An Optimal Strategy to Determine the Electricity Tariff During Different Operational Conditions

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Abstract: Apart from the objective of optimizing electricity bills by enhancing consumption patterns, the implementation of dynamic pricing for electric energy can facilitate the redistribution of demand from peak hours to non-peak hours. This strategic approach aims to effectively manage congestion issues and enhance the overall stability of the system. Therefore, it becomes crucial to determine tariff rate modifications by taking into account the demand side's elasticity and devising a strategy that maximizes the profitability for all stakeholders. In this study, two distinct time-of-use (ToU) tariffs, specifically a two-level and three-level structure, are utilized alongside the modeling of consumers' elastic behavior. The primary goal is to design an optimal tariff rate scheme that simultaneously maximizes the company's profits and minimizes the consumers' electric energy bills. To accomplish this, a genetic algorithm is employed to derive the most favorable tariff structure. The evaluation of the proposed strategy is con-ducted on the 24-bus IEEE system. To capture the diversity in consumers' consumption patterns, all loads are categorized into five distinct groups, with three categories representing residential loads and two categories representing industrial loads. The results obtained from the analysis demonstrate that by implementing an appropriate three-level ToU tariff and considering operational constraints, a substantial shift of more than 4.7% for residential loads and over 5% for industrial loads during peak hours can be achieved, redirecting them towards off-peak hours.

Keywords: Tariff rate strategy; demand side elasticity; ToU tariff; Genetic Algorithm.

1. Introduction

In many countries, the existing power grid infrastructure, initially designed for earlier generations, is increasingly showing signs of strain. This situation is further exacerbated by the growing demand for electricity, which is projected to rise sharply with the widespread adoption of electric vehicles (EVs). The shift towards EVs, though environmentally beneficial, places additional burdens on power grids, necessitating significant enhancements in capacity and efficiency [1].

However, upgrading the grid infrastructure is a daunting task. It involves not just the installation of new equipment, but also the modernization of aging components – a process that can be both expensive and complex. These upgrades are essential for accommodating future power demands, but they come with challenges related to cost, implementation, and disruption to existing services [2].

To mitigate these challenges, Demand Response (DR) programs have become a key strategy. DR focuses on managing and adjusting the electricity consumption patterns of users, particularly during peak times or when the grid is under considerable stress. By incentivizing users to lower or shift their power usage, these programs help in balancing the grid load more efficiently. This not only aids in enhancing grid reliability but also reduces the urgency for extensive and expensive infrastructure overhauls. DR programs, thus, offer a pragmatic approach to extending the current grid's capacity and ensuring its stability, bridging the immediate need for managing rising energy demands with the longer-term objectives of energy sustainability and resilience [3].

In this filed, several studies have focused on energy consumption management, including the evaluation of energy saving methods for large public buildings [4-5], estimating the cost of energy [6], analysis of residential energy consumption for two periods before and after the modification of their energy consumption structure [7-9], and the comparison of the energy consumption in residential areas [10-12]. In [13], it is shown that with the help of lighting control in a smart home and the use of special sensors, it is even possible to save 54% of energy consumption. In [14], the effect of building automation control systems on the consumption performance of consumers in Italy has been studied. The obtained results show that building energy control systems can improve the energy performance of homes, significantly. DR provides an opportunity for customers to play a significant role in the consumption management by reducing or shifting their energy consumption during peak-load hours in response to time of use (TOU) rates or other incentive programs [15]. In other side, DR is a program that is implemented voluntarily by consumers and generally consists of incentive-based and price-based programs. An incentive-based program creates incentives for the user to participate in DR programs by paying incentives [16]. Price-based program increases the tariff rate during peak-load hours and decreases it during off-peak hours which helps to reduce the congestion of distribution networks and power losses during peak-load hours [14].

