Efficient Grid Management System with Renewable and Conventional Power Sources

R.Jayavel, T R Rangaswamy, S.Prakash

Abstract: ***The main aim of this paper is to enhance the utilisation of solar and wind power in Power grid. Active network management ensures the overall grid balance and stability in the existing system with Renewable Energy Sources. Grid connected Renewable Energy Sources (RES) employs power electronic converters which are usually controlled by proportional integral (PI) controller in order to ensure sinusoidal current injection to the grid. Although the PI controller is well established and easy to use under normal grid conditions, it leads to system instability under abnormal grid conditions. A new method is developed using the proportional resonant (PR) controller to replace (PI). Thirty bus systems with and without renewable sources are designed and the simulation outcomes were presented. Requirement of conventional real power was found to be reduced by adding non-conventional system like wind and solar sources. Superiority of the proposed system was highlighted.***

Keywords: ***Grid Management, Economic dispatch, Proportional resonant controller, Renewable Energy, 30 bus system.***

I. INTRODUCTION

Reliability and sustainability of power supply is a vital requirement in power sector due to more utilization of Renewable Energy sources. In order to give more importance to promote Green Energy, optimal utilization of Renewable Energy source is needed when compared to conventional sources.

Guobin Xu et al [1] addressed the issue of integrating distributed energy resources and energy storage devices in the power grid. They focused on network power demand calculation through generation and demand flow curve for reliable operation.

.Abdulhakim Khalaf Alsaif [2] reviewed the importance of renewable energy in the power grid. In this paper he analyzed power quality issues, power variation, location of renewable resources, forecasting etc for green energy revolution.

Jing Hu et al [3] reviewed barriers of European electricity system for integrating renewable energy resources. They also recommended a capacity based scheme to reduce the cost of integration.

Subramanian et al. [4], developed a soft technique algorithm to solve economic dispatch problems. The cost of generation is mainly usage of more fuel than required for particular load condition. They gave importance to reduce the generation cost due to transmission losses also.

Mamatha Sandhu Et al [5] reviewed in the issues, challenges, causes, impacts and adding of renewable energy sources in Grid system. They suggested using power electronics devices optimally to control the fluctuation in the grid system.

[6] Addressed a Microgrid system including solar and WTs, two operation modes: a standalone mode and a grid-connected mode. In the standalone mode, the microgrid could be isolated from the main power grid as a result of geographical isolation or failure of the main grid. In their work architecture of a real-time energy management was presented. It provides several smart meters that continuously monitors connected loads and [7,8] communicate with a Smart Concentrator via Control Area Network.

II. EXISTING GRID SYSTEM

In general power grid systems are interconnection of thermal plants and nuclear plants. Solar and Wind energy are less and underutilized. Due to long transmission and utilization, the energy loss is more and cost is also more.

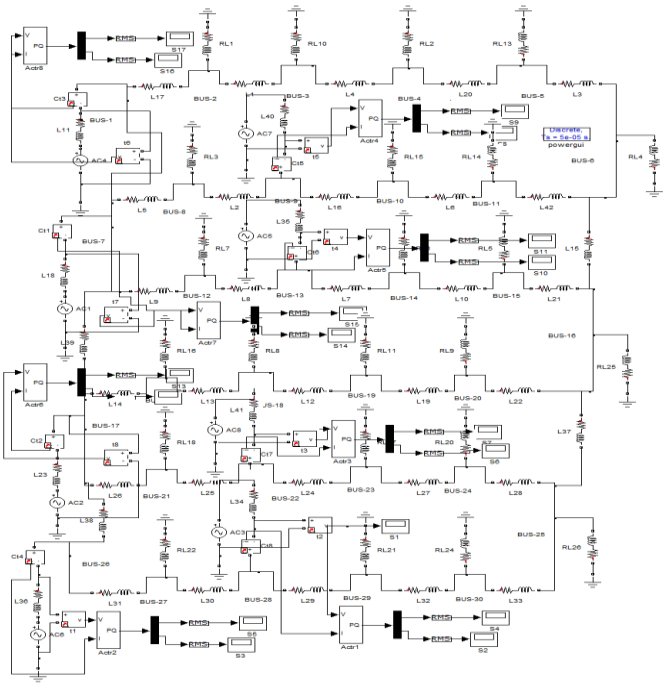

Fig. 1(a) Circuit diagram of 30-bus system without renewable sources

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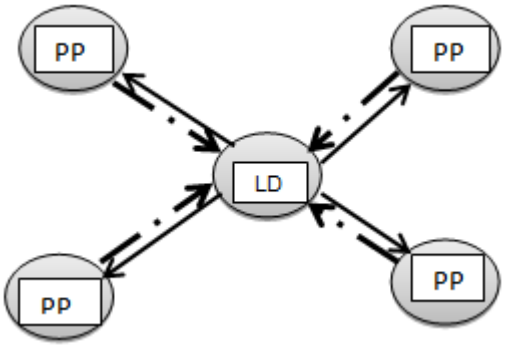

Fig. 1(b) Conventional generation with load dispatch

Power generation is not well optimized. Natural resources are added during peak load time only. Protection of grid system and also maintenance is very difficult to manage.

