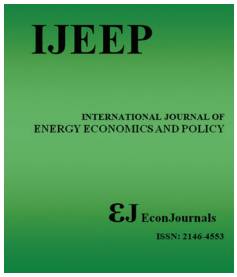

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2021, 11(5), 490-498.

Improve the Incremental Block Tariffs of Electricity: To Harmonize Pricing Policy Targets in the New Context of Power Supply and Demand in Vietnam

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Received: 24 April 2021 **Accepted:** 10 July 2021 **DOI:** https://doi.org/10.32479/ijeep.11534

ABSTRACT

The existing retail electricity tariff for households in Vietnam is the incremental block structure. However, the most recent revision of the electricity tariff structure was in 2014 which it was 7 years - a long period of change in conditions of electricity supply and consumption leading to the need to adjust this structural price appropriately. This article provides an in-depth analysis of the current residential block tariff of residential electricity use to identify shortcomings, thereby, for building options to improve this incremental block tariff structure to ensure the harmonization of different pricing targets especially the equity, efficiency and promote the electricity saving, in the new context of electricity supply and demand in Vietnam.

Keywords: Electricity Pricing Policy, Incremental Block Tariff, Electricity of Vietnam
JEL Classifications: D4, Q31, Q41, Q43. Q48

1. INTRODUCTION

In Vietnam, the electricity tariff level, tariff structure and tariff adjustment regime[1] for end-users are determined by the authority of the Prime Minister. Until now, electricity user types are divided into four categories: Residential, industrial, administrative and business users and there are three tariff types applied: Incremental block tariffs (IBTs); time of use (TOU)[2] and tariff according to voltage levels. The IBTs have been applied for households for a long time and through many adjustments of tariff structure. Revised by Decision 28/2014/TTg in 2014, the last version tariff has six-tiers structure (Table 1).

This current block tariff structure still increases the price effects that drive residential consumers to use electricity efficiently and at the same time, enforcing social policies for users with low income, especially on the consumption of the first blocks. However, this tariff structure has been in use for 7 years while there are changes and adjustments observed from both consumer and power producer sides. It is necessary to conduct research on the improvement of the electricity tariff structure in accordance with the new context of the electricity supply and demand for the current period and the coming years. The research scope of the paper only focuses on the IBTs for households. Therefore, improving studies must ensure a financial balance for EVN, that is to reform the tariff structure (number of blocks, limits between them and value of each block) in a way that is appropriate to the current context and the years to come but ensure the necessary revenue for EVN such as that when applying

1 Tariff level is defined by the average retail tariff that allows the operator to break even under a regulated rate of return; tariff structure is the multidimensional combination of charges (fixed, variable), user types (residential, industrial, business or administrative etc..); services (HV, MV, LV), etc. which define the tariff grid; Tariff adjustment regime is set of rules and procedures by which retail tariffs are updated and changed over time.

2 TOU tariffs are implemented for industrial and business users. Accordingly, from Monday to Saturday, there are 5 peak hours with 2 time frames: from 9:30 a.m. to 11:30 a.m., from 5:00 p.m. to 8:00 p.m., there are 6 low hours with the frame from 10 p.m. to 4 a.m. the next morning, the rest is 13 normal. There is no set peak hour for Sunday.

the current price of electricity. The assessments are based on quantitative analysis with primary data collected from households and secondary data provided by EVN and its member units. The final result is the basis for governmental decision makers to adjust the current IBTs structure appropriately. So, the remainder of this paper is organized as follow: Section 2 and 3 give the literature review on theoretical and practical on IBTs after that analysis methodology, section 4 analyzes the existing increasing block tariffs for households. With the objective of improving the current tariff, section 5 designs the new IBTs for residential electricity users followed by conclusions and suggestions in section 6.

2. LITERATURE REVIEW OF IBTS FOR ELECTRICITY PRICING POLICY

Historically, electricity pricing policy is always regulated by the Government. There are normally 4 regulatory objectives, the first one is the sustainability defined by covering economic costs of the electricity service; the second is the allocative efficiency – that means providing signals for efficient use of resources; the third objective is productive efficiency defined by creating incentives for cost minimization and the last one is the equity – that means protecting poor users in terms of access and affordability Bui (2008) and Percebois (1988). Therefore, there are many electrical tariffs that can be applied to end-users and the choice of the tariff structure depends on many factors: The level of reflection about cost by nature and characteristics in consumption; an effect about the price towards efficient use and power saving; and social macro-economic policy issues in electricity pricing and the conditions of technical infrastructure of the sector Aiming (2012) and Munasinghe (2009).