One of the important parts of residential consumed energy is lighting system. By designing practical approaches, it is possible to manage the energy consumption in this area so that with keeping lighting standards, reducing the energy as much as possible. The implementation of such systems depends on many different factors, including the type of residential area, the time period of daylight, and the details of the lighting system. According to the review, it was found that the control of the lighting system along with the evaluation of the implementation of DR programs has not yet been comprehensively studied [17]. In this paper, we propose a new approach for demand response management through power aggregator and right of flexibility. The main contributions of this paper are as follows:

- We introduce the concept of right of flexibility, which is a coefficient that reflects the consumer's willingness to participate in DR programs and reduce their energy consumption during peak-load hours.
- We design a lighting intensity control system that can adjust the lighting level according to the natural daylight and the consumer's preference.
- We formulate an optimization problem that maximizes the social welfare of the power aggregator and the consumers by considering the right of flexibility, the lighting control system, and the time-of-use tariff rate.
- We propose an algorithm that can solve the optimization problem in a distributed manner and obtain the optimal electricity price and demand response strategy for each consumer.
- We conduct simulations to evaluate the performance of our proposed approach and compare it with other existing methods.

The following content is organized as follows:

The rest of this paper is organized as follows. Section 2 presents a review on dynamic pricing schemes for electric energy and their impacts on demand response [18-20]. Section 3 describes the characteristics of generation units and load points in the 24-bus IEEE system are explained, and then the results of applying 2-level and 3-level ToU tariff rates are shown with using tables and figures. In the last part, the results obtained from the implementation of the genetic algorithm on the standard network have been evaluated in order to determine the optimal tariff rate.

2. Problem formulation

2.1. Dynamic pricing Analysis

Dynamic pricing, primarily via the Time-of-Use (ToU) tariff method, is pivotal in directing consumer electricity consumption habits, persuading them to shift from high-demand peak times to lower-demand off-peak periods. The ToU tariff dynamically adjusts electricity prices over the course of the day to mirror the changing costs of generation and transmission. These fluctuating prices are typically in sync with the varying power demand, altering according to different times of the day and across seasons [15].

At its core, the ToU tariff is designed to reflect the variable operational expenses and demand patterns in electricity supply throughout the day. During peak hours, for example, when electricity demand surges, generation costs tend to increase due to the additional burden on energy resources, which might be costlier or less efficient. In contrast, during off-peak periods, when demand dwindles, electricity supply becomes cheaper, mainly owing to greater dependence on baseline power plants that are more economical in operation [18].

A conventional ToU tariff framework divides electricity rates into three distinct segments: off-peak, mid-peak, and peak-load times. This tiered pricing model is intended to motivate consumers to decrease their energy usage during expensive peak times and increase it during the less costly off-peak intervals. Furthermore, these rates may vary depending on the day of the week and seasonally, thus addressing the periodic fluctuations in electricity demand and supply [15,18]. In doing this, ToU tariffs seek to ensure a balanced load on the grid, encourage more efficient energy use, and possibly reduce costs for both energy providers and users.

Implementing ToU tariffs aims to foster a more efficient and balanced power grid operation. It offers economic incentives for consumers to alter their power usage habits, which can reduce energy bills and support a more sustainable energy consumption model. Efficient demand management through ToU tariffs also helps utilities minimize their dependence on peaker plants, which are typically costlier and more environmentally detrimental. This strategy, in turn, contributes to wider efforts in environmental conservation and sustainable energy practices [15].

Under the implementation of the smart grid infrastructure, both network utilities and consumers will have the opportunity to participate for defining the electricity tariff in such a way that both players benefit [21]. From the utility's side, the main motivation for changing the type of tariff from the fixed rate to dynamic pricing is shifting a significant part of the load during peak-load to off-peak hours in order to improve network power quality indicators and control the congestion in critical periods. On the other hand [22], consumers can reduce their bills by participating in DR programs. Of course, it should be noted that in order to determine the tariff rate in a fair way, it is necessary to study the behavior of subscribers against rate changes, carefully. In other words, the excessive increase in the tariff rate not only cannot help to reduce energy consumption, but also increase dissatisfaction for the subscribers [21]. Therefore, it is necessary to design the tariff rate in such a way that the level of social welfare of all players is maximized by considering the consumer's elasticity, generation and transmission costs.

2.2. Objective Function

In this paper, two different ToU tariffs are considered. The first model is the 2-level ToU tariff rate which includes the peak-load and off-peak periods and another one is the 3-level tariff rate consists of peak-load, mid-peak and off-peak periods [19]. From the consumer's point of view, minimization of the consumption bill has a great importance, and from utility's point of view, maximization of profit after the initial investment is very crucial [12]. In this situation, an optimal tariff rate should be capable to minimize consumer's total cost as well as provides a higher profit for utilities compared to the fixed tariff rate.