Circuit diagram of 30-bus system without renewable sources is shown in Fig.1a.and 1.b.

The existing system the renewable wind and solar energy resources and are often used in power grid during periods of heavy demand only.

III. PROPOSED GRID MANAGEMENT STSTEM

Modernizing the grid system includes integration of renewable energy resources with conventional generation. This will improve the reliability of the grid system and also cost effective scheme. Renewable energy injection can be implemented through PID or Proportional resonant controller (PR).

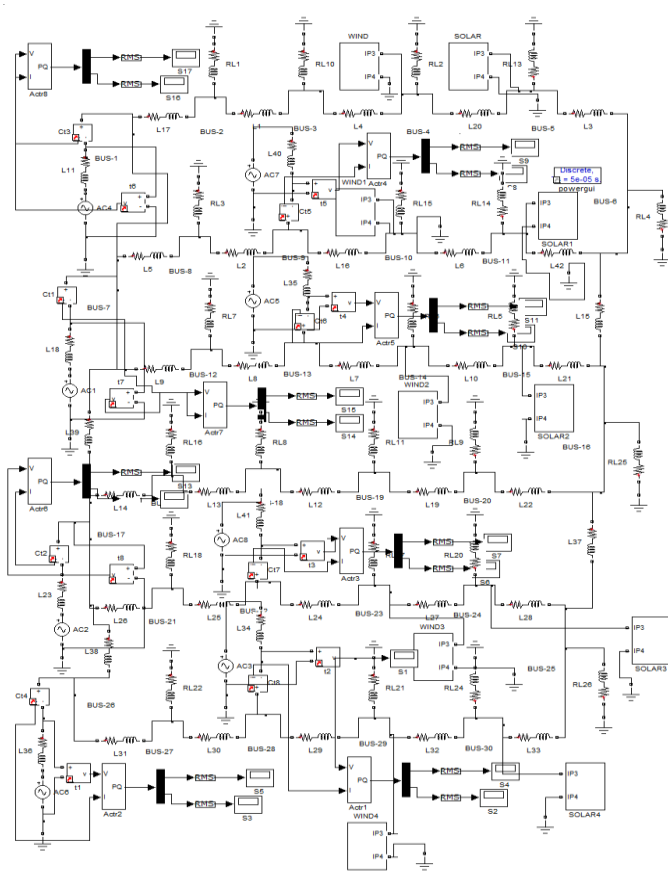

Fig. 2 Circuit diagram of 30-bus system with renewable sources

Conventional Proportional Integral and Derivative control (PID) are well suitable for linear systems. It is very difficult to control during transient conditions. Proportional resonant (PR) controller is well suitable to handle transient situations.

In the conventional power management system, Proportional Integral controller is used. But it produces steady state error.

Transfer function of PI controller is $G_{PI}(s) = K_p + K_i/s$

To alleviate the issues of using PI controller, a proportional plus resonance (PR) controller is used. The PR controller is a double integrator that has an infinite gain at a certain frequency and almost no attenuation outside this frequency.

Transfer function of PR controller is $G_{PR}(s) = K_p + 2K_i s/(s^2+\omega^2)$

Where, ω is the fundamental frequency of the grid, and Kp and Ki for both PI & PR are equal .

The Circuit diagram of 30-bus system with renewable sources is shown in Fig.2.

A 30 bus system is considered for simulation with and without renewable energy resources. The comparison of performances of Thirty Bus System with and without non-conventional sources is not much reported in the literature. This work deals with comparison of Thirty Bus Systems with and without non-conventional sources.

The MATLAB Simulation response of 30-bus system Real power at bus-1 without renewable sources is shown in Fig 3 and its value is $13.8*10^7$watts.

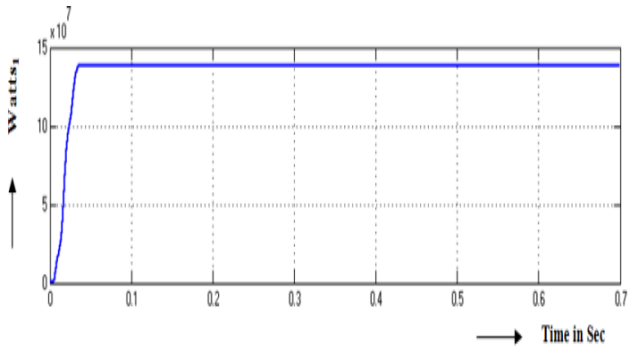

Fig. 3 Real power at bus-1 without renewable sources

In 30-bus system the real power at bus-1 with renewable sources is shown in Fig 4 and its value is $1.73*10^8$watts.