The application of incremental block pricing is widespread in the water and electricity sectors because with the constraint of compensation cost, this pricing approach was an optimal method of second best pricing compared to marginal cost pricing, Porter (1996). The IBTs is a pricing for incremental blocks of consuming electricity as we observed the electric tariff system around the world such as USA, Japan, India, China, Thai Lan, Malaysia, Vietnam or Korea etc., USAID (2013).[3]

3 In fact, electricity sector is very specific because an electricity supply process always consists of two components: required capacity and used energy. For that matter, there is another type of block tariff that is a pricing for block of required capacity with unique tariff or time of use tariff for electricity consumption as we can observe in France (EDF) for example.

Table 1: Structure of the current IBTs for residential electricity user

Group of households (kWh)	Proportion in comparing with adjusted average retail price approved by Government (%)	Latest electricity retail price (VNĐ/kWh) -2020 (excl. VAT)
Block 1: 0–50	92	1,678.00
Block 2: 51–100	95	1,734.00
Block 3: 101–200	110	2,014.00
Block 4: 201–300	138	2,536.00
Block 5: 301–400	154	2,834.00
Block 6: 401 or more	159	2,927.00

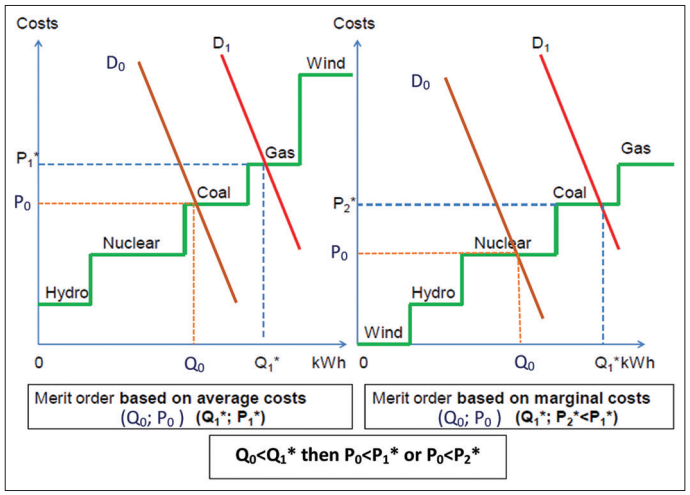
Source: Decision 28 of Prime Minister and Decision 648 of MOIT

The reason why it is called incremental block is that this tariff structure is designed with electricity consumption divided into different blocks, arranged in ascending cumulative order, and also gradually increasing prices of blocks. Especially, the IBTs is applied to residential consumers due to the nature, characteristics and uniformity of electricity consumption that is the increase in electricity consumption mainly at the peak period of the power system. With the technical and economic characteristics of the electric power sector, and the increase in consumption during peak periods we must use high-cost power plants to meet electricity demand. The IBTs with the logic of using more, the more expensive it is, reflects the specific characteristics of the cost of the electricity system and of electric consumption of households IBTs according to incremental costs they impose on the electric power supply. The IBTs structure implies an increasing marginal price for electricity (Figure 1).

On the other hand, with the construction logic of an increasing blocks price, households that consume less electricity will pay a lower price for their electricity consumption and the more electricity households consume, the higher the price. In this respect, the IBTs for residential users allows the implementation of social policies in electricity pricing policy as the principle of a value-in-use pricing system. In other words, the theoretical basis for IBTs is Ramsey pricing, which obeys the rule "contrast with elasticity." An increasing block tariff seeks to emphasize the goal of equity based on the assumption that higher electric consumption is correlated with higher income and therefore reflects, to some extent, a greater ability to pay and vice-versa… Borenstein (2008), Boqiang and Zhujun (2012). In addition, logic of higher price for high-income people cannot only reflect the incremental cost due to more residential electricity consumption usually at peak hours but also restrain electrical waste and promote energy efficiency. This is, therefore, a fairly effective type of the pricing policy for the electric power sector while simultaneously achieving different pricing targets. It is not obvious that the IBTs applies only to residential users, but not to other electricity consumers (Bui, 2019).

The domestic studies on the residential electricity pricing mechanism are rare. It is easy to understand because since the

Figure 1: The cost of the electricity system in order to answer the evolution of electricity demand



Source: Conseil Français de l'Energie (2014)

power system unified the three regions in 1994, the electricity tariff system has always been designed by Government and the IBTs was used for residential customers. The adjustments realized by Government and the last version of tariff structure was adjusted in 2014. Some projects financed by Ministry of Industry and Trade (MOIT) and World Bank (WB) and realized by foreigner specialists focus on assessment of tariff structure and tariff framework Pardina (2015).