Objective function can be defined as (1). The PFT_{se} expresses the profit obtained for the operator and the DCT_{cons} is the discount for consumers. In this objective function, the main goal is maximization of the profit of the utilities and the discount of the consumer's bill at the same time. PFT_{se} is obtained from the difference between the revenue and related costs, and DCT_{cons} is determined by calculating the difference between the price of consumed energy in the case of using a fixed tariff rate and ToU rate. PFT_{se} is calculated according to (2). The total income of the utility can be calculated by (3). Indeed, Revenue comes from selling the injected energy to the grid. The two terms on the right side of (3) determine the injected energy for peak-load and off-peak periods, respectively. The parameters $t_{(p)}$ and $t_{(np)}$ represent the duration of peak-load and off-peak periods and SD is used for shifted loads between these two periods. Tar variable also represents the tariff rate for consumers, which is obtained as output by solving the problem with genetic algorithm. Due to the fact that the duration of the peak-load period is not equal to the period of off-peak, α coefficient has been used to create a balance between these two time periods.

$$Max\ Objective\ Function = [PFT_{se} - DCT_{cons}] \tag{1}$$

$$PFT_{se} = (Revenue - Costs) \tag{2}$$

$$Revenue = t_{(p)}.\sum_{j\epsilon\Omega}\left[\left(D_{j,p} - SD_j\right).Tar_{cons(j,p)}\right] + t_{(np)}\sum_{j\epsilon\Omega}\left[\left(D_{j,np} + \alpha.SD_j\right).Tar_{cons(j,np)}\right] \tag{3}$$

$$TeneC = D_p.Tar_{se,p}.t_p + D_{np}.Tar_{se,np}.t_{np} \tag{4}$$

$$TdemC = D_p.C_{d,p}.t_p + D_{np}.C_{d,np}.t_{np} \tag{5}$$

$$TinvC = D_p.C_p + D_{np}.C_{np} \quad (6)$$

$$D_p = \sum_{j\epsilon\Omega}\left[\left(D_{j,p} - SD_j\right)\right] \quad (7)$$

$$D_{np} = \sum_{j\epsilon\Omega}\left[\left(D_{j,np} + \alpha.SD_j\right)\right], \alpha = \frac{t_{(p)}}{t_{(np)}} \quad (8)$$

The second part of the objective function stated in (1) is dedicated to the discount of the electricity bill for the subscribers. This issue is stated in (9). In this equation, the expressions $Bill_0$ and $Bill_{ToU}$ express the cost of bill in the fixed tariff and ToU tariff rate, respectively. The Tf parameter also considered for the fixed rate.

$$DCT_{cons} = Bill_0 - Bill_{ToU} \quad (9)$$

$$Bill_0 = \left(D_{j,p}.t_p + D_{j,np}.t_{np}\right).Tf \quad (10)$$

$$Bill_{ToU} = t_p\left(D_{j,p} - SD_j\right)Tar_{cons(j,p)} + t_{np}\left(D_{j,np} + \alpha.SD_j\right)Tar_{cons(j,np)} \quad (11)$$

2.3. Elasticity behavior

For determining the behavior of subscribers, it is necessary to model the elasticity of the demand side according to tariff rate changes. In this regard, the elasticity model of [15] has been used (12).

$$\begin{aligned} &SD_{(j)} - \left(\frac{1}{1 + e^{-a_{(j,p)}\left(Tar_{cons(j,p)} - Tf\right)}} - 0.5\right) \\ &SD_{(j)}^{max} = 0 \\ &SD_{(j)} - \left(\frac{1}{1 + e^{-a_{(j,np)}\left(Tar_{cons(j,np)} - Tf\right)}} - 0.5\right) \\ &SD_{(j)}^{max} = 0 \end{aligned} \quad (9)$$

2.4. Structure of proposed approach

In the proposed approach, it is necessary to model the reaction of subscribers to tariff rate changes. This model actually expresses the fact that with changes in the ToU tariff rate, how much the profile of the consumption pattern can be changed[16]. Next, it is necessary to calculate the information related to the cost of energy (investment, denervation and transmission)[19]. With considering the above information, genetic algorithm is used to find the optimal tariff rate for 2-level and 3-level to modes. It should be noted that the pattern of energy consumption of industrial and residential customers and their interaction with changes in the tariff rates are not the same, and for this reason, three categories for residential consumers and two categories for industrial ones are defined to make the obtained results more practical. The flowchart of this structure is shown in Figure 1.