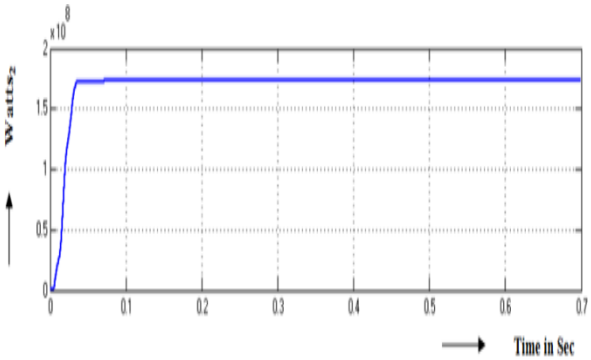

Fig. 4 Real powers at bus-1 with renewable sources

The Comparison of Real power and Reactive Power is given in Table-1. When renewable source are added, the utilization of real power get increased.

Table. 1 Comparison of Real Power

Bus No	Real power without wind & solar (MW)	Real power with wind & solar (MW)
Bus-1	138.20	173.10
Bus-7	133.35	172.22
Bus-9	137.75	227.15
Bus-13	179.53	224.31
Bus-17	158.81	194.47
bus-22	178.86	220.13
bus-26	99.30	110.13
Generator bus-28	166.65	204.66
Total	1192	1526

The comparison of time domain performance is given in Table 2. The rise time is reduced from 0.48 Sec to 0.35 Sec; the peak time is reduced from 0.48 to 0.41 Sec; the Settling time is reduced from 0.52 to 0.27 Sec and steady state error is reduced from 1.2KV to 0.14KV by replacing PI controller with PR-controller. The transient response is also improved by using PR-controller.

Table. 2 Comparison of time domain performance

Controllers	Rise time (s)	Peak time (s)	Settling time (s)	Steady state error (KV)
PI	0.48	0.48	0.52	1.2
PR	0.35	0.41	0.27	0.14

IV. CONCLUSION

Thirty bus systems with and without renewable sources are successfully designed and simulated. The performance results were compared. The conventional real power is reduced by adding non-conventional energy sources like wind and solar energy sources. The present work deals with thirty bus systems with and without renewable sources. The proposed design has ability to take care transient and add renewable energy source efficiently without much time delay. The response of the proposed PR controller is found to be satisfactory when compared with the conventional PI controllers. The performance of fifty bus system will be done in second phase.

REFERENCES

1. Guobin Xu, Wei Yu, David Griffith, Nada Golmie, and Paul Moulema," Towards Integrating Distributed Energy Resources and Storage Devices in Smart GridIEEE" Internet Things J. 2017 Feb; 4(1): 192–204.
2. Abdulhakim Khalaf Alsaif, "Challenges and Benefits of Integrating the Renewable Energy Technologies into the AC Power System Grid" American Journal of Engineering Research (AJER), Volume-6,2017, Issue-4, pp-95-100
3. Jing Hu, Robert Harmsen, Wina Crijns-Graus, Ernst Worrell, Machteld van den Broek, "Identifying barriers to large-scale integration of variable renewable electricity into the electricity market: A literature review of market design" Renewable and Sustainable Energy Reviews, Volume 81, Part 2, 2018, pp. 2181-2195
4. Subramanian R. and Thanushkodi K., "An Efficient Firefly Algorithm To Solve Economic Dispatch Problems", International Journal of Soft Computing And Engineering, vol. 2, issue 1, pp 52-55, March 2013.
5. Mamatha Sandhu , Dr.Tilak Thakur, "Issues, Challenges, Causes, Impacts and Utilization of Renewable Energy Sources - Grid Integration" Int. Journal of Engineering Research and Applications, ISSN : 2248-9622, Vol. 4, Issue 3(Version 1), March 2014, pp.636-643
6. Christober C. and Asir R., "An Evolutionary Programming Based Simulated Annealing Method for Unit Commitment Problem with Cooling - Banking Constraints", 2004.
7. F. Clarizia, D. Gallo, C. Landi, M. Luiso and R. Rinaldi, "Smart meter systems for smart grid management," *2016 IEEE International Instrumentation and Measurement Technology Conference Proceedings*, Taipei, 2016, pp. 1-6.
8. A. Calanducci, C. Cherubino, L. N. Ciuffo, M. Fargetta and D. Scardaci, "A Digital Library Management System *for Grid*," 16th IEEE International Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE 2007), *Evry, 2007, pp. 269-272.*