conduct, alongside the control of the miniature age units is performed by F. Kateraie [7]. This miniature framework depends on the benchmark arrangement of the IEEE Standard 399-1997 [11], which comprises of three age units involving a diesel generator or a gas turbine generator, an electronically interfaced conveyed age and a fixed speed wind power generator.

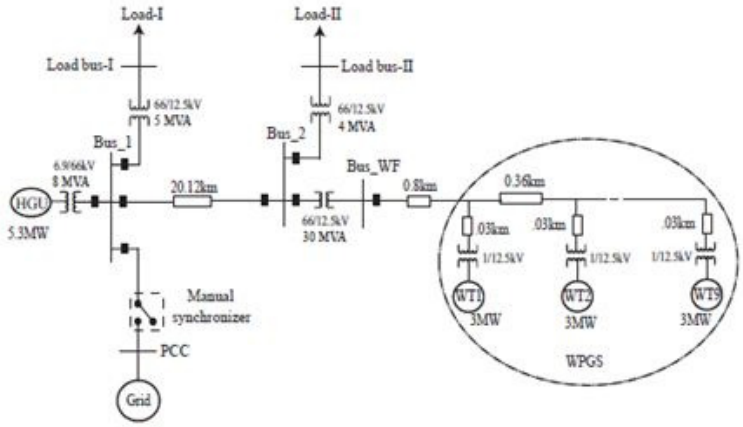

Fig. 1. Micro-grid network under exploration

The different miniature age units in a miniature framework what's more, the craving to coordinate all the more spotless force in future force network has prompted an attention on a miniature matrix framework dependent on sustainable force age units in this exploration. All in all, the qualities of a miniature grid framework rely upon the size furthermore, nature of the miniature age units in the miniature matrix, as well as the site, and the accessibility of the essential energy assets on the site, particularly for sustainable force sources. Hence, taking a

current genuine framework is the better way to deal with research the miniature matrix framework issues rather than accepting or taking a theoretical framework.

The target of this exploration is to research the framework conduct and specialized issues of a miniature matrix framework contains sustainable force age units in Newfoundland. Thinking about these reasons, the specialized difficulties and techniques for tending to them for the framework appeared in Figure 1 have not been explored at this point. This paper researches the specialized difficulties associated with the wind ranch and hydro age based miniature network framework. So as to group the specialized difficulties for the miniature network framework under examination, three operational modes (Figure2) are thought of: (a) network associated framework, (b) disengaged framework with wind power age, and (c) disconnected framework without wind power age.

II. THE MICRO - GRID SYSTEM

The schematic of the miniature lattice framework appeared in Figure 1 comprises of a HGU, a WPGS, and two burden territories spoke to as Load- I (3.94 MW, .9 MVar) and Load-II (2.82 MW, 0.84 MVar). The two burden territories are associated through a 20.12 km transmission line and the two producing frameworks are associated through a 21 km transmission line. The wind turbines are associated with bus 2 utilizing its own transmission lines and a 12.5/66kV, 30 MVA power transformer. Load bus II is associated with bus 2 and the force is conveyed to the heap utilizing a 66/12.5kV, 4 MVA power transformer. Load bus I is associated with bus 1 and the force is conveyed to the heap utilizing a 66/12.5kV, 5 MVA power transformer. The HGU is associated with bus 1 utilizing a 6.9/66kV, 8MVA force transformer.

A regular coordinated generator, prepared with IEEE standard excitation and lead representative framework, is utilized for the HGU. A 66kV,1000 MVA framework is associated with bus 1. Both force age frameworks work in network associated mode. The programmed separated activity of the HGU isn't the current act of the utility proprietor, and the WPGS isn't permitted to work in separated mode. If the framework power is lost because of shortcomings or planned support, a dark out would result until the HGU comes in activity. Indeed, even with the HGU in activity, some heap shedding might be important since the HGU would not have the option to satisfy the heap need. Hence, the results of the network blackout are the key drivers which direct the operational methods of the miniature matrix framework.