3. Simulation Results

3.1. Network characteristics

In this paper, the 24-bus IEEE standard network is used (Figure 2). This network consists of 32 generation units, 17 load points and 38 lines. The information of the generating units and load points are expressed in Table 1 and Table 2, respectively. The characteristics of transmission lines are stated in [16].

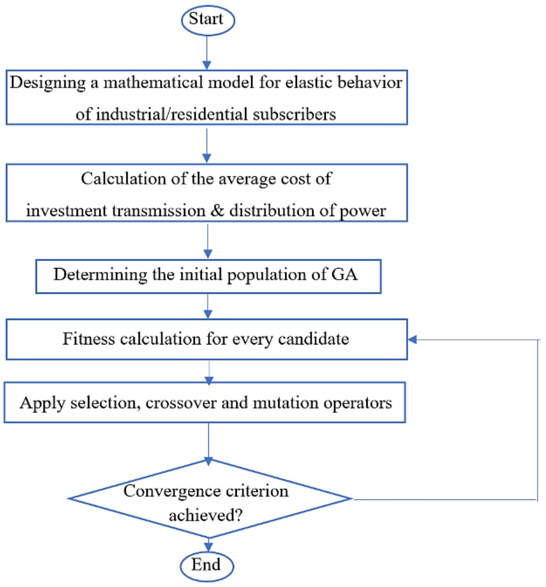

Figure 1. Flowchart of proposed structure.

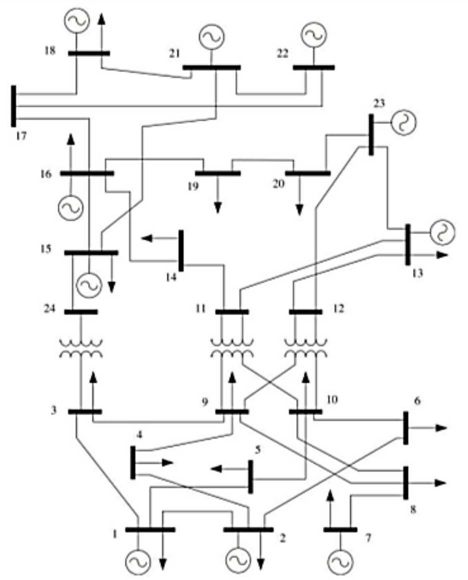

Figure 2. 24-bus IEEE standard power system [10]

Table 1. Untts for magnetic properties.

Bus. No.	Gen. unit.	Capacity (MW)	Bus. No.	Gen. unit.	Capacity (MW)
22	1-6	100	15	7-11	24
15	12	310	7	13-15	200
13	16-18	394	1	19-20	40
1	21-22	152	2	23-24	40
2	25-26	152	23	27-28	310
23	29	700	18	30	800
21	31	800	16	32	310

Table 2. Characteristics of load points

Bus. No.	Gen. unit.	Capacity (MW)	Bus. No.	Gen. unit.	Capacity (MW)
1	1	216	10	10	390
2	2	194	11	13	580
3	3	360	12	14	388
4	4	148	13	15	634
5	5	142	14	16	200
6	6	272	15	18	666
7	7	280	16	19	382

3.2. Scenario Results 1: 2-level ToU tariff

Genetic algorithm is used in this paper, which is effective tool for solving nonlinear problems. The number of variables considered in these condition is 34. The first 24 variables are related to the shifted power for 24 buses, and the rest of the variables include the off-peak and peak-load tariff rates for 5 types of consumers. Table 3 shows the types of consumers and considered bus with their price elasticity coefficients. As can be seen, five types of consumers are used in this modeling, three of which are residential and rest of them are industrial. The coefficients related to the utility's cost in this type of tariff are stated in Table 4. These coefficients are related to the tariff rate of purchased energy from the electricity market, the cost coefficients for calculating the investment cost and demand cost.