3. METHODOLOGY AND DATA

The IBTs is popular tariff type and is used quite a lot in the process of building structure of electricity pricing in many countries. Generally speaking, the electricity bill under the IBTs can be established by formula (I) taking the Vietnamese six-tiers structure as an example.

$$TC = \begin{cases} q*p1 & q \le q1 \\ q1*p1+(q-q1)*p2 & q1 \le q \le q2 \\ q1*p1+(q2-q1)*p2 & \\ +\ (q-q2)*p3 & q2 \le q \le q3 \\ q1*p1+(q2-q1)*p2+\ (q3-q2) & \\ *p3+(q-q3)*p4 & q3 \le q \le q4 \\ q1*p1+(q2-q1)*p2+\ (q3-q2)*p3 & \\ +(q4-q3)*p4+(q-q4)*p5 & q3 \le q \le q4 \\ q_{1*}p_1+(q_2-q_1)*p_2+\ (q_3-q_2)*p_3 & \\ +(q_4-q_3)*p_4+(q_5-q_4)*p_5 & \\ +(q-q_5)*p & q_5 < q \end{cases} \quad (1)$$

Where:

- TC is the expenditure on electricity consumption
- q_i (i = 1, - 6) is the threshold of electricity consumption in the ith block
- q is the real amount of electricity use
- p_i is the price in the ith block.

In terms of constructing method, the key of the IBTs design includes: Numbers of blocks, the volume of electricity consumption and price for each block. IBTs design is often based on income groups, the consumption structure of households and the structure of costs incurred by users to the electricity system, thus determining numbers of blocks, limits between them and the value of each block. An appropriate IBTs structure cannot only promote social equity and efficiency of the subsidies mechanism, but reflect the supply costs, improve energy efficiency and encourage energy saving.

The first step is to design of the number of blocks. In theory, the larger the gaps between incomes of households are, the more tiers should be set to ensure the efficiency of income redistribution. However, considering the structure of electricity supply cost, the common structure of IBTs usually consists of three to seven tiers. In other words, the income, expenditure and life style among different groups of households are the most important basics to determine the number of blocks.

The second step is to set the volume of electric energy consumption in each block. The income is usually used as a measurement for the residential user's ability to pay electricity bill. We adopt the approach whereby demand in electricity increase with income level Barnes et al. (2004). Thus, in this research the essential objective is to improve the current IBTs, we will re-design the electric energy consumption of each block based on income, combining the electricity use of all equipment of typical groups households.

The last step is to determine the electricity price for each block. Considering the aims of IBTs, multi-tiered increasing prices can be constructed so that lowest prices is a subsidized price and higher prices compensate for this subsidy, especially for the incremental cost of electricity supply for households. We will combine three different objectives: Income redistribution, reflection of costs incurred by households for the power system; promotion of energy efficiency and energy saving to design the electricity price for block tariff structure.

In fact, despite the same increasing block tariff principle, the literature review indicates that due to different national context, the design and structure of IBTs vary among different countries. In general, the first blocks are designed to meet household needs for principal purposes, and the volume is higher in developed countries in comparing to that in developing countries Boqiang and Zhujun (2012). The number and scale of blocks are also different depending on the characteristics of residential consumers as well as social policies in electricity pricing of each country.

In this paper, we will analyze and evaluate the key of current IBTs structure (numbers of blocks, the volume and price in each block) implemented since 2014 before improve it. Our analysis and evaluations will be based on the regulatory objectives as described in Table 2 below. For improving the tariff structure, a new design of IBTs for residential electricity use in Vietnam will be proposed. The key of IBTs will be designed on the basis of reasonable harmonization of electricity pricing policy targets in the new context of power supply and demand.

On the issue of data collection for evaluation analysis, all secondary data on the power system is collected at EVN and its member electricity distribution companies, the income of

Table 2: Regulatory objectives for analysis of current tariff structure

Objective	Definition
Sustainability	Cover economics cost of electric service, reflect the cost incurred by customer for power system
Allocative efficiency	Provide the price signals for efficient use of resources
Productive efficiency	Create incentives for cost minimization
Equity	Protect poor households in terms of access and affordability

Source: Elaborated by author

household data is collected at the General Statistics Office. For the primary data that determines the characteristics of residential users (characteristic of income, expenditure for electricity consumption, volume of electricity consumption, TOU structure of consumption etc.), surveys are conducted on a large scale (more than 8000 households surveyed) to ensure the reliability of the statistical data. The method of calculating sample size of households according to the normal distribution function is used to determine the minimum number of samples.