III. OPERATIONAL MODES OF THE MICRO - GRID

Framework Specialized issues, for example, control, power balance techniques, operation, security and capacity procedures vary from one miniature matrix to another. The fundamental reasons are the combination of high number of appropriated power age units close to the electrical burdens, the nature and size of the miniature age units, and accessibility of essential fuel hotspots for sustainable power age units.

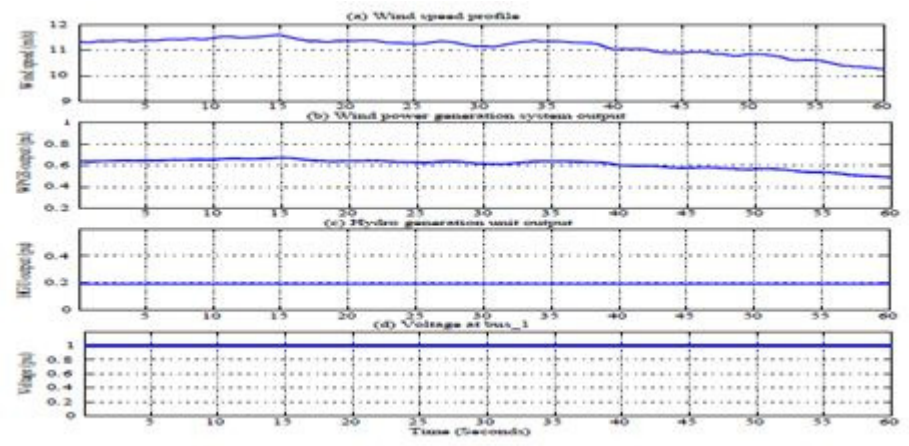

Fig. 2. (a) Wind speed contour, (b) WPGS output influence, (c) HGU output influence, (d) Voltage at bus 1

IV. MODELING AND SIMULATION

The segments of the distinguished framework are demonstrated utilizing MATLAB/SIMULINK programming instrument. The HGU model is the mix of the model of simultaneous generator, hydro turbine and turbine lead representative framework, and excitation framework. The simultaneous machine electrical framework is demonstrated in a d-q rotor reference outline with the elements of stator, rotor and damper windings [17]. The simultaneous machine boundaries are acquired from Newfoundland Power, Canada and from [18]. Hydro turbine and turbine lead representative framework model is given in [19]. The boundaries for the hydro turbine and penstock are acquired from Newfoundland Power, Canada. The WPGS model comprises of dynamic model of nine variable-speed doubly-took care of acceptance generator based wind turbines. Vestas-90 wind turbine boundaries are utilized in the created wind turbine rotor model [20]. The acceptance machine electrical framework is demonstrated in a d-q simultaneously pivoting reference outline [17].

Generator boundaries are gotten from [20, 21]. The utility matrix is spoken to by an identical model of 66kV three stage voltage source with the short out limit of 1000 MVA and the reactance to opposition proportion of 22.2 [11]. A consistent impedance load model is utilized in the framework. The boundary data about the line, transformer and burden are gotten from the service organization, Newfoundland Power. Reproductions for three operational modes (Fig. 2)

are performed and the reenactment results are introduced in the accompanying segments. The estimations introduced in the reenactment results are in per unit, while the base force is 27 MVA. The recreation was performed for a 60 seconds span. The wind speed model [22] is utilized as the wind profile for the wind turbine rotor.

WPGS with no yield power speaks to the absence of adequate wind speed to create electric force. The network is disengaged from the framework at t=5 seconds in view of a deficiency or ordinary upkeep in the transmission frameworks. The deficiency in the network transmission frameworks (accidental islanding) or their standard support (deliberate islanding) is recreated utilizing a three stage electrical switch with explicit time settings.