Table 3. Elastic parameters of consumer's energy consumption (Two-Level Tariff)

Type of Consumer	Bus No.	a_p (kWh/$)	a_{np} (kWh/$)
Residential 1	4 – 5 – 8 – 9 – 10 14 – 15 – 16 – 21 – 22	7	-25.5
Residential 2	2 – 11 – 12 13 – 19 – 20	5	-24
Residential 3	1 – 3 – 17 – 18	5.5	-24.5
Industrial 1	6 – 23	6	-26
Industrial 2	7 – 24	7	-27

These values are determined based on utility's cost. It must be noted that utility purchases energy from electrical market which coefficients are stated in the first row of Table 4. After the implementation of the GA, the optimal values of the shifted demand for all of the network buses have been calculated, which is as shown in Figure 3. As can be seen in Figure 3, the total number of network buses is 24, but 7 buses are not participated in the consumption management program because they do not have a demand and just transmit the power between other buses. The values of 2-level tariff rate are shown in Table 5.

Table 4. Operator's coefficients in Two-Level Tariff Rate

Cost	Peak-load	Off-peak
TarSE ($/kWh)	0.4058	0.2736
Cd ($/kWh)	27.26	10.34
C ($/kWh)	17.00	17.00

Table 5. Optimal tariff rate (Two-Level Tariff)

Type of Consumer	Tariff for off-peak ($/kWh)	Tariff for peak-load ($/kWh)
Residential 1	1.185	0.266
Residential 2	1.186	0.330
Residential 3	0.931	0.381
Industrial 1	0.184	0.290
Industrial 2	0.918	0.376

3.3. Scenario Results 2: 3-level ToU tariff

In this part, 39 variables are considered. The first 24 variables are related to dispatch power for 24 network busses, and the rest of the variables include off-peak, mid-peak and peak-load tariff rates for 5 different types of consumers. Table 6 shows elasticity coefficients for this type of tariff. The coefficients for the utility costs in this type of tariff is stated in Table 7. After the applying GA, the optimal values for the shifted demand are obtained (Figure 4). Finally, the values of tariff rate for different periods are shown in Figure 5. In order to compare the calculated tariffs, these values are also shown in Table 8.

As it is clear from the results, the amount of tariff in peak-load period is very different from mid-peak or off-peak periods, and this issue creates a great incentive for consumers to shift their loads.

Table 6. Elastic parameters of consumer's energy consumption (3- Level Tariff)

Type of Consumer	a_p (kWh/$)	a_{mp} (kWh/$)	a_{np} (kWh/$)
Residential 1	7	-5	-25.5
Residential 2	5	-4.5	-24
Residential 3	5.5	-4.8	-24.5
Industrial 1	6	-5.5	-26
Industrial 2	7	-7	-27

Table 7. Operator's coefficients in 3-Level Tariff Rate

Cost	Peak-load	Mid-peak	Off-peak
TarSE ($/kWh)	0.4058	0.3397	0.2736
Cd ($/kWh)	27.26	18.80	10.34
C ($/kWh)	17.00	17.00	17.00

Table 8. Optimal tariff rate (3-Level Tariff)

Type of Consumer	Tariff for off-peak ($/kWh)	Tariff for mid-peak ($/kWh)	Tariff for peak-load ($/kWh)
Residential 1	0.4	0.414	0.631
Residential 2	0.397	0.400	0.699
Residential 3	0.399	0.400	0.663
Industrial 1	0.399	0.400	0.661
Industrial 2	0.388	0.404	0.678