4. ASSESSMENT OF THE CURRENT SITUATION OF THE IBTS FOR DOMESTIC USE

4.1. Setting the Number of Blocks and the Volume of Electricity Consumption in Each Block

In Vietnam, the current IBTs structure is divided into 6 blocks without considering the difference between rural and urban residents, and residents in mountainous, island, border areas not connected to the national grid, even though the income, expenditure and lifestyle among different areas differ clearly. Large gaps between rural and urban households in electricity consumption are also found by analyzing the survey results specially the ownership of electrical equipment. Table 3 shows the structure of residential users and indicates that 69.65% (2019's data) residents consume less than 200 kWh/month and most of them are in the countryside (surveyed in three regional electricity distribution companies). However, it isn't necessary to separate the rural and urban households for following two reasons: First, poor households, according to government standards, will be paid the first 30 kWh of electricity from the state's budget; second, with the characteristics of the increasing block tariff, low electricity consumption means that at the first blocks the price of electricity is also low.

In contrast, we believe that it will be more reasonable and practical to re-design the IBTs with five-tier structure rather than the current six-tier structure. There are many reasons to explain our re-structure. First, six-tier structure seems too many, too detailed compared to the changes in electricity consumption of households in current blocks structure and complicated in the process of electric power business management especially when there are more than 26 million consumers. It is necessary to study the reduction to ensure the simpler and more effective application. Second, the volume of electricity use in the first block of 50 kWh/month, designed in 2014, is too low in the actual context of electric power consumption. Moreover, the percentage of these households has decreased continuously over time (Table 3) and it is only 14.29% in 2019. Thus, the basic electricity demand of low income residents in rural and urban area has gradually increased and it would be appropriate to combine the first two blocks into one with the more suitable volume. Third, according to the date of the General Statistics Office, people's income is now divided into 5 groups, so the five-tier should be set for residential user instead of the actual six-tier structure. Therefore, from the structure of consumer households according to the current 5 levels of income and current 6-tiers of electricity consumption, we will propose a new five-tier structure.

Table 3: Structure of residential users following consumption blocks

Cumulative structure of electricity consumers (%)	2017 (%)	2018 (%)	2019 (%)
Number of households below 50 kWh (Block 1)	17.1	16.5	14.29
Number of households <100 kWh (Block 2)	39.8	38.2	32.99
Number of households <200 kWh (Block 3)	76.1	75.5	69.65
Number of households <300 kWh (Block 4)	89.0	89.0	85.06
Number of households <400 kWh (Block 5)	94.0	94.1	91.69
Number of households >400 kWh (Block 6)	100	100	100

Source: Results of survey, treated by author

For setting the volume of electricity consumption in each block, as mentioned above, our method is based on the statistic on income of groups of households, combined with the electricity use for all appliances that we surveyed all over Vietnam. In fact, the analysis of business data for the past 3 years (2017-2019) continues to maintain the same household structure: The largest number of households consuming 101 to 200 kWh/month was 36.6%; a very small proportion of 6-7% of households consumed over 300 and over 400 kWh; regarding the variable trend, the number of households in the first two blocks has decreased continuously over the years,; moreover, households that consume a lot of electricity gradually increase, although the number of households has not increased much, but the volume of electricity consumption increases remarkably, According to the statistic in 2019, the households in the last block (consuming >400 kWh/month) only account for 8.32% of the total number of households, but they consumed up to 36% of the total residential electricity quantity and contributing about 42% of the household turnover. Based on the surveyed data, we found that the income, expenditure and lifestyle among different households in the last blocks differ greatly. These analysis results allow us to re-design a new tariff structure aiming at improving the IBTs to better suit the new context of electricity supply and demand.

4.2. Electricity Supply Cost Reflection and Price of Each Block

According to EVN's electricity load research in 2019, household's electric load is the worst load of the power system when the difference between P_{min} and P_{max} is over 50.7% (Table 4) and households electric load mainly contribute to power system's evening peak. Therefore, using an IBTs is still suitable for this customer type because electricity consumption volume affects supply costs and also reflects demand characteristics.

We clarify the relevance of the structure of incremental blocks prices with the electricity supply cost by analyzing household's cost in the first and last blocks. For households of first block whose consumption is less than 50 kWh/month, the current price is only 92% of the average retail price approved by Government. To do this analysis, in the first step, we conducted a survey of households of all 5 distribution companies-members of EVN to find out the electricity consumption characteristics of these households and the survey data is treated as typical daily electricity consumption and in details according to low, normal and peak hours. According to the

Table 4: Difference between Pmin et Pmax (in %) of household's electric load for typical day

6 low hours	49.3%	49.8%	51.9%	51.9%	55.6%	57.9%							
13 normal hours	61.7%	62.4%	65.3%	68.1%	71.3%	73.7%	75.9%	76.1%	77.3%	77.7%	78.2%	79.0%	80.9%
5 peak hours	82.2%	88.5%	89.5%	99.9%	100%								

Source: EVN's data, treated by author

survey data, households with consumption below 50 kWh/month have the consumption structure of 12.7% in low hours, 38.9% in normal hours, and 48.5% in peak period. In second step, we calculated the cost of electricity supply and determine the variation of costs according to peak, normal and low hours.

