Improvement of Power System Using Dynamic Pricing Mechanism

Md. Faiyazussalekin[1], Prof. Abhishek Chourey[2], Prof. Balram Yadav[3]

[1]M. Tech. Scholar, Department of Electrical & Electronics Engineering

[2]Assistant Professor, Department of Electrical & Electronics Engineering

[3] Head & Professor, Department of Electrical & Electronics Engineering

[1,2,3] Scope College of Engineering, Bhopal, India

Abstract- *The renewable energy resources (RERs) have brought green revolution in mitigation of greenhouse gaseous emission resulted from traditional energy resources (TERs). Moreover, the effective utilization of these resources is influenced by pricing schemes which have limitations. Therefore, this research aims at optimization modeling for dynamic price-based demand response (DR) which includes flexible and inflexible loads along with the effective utilization of RERs i.e. photovoltaic (PVs) and wind turbines (WTs) in a microgrid (MG). The optimization problem regarding profit maximization for loads (flexible and inflexible) is solved via particle swarm optimization (PSO). Two cases are used to evaluate the performance of proposed dynamic pricing scheme. The simulation results have shown that proposed scheme is suitable in term of profit and comfort for flexible and inflexible loads as compared to fixed pricing scheme in both cases. In addition, the dynamic pricing scheme is exemplified as plug and play devices because of its easy implementation in present market structure without any modification. This research aims at profit maximization for both flexible and inflexible load customers. For this purpose, the dynamic pricing scheme for demand response in microgrids is designed which utilizes the renewable energy resources and main grid in efficient way. The simulation results of elaborated that the profit of load customers through dynamic pricing scheme is higher than fixed pricing scheme. In, flexible and inflexible loads are used in dynamic and fixed pricing schemes.*

Keywords:- Dynamic pricing scheme, Demand response, Microgrid, Renewable energy resources, Particle swarm optimization.

Introduction

Electricity pricing has been identified as a major cause of the demand supply gap in the power sector. End user electricity prices are too low and are fixed for a much longer period with a quarterly or annual review and do not reflect generation costs with a shift from the relatively to cheaper hydro to gas and light crude oil. The focus of this project is to examine the current pricing mechanism against an alternative pricing scheme in the form of real time pricing. Other related causes of this problem that is not the focus for this thesis include unfunded and weak targeted subsidies to consumers, power theft and nonpayment of utility bills. These have harmed the financial health of the Electricity utility providers (Joe Amoako Tuffour et al, 2015). The low prices have been a disincentive to local and foreign private investors in the generation sector. A higher price that is equal to or above the marginal cost of generating electricity could have been an appropriate option to attract private investors to help reduce the demand supply gap. However higher prices would deprive most household consumers of electricity since they cannot afford to pay. While low prices are directly beneficial to poor people, blackouts are problematic, and so is the economic inefficiency of the entire electricity system that follows from regulated prices.[4]

An alternative pricing mechanism that has been adopted by other countries to address the shortfall in electricity supply is time varying electricity pricing. This system ensures that supply is always equal to demand through a constant variation in price in real time with advanced metering systems that send signals to consumers to alert them during periods of high prices and periods of low prices. This system maximizes benefits for both producers and consumers of electricity. Prices are high during peak demand periods when expensive sources of generation are used. Inversely prices will be low during off peak periods.[3] This affords consumers the opportunity to buy electricity at a cheaper price and to reduce consumption when prices are high.

II. Methodology

The PV system design starts with a Ramp-up/ down module that controls and fluctuates the value of the temperature and the irradiance to simulate real life conditions. These values are being fed to the PV array block, which outputs a certain voltage and current depending on the specific values of the temperature and irradiance. The voltage and current values taken from the PV array are used as inputs to the MPPT controller while the output of the array is connected to a DC-DC Boost converter. The MPPT controller uses the input PV voltage and current value to continuously calculate the duty cycle, which is then fed to the boost converter. The boos converter controls the voltage level according to the duty cycle to keep tracking the Maximum Power Point at all times. Finally, the output of the boost converter is then connected to a resistive load, which acts as a demand side load for the standalone system. The target of the MPPT is to track and locate the global MPP since it has the highest efficiency. However most tracking techniques might mistake the local MPP with a global MPP and thus it will take longer to track and it might need more advanced algorithms for better tracking of the global MPP. To combat both the efficiency concern and to try and reduce the time needed to locate the global maximum, an integral regulator was used along with the incremental conductance and Integral Regulator.