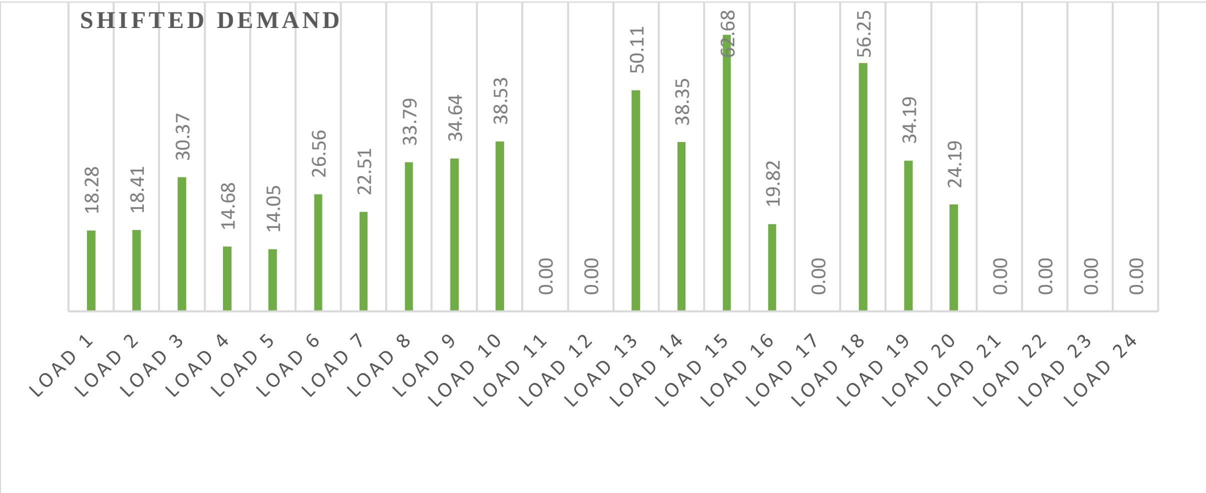

Figure 3. Shifted demand for all busses (2-level tariff)

4. Conclusion

The objective function of this research paper incorporates the simultaneous maximization of the utility's profit and the discount of electricity prices for consumer bills. All aspects related to the revenue and cost of the utility have been modeled, including an investigation into the disparity between fixed rate tariff and Time of Use (ToU) tariff rates. This approach involves mathematically modeling the response of subscribers to changes in tariff rates and con-ducting a comprehensive assessment of their elasticity. The 24-bus IEEE standard system has been selected as the study's framework, and a genetic algorithm (GA) is employed to determine the optimal tariff rates for off-peak, mid-peak, and peak-load periods. Within this paper, two ToU tariff models (2-level and 3-level) are evaluated. To enhance the practicality of the results, the study considers five distinct types of loads over the course of one month. Among these loads, three are categorized as residential and two are classified as industrial. The use of the genetic algorithm enables efficient convergence and easy parameter updates, making it a suitable choice for obtaining accurate outcomes when modifying the problem conditions.

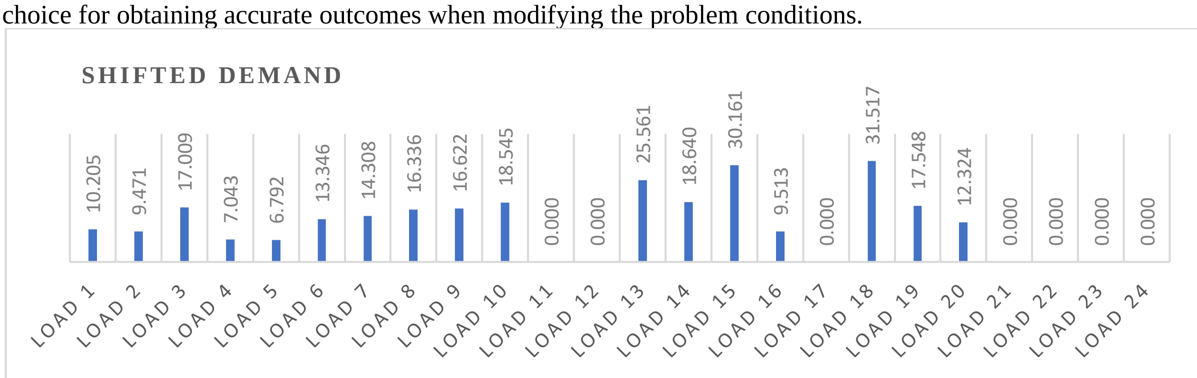

Figure 4. Shifted demand for all busses (3-level tariff)