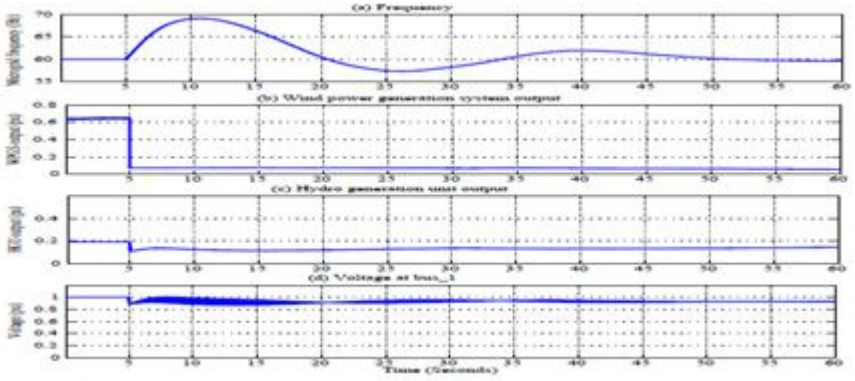

Fig. 3. (a) Micro-grid frequency (Hz), (b) WPGS output influence, (c) HGU output influence, (d) Voltage at bus 1

A. ***Mode-I:*** Grid associated mode - The reproduction results for Mode-I are spoken to in Figures, while WPGS and HGU are associated with the framework. No underlying transient shows the consistent state activity of the framework in matrix associated mode. Figure 3(a) shows the wind speed profile gave into the wind turbine rotor. Figure 3(c) and 3(b) show the created power by the HGU, and by the WPGS, while nine wind turbines are in activity. The yield of the WPGS shifts because of the wind speed variety. Figure 3(d) speaks to the voltage at bus 1 which is in its evaluated esteem. These outcomes show that the activity of the HGU and WPGS in framework associated mode is directed by the matrix with the normal framework voltages and recurrence set by the network.

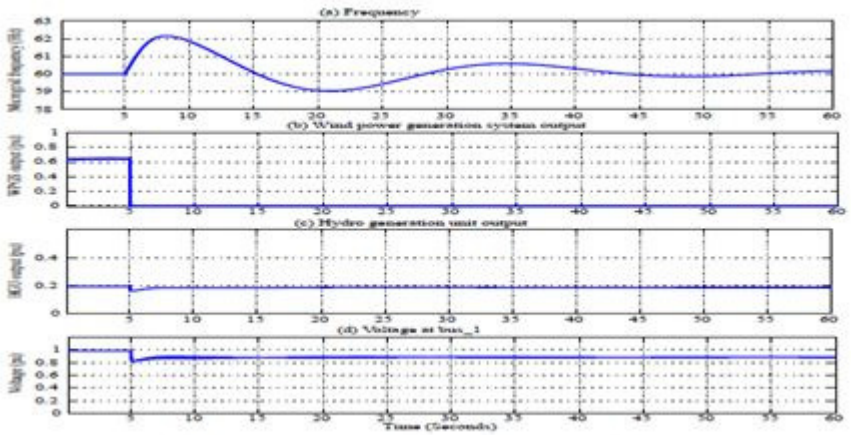

Fig. 4. (a) Micro-grid frequency (Hz), (b) WPGS output influence, (c) HGU output influence, (d) Voltage at bus 1

B. ***Mode-II:*** Isolated framework with wind power age The framework activity follows the Mode-I until t=5 seconds. After t=5 seconds, the framework is segregated from the framework. Figure 4(a) shows the miniature framework recurrence, which isn't in a satisfactory reach for the miniature network activity. This demonstrates that the force age and utilization isn't adjusted in the miniature framework. Figure 4(b) and 4(c) show the force commitment by the two age units into the miniature brace, while accepting just one wind turbine is in activity in the WPGS after t=5 seconds. As HGU is the firm force age framework, it is chosen to work the HGU during the whole activity. Nonetheless, the activity of WPGS with at least one wind turbines is chosen dependent on load interest.