The integral regulator is used to increase the output efficiency by performing duty cycle correction. This allows for more control, grip, and adaptation with the ever-changing weather conditions that affect the MPP and hence increase the system efficiency. The algorithm based on a particles swarm optimization (PSO) is a heuristic search method with a population that takes stochastic values, which is inspired by swarms. The PSO algorithm generates a set of values or random particles and each particle represents a candidate solution.

The position of each particle is influenced by a particle in a better position, in our case by the reference voltage value that generates the greatest power conversion. Once the particle with a better position is found, all particles will be influenced by this. The particle with a better position will eventually be the final output of the algorithm after a predefined number of iterations or by a margin determined previously. However, the convergence to MPP cannot be ensured. Therefore, the stopping condition could be either, or a combination, of these situations, to ensure that there shall not be an endless number of cycles. The algorithm applied to the power conversion of a PV panel.

Table I: Data for Different Sources

SOURCE	MPPT	LOAD (kW)	Types of load
DG1	MPPT	26	FLEXIBLE
DG2	MPPT	31	FLEXIBLE
DG3	MPPT	37	FLEXIBLE
DG4	MPPT	20	FLEXIBLE
DG5	MPPT	22	FLEXIBLE
DG6	MPPT	15	FLEXIBLE
DG7	MPPT	19	INFLEXIBLE
DG8	MPPT	15	INFLEXIBLE
DG9	MPPT	10	INFLEXIBLE
DG10	MPPT	16	INFLEXIBLE
DG11	MPPT	11	INFLEXIBLE
DG12	MPPT	20	INFLEXIBLE

A. Dynamic pricing scheme

The active power generation in WT and PV is shown, and the evolution of their power is zero. The active generation of WT (DG1, DG4, DG6, DG8, DG9, and DG12) and PV (DG2, DG3, DG5, DG7, DG10, and DG11) depending on their natural resources, is wind speed and solar power. The highest energy levels of DG1 and DG12 were also experienced at time t, and their breasts (active power generation) were similar to those of DG4 and DG9. For PV, DG5 and DG7 have the most power, while DG2, DG3, DG10 and DG11 have the least power output. Demonstrate active and productive power generation from large databases. In the event of a shortage of renewable energy, large reserves of electricity supply it. Large plates force the production of excess electricity from renewable sources. Although the interference is great under environmental conditions, the color and texture of all MG products remain constant across the line.

The dynamic pricing model is given below:

$$f(t)=a\left(1-\frac{P_{RESS}(t)Xk}{P_g(t)+P_{RESS}(t)}\right)$$

Where f(t) and $P_g(t)$ are the final dynamic price and total active power output from main grid at time t respectively. The total active power outputs from RESs (PVs and WTs) at time t is represented by $P_{RESs}(t)$. The basic price and constant parameter are represented by a and k.

III. Results

The simulation results have shown that proposed scheme is suitable in term of profit and comfort for flexible and inflexible loads as compared to fixed pricing scheme in both cases. In addition, the dynamic pricing scheme is exemplified as plug and play devices because of its easy implementation in present market structure without any modification

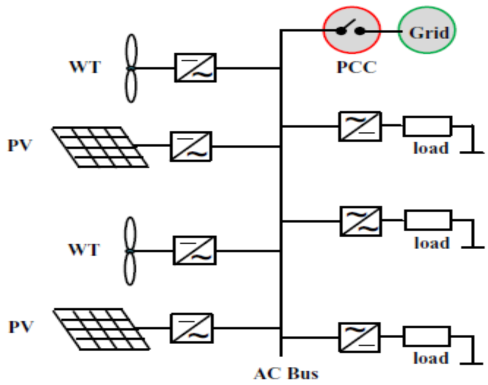

Fig.1. Schematic Diagram of Microgrid

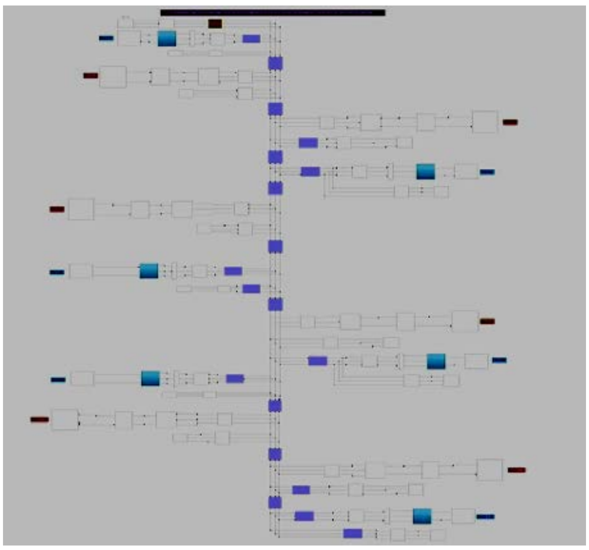

Fig. 2. SIMULINK model of Proposed Microgrid

ISSN: 2581-3404 (Online)
International Journal of Innovative Research in Technology and Management, Vol-5, Issue-2, 2021.