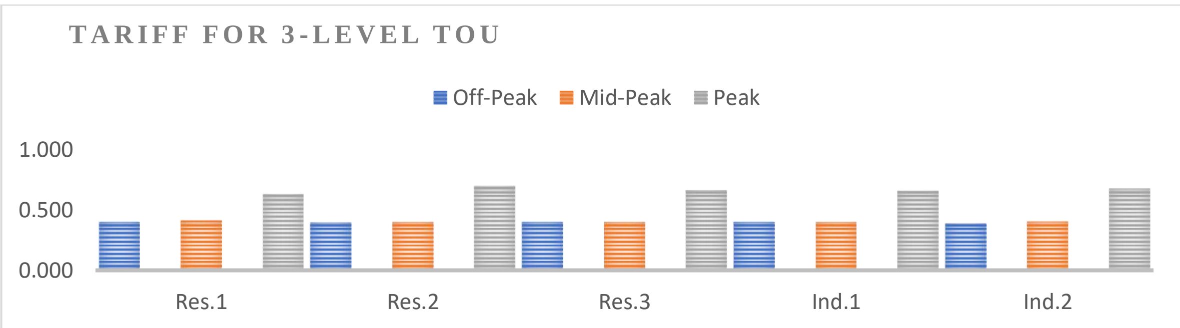

Figure 5. Optimal tariff rate (3-level tariff)

References

1. Qader, Aleem Ahmed, Zhang Jingwei, Muhammad Suhail Shaikh, and Lijuan Liu. "Optical Energy Policy for Electricity Tariff: An Optimization Approach Over Price Integration." IEEE Canadian Journal of Electrical and Computer Engineering, vol. 45, no. 2, pp. 159-170, 2022.
2. Ampimah, Benjamin Chris, Mei Sun, Dun Han, and Xueyin Wang. "Optimizing sheddable and shiftable residential electricity consumption by incentivized peak and off-peak credit function approach." Applied Energy, vol. 210, pp. 1299-1309, 2018.
3. Oprea, Simona Vasilica, Adela Bâra, and George Ifrim. "Flattening the electricity consumption peak and reducing the electricity payment for residential consumers in the context of smart grid by means of shifting optimization algorithm." Computers & Industrial Engineering, vol. 122, pp. 125-139, 2018.
4. Q. J. U. D. E. Qdr, "Benefits of demand response in electricity markets and recommendations for achieving them," U.S. Dept. Energy, Washington, DC, USA, Tech. Rep 2006, 2006. [Online]. Available: https://www.osti.gov/biblio/881324.
5. Sulaima, Mohamad Fani, N. B. Baharin, Aida Fazliana Abdul Kadir, N. B. S. Obtained, and Elia Erwani Hassan. "Investigation of electricity load shifting under various tariff design using ant colony optimization algorithm." Indonesian Journal of Electrical Engineering and Computer Science, vol. 28, no. 1, pp. 1-11, 2022
6. M. Parvania, M. Fotuhi-Firuzabad, and M. Shahidehpour, "ISO's optimal strategies for scheduling the hourly demand response in day-ahead markets," IEEE Transactions on Power Systems, vol. 29, no. 6, pp. 2636-2645, 2014.
7. Aalami, H. A., M. Parsa Moghaddam, and G. R. Yousefi. "Demand response modeling considering interruptible/curtailable loads and capacity market programs." Applied energy, vol. 87, no. 1, pp.243-250, 2010
8. R. Barzamini, F. Hajati, S. Gheisari and M.B. Motamadinejad, "Short term load forecasting using multi-layer perception and fuzzy inference systems for Islamic countries," Journal of Applied Sciences, vol. 12, no. 1, pp. 40-47, 2012.
9. R. Barzamini, M.B. Menhaj, A. Khosravi and S.H. Kamalvand, "Short term load forecasting for Iran national power system and its regions using multi layer perceptron and fuzzy inference systems," in Proceedings. 2005 IEEE International Joint Conference on Neural Networks, 2005., Montreal, Que., Canada, 2005, pp. 2877-2882.
10. Aalami, H., M. Parsa Moghadam, and G. R. Yousefi. "Optimum time of use program proposal for Iranian power systems." In 2009 International Conference on Electric Power and Energy Conversion Systems,(EPECS), pp. 1-6. IEEE, 2009.
11. Kia, M., M. Setayesh-Nazar, and S. M. Sepasian. "Simultaneous Implementation of Time of Use Demand Response and Security Constraint Unit Commitment." Nashriyyah-i Muhandisi-i Barq va Muhandisi-i Kampyutar-i Iran, vol. 41, no. 1, 2015.
12. Scheider Jr, A. W. "The IEEE reliability test system-1996." IEEE Transaction on Power System, 1999.
13. Talwariya, Akash, Pushpendra Singh, and Mohan Lal Kolhe. "A Stackelberg Game Theory Based Demand Response Algorithm for Domestic Consumers." Electric Power Components and Systems, vol. 50, no. 19-20, pp. 1186-1199, 2022.
14. Antunes, Carlos Henggeler, Maria João Alves, and Inês Soares. "A comprehensive and modular set of appliance operation MILP models for demand response optimization." Applied Energy, vol. 320, pp. 119142, 2022.
15. Sulaima, Mohamad Fani, Nofri Yenita Dahlan, Zuhaila Mat Yasin, Marlinda Mohd Rosli, Zulkiflee Omar, and Mohammad Yusri Hassan. "A review of electricity pricing in peninsular Malaysia: Empirical investigation about the appropriateness of Enhanced Time of Use (ETOU) electricity tariff." Renewable and Sustainable Energy Reviews, vol. 110, pp. 348-367, 2019.
16. Menta, R. V., Edimar José de Oliveira, L. W. Oliveira, Bruno Henriques Dias, and André Luís Marques Marcato. "Optimal model for electricity Tariff calculation." In 2016 power systems computation conference (PSCC), pp. 1-7. IEEE, 2016.
17. Scheider Jr, A. W. "The IEEE reliability test system-1996." IEEE Transaction on Power System, 1999.
18. Kovács, L., and J. Váncza. "Dynamic pricing for responsive manufacturing." Acta Polytechnica Hungarica, vol. 12, no. 7, pp. 5-22, 2015.Khan, Murad, Bhagya Nathali Silva, and Kijun Han. "Internet of things based energy aware smart home control system." Ieee Access 4 (2016): 7556-7566.
19. Kovács, L., and J. Váncza. "A model for demand response in smart grids." Acta Polytechnica Hungarica, vol. 14, no. 2, pp. 5-24, 2017.
20. Molnár, B., and G. Bitay. "Demand response optimization for smart homes." Acta Polytechnica Hungarica, vol. 15, no. 4, pp. 7-26, 2018.
21. Hamim, S. J., Fakir Sharif Hossain, Md Mehedi Hasan, Dip Sarkar, and Mohammad Mainuddin. "A Time of Use Tariff Based