After that, we processed the secondary data about electricity supply cost in time of use from the marginal cost interpolated from the marginal price of the electricity market of Vietnam (SMP- that means the price of the most expensive offer per hour needs to be mobilized to meet the load after arranging bids in ascending order from low to high). However, the electricity market in Vietnam is designed with "cost based" method, so in addition to SMP, power plants are also compensated with the hourly capacity price (CAN) calculated in advance annually according to the operational plan in the electricity market. Therefore, the full market price for electricity is paid for power plant: FMP = SMP + CAN (Figure 2 for results of 3 years of FMP variations).

On the basis of the full marginal price of the hours of the typical day in 2019, we perform the necessary calculation of variable trend of cost for 3 time frames and extra charge with the costs, the value of loss of transmission and distribution to low-voltage level for households purchasing electricity (in 0.4 kV), we have the results of variation of supply cost in time of use (TOU) compared with the total average cost: 85.2% for low hours, 102.8% for normal hours and 110.5% for peak period. In combination with the electricity consumption structure of household user below 50 kWh/month, we calculate the average cost caused by this residential user is: 104.7% = (85.2% * 12.7% + 102.8% * 38.9% + 110.5 * 48.5%) compared with the total average cost. With the similarity between the total average cost and average retail price, the retail price for these households is much lower than the cost of supply. Indeed, the supply cost for the users of the first block is 104.7% of total average price but the selling price for these users is only 92% of average retail price. Furthermore, poor households, according to government standards, are paid the first 30 kWh/month. In the analysis of households in the last block consuming over 400 kWh/month, we also obtained similar results: The retail price structure setting for each block is very different from the cost caused to the electricity system.

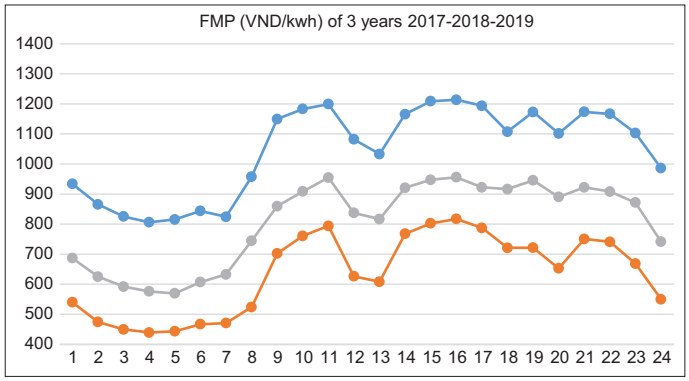
Moreover, according to the data provided by EVN that we treated and showed in Table 3, up to 69.65% of residential households have consumption below 200 kWh/month. Calculations in Table 5 show that, 69.65% of households corresponding to 43% of total residential electricity consumption are enjoying a lower price than the electricity supply average cost. In this situation,

Table 5: Summary of average electricity price for groups of residential households in 2017-2019

Average electricity price for each household by block (VND / kWh)	2017	2018	2019
Less than 50 kWh	1484.0	1484.0	1549.0
From 51-100kWh	1500.6	1501.0	1566.8
From 101-200 kWh	**1593.2**	**1593.3**	**1662.0**
From 201-300 kWh	1750.2	1750.1	1825.6
From 301-400 kWh	1929.5	1929.2	2013.2
From 401 or more	2248.7	2251.9	2365.2
The electricity supply average cost (VND/kWh)	**1665.35**	**1667**	**1723.3**

Source: Sales Department, EVN Finance Department, compiled by the author

Figure 2: Variation of full market price of typical day in electricity market of Vietnam



Source: EVN- National Load Dispatching Centre

to ensure the financial balance of EVN, households consuming more than 300 kWh/month must pay a much higher price. The important cross-compensation is happening among residential consumers while they share the same characteristics and nature of electricity consumption. The price between the levels is no longer appropriate. Thus, in terms of electricity prices for each block, it is also necessary to make adjustments to ensure more harmonization of different pricing objectives.