Table 2: Parameter Used in Simulation

PARAMETERS	VALUES
Number of cells per module for panel 1	96
Number of series-connected modules per string	5
Number of parallel strings	66
TRANSFORMER	47 MVA
BASE WIND SPEED (m\s) WT1	12
BASE WIND SPEED (m\s) WT2	12
BASE WIND SPEED (m\s) WT3	12
BASE WIND SPEED (m\s) WT4	12
BASE WIND SPEED (m\s) WT5	12

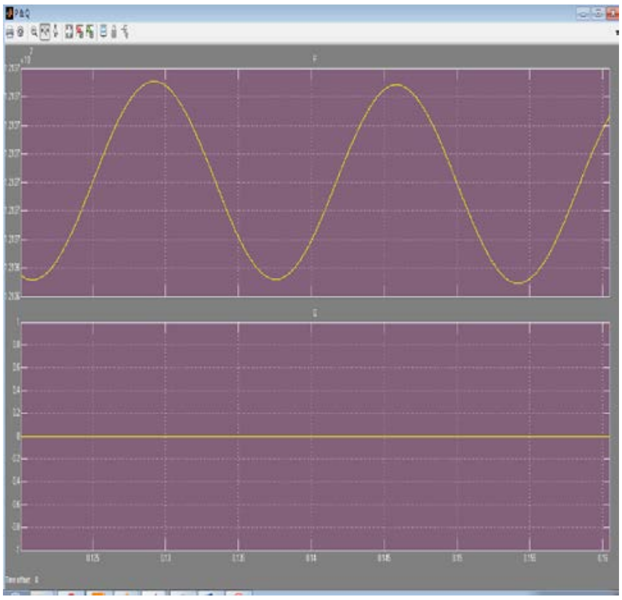

Fig.3. Active and reactive power outputs of DG1

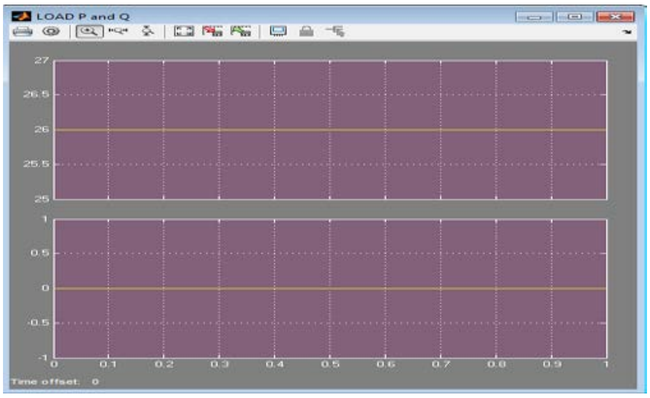

Fig.4. Load P & Q of DG1

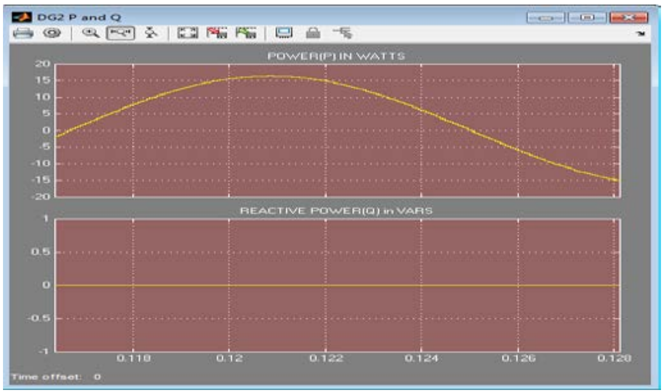

Fig.5. Active and reactive power

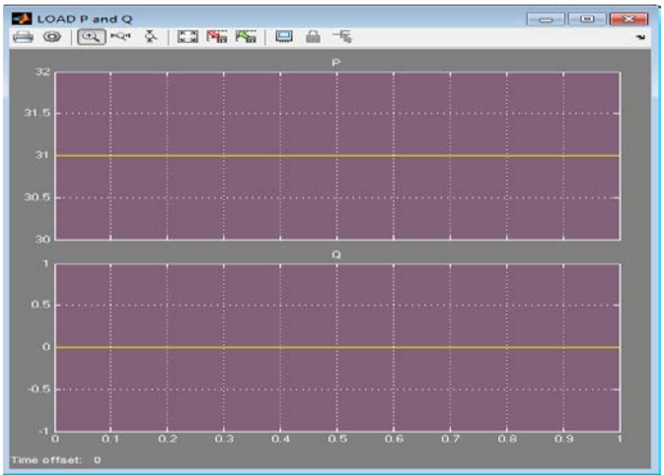

Fig. 6. Load P & Q of DG2

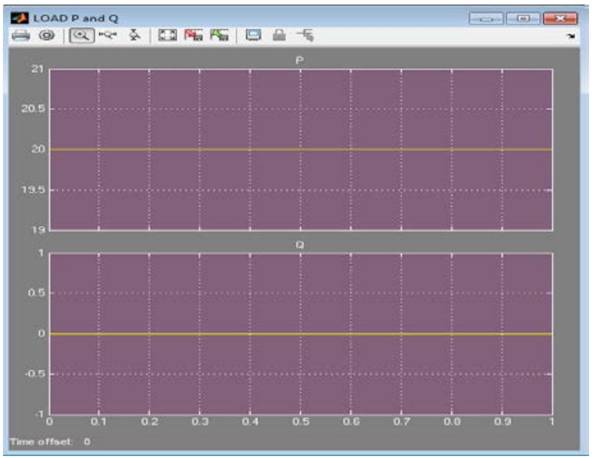

Fig. 7. Active and reactive power outputs of DG3

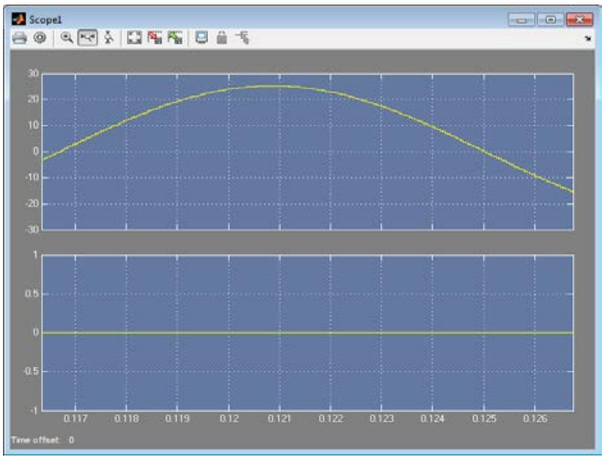

Fig. 8. Load P & of DG3

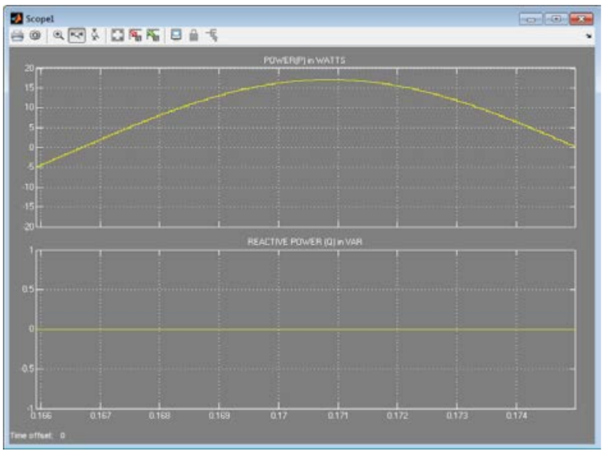

Fig. 9. Active and reactive power outputs of DG4

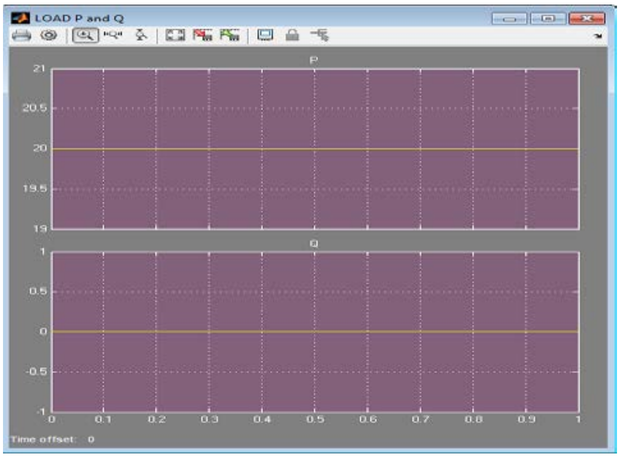

Fig. 10. Load P & Q of DG4

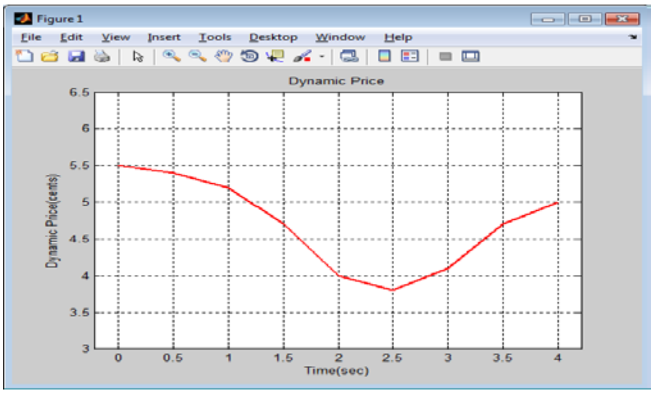

Fig.11.Dynamic pricing scheme

IV. Conclusion

This research aims at profit maximization for both flexible and inflexible load customers. For this purpose, the dynamic pricing scheme for demand response in microgrids is designed which utilizes the renewable energy resources and main grid in efficient way. The simulation results of