Demand Side Management Algorithm for Residential Consumers." In 2022 4th International Conference on Sustainable Technologies for Industry 4.0 (STI), pp. 1-6. IEEE, 2022.

22. Hamim, S. J., Fakir Sharif Hossain, Md Mehedi Hasan, Dip Sarkar, and Mohammad Mainuddin. "A Time of Use Tariff Based Demand Side Management Algorithm for Residential Consumers." In 2022 4th International Conference on Sustainable Technologies for Industry 4.0 (STI), pp. 1-6. IEEE, 2022.
23. [16] Izadi, A., Hajati, F., Barzamini, R., Janpors, N., Farjad, B., Barzamini, S. (2023). Control and Diagnosis of Brain Tumors Using Deep Neural Networks. In: Barolli, L. (eds) Advanced Information Networking and Applications. AINA 2023. Lecture Notes in Networks and Systems, vol 655. Springer, Cham. https://doi.org/10.1007/978-3-031-28694-0_53
24. [17] Izadi, A., Barzamini, R., Hajati, F., Janpors, N. "UAVs' Flight Control Optimization for Delivering MotionSensitive Blood Products" NeuroQuantology|August 2022|Volume20|Issue10|Page 7661-7669|doi:10.14704/nq.2022.20.10.NQ55754
25. [18] Razmara, S., Barzamini, R., Izadi, A. and Janpors, N., 2022. A Hybrid Neural Network Approach for Congestion Control in TCP/IP Networks. Specialusis Ugdymas, 1(43), pp.8504-8518.
26. [19] A IZADI , R BARZAMINI, F HAJATI and N JANPORS (2023). "DIAGNOSIS OF STUDY URODYNAMICS RESULTS OF BLADDER DISEASE BASED ON DEEP LEARNING". DOI: 10.5281/zenodo.10069116