Voltage at bus 1 is appeared in Figure-4(d) which diminishes after framework disengagement. This demonstrates the absence of adequate responsive force in the miniature lattice framework, which was really provided by the matrix in the network associated mode. More than one wind turbine working in the WPGS will convey more dynamic force in the miniature matrix framework than the heap interest. In such case, the responsive force request will likewise increment in the miniature network framework which brings about more decrease in voltage level at various areas in the miniature lattice framework. C. Mode-III: Isolated framework without wind power age The framework activity follows the Mode-I until t=5 seconds. Be that as it may, at t=5 seconds, the network is disconnected from the framework.

Simultaneously, the WPGS has no yield power as there is inadequate wind asset to create power. This method of activity is reproduced, and the outcomes are appeared in Figure 5(a-d). Figure 5(a) shows the miniature framework recurrence, which isn't decent by the framework. This likewise shows that the force age and utilization in miniature network framework isn't adjusted. Figure 5(c) shows the HGU yield power and the zero yield power from the WPGS is appeared in Figure 5(b). The voltage level at bus 1 is appeared in Figure 5(d) which is a lot of lower than its appraised esteem.

This demonstrates the prerequisite for responsive force in the miniature matrix framework. As the WPGS can't convey power (Fig. 5(b)) after t=5 seconds because of the absence of adequate wind, the prerequisite of extra force from a dependable stockpiling framework is basic. In light of recreation results, the issues identified with miniature matrix activity of the framework under scrutiny can be summed up as: • Active force lopsidedness or potentially variety happens in segregated miniature lattice mode when wind power is accessible. A control conspire is needed to keep up dynamic force balance by putting away or unloading overflow power. Engine siphon sets can be utilized to siphon water utilizing surplus power. Nonetheless, a dump load is needed to accomplish better precision in power-recurrence balance.

• Active force awkwardness will happen between age units and burdens when wind power isn't accessible in segregated miniature network mode. A reasonable stockpiling framework alongside a control plot is needed to keep up power-recurrence balance.

• Reactive force is needed during detached miniature framework activity to keep up the normal voltage level at various buss in the miniature network framework. The responsive force request can be furnished by STATCOM during disconnected framework with wind power age and by capacity unit during segregated framework without wind power age. Also, a control organizer and observing framework is required for the miniature lattice activity. A heap stream based microgrid checking and control organizer plan can be picked for the proposed miniature lattice framework activity.

CONCLUSION

Miniature matrix activity of a framework dependent on sustainable force age units is introduced in this paper. The framework conduct and specialized issues associated with three operational modes in miniature matrix conspire are distinguished and examined. The examination is performed dependent on reenactment results utilizing Matlab/Simulink programming bundle. Reproduction results show that dump load and reasonable stockpiling framework alongside legitimate control plot are moreover needed for the activity of the investigation framework in a miniature network conspire. A control facilitator and observing framework is additionally needed to screen miniature lattice framework state and choose the fundamental control activity for an operational mode. The necessary control plans improvement for the proposed miniature lattice framework is as of now under scrutiny by the creators.

REFERENCES

[1] T. Ackermann and V. Knyazkin, “Interaction between distributed generation and the distribution network: Operation aspects”, Sec- ond Int. Symp. Distributed Generations: Power System Market Aspects, Stockholm, Sweden, 2002.

[2] C. Abbey, F. Katiraei, C. Brothers, “Integration of distributed generation and wind energy in Canada”, Invited paper IEEE Power Engineering Society General Meeting and Conference, Montreal, Canada, June 18-22, 2006.

[3] FredeBlaabjerg, Remus Teodorescu, Marco Liserre, Adrian V.Timbus, “Overview of control and grid synchronization for dis- tributed power generation systems”, IEEE Transactions on Indus- trial Electronics, Vol. 53, No. 5,October 2006.

[4] F. Katiraei, C. Abbey, Richard Bahry, “Analysis of voltage reg- ulation problem for 25kV distribution network with distributed generation”, IEEE Power Engineering Society General Meeting, Montreal, 2006.