5. AN IMPROVEMENT OF TARIFF STRUCTURE: THE NEW DESIGN OF IBTS FOR RESIDENTIAL ELECTRICITY USE IN VIETNAM

As mentioned above, the improvement of incremental block tariff includes: re-setting the numbers of blocks, the volume of electricity consumption in each block and re-determining the electricity

Table 6: New structure of numbers of blocks and the volume of electricity use in each block

Structure of the current 6-tiers (kWh/month)	50	51-100	101-200	201-300	301-400	>400
Percentage of households in 2019	14.29%	18.70%	36.66%	15.41%	6.63%	8.32%
Proposed Five- tiers structure (kWh/month)	<100		101-200	201-400	401-700	>701
Percentage of households in new tariff structure	32.99%		36.66%	22.04%	6.06%	2.26%
Income of 5 levels of household (in millions VNĐ)	<5	5 to <10	10–<15	15–<20	Above 20	

Source: EVN's data collected by author and General Statistics Office for income data

price of each block. The increasing block tariff structure will be improved based on the following fundamental combinations: (1) variation of supply cost in time of use; (2) electric load characteristics of residential use, electricity consumption, income structure; expenditure for electricity of households and structure of current number of consumers; (3) effective and saving electricity use (4) efficiency of income redistribution; (5) assurance of the financial balance for Electricity of Vietnam and its member units in comparison with the current situation.

5.1. Regrouping of Households for Designing of Numbers of Blocks and the Volume of Electricity Use in Each Block

The first step of the improvement is to design the numbers of block by more suitable regrouping of households. From the analysis results of the current situation, the current number of levels (6 levels) is too much compared to the fluctuation of costs and complexity in business management, therefore, in the proposed plan, we have studied 03 options to reduce the number of blocks: five-tiers, four-tiers, and three-tiers. Balancing between other pricing targets, the most optimal one is the five-tier structure. This option is researched on the basis of the regrouping of households in the current blocks 1 and 2 into one block and re-dividing the volume of electricity to suit the consumption characteristics and the income pyramid of the current households especially for group of high-consuming households. In addition, the reorganization of five-tier structure corresponds to the classification of 5 income levels of households according to the classification of the General Statistics Office (we adopted the logic according to which demand for electricity increases with income level of households, Barnes et al., 2004). The description of the new design of numbers of blocks and electricity volume for each block is specified in Table 6.

5.2. Calculating the Electricity Price of Each Block and Proposal of New IBTs

For improving the tariff structure in term of electricity price for each block, we combined the cost-plus method to determine the supply cost by voltage levels and the marginal cost method to calculate the low, normal and peak cost structure at each voltage level. The calculation results show that at 0.4 kV (all residents consume at this voltage level) the time of use cost structure is: 87.1% in low hours, 104.7% for normal and 112.5% in peak hours compared to the average cost of commercial electricity. To get these results, we are based on different cost data from the past 3 years 2017-2019 and analyzed the forecast of these costs for the current and future years according to the fluctuating trends of the past and some other hypothesis for determining this time of use cost structure. After that, from the new design of number of blocks and limits between them, we will calculate the electricity price of each block.

Table 7: Electrical load structures of low- peak points according to the new structure of five-tiers

Structure of new five-tiers (kWh/month)	<100	101-200	201-400	401-700	>700
Low-normal- peak electricity use structure (in %)					
Normal period	41.366%	43.350%	43.390%	42.906%	42.828%
Low period	14.245%	18.459%	21.165%	23.991%	25.216%
Peak period	44.389%	38.192%	35.444%	33.103%	31.956%
Supply cost structure at 0.4 kV					
Normal period			104.7%		
Low period			87.1%		
Peak period			112.5%		

Source: Synthetized and calculated by author

The method of calculation is as follows: from the surveyed data, we synthesize and calculate the structure (in %) of electricity consumption in the low-normal and peak periods for each type of household as demonstrated in Table 7. From that we calculate electricity volume of each time period for typical households and allocate it into each block according to the principle "increasing volume from low to normal to peak periods corresponding increasing block." Combined with the time of use cost structure, the household's cost simulated by each block will be calculated for each typical household in each block, the description of these calculation results is indicated in Table 8.