elaborated that the profit of load customers through dynamic pricing scheme is higher than fixed pricing scheme. In, flexible and inflexible loads are used in dynamic and fixed pricing schemes. In this case, the profit of flexible load customers is also higher in dynamic pricing scheme as compared to fixed pricing scheme. Comparatively, the dynamic pricing scheme is cost saving for inflexible load customers as compared to fixed pricing scheme. In all, it is concluded that dynamic pricing scheme is relatively more beneficial for flexible and inflexible load customers in both cases. Furthermore, this scheme can easily be implemented in present market infrastructure without any additional substitution.

References

[1]. Andersson, G., Donalek, P., Farmer, R., Hatziargyriou, N., Kamwa, I., Kundur, P.,& Schulz, R. (2005). Causes of the 2003 major grid blackouts in North America and Europe, and recommended means to improve system dynamic performance. IEEE transactions on Power Systems, 20(4), 1922-1928.

[2]. Fang, X., Misra, S., Xue, G., & Yang, D. (2012). Managing smart grid information in the cloud: opportunities, model, and applications. IEEE network, 26(4), 32-38.

[3]. Steiner, F. (2000). Regulation, industry structure, and performance in the electricity supply industry. Available at SSRN 223648.

[4]. Siano, P. (2014). Demand response and smart grids—A survey. Renewable and sustainable energy reviews, 30, 461-478.

[5]. Buyya, R., Yeo, C. S., Venugopal, S., Broberg, J., &Brandic, I. (2009). Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility. Future Generation computer systems, 25(6), 599-616.

[6] Chao, H. P., & Peck, S. (1996). A market mechanism for electric power transmission. Journal of regulatory economics, 10(1), 25-59.

[7] Anghel, M., Werley, K. A., &Motter, A. E. (2007, January). Stochastic model for power grid dynamics. In 2007 40th Annual Hawaii International Conference on System Sciences (HICSS'07) (pp. 113-113). IEEE.

[8] Hauer, J. F., &DeSteese, J. G. (2004). A tutorial on detection and characterization of special behavior in large electric power systems (No. PNNL-14655). Pacific Northwest National Lab.(PNNL), Richland, WA (United States).

[9] Yang, J. B., Liu, J., Wang, J., Sii, H. S., & Wang, H. W. (2006). Belief rule-base inference methodology using the evidential reasoning approach-RIMER. IEEE Transactions on systems, Man, and Cybernetics-part A: Systems and Humans, 36(2), 266-285.

[10] Maldonado, G. I. (2004, October). The performance of North American nuclear power plants during the electric power blackout of August 14, 2003. In IEEE Symposium Conference Record Nuclear Science 2004. (Vol. 7, pp. 4603-4606). IEEE.