[5] R. H. Lasseter, “Microgrids (distributed power generation)”, IEEE Power Engineering Society Winter Meeting, Vol. 01, pp. 146-149, Columbus, Ohio, Feb 2001.

[6] R. H. Lasseter, “Microgrids”, IEEE Power Engineering Society Winter Meeting , Vol. 01, pp. 305-308, New York, NY, 2002.

[7] F. Katiraei, M. R. Iravani, P. W. Lehn, “Small signal dynamic model of a micro-grid including conventional and electronically interfaced distributed resources”, IET Gener. Transm.Distrib., Vol. 01, Issue 3, pp. 369-378, 2007.

[8] M. Barnes, A. Dimeas, A. Engler, C. Fitzer, N. Hatziargyriou, C. Jones, S. Papathanassiou, M. Vandenbergh, “Micro-grid lab- oratory facilities”, International Conference on Future Power System,November 2005.

[9] N. Hatziargyriou, H. Asano, R. Iravani, C. Marnay, “Micro-gridsAnoverview of ongoing research, development and demonstration projects”, IEEE Power and Energy Magazine, pp. 78-94, July/August 2007.

[10] S. Morozumi,, “Overview of micro-grid research and develop- ment activities in Japan”, A Symposium on Micro-grids,Montreal, June 23, 2006.

[11] “IEEE Recommended Practice for Industrial and Commercial Power System Analysis”, IEEE Standard., IEEE Std 399-1997, 1997.

[12] M. Shahabi, M. R. Haghifam, M. Mohamadian, S. A. NabaviNiaki, “Microgrid Dynamic Performance Improvement Using a Doubly Fed Induction Wind Generator”, IEEE Transactions on Energy Conversion,Vol. 24, No. 1, March 2009.

[13] R. Majumder A. Ghosh G. Ledwich F. Zare, "Load sharing and power quality enhanced operation of a distributed micro-grid", IET Renew. Power Gener., Vol. 3, Iss. 2, pp. 109-119, 2009.

[14] C. Nayar, "Remote Area Micro-Grid System using Diesel Driven Doubly Fed Induction Generators, Photovoltaics and Wind Gen- erators", IEEE International Conferences on Sustainable Energy Technologies, Singapore, pp. 1081-1086, November 24-27, 2008.

[15] C. Nayar, M. Tang, W. Suponthana, "Wind/PV/Diesel Micro Grid System implemented in Remote Islands in the Republic of Maldives", IEEE International Conferences on Sustainable Energy Technologies, Singapore, pp. 1076-1080, November 24-27, 2008.

[16] H. Al-Nasseri, M ARedfern, R. O'Gorman, "Protecting Micro- grid Systems containing Solid-State Converter Generation", Inter- national Conference on Future Power System, November 2005.

[17] P. C. Krause, O. Wasynczuk, S. D. Sudhoff, "Analysis of Electric Machinery", IEEE Press, 2002.

[18] F. Katiraei, M. R. Iravani, P. W. Lehn, "Micro-Grid Autonomous Operation During and Subsequent to Islanding Process", IEEE Transactions on Power Delivery, vol. 20, no. 1, January 2005.

[19] IEEE Working Group on Prime Mover and Energy Supply Models for System Dynamic Performance Studies, "Hydraulic Turbine and Turbine Control Models for Dynamic Studies", IEEE Transactions on Power Systems, Vol.7, No.1, February, 1992, pp.167- 179.

[20] "Mechanical Operating and Maintenance Manual V90 - 3.0 MW, VCRS 60 Hz", Item no.: 964106.R00, June 2007.

[21] A. Gaillard, P. Poure, S. Saadate, M. Machmoum, "Variable speed DFIG wind energy system for power generation and harmonic current mitigation", Renewable Energy Journal, Vol. 34, pp. 1545-1553, 2009.

[22] M. J. Khan, M. T. Iqbal, "Analysis of a small wind- hydrogen stand-alone hybrid energy system", Applied Energy, Vol. 86, pp. 2429- 2442, 2009.