From the calculation results specified in Table 8, with the weighted average method, according to the proportion of households consuming the volume of electricity level at each tier, the price of the 5 different blocks is calculated. For example, 32,99% of users consume up to 100 kWh/month; 36,66% consume from 101 up to 200 kWh/month, 22,03% from 201 up to 400 kWh/month, 6.06% from 401 up to 700 kWh/month and 2.26% from 701 kWh/month or more. That means the same structure of households at each block consume all the first 100 kWh. With the calculation of house's cost simulation for the first tier (that means 100 kWh): 105.7% for consumer block 1, 98% for block 2, 89.8% for block 3, 87.1% for block 4 and 87.1 for consumer block 5. By the weighted average calculation method, we find the price following supply cost of the first block is 97.83% (97.83 = 32.99%*105.7% + 36.66%*98%+22.03%*89.8%+6.06%*87.1%*+2.26%*87.1%). Similarly, we calculated the price of second block, we have in total 67% of

Table 8: Calculations of typical household's cost simulated by each block

Household in block 1: ≤100 kWh/month							
Structures	Blocks structure		≤100				
Time of use volumes structure (kWh)	Low	14.25	14.25				
	Normal	41.37	41.37				
	Peak	44.39	44.39				
Time of use costs structure (%)	Low	87.1%	87.1%				
	Normal	104.7%	104.7%				
	Peak	112.5%	112.5%				
Household's cost simulated by each block			105.7%				
Household in block 2: ≤200 kWh/month							
Structures	Blocks structure		≤100	101-200			
Time of use volume structure (kWh)	Low	36.92	36.92				
	Normal	86.70	63.08	23.62			
	Peak	76.38		76.38			
Time of use costs structure (%)	Low	87.1%	87.1%				
	Normal	104.7%	104.70%	104.70%			
	Peak	112.5%		112.5%			
Household's cost simulated by each block			98.0%	110.66%			
Household in block 3: ≤400 kWh/month							
Structures	Blocks structure		<100	101-200	201-400		
Time of use volume structure (kWh)	Low	84.66	84.66				
	Normal	173.56	15.34	100.00	58.2		
	Peak	141.78			141.78		
Time of use costs structure (%)	Low	87.1%	87.1%				
	Normal	104.7%	104.70%	104.70%	104.70%		
	Peak	112.5%			112.50%		
Household's cost simulated by each block			89.8%	104.7%	110.2%		
Household in block 4:≤ 700 kWh/month							
Structures	Blocks structure		<100	101-200	201-400	401-700	
Time of use volume structure (kWh)	Low	167.94	100.00	67.9			
	Normal	300.34		32.06	200.0	68.3	
	Peak	231.72				231.7	
Time of use costs structure (%)	Low	87.1%	87.1%	87.1%			
	Normal	104.7%		104.70%	104.70%	104.70%	
	Peak	112.5%				112.5%	
Household's cost simulated by each block			87.1%	92.3%	104.7%	110.7	
Household in block 5: >700 kWh/month							
Structures	Blocks structure		<100	101-200	201-400	401-700	>700
Time of use volume structure (kWh)	Low	226.98	100.00	100.00	26.98		
	Normal	385.47			173.02	212.45	
	Peak	287.64				87.55	200.09
Time of use costs structure (%)	Low	87.1%	87.1%	87.1%	87.1%		
	Normal	104.7%			104.70%	104.70%	
	Peak	112.5%				112.5%	112.5%
Household's cost simulated by each block			87.1%	87.1%	102.3%	107.0%	112.5%

Source: Calculated by author

Table 9: Calculation of price structure following supply cost structure

Structure of households	kWh/month	≤100 (%)	101-200 (%)	201-400 (%)	401-700 (%)	>700 (%)	Total (%)
Proportion of households consuming by each electricity consumption tier (%)	Tier 1-100 kWh	32.99	36.66	22.03	6.06	2.26	100
	Tier 2-100 kWh		54.70	32.88	9.04	3.37	100
	Tier 3-200 kWh			72.60	19.97	7.44	100
	Tier 4-300 kWh				72.86	27.14	100
	Tier 5-over 700					100	100
Structure of price following supply cost	**kWh/month**	**≤100 (%)**	**101-200 (%)**	**201-400 (%)**	**401-700 (%)**	**>700 (%)**	**Structure price (%)**
Cost and calculation of price of each block (%)	Block 1	105.7	98.0	89.8	87.1	87.1	97.83
	Block 2		110.7	104.7	92.3	87.1	106.27
	Block 3			110.2	104.7	102.3	108.51
	Block 4				110.7	107.0	109.70
	Block 5					112.5	112.50

Source: Calculations of author

Table 10: Proposal of new IBTs structure for residential electricity use

Structure	Group of customers Retail price of electricity for residential electricity use	Proportion in comparing with adjusted average retail price approved by government (%)
Incremental block tariff	Block 1: from 0 to 100 kWh	95
	Block 2: from 101 to 200 kWh	113
	Block 3: from 201 to 400 kWh	137
	Block 4: from 401 to 700 kWh	151
	Block 5: From 701 kWh or more	156

Source: Proposal of the study

residential users consume from 101 kWh/month or more. It can be seen that 54.70% of users consume from 101 up to 200 kWh/month, 32.88% from 201 up to 400 kWh, 9.04% from 401 up to 700 kWh and 3.37% from 701 and more. Again, using the weighted average calculation method, the price of second block is 106.27%. With the same calculation, we find the price of all other blocks as demonstrates Table 9.

From these results, we proceed to propose the new incremental block tariff structure to improve the current structure. We have developed options based on objective of harmonizing other pricing targets including cost reflection, efficient use of electricity savings, income redistribution, and financial balance and assessed the impact of each option on consumers, EVN's financial balance and on the economy in comparison to the current price structure. After the impact analysis, the best option for improving the tariff structure for households is proposed in Table 10.

Indeed, the calculation results show that the above proposal is a positive one and creates a good effect when calculating the impacts on both consumers, EVN and society. Firstly, EVN's revenue from household customers remains unchanged and for that, EVN's financial balance is not affected by this price structure adjustment. In addition, electricity businesses will find management much simpler when the number of levels is reduced to five-tiers. For electricity consumers, the reorganization of numbers of blocks and the volume of electricity consumption in each block is more suitable for actual consumption structure and income groups. Especially, if the current tariff is often criticized by charging too low for low-consumption households and too high for important-consumption households, the prices in new structure are more reasonable for all. In fact, the monthly electricity bills of the users of the first two blocks insignificantly increase up to only 2,797 VND/month (the actual bill for the first 50 kWh/month is 83,900.00 VND). The expenditure for electricity of the households of blocks 3 and 4 also increase slightly by VND 6,525 and VND 8,390/month, respectively. These prices more closely reflect the cost of electricity supply for this group of households in comparing with the current tariff structure. In contrast, for the users consuming from 301 kWh/month onwards, the electricity bills decrease. We calculated household consuming 900 kWh/month, the monthly electricity bill will decrease: -81,100 VND/month and the larger the consumption output, the larger the reduction in money expenditure will be. This result allows to reduce cross-compensation between households, that is one of Vietnamese's government objectives in electricity pricing policy. Regarding the CPI, there would be no negative impact when total expenditure on residential electricity remains unchanged compared to the current tariff structure. Finally, regarding the support policy for poor household, the current support is equivalent to first 30 kWh/month, calculated at the price of the first block. If the price of block 1 is adjusted upwards, it will increase the government's spending on supporting the poverty group. However, this increase is not significant, so it does not create negative effects on the government's budget.

Altogether, the proposed IBTs for residential electricity use is developed in balancing pricing goals. The results of the impact assessment show that from consumers, to EVN, the government and the economy is very harmonious: The price structure reflects supply costs more closely, ensuring more equity among households. The proposed improvement of tariffs structure ensures revenue of electricity sector from household consumption and does not cause negative impacts on social life, and does not significantly increase the budget to support the low income group related to electricity consumption.

6. CONCLUSION AND SUGGESTIONS

The paper aims to research on improving the current IBTs implemented in Vietnam for residential electricity use. The current situation assessment showed that the current IBTs structure designed in 2014 is no longer suitable due to changes in electricity supply and consumption in the new context and for other objectives of electricity pricing policy. The research has built the basis of calculation and proceeds to propose the most reasonable solution to improve the tariffs structure. By reducing the numbers of blocks, based on the costs incurred by different group of households and the characteristics of households' income, the new structure of five-tiers is designed for residential electricity use. The proposed new IBTs structure is detailed, specific, clearly grounded and consideration of the possibility of adjustment in the coming years to ensure the effectiveness of the proposed tariffs structure. The new IBTs structure has also reached its objective of harmonizing different pricing targets in the new context of electricity supply and demand in Vietnam.

Some suggestions can be drawn from this research. First, this article only focuses on the research objective of improving the incremental block tariff for residential electricity use without studying other types of tariff for this customer group. Therefore, the limitations of the IBTs still exist for example, a sudden increase in electricity bills of households in the summer due to the incremental tariff effect especially in the North of Vietnam or the hypothesis of low income-low electricity use is not completely true when some low income users with a large family may consume more

electricity and pay the high price. Furthermore, in parallel with the improvement of the tariff structure for residential electricity users, it is necessary to study and propose a periodic adjustment mechanism of retail prices. Electricity's retail prices are regulated by the government with the authority of the Prime Minister and price adjustments are not cyclical. For example, the last adjustment of electricity retail prices was made in March 2019, which means that the retail price has not changed for more than 2 years. This will cause great pressure for the next adjustment, so electricity prices are always a hot topic in Vietnam.

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